NIST NCSTAR 1-1B (Draft)

Federal Building and Fire Safety Investigation of the World Trade Center Disaster

Comparison of Building Code Structural Requirements (Draft)

S. K. Ghosh
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For Public Comment

NIST National Institute of Standards and Technology • Technology Administration • U.S. Department of Commerce

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U.S. Department of Commerce
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Technology Administration
Phillip J. Bond, Under Secretary for Technology

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Hratch G. Semerjian, Acting Director

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ABSTRACT

This report provides a comparison of the structural provisions of: (1) the New York City Building Code, 1968 edition, (2) the New York City Building Code, 2001 edition, (3) the New York State Building Construction Code, 1964 edition, (4) the Municipal Code of Chicago, 1967 edition, and (5) the Building Officials and Code Administrators (known as BOCA) Basic Building Code, 1965 edition. Detailed comparisons are provided in a tabular form. The comparisons are summarized in the body of the report.

Keywords: Code, construction, design, foundations, loads, materials, standards, World Trade Center.

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TABLE OF CONTENTS

List of Figures

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List of Tables

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List of Acronyms and Abbreviations

Acronyms

AA	Aluminum Association
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AF&PA	American Forest and Paper Association
AITC	American Institute of Timber Construction
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
APA	American Plywood Association
AREA	American Railway Engineering Association
ASA	American Standards Association
ASCE	American Society of Civil Engineers
ASD	Allowable Stress Design
ASTM	ASTM International (formerly American Society for Testing and Materials)
AWPA	American Wood-Preservers' Association
AWS	American Welding Society
BBC	Basic Building Code
BCB	Building Code Bureau (State of New York)
BOCA	Building Officials Conference of America (later Building Officials and Code Administrators, International)
CS	Commercial or Commodity Standards
DFPA	Douglas Fir Plywood Association
FEMA	Federal Emergency Management Agency
LRFD	Load and Resistance Factor Design
NIST	National Institute of Standards and Technology
NLMA	National Lumber Manufacturers Association
NYC	New York City

PCI	Prestressed Concrete Institute
RS	reference standard
SJI	Steel Joist Institute
UBC	Uniform Building Code
USASI	United States of America Standards Institute
USC	United States Code
USDA	United States Department of Agriculture
WTC	World Trade Center
WTC 1	World Trade Center 1 (North Tower)
WTC 2	World Trade Center 2 (South Tower)
WTC 7	World Trade Center 7

Abbreviations

°F	degrees Fahrenheit
D	effects of dead load
E	effects of earthquake
F	effects of weight and pressures of fluids with well-known densities and controllable maximum heights
ft	foot
ft^2	square foot
in.	inch
L	effects of live load
min	minimum
plf	pounds per linear foot
psf	pounds per square foot
psi	pounds-force per square inch
RL	effects of reduced live load
SH	effects of shrinkage
T	effects of thermal forces
UL	effects of unreduced live loads where live load reduction is permitted
W	effects of wind load
Q	the combination of any two or more of W, T, SH, and UL
ϕ	strength reduction factor

METRIC CONVERSION TABLE

To convert from	to	Multiply by
AREA AND SECOND MOMENT OF AREA		
square foot (ft^2)	square meter (m^2)	9.290 304 E-02
square inch ($in.^2$)	square meter (m^2)	6.4516 E-04
square inch ($in.^2$)	square centimeter (cm^2)	6.4516 E+00
square yard (yd^2)	square meter (m^2)	8.361 274 E-01
ENERGY (includes WORK)		
kilowatt hour (kW · h)	joule (J)	3.6 E+06
quad (1015 BtuIT)	joule (J)	1.055 056 E+18
therm (U.S.)	joule (J)	1.054 804 E+08
ton of TNT (energy equivalent)	joule (J)	4.184 E+09
watt hour (W · h)	joule (J)	3.6 E+03
watt second (W · s)	joule (J)	1.0 E+00
FORCE		
dyne (dyn)	newton (N)	1.0 E-05
kilogram-force (kgf)	newton (N)	9.806 65 E+00
kilopond (kilogram-force) (kp)	newton (N)	9.806 65 E+00
kip (1 kip=1,000 lbf)	newton (N)	4.448 222 E+03
kip (1 kip=1,000 lbf)	kilonewton (kN)	4.448 222 E+00
pound-force (lbf)	newton (N)	4.448 222 E+00
FORCE DIVIDED BY LENGTH		
pound-force per foot (lbf/ft)	newton per meter (N/m)	1.459 390 E+01
pound-force per inch (lbf/in.)	newton per meter (N/m)	1.751 268 E+02
HEAT FLOW RATE		
calorieth per minute (calth/min)	watt (W)	6.973 333 E-02
calorieth per second (calth/s)	watt (W)	4.184 E+00
kilocalorieth per minute (kcalth/min)	watt (W)	6.973 333 E+01
kilocalorieth per second (kcalth/s)	watt (W)	4.184 E+03

To convert from	to	Multiply by
LENGTH		
foot (ft)	meter (m)	3.048 E-01
inch (in)	meter (m)	2.54 E-02
inch (in.)	centimeter (cm)	2.54 E+00
micron (m)	meter (m)	1.0 E-06
yard (yd)	meter (m)	9.144 E-01
MASS and MOMENT OF INERTIA		
kilogram-force second squared per meter ($kgf \cdot s^2/m$)	kilogram (kg)	9.806 65 E+00
pound foot squared ($lb \cdot ft^2$)	kilogram meter squared ($kg \cdot m^2$)	4.214 011 E-02
pound inch squared ($lb \cdot in.^2$)	kilogram meter squared ($kg \cdot m^2$)	2.926 397 E-04
ton, metric (t)	kilogram (kg)	1.0 E+03
ton, short (2,000 lb)	kilogram (kg)	9.071 847 E+02
MASS DIVIDED BY AREA		
pound per square foot (lb/ft^2)	kilogram per square meter (kg/m^2)	4.882 428 E+00
pound per square inch (*not* pound force) ($lb/in.^2$)	kilogram per square meter (kg/m^2)	7.030 696 E+02
MASS DIVIDED BY LENGTH		
pound per foot (lb/ft)	kilogram per meter (kg/m)	1.488 164 E+00
pound per inch (lb/in.)	kilogram per meter (kg/m)	1.785 797 E+01
pound per yard (lb/yd)	kilogram per meter (kg/m)	4.960 546 E-01
PRESSURE or STRESS (FORCE DIVIDED BY AREA)		
kilogram-force per square centimeter (kgf/cm^2)	pascal (Pa)	9.806 65 E+04
kilogram-force per square meter (kgf/m^2)	pascal (Pa)	9.806 65 E+00
kilogram-force per square millimeter (kgf/mm^2)	pascal (Pa)	9.806 65 E+06
kip per square inch (ksi) ($kip/in.^2$)	pascal (Pa)	6.894 757 E+06
kip per square inch (ksi) ($kip/in.^2$)	kilopascal (kPa)	6.894 757 E+03
pound-force per square foot (lbf/ft^2)	pascal (Pa)	4.788 026 E+01
pound-force per square inch (psi) ($lbf/in.^2$)	pascal (Pa)	6.894 757 E+03
pound-force per square inch (psi) ($lbf/in.^2$)	kilopascal (kPa)	6.894 757 E+00
psi (pound-force per square inch) ($lbf/in.^2$)	pascal (Pa)	6.894 757 E+03
psi (pound-force per square inch) ($lbf/in.^2$)	kilopascal (kPa)	6.894 757 E+00

To convert from	**to**	**Multiply by**
TEMPERATURE		
degree Celsius (°C)	kelvin (K)	T/K = t/°C + 273.15
degree centigrade	degree Celsius (°C)	t/°C ≈ t /deg. cent.
degree Fahrenheit (°F)	degree Celsius (°C)	t/°C = (t/°F - 32)/1.8
degree Fahrenheit (°F)	kelvin (K)	T/K = (t/°F + 459.67)/1.8
kelvin (K)	degree Celsius (°C)	t/°C = T/K 2 273.15
TEMPERATURE INTERVAL		
degree Celsius (°C)	kelvin (K)	1.0 E+00
degree centigrade	degree Celsius (°C)	1.0 E+00
degree Fahrenheit (°F)	degree Celsius (°C)	5.555 556 E-01
degree Fahrenheit (°F)	kelvin (K)	5.555 556 E-01
degree Rankine (°R)	kelvin (K)	5.555 556 E-01
VELOCITY (includes SPEED)		
foot per second (ft/s)	meter per second (m/s)	3.048 E-01
inch per second (in./s)	meter per second (m/s)	2.54 E-02
kilometer per hour (km/h)	meter per second (m/s)	2.777 778 E-01
mile per hour (mi/h)	kilometer per hour (km/h)	1.609 344 E+00
mile per minute (mi/min)	meter per second (m/s)	2.682 24 E+01
VOLUME (includes CAPACITY)		
cubic foot (ft^3)	cubic meter (m^3)	2.831 685 E-02
cubic inch ($in.^3$)	cubic meter (m^3)	1.638 706 E-05
cubic yard (yd^3)	cubic meter (m^3)	7.645 549 E-01
gallon (U.S.) (gal)	cubic meter (m^3)	3.785 412 E-03
gallon (U.S.) (gal)	liter (L)	3.785 412 E+00
liter (L)	cubic meter (m^3)	1.0 E-03
ounce (U.S. fluid) (fl oz)	cubic meter (m^3)	2.957 353 E-05
ounce (U.S. fluid) (fl oz)	milliliter (mL)	2.957 353 E+01

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PREFACE

Genesis of This Investigation

Immediately following the attack on the World Trade Center (WTC) on September 11, 2001, the Federal Emergency Management Agency (FEMA) and the American Society of Civil Engineers began planning a building performance study of the disaster. The week of October 7, as soon as the rescue and search efforts ceased, the Building Performance Study Team went to the site and began their assessment. This was to be a brief effort, as the study team consisted of experts who largely volunteered their time away from their other professional commitments. The Building Performance Study Team issued their report in May 2002, fulfilling their goal "to determine probable failure mechanisms and to identify areas of future investigation that could lead to practical measures for improving the damage resistance of buildings against such unforeseen events."

On August 21, 2002, with funding from the U.S. Congress through FEMA, the National Institute of Standards and Technology (NIST) announced its building and fire safety investigation of the WTC disaster. On October 1, 2002, the National Construction Safety Team Act (Public Law 107-231), was signed into law. (A copy of the Public Law is included in Appendix A.) The NIST WTC Investigation was conducted under the authority of the National Construction Safety Team Act.

The goals of the investigation of the WTC disaster were:

- To investigate the building construction, the materials used, and the technical conditions that contributed to the outcome of the WTC disaster.
- To serve as the basis for:
  - Improvements in the way buildings are designed, constructed, maintained, and used;
  - Improved tools and guidance for industry and safety officials;
  - Recommended revisions to current codes, standards, and practices; and
  - Improved public safety.

The specific objectives were:

1. Determine why and how WTC 1 and WTC 2 collapsed following the initial impacts of the aircraft and why and how WTC 7 collapsed;
2. Determine why the injuries and fatalities were so high or low depending on location, including all technical aspects of fire protection, occupant behavior, evacuation, and emergency response;
3. Determine what procedures and practices were used in the design, construction, operation, and maintenance of WTC 1, 2, and 7; and
4. Identify, as specifically as possible, areas in current building and fire codes, standards, and practices that warrant revision.

NIST is a nonregulatory agency of the U.S. Department of Commerce's Technology Administration. The purposes of NIST investigations under the National Construction Safety Team Act are to improve the safety and structural integrity of buildings in the United States, and the focus is on fact finding. NIST investigative teams are required to assess building performance and emergency response and evacuation procedures in the wake of any building failure that has resulted in substantial loss of life or that posed significant potential of substantial loss of life. NIST does not have the statutory authority to make findings of fault or negligence by individuals or organizations. Further, no part of any report resulting from a NIST investigation into a building failure or from an investigation under the National Construction Safety Team Act may be used in any suit or action for damages arising out of any matter mentioned in such report (15 USC 281a, as amended by Public Law 107-231).

Organization of the Investigation

The National Construction Safety Team for this Investigation, appointed by the NIST Director, was led by Dr. S. Shyam Sunder. Dr. William L. Grosshandler served as Associate Lead Investigator, Mr. Stephen A. Cauffman served as Program Manager for Administration, and Mr. Harold E. Nelson served on the team as a private sector expert. The Investigation included eight interdependent projects whose leaders comprised the remainder of the team. A detailed description of each of these eight projects is available at http://wtc.nist.gov. The purpose of each project is summarized in Table P–1, and the key interdependencies among the projects are illustrated in Figure P–1.

Table P–1. Federal building and fire safety investigation of the WTC disaster.

Technical Area and Project Leader	Project Purpose
Analysis of Building and Fire Codes and Practices; Project Leaders: Dr. H. S. Lew and Mr. Richard W. Bukowski	Document and analyze the code provisions, procedures, and practices used in the design, construction, operation, and maintenance of the structural, passive fire protection, and emergency access and evacuation systems of WTC 1, 2, and 7.
Baseline Structural Performance and Aircraft Impact Damage Analysis; Project Leader: Dr. Fahim H. Sadek	Analyze the baseline performance of WTC 1 and WTC 2 under design, service, and abnormal loads, and aircraft impact damage on the structural, fire protection, and egress systems.
Mechanical and Metallurgical Analysis of Structural Steel; Project Leader: Dr. Frank W. Gayle	Determine and analyze the mechanical and metallurgical properties and quality of steel, weldments, and connections from steel recovered from WTC 1, 2, and 7.
Investigation of Active Fire Protection Systems; Project Leader: Dr. David D. Evans	Investigate the performance of the active fire protection systems in WTC 1, 2, and 7 and their role in fire control, emergency response, and fate of occupants and responders.
Reconstruction of Thermal and Tenability Environment; Project Leader: Dr. Richard G. Gann	Reconstruct the time-evolving temperature, thermal environment, and smoke movement in WTC 1, 2, and 7 for use in evaluating the structural performance of the buildings and behavior and fate of occupants and responders.
Structural Fire Response and Collapse Analysis; Project Leaders: Dr. John L. Gross and Dr. Therese P. McAllister	Analyze the response of the WTC towers to fires with and without aircraft damage, the response of WTC 7 in fires, the performance of composite steel-trussed floor systems, and determine the most probable structural collapse sequence for WTC 1, 2, and 7.
Occupant Behavior, Egress, and Emergency Communications; Project Leader: Mr. Jason D. Averill	Analyze the behavior and fate of occupants and responders, both those who survived and those who did not, and the performance of the evacuation system.
Emergency Response Technologies and Guidelines; Project Leader: Mr. J. Randall Lawson	Document the activities of the emergency responders from the time of the attacks on WTC 1 and WTC 2 until the collapse of WTC 7, including practices followed and technologies used.

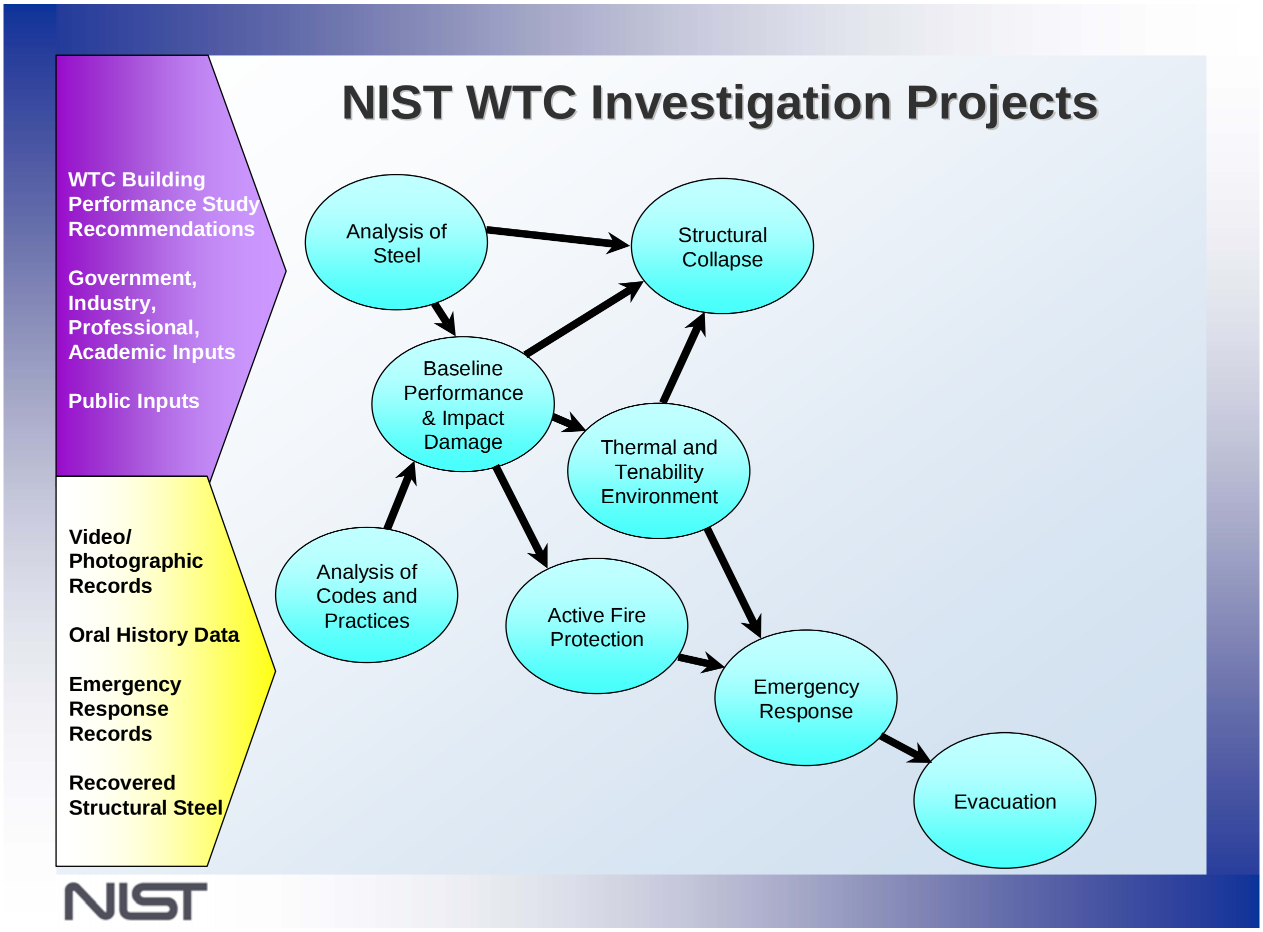

Figure P–1. The eight projects in the federal building and fire safety investigation of the WTC disaster.

National Construction Safety Team Advisory Committee

The NIST Director also established an advisory committee as mandated under the National Construction Safety Team Act. The initial members of the committee were appointed following a public solicitation. These were:

- Paul Fitzgerald, Executive Vice President (retired) FM Global, National Construction Safety Team Advisory Committee Chair
- John Barsom, President, Barsom Consulting, Ltd.
- John Bryan, Professor Emeritus, University of Maryland
- David Collins, President, The Preview Group, Inc.
- Glenn Corbett, Professor, John Jay College of Criminal Justice
- Philip DiNenno, President, Hughes Associates, Inc.

- Robert Hanson, Professor Emeritus, University of Michigan
- Charles Thornton, Co-Chairman and Managing Principal, The Thornton-Tomasetti Group, Inc.
- Kathleen Tierney, Director, Natural Hazards Research and Applications Information Center, University of Colorado at Boulder
- Forman Williams, Director, Center for Energy Research, University of California at San Diego

This National Construction Safety Team Advisory Committee provided technical counsel during the Investigation and commentary on drafts of the Investigation reports prior to their public release.

Public Outreach

During the course of this Investigation, NIST held public briefings and meetings (listed in Table P–2) to solicit input from the public, present preliminary findings, and obtain comments on the direction and progress of the Investigation from the public and the Advisory Committee.

NIST maintained a publicly accessible Web site during this Investigation at http://wtc.nist.gov. The site contained extensive information on the background and progress of the Investigation.

NIST's WTC Public-Private Response Plan

The collapse of the WTC buildings has led to broad reexamination of how tall buildings are designed, constructed, maintained, and used, especially with regard to major events such as fires, natural disasters, and terrorist attacks. Reflecting the enhanced interest in effecting necessary change, NIST, with support from Congress and the Administration, has put in place a program, the goal of which is to develop and implement the standards, technology, and practices needed for cost-effective improvements to the safety and security of buildings and building occupants, including evacuation, emergency response procedures, and threat mitigation.

The strategy to meet this goal is a three-part NIST-led public-private response program that includes:

- A federal building and fire safety investigation to study the most probable factors that contributed to post-aircraft impact collapse of the WTC towers and the 47-story WTC 7 building, and the associated evacuation and emergency response experience.
- A research and development (R&D) program to (a) facilitate the implementation of recommendations resulting from the WTC Investigation, and (b) provide the technical basis for cost-effective improvements to national building and fire codes, standards, and practices that enhance the safety of buildings, their occupants, and emergency responders.

Table P–2. Public meetings and briefings of the WTC Investigation.

Date	Location	Principal Agenda
June 24, 2002	New York City, NY	Public meeting: Public comments on the *Draft Plan* for the pending WTC Investigation.
December 9, 2002	Washington, DC	Media briefing on release of the *Public Update* and NIST request for photographs and videos.
April 8, 2003	New York City, NY	Joint public forum with Columbia University on first-person interviews.
April 29-30, 2003	Gaithersburg, MD	National Construction Safety Team (NCST) Advisory Committee meeting on plan for and progress on WTC Investigation with a public comment session.
May 7, 2003	New York City, NY	Media briefing on release of the *May 2003 Progress Report*
August 26-27, 2003	Gaithersburg, MD	NCST Advisory Committee meeting on status of WTC investigation with a public comment session.
September 17, 2003	New York City, NY	Media briefing and public briefing on initiation of first-person data collection projects.
December 2-3, 2003	Gaithersburg, MD	NCST Advisory Committee meeting on status and initial results and the release of the *Public Update* with a public comment session.
February 12, 2004	New York City, NY	Public meeting: Briefing on progress and preliminary findings with public comments on issues to be considered in formulating final recommendations.
June 18, 2004	New York City, NY	Media briefing and public briefing on release of the *June 2004 Progress Report.*
June 22-23, 2004	Gaithersburg, MD	NCST Advisory Committee meeting on the status of and preliminary findings from the WTC Investigation with a public comment session.
August 24, 2004	Northbrook, IL	Public viewing of standard fire resistance test of WTC floor system at Underwriters Laboratories, Inc.
October 19-20, 2004	Gaithersburg, MD	NCST Advisory Committee meeting on status and near complete set of preliminary findings with a public comment session.
November 22, 2004	Gaithersburg, MD	NCST Advisory Committee discussion on draft annual report to Congress, a public comment session, and a closed session to discuss pre-draft recommendations for WTC Investigation.
April 5, 2005	New York City, NY	Media briefing and public briefing on release of the probable collapse sequence for the WTC towers and draft reports for the projects on codes and practices, evacuation, and emergency response.

- A dissemination and technical assistance program (DTAP) to (a) engage leaders of the construction and building community in ensuring timely adoption and widespread use of proposed changes to practices, standards, and codes resulting from the WTC Investigation and the R&D program, and (b) provide practical guidance and tools to better prepare facility owners, contractors, architects, engineers, emergency responders, and regulatory authorities to respond to future disasters.

The desired outcomes are to make buildings, occupants, and first responders safer in future disaster events.

National Construction Safety Team Reports on the WTC Investigation

A draft of the final report on the collapses of the WTC towers is being issued as NIST NCSTAR 1. A companion report on the collapse of WTC 7 is being issued as NIST NCSTAR 1A. The present report is one of a set that provides more detailed documentation of the Investigation findings and the means by which these technical results were achieved. As such, it is part of the archival record of this Investigation. The titles of the full set of Investigation publications are:

NIST (National Institute of Standards and Technology). 2005. *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Final Report of the National Construction Safety Team on the Collapses of the World Trade Center Towers.* NIST NCSTAR 1. Gaithersburg, MD, September.

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EXECUTIVE SUMMARY

This report provides a comparison of the structural provisions of the 1968 New York City Building Code, which was used in the design of the World Trade Center (WTC) towers, with those of three contemporaneous building codes as well as the 2001 edition of the New York City Building Code, which is currently in effect. The contemporaneous codes chosen for comparison were:

1. The New York State Building Construction Code, 1964 edition,
2. The Municipal Code of Chicago, 1967 edition, and
3. The Building Officials and Code Administrators (BOCA) Basic Building Code (BBC), 1965 edition.

The New York State code was chosen as the building code in effect in the State of New York at the time the WTC towers were designed. The Chicago code was chosen as the code then in effect in a large city with tall buildings outside of the northeastern states where the WTC towers are located. The BOCA code was chosen as the model code typically adopted at that time in the northeastern states.

Structural provisions include those concerning design loads, materials and methods of construction, design methods including design load combinations, the major materials of construction (concrete, masonry, steel, and wood), and design and construction of foundations. Detailed comparisons of provisions are provided in the form of tables. The comparisons are summarized in the body of this report.

A comparison is provided of uniform design live load values from the reviewed codes for the types of live load (on different floor areas) used in the design of the WTC towers. A summary is provided of the live load reductions permitted by the various codes for columns, walls, piers, beams, and girders. The New York City Building Codes have live load reduction provisions based on contributory floor area and live-to-dead load ratio. For live-to-dead load ratios of 0.625 or less, these provisions may yield higher live load reductions than the other codes. The same comments do not apply to the alternative live load reduction provision of the New York City Building Codes.

Based on the comparison of minimum wind loads on vertical surfaces required by the various building codes, the largest shear force at the base of a building the height of the WTC towers is obtained from the BOCA-BBC. Similarly, the largest overturning moment at the base of a building the height of the WTC towers is also obtained from the BOCA-BBC. The lowest base shear and moment are obtained from the 1968 and 2001 New York City Codes. The base shear from the New York City Codes is approximately 20 percent less than that from BOCA, while the base moment is approximately 10 percent less.

Of the codes compared, only the 2001 New York City Building Code and the BOCA-BBC have seismic design provisions. Those provisions are based on the 1988 edition (including the 1990 Accumulative Supplement) and the 1962 edition of the Uniform Building Code, respectively (ICBO 1962, ICBO 1988).

The primary materials standards referenced in the 1968 New York City Building Code, the Chicago Municipal Code, and the BOCA-BBC are the 1963 edition of ACI 318, *Building Code Requirements for Reinforced Concrete*, and the 1963 edition of the AISC specification, *Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings*. The New York State Building Code, being a performance code, does not adopt any standards by reference. The 2001 New York City Building Code references updated steel and concrete standards.

The New York City Building Codes have extensive and rigorous foundation design and construction requirements; the other codes are less extensive and typically less rigorous.

Chapter 1
INTRODUCTION

The objective of this study was to examine how the structural provisions of the 1968 edition of the New York City Building Code, which was used in the design of World Trade Center (WTC) 1 and WTC 2, compared with the structural provisions in a number of contemporaneous codes, as well as in the 2001 edition of the New York City Building Code, which is currently in effect. One of the selected contemporaneous codes was the building code in effect in the State of New York at the time WTC 1 and WTC 2 were designed. Another selected code was the building code then in effect in Chicago, which represented a large city with tall buildings outside of the northeastern states where the WTC towers are located. The third code selected was the model building code that was typically adopted in the northeastern states at the time the WTC towers were designed. Thus, this report provides a comparison of the structural provisions of the following codes:

1. The New York City Building Code, 1968 edition (The City of New York 1968)
2. The New York City Building Code, 2001 edition (The City of New York 2001)
3. The New York State Building Construction Code, 1964 edition (BCB 1964)
4. The Municipal Code of Chicago, 1967 edition (The City of Chicago 1967)
5. The BOCA Basic Building Code, 1965 edition (BOCA 1965)

Structural provisions include those concerning design loads, such as dead loads, live loads (including live load reduction), wind loads, earthquake loads and other loads. They also include provisions concerning what is called “structural work” in the New York City Building Codes (this term is not used in the other codes). The scope of “structural work” includes, but is not limited to, materials and methods of construction, design methods including design load combinations, and the materials of construction including concrete, masonry, steel and wood. Structural provisions also include those for foundation design and construction.

Detailed comparisons are provided in Tables 7–1 through 7–4. The comparisons are based on detailed section-by-section, subsection-by-subsection reviews of comparable provisions in the five codes included in this study. There is a “Comments” column in each table, which summarizes the differences among the five codes. The comparisons are summarized in the body of this report.

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Chapter 2
CODES INCLUDED IN COMPARISON

The Port of New York Authority (whose name was changed to the Port Authority of New York and New Jersey in 1972 and which will be referred to as "the Port Authority") is not required to comply with the local building code. As an interstate compact created under a clause of the U.S. Constitution, it is not bound by the authority having jurisdiction, which in the case of the World Trade Center (WTC) would be the New York City Department of Buildings. In 1963, the Port of New York Authority, however, instructed the architect and consulting engineers to prepare their designs for WTC 1 and WTC 2 to comply with the New York City Building Code.[1] Although it is not explicitly stated in the 1963 letter, the 1938 edition of the Code was in effect at the time. In areas where the Code was not explicit or where technological advances made portions of it obsolete, the Port Authority directed the consultants to propose designs "based on acceptable engineering practice," and required them to inform the WTC Planning Division when such situations occurred.

In 1965, the Port Authority instructed the design consultants for WTC 1 and WTC 2 to comply with the second and third drafts of the revised New York City Building Code then being finalized and to undertake any design revisions necessary to comply with such provisions.[2] The new edition of the New York City Building Code became effective in December 1968 (The City of New York 1968).

A consortium of Seven World Trade Company and Silverstein Development Corporation designed and constructed WTC 7 as a Port Authority "Tenant Alteration" project. This was very different from the cases of WTC 1 and WTC 2. Section 5A.3 of the WTC 7 project specifications (WTC 7 Project Specifications 1984) required the structural steel to be designed in accordance with the New York City Building Code in effect at the time and the latest edition of the *Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings* published by the American Institute of Steel Construction. When the building was designed in the 1980s, the 1968 edition of the New York City Building Code with amendments was in effect; no revisions were made to the applicable structural provisions in the New York City Building Code until 1987.

The building code in effect in the State of New York at the time WTC 1 and WTC 2 were designed was the New York State Building Construction Code, 1964 edition.

To compare with contemporaneous building code requirements in a major U.S. city with tall buildings outside of the northeastern states at the time the WTC towers were being designed, the structural provisions of the 1967 edition of the Municipal Code of Chicago are included in this review.

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[1] Letter dated May 15, 1963, from Malcolm P. Levy (Chief, Planning Division, World Trade Department) to Minoru Yamasaki (Minoru Yamasaki & Associates).

[2] Letter dated September 29, 1965, from Malcolm P. Levy (Chief, Planning Division, World Trade Department) to Minoru Yamasaki (Minoru Yamasaki & Associates).

In the northeastern region of the United States, which includes the WTC site, the model code typically adopted by local jurisdictions was the Building Officials and Code Administrator (BOCA) National Building Code. This code, prior to the mid-1980s, was called the BOCA Basic Building Code (BBC). The 1965 edition of the BOCA BBC was the latest edition published at the time the WTC towers were being designed.

The 2001 edition of the New York City Building Code is also included in this review, as it is the latest edition in effect at the time of this writing.

Thus, this report provides a comparison of the structural provisions of five building codes: the 1968 and 2001 editions of the New York City Building Code, the 1964 edition of the New York State Building Code, the 1967 edition of the Municipal Code of Chicago, and the 1965 edition of the BOCA BBC.

Tables 7–1 through 7–4 of this report provide detailed comparisons of the structural provisions of the five codes. The reference standards mentioned in the comparisons are listed in Annex A1 through Annex A5. The code tables mentioned in the comparisons are included in Annex B1 through Annex B5. This report summarizes the detailed comparisons presented in Tables 7–1 through 7–4.

Chapter 3
OVERVIEW OF CODES COMPARED

3.1 1968 AND 2001 NEW YORK CITY BUILDING CODES

The report dated June 28, 1968, of the Committee on Buildings to the City Council (The City of New York Committee on Buildings 1968), which favored the adoption of the proposed 1968 Building Code, stated: "Since the existing Building Code was first adopted in 1938, technology has undertaken major revolutionary shifts, producing new materials and methods. Also, workable standards have now been developed and perfected for describing and testing the desired characteristics of materials." It was concluded that there would be nothing to gain by attempting to revise the 1938 code. "Rather an entirely new code should be written." It was decided that the new code should be a combination of performance and prescriptive requirements with strong emphasis on performance, whenever possible, and with liberal reference to acceptable national standards. In the opinion of the Committee on Buildings, the new code thoroughly "futurized" the building laws for the City of New York. In the words of the Committee Chairman, "New construction techniques in New York will only be inhibited by technology itself."

The structural provisions of the 1968 Code are contained principally in Articles 9 through 11 and Article 19. Compared with the 1938 Code, the new structural provisions modernized the method of load analysis and mandated specific consideration of previously neglected phenomena such as thermal forces and shrinkage. Certain loads, such as for private dwellings and roofs, were decreased while wind loads were increased. In view of more rigorous requirements for structural analysis, allowable temporary overstresses were increased. The 1968 code prescribed an approach of performance engineering design, as contrasted with the empirical and prescriptive methods of the 1938 Code. The 1968 Code permitted all modern design concepts including ultimate strength analysis, prestressed concrete, shell and folded plate design, cable suspension, reinforced masonry and structural plywood. The foundation provisions made foundation design much less stringent. Increased foundation loads (in instances, conceivably many times previous limits) were permitted; however, the evaluation procedure was thorough and rigorous. The sub-soil evaluation procedures were revised to produce more meaningful information, and a uniform system of soil classification was adopted. A five-point procedure for determining permissible pile loads was established. Provisions regarding safety of the public and property during construction were revised and unified in Article 19. Rigorous procedures for control of cranes, power buggies and power equipment were newly mandated.

The structure of the City of New York Building Code has two unique features. First, the code is continually updated by incorporating "local laws" that are approved by the City Council. For instance, in the 2001 edition of the New York City Building Code, Reference Standard RS 10-3 is ACI 318-83 "*Building Code Requirements for Reinforced Concrete*," but the user finds the following statement: "repealed by Local Law 17/1995, eff. 2/21/96. See other Reference Standard RS 10-3 below, added by Local Law 17/1995, eff. 2/21/96." The other Reference Standard RS 10-3 is ACI 318-89 "*Building Code Requirements for Reinforced Concrete*."

The second unique feature is the way Reference Standards (RS) are used. The substantive provisions of the code are supplemented by the Building Code Reference Standards, which are designated as "Building Code Rules." The text of certain reference standards is printed in full. The text of other standards is incorporated by reference to their national designation. However, code modifications to these standards are permitted. There are approximately 300 reference standards. The Building Code Rules may be revised by an administrative procedure. The Board of Standards and Appeals is empowered to amend or revise the building code rules or issue new building code reference standards consistent with the remainder of the code only upon an application by the Building Commissioner and only within the scope of the application.

3.2 1964 NEW YORK STATE BUILDING CODE

The New York State Building Construction Code (Code) is promulgated by the State Building Code Council of the State of New York. The State Building Code Council is concerned with regulations for the construction of buildings and the installation therein of equipment that is essential to building operation and maintenance. The purpose of its regulations is to establish reasonable safeguards for the safety, health, and welfare of the occupants and users of buildings.

The municipalities of the State of New York have the option to adopt the State Building Construction Code. The administration and enforcement of the Code are the responsibility of the local municipality pursuant to its administrative ordinances.

In addition to the Code, the Council publishes a Code Manual to assist in the application and enforcement of the Code. The Code Manual indicates and illustrates acceptable methods of compliance with the performance requirements set forth in the Code, but does not exclude other possible methods of meeting these requirements. Where adopted, the Code is the law; the Code Manual is not.

As a further guide in determining compliance with the performance requirements of the Code, the Council publishes a list of Generally Accepted Standards. Compliance with these standards is deemed to satisfy code requirements.

3.3 1967 CHICAGO MUNICIPAL CODE

The Chicago Municipal Code comprises the ordinances of the City of Chicago on building construction and maintenance. In addition, it includes regulations for environmental control, sidewalks and fire prevention for new construction or major alteration projects.

The structural provisions of the 1967 Chicago Municipal Code are to be found in Chapters 68, 69, and 70. Section 69.4 contains a list of referenced standards. The standards for (a) foundations, (b) masonry, (c) wood, (d) reinforced concrete, (e) reinforced gypsum, (f) steel and metals, (g) plastering, and (h) single family dwellings represent accepted engineering practice.

The regulations of the Chicago Municipal Code are subject to amendment by the Chicago City Council. To keep users abreast of such amendments, the publisher of the code issues a periodic supplement.

3.4 1965 BOCA-BASIC BUILDING CODE

The BOCA-Basic Building Code (BBC) published by the Building Officials Conference of America, Inc. (BOCA, later Building Officials and Code Administrators International) is one of three model codes that used to, and in many cases still do, form the basis of the building codes of various local jurisdictions. The BOCA-BBC has been the model code of choice in the northeastern region of the United States, which includes the cities of New York and Chicago. The City of New York has never adopted the BOCA-BBC or any model code (with the exception of the earthquake design provisions of the 1988 Uniform Building Code (ICBO 1988), which were adopted in later versions of the code). The City of Chicago has used the BOCA-BBC as a basis for its municipal code, but it has never made a complete adoption, as for instance the State of New Jersey has done.

The BOCA-BBC provisions are written n terms of performance, and not in the form of prescriptive requirements for materials and methods. Performance-based codes make it easier to accept new materials and methods of construction that can be evaluated by accepted standards.

The BOCA-BBC accepts nationally recognized standards as the criteria for evaluation of minimum safe practice or for determining the performance of materials or systems of construction. The application of these standards is stated in the text of the code requirements, but the standards are listed and identified in the appendixes to the code. This makes it convenient to update any standard as it is revised or reissued by the standards development organization.

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Chapter 4
LOADS

Article 9 of the 1968 New York City Building Code contains the minimum loads to be used in the design of buildings. According to Section C26-900.2, Reference Standards (RS), the minimum dead, live, and wind loads prescribed in Reference Standard RS 9, Loads (Annex A1 of this report), are a part of Article 9. In no case are the loads used in design to be less than the minimum values contained in that article. The 2001 New York City Building Code has the same provision.

The 1964 New York State Building Code requires that loads include dead load and the following imposed loads where applicable: live, snow, wind, soil pressure including surcharge, hydrostatic, and impact. Notice that earthquake loads are not mentioned. The Chicago Municipal Code prescribes minimum design loads, including dead loads. The 1965 BOCA Basic Building Code (BOCA-BBC) prescribes all superimposed live and special loads in addition to dead load.

4.1 DEAD LOADS

1968 and 2001 New York City Building Codes—Dead loads are defined in Sub-Article 901.0, Dead Loads, of the 1968 New York City Building Code, as the actual weight of the building materials or construction assemblies to be supported, based on the unit weights provided in Reference Standard RS 9-1, Minimum Unit Dead Loads for Structural Design Purposes (Section C26-901.1). Weights in pounds per square foot (psf) of floor area are listed for various types of walls and partitions, floor finishes and fills, ceilings, roof and wall coverings, and floors (wood joist construction). The densities of miscellaneous materials are also given. Actual weights may be determined by analysis or from data in manufacturers' drawings and catalogs, but in no case are the unit weights permitted to be less than those contained in Reference Standards RS 9-1, unless the building commissioner approves them. The 2001 New York City Building Code has the same provision.

According to the 1968 New York City Building Code, weights from service equipment (plumbing stacks; piping; heating, ventilation, and air conditioning; etc.) are to be included in the dead load (Section C26-901.2). The weight of equipment that is part of the occupancy of a given area is to be considered as live load. The 2001 New York City Building Code has the same provision.

The 1968 and 2001 New York City Building Codes require that weights of all partitions be considered, using actual weights at locations shown on plans. The equivalent uniform partition loads in Reference Standard RS 9-1 (Annex A1 of this report) may be used in lieu of actual partition weights, except in stipulated situations, where actual partition weights must be used. Equivalent uniform loads must be used in areas where locations of partitions are not shown on plans, or in areas where partitions are subject to rearrangement and relocation.

New York State Building Code—There are no provisions similar to those of the New York City Building Code concerning dead loads. There is no provision concerning equipment weight. There is also no provision concerning partition loads.

***Chicago Municipal Code*—**There are no provisions similar to those of the New York City Building Code concerning dead loads. There is no provision concerning equipment weight. A minimum partition load of 20 psf is prescribed.

***BOCA-BBC*—**The 1965 BOCA-BBC requires actual weights of materials to be used in estimating dead loads, but the actual weights cannot be less than the unit dead loads prescribed in Appendix J of the code (Annex A5 of this report). The BOCA-BBC has a provision concerning equipment weight that is similar to the corresponding provisions of the New York City Building Code. The BOCA code requires consideration of the actual weight of the partitions or an equivalent uniform load of no less than 20 psf of floor area.

4.2 FLOOR LIVE LOADS

1968 New York City Building Code—Requirements for live loads are given in 902.0, Live Loads, of the 1968 New York City Building Code, with specific requirements for floor live loads given in C26-902.2. Minimum design values for uniformly distributed and concentrated floor live loads for various occupancies are contained in Reference Standard RS 9-2 (Annex A1 of this report), Minimum Requirements for Uniformly Distributed and Concentrated Live Loads (Section C26-902.2). For occupancies that are not listed, design live loads are to be determined by the architect or engineer subject to approval by the building commissioner. Provisions are also given on how to apply concentrated live loads so as to produce maximum stress in the structural elements.

2001 New York City Building Code—The live load provisions in the 1968 Code remained unchanged.

New York State Building Code—This code states that uniformly distributed and concentrated live loads must be the greatest loads provided by the intended occupancy and use, subject to minimum values listed in Table C304-2.2 (Annex B3 of this report). Minimum loads for occupancies and uses not listed are to be in conformity with generally accepted standards.

Chicago Municipal Code—The minimum uniformly distributed and concentrated live loads are given in Table 68-2.1 (Annex B4 of this report).

BOCA-BBC—The minimum uniformly distributed and concentrated live loads are given in Table 13 (Annex B5 of this report).

Table 4–1 of this report provides a comparison of uniform live load values of the codes reviewed for types of live loads used in the design of World Trade Center (WTC) 1 and WTC 2 (see Section 2.2.1, NCSTAR 1-1A).[1]

The New York City Building Codes give the most comprehensive provisions for roofs subjected to special loads.

[1] This reference is to one of the companion documents from this Investigation. A list of these documents appears in the Preface to this report.

Table 4–1. Comparison of uniform live load values of reviewed codes for types of live loads used in design of WTC towers (psf)

Use of Spaces	1968 and 2001 NYC Codes	1964 NY State Code	1967 Chicago Municipal Code	1965 BOCA-BBC
Cafeteria	100	100	100	100
Closets (tenant floors)	100	120	100	125
Concourse	100	100	100	100
Corridors within core (mechanical equipment floor)	75	100	NA	NA
Corridors within core (skylobby floor)	100	100	100	100
Corridors within core (typical office floor)	75	100	75	100
Duct offset space	75	100	NA	NA
Electric closet	75	100	100	125
Electric substation & transformer room	75	100	NA	NA
Elevator machine room (plus elevator reactions)	(a)	100	NA	100
Elevator pits (plus elevator reactions)	(a)	100	NA	NA
Expansion tank room	75	100	NA	NA
Janitor's closets	100	120	100	125
Kitchen	100	100	75	100
Local passenger elevator lobbies (skylobby floors)	100	100	100	100
Main shuttle elevator lobbies (skylobby floors)	100	100	100	100
Mechanical equipment rooms	75	100	NA	NA
Men's toilets	40	60	NA	NA
Observation lobby	100	100	100	100
Office areas	50	50	50	50
Passenger elevator lobbies (tenant floors)	100	100	100	100
Powder rooms	40	60	NA	NA
Restaurant	100	100	100	100
Roof	30	20	25	20
Secondary motor rooms	75	100	NA	NA
Service room[b] (mechanical equipment floor)	75	100	NA	NA
Service room (tenant floor)	75	100	NA	NA
Sprinkler tank room	75	100	NA	NA
Stairs	75	100	100	100
Telephone closets	80	NA	NA	NA
Tenant spaces within core	50	50	50	50

a. Refers to ANSI/ASME A17.1.
b. Considered as mechanical equipment rooms.
Key: NA, not available.

4.3 ROOF LIVE LOADS

1968 and 2001 New York City Building Codes—Roof live load of 30 psf of horizontal projection, reduced by 1 psf for each degree of slope in excess of 20 degrees, is prescribed. The concentrated load provisions of Section C26-902.2 (b) apply.

New York State Building Code—On roofs not used as promenades, the minimum imposed load must be 20 psf perpendicular to the roof surface, where snow plus wind loads total less than 20 psf.

Chicago Municipal Code—The prescribed value is 25 psf of roof area, acting normal to roof surface (this includes snow). May be taken as zero for roofs having a pitch of 30 degrees or more.

BOCA-BBC—The roof live load is 20 psf of horizontal projection. In areas subject to snow loads, it is 30 psf of horizontal projection.

4.4 MOVING LOADS

Only the New York City Building Codes have provisions on moving loads, such as vehicles and machinery, which are detailed in Table 7–2 of this report.

4.5 PARTIAL LOADING CONDITIONS

The New York City Building Codes give simplified methods and the most detailed provisions concerning partial loading conditions (not all spans loaded at the same time with the full design live loads). The Chicago Municipal Code is the only other code that gives provisions that are general in nature.

4.6 ROOF LIVE LOAD REDUCTION

The New York State Code is the only code that allows roof live load reduction. The New York City, Chicago, and BOCA codes do not allow any reduction for roof live load.

4.7 FLOOR LIVE LOAD REDUCTION

1968 New York City Building Code—Provisions for live load reduction are contained in 903.0, Live Load Reduction. The allowable reduced live load for floor members is determined by multiplying the basic live load value from Reference Standard RS 9-2 by the percentages given in Table 9–1 of the Code, which is reproduced here as Table 4–2. These percentages are a function of the contributory floor area, which is defined in Section C26-903.3, and the ratio of live load to dead load.

Table 4–2. Reduced live load per the 1968 New York City Building Code Table 9–1 (percent).

Contributory Area (ft^2)[b]	Ratio of Live Load to Dead Load[a]		
	0.625 or Less	**1**	**2 or More**
149 or less	100	100	100
150–299	80	85	85
300–449	60	70	75
450–599	50	60	70
600 or more	40	55	65

a. For intermediate values of live load/dead load, the applicable percentages of live load may be interpolated.
b. Contributory areas are computed as follows (see Section C26-903.3):
For one-way and two-way slabs: product of the shorter span length and a width equal to one-half the shorter span length. Ribbed slabs shall be considered as though the slabs were solid.
For flat plate or flat slab construction: one-half the area of the panel.
For columns, girders, or trusses framing into columns: the loaded area directly supported by the column, girder, or truss. For columns supporting more than one floor, the loaded area shall be the cumulative total area of all the floors that are supported.
For joists and similar multiple members framing into girders or trusses, or minor framing around openings: twice the loaded area directly supported but not more than the area of the panel in which the framing occurs.

No live load reduction is permitted for members and connections (other than columns, piers, and walls) supporting:

- Floor areas used for storage (including warehouses, library stacks, and record storage);
- Areas used for parking of vehicles;
- Areas used as places of assembly, for manufacturing, and for retail or wholesale sales.

The maximum live load reduction is 20 percent for columns, piers and walls supporting such areas.

Live load reduction is also not permitted for calculating shear stresses at the heads of columns in flat slab or flat plate construction. Flat slabs and flat plates are reinforced concrete slabs supported directly on columns, without any beams along the column lines. The provision applies only at the joints of such slabs and supporting columns.

As an alternative to the percentages given in Table 4–2 of this report, live load reduction for columns, piers, and walls are permitted to be taken as 15 percent of the live load on the top floor, increased at the rate of 5 percent on each successive lower floor, with a maximum reduction of 50 percent. For girders supporting 200 ft^2 or more of floor area, the allowable live load reduction is 15 percent.

2001 New York City Building Code—Floor live load reduction provisions of the 1968 New York City Building Code remained unchanged in the 2001 version of the Code.

New York State Building Code—Provisions are given in Section C304.2.1 (c, d) of the New York State Code.

(a) Uniformly distributed live loads on beams and girders supporting other than storage areas and motor vehicle parking areas, when such member supports 150 ft^2 or more of roof or floor area per floor:

- $DL \leq 25$ psf, maximum reduction is 20 percent
- 25 psf < $DL \leq 100$ psf, maximum reduction is the least of
  - 60 %
  - 0.08 % per ft^2
  - $\frac{(DL+LL)}{4.33(LL)} \times 100\%$

(b) For columns, girders supporting columns, bearing walls, and walls supporting 150 ft^2 or more of roof or floor area per floor other than storage areas and parking areas:

Maximum reduction is 20 percent for the top three floors including the roof, increased successively at the rate of 5 percent for each successive lower floor, with a maximum reduction of 50 percent.

Chicago Municipal Code—Provisions are given in Section 68-2.2 of the Chicago Municipal Code.

(a) Columns, walls, piers and foundations: Live load reduction may be taken as 15 percent of the live load for the top floor, increased at the rate of 5 percent on each successive lower floor, with a maximum reduction of 50 percent. This is the same as the alternative live load reduction by the New York City Building Code.

(b) Live load reduction for beams, girders and trusses is reproduced in the following table.

Tributary Area (ft^2)	Maximum *LL* Reduction (%)
< 100	0
100-200	5
200-300	10
> 300	15

(c) Alternatively to (a) and (b), when $DL > LL$, the *LL* specified in Section 68-2.1 of the Chicago Municipal Code may be reduced by the ratio of the specified *LL* to the *DL*. The reduced *LL* must in no case be less than 2/3 of the *LL* specified in Section 68-2.1.

For storage rooms, reduction must not exceed one-half of the percentage reduction provided above.

BOCA-BBC—Provisions are given in Section 721.0 of the BOCA-BBC.

(a) Live load ≤ 100 psf, maximum reduction is the least of

- 60 %
- 0.08 % per ft^2
- $\frac{(DL + LL)}{4.33(LL)} \times 100\%$

No reduction is permitted for areas of public assembly. Note that the above is the same as in the New York State Building Code requirements for beams and girders supporting more than 25 psf of dead load.

(b) Live load > 100 psf, no reduction, except that *LL* on columns may be reduced 20 percent.

See Fig. 4–1 and Table 4–3 for comparisons of the permitted live load reductions. The New York City Building Code does not permit live load reduction in calculating shear stresses at the heads of columns in flat slab or flat plate construction.

Figure 4–1. Reduced live load of various building codes for columns, walls, and piers.

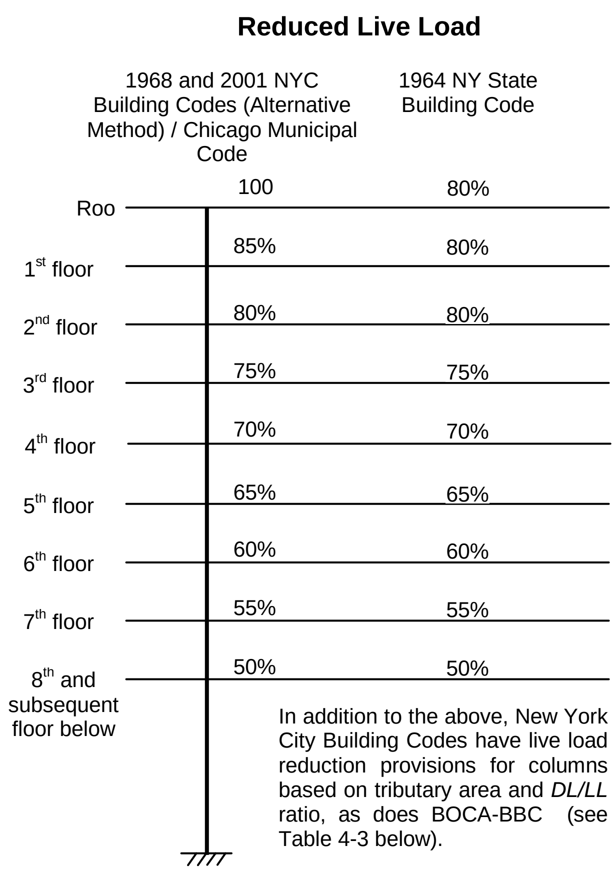

Table 4–3. Reduced live load of various building codes for beams and girders.

<table>
<tr><th>Contributary Area (ft²)</th><th colspan="2">1968 and 2001 NY City Building Codes</th><th>1967 Chicago Municipal Code</th><th colspan="2">1964 NY State/1965 BOCA Codes</th></tr>
<tr><td>100 or less</td><td colspan="2">100 %</td><td>100 %</td><td colspan="2">100 %</td></tr>
<tr><td>100-150</td><td colspan="2">100 %</td><td>95 %</td><td colspan="2">100 %</td></tr>
<tr><td>150-200</td><td>80-85 %</td><td rowspan="5">Also depends on the DL/LL ratio.</td><td>95 %</td><td>84-88 %</td><td rowspan="5">These values are determined as the larger of :
• [100-0.08×(tributary area)], or
• 40 %
The percentage values also must not be less than
$(1-\frac{DL+LL}{4.33LL})\times 100$, which
is not reflected in the ranges listed.</td></tr>
<tr><td>200-300</td><td>80-85 %</td><td>90 %</td><td>76-84 %</td></tr>
<tr><td>300-450</td><td>60-75 %</td><td>85 %</td><td>64-76 %</td></tr>
<tr><td>450-600</td><td>50-70 %</td><td>85 %</td><td>52-64 %</td></tr>
<tr><td>600 and more</td><td>40-65 %</td><td>85 %</td><td>40-52 %</td></tr>
</table>

4.8 WIND LOADS

1968 New York City Building Code—According to Sub-Article 904.0, Wind Loads, wind forces are computed in accordance with the New York City Building Code Reference Standard RS 9-5, Minimum Design Wind Pressures. Wind is assumed to act from any direction, and for continuous framing (structural members continuous over their supports – for example, beams having full moment connections with columns), the effects of partial loading conditions are considered. Minimum design wind pressures acting on vertical surfaces are contained in Table RS 9-5-1, which is reproduced here as Table 4–4.

Table RS 9-5-2 of the 1968 New York City Building Code (reproduced here as Table 4–5) contains the design wind pressures normal to horizontal and inclined surfaces.

Table 4–4. Design wind pressures on vertical surfaces per the 1968 New York City Building Code (Table RS 9-5-1).

Height Zone (ft above curb level)	Minimum Design Wind Pressure on Vertical Surfaces (psf of projected solid surface)	
	Structural Frame	Glass Panels
0–50[a]	15	–
0–100	20	30
101–300	25	30
301–600	30	35
601–1000	35	40
Over 1000	40	40

a. Signs and similar constructions of shallow depth only.

Table 4–5. Design wind pressures on horizontal and inclined surfaces per the 1968 New York City Building Code (Table RS 9-5-2).

Roof Slope	Design Wind Pressure Normal to Surface
30 degrees or less	Either pressure or suction equal to 40 % of the values in Table RS 9-5-1 over the entire roof area
More than 30 degrees	Windward slope: pressure equal to 60 % of the values in Table RS 9-5-1. Leeward slope: suction equal to 40 % of the values in Table RS 9-5-1.

For purposes of design, pressures on vertical, horizontal, and inclined surfaces of the building are to be applied simultaneously.

For the design of wall elements other than glass panels (i.e., mullions, muntins, girts, panels, and other wall elements including their fastenings), the design wind pressure, which includes allowances for gust, acting normal to wall surfaces, is specified as 30 psf pressure or as 20 psf suction for all heights up to 500 ft. Applicable design pressures for heights over 500 ft are to be determined from a special investigation, but are not allowed to be less than those pressures indicated in Table RS 9-5-1. Minimum design wind pressures are also given for other building elements by multiplying the pressures in Table RS 9-5-1 by the appropriate shape factors in Table RS 9-5-3. The shape factors vary from 0.7 degrees for upright, circular cylindrical surfaces to 2.0 for signs with less than 70 percent solid surface.

In lieu of the wind pressures mentioned above, design wind pressures may be determined by “suitably conducted model tests,” subject to review and approval of the building commissioner. The tests are to be based on a basic (fastest-mile) wind velocity of 80 mph at 30 ft above ground, and are to simulate and include all factors involved in consideration of wind pressure, including pressure and suction effects, shape factors, functional effects, gusts, and internal pressures and suctions.

2001 New York City Building Code—The wind provisions of the 1968 Code remained unchanged in the 2001 version of the New York City Building Code.

New York State Building Code—Minimum wind loads on walls (as well as eaves, cornices, towers, masts, and chimneys) are given in Table C304-4a of the New York Sate Code (shown in Annex B3 of this report) and are compared with the New York City Building Code requirements in Fig. 4–2 of this report. Figure 4–3 provides details of the New York State Building Code requirements. Wind loads on roofs are given in Table 304-4b (in Annex B3 of this). Detailed provisions are summarized in Table 7–2 of this report. There are no provisions on the use of model tests to establish the design wind pressures.

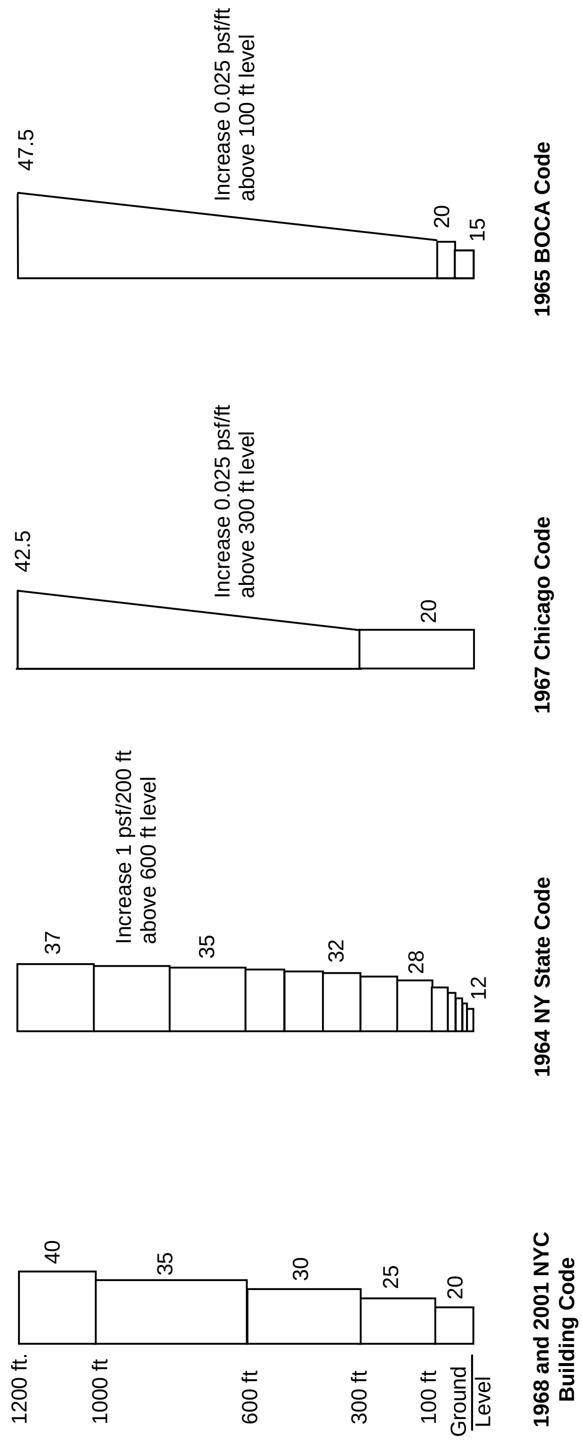

Figure 4–2. Minimum wind load (psf) on vertical surfaces required by various building codes.

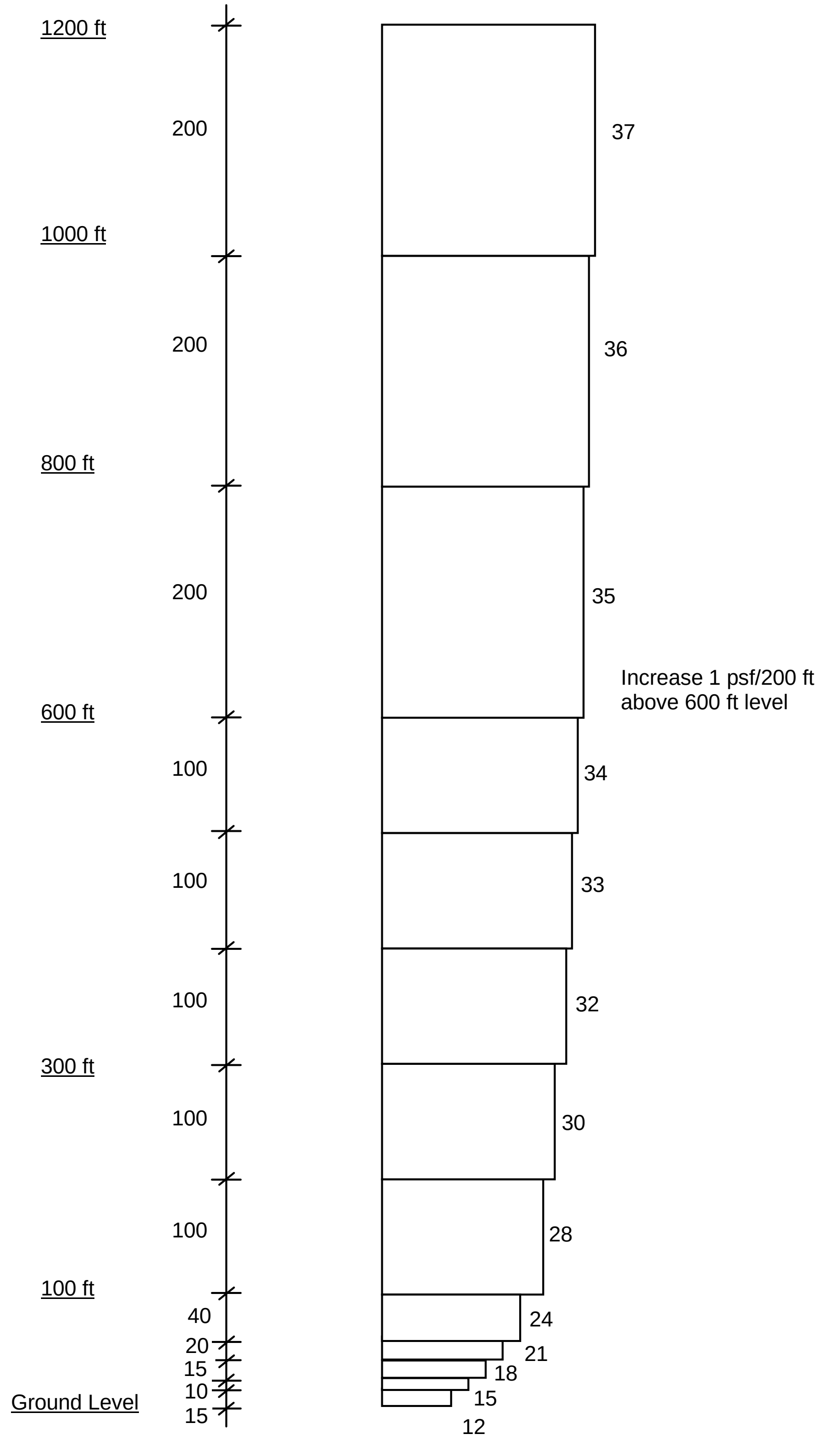

Figure 4–3. Minimum wind load (psf) as a function of height (ft) on vertical surfaces required by 1964 New York State Building Code.

Chicago Municipal Code—Minimum design horizontal pressures are given in Table 68–4.1 of the Chicago Municipal Code (see Annex B4 of this report), and are compared with the New York City Building Code requirements in Fig. 4–2.

The Chicago Municipal Code states: roofs shall be designed for outward pressure equal to 75 percent of those in Table 68–4.1. Roofs with slopes greater than 30 degrees shall be designed for inward pressure equal to those in Table 68–4.1. Overhanging eaves and cornices shall be designed and constructed for upward pressure equal to twice that in Table 68–4.1. There are no provisions on the use of model tests to establish the design wind pressures.

BOCA-BBC—Wind load on vertical surfaces is prescribed in Section 714.0 of the BOCA Code and is compared with the New York City Building Code requirements in Fig. 4–2. Wind on roof surfaces is prescribed in Section 715.0 of BOCA-BCCC (see Table 7–2 and Annex B5 of this report). There is a provision (Section 715.3) on the use of wind tunnel tests to determine the effect of shape of irregular or unusual roofs, but there is no similar testing provision for wind pressures on vertical surfaces.

A comparison using the wind pressures from the aforementioned codes reveals that the largest shear force at the base of a building the height of the WTC towers is obtained from the BOCA-BBC. Similarly, the largest overturning moment at the base of a building the height of the WTC towers is also obtained from the BOCA-BBC. The lowest base shear and moment are obtained from the 1968 and 2001 New York City Codes. The base shear from the New York City Codes is approximately 20 percent less than that from the BOCA code, while the base moment is approximately 10 percent less (see Table 4–6).

Table 4–6. Base shears and overturning moments (per ft of building width) from reviewed codes for a building the height of WTC towers (1,368 ft).

	1968 NYC Code	2001 NYC Code	1964 NY State Code	1967 Chicago Municipal Code	1965 BOCA-BBC
Base shear (kip)	44.7	44.7	45.7	41.6	47.2
Overturning moment(ft-kip)	33,778	33,778	33,474	33,143	37,707

4.9 EARTHQUAKE LOADS

1968 New York City Building Code—There are no provisions for earthquake loads.

2001 New York City Building Code—This edition contains seismic design provisions from the 1988 edition of the Uniform Building Code (ICBO 1988), including the 1990 Accumulative Supplement. Significant modifications and amendments are made, however (see Exhibit RS 9-6 in Annex A2 of this report). The amendments include consideration of liquefiable soils, which is not included in the Uniform Building Code.

New York State Building Code—The 1964 edition of this Code has no provisions for earthquake loads.

Chicago Municipal Code—The 1967 edition of this Code has no provisions for earthquake loads.

BOCA-BBC—The 1965 edition of this Code contains provisions in Appendix K-11 that are adapted from the 1962 edition of the Uniform Building Code.

4.10 SNOW LOADS

1968 and 2001 New York City Building Codes—The minimum roof load is specified to be 30 psf. The value is such that it most likely includes snow loads.

New York State Building Code—Minimum snow loads must be determined from Table C304-3 (Annex B3 of this report) and the given snow map, and must be applied perpendicular to the roof surface. For a horizontal roof, a minimum 30 psf load must be used.

Chicago Municipal Code—A minimum of 25 psf roof live load normal to the roof surface, including snow loads, is specified for roofs having a pitch less than 30 degrees. Such live loads may be neglected for roofs having a pitch of 30 degrees or more. However, wind pressures determined in accordance with Section 68-4.3 must be considered in the latter case. A minimum of 60 psf live load is required for roofs used for terraces, promenades, and similar structures.

BOCA-BBC—Minimum snow load on the roof in snow areas is 30 psf. When the effect of the shape of the roof as determined by actual tests indicates less or greater snow retention than specified in the code, the roof load shall be modified accordingly. Special snow loads as indicated by the average snow depth in the records of the U.S. Weather Bureau must also be considered.

4.11 SOIL AND HYDROSTATIC PRESSURE

The 1968 and 2001 editions of the New York City Building Codes require that foundation walls and retaining walls be designed to resist, in addition to the vertical loads acting on them, the incident lateral earth pressures and surcharges, plus hydrostatic pressures corresponding to the maximum probable ground water level. The three other codes have similar provisions (see Table 7–2 for comparison).

4.12 CONSTRUCTION LOADS

1968 and 2001 New York City Building Codes—Comprehensive provisions for construction loads are provided in Article 19 (1968 Code) or Subchapter 19 (2001 Code), Safety of Public and Property during Construction Operations. Topics covered include general provisions, provisions for maintenance of site and adjacent areas, for protection of adjoining property, for excavation operations, for erection operations, for demolition operations, for repair and alteration operations, for scaffolds, for structural ramps, runways, and platforms, for material, handling and hoisting equipment, for explosive powered and projectile tools, for explosives and blasting, and for flammable and combustible mixtures, compressed gases, and other hazardous materials.

New York State Building Code—All flooring, structural members, walls, bracing, scaffolding, sidewalk sheds or bridges, hoists and temporary supports of any kind incidental to the erection, alteration or repair of any building shall be of such strength as to suffer no structural damage when subject to the temporary loads and wind loads imposed during construction.

Chicago Municipal Code—There are no requirements related to construction loads.

BOCA-BBC—Provisions must be made for resisting temporary construction and wind loads that may occur during the erection of the building.

4.13 FLUID PRESSURES

Only the New York City Building Codes have provisions related to fluid pressure. The design of building components must consider pressures, both positive and negative, of confined fluids and gases.

4.14 ICE LOADS

Only the New York City Building Codes have provisions related to ice loads. The weight of 1/2 in. radial thickness of ice on all surfaces must be considered as part of the live load in the design of open framed or guyed towers.

4.15 THERMAL FORCES

Only the New York City Building Codes have provisions on thermally induced forces. Enclosed buildings more than 250 ft in plan dimension shall be designed for 40 ^{o}F temperature change. Exterior exposed structures regardless of plan dimensions must be designed for 40 ^{o}F temperature change for concrete and masonry construction and 60 ^{o}F for metal construction. Provisions for piping are also given.

4.16 SHRINKAGE

Only the New York City Building Codes have provisions on the effects of shrinkage of concrete structures. Reinforced concrete components must be designed for shrinkage deformation of 0.0002 (normal-weight concrete) or 0.0003 (lightweight concrete) times the length between contraction joints.

4.17 DISTRIBUTION OF VERTICAL AND HORIZONTAL LOADS

Only the New York City Building Codes have provisions related to distribution of loads vertically along the structure and horizontally to various resisting elements.

Vertical Load Distribution—Distribution of vertical loads to supporting members must be determined on the basis of a recognized method of elastic analysis or "system of coefficients of approximation." Elastic or inelastic displacements of supports shall be considered and, for the distribution of dead loads, the modulus of elasticity of concrete or composite sections shall be reduced to consider plastic flow. Secondary effects, due to warping of the floors, must be considered.

***Horizontal Load Distribution*—**Provisions are given for distribution of horizontal loads to vertical frames, trusses and shear walls, which must be based on relative rigidity; and for distribution of horizontal loads within rigid frames of tier buildings, which can be based on elastic analysis, or given simplified assumptions if certain limitations are satisfied, such as requiring approval of simplifying assumptions for buildings over 300 ft in height (see 906.2 for 1968 Code in Table 7–2).

Chapter 5
STRUCTURAL WORK

"Structural work" is a term used in the New York City Building Codes and not in the other codes. The scope of "structural work" includes, but is not limited to, materials and methods of construction; design methods, including design load combinations; and the materials of construction, including concrete, masonry, steel, and wood. Table 7–3 compares code provisions related to these topics.

5.1 STANDARDS

***1968 New York City Building Code*—**The design standards adopted by this code are listed in Annex A1 of this report. The primary references of interest are the 1963 edition of ACI 318, *Building Code Requirements for Reinforced Concrete*, and AISC 1963, *Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings*.

***2001 New York City Building Code*—**The design standards adopted by reference in this code are listed in Annex A2 of this report. The primary references are: the 1989 edition of the ACI 318, *Building Code Requirements for Reinforced Concrete*, AISC 1989, *Specifications for Structural Steel Buildings – ASD and Plastic Design*, and AISC-LRFD 1993, *Load and Residence Factor Design Specifications for Structural Steel Buildings*.

***New York State Building Code*—**This code is a performance code, and does not adopt any standards by reference. However, the State Building Code Council of the State of New York publishes a list of Generally Accepted Standards that are listed in Annex A3 of this report. The list includes the 1963 edition of ACI 318, *Building Code Requirements for Reinforced Concrete*, and the 1963 edition of AISC, *Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings*. The State Building Code Council also publishes a Code Manual to help the user implement the State Building Construction Code. This Manual references standards that are deemed to comply with the requirements of the code.

***Chicago Municipal Code*—**The standards referenced by this code are listed in Annex A 4 of this report. The primary references are the 1963 edition of ACI 318, *Building Code Requirements for Reinforced Concrete*, and AISC 1963, *Specification for the Design, Fabrication and Erection of Structural Steel for Buildings*.

***BOCA-BBC*—**The adopted standards are listed in the appendixes to the BOCA-BBC (see Annex A5 of this report). The referenced design standards for steel and concrete are the same as in the 1968 New York City Building Code and the Chicago Municipal Code.

5.2 ALTERATION OF EXISTING BUILDINGS

***1968 and 2001 New York City Building Codes*—**Requirements for alterations are based on the cost of an alteration as a percentage of building value. Whether the altered building or the alternations only need to comply with the requirements of the Code depends on the cost of alterations versus the value of the building. When the cost of alterations relative to the value of building is low, the alterations may not have to be in compliance with the current Code “provided the general safety and public welfare are not thereby endangered.”

***New York State Building Code*—**It is required that any addition or alteration regardless of building value must be made in conformity with the Code. The New York State Code is silent on the requirements for the remainder of the structure being altered.

***Chicago Municipal Code*—**The provisions are similar to those of the New York City Codes.

***BOCA-BBC*—**The provisions are similar to those of the New York City Codes.

5.3 MATERIALS AND METHODS OF CONSTRUCTION

***1968 and 2001 New York City Building Codes*—**These codes prescribe testing and inspection requirements for materials, assemblies, forms, and methods of construction. The other three codes make a distinction between "controlled" and "ordinary" materials, "ordinary" materials being those that are not "controlled." Materials, assemblies, frames and methods of construction permitted by the New York City Building Codes would fall under the classification of “controlled materials" by the other codes.

***New York State Building Code*—**According to this Code, “controlled materials” are those that have been identified and certified for quality and strength by a recognized authoritative inspection service, grading organization or testing laboratory, or are identified by manufacturer, producer, and mill test as meeting generally accepted standards (Section C303-2 of the Code).

***Chicago Municipal Code*—**According to this Code, “controlled materials” refers to a building, structure, or part thereof, which has been designed or constructed under the following conditions (Section 69-3.1 of the Code):

- All materials must be selected or tested to meet the special strength, durability and fire resistance requirements upon which the design is based.
- The design, preparation of working drawings, including details and connections, the checking and approval of all shop and field details and the inspection of the work during construction must be under the supervision of a registered architect or structural engineer.

BOCA-BBC—According to BOCA-BBC Section 701.0, “controlled materials” are materials that are certified by an accredited authoritative agency as meeting accepted engineering standards for quality.

5.4 USED AND UNIDENTIFIED MATERIALS

1968 and 2001 New York City Building Codes—Used materials and unidentified or ungraded materials must be limited to nonstructural elements except for the following three conditions (see Sec. C26.1000.9 in the 1968 Code):

- The elements or materials will be subject to stress levels that were experienced in previous construction. In lieu of this, the load test procedures in Section C26.1002.4 may be used to determine the load capacity of the materials or elements.
- Unidentified materials may be graded by the recovery and test of representative samples, or by other means satisfactory to the building commissioner.
- Used materials are considered to be graded when the grade is clearly indicated on the approved plans for the existing construction. In such cases, allowable stresses are permitted to be taken equal to those for that grade of like materials that were required at the time of existing construction.

New York State Building Code—No provisions are included.

Chicago Municipal Code—Used materials are permitted to be used as long as they meet the minimum requirements for new materials and all other special requirements of the Code.

BOCA-BBC—Similar to the Chicago Municipal Code, used materials are permitted as long as they meet the minimum requirements of the Code for new materials.

5.5 EQUIVALENT SYSTEMS OF DESIGN

Each of the five codes reviewed permits designs that do not conform to the specific code, yet can provide performance equivalent or superior to that required by the respective code.

5.6 STABILITY

Only the New York City Building Codes contain a provision (1968 Section C26-1001.1; 2001 Section 27-591) requiring that a building, or any element thereof, be proportioned to provide a minimum factor of safety of 1.50 against failure by sliding or overturning. The required stability must be provided solely by the dead load plus any permanent anchorage provided.

5.7 BRACING

Only the New York City Building Codes (1968 Section C26-1001.2; 2001 Section 27-592) specifically require that members used to brace compression members be proportioned to resist an axial load of at least 2 percent of the total compressive design stress in the member braced, plus any transverse shear therein.

5.8 SECONDARY STRESSES

Only the New York City Building Codes (1968 Section C26-1001.3; 2001 Section 27-593) explicitly require that secondary stresses in trusses be considered and, where of significant magnitude, their effects provided for in design.

5.9 LOAD COMBINATIONS

5.9.1 Allowable Stress Design

The following discussion on the load combinations for allowable stress design is applicable in the design of structural steel (as well as masonry or wood) members in buildings.

1968 New York City Building Code—The following is a list of all possible load combinations that are specified in Section C26.1001.4:

1. $D + L + RL$
2. $0.75[D + (W \text{ or } SH \text{ or } T \text{ or } UL)]$
3. $0.75[D + L + RL + (W \text{ or } SH \text{ or } T \text{ or } UL)]$
4. $0.67\{[D \text{ or } (D + L + RL)] + Q\}$

where:

D	=	effects of dead load (basic load)
L	=	effects of live load (basic load)
RL	=	effects of reduced live load (basic load)
W	=	effects of wind load (load of infrequent occurrence)
SH	=	effects of shrinkage (load of infrequent occurrence)
T	=	effects of thermal forces (load of infrequent occurrence)
UL	=	effects of unreduced live loads where live load reduction is permitted by Article 9 (load of infrequent occurrence)
Q	=	the combination of any two or more of *W*, *T*, *SH*, and *UL*

2001 New York City Building Code—The load combinations for allowable stress design are the same as for the 1968 New York City Building Code, except that the effects from earthquake forces (*E*) are included as loads of infrequent occurrence.

***New York State Building Code*—**When the stress due to wind is less than one-third of the stress due to dead load plus imposed loads excluding wind loads (live, snow, soil pressure including surcharge, hydrostatic head, and impact), the stress due to wind may be ignored. However, when the stress due to wind exceeds one-third of the stress due to dead load plus imposed loads excluding wind, the allowable stress of the material may be increased by one-third. Thus, the New York State Building Code accommodates loads of infrequent occurrence by permitting higher stresses.

***Chicago Municipal Code*—**For combined stresses due to dead, live (including snow), and wind loads, the allowable stresses may be increased by one-third, provided the section thus determined can resist at least the stresses due to dead and live loads alone.

***BOCA-BBC*—**The provision for allowable stresses due to dead, live, snow, and wind is the same as that in the Chicago Municipal Code. Additionally, BOCA-BBC also allows a one-third increase in the allowable stress when the effects of earthquake forces are combined with the effects of dead, live, and snow loads.

5.9.2 Ultimate Strength Design

This section on load combinations for ultimate strength design is applicable to the design of reinforced concrete members in buildings. At the time of the design of the WTC towers, steel members were designed by the allowable stress method only.

The 1968 New York City Building Code, the Chicago Municipal Code, and the BOCA-BBC reference the 1963 edition of the ACI 318, *Building Code Requirements for Reinforced Concrete*, for the design of reinforced concrete structural members. The New York State Building Code, as has been mentioned previously, is a performance code and does not adopt standards by reference. The following load combinations are specified in ACI 318-63:

1. $1.5D + 1.8L$
2. $1.25[D + L + (W \text{ or } E)]$
3. $0.9D + 1.1(W \text{ or } E)$

The effects of *SH* or *T* are to be considered on the same basis as the effects of *D* (the same load factor should be applied to *SH* or *T* as is applicable to *D* in a particular load combination).

The strength reduction factors corresponding to the above load combinations are 0.90 for flexure; 0.85 for diagonal tension, bond, and anchorage; 0.75 for spirally reinforced compression members; and 0.70 for tied compression members.

The strength design load combinations of ACI 318-89, adopted into the 2001 New York City Building Code, are:

1. $1.4D + 1.7L$
2. $0.75[1.4D + 1.7L + 1.7(W \text{ or } 1.1E)]$

3. $0.9D + 1.3(W \text{ or } 1.1E)$

4a. $1.4D + 1.7L + 1.7H \geq 1.4D + 1.7L$

4b. $0.9D + 1.7H \geq 1.4D + 1.7L$

5a. $1.4D + 1.7L + 1.4F \geq 1.4D + 1.7L$

5b. $0.9D + 1.4F \geq 1.4D + 1.7L$

(F = effects of weight and pressures of fluids with well-known densities and controllable maximum heights.)

6. $0.75\ (1.4D + 1.4T + 1.7L) \geq 1.4\ (D + T)$

If resistance to impact effects is taken into account in design, such effects shall be included with live load L.

The strength reduction factors, to go with the above load combinations, are as follows:

- Flexure, without axial load 0.90
- Axial tension, and axial tension with flexure 0.90
- Axial compression, and axial compression with flexure:
  - Members with spiral reinforcement 0.75
  - Other reinforced members 0.70

  Except that for low values of axial compression, ϕ may be increased gradually to 0.90.
- Shear and tension 0.85
- Bearing on concrete 0.70

There are modifications of the strength reduction factor for regions of high seismic risk.

5.10 DEFLECTION LIMITATIONS

All five codes contain similar limits on vertical deflections of floor and roof assemblies.

1968 and 2001 New York City Building Codes**—**The relevant provisions of several reference standards cited in the Article (1968 Code) or Subchapter (2001 Code) on Structural Work apply. In addition, the total of the dead plus live load vertical deflections (including effects of creep and shrinkage) of members supporting walls, veneered walls, or partitions constructed of or containing panels of masonry, glass, or other frangible materials must not exceed 1/360 of the span.

***New York State Building Code*—**Under imposed load, the deflection must not exceed 1/360 of the span when the inside is to include plastered partition walls, and 1/240 of the span if it does not. When a roof is not to be used as a promenade, and the underside is not to be plastered, the deflection must not exceed 1/180 of the span.

***Chicago Municipal Code*—**Under design live load, the deflection must not be greater than 1/360 of the span for plastered construction or 1/240 of the span for unplastered construction.

***BOCA-BBC*—**The deflection of floor and roof assemblies must not be greater than 1/360 of the span for plastered construction; 1/240 of the span for unplastered floor construction; and 1/180 of the span for unplastered roof construction.

5.11 LOAD TESTS/CORE TESTS

Load tests and tests of in-situ concrete are carried out for various purposes, as enumerated in the New York City Building Codes.

***1968 and 2001 New York City Building Codes*—**These Codes have provisions for: (1) load tests carried out to verify adequacy of structural design for a member or an assembly, (2) load tests carried out to verify adequacy of questionable construction, (3) core tests to verify adequacy of concrete, (4) prequalifying load tests for structural members before they are incorporated into structure, and (5) load tests of completed construction to verify its strength and compliance with deflection limitations.

New York State Building Code—Provisions are included for (1) and (5) above.

Chicago Municipal Code—Provisions are found for (1), (3), and (5) above.

BOCA-BBC—Provisions are included for (1) and (2) above.

5.12 EXTERIOR WALL MATERIALS

Only the New York State Building Code and the BOCA-BBC have specific provisions related to exterior wall materials. These are required to be weather-resistant and durable.

5.13 PREFABRICATED CONSTRUCTION

Only the Chicago Municipal Code and the BOCA-BBC have provisions concerning prefabricated construction.

5.14 MASONRY CONSTRUCTION

1968 and 2001 New York City Building Codes—Requirements for unreinforced masonry design and construction are given in Reference Standard 10-1 (Annex A1 of this report). *American Standard Building Code Requirements for Masonry*, USASI A-41.4, 1960, is adopted as Reference Standard 10-2 for reinforced masonry design and construction in the 1968 New York City Building Code. ACI 530-92/ASCE 5-92 *Building Code Requirements for Masonry Structures* and

ACI 530.1-92/ASCE 6-92 *Specification for Masonry Structures* are adopted as Reference Standard 10-2 for reinforced masonry design and construction in the 2001 edition of the New York City Building Code.

New York State Building Code—This code contains a general statement requiring that all structural units of natural or manufactured materials must comply with applicable specifications of authoritative agencies, or must be subjected to test in conformity with generally accepted standards in order to determine their characteristics.

***Chicago Municipal Code*—**The 1954 edition of the *American Standard Building Code Requirements for Masonry*, USASI A-41.4, is adopted by reference. Provisions for allowable stresses for grouted brick masonry and for reinforcement and allowable stresses for reinforced brick masonry are also given.

***BOCA-BBC*—**Specific provisions for various masonry elements are given.

5.15 CONCRETE

***1968 New York City Building Code*—**ACI 318-63 is adopted to regulate concrete materials, design and construction. ACI 525-1963, *Minimum Requirements for Thin-Section Precast Concrete Construction*, is adopted to regulate precast concrete construction "utilizing a thin skin or slab stiffened or supported by a system of ribs." In both cases, modifications are made. In addition, the 1968 New York City Building Code has provisions on:

- Identification of metal reinforcement;
- Concrete mixtures (concrete may be proportioned, batched, and mixed by Method I, which stipulates a minimum cement content, or Method II, performance concrete);
- Documentation;
- On-site inspection;
- Admixtures;
- Licensed concrete testing laboratories;
- Short-span concrete floor and roof construction supported on steel beams;
- Pneumatically placed concrete (shotcrete);
- Formwork; and
- Preplaced-aggregate concrete.

***2001 New York City Building Code*—**ACI 318-89 has been adopted to regulate concrete materials, design and construction. ACI 318-89 as well as MNL-120 1985, *PCI Design Handbook*, Third Edition, has been adopted to regulate precast concrete construction. In both cases modifications have been made. Additional provisions are included on the same topics as in the 1968 Code. In many cases, these provisions have been updated, as detailed in Table 7–3 of this report. For instance, in mix design

Method I, "cement factor" has been replaced by "cement content." Mix design Method II, Performance concrete, has been changed to "Proportioning on the basis of field experience."

New York State Building Code—This Code contains a general statement requiring that all structural units of natural or manufactured material must comply with applicable specifications of authoritative agencies, or must be subjected to test in conformity with generally accepted standards in order to determine their characteristics.

Chicago Municipal Code—The design and construction of reinforced concrete is required to be in accordance with ACI 318-63. Detailed provisions for steel-concrete composite beams are given.

BOCA-BBC—The following documents are adopted for reinforced (including precast) concrete design and construction: (1) ACI 711 1958, *Minimum Standard Requirements for Precast Concrete Floor and Roof Units*, (2) ASA (American Standards Association) A59.1 1954, *Specifications for Reinforced Gypsum Concrete*, (3) ACI 318 1963, *Building Code Requirements for Reinforced Concrete*, (4) ACI 315 1965, *Manual of Standard Practice for Detailing Reinforced Concrete Structures*, (5) AWS D12.1 1961, *Recommended Practices for Welding Steel, Metal Inserts and Connections in Reinforced Concrete Construction*. In addition, a number of material standards are adopted in Appendix C (Annex A5 of this report).

The Code has provisions on Concrete Aggregates (817.0), Ready-Mix Concrete (818.0), Reinforcing Steel (830.0), Reinforced Concrete (842.0), Controlled Concrete (843.0), Ordinary Concrete (844.), Structural Cinder (lightweight) Concrete (845.0), Short Span Floor Filling (846.0), Concrete-Filled Pipe Columns 9847.0), Pneumatic Concrete (848.0), Minimum Concrete Dimensions (849.0), and Reinforced Gypsum Concrete (850.0).

5.16 STEEL

1968 New York City Building Code—Materials, design, and construction methods must meet the requirements of:

- AISC 1963, *Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings*
- AISI 1962, *Specification for the Design of Light Gage Cold-Formed Steel Structural Members*
- AISI/SJI July 1, 1966, *Standard Specifications and Load Tables for Long Span Steel Joists, LJ-Series and LH-Series*
- AISI/SJI February, 1965, *Standard Specifications and Load Tables for Open Web Steel Joists, J-Series and H-Series*

In each case, modifications are made. In addition, there are specific identification (i.e., marks on steel) and quality control requirements.

2001 New York City Building Code—Materials, design and construction methods must meet the requirements of:

- AISC 1989, *Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design*
- AISC-LRFD 1993, *Load and Resistance Factor Design Specification for Structural Steel Buildings*
- Uniform Building Code 1988, including 1990 Accumulative Supplement, Section 2723, *Steel Structures Resisting Forces Induced by Earthquake Motions in Seismic Zones No. 1 and 2.*
- AISI 1986, *Specification for the Design of Cold Formed Stainless Steel Structural Members*
- AISI 1974, *Specification for the Design of Cold-Formed Steel Structural Members*
- SJI 1978, Revised 1983, *Standard Specifications for Open Web Steel Joist, H-Series*
- SJI 1985, Revised 1987, *Standard Specifications for Open Web Steel Joists, K-Series*
- SJI 1978, Revised 1987, *Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLJH-Series*
- SJI 1078, Revised 1987, *Standard Specifications for Joist Girders*
- SJI 1988, *Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders*

Modifications are made to each of the above standards.

New York State Building Code—This Code is a performance code. It contains a general statement requiring that all structural units of natural or manufactured materials must comply with applicable specifications of authoritative agencies, or must be subjected to test in conformity with generally accepted standards in order to determine their characteristics.

Chicago Municipal Code—The following standards are adopted by reference:

- AISC 1963, *Specifications for the Design, Fabrication and Erection of structural Steel for Buildings*
- AISI 1962, *Light Gage Cold-Formed Steel Design Manual*
- SJI 1963, *Open Web Joist – Standard Specifications and Load Tables*

There are also provisions for cast iron, cast steel, and special steels.

***BOCA-BBC*—**The following standards are adopted:

- AISC 1963, *Specifications for the Design, Fabrication and Erection of structural Steel for Buildings*
- AISC 1960, *Specifications for Architectural Exposed Structural Steel*
- AISC 1964, *Specifications for Structural Joints using ASTM A325 or A490 Bolts*
- AISI 1962, *Light Gage Cold-Formed Steel Design Manual*
- AISI 1962, *Specifications for Light Gage Cold-Formed Steel Structural Members*
- AISC-SJI 1961, *Standard Specifications for Open Web Steel Joists, Longspan or LA-Series*
- SJI- AISC 1965, *Specifications and Load Tables for Open Web Steel Joists, J-Series and H-Series*
- SJI-AISC 1962, *Standard Specifications for open Web Steel Joists, Longspan or LH-Series*

There are also provisions for cast steel construction, cast iron construction, special steels, lightweight metal alloys, alloy, and special steel.

5.17 WOOD

***1968 New York City Building Code*—**Materials (other than non-stress graded lumber), design and construction methods must meet the requirements of the following:

- Lumber and Timber – NLMA (National Lumber Manufactures Association) 1962, *National Design Specification for Stress-Graded Lumber and its Fastenings*
- Plywood – Specifications are given as part of the code itself in Reference Standard 10-9 (Annex A1 of this report)
- Structural glued-laminated lumber – U.S. Department of Commerce CS 253-1963, *U.S. Commercial Standard for Structural Glued Laminated Lumber*

Modifications are made to the NLMA and U.S. Department of Commerce standards.[1] In addition, there are provisions on: identification, use of non-stress graded wood, quality control, general construction requirements, empirical provisions in lieu of design, heavy timber construction, and construction methods.

[1] U.S. Department of Commerce (DOC) Voluntary Product Standards are developed by U.S. industry and published by DOC following *Procedures for the Development of Voluntary Product Standards* contained in Title 15 Code of Federal Regulations Part 10. The National Institute of Standards and Technology administers this program, on behalf of the DOC, on a fee for service basis.

2001 New York City Building Code—Materials (other than non-stress graded lumber), design, and construction methods must meet the requirements of:

- Lumber and Timber – AF&PA (American Forest and Paper Association) 1991, *National Design Specification for Wood Construction* and its 1991 Supplement with 1993 Revisions
- Plywood – Specifications are given as part of the code itself in Reference Standard 10-9 (Annex A2 of this report)
- Structural glued-laminated lumber – ANSI/AITC (American Institute of Timber Construction) A190.1 1992, *Structural Glued Laminated Timber* and AITC 200-92 *Inspection Manual*
  - AITC 117 1987, *Specification for Structural Glued Laminated Timber of Softwood Species –Design Standard*
  - AITC 117 1988, *Specification for Structural Glued Laminated Timber for Softwood Species – Construction Standard*

Modifications are made to the AF&PA Standard. In addition, there are provisions on the same items as in the 1968 code.

New York State Building Code—This is a performance code. It contains a general statement requiring that all structural units of natural or manufactured materials must comply with applicable specifications of authoritative agencies, or must be subjected to test in conformity with generally accepted standards in order to determine their characteristics.

Chicago Municipal Code—NLMA – 1957 *National Design Specifications for Stress-Graded Lumber and its Fastenings* is adopted by reference. In addition, maximum allowable unit stresses for lumber used as ordinary material (as opposed to controlled material) are given. Also given are provisions for bolted joints and ventilation of enclosed wood construction.

BOCA-BBC—The following are adopted by reference:

- AITC-200 1963, *Inspection Manual for Structural Glued Laminated Lumber*
- NLMA 1962, *National Design Specifications for Stress Graded Lumber and Its Fastenings*
- NLMA 1957, *Wood Structural Design Data*
- AITC-100 1962, *Timber Construction Standards*
- USDA Handbook No. 72 1955, *Wood Handbook*

In addition, a number of American Plywood Association (APA, formerly DFPA, or Douglas Fir Plywood Association) standards are adopted.

There are detailed provisions for Lumber and Timber Construction (853.0), Heavy Timber Type Construction (854.0), Wood Frame Construction (855.0), Stress Skin Panels (856.0), and Glued Laminated and Built-Up Lumber Construction (857.0).

5.18 ALUMINUM

The 1968 New York City Building Code adopted ASCE-1963 *Suggested Specifications for Structures of Aluminum Alloy*. The 2001 New York City Building Code adopts:

- AA (Aluminum Association) SAS 30 1986, *Specifications for Aluminum Structures,* Fifth Edition
- ASTM B209 1988, *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate*
- ASTM B308 1988, *Standard Specification for Aluminum* –Alloy 6061-T6 *Standard Structural Shapes, Rolled or Extruded*
- ASTM B429 1988, *Standard Specification for Aluminum –Alloy Extruded Structural Pipe and Tube*

In addition, there are specific requirements on identification, quality control, and erection.

The only other code with provisions for structural aluminum is the BOCA-BBC, which has adopted:

- AA 1963, *Aluminum Construction Manual, Section A – Specifications for Structures of Aluminum Alloys*

5.19 REINFORCED GYPSUM CONCRETE

Gypsum concrete is intended for use in the construction of poured-in-place roof decks or slabs.

1968 New York City Building Code—USASI A59.1-1954, *American Standard Specification for Reinforced Gypsum Concrete* is adopted. Also contained are provision on identification of metal reinforcement and limitation of use.

2001 New York City Building Code**—**ASTM C 317-1976, *Standard Specification for Gypsum Concrete* (Reapproved 1981) is adopted. Also included are provisions on identification of metal reinforcement and limitation of use.

New York State Building Code**—**This is a performance code; thus, no specific standard is adopted by reference.

Chicago Municipal Code**—**ASA (American Standards Association) A59.1-1954 (described as USASI A59.1-1954 in the 1968 New York City Building Code) is adopted.

BOCA-BBC**—**Refers to the same standard as the Chicago Municipal Code.

5.20 THIN SHELL AND FOLDED PLATE CONSTRUCTION

Only the New York City Building Codes have specific provisions summarized in Table 7–3 of this report.

5.21 SUSPENDED STRUCTURES

Only the New York City Building Codes have specific provisions summarized in Table 7–3 of this report.

Chapter 6
FOUNDATIONS

6.1 GENERAL REQUIREMENTS

1968 and 2001 New York City Building Codes—Foundations of buildings including retaining walls and other structures are required to bear on, or be carried down to, satisfactory bearing materials in such a manner that the entire transmitted load will be distributed over the supporting soils at any depth beneath the foundation at unit intensities within the allowable bearing values. In addition, foundations must be proportioned to limit settlements to a magnitude that will not cause damage to the proposed construction or to existing adjacent or nearby buildings during and after construction. The New York City Building Codes specifically adopt a number of American Wood–Preservers' Association and ASTM International (ASTM) standards as Reference Standard RS 11. The specified depth of foundation is below "the lowest level of the adjoining ground or pavement surface that is exposed to frost."

New York State Building Code—Protection is required whenever structural material or assemblies are subject to deterioration from causes such as freezing and thawing and might become structurally unsound if unprotected. Also required is prevention of ground and surface water penetrating into habitable spaces, basements and cellars. There is no requirement concerning depth of foundation.

***Chicago Municipal Code*—**Encroachment of foundations on public property is discussed. The depth of foundation must be below the adjoining ground surface.

***BOCA-BBC*—**Foundations must have adequate strength to support the superimposed live and specified loads in addition to their own dead load without exceeding the allowable stress specified in the Basic Code or in accepted engineering standards. The Building Officials and Code Administrator (BOCA) Basic Building Code (BBC) also requires: "Except when erected on rock or when otherwise protected from frost, foundation walls, piers and other permanent supports shall extend below the frost line….No footings shall be founded on frozen soils unless such frozen condition is permanent."

6.2 SOIL INVESTIGATIONS

***1968 and 2001 New York City Building Codes*—**Soil investigation (borings or test pits) is mandatory, although certain exceptions are allowed. The New York City Codes have provisions concerning boring methods and provisions for the use of probings, auger borings, or geophysical methods to substitute for borings. The other codes do not have similar provisions. The New York City Codes also allow existing boring data to be used, provided certain specified conditions are met.

***New York State Building Code*—**Soil investigation is mandatory for buildings in which the sum of snow load and live loads of all floors that are transmitted by columns or walls to the soils, divided by grade-floor area, exceeds 200 psf.

***Chicago Municipal Code*—**Where there is reasonable doubt as to the character and bearing capacity of the soil, the building commissioner may require borings, test pits, or test loads.

***BOCA-BBC*—**Only one exploratory boring is mandatory for other than low-rise buildings or for deep foundations “in the absence of satisfactory data from immediately adjacent areas.”

6.3 FOUNDATION LOADS

1968 and 2001 New York City Building Codes—The loads to be used in computing the bearing pressures on materials directly underlying footings, and the loads to be used in computing pile reactions are clearly set forth. Provisions are given for: (a) earth and ground water pressures, (b) wind and other superstructure loads, and (c) soil movements. Provision for eccentricity of loading on foundations is given. Uplift and overturning forces due to wind and hydrostatic pressure are required to be considered. Impact loads are allowed to be neglected except in certain specified cases.

New York State Building Code—Overturning and uplift forces due to wind or hydrostatic head are required to be considered, but no other provisions are included.

Chicago Municipal Code—No provisions concerning foundation loads are included.

BOCA-BBC—All retaining walls and other walls below grade are required to be designed to resist lateral soil pressures with due allowance for hydrostatic pressures for all superimposed vertical loads. All foundation slabs and other footings subjected to water pressure are also required to be designed to resist a uniformly distributed uplift equal to the full hydrostatic pressure.

6.4 ALLOWABLE SOIL BEARING PRESSURES

***1968 and 2001 New York City Building Codes*—**Soils are classified in Code Table 11–1 (Annex B1 of this report). Some soils are designated as satisfactory bearing materials, others are designated as nominally unsatisfactory bearing materials. The allowable bearing pressures on satisfactory bearing materials are given in Code Table 11–2 (Annex B1). Provisions are included for construction on nominally satisfactory bearing materials. Provisions are also given to prevent damage to utility service lines laid in soil materials.

***New York State Building Code*—**The bearing value of soil is required to be determined so that foundations are proportioned to provide a minimum of absolute and differential settlement. Soil or pile tests, presumptive bearing values of the soil, reduction factors for pile groups, and pile driving formulas, referred to in the code, must be in conformity with generally accepted standards. When it can be proven conclusively that the presumptive soil bearing value is adequate for the proposed load, the enforcement officer may accept such proof in lieu of the bearing capacity determination

***Chicago Municipal Code*—**Soils are classified into: solid rock, soft rock, boulders, gravel, sand, inorganic silt, clay, hardpan, and organic soil. Maximum allowable pressures on the supporting soils at the bottom of footings are given in Code Table 70–2.4(a) (Annex B4 of this report).

***BOCA-BBC*—**Presumptive surface bearing values of foundation materials are given in Table 15 (Annex B5 of this report). Except when determined by field loading tests or as otherwise provided in the code, the maximum allowable pressure on supporting soils under spread footings at or near the surface is required not to exceed the values specified in Table 15. Surface values of allowable bearing pressures may be adjusted for deep footings and for bearing under piles as provided for in the BOCA-BBC.

6.5 SOIL LOAD BEARING TESTS

1968 and 2001 New York City Building Codes—Soil load bearing tests may be accepted as evidence of allowable bearing capacity of a given soil stratum, subject to a number of limitations, one of which is that such tests must not be used to justify allowable bearing pressures in excess of the maximum allowable bearing values in Code Table 11–2 (Annex B1 of this report). Provisions are given for preparation, loading of the soil, and determination of bearing capacity.

New York State Building Code—Acceptance criteria for field loading soil tests are given.

***Chicago Municipal Code*—**Whenever the bearing value of soil is in reasonable doubt or when it is desired to use soil-bearing values in excess of those established in Code Table 70–2.4(a) (Annex B4 of this report), the allowable load on a bearing material may be determined by test in accordance with requirements given in the Code.

***BOCA-BBC*—**The maximum allowable pressure on supporting soils may be determined by field loading test. Test procedure and acceptance criteria are given.

6.6 FOOTINGS, FOUNDATION PIERS, AND FOUNDATION WALLS

***1968 New York City Building Code*—**There are provisions concerning wood footings, wood and steel poles supporting buildings, foundation grillages, concrete footings that must conform to ACI 318-63 and masonry footings that must conform to USASI A-41.2 1960. The Code also has provisions concerning foundation piers, which must be designed as columns, of unreinforced and reinforced concrete as well as unreinforced and reinforced masonry. Finally, there are provisions concerning concrete and masonry foundation walls. Provisions regulating construction of footings, foundation piers, and foundation walls are also included.

***2001 New York City Building Code*—**The same provisions as in the 1968 Code are included, but the standards have been updated.

***New York State Building Code*—**There are no specific provisions on footings, foundation piers, or foundation walls.

***Chicago Municipal Code*—**There are provisions concerning concrete footings, which must be constructed of solid masonry or concrete with or without reinforcement. There are provisions concerning foundation columns, which must consist of steel pipe shells extending to rock and completely filled with concrete with or without steel reinforcement or cores. There are provisions concerning foundation piers and caissons, which must be of concrete with or without steel reinforcement, extending to solid rock or to hardpan.

BOCA-BBC—There are provisions concerning footing design, timber footing, steel grillages, unreinforced concrete footings, masonry unit footings, reinforced concrete footings, and mat, raft and float foundations. There are provisions concerning foundation piers—unreinforced, reinforced, and with steel shells, and foundation walls.

6.7 PILE FOUNDATIONS—GENERAL REQUIREMENTS

1968 and 2001 New York City Building Codes—Provisions are included concerning minimum pile penetrations, use of existing piles at demolished structures, tolerances and modification of design due to field conditions, minimum spacing of piles, minimum section, capping and bracing of piles, splicing of piles, general requirements for installation of piles, use of uncased concrete pile shafts, use of more than one pile type, pile capacity, or method of pile installation and pile materials.

New York State Building Code—There are no specific provisions on any of the above.

Chicago Municipal Code—Provisions are included concerning minimum spacing of piles and pile caps.

BOCA-BBC—A building site must be investigated for all conditions that might promote deterioration of pile foundations, and approved protective measures must be taken. The BOCA-BBC also contains provisions concerning minimum length and penetration of piles, precautions (including tolerance to lateral deviation from plumb), spacing of piles, minimum dimensions, piles in wall foundations, isolated pier plies, splices, and corrosion protection.

6.8 PILE FOUNDATION—LOADS

1968 and 2001 New York City Building Codes—The allowable axial load on a pile must be the least value considering (a) the capacity of the pile as a structural member, (b) allowable bearing pressure on soil strata underlying the pile tips, (c) capacity as indicated by resistance to penetration, (d) capacity as indicated by load test, and (e) maximum allowable loads – (1) Basic maximum load values are given in Code Table 11–6 (Annex B1 of this report); (2) Loads higher than the basic values can be substantiated on the basis of tests and analysis. Provisions for allowable lateral load are given. A minimum factor of safety of two is required against withdrawal. The safety factor needs to be greater if the pile is subject to dynamic loading. If the safety factor is three or more, no pull-out test is required.

New York State Building Code—No specific provisions are included concerning allowable pile load.

Chicago Municipal Code and BOCA-BBC—Both codes have detailed provisions, summarized in Table 7–4, which are similar to those in the New York City Building Codes.

6.9 PILE DRIVING OPERATIONS

The New York City Building Codes have provisions concerning equipment and procedures for pile driving with the proviso that the provisions do not apply to piles driven with a vibration hammer or other equipment wherein the energy of impact cannot be evaluated. The BOCA-BBC is the only other code with provisions on pile driving operations, but regulates jetting only.

6.10 PILE TYPES – SPECIFIC REQUIREMENTS

1968 and 2001 New York City Building Codes—There are provisions concerning timber piles, precast concrete piles, cast-in-place concrete piles, compacted concrete piles (a concrete pile formed with an enlarged base in which the concrete in the base is placed in small batches that are compacted prior to attaining an initial set), steel H piles, concrete filled pipe piles, caisson piles (concrete filled pipe piles that are socketed into bedrocks of certain classes and constructed with steel cores), and composite piles.

New York State Building Code—There are no specific provisions.

Chicago Municipal Code—There are provisions concerning timber piles, precast concrete piles, cast-in-place concrete piles, structural steel pipe piles, concrete-filled steel piles, and special type of piles, including composite piles.

BOCA-BBC—This code contains provisions concerning timber piles, precast concrete piles, cast-in-place concrete piles, structural steel pipe piles, concrete-filled steel piles, drilled caissons, composite piles, as well as special piles and caissons.

6.11 UNDERPINNING

The New York City Codes are the only ones among the five codes reviewed to have specific provisions concerning support of adjacent existing structures.

6.12 STABILITY

The New York City Building Codes specify minimum factors of safety against sliding and overturning. There is no such explicit requirement in the other codes. (Section 5.6 of this report dealt with stability of structural elements; this section deals with stability of foundation elements.)

6.13 INSPECTION

The New York City Building Codes specifically require inspection of the following: boring operation; piling; footings, foundation piers, foundation walls and pile caps; subgrade for footing, foundation piers, and foundation walls; construction required for or affecting the support of adjacent properties or buildings. The other codes do not have any specific foundation inspection requirements.

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Chapter 7
DETAILED COMPARISON TABLES

Tables have been prepared to provide detailed comparisons of the structural provisions of the five codes that were reviewed. Comparisons of provisions concerning definitions, loads, structural work, and foundations are given in Tables 7–1 through 7–4, as follows:

- Table 7–1, Definitions
- Table 7–2, Loads
- Table 7–3, Structural Work
- Table 7–4, Foundations

These tables can be found following Chapter 9 of this report. The tables include "comments" that summarize the comparisons.

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Chapter 8
SUMMARY

The structural provisions of the New York City Building Code, 1968 edition, which were required by the Port Authority to be followed in the design of World Trade Center (WTC) 1 and WTC 2, are compared in this report with the structural provisions of the 2001 edition, the edition currently in effect. Also compared are the structural provisions of three other contemporaneous codes: the New York State Building Code, 1964 edition; the Municipal Code of Chicago, 1967 edition (Chicago was chosen as a major U.S. city with tall buildings, outside of the northeastern states); and the Building Officials and Code Administrator (BOCA) Basic Building Code (BBC), 1965 edition (chosen as the model building code typically adopted as the basis of local codes in the northeastern states).

With respect to structural design provisions, the major changes from the 1968 to the 2001 edition of the New York City Building Code are the inclusion of seismic design requirements and updating of standards. Of the codes contemporaneous with the 1968 New York City Building Code, only the BOCA-BBC had seismic design requirements, which were adopted from the 1962 edition of the Uniform Building Code (UBC). Taller buildings have longer periods of vibration, which means lower seismic design forces. Also, since New York City is in an area of moderate seismicity (UBC Zone 2A), additional seismic detailing requirements are minimal to nonexistent.

The alternate live load reduction provisions for columns, walls, and piers of the 1968 and 2001 New York City Building Codes are the same as in the Chicago Municipal Code; the New York State Building Code has more liberal live load reduction provisions for upper portions of buildings (see Fig. 4–1 of this report). The New York City Building Codes also have live load reduction provisions based on contributory floor area and live-to-dead load ratio. For live-to-dead load ratios of 0.625 or less, the New York City code provisions may yield higher live load reduction for columns, walls, and piers than allowed by the other codes. For beams and girders, the live load reduction provisions of the New York City Building Codes are comparable to those of the New York State Building Code and the BOCA-BBC. The Chicago Municipal Code has more conservative requirements (see Table 4–2 of this report). The maximum live load reduction allowed for beams and girders in the Chicago Municipal Code is 15 percent, compared with 40 percent in the other codes.

Minimum wind loads on vertical surfaces required by the various building codes are compared in Fig. 4–2. The largest shear force at the base of a building is obtained from the BOCA-BBC when the height of the building is taken equal to 1,368 ft (i.e., the height of WTC 1). Similarly, the largest overturning moment at the base of a building the height of the WTC towers is also obtained from the BOCA-BBC. Thus, the New York City Building Codes do not have the most stringent wind load provisions. Base shear forces and overturning moments from the codes reviewed for a building the height of WTC towers are compared in Table 4–6 of this report.

The primary materials design standards referenced by the 1968 New York City Building Code, the Chicago Municipal Code and the BOCA-BBC are the 1963 edition of ACI 318, *Building Code Requirements for Reinforced Concrete*, and AISC 1963, *Specifications for the Design, Fabrication and*

Erection of Structural Steel for Buildings. The New York State Building Code, being a performance code, does not adopt any specific standards by reference. The 2001 New York City Building Code adopts the 1989 edition of ACI 318, AISC 1989, *Specifications for Structural Steel Buildings – ASD and Plastic Design*, and AISC-LRFD 1993, *Load and Resistance Factor Design Specifications for Structural Steel Buildings*.

The New York City Building Codes have extensive and quite rigorous foundation design and construction requirements. The foundation related provisions of the other codes are less extensive and typically less rigorous.

New York City Building Codes prescribe testing and inspection requirements for all materials, assemblies, forms and methods of construction. The other three codes require that materials and methods of construction meet the criteria of generally accepted standards. With respect to foundations, only the New York City Building Codes have specific requirements for foundation inspection.

Chapter 9
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Table 7–1. Definitions.

Table 7–1. Definitions.

NYC Building Code (1968)		NYC Building Code (2001)		NY State Building Construction Code (1964)	
Article 2 Definitions				***C108 Abbreviations and Definitions***	
Sub-Article 200.0 General				***C108-1 General***	
200.1	Application of terms	27-229	Same		
200.2	Definitions in reference standards	27-230	Same		
200.3	Tense, gender, and number	27-231	Same		
				C108-2	Abbreviations
Sub-Article 201.0 Definitions		***27-232***		***C108-3 Definitions***	
Accessory building		Accessory Building		Accessory structure	
Accessory use		Accessory use		Accessory use	
		Accessible			
		Accessible route			
Access stair					
		Adaptable dwelling units			
Addition		Addition		Addition	
Adjoining grade elevation		Adjoining grade elevation			
				Alley	
		Allowable soil pressure			
		Allowable stress			
Alteration		Alteration		Alteration	
Apartment house		Apartment house			
		Approved		Approved	
Area of refuge		Area of refuge			

Municipal Code of Chicago (1967)		BOCA Building Code - Basic Code (1965)		Comments
		Article 2 Definitions and Classifications		
		200.0 Scope		
		200.1	Application of terms	
		200.2	Application of other laws	
		201.1	Tense, Gender and number	
		201.2	Terms not defined	
Chapter 47 Definitions		***Definitions***		
		ABC		
Accepted engineering practice		Accepted engineering practice		
Building, accessory		Accessory structure		
Accessory use		Accessory use		
Addition		Addition		
Aisles, longitudinal				
Aisles, transverse				
Alcove				
		Alley		
Alteration		Alteration		
Apartment building		Apartment		
Approved		Approved		
		Appurtenant structure		
		ABC		
Accepted engineering practice		Accepted engineering practice		
Building, accessory		Accessory structure		
		Appurtenant structure		
		ABC		
Accepted engineering practice		Accepted engineering practice		
Building, accessory		Accessory structure		
		Area (building)		
		Area (floor surface measurement)		

Table 7–1. Definitions (continued).

NYC Building Code (1968)	NYC Building Code (2001)	NY State Building Construction Code (1964)
Areaway	Areaway	
Assembly space	Assembly space	Assembly place
Attic	Attic	Attic
Balloon frame	Balloon frame	
Basement	Basement	Basement
		Bathroom
Bearing	Bearing	
Breezeway	Breezeway	
Building	Building	Building
		Building line
Building section	Building section	
Bulkhead	Bulkhead	
	Cabaret	
Casing-off	Casing-off	
Catch platform	Catch platform	
Cellar	Cellar	Cellar
Chimney	Chimney	
Chimney connector	Chimney connector	
Concentrated load	Concentrated load	
Concurrent loads	Concurrent loads	
Construction	Construction	

Municipal Code of Chicago (1967)	BOCA Building Code - Basic Code (1965)	Comments
	Areaway	
	Ashlar facing	
	Ashlar masonry	
Assembly unit		
	Attic	
Balcony		
Basement	Basement	
	BBC	
	Bay	
	Bay window	
	Brick	
Building	Building	
	Building line	
	Building official	
	Building service equipment	
	Building site	
	Buttress	
	Cellar	
	Certificate of use and occupancy	
	Change of use	
Chimney	Chimney	
	Clay masonry unit	
	Concrete	
	Concrete masonry unit	

Table 7–1. Definitions (continued).

NYC Building Code (1968)	NYC Building Code (2001)	NY State Building Construction Code (1964)
Construction class	Construction class	Construction classification
		Construction fireproof
Console lift	Console lift	
Contractor	Contractor	
Controlled inspection	Controlled inspection	
		Convalescent home
Corridor	Corridor	Corridor
Court	Court	Court, inner
		Court, inner, width
Cross aisle	Cross aisle	
		Curb level
Dead load	Dead load	Load, dead
Demolition	Demolition	
Dwelling	Dwelling	
Dwelling unit	Dwelling unit	
		Enforcement officer
Engineer	Engineer	
Equivalent uniform load	Equivalent uniform load	
	Existing building	
	Existing high rise building	
	Existing office building, >100 ft	
Exit	Exit	Exit
Exterior separation	Exterior separation	
Exterior stair	Exterior stair	
		Fallout shelter
Floor area	Floor area	Floor area
Floor area (net)	Floor area (net)	
Folded plate	Folded plate	
Footing	Footing	
Foundation (building)	Foundation (building)	
Foundation pier	Foundation pier	
Foundation wall	Foundation wall	
Framework	Framework	

Municipal Code of Chicago (1967)	BOCA Building Code - Basic Code (1965)	Comments
	Construction equipment	
	Construction operation	
Controlled materials	Controlled materials	
	Corridor	
Court, inner	Court	
	Curb level	
	Dwellings	
Dwelling unit	Dwelling unit	
Building, existing	Existing building	
Exit	Exitways	
	Exterior masonry wall construction	
	Concrete masonry unit	
Floor area		
	Formed steel	
	Foundation	
Foyer	Foyer	
	Frame construction	

Table 7–1. Definitions (continued).

NYC Building Code (1968)	NYC Building Code (2001)	NY State Building Construction Code (1964)
		Generally accepted standard
Grade	Grade	Grade, finished
Grade beam	Grade beam	
Grandstand	Grandstand	
Habitable room	Habitable room	Habitable space
		Hallway
		Hanger
Height (buildings)	Height (buildings)	Height, building
	High rise	
Hoistway	Hoistway	Hoistway
Horizontal exit	Horizontal exit	Horizontal exit
Impact load	Impact load	
Inner court	Inner court	
		Interior finish
Interior stair	Interior stair	
		Interior trim
		Kitchen
		Kitchenette
Lagging	Lagging	
Lamella	Lamella	
		Legal open space
Live load	Live load	Load, live
		Load, design
		Load, imposed
		Load, racking
Load bearing	Load bearing	
Loading ramp	Loading ramp	
		Lobby
Lot line	Lot line	Lot line
	Low rise	
		Luminous ceiling
	Mall	
		Masonry
Mezzanine	Mezzanine	Mezzanine
Minor alterations	Minor alterations	

Municipal Code of Chicago (1967)	BOCA Building Code - Basic Code (1965)	Comments
Garage	Garage	
	Grade	
	Grade hallway	
	Habbitable room	
	Hallway, grade; hallway, public	
	Airplane hanger	
Height	Height, building	
	Hoistway enclosure	
	Light gauge steel construction	
	Limit control	
	Load	
	Lobby	
	Lot line	
	Masonry	
Mezzanine	Mezzanine	

Table 7–1. Definitions (continued).

NYC Building Code (1968)	NYC Building Code (2001)	NY State Building Construction Code (1964)
		Mixed occupancy
		Municipality
Multiple dwelling	Multiple dwelling	
Nonbearing	Nonbearing	
Nonconcurrent loads	Nonconcurrent loads	
Nonloadbearing	Nonloadbearing	
		Nonhabitable space
		Nursing home
Occupancy	Occupancy	Occupancy
Occupancy group	Occupancy group	Occupancy classification
Occupant load	Occupant load	
Occupiable room	Occupiable room	
		Occupied
		Occupied space
		Old-age home
Open parking lot	Open parking lot	
Open parking structure	Open parking structure	Open parking structure
Open shaft	Open shaft	
Ordinary repairs	Ordinary repairs	
Outer court	Outer court	Court, outer
		Court, outer, width
		Owner
Parapet	Parapet	Wall, parapet
		Parking lift, automobile
Parking tier	Parking tier	
Partition	Partition	
		Passage way
Penthouse	Penthouse	
Pile	Pile	
Pile car	Pile car	
Place of assembly	Place of assembly	
Platform frame	Platform frame	

Municipal Code of Chicago (1967)	BOCA Building Code - Basic Code (1965)	Comments
	Minimum habitable room height	
	Minimum habitable room size	
	Mortar	
	Municipality	
Occupancy		
	Occupancy load	
	Occupiable room	
	Occupied	
Ordinary construction	Ordinary materials	
	Oriel window	
Court, outer		
	Owner	
	Panel	
	Panel wall	
Partition		
Partition, bearing		
	Passageway	
Penthouse	Penthouse	
	Place of assembly	

Table 7–1. Definitions (continued).

NYC Building Code (1968)	NYC Building Code (2001)	NY State Building Construction Code (1964)
Pole footing	Pole footing	
Ponding	Ponding	
		Premises
Private garage	Private garage	
		Projection, street
		Property line
Public garage	Public garage	
Public space	Public space	Public space
Rebound	Rebound	
		Repair
Required	Required	Required
		Residual deflection
Retaining wall	Retaining wall	
Roof	Roof	
Roof covering	Roof covering	Roof covering
Roof structure	Roof structure	
Safe area	Safe area	
School	School	
Self-relieving construction	Self-relieving construction	
Service equipment	Service equipment	
Shaft	Shaft	Shaft
Shall	Shall	Shall
Shell	Shell	
Spandrel wall	Spandrel wall	Wall, spandrel
Spray booth	Spray booth	
Stack	Stack	
		Stage
		Stairway
		Store

Municipal Code of Chicago (1967)	BOCA Building Code - Basic Code (1965)	Comments
	Prefabricated	
	Prefabricated building	
	Prefabricated sub-assembly	
	Prefabricated unit	
	Preservative treated wood	
	Primary member	
	Professional engineer or architect	
	Public space	
	Reinforced concrete	
	Repair	
	Required	
	Roof	
	Roof covering	
	Roof structure	
	Rubble masonry	
	Secondary member	
	Shaft	
	Shall	
	Solid masonry	
	Stage	
	Stairway	

Table 7–1. Definitions (continued).

NYC Building Code (1968)	NYC Building Code (2001)	NY State Building Construction Code (1964)
Story		
Street floor		
		Structural failure
Structure	Structure	
Sump pit	Sump pit	
Transfer column	Transfer column	
Uniformly distributed load	Uniformly distributed load	
Use (used)	Use (used)	
		Wall, curtain
		Wall, panel
		Wall, party
		Watchman's system
Yard	Yard	Yard
		Yield strength
Zone	Zone	
Zoning resolution	Zoning resolution	

Municipal Code of Chicago (1967)	BOCA Building Code - Basic Code (1965)	Comments
	Story	
	Street	
	Street lot line	
	Structure	
	Structural clay tile	
	Tile	
	Use group	
	Apron wall	
Wall, bearing	Bearing wall	
	Curtain wall	
	Panel wall	
	Party wall	
	Division wall	
Wall, non-bearing	Non-bearing wall	
Wall, parapet	Parapet wall	
Wall, retaining	Retaining wall	
	Skeleton or panel wall	
	Spandrel wall	
	Yard	
	Zoning	

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Table 7–2. Loads

Table 7–2. Loads.

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Article 9 Loads			***Subchapter 9 Loads***		***C304 Design Loads***	
Sub-Article 900.0 General			***Article 1 General***		***C304-1 General Requirements***	
900.1	Scope	Buildings and parts thereof, shall be capable of resisting all loads actually imposed thereon without exceeding the allowable stresses prescribed in Articles 10 (Structural Work) and 11 (Foundation). In no case shall the assumed loads be less than the minimum values established herein.	27-550	Same; In addition, within special flood hazard areas, and below the flood datum, as described in Article 10 of Subchapter 4 of this chapter, applicable load requirements of Reference Standard RS 4-5 [Annex A2][a] shall be applied.	C301-a C304-1	C301 a- Buildings and parts thereof shall be capable of sustaining safely their own weight and the loads to which they may be subject. C304-1 A building and all parts thereof shall be of sufficient strength to support the design loads and to resist the deformations caused by such loads to which they may by subjected, without exceeding the allowable stresses as described in C305-1. Such loads shall include the dead load and the following imposed loads where applicable: live, snow, wind, and soil pressure including surcharge, hydrostatic head, and impact loads.
900.2	Reference Standards	The provisions of Reference Standard RS-9 [Annex A1] shall be a part of this article.	27-551	Same		
900.3	Definitions	For definitions used in the interpretation of this article, see Article 2- Definitions.	27-552	Same	C108-3	Definitions

a. These are references to Annexes to this report that contain the items referenced in the codes.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
Chapter 68 Minimum Design Loads			***Article 7 Structural and Foundation Loads and Stress***			
68-1 General			***700.0 Scope***			
		Buildings or other structures hereafter erected shall be designed and constructed to support safely the minimum design loads, including dead loads as required in this section, without exceeding the allowable stresses required in this code for the materials of construction in the structural members.			The provisions of this article shall control the structural design of all buildings and structures and their foundations hereafter erected to insure adequate strength of all parts thereof for the safe support of all superimposed live and special loads to which they may by subjected in addition to their own dead load, without exceeding the allowable stresses prescribed in the Basic Code or in accepted engineering practice.	
		See Chapter 48 (Definitions).			See Article 2. Definitions for the following terms are also given in Section 701.0: Controlled construction; Controlled materials; Foundation wall; Light gage steel construction; Load: (dead load; earthquake load; impact load; lateral soil load; live load; wind load); Ordinary materials; Primary member; Secondary member; Steel joist; Structural steel member.	Besides the definitions in Article 2, BOCA includes some additional definitions for terminologies used in Article 7.
			702.0	Design Safe Load	702.1 Structural analysis. The safe load shall be determined by accepted analysis or tests if not capable of analysis. 702.2 Check tests. When there is reasonable doubt as to the design capacity.	
			703.0	Test Safe Load	703.1 When required. When not capable of design by accepted engineering analysis, any system shall be subjected to tests prescribed in Article 8 or test standards in Appendixes D, E [Annex A5], or other tests accepted by building officials. 703.2 Test load. When approved by test, every structural assembly shall sustain without failure minimum superimposed loads equal to 2.5 times the required live load; and under the approved working load, the deflection shall not exceed the limits prescribed in Section 804.	

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Sub-Article 901.0 Dead Loads			***Article 2 Dead Loads***			
901.1	Construction Materials and Assembled Elements of Construction	Except as provided in Section 901.3, the dead load shall be the actual weight of the building materials or construction assemblies to be supported, computed from the unit weights given in Reference Standard RS 9-1 [Annex A1]. Where unit weights are not established in RS 9-1, the actual weights may be determined by analysis or from data in manufacturer's drawings or catalogs. Unit weights less than those given in RS 9-1 may be used only with approval of the commissioner.	27-553	Same		
901.2	Service Equipment	Provision shall be made for the weights of all building service equipment. The weights of such equipment (or the allowances therefore) shall be included in the dead load. The weight of equipment that is part of the occupancy of a given area shall be considered as live load. See also Sections C26-902.2 (b) (2) and C26-902.2 (d).	27-554	Same		
901.3	Partition Loads	Weights of all partitions shall be considered, using either actual weights or the equivalent uniform load given in (b) below. (a) Actual loads. - Where actual partition weights are used, the uniform design live load may be omitted from the strip of floor area under each partition. (b) Equivalent uniform load. - The equivalent uniform partition loads in Reference Standard RS 9-1 [Annex A1] may be used in lieu of actual partition weights except for bearing partitions or partitions in toilet room areas (other than in one- and two-family dwellings), at stairs and elevators, and similar areas where partitions are concentrated. In such cases, actual partition weights shall be used in design. Except as otherwise exempted, equivalent uniform loads shall be used in areas where partitions are not definitely located on the plans, or in areas where partitions are subject to rearrangement or relocation.	27-555	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
			705.0	***Design Dead Load***		
			705.1	Construction Materials	In estimating dead load for the purposes of structural design, the actual weights of materials shall be used, but in no case less than the unit dead loads prescribed in Appendix J [Annex A5].	There are some differences in the dead load values prescribed in the NYC and BOCA codes, e.g.: 12" hollow concrete block: 85 psf (NYC) vs. 74 psf (BOCA); 6" hollow concrete block: 42 psf (BOCA), vs. not found in NYC. No corresponding provisions are given in NY State and Chicago codes.
			705.2	Service Equipment	The weight of all building service equipment shall be included in the dead load supported by the structural frame.	NYC Building Code is more specific than BOCA. The NY State and Chicago Building Codes do not have comparable provisions.
68-2.7	Partitions	In office buildings or similar structures in which subdividing partitions may be erected, dead load for such partition of not less than 20 psf shall be assumed	705.3	Partition Load	In office or other buildings, provisions shall be made to support the actual weight of the partitions where they occur or for an equivalent uniform load, which shall be not less than 20 psf of floor area.	NYC 1968 and 2001: Equiv. uniformly distributed partition loads are given, which are less than or equal to 20 psf (See RS 9-1). NY State: No relevant provisions are given. Chicago & BOCA: Not less than 20 psf.

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Sub-Article 902.0 Live Loads			***Article 3 Live Loads***		***C304-2 Live Loads***	
902.1	General	In addition to the applicable dead, wind, and other loads, the building shall be designed for uniform live loads, for concentrated live loads, or for concurrent combinations of uniform and concentrated live loads, whichever produce the greatest stress.	27-556	Same	C304-2.1	General a- Loads set forth in Table C304-2.2 do not include unusual concentrations, such as heavy machinery, equipment, water tanks and elevator machine loads. Where such loads occur, suitable provisions shall be made for their support. b- Where such unusual concentrations do not occur, structural members and floors shall be designed to support the uniformly distributed loads or the concentrated loads in Table C304-2.2 [Annex B3], whichever produce the greater stress.
902.2	Floor Live Loads	(a) Uniformly distributed live loads.- The minimum design values established in Reference Standard RS 9-2 [Annex A1] for various occupancies or uses shall be used subjected to the provisions of (d) below. Where the occupancy or use of a space does not conform to any of those listed, the design load shall be determined by the architect or engineer subject to approval by the commissioner. (b) Concentrated live loads.- (1) The bldg shall be able to support concentrated live load established in RS 9-2 [Annex A1], placed so as to produce maximum stress. (2) Floors that support any items of machinery, electrical or mechanical equipment, or other concentrated live load in excess of 1000 lbs. (including the weights of pads or bases) shall be designed to support such weight as a concentrated load or group of concentrated loads. (c) Where RS 9-2 [Annex A1] indicates that the concentrated live load is nonconcurrent with the uniform live load, it may be assumed that the total concentrated load is to be omitted when the uniform load is present and that the total uniform load is to be omitted when the concentrated load is present. (d) Conformance. - For purpose of determining that the magnitude of the actual live load conforms to or is less than the minimum design live load established in this section, the actual uniform live load shall be approximated by averaging the total load actually applied over a rectangular area of 150 sft having no side less than 8 ft.	27-557	Same	C304-2.2	**Uniformly distributed and concentrated live loads:** Shall be the greatest loads produced by the intended occupancy and use, but in no case less than the minimum LL in conformity with Table C304-2.2 [Annex B3]. Minimum loads for occupancies and uses not included in the table shall be in conformity with generally accepted standards. Where a concentrated load is not given, load shall be > 250 lbs on an area of 1in. in diameter. Load values for some specific concentrated load situations are given.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
			704.0	***Design Live Load***		
					704.1 Required live load: Shall be the greatest load produced by the intended use and occupancy, but in no case less than required in section 707. 704.2 Load not specified.- Building official shall determine the value for the loads not listed in Table 13 [Annex B5].	As in the case of dead load, the live load provisions are categorized in a similar, but not completely comparable way in the four codes (NYC 1968 and 2001 are the same). The values specified are similar.
68-2	Floor Loads	68-2.1 Uniformly distributed floor loads: The live loads assumed for purpose of design shall be the greatest combination of loads that it is estimated will be produced by the intended occupancies or uses; provided that the live loads to be considered as uniformly distributed shall be not less than the values established in Table 68-2.1 [annex B4], with reductions as permitted in 68-2.2. 68-2.3 Concentrate live load: Floors shall be designed to carry the specified uniformly distributed live load or the following minimum concentrated loads, whichever may produce the greater stress. The indicated concentrations shall be assumed to occupy an area of 2.5 sft and to be so placed as to produce maximum stresses in the affected members. Office floors: 2000 lbs. Garages for passenger automobiles: 2000 lbs. Garages for buses and trucks: not less than actual rear wheel load when fully loaded.	707.0 708.0	Unit Live Loads Concentrated Loads	707.1 Uniform live load.- The minimum uniformly distributed live load shall be as provided in Table 13 [Annex B5] and for all concentrated loads wherever they occur as provided in Section 708. 707.2 Heavy truck loads.- The floor loads for garages designed to house trucks or buses exceeding 20,000 lbs shall be determined by the actual load conditions; but in no case shall the assumed load be less than 150 % of the max wheel load. 708.0 Concentrated loads.- Floors of buildings in the use groups specified in Table 14 [Annex B5] shall be designed to support the uniformly distributed live loads in Section 707 or the following concentrated loads, whichever produces the greater stresses. Unless otherwise specified, the indicated concentration shall be assumed to occupy an area of 2.5 sft and shall be positioned to produce maximum stress condition. Exceptions are given for steel joist constructions.	Code requirements are similar.

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
902.3	Live Loads for Sidewalks, Driveways, and Railings	(a) Sidewalks and driveways. - All sidewalks and driveways or portions thereof that are structurally supported shall be designed for a live load of 100 psf uniformly distributed and in accordance with the provisions of Article 10. When subjected to intentionally or accidentally imposed wheel loads of vehicles, the sidewalks and driveways shall be designed for 600 psf uniformly distributed load or maximum vehicular wheel load that could be imposed thereon, whichever develops greater stress. (b) Railings and parapets. - Other than those for place of assembly, railings and parapets shall be designed to resist the simultaneous application of a lateral force of 40 plf and a vertical force of 50 plf to the top of the railing. In places of assembly, the lateral loads shall be increased to 50 plf and the vertical load to 100 plf. An exception is made for railings in one- and two-family dwellings, where a lateral force of 20 plf and a vertical force of 20 plf shall be considered. The total lateral and the total vertical force shall be at least 200 lbs each. Intermediate and bottom rails: Shall be designed for simultaneous application of 40 plf lateral and 50 plf vertical forces. For railings with solid panels: 20 psf. In parking area: 300 plf applied at least 21 in. above the roadway, but no less than 2500 lbs per vehicle.	27-558	(a) Same. (b) Same		
902.4	Columns in Parking Areas	Unless specially protected, columns in parking areas subject to impact of moving vehicles shall be designed to resist the lateral load due to impact and this load shall be considered a load of infrequent occurrence. For passenger vehicles, this lateral load shall be taken as a minimum of 2500 lbs. applied at least 21 in. above the roadway and acting simultaneously with other design loads.	27-559	Same		
902.5	Stage Areas using Scenery or Scenic Elements	Shall be designed for 30 plf of batten length. Locking rails shall be designed for a uniform uplift of 500 psf with a 1000 lbs concentration. Impact factor for batten shall be 75 % and for loft and head block beam shall be 25 %.	27-560	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
68-2.4	Special Loads	Driveways, sidewalks, spaces for storage of loaded or unloaded trucks and buses, and tanks and tracks shall be designed for the actual weight.	702.3	Railings	Railings around stairwells and other floor openings shall be designed to resist a lateral force applied horizontally at the top of the railings of 40 plf, and railings at front of balconies of theatres and similar locations a lateral force of 50 plf. In addition to the lateral load, railings and guards of outdoor assemblies shall sustain a vertical load of 100 plf.	The NYC Building Codes give the most comprehensive provisions. Chicago Code has provisions similar to those in the NYC code. BOCA only has provisions for railings, not covering driveways and sidewalks. NY State Code does not have provisions on this topic.
68-6	Other Loads	Other loads: Railings- Shall be designed to resist a horizontal thrust of 50 plf applied at the top of the railing. Scuttles and Skylights- Shall be designed to support a concentrated load of 200 lbs occupying an area of 2.5 sft and so placed as to produce maximum stresses in the affected members.				

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
902.6	Roof Loads	Roofs and marquees shall be designed for wind, live, and other loads as prescribed in (a) through (d) below. It may be assumed that maximum wind load occurs with zero live load and that maximum live load occurs with zero wind load. For dwellings an exception is made for awnings, canopies, and patio covers, which may be designed for a live load of 20 psf of horizontal projection. (a) Live load. - Minimum design live loads: (1) For roofs with slopes up to and including 20^o from the horizontal, the minimum design live load shall be 30 psf of horizontal projection. (2) For roofs with slope >20^o, shall be 30 psf of horizontal projection, reduced by 1.0 psf for each degree in excess of 20^o. (3) For valleys, live load shall be increased to provide for accumulation of snow. (4) Other shapes, established by architect or engineer. (b) Wind load. - The provisions of Section C26-904.0 shall apply. (c) Concentrated loads.- The provisions of Section C26-902.2(b) shall apply. (d) Special loads.- (1) For roofs used as promenades, assembly areas, or roof gardens, design live load shall be as indicated in RS 9-2 [Annex A1] . (2) When roofs are intended for the ponding of water, the roof shall be designed for maximum possible depth of water. (3) Girders and roof trusses that are regularly utilized for repair of vehicles shall resist, in addition to LL+W, a concentrated live load of 2000 lbs applied on lower chord. (4) When roofs are landscaped, the LL shall be 30 psf, the landscape materials shall be considered as DL computed based on saturated earth, and the area adjacent to the landscape shall be considered as assembly areas unless otherwise specified. (5) When equipment is placed on roof, the design shall provide support.	27-561	Same	C304 - 10 (c)	On roofs not used as promenades, the minimum imposed load shall be 20 psf perpendicular to the roof surface, where snow plus wind loads total less than 20 psf.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
68-3	Roof Loads	68-3.1 Roofs having a pitch of less than 30° shall be designed for a live load normal to the roof surface (including snow load) of 25 psf of roof area. Such live load may be neglected in the design of roofs having a pitch of 30° or more, which shall be designed for wind pressures as required in 68-4.3. 68-3.2 Roofs used for terraces, promenades or similar uses shall be designed for a minimum live load of 60 psf.	711.0	Roof Loads	The structural supports of roofs shall be designed to resist wind and where applicable snow and EQ loads in addition to the dead load and the live load. 711.1 Minimum roof load.- Flat and pitched roof shall be designed for a live load of not less than 20 psf of horizontal projection. In areas subject to snow loads, the roof shall be designed for 30 psf in the absence of specific information as described in 712.2. When used for incidental promenade purposes, roof shall be designed for a minimum of 60 psf; and 100 psf when designed for roof-garden or assembly use. 711.2 Curved roofs.- Roofs with a radius not less than 1/2 span nor more than 3/4 span shall be designed to resist 10 psf of horizontally projected area on buildings 40 ft or less in height; and 15 psf for buildings higher than 40 ft. 711.3 Overhanging eaves.- Minimum 60 psf.	NYC Code: 30 psf (max), reduce 1 psf /1° for pitch > 20°. Chicago: 25 psf; 0 for pitch > or = 30°. BOCA: > or = 20 psf of horizontal projection. In areas subjected to snow loads, 30 psf. NYC Building Codes gives the most comprehensive provisions for roofs subjected to special loads, while NY State Code does not have such provisions.

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
902.7	Moving Loads	(a) General. - C26-902.2 (a) and C26-902.2 (b). (b) Passenger vehicles.- RS 9-2 [Annex A1]. (c) Truck load.- Shall conform to RS 9-3 [Annex A1]. Impact shall be taken as 10 % of vertical load. (d) Railroad equipment.- Shall conform to RS 9-4 [Annex A1]. (e) Crane runways and supports.- (1) Vertical loads: increase 25 % of the lifted loads or 15 % of the wheel loads for impact, whichever is larger. (2) Horizontal load: a- lateral load; b- longitudinal load. (f) Monorail beams and supports (g) Loads on supports for elevators, dumbwaiters, and escalators. (h) Loads on machinery supports (i) Assembly structures (j) Heliports and helistops	27-562	Same		
902.8	Partial Loading Conditions	(a) Uniformly distributed loads. - In continuous framing and cantilever construction, the design shall consider live load on all spans and arrangements of partial live load that will produce maximum stresses in the supporting members. The simplifications given in (1) through (3) below are permissible. (1) Floor and roof framing. - a. For vertical live load applied to the level under consideration, the far ends of the columns above and below that level may be assumed as fixed. b. Combinations of live load may be limited to the following: 1. Live load placed on two adjacent spans. 2. Live load placed on alternate spans. The effects of live load on spans more than two spans away from the span under consideration may be neglected. (2) Arches and gabled frames (3) Columns (b) Moving concentrated loads. - To be arranged to produce maximum stress.	27-563	Same		
902.9	Floor Load to be Posted	(a) Posting required: Shall conform to Section 27-225. (b) Data required: Provisions are given for required data to be shown for uniformly distributed and concentrated loads.	27-564	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only the NYC Building Codes have provisions.
68-2.6	Partial Loads	When the construction is such that the structural elements thereof act together as an elastic frame due to their continuity and the rigidity of the connections, the effect of such partial loading as will produce maximum stress in any member shall be provided for in the design.				The NYC Building Codes give simplified methods, and the most detailed provisions; Chicago is the only other code that gives provisions, which are general in nature.
68-2.8	Posting of Floor Loads	Provisions are given for buildings used for mercantile, industrial or storage purposes. Postings are not required for buildings used for production and distribution of electricity, gas and steam.				Only NYC Building Codes and Chicago Code have provisions concerning posting of floor loads.

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Sub-Article 903.0		***Live Load Reduction***	***Article 4***	***Live Load Reduction***		
903.1	Roof Loads	No reduction shall be permitted.	27-565	Same		Roof load reduction allowed. See C304-2.1.
903.2	Floor Live Loads	The uniform live load to be used for design shall be the basic values in RS 9-2 [Annex A1] multiplied by the percentages given in (a) through (d) below. (a) Except as provided in subdivisions (b),(c),and (d), the percentage in Table 9-1 [Annex B1] shall apply. Contributory areas shall be computed in accordance with C26-903.3. (b) No live load reduction shall be permitted for the following: members and connections (other than columns, piers, and walls) supporting floor areas used for storage (including warehouses, library stacks, and record storage); areas used for parking of vehicles; and areas used as place of assembly, for manufacturing, and for retail or wholesale sales. For columns, piers, and walls supporting such floor areas, the maximum live load reduction shall be 20 %. (c) No live load reduction shall be permitted for calculating shear stresses at the heads of column in flat slab or flat plate construction. (d) In lieu of the percentages given in Table 9-1 [Annex B1], the live load reductions for columns, piers and walls may be taken as 15 % of the live load on the top floor, increased successively at the rate of 5 % on each successive lower floor, with a maximum reduction of 50 %; and for girders supporting 200 sft or more of floor area, the live load reduction may be taken as 15 %. The limitations of (b), (c), and (d) above shall apply.	27-566	Same	C304-2.1	c- Uniformly distributed live loads on beams and girders supporting other than storage areas and motor vehicle parking areas, when such member supports 150 sft or more roof area or floor area per floor, may be reduced as follows: when the DL is not more than 25 psf, the reduction shall be not more than 20 %. When the DL>25 psf, and LL< or = 100 psf, the reduction shall not exceed the least of the following 3 criteria: 60 %; 0.08 %/sft; or 100 %*(DL+LL)/4.33(LL) (psf). d- For columns, girders supporting columns, bearing walls, and foundation walls supporting 150 sft or more roof area or floor area per floor other than storage areas and parking area, the uniformly distributed LL shall not be less than the following percentages of the total LL on the following levels: 80 % on the roof, the floor immediately below the roof, the 2nd floor below the roof; 75 % on the 3rd floor below the roof; 70 % on the 4th floor below; 65 % on the 5th floor below; 60 % on the 6th floor below; 55 % on the 7th floor below; 50 % on the 8th and subsequent floors below.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
68-2.2	Roof Load Reduction	Roof live load reduction is not permitted.	721.0	Live Load Reduction	Roof live load reduction is not permitted.	NY State Code is the only one that allows roof live load reduction.
68-2.2	Reduction of Uniformly Distributed Floor Loads	(1) Columns, walls and piers.- Shall be designed to not carry less than the specified percentage of live load of all floors above. 1 floor: 85 %; 2 floors: 80 % 3 floors: 75 %; 4 floors: 70 % 5 floors: 65 %; 6 floors: 60 % 7 floors: 55 %; 8 floors:50 % (2) Foundations: same as (1). (3) Beams, girders and trusses.- Shall be designed to carry not less than the following percentage of live loads based on the tributary area of the members: For tributary area of 100 sft or less: 100 %; more than 100 sft and not more than 200 sft: 95 %; more than 200 and not more than 300 sft: 90 %; more than 300 sft: 85 %. (4) When the dead load exceeds the live load, the live load specified in 68-2.1 may be reduced by multiplying with the ratio of the specified live load to the dead load, but in no case shall the reduced live load be less than 2/3 of the live load specified in 68-2.1. These reduced live loads are subject to all other provisions in Chap.68. This reduction in live load will not apply to the ultimate strength method in concrete design. Exceptions: For storage rooms, reduction shall not exceed 1/2 of the percentage reductions provided above.	721.0	Live Load Reduction	721.1 Live load not more than 100 psf: The design live load for any member supporting more than 150 sft may be reduced at the rate of 0.08 %/sq.ft. of area supported by the member, except for areas of public assembly (no reduction). The reduction shall exceed neither R as determined by the following formula, nor 60 %: R=100*(D+L)/(4.33L). D&L are design dead and live load per sft supported by the member. 721.2 Live load more than 100 psf: No reduction shall be made, except that the design live load on columns may be reduced 20 %. 721.3 Foundations and column supports: The full dead load plus the reduced live load shall be used in the design of foundations and of trusses or girders which support columns.	NYC Building Codes: Floor live load reduction is based on contributary area and DL/LL ratio; alternative method is based on number of floors above. NY State: Live load reduction for column is based on number of floors above; for beams and girders, it is the same as in BOCA. Upper limit of 100 psf on reducible LL exists. Chicago: Live load reduction for columns is based on number of floors above; for beams and girders, it is based on tributary area. Upper limit of 100 psf on reducible LL exists. BOCA: 0.08 %/sft for floors more than 150 sft in area, but limited by R or 60 %.

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
903.3	Contributory Floor Areas	(a) For the design of one-way and two-way slabs: the product of the shorter span length and a width equal to 1/2 the shorter span length. Ribbed slabs shall be considered as though the slabs were solid. (b) For the design of slabs in flat plate or flat slab construction: 1/2 the area of the panel. (c) For the design of columns and girders or trusses framing into columns: the loaded area directly supported by the column, girder, or truss. For columns supporting more than one floor, the loaded area shall be the cumulative total area of all of the floors that are supported. (d) For the design of joists and similar multiple members framing into girders or trusses, or minor framing around openings: twice the loaded area directly supported but not more than the area of the panel in which the framing occurs.	27-567	Same		
903.4	Foundations and Column Supports	The live load to be supported by the foundation or by trusses or girders that support columns shall be the total column reaction reduced as provided in C26-903.2 and C26-903.3.	27-568	Same		
					C304-3 Snow Loads	Minimum snow loads shall be in conformity with Table C304-3 [Annex B3] and the given snow map, and shall be applied normal to the roof surface. Minimum 30 psf for horizontal roof.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only the NYC Building Codes have provisions.
						Only the NYC Building Codes have provisions.
	68.3.1	Snow load is included as part of the roof load.	712.0	Snow Load	711.1 Minimum roof load.- 30 psf in snow area. 712.1 Shape of roof.- When the effect of the shape of the roof as determined by actual test indicates less or greater snow retention than specified in the article, the roof load shall be modified accordingly. 712.2 Special snow loads.- In sections subject to snow loads as indicated by the average snow depth in the records of US Weather Bureau, the design loads shall be modified accordingly.	Similar in values; NYC Building Codes specify minimum roof load as 30 psf, implying the inclusion of snow load in roof load specifications. Chicago code also includes the snow load in roof load.

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Sub-Article 904.0 Wind Loads			*Article 5 Wind Loads and Earthquake Loads*			
		The structural frame and exterior components of all buildings, signs, tanks, and other exposed constructions shall be designed to resist the pressures due to wind as prescribed in RS 9-5 [Annex A1]. Wind shall be assumed to act from any direction. For continuous framing, the effects of partial loading conditions shall be considered. RS 9-5: 1. Design wind pressures on structural frames. Minimum design pressure due to wind acting on vertical surfaces shall be in accordance with Table RS 9-5.1 [Annex B1], and minimum design pressure acting normal to horizontal or inclined surfaces shall be in accordance with Table RS 9-5.2 [Annex B1]. The occurrence of the pressure on vertical, horizontal, and inclined surfaces of the bldg shall be considered as simultaneous. 2. Wall element. For design of wall elements other than glass panels, the wind pressure acting normal to wall surfaces shall be 30 psf or a 20 psf suction, for all height zones up to 500 ft. These values shall be deemed to include allowance for gust factor. For height zones over 500 ft, the pressure shall be specifically investigated, but not less than the value in Table RS 9-5.1. 3. Roof elements. Wind pressure acting on roof elements supporting small contributory area of wind presentment shall be 1.5 times the value in Table RS 9-5.2. 4. Other bldg elements. Minimum wind pressure to be used in the design of other bldg elements (signs, tanks, chimneys, etc) shall be the values in Table RS 9-5.1 multiplied by the shape factors given in Table RS 9-5.3 [Annex B1]. 5. Eaves and cornices. Overhanging elements of the bldg shall be designed for upward pressures of twice the values in Table RS 9-5.1. 6. Wind load by model test. In lieu of the design wind pressure established in sections 1 &2, design wind pressure may be approximated from suitably conducted model tests. The tests shall be predicted on a basic wind speed of 80 mph at 30 ft level, and shall simulate and include all factors including pressure and suction effects, shape factors, functional effects, gusts, and internal pressures and suctions.	27-569	Article 5 Wind Loads and Earthquake Loads (a) Wind load: same	C304-4 Wind Loads	Minimum wind loads shall be in conformity with Tables C304-4a [Annex B3] and C304-4b [Annex B3], and shall be applied normal to the surface. These loads are based on a design wind speed of 75 mph at a height of 30 ft above grade level. Minimum wind load on signs shall be in conformity with generally accepted standards.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
68-4	Wind Load	68-4.1 Minimum design pressure. Buildings shall be designed and constructed to withstand the horizontal pressures in Table 68-4.1 [Annex B4], allowing for wind from any direction. The height is to be measured above the average level of the ground adjacent to the building. 68-4.2 Exterior wall. Shall be designed and constructed to withstand the pressure required in 68-4.1, acting either inward or outward. 68-4.3 Roofs. Shall be designed for outward pressure equal to 75 % of those in Table 68-4.1. Roofs with slopes greater than 30^{o} shall be designed for inward pressure equal to those in Table 68-4.1. Overhanging eaves and cornices shall be designed and constructed for upward pressure equal to twice those in Table 68-4.1. 68-4.4 Chimneys, tanks and towers. Shall be designed and constructed to withstand the pressures in Table 68-4.1 applied to the projected vertical area multiplied by the following factors: square or rectangular shape: 1.0; hexagonal, octagonal, and round or elliptical shape: 0.8. 68-4.5 Provisions for signs are given. 68-4.6 Provisions for flagpoles are given. 68-4.7 For combined stresses due to dead, live, and wind loads, the allowable stresses in materials may be increased by 1/3, provided that the section thus determined is at least as strong as that required for dead and live load alone. Snow load shall be considered a live load. 68-4.8 Provisions for overturning and sliding are given. 68-4.9 Adequate anchorage of the roof to walls and columns, and of walls and columns to the foundations to resist overturning, uplifting, and sliding shall be provided. 68-4.10 Provisions shall be made for wind stress during erection of a building or other structures.	713.0	Wind Load	The structural frame of all buildings, signs, tanks and other exposed structures or parts thereof shall be designed to resist the horizontal pressures due to wind in any direction, both inwardly and outwardly, allowing for suction on the leeward side, as provided in 714 to 718. 713.1 Torsional resistance- The structural frame shall be designed to resist the torsional moment due to eccentricity of the resultant load.	

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
					C304-5 Overturning Force and Moment Due to Wind	a- The overturning force shall be the wind load. The wind load shall be the load in Table C304-4a [Annex B3], and shall be applied only to the windward vertical surface above the horizontal plane under consideration, and to the rise of the roof. The resisting force shall be the dead load of the structure above the horizontal plane under consideration, plus the strength of material and fastenings establishing continuity with the structure below. b- The moments of stability and overturning shall be computed about the leeward edge of the horizontal plane under consideration. c- The moment of stability of the structure above the horizontal plane under consideration shall be not less than 1.5 times the overturning moment due to wind.
					C304-6 Sliding Force Due to Wind	The sliding force due to wind load, equal to the overturning force, determined in conformity with C304-5, shall be resisted by the dead load of the structure above the horizontal plane under consideration, by anchors, and where applicable, by soil friction, providing a total resisting force equal to not less than 1.5 times the sliding force. Anchors used to resist overturning may also provide resistance to sliding.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
			714.0	Wind on Vertical Surfaces	714.1 Primary framing members.- Height not more than 50 ft: 15 psf. Height not more than 100 ft: 20 psf for the surface above the 50 ft level. Height more than 100 ft: increase by 0.025 psf for each foot in excess of 100 ft above the 100 ft level. 714.2 Distribution of wind force: The wind pressure shall be distributed between opposite walls, 2/3 as normal pressure on the windward side and 1/3 as normal outward suction on the leeward side. 714.3 Secondary wall framing and wall panels.- In buildings provided with 1/3 or more wall openings, internal wind forces of 10 psf shall be assumed to occur simultaneously with the above external forces both in pressure and suction. 714.3.1 External pressures.- External pressure to be considered in the design of secondary wall framing and wall panels and sheathing and their connections shall be 1.5 times those determined in accordance with 714.2. 714.3.2 Internal pressures.- If having 1/3 or more wall surface open, 10 psf internal pressure or 5 psf internal suction, whichever is critical, shall be considered in the design of secondary members. If having less than 1/3 wall surface open, half of the foregoing values apply. 714.4 Design wind load for glass.- Appendix K-12 [Annex A5].	Minimum design wind loads required in various codes on a vertical surface up to a height of 1200 ft are illustrated in Figure 2. NYC Building Code, Chicago Code, and BOCA also provide provisions for secondary elements such as wall elements, roof elements, and other building elements such as chimney, etc. NY State Code, Chicago Code, and BOCA include provisions for overturning, sliding and uplifting forces caused by wind.
			715.0	Wind Load on Roofs	Primary roof framing and truss: 715.1 and 715.2. Secondary roof framing etc.: 1.5 times those determined in 715.1 and 715.2 for external pressure; provisions in 714.3 for internal pressure. 715.1 Pitched roofs. Provisions for the external wind force on primary roof members are given in Exhibit B5-1[Annex B5]. 715.2 Curved roofs. Provisions for curved roofs are given. 715.3 Test determination. The effect of shape of irregular or unusual roofs may be determined by wind tunnel or equivalent tests. 715.4 Anchorage. Roof framing shall be anchored to resist wind uplift and sliding in excess of 75 % of the dead load resistance.	

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
					C304-7 Uplift Force	Uplift force due to wind or hydrostatic head shall be resisted by dead load, acting directly or through anchors or fastening, of not less than 1.25 times the uplift force.
				Article 5 Wind Loads and Earthquake Loads (b) Earthquake loads.- Every building, structure and portion thereof shall, at a minimum, be designed and constructed to resist the effects of seismic ground motions as prescribed in RS 9-6 [Annex A2], which adopted UBC Section 2312 from the 1988 UBC, including the 1990 Accumulative Supplement.		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
			718.0	Overturning and Sliding	718.0 The overturning moment due to wind load shall not exceed 75 % of the moment resulting from the dead load from the building, unless the building is anchored to resist the excess overturning moment and the excess horizontal shear over sliding friction.	
			716.0 717.0	Wind Loads on Signs, Tanks and Radio Towers and Chimneys Unusual Wind Exposures	716.1 Ground signs and towers.- 15 psf for structures up to 50 ft in height, and 20 psf for structures over 50 ft in height. 716.2 Roof Structures.- Roof signs, tank towers, stacks, chimney, etc.: 30 psf. 716.3 Shielding effect.- No shielding effect of one element by another shall be considered when the distance between them exceeds 4 times of the projected smallest dimension of the windward element. 716.4 Effect of shape: Wind pressure on circular structures: 2/3 of the projected area. For hexagonal or octagonal structures: 7/8 of the projected area. 716.5 Radio towers: Shall conform to the provisions in Section 427 and 428 unless smaller or greater loads are approved by test. 717.0 The design load for buildings subject to higher wind loads than herein specified shall be determined by the prevailing conditions.	
			719.0	Earthquake Load	In regions where loss of life or damage of buildings resulting from EQs occur, buildings and structures shall be designed to withstand lateral forces as in Appendix K-11 [Annex A5], except as exempted in section 719.1. 719.1 Exemptions.- In zone "0", and where no loss of life or damage to property were recorded, regardless of zone, or when the building complies with any one or more of the following conditions, no EQ loading shall be required: (a) is a 1- or 2- family dwelling; (b) is a minor accessory building; (c) is not >3 stories or 35 ft in height; (d) is of skeleton frame construction with wind and sway bracing as required by approved engineering practice for the type of frame used, and the least dimension of the building is not less than 35 % of the height.	NYC 2001 code added EQ provisions; BOCA includes EQ provisions.

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Sub-Article 905.0 Other Loads			*Article 6 Other Loads*			
905.1	Earth Pressure and Foundation Loads	The provisions of Sub-article 1102.0 shall apply. 1102.3- Foundation wall and retaining wall shall be designed to resist, in addition to the vertical loads acting thereon, the incident lateral earth pressures and surcharges, plus hydrostatic pressures corresponding to the max probable ground water level.	27-570	Same	C304-8	Soil pressure and hydrostatic head loads 1. General. Retaining walls and parts of the building below ground shall be designed to withstand the following load, if applicable, in addition to other loads: lateral loads due to adjacent soil; from hydrostatic head; from surcharge of fixed or moving loads; or uplift from hydrostatic head. 2. Freestanding retaining walls. The moment of stability and overturning shall be computed about the bottom base edge on the low earth side. The moment of stability shall not be less than 1.5 times the overturning moment. The resistance force due to soil friction shall not be less than 1.5 times the sliding force.
905.2	Bins and Bunkers	Loads on component parts of bins and bunkers may be reduced for friction on sidewalls, provided that sidewalls and supports are proportioned for the increased vertical loads.	27-571	Same		
905.3	Pre-stressing Forces	Prestressing forces shall be considered in the design of prestressed concrete structures, cable structures, guyed structures, and multiple intersecting truss webs utilizing tension members.	27-572	Same		
					C304-9	Horizontal impact loads a- Nonbearing partitions shall be designed to resist w/o displacement at top or bottom a minimum linear load of 10 plf applied at mid height. b- Parapet walls and railings shall be designed to resist minimum 50 plf at top. c- Provisions for parapet walls or barriers at parking deck where vehicles are parked by a driver are given. d- Provisions for barriers at parking deck, where vehicles are parked mechanically, are given. e- Provisions for grandstands are given. f - Provisions for craneways are given.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
68-5	Soil and Hydrostatic Pressure	Provisions for basement walls and basement floors are given.	871.5	Lateral Stability	Foundation walls which serve as retaining walls shall be able to resist lateral soil and hydrostatic pressure when subjected thereto.	The provisions in the various codes are similar.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
68-2.5	Impact Loads	The live load assumed in this chapter may be assumed to include a sufficient allowance to cover the effects of ordinary impact. For unusual impacts, suitable increase shall be made in the assumed live load.	709.0	Impact Loads	The unit live loads specified in Section 707 shall be assumed to include adequate allowance for ordinary impact conditions. Provisions shall be made for special uses and loads which involve vibration and impact forces. Provisions for elevators, heavy machinery, craneways, and outdoor assembly structures are given.	NYC Building Codes do not have provisions for impact loads. In Chicago and BOCA codes, ordinary impact loads are assumed covered in the prescribed live loads. NY State Code gives provisions for horizontal impact loads.

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
905.4	Construction Loads	Provisions of Article 19- Safety of Public and Property During Construction Operations- shall apply.	27-573	Same	C304-12	Loads imposed during construction: All flooring, structural members, walls, bracing, scaffolding, sidewalk sheds or bridges, hoists and temporary supports of any kind incidental to the erection, alteration or repair of any bldg shall be of such strength as to suffer no structural damage when subject to the temporary loads and wind load imposed during construction.
					C304-11	Elevator machine loads: Shall conform to generally accepted standards.
905.5	Fluid Pressures	The design of building components shall consider pressures, both positive and negative, of confined fluids and gases.	27-574	Same		
905.6	Ice	The weight of 1/2 in. radial thickness of ice on all surfaces shall be considered as part of the live load in the design of open framed or guyed towers.	27-575	Same		
905.7	Thermal Forces	Enclosed buildings > 250 ft in plan shall be designed for 40 ^{o}F temperature change. Exterior exposed structures regardless of plan dimensions shall be designed for 40 ^{o}F temperature change for concrete and masonry construction and 60 ^{o}F for metal construction. Provisions for piping are also given.	27-576	Same		
905.8	Shrinkage	RC components shall be designed for shrinkage of 0.0002 (standard weight concrete) or 0.0003 (light weight concrete) times the length between contraction joints.	27-577	Same		
Sub-Article 906.0 Distribution of Loads			***Article 7 Distribution of Loads***			
906.1	Distribution of Vertical Loads	Distribution of vertical loads to supporting members shall be determined on the basis of a recognized method of elastic analysis or system of coefficients of approximation. Elastic or inelastic displacements of supports shall be considered and, for the distribution of dead loads, the modulus of elasticity of concrete or composite sections shall be reduced to consider plastic flow. Secondary effects, due to warping of the floors shall be considered.	27-578	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
			710.4	Construction Loads and Erection Stress	Provisions shall be made for temporary construction and wind loads which may occur during the erection of the building, to prevent overstressing.	
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.

Table 7–2. Loads (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
906.2	Distribution of Horizontal Loads	The following provisions shall apply to superstructure framing only, and shall not apply to structures wherein horizontal loads are transmitted to the foundation by stay-cables, arches, non-rectangular frames, or by frames, trusses, or shear walls not oriented in the vertical planes. (a) Distribution of horizontal loads to vertical frames, trusses and shear walls. Load should be assumed to be distributed by floor and roof systems acting as horizontal diaphragms. Proportion of total load to be resisted by any given vertical member shall be determined based on relative rigidity, considering the eccentricity of the applied load with respect to the center of resistance. For vertical trusses, web deformations shall be considered in evaluating the rigidity. (b) Distribution of horizontal loads within rigid frames of tier buildings.- (1) Assumptions: Load distribution can be determined based on elastic analysis or, subject to limitations in (2) below, the following simplifying assumptions: Points of deflection in beams and columns are at their midspan and midheight, respectively. The story shear is distributed to the columns in proportion to their stiffness. The change of length of columns due to axial effects of the horizontal loads may be neglected. Vertical column loads due to horizontal forces are taken by the exterior columns only, or are resisted by the columns in proportion to the column distances from the neutral axis of the bent. (2) Limitations: For buildings over 300 ft in height, change in length of the columns due to the horizontal load shall be evaluated. Simplifying assumptions shall be subject to the approval by the commissioner for the following circumstances: For buildings over 300 ft or with a height-width ratio greater than 5; At two-story entrances or intermediate floors; Where offsets in the building occur; Where transfer columns occur; In any similar circumstances of irregularity or discontinuities in the framing. (c) Distribution of load in self-relieving construction.- Assume connections are fully rigid in resisting moments due to lateral load, and that any larger moment due to gravity or a combination of gravity and lateral load will be relieved by deformation of the connection material. (d) Structural walls and partitions.- If specifically designed to resist the applied forces, they may be considered as contributing to the resistance or rigidity of the structure with regard to horizontal load.	27-579	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only NYC Building Codes have provisions.

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Table 7–3. Structural Work

Table 7–3. Structural Work.

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Article 10 Structural Work			***Subchapter 10 Structural Work***			
Sub-Article 1000.0 Scope and General Requirements			***Article 1 Scope and General Requirements***			
1000.1	Scope	The provisions of this article, supplemented by the additional requirements of Article 11, shall establish minimum requirements for materials, design, and construction to be used for all structural elements in buildings.	27-580	Same; In addition, within special flood hazard areas and below the regulatory flood datum, as described in Article 10 of Subchapter 4 of this chapter, materials, designs and construction required for structural elements by Reference Standard RS 4-5 shall be applicable.	C301	General Requirements c- Wherever structural material or assemblies are subjected to deterioration and might become structurally unsound if unprotected, protection in conformity with generally accepted standards for the material involved shall be provided. Causes of such deterioration include, among others, action of freezing and thawing, dampness, corrosion, wetting and drying, and termites and other destructive insects.
1000.2	Standards	The provisions of Reference Standard RS 10 [Annex A1] shall be a part of this article.	27-581	Same. Reference standards have been updated.	Foreword	The State Building Code Council publishes a list of Generally Accepted Standards. The list of Generally Accepted Standards for the 1968 State Building Construction Code (the oldest version the state has available) is listed in Annex A3.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
69-1	Scope	The provisions of this section shall govern the quality and strength of materials and methods of design and construction hereafter used in the construction of buildings and structures. Materials and methods of design and construction shall conform to the requirements of accepted engineering practice and the recognized standards consistent therewith.	800.0	Scope	The provisions of this article shall govern the quality, workmanship and requirements for all materials and methods and the minimum specifications for enclosure walls and wall thickness hereafter used in the construction of buildings and structures. All materials and methods of construction shall conform to the approved rules and standards for materials and tests of accredited authoritative agencies and the requirements of accepted engineering practice as listed in Appendix A through I [Annex A5].	Provisions in all the codes are similar. The NY State Code discusses protection of structural material or assembles against deterioration.
41.1-6 69-4	Standards and Tests of Materials Accepted Engineering Practice	All building materials shall be of a quality to meet the intent of the building provisions of this code, and shall conform to requirements promulgated as rules by the commissioner. Except as hereinafter specified for particular materials, every material permitted to be used in the buildings or structures in the city shall meet the standards performance expectations for that material as prepared by the ASTM and as adopted by that society in 1958. Where such standards require acceptance tests for the determination of the performance and properties of material, proper evidence of the making of such acceptance tests shall be submitted. Where in this code some other standard of performance is set up for any particular type of construction, the same shall take precedence over ASTM, but any standard requirement in ASTM not in conflict with the same shall remain in full force and effect. The regulations, specifications, standards and tests of the technical organizations which are referred to in this code are hereby incorporated by such reference with the same effect as though set forth. The standards [Annex A4] for (a) Foundations; (b) Masonry; (c) Wood; (d) Reinforced concrete; (e) Reinforced Gypsum; (f) Steel and metals; (g) Plastering; (h) Single family dwellings; and (i) Abbreviations, shall be deemed to represent accepted engineering practice with respect to the materials, equipment, systems and methods of construction respectively specified therein.			All structural units and assemblies shall be tested in accordance with the standards listed in Appendixes D, E and F [Annex A5]. In the absence of a testing procedure, the building official shall accept authenticated reports which meet the requirements of the Basic Code. Material Standards, Structural Unit Test Standards, Structural Assembly Test Standards, Durability Test Standards are listed in Appendixes C, D, E, and F [Annex A5], respectively.	The NYC Building Code uses the system of Reference Standards (RS). An RS may be a referenced standard (e.g. ACI 318-63), a document that is not a standard (e.g. an ACI Committee Report), a section of a code, or may consist of a set of requirements that are spelt out. The NY State Code is a performance code. The Building Code Counsel of the State publishes a list of generally accepted standards. These standards are deemed to comply with the performance of the code. The Chicago Municipal Code adopts reference standards listed in Section 69-4 of the code. The BOCA-BBC adopts reference standards listed in the appendixes to the code.

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1000.3	Definitions	See Article 2.	27-582	Same		
1000.6	General Requirements	For purposes of this code, the structural elements of a building shall normally include all floor, roof, and wall framing members and slabs (but not including slabs-on-grade); all piers, walls, footings, piles, and similar elements of the foundation; and all other elements of both foundation and superstructure which, in engineering practice, are proportioned on the basis of calculated stress. Where doubt exists as to the structural nature of an element, the provisions of this article, and of Article 11, shall be deemed to apply only to an element in which the materials are stressed in excess of 33.3 % of the allowable stress values (without increase for infrequent stress conditions) for such material in its proposed use, or to an element wherein public safety would be involved in the event of excessive distortion under the applied loads.	27-585	Same		
103	Alteration of Existing Buildings	103.1 Alterations exceeding 60 % of building value.- If the cost of making alterations in any 12-month period shall exceed 60 % of the value of the building, the entire building shall be made to comply with the requirement of this code. 103.2 Alterations between 30 % and 60 % of building value.- Only those portions of the building altered shall be made to comply with the requirements of this code. 103.3 Alteration under 30 % of building value.- Those portions altered may, at the option of the owner, be altered in accordance with the requirement of this code, or altered in compliance with their previously required condition and with the same or equivalent materials and equipment, provided the general safety and public welfare are not thereby endangered.	27-114	Alteration of existing buildings.- In addition to the same requirements as in the 1968 code, specifications are given for alterations that shall conform with the requirements of this code regardless of the magnitude or cost. The provisions in the rest of this section are the same as the 1968 code provisions.	C105-2 Existing Building	2.1 General: Definition for the term "existing buildings" is given. 2.2 Roof Covering: Whenever more than 25 % of the roof covering of a building is replaced in any 12-month period, all roof covering shall be made to comply with applicable regulations of this code. 2.3 Addition or alteration: Any addition or alteration, regardless of cost, made to a building shall be made in conformity with applicable regulations of this code. 2.4 Existing uses continued: Except as otherwise herein provided, nothing in this code shall require removal, alteration, or abandonment of, nor prevent continued occupancy or use of, an existing building.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only NYC Building Codes try to clearly define the applicability of the structural provisions.
Chap. 78	Existing buildings	78-8 Alterations and repairs. 78-8.2 Change of occupancy, height or area: (a) When the occupancy of an existing building is changed from one classification to another, the higher provisions for the new occupancy shall be complied with. (b) When a building is increased in height or area, the building shall comply with the applicable requirements of this code. 78-8.5 More than 50 %: Such buildings and structures shall be made to conform to all requirements of this code applicable to new buildings and structures. 78-8.6 25 % to 50 %: All new constructions shall conform to the requirements of this code for new buildings or structures of like area, height and occupancy. 78-8.7 25 % or less: Certain exceptions can be made that allow the use of materials that conform to the strength and fire resistance for the materials with which the building is constructed. Otherwise, all new construction shall conform to the requirements of this code for a new building. 78-8.8 Repairs to roof coverings: Not more than 25 % of the roof covering shall be replaced in any 12-month period unless the entire roof covering is made to conform to requirements for new buildings.	706.0	Existing building	In the reconstruction, repair, extension or alteration of existing buildings, the allowable working stresses used in design shall be as follows: 1. Building extended: If altered by an extension in height or area, all existing structural parts affected by the addition shall be strengthened where necessary and all new structural parts shall be designed to meet the requirements for buildings hereafter erected. 2. Building repaired: When the uncovered structural parts are found unsound, such parts shall be made to conform to the requirements for buildings hereafter erected. 3. Existing live load: When an existing bldg heretofore approved is altered or repaired within the limitation prescribed in Section 106.3 (alteration under 50 %) and 106.4 (alteration under 25 %), the structure may be designed for the loads and stresses applicable at the time of erection, provided that public safety is not endangered. 4. Posted live load: May be posted for original approved live loads.	The provisions of all codes other than the NY State Building Code are broadly similar. The NY State Code requires that any addition or alteration shall be made in conformity with that code. It is silent as to the structure being altered.

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1000.7	Materials and Methods of Construction	Materials and methods of construction used in the manufacture and/or placement of structural elements in a building shall be subject to the requirements of Sub-article 106.0 (Materials, Assemblies, Forms, and Methods of Construction), the inspection provisions established in Tables 10-1 and 10-2 [Annex B1] and the detailed requirements of Sub-articles 1003.0 through 1011.0 and Sub-article 1112.0.	27-586	Same	C309 C303 Allowable stresses of materials	C309 Material requirements: All structural units of natural or manufactured materials shall comply with applicable specifications of authoritative agencies, or shall be subjected to test in conformity with generally accepted standards in order to determine their characteristics. C303 Allowable Stresses of Materials C303-1 General requirements: Safe working stresses shall be assigned to materials in accordance with their classification either as controlled materials or ordinary materials, and these stresses shall not be exceeded unless specifically permitted in C304-10. C303-2 Controlled materials: The safe working stresses of materials which have been identified and certified for quality and strength shall conform to the specifications and stresses for such materials. When a material is formed and cast in the field, tests prior to and during the construction shall be made, and the composition and strength of the material shall be certified. C303-3 Ordinary materials: Materials which do not conform to the requirements for controlled materials shall be considered ordinary materials, and their quality and safe working stresses shall conform to the specifications and stresses for ordinary materials in generally accepted standards. When quality and safe working stresses are not so specified, they shall be determined by test in conformity with C305-1. When a material is formed and cast in field, tests shall be made during the construction and its composition and strength certified.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
69-3	Classification of Construction Materials	All materials and methods used in the design and construction of buildings and structures shall be classified as "controlled materials" and "ordinary materials" as defined herein. 69-3.1 Controlled materials: Means all materials shall be selected and tested to meet the special strength, durability and fire resistance requirements. Design, shop and field details and inspection of construction shall be under supervision. 69-3.2 Ordinary materials: Materials meeting the requirements for minimum strength, durability and fire resistance for average materials without special selection, testing and supervision.	701.0	Definitions	701.0 Definitions. Controlled Materials. Materials which are certified by an accredited authoritative agency as meeting accepted engineering standards for quality and as provided in Sections 722 and 800. Ordinary Materials. Materials which do not conform to the requirements of the Basic Code for controlled materials.	The NYC has broad requirements. The other codes primarily address allowable stresses and make a distinction between controlled and ordinary materials.
			722.0	Allowable Working Stress	722.1 Controlled materials.- The design and working stress of all controlled materials shall conform to the specifications and methods of design for accepted engineering practice or to the approved rules. 722.2 Ordinary materials.- Shall be limited to the average unit working stresses in Appendix K [Annex A5]. 722.3 New materials.- For materials which are not specifically provided for in the Basic Code, the working stresses shall be established by tests.	
			800.1	General	800.1 The quality, use and installation of all materials and methods of building construction shall be controlled by the standards for accepted engineering practice as listed in Appendix B [Annex A5] except where otherwise specifically provided in the Basic Code.	
			800.2	Material Standards	800.2 All building units used in wall, partition and floor construction and for fireproofing or other insulation purposes shall comply with the applicable standards listed in Appendix C [Annex A5].	
			800.3	New Materials	800.3 All new building materials, equipment, appliances, systems or methods of construction not provided for in the Basic Code, and any material of questioned suitability proposed for use in the construction of a building or structure, shall be subjected to the tests prescribed in this article and in the approved rules to determine its character, quality and limitations of use.	
			800.5	Alternate Test Procedure	800.5 In the absence of approved rules or other accepted standards, the building officials shall make or cause to be made the necessary tests and investigations, or he shall accept duly authenticated reports from recognized testing authorities in respect to the quality and manner of use of new materials.	

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1000.9	Use of Used and Unidentified Materials	The utilization of used materials and unidentified or ungraded materials shall be limited to non-structural elements, except: (a) such materials (or elements) may be reused, or continued in use, at stress levels to which the materials or elements were subjected in the previous construction, or at load capacity as demonstrated by load test procedures as described in 1002.4. (b) Unidentified materials may be graded by the recovery and test of representative samples, or by other means satisfactory to the commissioner. (c) Used materials shall be considered to be graded where the grade is clearly indicated on the approved plans for the existing construction and may be used at the allowable stress levels for that grade of like materials as established in the building code in force at the time the plans for the existing construction were approved.	27-588	Same		
1000.10	Equivalent Systems of Design	Nothing in this article shall be construed to prohibit the use of any system of design, alternate to those indicated, provided that it can be demonstrated to the satisfaction of the commissioner that such system of design will provide a factor of safety against structural failure consistent with the requirements of Sub-article 1003.0 through 1011.0, fire safety in consonance with the requirements of Articles 3 through 8, and such other characteristics pertinent to the safety of life, health, and property as prescribed in this article or as may be required by the commissioner. Alternate or equivalent materials or methods of construction shall be subject to the provisions of C26-106.4.	27-589	Same	C107 Accepta-bility	a- Compliance with applicable provisions of generally accepted standards, except as otherwise prescribed in this code, shall constitute compliance with this code. b- Deviations from applicable provisions of generally accepted standards, when it shall have been conclusively proved that such deviations meet the performance requirements of this code, shall constitute compliance with the code.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
69-2	Used Materials	Used materials which meet the minimum requirements for new materials and all other special requirements of the code shall be permitted.	800.4	Used Materials	The use of all second-hand materials which meet the minimum requirements of the Basic Code for new materials shall be permitted.	The NYC Building Codes have more specific requirements than the Chicago and the BOCA Codes. The NY State Building Code has no explicit requirement.
41.1	Building Standards and Tests	41.1-1 For the purpose of insuring public safety and for the purpose of ascertaining the suitability of materials, methods, or systems of construction, or arrangements of materials, not permitted by, or varying from, the performance requirements in this code, but which are claimed to be equally as good as or superior to those permitted hereunder, the mayor shall appoint a committee on standards and tests.	109.2	Accepted Engineer-ing Practice	In the absence of approved rules, the regulations, specifications and standards listed in Appendix A [Annex A5] - Accredited Authoritative Agencies, Appendix B [Annex A5]- Accepted Engineering Practice, and Appendix C [Annex A5] - Accredited Material Standards, shall be deemed to represent accepted engineering practice in respect to the material, equipment, system or method of construction therein specified.	The various codes investigated here all permit designs that do not conform to the codes, if the design can provide equivalent or superior performance as required in the said code.

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1000.11	Deferred detailing	Where structural elements are normally detailed on shop or working drawings, the application for the permit shall so state, and insurance of the permit shall be conditioned upon future submission of such shop or working drawings showing the approval of an architect or engineer. In cases where the detailing is based on information in manufacturer's catalogue, the application for approval of the plans shall so state and issuance of such acceptance shall be conditional upon submission of statement by manufacturer, attesting the accuracy of the data and that such data were derived in conformance with this code. Where the detailing is based on data published in technical documents of recognized authority issued by, or accredited by, the agency or association promulgating the applicable reference standard cited in this code, such statements will not be required.	27-590	Same		
Sub-Article 1001.0 Structural Design - General Requirements			***Article 2 Structural Design - General Requirements***			
1001.1	Stability	Except as provided in 1111.0 with regard to foundation elements, a building, or any element thereof shall be proportioned to provide a minimum factor of safety of 1.50 against failure by sliding or overturning. The required stability shall be provided solely by the dead load plus any permanent anchorages which may be provided.	27-591	Same		
1001.2	Bracing	Unless otherwise specified in the reference standards, members used to brace compression members shall be proportioned to resist an axial load of at least 2 % of the total compressive design stress in the member braced, plus any transverse shear therein.	27-592	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only the NYC Building Codes have a specific provision concerning issuance of permit conditional upon future submission of shop or working drawings.
						Only NYC Building Codes have an explicit statement concerning stability against sliding and overturning.
						Only the NYC Building Codes have this structurally important requirement.

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1001.3	Secondary Stresses	Secondary stresses in trusses shall be considered and where of significant magnitude, their effects shall be provided for in the design.	27-593	Same		
1001.4	Combina-tion of Loads	Dead loads, live loads (including impact) and reduced live loads, where applicable, shall be considered as basic loads. Wind, thermal forces, shrinkage, and unreduced live loads (where live load reduction is permitted by Article 9) shall be considered as loads of infrequent occurrence. Members shall have adequate capacity to resist all applicable combinations of the loads listed in Article 9, in accordance with the following: (a) Where design is based on allowable working stresses, the loads as described in Article 9 shall be multiplied by the following factors and the design shall be based on the resulting load values: (1) For combinations of basic loads, only, the factor shall be 1.0, except that for the design of temporary structures (defined as a structure which will be in place 6 months or less) the factor shall be 0.75. (2) For any combination of one or more basic loads with any one load of infrequent occurrence, the factor shall be 0.75, except that for the design of temporary structures the factor shall be 0.67. (3) For any combination of one or more basic loads with two or more loads of infrequent occurrence, the factor shall be 0.67. Exception-The provisions of RS 10-8 [Annex A1] and RS 10-9 [Annex A1] relating to increases of allowable unit stresses for short-time loading shall apply. (b) Where design is based on ultimate strength criteria (including plastic design of steel structures and proportioning of suspended structures), the loads, as described in Article 9 shall be multiplied by the factors indicated in C26-1010.5 (e) and in the applicable reference standards. The design shall be based on the resulting load values. Exceptions- 1. Where combinations of loads for which factors are given in the reference standard include the load of wind (or earthquake) the design additionally shall consider combinations of loads wherein each other of the loads of infrequent occurrence as listed in this paragraph are substituted for the load of wind. -2. The design also shall consider combinations of loads wherein two most critical of the loads of infrequent occurrence are combined with the basic loads. For such combinations, however, the factors indicated in the reference standards and in C26-1010.5 (e) for suspended structures, for the combination of basic loads plus one load of infrequent occurrence may be reduced 15 %.	27-594	Second line: Wind, **earthquake,** thermal forces… Otherwise the same.	C304-10 Combined Loads	a- The stress due to wind may be ignored if it is less than 1/3 of the stress due to DL plus imposed load excluding wind load. b- If the stress due to wind exceeds 1/3 of the stress due to DL plus imposed load excluding W, the allowable stress of the material may be increased by 1/3. c- On roofs not used as promenades, the min imposed load shall be 20 psf perpendicular to the roof surface, where snow plus wind loads total less than 20 psf. d- On roofs and eaves, snow or live load, and the wind load, shall be considered as acting simultaneously in such combination as imposes the greater stress.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only the NYC Building Codes have a requirement concerning secondary stresses in trusses.
68-4.7		For combined stresses due to dead, live, and wind load, the allowable stresses in materials may be increased 1/3, provided the section thus determined is at least as strong as that required for dead and live load alone. Snow load shall be considered a live load.	720.0	Combined Loading	The structural frame of all buildings shall be investigated for the combined effect of lateral and vertical loading and the individual members of the frame shall be proportioned as follows: 720.1 With EQ.- EQ+DL+LL+S: The allowable working stress may be increased 33.33 %. 720.2 With wind.- W+DL+LL+S: The allowable working stress may be increased 33.33 %. 720.3 Minimum section.- The section determined from combined load shall be compared with that required for DL, LL and S only. The section with the greatest strength shall be used. 720.4 Wind neglected.- When the stress due to wind is less than 1/3 of the stress due to dead load plus live load, the wind stress may be neglected.	The BOCA Code has simple and very explicit requirements. The NY State and Chicago Code requirements are similar. The NYC Building Codes use reduced load factors where basic loads are considered together with loads of infrequent occurrence, instead of allowing increased allowable stresses. The two schemes cannot be compared without a more detailed study.

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1001.5	Deflection Limitations	The applicable provisions of the several reference standards cited in this article shall apply. In addition, the total of the dead plus live load vertical deflections (including effects of creep and shrinkage) of members supporting walls, veneered walls, or partitions constructed of or containing panels of masonry, glass, or other frangible materials shall not exceed 1/360 of the span.	27-595	Same	C306-2	Performance criteria under test.- Under imposed load, the deflection shall not exceed 1/360 of the span when the inside is to be plastered, and 1/240 if it is not. When a roof is not to be used as a promenade, and the underside is not to be plastered, the deflection shall not exceed 1/180 of the span.
Sub-Article 1002.0	***Adequacy of the Structural Design***		***Article 3 Adequacy of the Structural Design***		***C305 Analysis and test of structural assemblies***	
1002.1	General	The structural design of a member or assembly shall be deemed to be adequate if the design computations demonstrate conformance with the applicable standards noted in 1003.0 through 1011.0. Where, because of practical difficulties, such computations cannot be executed, the structural design may be deemed adequate if the member or assembly is subjected to , and satisfactorily performs under, load tests in accordance with the provisions of 1002.4 (a). Where there is a question as to the adequacy of a completed or partly completed construction, the provisions of 1002.2, 1002.3 and 1002.4(b) shall apply.	27-596	Same	C305-1 General	The capacity of an assembly to sustain dead and imposed loads w/o exceeding the allowable stresses shall be determined by any one of the procedures described in this section, or by an approved combination thereof. a- Design analysis. Stress shall not exceed safe working stress defined in generally accepted standards or established by tests considering the reliability, durability, and uniformity of the material and its behavior under stress. In no case shall the assigned safe working stress exceed 2/3 of the yield strength nor 1/2 of the ultimate strength of the material unless specified in C304-10. b- Test.- Shall be made in conformity with generally accepted standards of assemblies truly representative of the construction to be used, in order to establish that such assemblies conform to the performance criteria set forth in C306. c- Comparison with an approved assembly of known characteristics and behavior under load, which assembly is directly comparable in all essential characteristics to the assembly under consideration.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
69-5.4		(a) Floor, wall and roof transverse tests- (2) Deflection: Under design live load, the deflection shall be not greater than 1/360 of the span for plastered construction and 1/240 of the span for unplastered construction.	804.2	Working Load Deflection	The deflection of floor and roof assemblies shall not be greater than 1/360 of the span for plastered construction; 1/240 of the span for unplastered floor construction; and 1/180 of the span for unplastered roof construction.	The provisions in various codes are similar.
69-5.3	Test of Structural Assemblies	When a structural assembly is not capable of design by accepted engineering analysis, or when there is reasonable doubt as to its strength or stability, the safe load-bearing capacity of such structural assemblies shall be determined by tests acceptable to the commissioner of buildings. Such tests shall simulate the loads and conditions of application to which the complete structure will be subjected in normal use.	803.0	Tests	All structural units and assemblies shall be tested in accordance with the standards listed in appendixes D, E and F [Annex A5]. In the absence of a testing procedure, the building official shall accept authenticated reports which meet the requirements of the Basic Code. 803.1 Strength tests.- Strength tests prescribed in this code, or acceptable alternative tests, shall be made to determine the safe uniformly distributed working load, when a structure is not capable of design by accepted engineering analysis, or there is reasonable doubt as to the strength or stability of an assembly. Structural load determinations shall include transverse floor and roof, wall compression and racking, concentrated load, plaster bond, puncture penetration and soil tests. 803.1.1 Strength tests for Glass.- Shall comply with Appendix K-12-B [Annex A5]. 803.2 Durability and endurance tests.- Whenever required, the material or construction shall be subjected to sustained and repetitive loading to determine its resistance to fatigue, and to tests for durability and weather resistance. 803.3 Maintenance test.- Tests of all materials shall be made to assure the maintenance of the standards of approved materials when reasonable doubt exists. 803.5 Tests of service equipment and devices.- Provisions are given for service equipment and accessories that shall be included in the tests. 803.8 Test specimens.- Test procedures shall conform to those listed in the appendixes.	

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1002.2	Questionable Construction	If a construction shows open cracks, spallings, other signs of distress; or should inspection records show some significant deficiency of construction; or tests of concrete or other materials that have been incorporated into the work indicate deficiency of strength; or should there be a reasonable doubt as to the strength, stability, or adequacy of the construction, such construction may be checked by computation, or by core or load tests. Should the adequacy not be verified within a reasonable time, such construction shall be demolished or reinforced or rebuilt to be made safe in conformance with the requirements of this code.	27-597	Same		
1002.3	Core Tests of Concrete Construction	The adequacy of the concrete may be ascertained by the recovery and testing of cores. The compressive strength so determined shall meet the requirements for strength tests as described in RS 10-3 [Annex A1].	27-598	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
69-5.5	Workman-ship Tests	(a) Whenever there is reasonable doubt as to the stability or structural safety of a completed building, the commissioner of buildings may require a load test of the building unit or portion of the structure. (b) Unless otherwise provided for in this code, the structure under consideration shall be subjected to a superimposed load equal to 2 times the design live load which shall be left in position for a period of 24 hrs. If during the test or upon removal of the test load, the structure shows evidences of failure, he shall order reinforcement or modifications necessary to ensure adequacy of the structure for the rated capacity; or he may determine the safe load capacity to which the structure shall be limited. (c) The structure shall be considered to have successfully passed the test if the total deflection does not exceed the theoretical deflection computed by accepted engineering formulae, or if the total deflection exceeds the theoretical value, the structure shall be considered safe for the design load if it recovers 75 % of the maximum deflection within 24 hrs after removal of the test load.	803.4	Workman ship Test	Whenever there is reasonable doubt as to the stability or safety of a completed building, the building official may require a load test of the building unit in question. Such existing structure shall be subjected to two times the design live load for 24 hrs. If the structure shows evidence of failure, reinforcement or modifications shall be made, or a reduced working load limit shall be specified. The structure shall be considered to have met the requirements if the total deflection does not exceed the computed theoretical deflection. When the total deflection is greater than such theoretical value, the structure shall be considered safe for the design load if it recovers 75 % of the maximum deflection within 24 hrs after removal of the test load.	
						Only NYC Building Codes have provisions.

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1002.4	Load Tests	(a) Prequalifying load tests: For structural members before they are incorporated into work. (1) Test specimens: Shall be a true representation of the units to be used in work. (2) Support conditions and interaction: Shall simulate the conditions of support in building, except partial fixity may be approximated by conditions of full or zero restraint, whichever produces a more severe stress condition. (3) Strength requirements: The member or assembly shall be capable of supporting a. Without visible damage (other than hairline cracks) its own weight plus 150 % of the design live load plus 150 % of any dead load that will be added on the site. b. Without collapse, its own weight plus 50 % of its own weight plus 250 % of the design live load plus 250 % of the dead load that will be added on the site. The latter loading shall remain in place for a minimum period of one week. All loading conditions described in Article 9 shall be considered. The design live load shall be the nominal value reduced for contributory area as described in Article 9. Except as permitted under (5) below, units to be tested shall be full size. Load bearing wall and partition assemblies shall be tested both with and without window and door framing where such framing will be included in the final assemblies. Test load may be reduced if the load tests are conducted and the results promulgated in a manner that will permit clear differentiation between the dead and live load components added at the site. (4) Deflection requirement: The percentage of recovery of deflection caused by the superimposed load should be at least 75 %. The deflection under the design live load shall not exceed that permitted in this article. (5) Model tests. Tests on models less than full size may be used to determine the relative intensity, direction, and distribution of stresses and applied loads, but shall not be considered as a proper method for evaluating stresses in, nor the strength of, individual members unless approved by the commissioner for this purpose.	27-599	(a) Same	C306	**Performance Criteria under Test** C306-1 General requirements: Buildings and their components subjected to this code shall meet the performance criteria prescribed for each test. Failure to meet the criteria shall be evidence of noncompliance of this code. C306-2 Under imposed load: When the assembly reacts by bending under the uniformly distributed imposed load, excluding impact, the deflection shall not exceed 1/360 of the span when the inside is to be plastered. When it's not plastered, 1/240 of the span is the limit. When a roof is not to be used as a Promenade, and the underside is not to be plastered, 1/180 of the span is the deflection limit. C306-3 Under 1.5 times imposed load: a- Under its DL, and 1.5 times the uniformly distributed imposed load, excluding impact, the assembly shall sustain the load w/o structural damage. In testing floor assemblies and assemblies in compression, the load shall be applied twice. b- For floor assemblies, the residual deflection from the first load application shall not exceed 25 % of the maximum deflection under the load. After the 2nd application of the load, the total residual deflection shall not exceed 1.1 times the residual deflection from the 1st load. C306-4 Under 2 times imposed load: Under its DL and 2 times the uniformly distributed imposed load, excluding impact, the floor, roof, and wall assembly shall sustain load w/o structural failure for a minimum of 24 hrs. C306-5 Impact loads: Under an impact load of 60 lbs falling 4 ft for floors, 1.5 ft for walls, roofs and nonbearing partitions, on an area 10 in. in diameter, applied perpendicular to the assembly at its center, the assembly shall sustain no structural damage. C306-6 Racking loads: Where exterior walls and partitions react by racking, the racking deformation, while the assembly is sustaining the imposed load, shall not exceed 1/400 of the height of the wall. Under 1.5 times the load there shall be no structural damage, and under 2 times the load there shall be no structural failure. C306-7 Transmitted loads: Fastening and connections shall be capable of transmitting, w/o failure, twice the loads for which they are designed.

Municipal Code of Chicago (1967)			BOCA Building Code – Basic Code (1965)			Comments
69-5	Tests	69-5.1 Test specimens: The selection and construction of all test specimens and the details of test procedures herein shall conform to the applicable standards of authoritative testing agencies and laboratories. 69-5.2 Test of materials: (a) When the strength, durability, weather-resistance and other qualities of a material necessary to the conditions of its use have not been established by accepted engineering practice, or are in reasonable doubt, tests shall be made as hereafter provided. (b) Tests of materials shall also be made where specifically required by the provisions of this code. (c) Materials, when required, shall be subjected to sustained and repetitive loading to determine resistance to fatigue, and to tests for durability and weather-resistance when applicable to the use of the material. (d) When not otherwise required in this code, the applicable standards and specifications of ASTM shall be deemed accepted practice in the conduct of tests of materials, assemblies and systems. 69-5.4 In evaluating the physical properties of structural assemblies, the structural requirements shall be based on the following conditions of acceptance: (a) Floor, wall and roof transverse tests: (1) Test load: Shall sustain superimposed load equal to 2.5 times the design live load. (2) Deflection: Under design live load, the deflection shall not be greater than 1/360 of the span for plastered construction, and 1/240 of the span for unplastered construction. (3) Residual deflection: If the deflection is greater than the computed theoretical deflection after 24 hrs under the total static test load, upon removal of the load the construction shall recover not less than 3/4 of the total test load deflection. (b) Wall and partition compression tests: (1) Test load: The assembly, both with and without window framing, shall sustain without failure, superimposed loads equal to 2.5 times the vertical design live load. (2) Recovery: After 24 hrs under the static test load, and after removal of the superimposed load, the specimen shall recover not less than 1/2 of all vertical and horizontal distortion and strain. (c) Wall racking tests:(1) Test load: The assembly shall sustain the design live load without excessive distortion and not less than 2.5 times the design live load without failure. (2) Recovery: After 24 hrs under the total static load, upon removal of the load, the construction shall recover not less than 1/2 of the total deflection. (3) Comparative tests: When not available from existing authoritative test data, the building official may require comparative tests of standard traditional form of construction assemblies of similar dimensions and sizes, to assist in determining the adequacy of the new construction. (d) Concentrated load test: Where design for concentrated loads is required in Section 62-8, floor constructions not capable of design shall be subjected to a concentrated load test when such loading exceeds in stress effect the prescribed uniformly distributed load.	804.0	Conditions of Acceptance	In evaluating the physical properties of materials and methods of construction when not subject to design by accepted engineering analysis, the structural requirements shall be based on the criteria established by the following provisions.	
			804.1	Test Load Factor	The test assembly shall sustain without failure, superimposed loads equal to 2.5 times the design live load.	
			804.2	Working Load Deflection	The deflection of floor and roof assemblies shall not be greater than 1/360 of the span for plastered construction; 1/240 of the span for unplastered floor construction; and 1/180 of the span for unplastered roof construction.	
			804.3	Wall and Partition Assemblies	Bearing wall and partition assemblies shall sustain the load test both with and without window framing.	
			804.4	Comparative Tests	May require comparative tests of assemblies of standard traditional forms of construction to assist in determining the adequacy of the new construction.	
			804.5	Concentrated Load Tests	All floor constructions specified in Table 14 [Annex B5] shall be subjected to the concentrated loads therein prescribed when such loading exceeds in stress effect the uniformly distributed load specified for such uses in Table 13 [Annex B5].	
			804.6	Puncture Penetration Tests	All finished floor constructions in which light gage metal or other thin materials are used as the structural floor shall withstand the application of a 200 lb concentrated load applied to the top surface on an area of 1 in.^{2} at any point.	

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1002.4	Load Tests	(b) Load tests of completed construction (1) Strength.- The construction shall be loaded in two stages: (a) With all dead load to which it will be subjected in service plus a superimposed load equal to the design live load reduced as described in Article 9; and (b) with a total load, including its own weight, equal to 150 % of the total dead load to be supported in service plus 180 % of the design live load, reduced for contributory area, which load shall remain in place for a minimum of 24 hrs. (2) Deflection requirement.- Under the first stage of loading, the deflection shall nor exceed that permitted in the applicable reference standard. The residual deflection after removal of the second stage loading shall not exceed 25 % of the calculated elastic deflection under the superimposed test load. The structure, after recovery of the deflection, shall not show any evidence of serious distress. (3) Interaction. -The loaded area shall be extended to include the loading of all framing and elements that contribute to the strength of the element by way of interaction. (4) Lateral loads.- The applied live load and lateral load components may be adjusted as in 1001.4, provided that the stress condition under the load increments described in (1) above is not more critical. (5) Reloading.- Not permitted. (6) Limitation on use of load tests of concrete structures.- Where the strength tests of the concrete that initiated the requirement for load tests show strengths less than 2/3 of the strength required by the design of the specific element, the use of load tests to show the adequacy of the structure will not be permitted.	27-599	(b) Same, except for the following changes: The following paragraph is added after the title "Load tests of completed construction": "The provisions of this subdivision shall apply to any type of construction where the appropriate reference standard does not provide for load test of completed construction and the construction is questionable. When the appropriate reference standard provides for such load testing, the provisions of reference standard shall be used." Sub-item (6) "Limitation on use of load tests of concrete structures" is deleted.	C305-2	Load test on completed work a- Safe performance under load tests shall be evidence of the acceptability of the construction. b- The assembly shall be able to sustain the dead load and two times the uniformly distributed imposed load, excluding impact, without structural failure for a min 24 hrs.
					C307	**Exterior Protection** C307-1 General requirement: Whenever structural material or assemblies are subject to deterioration and may become structurally unsound under the proposed condition of use, adequate protection shall be provided. C307-2 Exterior material: Exterior facing or covering shall be resistant to causes of deterioration as set forth in C301c w/o loss of strength or loss of attachment which will render it unfit for use. The material shall be treated if necessary. C307-3 Flashing C307-4 Waterproofing C307-5 Grade protection

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only NYC Building Codes have provisions.

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Sub-Article 1003.0 Masonry			***Article 4 Masonry***			
1003.1	General Require-ments	(a) Unreinforced masonry. -Shall meet the requirements of RS 10-1 [Annex A1]. (b) Reinforced masonry. - Shall meet the requirements of RS 10-2 [Annex A1].	27-6	Same	C309 Material Require-ments	All structural units of natural or manufactured materials shall comply with applicable specifications of authoritative agencies, or shall be subjected to test in conformity with generally accepted standards in order to determine their characteristics.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
69-6	Prefabricated Construction	(a) Definition: A prefabricated assembly is a building unit, the parts of which have been built up or assembled prior to incorporation in the building. (b) Performance standards: All requirements of this code and accepted engineering practice. (c) Tests: As in Section 69-5. Commissioner may require comparative tests.	803.7	Prefabricate d Construction Tests	Shall meet all the requirements and tests for at-site construction. The floor panels shall be assembled to form an integrated specimen of not less than 3 units in width with 2 longitudinal joints.	
69-8	Welded Construction	Shall be done under certified inspection.				Only Chicago Code has explicit provisions.
	Chapter 71	***Masonry Construction***			***Masonry Construction***	
71-1 71-2 71-3	General Grouted Brick Masonry Reinforced Brick Masonry	71-1 Design and construction shall be in accordance with the provisions of the American Standard Building Code Requirements for Masonry (1954). 71-2 Provisions for allowable compressive stresses are given. 71-3 Provisions are given for reinforcement and allowable stresses.	835.0	Masonry Wall Construction	All masonry construction shall comply with the provisions of this article governing quality of materials and manner of construction; and shall be of adequate strength and proportions to support all superimposed loads within working stresses prescribed in the Basic Code and the standards of accepted engineering practice. Provisions are also given concerning wetting of brick and precautions against freezing.	NYC Building Code and Chicago Code give general provisions for masonry construction. NY State code has provisions only for general construction, not specifically for Masonry construction. BOCA gives specific provisions for various masonry elements.
			836.0	Bonding of Walls	Walls of solid, composite and hollow masonry and cavity and other hollow walls shall be bonded in accordance with accepted engineering practice. Specific provisions are given on rubble stonewalls, buttresses and piers, intersecting walls and partitions, and erecting precautions.	
			837.0	Lateral Bracing of Bearing Walls	All masonry bearing walls shall be laterally supported by horizontal bracing of floor and roof framing or vertical bracing of columns, buttresses or cross-walls at vertical or horizontal intervals as specified in Appendix B [Annex A5]; and provisions shall be made in the structure to transfer wind pressures and other lateral forces to the foundations.	
			838.0	Chases and Recesses in Bearing Walls	Chases and recesses are prohibited in many situations. Provisions on maximum size of chases and recesses are prescribed.	
			839.0	Corbelled & Projected Masonry	Limitations on the use of corbels and other projections are given.	
			840.0	Bearing on Hollowed Unit Walls	Provisions on bearing area and closure tile are given.	

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1003.2	Identification	(a) Masonry units. - Shall show the grade of the unit and the compressive strength. (b) Metal reinforcement. - Shall be able to identify the grade and size.	27-601	Same		
1003.3	Inspection	Shall conform to Tables 10-1 and 10-2 [Annex B1].	27-602	Same		
Sub-Article 1004.0 Concrete			***Article 5 Concrete***			
1004.1	General Requirements	Concrete materials, design, and construction shall meet the requirements of Reference Standard RS 10-3 [Annex A1]. Precast concrete construction utilizing a thin skin or slab stiffened or supported by a system of ribs shall conform to the requirements of Reference Standard RS 10-4 [Annex A1].	27-603	Concrete materials, design, construction, *quality, inspection and testing* shall meet the requirements of Reference Standard RS 10-3 [Annex A2]. The rest is the same as in the 1968 Code.		All structural units of natural or manufactured materials shall comply with applicable specifications of authoritative agencies, or shall be subjected to test in conformity with generally accepted standards in order to determine their characteristics.
1004.2	Identification of Metal-Reinforcement	Shall be able to identify type, grade and size.	27-604	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
			806.1	Identification	All masonry units shall bear the identification mark of the manufacturer consisting of a cast impression, embossing or painting.	NYC Building Codes and BOCA have similar provisions. NY State and Chicago Codes do not have provisions on Identification.
						Only NYC Building Codes have provisions.
Chap 73	***Reinforced Concrete Construction***					
73-1	Portland Cement Concrete	The design and construction of reinforced concrete shall be in accordance with ACI 318-63. 73-1.1 Composite beams: Detailed provisions for composite beams are given.				
			830.0	Reinforcing Steel	Shall comply with Appendix B [Annex A5]. 1. Identification. Shall be rolled with symbols or letter, or for wires, tagged, to identify the manufacturer and the grade of steel. 2. High yield steel. If yield point is 50,000 psi or more, tension stress in bending or compression stress in vertical column reinforcement shall not be more than 40 % of the yield point; but shall not be more than 30,000 psi except in one-way slab or prestressed reinforcement.	
			817.0	Concrete Aggregates	Provisions are given for Aggregate quality, Fire resistance, Grade 1 Concrete, Grade 2 Concrete, Size of Aggregates, and Special aggregates.	

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1004.3	Mixes	Concrete may be proportioned, batched, and mixed by any of the following methods: (a) Method I. Mixes with Minimum Cement Factor. (1) Minimum cement factor: The cement factor used in the work shall not be less than the factor given in Table 10-3 [Annex B1] for the corresponding strength of concrete. (2) Water-cement ratio. - The concrete used in the work, whether proportioned on the basis of preliminary tests or of prequalified mix designs, shall be produced by using a water-cement ratio corresponding to a point on the strength vs. water-cement ratio curve representing (at a slump of 5 +/- 1 in. for concrete with gravel or stone aggregate and at a slump of 4 +/- 1 in. for concrete with lightweight aggregate) a strength of concrete at least 25 % higher than the specified strength called for on the plans. The cement factor shall not be less than the factor shown in Table 10-3 [Annex B1]. (3) Preliminary tests.- Except as provided in C26-1004.3 (a)(4), preliminary tests of concrete shall be made in advance of the beginning of any concreting operation and shall be subject to controlled inspection. Preliminary tests shall consist of compressive strength test of molded concrete cylinders made in accordance with RS 10-17 [Annex A1] and RS 10-21 [Annex A1]. A curve representing the relation between the average strength of the concrete at 28 days, or at earlier periods, and the water-cement ratio shall be established. The tests shall include at least 4 different water-cement ratios and at least 4 cylinder specimens for each water-cement ratio. The cylinder strength tests shall be supplemented by tests to confirm that the cement and aggregates conform to the provisions of RS 10-3 [Annex A1]. (4) Prequalified mixes. - In lieu of the making of preliminary tests for individual buildings or groups of buildings, a concrete producer may provide concrete proportioned on the basis of prequalified or previously accepted mix designs, which designs, including the applicable batching weights, the results of applicable preliminary tests and of tests to confirm that the cement and aggregates conform to the provisions of RS 10-3 [Annex A1], shall be submitted not less often than once a year to the commissioner for review and prequalification. The preliminary tests shall be made under the supervision of an architect or engineer engaged by the producer. Concrete proportioned according to prequalified mixes shall be produced only from batch plants satisfactory to the commissioner. Separate prequalification shall be required for mixes utilizing different combinations of aggregates and admixtures from all sources which are to be utilized. (5) Quality control and inspection of materials and of batching. - Shall meet the requirements in Table 10-1 [Annex B1].	27-605	Some terminologies are different, e.g. the term "cement content" is used in the 2001 code, rather than "cement factor" in the 1968 code. "Water-cement ratio" is also referred to as "strength-cement ratio" in the 2001 code. The wordings of some provisions are also different. In the provisions for water-cement ratio, the 2001 code specifically gives provisions for lightweight and heavyweight concrete.		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
			818.0	Ready-Mix Concrete	818.1 Control. Shall conform to Section 842 for reinforced concrete.	

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1004.3	Mixes (Cont'd)	(b) Method II - Performance concrete. (1) Preliminary tests: Shall be in accordance with 1004.3 (a)(3). Mixes with performance data from previous projects, similarly proportioned, may be accepted, provided that acceptable performance data from such previous projects are provided and the conditions of paragraph (4) below are met. (2) Performance cement factor: Shall be determined in (3) below. (3) Strength. a. Concrete manufactured with stone and gravel aggregate: the water-cement ratio shall correspond to a concrete strength, at design slump, at least 25 % higher than the specified strength called for on the plan. The 25 % factor can be changed if satisfactory coefficient of variation can be provided by the plant, but in no case shall the water-cement ratio be larger than that corresponding to a concrete strength 15 % higher than the specified strength. b. Concrete manufactured with lightweight aggregate.- The concrete shall be proportioned on a strength vs. cement content basis in accordance with RS 10-65 [Annex A1] for a strength at least 25 % higher than the specified strength. The provisions of a. above relating to reduction in the strength requirement for demonstrable quality control shall apply. (4) Materials. Ingredients of the concrete for the buildings shall be the same as those in the preliminary tests. (5) Batching. Provisions for batching plant are given. (6) Quality control and inspection of materials and of batching. Provisions of 1004.3(a)(5) shall apply.		Method II is defined as "proportioning on the basis of field experience". Similar provisions are given as those in the 1968 code. Provisions are added for Method III -"Average Concrete. In lieu of making preliminary tests, provisions are given for the cement and water content for average concrete of 2000, 2500, or 3000 psi. Each load of concrete shall be certified by the producer.		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1004.4	Docu-mentation	All required attestations shall become a part of the documentation to be filed with the commissioner, and shall be subject to verification by strength tests, as hereinafter described, by check sampling of ingredients, or by such other inspections as the commissioner or the architect or engineer designated for controlled inspection may elect. Where automated batching equipment is used, the tapes recording the batched weights shall be available for inspection for a period of 2 years.	27-606	Similar		
1004.5	On-Site Inspec-tions	Inspection of concrete and concrete construction shall conform to Tables 10-1 and 10-2 [Annex B1] and the provisions of this article. (a) Controlled inspection. (1) Strength tests: Shall be performed on all structural concrete. The provisions of RS 10-3 [Annex A1] shall apply. Detailed provisions for concrete cylinders are provided. (2) Additional tests: Each sample recovered for strength test shall be additionally checked for slump, air content, unit weight, and temperature in accordance with RS 10-3 [Annex A1]. (3) Forms, reinforcement and placing: Provisions for the size and dimension of the forms, sizes and positions for reinforcement, and the placement of concrete are provided. (b) Other required inspection. Quality control and inspection shall be provided for operations that are not designated for controlled inspection.	27-607	Provisions in (a)- (1) and (2) are similar, but more comprehensive. The title for (a)-(3) is changed to "Controlled Inspection Log Book", and similar but more comprehensive provisions are given. Provisions in (b) are also similar, but more detailed and comprehensive.		
1004.6	Admix-tures	Admixtures, other than air-entraining and water-reducing agents, may be used only when batch plant inspection by a representative or employee of the architect or engineer designated for controlled inspection is provided. Where admixtures are used, the provisions of RS 10-3 [Annex A1] shall apply except that water-reducing agents shall conform to RS 10-44 [Annex A1], Type A or D, with the requirement for compressive strength increased to 110 % and for durability increased to 100 %. In addition, no anti-freeze agents shall be used. Admixtures shall be added only through calibrated dispensing devices. These dispensers shall be regularly inspected and certified as to accuracy by the manufacturer of the admixture.	27-608	Admixtures may be used in the concrete only where included in the preliminary test mixes proportioned in accordance with the provisions of Section 27-605 (a) (3) or mixes proportioned in accordance with the provisions of RS 10-3 [Annex A2]. In the case of mixes proportioned in accordance with section 27-605 (c), there shall be no reduction of the cement content called for in Table 10-3A [Annex B2] because admixtures are used in the mix. Where admixtures are used, the provisions of RS 10-3 [Annex A2] and RS 10-44 [Annex A2] shall apply. In addition, no anti-freeze agents shall be used. Admixtures shall be added in measured quantities in conformance with the accepted mix design.		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1004.7	Licensed concrete testing laboratories	All tests shall be performed by licensed testing laboratory.	27-609	Much more detailed provisions are given for the responsibilities of licensed concrete testing laboratory.		
1004.8	Short-span Concrete Floor and Roof Construction Supported on Steel Beams	The empirical equations in (c) and (d) below shall apply only where the steel beams are placed or encased in a manner that will provide section for the transfer of shear from slabs to beams larger or equal to the slab thickness required by the said equations. (a) Concrete.-Concrete shall have a minimum compressive strength at 28 days of 700 psi. (b) Reinforcement.- Reinforcement shall be or function as continuous. The main reinforcement shall be at least 0.15 % of the gross section where continuous steel fabric is used and at least 0.25 % when other forms of steel are used. All reinforcing shall be draped, with 1in. concrete cover at the center of the span and over the support (between the center of the reinforcing steel and the bottom or top of the slab). (c) Minimum slab thickness.- Shall be determined by the following Eq., but not less than 4 in. : $t=L/2+(w-75)/200$; t=total thickness, L=clear span between steel flanges (ft), w=gross uniform load (dead + reduced live)(psf). (d) Allowable load.- Shall be determined by following Eq.: $w=3CA_s/L^2$; A_s=area of main reinforcement, C=coefficient dependent on conc. and steel properties. (e) Openings in floors and roofs.- Provisions of the size of the openings that require to be framed is given.	27-610	Same		
1004.9	Pneumatically Placed Concrete	Shall conform to RS 10-15 [Annex A1].	27-611	Added: 27.611.1 Conveying concrete by pumping methods.- All classes and strengths of concrete may be conveyed by pumping methods. All materials and methods used shall conform to the rules promulgated by the commissioner.		
1004.10	Formwork	Shall conform to Article 19.	27-612	Formwork, slip form construction, lift method construction, precast and prestressed construction. - Shall conform to Sub-Chapter 19.		
1004.11	Concrete Utilizing Preplaced Aggregate	The use of concrete formed by the injection of grout into a mass of preplaced coarse aggregate will be permitted where it can be demonstrated by successful prototype installation that the proposed mix, materials, and methods of placement will produce a concrete of the specified strength and free of areas or inclusions of uncemented aggregate. Detailed provisions are given for prototypes, in-place concrete and inspection.	27-613	Same, except added: 27-613.1 Precast and prestressed concrete. 27-613.2 Thin-section precast concrete construction.		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only NYC Building Codes have provisions.
			848.0	Pneumatic Concrete	Provisions on the placement and mix of pneumatic concrete are given.	Only NYC Building Codes and BOCA Code have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Sub-Article 1005.0 Steel			***Article 6 Steel***			
1005.1	General Requirements	Materials, design, and construction methods shall meet the requirements of the following reference standards: (a) Structural steel- RS 10-5 [Annex A1]. (b) Light gauge cold formed steel - RS 10-6 [Annex A1]. (c) Open web steel. - RS 10-7 [Annex A1].	27-614	Same		All structural units of natural or manufactured materials shall comply with applicable specifications of authoritative agencies, or shall be subjected to test in conformity with generally accepted standards in order to determine their characteristics.

Municipal Code of Chicago (1967)			**BOCA Building Code - Basic Code (1965)**			**Comments**
Chap. 74 Steel and Metal Construction			***Provisions for Steel Construction***			
74-1	Structural Steel Design	Design, fabrication and erection of structural steel shall be in accordance with the following document: Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings, AISC 1963. Exceptions that do not follow this document are given.	827.0	Structural Steel Construction	Structural steel construction used in all buildings and structures shall be fabricated from materials of uniform quality, free from defects that would vitiate the strength or stability of the structure. Workmanship, design, fabrication, transportation and erection shall conform to accepted engineering practice as defined by the standards listed in Appendix B [Annex A5]. Provisions are given for Plans, Temporary and special stresses, Shop drawings, Welding, and Painting.	NYC Building Codes give general provisions for steel construction. Chicago and BOCA Codes give more specific provisions for various steel structural systems. The NY State Code has provisions only for general construction, it has not specific provisions for steel.
74-2	Light Gauge Steel Structural Members	Conform to Light Gage Cold-Formed Steel Design Manual, AISI 1962. Exceptions are also given.				
74-3	Steel Joist Construction	Conform to Open Web Joists-Standard Specifications and Load Tables. SJI-1963.	828.0	Formed Steel Construction	Design: Shall be based on allowable unit stresses and maximum deflections in accordance with Appendix B [Annex A5]. Provisions are also given for: Minimum thickness of metal; Secondary structural systems; Roof decking; Protection; and Tests.	
74-4	Light Weight Metal Alloys	Aluminum, magnesium and other lightweight metals and alloys shall be used only after approval by commissioner.				
74-5	Cast Iron	Conform to Standard Specifications for Gray Iron Castings- ASTM A48-62. Detailed provisions are given for the min thickness requirements for various structural members. Cast iron columns shall not be used where subjected to eccentric load which produce a net tension in the material, nor to resist wind load. Core of superimposed columns shall be of same dimensions above and below a splice. Cast steel shall conform to ASTM A27-62 (for grade 65-30) and A148-60 (grade 80-50).	829.0	Steel Joist Construction	Provisions are given for the design, protection, height and area limitations, and tests of steel joist constructions.	
			831.0	Cast Steel Construction	Provisions are given for materials, higher strength cast steel, and welding cast steel.	
			832.0	Cast Iron Construction	Provisions are given for materials, limitation of use, multi-story columns, and thickness of metal.	
			833.0	Special Steels	Identification: Alloy and high strength steel shall conform to the standards of accepted engineering practice. Shall be clearly marked. 2. Design and workmanship: Shall conform to the requirements of approved rules.	
74-6	Special Steels	Silicon, nickel and other alloy and high strength steels shall conform to the applicable standards of accepted engineering practice and may be used only under a controlled materials procedure. Detailed provisions are given for the stress, identification, and allowable unit stresses in columns.	834.0	Light Weight Metal Alloys	Shall be used in accordance with Appendix B [Annex A5].	
			723.0	Alloy and Special Steel	The use of alloy, high carbon or other special high-strength steels shall be permitted in the design and construction of buildings and structures as controlled materials and as prescribed in Section 833 in accordance with accepted engineering practice.	

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1005.2	Identification	Shall be marked or handled so that they can be positively identified.	27-615	Same		
1005.3	Quality Control	Provisions of Tables 10-1 and 10-2 [Annex B1] shall apply. Detailed provisions for welding and inspection are provided.	27-616	Same		
Sub-Article 1006.0 Wood			***Article 7 Wood***			
1006.1	General Requirements	Materials (other than non-stress grade lumber), design and construction methods shall meet the requirements of the following reference standard: (a) Lumber and timber - RS 10-8 [Annex A1]. (b) Plywood - RS 10-9 [Annex A1]. (c) Structural glued-laminated lumber - RS 10-18 [Annex A1].	27-617	Same		All structural units of natural or manufactured materials shall comply with applicable specifications of authoritative agencies, or shall be subjected to test in conformity with generally accepted standards in order to determine their characteristics.
1006.2	Identification	Provisions for identification requirements are given	27-618	Same		
1006.3	Use of Non-Stress Grade Wood	Conditions to which the use of non-stress grade wood should be limited are given.	27-619	Same		
1006.4	Quality Control	Inspection of the fabrication of glued-laminated assemblies, as stipulated in Table 10-2 [Annex B1], shall include a check of sizes of members of fit, and of gluing operations.	27-620	Same		
1006.5	General Construction Requirements	Provisions for various types of wood members are provided.	27-621	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
Chapter 72 Wood Construction						
 72-1 72-2 72-3 72-4	 General Maximum Allowable Unit Stresses Bolted Joints Ventilation	Abbreviations: NLMA: National Lumber Manufacturers Association. NDS: National Design Specifications for stress-grade lumber and its fastenings Wood structural members shall be of sufficient size to carry the dead + live load without exceeding the allowable unit stresses required in this chapter. Adequate bracing and bridging to resist wind and other lateral forces shall be provided. The applicable provisions of NDS shall govern. Maximum allowable unit stresses are given in Table 72-2 (a) [Annex B4, for ordinary materials]. Provisions for bolted joints are given. Provisions for ventilation are given.	853.0 854.0 855.0 856.0 857.0	Lumber and Timber Construction Heavy Timber Type Construction Wood Frame Construction Stress Skin Panels Glued, Laminated and Built-Up Lumber Construction	Provisions are given for the Design, Minimum dimensions, Fabrication, Trimmer and Header beams, Bearing and anchorage on girders, and Maintenance. Provisions are given for Wood, Other structural materials, Columns, Floors, and Beams and girders. The exterior walls, interior partitions, floors and roofs of wood frame construction shall be designed and constructed to develop adequate strength to resist all vertical and lateral forces due to both dead and live loads. Standard balloon, braced, platform and post and beam types of construction shall be acceptable framing methods. Detailed provisions are given for Wood-stud frame, Wall sheathing, Exterior weather boarding, veneers and condensation, Foundation anchorage, At-grade protection, Floors, Roofs, Flashing, and Interior finish. Provisions are given for Integrated assemblies, Splices, and Molded plywood units. Shall comply with Appendix B [Annex A5].	NY State code does not have specific provisions for wood construction.
			853.1		Requirements for identification of lumber and timber are given in Section 853.1.	Only NYC Building Codes and BOCA Code have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1006.6	Empirical Provisions in lieu of Design	Empirical provisions are given for certain buildings. The provisions cover Stud walls and partitions, Bracing of exterior walls, Floor and roof framing, Rafter and ceiling joist, and Built-up members.	27-622	Same		
1006.7	Heavy Timber Construction	Provisions for minimum sizes of members and construction details are given.	27-623	Same		
1006.8	Construction Methods	Provisions for fabrication and erection are provided.	27-624	Same		
Sub-Article 1007.0 Aluminum			***Article 8 Aluminum***			
1007.1	General Requirements	Materials, design and construction methods shall meet the requirements of RS 10-10 [Annex A1], and RS 10-11 [Annex A1].	27-625	Same		
1007.2	Identification		27-626	Same		
1007.3	Quality Control	Provisions of Tables 10-1 and 10-2 [Annex B1] shall apply. Provisions for welding are provided.	27-627	Same		
1007.4	Erection	Provisions for Bracing, Temporary connections, and Alignment are provided.	27-628	Same		
Sub-Article 1008.0 Reinforced Gypsum Concrete			***Article 9 Reinforced Gypsum Concrete***			
1008.1	General Requirements	Materials, design, and construction methods shall meet the requirements of RS 10-12 [Annex A1].	27-629	Same		
1008.2	Identification of Metal-Reinforcement	Bundles or rolls of welded wire fabric shall be securely tagged so as to identify the type and grade of the steel, and the size.	27-630	Same		
1008.3	Limitations of Use	Shall not be used where exposed directly to the weather or where subject to frequent or continuous wetting. Precast units shall be protected from weather and moisture.	27-631	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
			724.0 Light Weight Metals			
			Aluminum and other light weight metals and their alloys may be used in the design and construction of buildings or structures only upon special approval of the building official, subject to the determination of the physical properties by tests as prescribed in Article 8 and in accordance with provisions in section 834.			
73-2 Gypsum Concrete			***850.0 Reinforced Gypsum concrete***			
		The design and construction of reinforced gypsum concrete shall be in accordance with the provisions of the American Standard Specifications for Reinforced Gypsum Concrete.			Shall comply with Appendix B [Annex A5].	NY State code does not have specific provisions for gypsum concrete construction.
						Only NYC Building Codes have provisions.
					Same as in NYC Building Code.	Only NYC Building Codes and BOCA Code have provisions.

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Sub-Article 1009.0 Thin Shell and Folded-Plate Construction			***Article 10 Thin Shell and Folded-Plate Construction***			
1009.1	General Requirements	Applicable reference standards relating to allowable stress and the use of structural material shall apply.	27-632	Same		
1009.2	Analysis	Shall be based on assumptions of elastic behavior. The shell or plate may be assumed to be homogeneous and isotropic. The analysis for stability shall consider large deflections, creep and deviation between the actual and theoretical shell surface.	27-633	Same		
1009.3	Thin Concrete Shells	The provisions of Sections 403, 404 and 405 of RS 10-45 [Annex A1] shall apply with the following modifications. The remaining sections of RS 10-45 shall not apply. (1) The advisory provisions of this standard shall be considered mandatory. (2) Minimum ultimate strength of concrete for thin shells shall be 3000 psi. (3) Change all references to "the Building Code (ACI 318-63)" to "Reference Standard RS 10-4".	27-634	Same		
Sub-Article 1010.0 Suspended Structures			***Article 11 Suspended Structures***			
1010.1	General Requirements	Shall meet applicable requirements of the code and this section.	27-635	Same		
1010.2	Suspenders	Provisions for bridge wire cable and other materials are given.	27-636	Same		
1010.3	Tests of Materials for Bridge Wire Suspenders	Provisions on the minimum quantities of bridge wires to be tested are given.	27-637	Same		
1010.4	Tests of Materials for Other Types of Suspenders	RS 10-3 [Annex A1] and RS 10-5 [Annex A1] shall apply.	27-638	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.

Table 7–3. Structural Work (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1010.5	Design	Supplement design requirements to the applicable provisions for this article are given for the following topics. (a) Flexibility, (b) Elastic stretch, (c) Displacement, (d) Other considerations (effects of temperature, wind load, and vibration) and (e) Allowable working load. The allowable working load in suspenders formed from bridge wire cable shall be computed on the basis of factors equal to (1.5*DL+2.5*LL) or (1.2*DL+2*LL+2*W) applied to the specified, minimum, ultimate strength of the suspender. The allowable working load in suspenders conforming to the material specifications of several reference standards of this code shall be allowable working stress for tension members as prescribed in the applicable reference standard or, for those materials where allowable stresses for tension members are not prescribed, on the basis of factors of (1.5*DL+2.0*LL) or (1.2*DL+1.5*LL +1.5*W), also applied to the specified minimum ultimate strength of the suspender. In no case, however, shall the factor, applied to the yield strength of the material or to the prestretching or prestressing force, exceed (1.1*DL+1.25*LL).	27-639	Same		
1010.6	Fittings for Wire Cable Suspenders	Fittings for wire cable suspenders shall be capable of developing the specified minimum ultimate strength of the attached cable or strand without developing the yield stress.	27-640	Same		
1010.7	Construction	General provisions of RS 10-5 [Annex A1] relating to erection of steel shall apply.	27-641	Same		
1010.8	Protection of Suspenders		27-642	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.
						Only NYC Building Codes have provisions.

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Table 7–4. Foundations

Table 7–4. Foundations.

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Article 11 Foundations			***Subchapter 11 Foundations***		***Part 3 Structural Requirements C302 Soil Bearing Value***	
Sub-Article 1100.0 General			***Article 1 General***			
1100.1	Scope	The provisions of this article shall establish minimum requirements for the design and construction of the foundations of buildings.	27-652	Added: Flood areas should comply with RS 4-5 [Annex A2]. Otherwise the same.		
1100.2	Standards	RS 11 [Annex A1] shall be part of this article.	27-653	Same	C301	Shall be in conformity with generally accepted standards.
1100.3	Definitions	See Article 2.	27-654	Same		See Section C108-3.
1100.6	General Requirements	Except as otherwise specifically provided herein, the foundations of buildings including retaining walls and other structures shall bear on, or be carried down to, satisfactory bearing materials in such manner that the entire transmitted load will be distributed over the supporting soils at any depth beneath the foundation at unit intensities within the allowable bearing values established in this article. In addition, foundations shall be proportioned to limit settlements to a magnitude that will not cause damage to the proposed construction or to existing adjacent or nearby buildings during or after construction.	27-657	Same	C301 General Requirements	b- Buildings shall be constructed and integrated so that loads are transmitted to the soil without undue differential settlement, unsafe deformation or movement of the bldg or of any structural part. c- Wherever structural material or assemblies are subjected to deterioration and might become structurally unsound if unprotected, protection in conformity with generally accepted standards for the material involved shall be provided. Causes of such deterioration include, among others, action of freezing and thawing, dampness, corrosion, wetting and drying, and termites and other destructive insects. d- Buildings built in soil which is water bearing at any season of the year shall be constructed so that ground and surface water will not penetrate into habitable spaces, basements and cellars.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
Chapter 70 Foundations			*Article 7 Structural and Foundation Loads and Stresses*			
		See Chapter 47.			See Article 2. Some additional definitions are also given in Section 701.0.	
70-1	General Requirements	(a) Every building or structure shall be supported on footings, piles, foundation columns, piers or caissons complying with the requirements of this section. (b) The encroachment of foundations on public property shall be governed by section 77-2.1.	700.0	Scope	The provisions of this article shall control the structural design of all buildings and structures and their foundations hereafter erected to insure adequate strength of all parts thereof for the safe support of all superimposed live and special loads to which they may be subjected in addition to their own dead load, without exceeding the allowable stresses prescribed in the Basic Code or in accepted engineering practice.	The Chicago Code addresses encroachment of foundations on public property.

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1100.7	Depth of Foundations	The bottom of any footings and pile caps shall be carried down at least 4 ft below the lowest level of the adjoining ground or pavement surface that is exposed to frost. Exceptions to this provision are also given. For grade beams, the bottom of any grade beam shall be carried down at least 18 in. below the lowest level of the adjoining ground or pavement surface that is exposed to frost.	27-658	Same		
1100.8	Foundations at Different Levels	The influence of the pressure under the higher footings on the stability of the lower footings shall be considered.	27-659	Same		
1100.9	Slabs on Grade	Shall be designed to limit the settlement of such slabs.	27-660	Same		
1100.10	Constructions	The provisions of Article 19 relating to safety and of Article 10 relating to concrete, timber, masonry, and steel construction shall apply. For inspection requirements, see Section 1112.0. Provisions for cold weather and seepage are given.	27-661	Same		
Sub-Article 1101.0	***Soil Investigations***		***Article 2***	***Soil Investigation***		
1101.1	General	Borings in earth or rock, recovery of samples, tests of soil samples, load test, or other investigation or exploratory procedures shall be performed as necessary for the design and construction of a safe foundation subject to inspection in accordance with the requirements of 1112.0.	27-662	Same	C302-2 (b)	b- For buildings in which the sum of snow load and those live loads of all floors which are transferred by columns or walls to the soil, divided by grade-floor area, exceeds 200 psf, there shall be a min of 1 test pit or boring for every 2500 sft of grade-floor area, carried sufficiently into acceptable bearing materials to establish its character and thickness. Min depth requirements for at least 1 boring/10000 sft are given. Detailed provisions for boring record requirement are also given.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
70-3.2	Depth of Footings	All footings shall be carried to a depth of at least 3 ft 6 in. below the adjoining ground surface, except that a reinforced concrete slab foundation extending over the entire area below a one-story building shall be permitted at a lesser depth below the adjoining ground surface when so designed as to eliminate structural damage from frost action.	729.0	Depth of Footings	Except when erected on rock or when otherwise protected from frost, foundation walls, piers and other permanent supports shall extend below the frost line and spread footings of adequate size shall be provided to properly distribute the load within the allowable bearing value of the soil. Or such structures shall be supported on piles or ranging timbers when solid earth or rock is not available. No footings shall be founded on frozen soils unless such frozen condition is permanent. 729.1 Isolated footings. For footings on granular soil of classes 5-10 inclusive in Table 15 [Annex B5], the line drawn between the lower edges of adjoining footings shall not have a steeper slope than 30^{o} with the vertical, unless the material supporting the higher footing is laterally supported. 729.2 Floating mat. Shall be located on permanently undisturbed soil. Detailed provisions are given.	
70-2.2	Soil Investigation	All applications for building permits shall be accompanied by a statement from the architect or engineer as to the character of the soil. Where there is reasonable doubt as to the character and bearing capacity of the soil, the commissioner may require borings, test pits or test loads.	725.0	Bearing Value of Soils	All applications for permits for the construction of new buildings or structures, and for the alteration of a permanent structure which requires changes in foundation loads and distribution, shall be accompanied by a statement describing the soil in the ultimate bearing strata, including sufficient records and data to establish its character, nature and load-bearing capacity.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1101.2	Borings	(a) Number. At least one boring shall be made for every 2500 sft of building area or fraction thereof and, for buildings supported on piling of such type or capacity that load tests are required, one boring shall be made for every 1600 sft of building area except as indicated in (1) through (3) below. Detailed provisions are given for (1) One- and two-family dwellings, (2) Buildings having a plan area in excess of 10,000 sft and where subsurface meets certain conditions, and (3) Where foundations are to rest on rock of certain classes. (b) Location. At least 2/3 of the required number of borings shall be located within the area under the building, those outside shall be within 25 ft from the limits of the building. Borings shall be uniformly distributed or distributed in accordance with the loading pattern. (c) Depth. Provisions for the depth requirements for the borings are given. (d) Types. Provisions are given for soil borings and rock borings. (e) Data to be reported. Provisions are given for data that shall be recorded and reported. (f) Disposition of samples and cores. Soil samples and rock cores shall be retained in an accessible location for one year.	27-663	Same		
1101.3	Test Pits	Test pit may be substituted for borings on a one-for-one basis. All applicable requirements as to depth, number of samples, data to be reported, and disposition of samples shall be observed.	27-664	Added subdivision (b): provisions for buildings not more than one story in height and for one- or two-family residences not more than two stories in height.		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
70-2.3	Borings	All borings shall be made by a procedure that provides info capable of serving as basis for the classification of the subsurface materials as specified in 70-2.1. Detailed requirements for the content of the boring report are given.	726.1	When Required	In the absence of satisfactory data from immediately adjacent areas, the owner or applicant shall make borings, test pits, or other soil investigations at such locations and to sufficient depths of the bearing materials to the satisfaction of the building official. For all buildings, in other than residential use groups, which are more than 3 stories or 40 ft in height, and whenever it is proposed to use float, mat or any type of deep foundation, there shall be at least one exploratory boring to rock or to a depth of >50 ft below the load-bearing strata for every 2500 sft of built-over area, and such additional tests that the building official may direct.	
			726.2	Soil Samples	Samples of strata penetrated in test borings or test pits, representing the natural disposition and conditions at the site, shall be available for examination of the building official. Wash or bucket samples shall not be accepted.	
			726.3	Varying Soil Values	When test borings indicate non-uniformity of bearing materials, a sufficient number of additional borings shall be made to establish strata levels of equal bearing capacity.	
			726.4	Cost of Tests	Tests shall be made by and at the expense of the applicant and under the supervision of the building official.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1101.4	Borings Methods	Borings shall be made by continuous driving and cleaning out of a pipe casing except as permitted in (a) (b) and (c) following. Where casing is used, it shall be cleaned out to undisturbed soil prior to sampling and the sample spoon driven into soil that has not been affected by chopping, washing, or hydrostatic imbalance. Provisions for (a) Uncased borings, (b) Auger borings, and (c) Maximum diameter are given.	27-665			
1101.5	Probings and Geophysical Explorations	Provisions for the use of probings, auger borings or geophysical methods to substitute borings are given for foundations consisting of footings or foundation piers or walls bearing on rock of certain classes or piling bearing on rock of certain classes. Provisions for geophysical investigation are also given.	27-666	Same		
1101.6	Existing Borings	Existing boring data may be utilized subject to the following: (1) Borings, test pits, probings, etc., that have been made in accordance with all requirements of this section, but not necessarily for the investigation of the specific project for which application is being made, may be utilized in fulfillment of these provisions. (2) The logs of borings, test pits, probings, etc., that have been made in accordance with all requirements of this section, but wherein the soil samples and/or rock cores are not available for examination, may be utilized in fulfillment of these provisions to an extent not to exceed 1/2 of the required number of borings. (3) Borings, test pits, probings, etc., or the logs thereof, that do not meet the specific requirements of this article, but which are of suitable type and adequate penetration to provide the data required for the safe design and construction of the proposed foundation, may be utilized in fulfillment of the provisions of this section, subject to the approval of the commissioner.	27-667	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Sub-Article 1102.0 Foundation Loads			***Article 3 Foundation Loads***			
1102.1	Soil Bearing Pressures	The loads to be used in computing the bearing pressures on materials directly underlying footings shall be the total column, pier, or wall reactions determined in accordance with the provisions of Article 9, on the basis of reduced live load; plus the weight of the foundations; plus the weight of any soil, fill, and slabs on grade that is included within vertical planes projected upward from the extreme limits of the footing to the final ground surface. Live load on grade, or on slabs on grade, within these limits shall also be included. Impact loads shall be considered in accordance with 1102.6.	27-668	Same		
1102.2	Pile Reactions	The loads to be used in computing pile reactions shall be determined as provided in 1102.1, except where piles penetrate compressible strata, the pile load shall be increased by the amount of drag exerted by such material during consolidation. Provisions for the computation of the drag are given.	27-669	Same		
1102.3	Lateral Loads	Provisions for (a) Earth and ground water pressure, (b) Wind and other superstructure loads, and (c) Soil movements are given.	27-670	(a) Earth and ground water pressure: Added provisions for earthquake forces acting on the retaining wall.		
1102.4	Eccentricities	Provisions for eccentricity of loading in foundations are given. Soil pressure and pile load due to eccentricity shall be computed on the basis of straight line distribution of foundation reaction, or other modes of distribution with demonstrable evidence.	27-671	Same		
1102.5	Uplift Forces	Uplift and overturning forces due to wind and hydrostatic pressure shall be considered.	27-672	Same	C304-5 C304-7	Overturning Uplifting Overturning and uplifting forces due to wind or hydrostatic head shall be considered. Detailed provisions of these two sections can be found in Table B of this report.
1102.6	Impact Load	May be neglected in the design of foundations, except for foundations on loose soil, or those supporting heavy impact loads.	27-673	Same		
1102.7	Stability	Provisions in 1111.0 shall apply.	27-674	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
			710.1	Below Grade	All retaining walls and other walls below grade shall be designed to resist lateral soil pressures with due allowance for hydrostatic pressure and for all superimposed vertical loads.	
			710.2	Hydrostatic Uplift	All foundation slabs and other footings subjected to water pressure shall be designed to resist a uniformly distributed uplift equal to the full hydrostatic pressure.	
						Only NYC Building Code considers impact loads.

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1103.4	Allowable Soil Bearing Pressures	The allowable bearing pressures on satisfactory bearing materials shall be those established in Table 11-2 [Annex B1]. The allowable bearing pressures on nominally unsatisfactory bearing materials shall be those established in accordance with C26-1103.5. Allowable bearing pressure shall be considered to be the allowable pressure at a point in the soil mass in excess of the stabilized overburden pressure existing at the same point prior to construction operations. The stabilized overburden pressure existing at a point shall be defined as that portion of the weight of the overlying soil material that is supported by granular interaction rather than pore pressure. In general, the magnitude of the stabilized overburden pressure may be approximated as follows: (a) The overlying soil material shall be in place for an adequate length of time. Where the bearing stratum consists of soils of classes 5-65 through 8-65, the bearing stratum shall be considered to be fully consolidated. (b) The weight of fill material shall not be included in the stabilized overburden pressure unless its magnitude of stabilized pressure is verified by tests. (c) Where the bearing stratum consists of soils of classes 9-65 through 11-65, the stabilized overburden pressure shall be taken as zero unless its magnitude is verified by tests. (d) The stabilized overburden pressure shall not include the weight of any soil removed by excavation and not replaced. For footings, the stabilized overburden pressure shall not exceed the weight of 1 sft column of soil measured from the bottom of the footing to the lowest level of the final grade above the footing. For a boxed foundation, the pressure shall not exceed the weight of 1 sft column of soil measured from the bottom of the box to the lowest level of the adjacent grade. (e) Where the bearing stratum consists of soils of classes 9-65 through 11-65, the allowable bearing pressure shall be adjusted for the effects of rebound due to excavation. (f) Where the bearing stratum consists of rock of classes 1-65 through 3-65, the stabilized overburden pressure shall be neglected.	27-678	Same	C302-1 General Require-ment	The bearing value of the soil shall be determined in order that foundations may be proportioned so as to provide a min of absolute and differential settlement. Soil or pile tests, presumptive bearing values of the soil, reduction factors for pile groups, and pile driving formulas, referred to in this Code, shall be in conformity with generally accepted standards. When it can be conclusively proved that the presumptive soil bearing value is adequate for the proposed load, the enforcement officer may accept such proof in lieu of the determination prescribed in C302-2b.
					C302-2 Deter-mination	a- For buildings in which the sum of snow load and those live loads of all the floors which are transferred by columns or walls to the soil, divided by grade-floor area, is 200 psf or less, the allowable bearing value of the soil shall be the presumptive bearing value, or shall be determined by field load tests. b- For buildings in which the sum of snow load and those live loads of all floors which are transferred by columns or walls to the soil, divided by grade-floor area, exceeds 200 psf, there shall be a min of 1 test pit or boring for every 2500 sft of grade-floor area, carried sufficiently into acceptable bearing materials to establish its character and thickness. Min depth requirements for at least 1 boring/10000 sft are given. Detailed provisions for boring record requirement are also given. c- For buildings referred to in C302-2b, when the bldg load is transferred to the soil by spread footings, the allowable bearing values of the successive layers of soil determined by test pit or boring shall be the presumptive bearing values and, if required, shall be substantiated by field loading soil tests made on undisturbed, natural soil at the level of the proposed foundation, with fill, if any, removed. d. For buildings referred in C302-2b, when the load is transferred to the soil through the medium of friction or bearing piles, the capacity of a pile group shall be the number of piles multiplied by the capacity of 1 pile and by a reduction factor for friction piles. The capacity of a pile shall be determined by either a field loading pile test or a generally accepted pile-driving formula or a combination of both, with a limit determined by the strength of the pile as a structural member.

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
70-2.4	Soil Bearing Values	Maximum allowable pressures on the supporting soils at the bottom of the footings shall not exceed the values in Table 70-2.4 (a) [Annex B4] except when determined by tests or analysis. Exceptions to allowable bearing values: (1) Variation in soils. Where portions of the foundations of the same structure rest upon soils which vary substantially in bearing value, special provisions shall be made to prevent serious differential settlements which will impair the safety of the structures. (2) Where the bearing materials directly under a foundation overlie a stratum having smaller allowable bearing values, these smaller values shall not be exceeded at the level of such stratum. Computation of the vertical pressure in the bearing materials at any depth below a foundation shall be made on the assumption that the load is spread uniformly at an angle of sixty degrees with the horizontal. (3) Subject to the approval of the commissioner of buildings, bearing values greater than those required in 70-2.4 may be used if analysis based on laboratory tests, field loading tests or other pertinent information demonstrate that the greater values will not lead to excessive settlement.	725.2	Presumptive Bearing Values	Except when determined by field loading tests or as otherwise provided herein, the max allowable pressure on supporting soils under spread footings at or near the surface shall not exceed the values specified in Table 15 [Annex B5]. Presumptive bearing values shall apply to all materials of similar physical characteristics and disposition. Surface values shall be adjusted for deep footings and for the bearing strata under piles as provided in the Basic Code. When foundation caissons are driven to penetrate into sound rock, the allowable bearing values in Table 15 [Annex B5] may be increased as prescribed in Section 744.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1103.5	Bearing Capacity of Nominally Unsatisfactory Bearing Materials	A report based on soil tests and foundation analysis shall be submitted demonstrating that the proposed construction, under a condition of 100 % overload, is safe against failure of the soil materials. The report shall also show that the probable total magnitude and distribution of settlement to be expected under design conditions will not result in instability of the building or stresses in the structure in excess of the allowable values established in Article 10. In addition, the following provisions shall apply: (a) Fill materials. Provisions for controlled fills and uncontrolled fills are given. (b) Organic silts, Organic clays, Soft Inorganic clays, Loose inorganic silts, and Varved silts. Provisions for determining the allowable bearing pressure for the aforementioned materials are given. Also, the report required in this section shall include information regarding the geological profiles through the area, sufficient test data on the compressible material, cross sections showing the amount of fill and surcharge, the estimated amount and rate of settlement, and detailed analysis showing that the anticipated future settlement will not adversely affect the performance of the structure.	27-679	Same		
1103.6	Utility Services	Provisions are given to prevent damage to the utility service lines laid in soil materials.	27-680	Same		
Sub-Article 1104.0 Soil Load Bearing Tests			***Article 5 Soil Load Bearing Tests***			
1104.1	Applicability	Soil load bearing tests may be accepted as evidence of allowable bearing capacity of a given soil stratum, subject to the following limitations: (a) The applicability of soil load bearing tests shall be limited to soil materials of classes 5-65 through 10-65. (b) Soil load bearing tests shall not be used to justify allowable bearing pressures in excess of the maximum allowable bearing values in Table 11-2 [Annex B1]. (c) Soil bearing tests shall not be applicable where the proposed bearing stratum is underlain by a stratum of lower class, unless analysis indicates that the presence of the lower class will not create excessive settlement.	27-681	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
			725.3	Light Weight Structures	Mud, organic silt, or unprepared fill shall be assumed to have no presumptive bearing capacity unless approved by test, except where the bearing capacity is deemed adequate by the building official for the support of light weight and temporary structures.	
						Only NYC Building Codes have provisions to prevent damage to utility services.
	70-2.5	***Field Loading Tests***		***727.0***	***Soil Test Procedure***	
		(a) Whenever the bearing value of soil is in reasonable doubt or when it is desired to use soil bearing values in excess of those established in Table 70-2.4(a) [Annex B1], the allowable load on a bearing material may be determined by test in accordance with the requirements of this section.				

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1104.2	Procedure	Provisions are given for Preparation, Loading of the soil, and Determination of results.	27-682	Same	C302-3 Performance Criteria for Field Loading Soil Test	Under field loading test, the total settlement caused by the proposed load on the soil, measured after a period during which no settlement had occurred for 24 hrs, shall not exceed 3/4 in. The additional settlement caused by a 50 % increase in the proposed load, measured after a period during which no settlement had occurred for 24 hrs, shall not exceed 60 % of the total settlement as previously measured under the proposed load.
					C302-4 Performance Criteria for Pile Test	a- The test load shall be twice the proposed pile load, applied in increments of 1/4 of the proposed pile load, with readings of settlements taken to the nearest 1/32 in. and plotted against load. The test load may be increased to more than twice the proposed pile load value until the gross settlement is approximately 1 in. At each step the load shall remain unchanged until there is no settlement in a 2 hr period, and the test load shall remain in place until there is no settlement in 48 hrs. b- The total test load shall then be removed in decrements not exceeding 1/4 of the total test load at intervals of not less than 1hr, with rebound read after each removal of load and plotted against load and with the final rebound recorded 24 hrs after removal of the last decrement. The allowable pile load shall be the lesser of 1/2 of that load which caused a gross settlement of 1 in. or a net settlement equal to 0.01 in./ton times total test load in tons, with a limit determined by the strength of the pile as a structural member.
Sub-Article 1105.0 Footings, Foundations Piers, and Foundation Walls			***Article 6*** *(Same title as in '68 Code)*			
1105.1	Materials	All structural elements of foundations shall meet the requirements as to type and minimum quality of materials prescribed in Article 10.	27-683	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
		(b) Test procedure. (1) A sufficient number of tests shall be made to determine the bearing value of the soil over the entire building site. (2) Each load test area shall be no less than 4 ft^2, except that for soils of >10,000 psf bearing capacity, the area can be 1 ft^2. (3) Load increments shall not exceed 25 % of the proposed safe load until the load reaches 200 % of it. (4) The load increment shall be applied at uniform intervals such that the proposed safe load is reached in >8 hrs. This load shall remain until no measurable settlements shall occur in 16 hrs period. The total test shall then be completed in >8 hrs. The total load shall remain until no measurable settlement occurs in 16 hrs. (5) Measurements of settlement shall be recorded diagrammatically. (c) Conditions of acceptance. (1) The total settlement under the proposed safe load shall not exceed 3/8 in., and the total settlement under double the design load shall not exceed 1 in. (2) The proposed safe load shall not cause pressure on any underlying soil stratum in excess of maximum pressures established in Table 70-2.4(a). If the above conditions are not satisfied, the allowable safe load shall be determined by selecting a reduced load from the load-settlement diagram such that the above conditions are satisfied.	727.1	Soil Test Method	The test procedure and testing apparatus shall be approved by the building official before they are used; and a complete record of the tests together with a record of the soil profile shall be filed by the licensed engineer or architect who shall have a fully qualified representative on the site during all boring and test operations.	
			727.2	Loaded Area	For spread footings, the soil shall be loaded at one or more places and at the required level or levels. The loaded area shall be approximately 4 sft for all bearing materials; except that when the footing overlies wet clay or other soft materials, the test load shall be applied to an area of not less than 10 sft.	
			727.3	Recorded Settlements	Loads shall be applied in continuous increments of not more than 1/4 of the proposed safe load. When the proposed load has been reached, it shall remain undisturbed and readings shall be recorded to determine the rate of settlement until the settlement in 8 consecutive hrs is less than 0.01 in. A 50 % excess load shall then be applied and allowed to remain in place until the rate of settlement is less than 0.01 in. in 24 hrs.	
			727.4	Accuracy of Loading	Test loads applied by mechanical devices shall be automatically controlled so as to insure not more than 5 % variation in applied load. Such devices shall be calibrated prior to the test.	
			727.5	Test Acceptance	The load settlement shall be represented diagrammatically, and no test shall be deemed satisfactory if the net settlement after removal of the test load exceeds 0.01 in./ton of gross load applied.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1105.2	Footings	(a) Wood footings. May only be used for wood frame structures. Preservative treatment shall be in accordance with RS 11-4 [Annex A1]. (b) Pole buildings. Buildings not more than one story high may be supported on poles embedded in the ground. Shall have protective treatment for wood and steel poles. (c) Grillages. Shall have proper spacers, stiffeners, and diaphragms, or spaces between beams shall be filled with concrete and grout. (d) Design. (1) Concrete footings: per RS 10-3 [Annex A5]. Reinforcement shall extend to within 4 in. of the edges of the footings. (2) Masonry footings: Reinforced masonry footings shall meet the requirements of RS 10-2 [Annex A5] and shall be proportioned similarly to the proportioning of RC footings. Provisions are also given concerning the dimensions of unreinforced masonry footings.		Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
70-3	Footings	Footings shall be provided under walls, piers or columns where required to distribute their loads in accordance with the allowable bearing values of the supporting soils as provided in Section 70-2. 70-3.1 Proportioning. Footings shall be so proportioned as to insure a min. of unequal settlement. 70-3.2 Depth. All footings shall be carried to a depth of at least 3 ft 6 in. below the adjoining ground surface, except that a RC slab foundation below a one-story building shall be permitted at a lesser depth. 70-3.3 Construction. (a) General. Footings shall be constructed of solid masonry or concrete with or w/o reinforcement and shall be so designed that stresses in the material shall not exceed the maximum allowable stresses required in the following chapters: RC footings (Chap 73), plain concrete footings (Chap. 71, 73), masonry footings (Chap. 71). (b) Masonry footings. Footings constructed of solid masonry units shall have a depth at least twice the total projection beyond the wall or column base. When brick work in foundation walls is stepped to form a footing, the maximum offset for each course shall be 1.5 in. (c) Steel grillage footings. When structural steel members are used in footing construction, such members shall be entirely encased by at least 3 in. of concrete, and the space between the members shall be entirely filled with cement grout. Stress in steel members shall not exceed the allowable stress required in Chap. 74.	730.0	Footing Design	730.1 Design loads. The full dead load including the weight of foundations, footings, and overlying fill and reduced LL shall be used. 730.2 Pressure due to lateral loads (W, E).- May be neglected if <1/3 of the DL+LL pressure alone. If >1/3, such increased pressure shall be considered with a 1/3 increase in allowable soil pressure under the combined load. 730.3 EQ loads. Shall comply with Section 719.0. 730.4 Vibratory loads. Consideration shall be given to the design of the footings to prevent detrimental disturbance of the soil.	The BOCA Building Code has the most comprehensive footing design provisions.
			731.0	Timber Footing	731-1 Where permitted. Only for wood frame structures unless otherwise approved by Building Official. Shall be placed entirely below the permanent water level except when treated. 2.- Untreated timber.- The compressive stresses perpendicular to the grain in untreated timber footings shall not exceed 70 % of the allowable stresses of the specified lumber.	
			732.0	Steel Grillages	732.0 Shall be separated with approved steel spacers and shall be entirely encased in at least 3 in. of concrete and the spaces between the beams shall be filled with concrete or cement grout. When used on yielding soils, steel grillages shall rest on approved concrete beds >6 in. thick.	
			733.0	Unrein-forced Concrete Footings	733- 1. Concrete strength.- Not less than 2000 psi at 28 days. 2. Deposition.- Shall not be poured through water unless otherwise approved by the building official. When poured under or in the presence of water, the concrete shall be deposited by approved means, which insure minimum segregation of mix and negligible turbulence of the water. 3. Dimensions. Edge thickness shall be not less than 8 in. for footings on soil, and not less than 12 in. above the tops of piles for footings on piles. Except: May be reduced to 6" and 8" respectively for 1-story and basement buildings of wood frame or brick veneered walls. 4. Protection.- Shall be protected from freezing during deposition and not less than 5 days thereafter and no water shall be allowed to flow through the concrete.	
			734.0	Masonry Unit Footings	734- 1 Dimensions: Shall be laid in Type M or S mortar complying with Section 816. Provisions for depth and width of the wall are also given. 2.Offsets: Provisions for maximum offset of each course laid in single or double courses are given.	
			735.0	Rein-forced Concrete Footings	735- 1. Design: Shall comply with Sections 841, 842, 843, 844 and applicable standards in Appendix B [Annex A5]. 2. Dimensions: Edge thickness shall be not less than 5 in. above the reinf. if on soil, and not less than 12 in. if on piles. Provisions for dimensions of pile caps are also given. 3. Protection. When concrete is deposited directly against the ground, the reinf. shall have a minimum cover of 3 in. At other surfaces of foundation concrete, the minimum cover shall be 2 in.	
			736.0	Mat, Raft and Float Founda-tions	736.0 Shall be used only when the loading is uniformly balanced and the soil immediately below the mat is of uniform bearing capacity.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1105.3	Foundation Piers	Shall be designed as columns. RC piers shall conform to RS 10-3 [Annex A5]. Reinforced and unreinforced masonry piers shall conform to RS 10-2 [Annex A5] and RS 10-1 [Annex A5], respectively. Unreinforced concrete piers shall conform to C26-1105.3 (b). (a) Lateral support. May be determined by elastic analysis, or a pier may be assumed to be hinged, but laterally braced at intervals equal to the full height of the pier or eight times the least dimension of the pier, whichever is the lesser value. Provisions in 1105.3 (e) shall apply. (b) Unreinforced concrete piers. Provisions for the allowable compressive stress, the ratio of height to the least lateral dimensions, and maximum eccentricity are given. (c) Metal shells. Where piers are encased by a metal shell, provisions for when the shell can be considered as contributing to the structural strength of the pier are given. (d) Minimum dimensions. Provisions for pier dimensions are given. (e) Filling. The provisions of (a) and (d) shall apply only where the fill is placed around the pier as controlled fill. For uncontrolled fills, provisions are given for the dimensions of the piers.	27-685	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
70 -12	Founda-tion Columns	70-12 Foundation columns: shall consist of steel pipe shells extending to rock and completely filled with concrete with or w/o steel reinforcement or cores. 70-12.1 The pipe shall conform to ASTM specifications for welded and seamless steel pipe piles and shall have a minimum thickness of 0.3 in. The nominal diameter of pipe shall be not less than 22 in. 70-12.2 Foundation column shall extend to solid rock as defined in Section 70-2.1. 70-12.3 Allowable load and stresses. (a) If the base of the foundation column is less than 1ft below the surface of the solid rock, the bearing load on solid rock shall not exceed 100 tsf or the value determined by tests as provided in Section 70-2.5. (b) If the base of foundation column is 1 ft or more below the surface of the solid rock, the allowable bearing value may be increased 20 %/ft for each foot of depth greater than 1 ft, but shall not exceed 200 tsf. (c) When the column extends through a layer of unstable soil, the maximum design load shall be computed as for a column with an unsupported length equal to the depth of the unstable layer of soil, plus 4 times the diameter of the column.	749.0	Foun-dation Piers	1. Unreinforced: when the unsupported height of foundation piers exceeds 6 times the least dimension, the allowable working stress on piers of unit masonry or plain concrete shall be reduced in accordance with accepted engineering practice. 2. Reinforcement: 1) Design- May be reinforced with spiral or vertical reinf in accordance with provisions of column design in Appendix B [Annex A5]. When adequate lateral support is provided, the requirements for long column shall be waived. 2) Minimum percentage: An outer peripheral ring of a thickness of 1/10 of the pier perimeter, but not to exceed 2', shall be considered an envelope. Based on the area of such envelope, the min. vertical reinf. shall be 3/4 of 1 % and 2/10 of 1 % of horizontal reinf throughout its length. Minimum concrete cover shall be 3". 3. Steel shells: When concrete piers are entirely encased with a circular steel shell, the area of the shell steel may be considered as reinforcing provided it is protected per 738.0. All horizontal joints in the shell shall be spliced per Section 737. 4. Dimensions: Minimum dimension for isolated pile: 2', height< 12 times the least dimension unless it's RC or steel or encased in steel shell>1/4" thick. Greater length may be approved if adequate lateral support exists. 5. Belled bottoms: The edge thickness of the bell shall be >12" and the side of the bell shall slope at >60^o to the horizontal. 6. Dewatering: Shall insure accurate preparation and inspection of the bottom and the deposition or construction of sound concrete in the dry.	
70 -13	Foundati on Piers and Caissons	Shall be of concrete w/ or w/o steel reinforcement, extending to solid rock or to hardpan. 70-13.1 Piers or caissons bearing on hardpan may be belled to increase load carrying capacity, provided that such bell shall be at least 12 in. thick at its edge and that the sides shall slope at an angle of not less than 60^o with the horizontal. 70-13.2 Allowable load and stress. (a) The allowable bearing value shall be the bearing capacity of the hardpan or rock as in section 70-2.4. (b) The load used in determining the areas of the piers and of the belled bottom shall be the load supported at the top of the pier. 70-13.3 Tests. (a) Where piers are to be supported on hardpan, the thickness of the hardpan strata shall be determined by boring extended not less than 6' below the bottom of the pier. (b) When piers extend to bedrock, the thickness of the rock strata shall be determined by borings extended not less than 8 ft into solid rock. The rock bottom of not less than 10 % of the total number of piers evenly distributed over the site shall be so drilled.				

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1105.4	Foundation Walls	(a) Concrete.- Shall be designed according to RS 10-3 [Annex A5]. Provisions for equivalent unbraced height are given. (b) Masonry.- Provisions for the types and wall thickness are given. In addition, provisions in RS 10-1 [Annex A5] and RS 10-2 [Annex A5] should be followed.	27-686	Same		
1105.5	Construction of Footings, Foundation Piers, and Foundation walls	Provisions of 1100.10 and 1112.5 shall apply. In addition, provisions are given for conditions that shall be satisfied for the methods of installation and construction.	27-687	Same		
Sub-Article 1106.0 Pile Foundations-General Requirements			***Article 7*** *(Same title as in '68 Code)*			
1106.1	Administrative Requirements	Requirements concerning Identification of piles and Record of pile driving are given.	27-688	Same		
1106.2	Minimum Pile Penetrations	(a) Required by soil bearing capacity- 1107.1 (b)(1) shall apply. (b) Required for lateral restraint- 1106.7 shall apply. (c) Piles located near a lot line- provisions are given.	27-689	Same		
1106.3	Use of Existing Piles at Demolished Structures	Requirements for piles at demolished sites to be used for the support of new constructions are given.	27-690	Same		
1106.4	Tolerances and Modification of Design due to Field Conditions	Provisions are given for the tolerance in alignment of the pile axis, tolerance in location of the head of the pile, and Bent piles.	27-691	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
			871.0	Foundation Walls	Design: Foundation walls shall be designed to resist frost action and to support safely all vertical and lateral loads as provided in Article 7. The maximum stresses due to combined load shall be within the values specified for the materials used in the construction. Unless properly reinforced, tensile stresses shall not exceed those permitted in plain masonry. Provisions for minimum thickness of foundation walls of various materials are also given.	
Pile Foundations - General Requirements			***Pile Foundations***			
			737.0	Pile Foundations	Shall be designed to transmit loads to lower strata of foundation materials. The bearing value of the supporting soil shall be evaluated per Section 739. Piles may be constructed of any approved materials.	
			737.1	Site Investigation	The building site shall be investigated for all conditions which might promote deterioration of the pile foundations, and approved protective measures shall be taken.	
			737.6	Minimum Length and Penetration	Provisions for piles near lot line are given.	
						Only NYC Building Code has this provision.
			737.9	Precautions	During driving, all piles shall be held in their design location and shall be driven plumb. Tolerance to lateral deviation of the pile is given. Driving shall be under inspection.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1106.5	Minimum Spacing of Piles	Provisions for the minimum pile spacing are given.	27-692	Same		
1106.6	Minimum Section	Provisions for the minimum pile sections are given.	27-693	Same		
1106.7	Capping and Bracing of Piles	(a) Capping of piles.- Provisions are given for pile embedment, uplift, reinforcement, and design. (b) Bracing of piles.- Except for short piles, provisions are given for the lateral bracing of piles with caps, brace beams, concrete slab-on-grade, other means (anchors), and floor system. Special requirements for bracing batter piles are also given. (c) Bracing of short piles.- Provisions for bracing of short piles are given.	27-694	(c) Bracing of short piles, (1) Added, at the end of the paragraph, provisions for depth for pile penetration. Otherwise, the same.		
1106.8	Splicing of Piles	Provisions for splicing of piles are given.	27-695	Same		
1106.9	General Requirements for Installation of Piles	(a) Protection of adjacent property. (b) Protection of the pile during installation. (c) Protection of pile materials after installation. Specific provisions are given for untreated timber piles and piles installed in ash or garbage fills etc that need special protection. (d) Equipments for pile installation.	27-696	Same		
1106.10	Use of Uncased Concrete Pile Shafts	Conditions where uncased shafts can be used are given for bored piles and driven piles.	27-697	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
70-4 (a)	Minimum Spacing	Provisions for minimum spacing are given.	737.2	Spacing	The minimum C-C spacing of piles shall not be less than twice the diameter of a round pile, nor less than 1.75 times the diagonal dimension of a rectangular pile. When driven to rock, the spacing shall be not less than 24 in. When other than rock, the spacing shall not be less than 30 in. For piles which cannot be checked for plumbness, the minimum spacing prescribed herein shall be increased not less than 6 in.	
			737.5	Minimum Dimensions	Provisions for tapered piles and uniform circular and non-circular sections are given.	
70-4 (b)	Pile Caps	Provisions for pile caps are given.	737.3 737.4	Wall Piers Isolated Pier Piles	Piles in wall foundations shall be staggered about the C-line at a min. distance of 1/2 the top diameter. Exceptions for single row are given. Not less than 3 piles shall be furnished under isolated piers, unless lateral bracing is provided.	
			737.7	Splices	Shall be avoided if possible. Where used, splices shall be such that the resultant vertical and lateral loads at the splices are adequately transmitted. Detailed provisions are given.	
			738.0	Corrosion Protection	1. Preservative treatment. Shall comply with Section 740.5 and Appendix C [Annex A5]. 2. (Deleted). 3. Protective jackets. When surrounding soil contains destructive chemical elements, protective jacket shall be provided. When the jacket is of concrete, the thickness of the cover shall be not less than 1.5 in. 4. Cinder fill: Shall be considered sufficient reason for protective jacket.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1106.5	Minimum Spacing of Piles	Provisions for the minimum pile spacing are given.	27-692	Same		
1106.6	Minimum Section	Provisions for the minimum pile sections are given.	27-693	Same		
1106.7	Capping and Bracing of Piles	(a) Capping of piles.- Provisions are given for pile embedment, uplift, reinforcement, and design. (b) Bracing of piles.- Except for short piles, provisions are given for the lateral bracing of piles with caps, brace beams, concrete slab-on-grade, other means (anchors), and floor system. Special requirements for bracing batter piles are also given. (c) Bracing of short piles.- Provisions for bracing of short piles are given.	27-694	(c) Bracing of short piles, (1) Added, at the end of the paragraph, provisions for depth for pile penetration. Otherwise, the same.		
1106.8	Splicing of Piles	Provisions for splicing of piles are given.	27-695	Same		
1106.9	General Requirements for Installation of Piles	(a) Protection of adjacent property. (b) Protection of the pile during installation. (c) Protection of pile materials after installation. Specific provisions are given for untreated timber piles and piles installed in ash or garbage fills etc that need special protection. (d) Equipments for pile installation.	27-696	Same		
1106.10	Use of Uncased Concrete Pile Shafts	Conditions where uncased shafts can be used are given for bored piles and driven piles.	27-697	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
70-4 (a)	Minimum Spacing	Provisions for minimum spacing are given.	737.2	Spacing	The minimum C-C spacing of piles shall not be less than twice the diameter of a round pile, nor less than 1.75 times the diagonal dimension of a rectangular pile. When driven to rock, the spacing shall be not less than 24 in. When other than rock, the spacing shall not be less than 30 in. For piles which cannot be checked for plumbness, the minimum spacing prescribed herein shall be increased not less than 6 in.	
			737.5	Minimum Dimensions	Provisions for tapered piles and uniform circular and non-circular sections are given.	
70-4 (b)	Pile Caps	Provisions for pile caps are given.	737.3 737.4	Wall Piers Isolated Pier Piles	Piles in wall foundations shall be staggered about the C-line at a min. distance of 1/2 the top diameter. Exceptions for single row are given. Not less than 3 piles shall be furnished under isolated piers, unless lateral bracing is provided.	
			737.7	Splices	Shall be avoided if possible. Where used, splices shall be such that the resultant vertical and lateral loads at the splices are adequately transmitted. Detailed provisions are given.	
			738.0	Corrosion Protection	1. Preservative treatment. Shall comply with Section 740.5 and Appendix C [Annex A5]. 2. (Deleted). 3. Protective jackets. When surrounding soil contains destructive chemical elements, protective jacket shall be provided. When the jacket is of concrete, the thickness of the cover shall be not less than 1.5 in. 4. Cinder fill: Shall be considered sufficient reason for protective jacket.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1106.11	Where More Than One Pile Type, Pile Capacity, or Method of Pile Installation Is Used	The several parts of the building supported on the different types, capacities, or modes of piling shall be separated by suitable joints providing for differential movement, or a report shall be submitted showing that the proposed construction is adequate and safe.	27-698	Same		
1106.12	Pile Materials	The provisions of C26-1000.1 and 1000.9 relating to "classification of materials, assemblies and methods of construction" and to the use of "used and unidentified materials" shall apply.	27-699	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
			748.0	Lateral Support	1. Surrounding materials: Any soil other than water or fluid soil shall be deemed to afford sufficient lateral support to permit the design of any type of pile as a short column. When piles are driven through soil which will be removed subsequently to the completion of the foundation, the resistance offered by such material shall not be considered to contribute to the lateral supporting capacity. 2. Fixed ends: When not assumed laterally supported by the surrounding soils and when fixed by lateral supports at the upper end only, the unsupported length of pile or other isolated foundation shall be assumed as 3/4 the total length; and when supported at the bottom by drilling or other rigid attachment into the bed rock in addition to top lateral support, the unsupported length shall be assumed as 1/2 the total length.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Sub-Article 1107.0 Pile Foundations - Loads			***Article 8 Pile Foundations - Loads***			
1107.1	Allowable Axial Load	The allowable axial load on a pile shall be the least value permitted by consideration of the following factors: (a) The capacity of the pile as a structural member: Provisions for the embedded portion of the pile, and the portion that is not embedded, and the load distribution along embedded portion of the pile are given. (b) Allowable bearing pressure on soil strata underlying the pile tips: The allowable pile load shall be limited by the provision that the pressures in materials at and below the pile tips shall not exceed the allowable bearing values in 1103.0. Provisions of 1103.4 and 1103.5 shall apply. The transfer of load from piles to soil shall be determined by a recognized method of analysis. Alternative methods to determine load transfer are given for piles in different soil classes. In addition, bearing strata shall be established, to which the piles in the various sections of the building are to be penetrated. (c) Capacity as indicated by resistance to penetration: Where soils that the piles must penetrate consist of materials that present a hazard to the installation of the piles, the selection of types of piles and penetration criteria shall be subjected to approval. But in no case shall the minimum penetration resistance be less than that stipulated in Tables 11-4 and 11-5 [Annex B1]. Detailed provisions are given for (1) piles installed by use of steam-powered, air-powered, diesel-powered or hydraulic impact hammers, (2) piles installed by jacking or other static forces, and (3) piles installed by use of vibration hammer. (d) Capacity as indicated by load test.- Load test requirements are given for piles installed by static forces, by impact hammers, and by use of vibration hammers. Provisions for load test procedures are also given. Foundation piles within the area of influence of a given satisfactory load-tested pile shall be installed under identical conditions. Group load tests up to 150 % of the proposed group load may be required for pile groups. And temporary supporting capacity the soil might provide to the pile during the test shall be obviated by "casing off". (e) Maximum loads.- (1) Basic maximum load: Except as permitted in the provisions of (2) below, the maximum pile load shall not exceed the values in Table 11-6 [Annex B1]. (2) Substantiation of higher allowable loads: load values higher than those in Table 11-6 [Annex B1] can be substantiated on the basis of test and analysis. Detailed provisions are given.	27-700	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
70-5		***Allowable Loads on Piles***	***739.0***		***Allowable Pile Loads***	
		The average compressive stress on any cross-section of a pile under design load shall not exceed the allowable value for the material as provided in Chapters 72, 73, 74. All concrete in piling shall have a min. ultimate compressive strength of 3000 psi. 70-5.1 For pile loads not exceeding 25 tons for timber piles, nor 40 tons for concrete piles, concrete-filled steel pipe piles and rolled structural steel piles, the allowable pile loads may be determined by the value R obtained by one of the following formulas: Formulas for piles whose weight is equal to or less than, and whose is larger than, the weight of the striking part are given, respectively. R is the allowable pile load and is function of weight of the striking part, effective fall height, actual energy delivered by hammer per blow, penetration of pile per blow and weight of pile. 70-5.2 For pile loads exceeding 25 tons for timber or 40 tons for concrete etc, the allowable pile load shall be determined by control load tests as required in Section 70-5.3. 70-5.3 (a) The number of control test piles shall be determined by engineer or architect by the degree of variation in soil conditions. (b) A pile to be tested shall be loaded to double the proposed allowable load. Same as in 70-2.5 (b). (c) Measurement of settlement shall be taken and recorded immediately before and after each increment of load. In determining the settlement, proper deduction shall be made for elastic compression of the pile under test load. (d) The proposed allowable load shall be considered acceptable if the total net settlement under the total test load, after the elastic compression of the pile under the test load has been deducted, does not exceed 0.01 in./ton of total test load. (e) The proposed allowable load, if acceptable, shall be allowable for all piles driven in the same soil conditions if the driving resistance is not less than that of the control test pile. 70-5.4 (a) Where the resistance of a pile is developed in or above a compressible soil layer, the settlement due to compression of this soil shall be considered in the design. (b) Where the piles are jetted into position, allowable loads shall be determined either by Section 70-5.1 or 70-5.3.			Shall be determined by applicable formulas. The maximum load capacity shall be limited by the supporting capacity of the soil as determined by driving resistance or by load test, but shall not exceed the capacity of the pile designed as a short or long column. 739.1 Short column load. Except when extending above permanent ground level, or driven in material of negligible lateral support, or driven through soil which will be later removed, all piles shall be designed as short columns under the provisions of the basic code for the structural material used. The average compressive stress in any section of the pile shall not exceed the allowable column values of the basic code. 739.2 Driving formula load. The allowable load on any pile determined by the application of an approved driven formula shall not be >40 tons. 739.3 Approved test load. When greater loads per pile than permitted in Section 739.2 are desired, control piles shall be tested with the procedure in Section 727.The resulting allowable load shall be <1/2 of the test load which produces a permanent net settlement/ton not more than 0.01 in. All other piles shall have the capacity as that of the control pile, except as provided in Section 739.4. Not less than 3 piles shall be driven in any area of uniform foundation materials and 1 of such shall be test loaded. At least 1 test shall be made for each 15,000 sft of building area. 739.4 Group Pile load. 1. Limiting load. The total load on group of piles shall not exceed the bearing capacity on the gross loaded area of the underlying soil stratum, assuming a uniform load spread within 60^o with the horizontal from the area occupied by the pile group + 1 ft surrounding the periphery of the cluster. No overlapping of pressure areas from similar distribution of loads for adjacent pile groups. 2. Load test of pile groups: When driven through materials subjected to displacement or shifts, the immediate surrounding pile groups shall be driven in place before the test load is applied to that group. 739.5 Limiting pile loads: 200 tons when open-ended concrete-filled steel pipe piles are installed to bear on rock; 120 tons on all other types of piles when bearing on rock except timber piles (740.6); 80 tons when bearing on or in materials of classes 3,4,5 in Table 15.; 60 tons when bearing on or in materials classified in Table 15 [Annex B5].	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1107.2	Allowable Lateral Load	Provisions for allowable lateral load are given.	27-701	Same		
1107.3	Uplift Capacity	A minimum safety factor of 2 against withdrawal shall be provided. Shall be greater than 2 if subjected to dynamic uplifting. If factor of 3 or more is used, no need for pull-out test.	27-702	Same		
Sub-Article 1108.0 Pile Driving Operations			***Article 9 Pile Driving Operations***			
The provisions of this article shall not apply to piles driven with a vibration hammer or other equipment wherein the energy of impact cannot be evaluated.						
1108.1	Equipment	General provisions for equipment and specific provisions for cushion or cap block and followers are given.	27-704	Same		
1108.2	Procedure	Provisions for Continuous driving, Jetting, Sequence of installation, Heaved piles, and Penetration measurements are given.	27-705	Same		
Sub-Article 1109.0 Pile Types - Specific Requirements			***Article 10 Pile Types – Specific Requirements***			
1109.1	Scope		27-706	Same		
1109.2	Timber Piles	(a) Materials: Timber piles shall conform in quality to class A or B of RS 11-7 [Annex A5]. Provisions are given for the size of the piles. The limits for stress due to the applied loads are given for various wood types. (b) Limitation on use: Terminate driving directly when the pile reaches bearing on hard materials. (c) Legged and inverted piles: Provisions for double legging and single legging and inverted piles are given. (d) Installation: Damaged materials at the head of the pile shall be removed before capping. Sudden decrease in driving load shall be investigated, and may be adequate cause for rejection of the pile.	27-707	Same		
1109.3	Precast Concrete Piles	(a) Materials: Shall conform to C26-1004.0. (b) Construction: Provisions for handling stress, minimum lateral dimension are given. Structural design shall conform to 1107.0 and additional requirements for reinforcement, etc are given. (c) Tolerances: Tolerances for eccentricity are given. (d) Installation: Precast pile shall not be handled or driven until they have cured sufficiently to develop the necessary strength.	27-708	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
						This is an important provision that is only in the NYC Building Code.
			737.8	Jetting	Piles may be jetted through foundation material listed as Class 6-9 in Table 15 [Annex B1]. Immediately after completion of the jetting, the piles shall be driven to the required load resistance.	
70-6	Timber Piles	70-6.1 Timber piles shall be single pieces of timber of approved species containing no defect. Provisions for shape and diameter of piles are given. 70-6.2 All untreated timber piles shall be cut off at a level not less than 1 ft below the permanent ground water level. 70-6.3 Timber piles above permanent ground water level shall be treated to prevent decay.	740.0	Timber Piles	1. Species.- Approved species are given. All timber piles shall be driven in one piece except for composite piles as provided in Section 746. 2. Timber specifications.-Specification for round timber piles are given. 3. Min dimensions.- Shall comply with Section 737.5 with some specified exceptions. 4. Cut-off.- The tops shall be sawn off in a horizontal plane. If untreated, shall be below water level, except for light frame construction. 5. Untreated piles.- Provisions for creosoted piles are given. 6. Maximum load on piles.- Maximum load on Class A or B piles shall be as in Section 739.0. Piles of smaller sizes shall be as in Sections 739.3 and 740.3.	
70-7	Precast Concret e Piles	70-7.1 Piles shall be reinforced to resist both handling and driving stresses. The diameter of precast pile shall be not less than 8 in, and at the top shall be at least 2 % of the length. Concrete cover of reinforcing shall be not less than 1.5 in. 70-7.2 Precast piles shall not be handled nor driven until the min. ultimate compressive strength of 3000 psi of the concrete has been attained.	741.0	Precast Concret e Piles	1. Concrete strength.- Shall be driven after attaining compressive strength of not less than 3000 psi. 2. Design: Shall be in accordance with Appendix B [Annex A5]. Lateral reinforcement at both ends of the pile shall be spaced in not more than 3 in. 3. Protection: 2 in. cover shall be provided over all reinforcement, except for severe exposure, where 3 in. cover shall be provided.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1109.4	Cast-In-Place Concrete Piles	(a) Description: Shall be cast in shells previously installed in the ground or, with the limitations in 1106.10, may be cast in an uncased hole. They may be tapered or cylindrical, or a combination of tapered and cylindrical shapes. (b) Materials: Provisions for concrete and pile shells are given. (c) Installation: After installation to final depth and immediately before filling with concrete, the inside of the tube, shell, or bore shall be thoroughly cleaned and inspected. Concrete shall be filled so that the entire volume is filled and separation of ingredients shall be precluded. No concrete shall be placed in a cast-in-place pile until all piles within a radius of 15 ft, or within the heave range, have been driven. Rejected shells shall be filled with sand or concrete. The concrete cap shall not be placed until at least 1 hr. after all piles within the cap group are completely filled.	27-709	Same		
1109.5	Compacted Concrete Piles	(a) Description: A concrete pile formed with an enlarged base in which the concrete in the base is placed in small batches that are compacted prior to attaining an initial set. (b) Materials: Provisions for concrete properties are given. (c) Spacing: Minimum spacing between compacted concrete piles is given. (d) Installation: Provisions for the installation of the base concrete and the shaft are given. (e) Bearing materials: Provisions for the bearing materials for the enlarged base are given.	27-710	Same		
1109.6	Steel H Sections	(a) Materials: H sections shall be of any steel permitted by RS 10-5 [Annex A5]. The use of built-up sections or sections other than H will be permitted if the sections are adequately connected or the width/thickness ratios do not exceed those of H shapes. (b) Limitations on use: Driving shall be terminated directly when the pile reaches refusal on the rock surface.	27-711	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
70-8	Cast-In-Place Concrete Piles	70-8.1 Construction. Permanent metal casings shall in all cases be used with cast-in-place concrete piles. Casing shall be inspected before fill, and shall not be buckled or otherwise damaged. 70-8.2 Allowable stresses. The maximum compressive stress shall not exceed 40 % of the ultimate compressive strength of the concrete. Where the metal casing is 1/8 in. or more in thickness, the pile shall be considered a concrete-filled steel pipe pile.	742.0	Cast-In-Place Concrete piles	1. Concrete strength: Shall develop a compressive strength of not less than 2500 psi at 28 days. Shall be deposited continuously and placed in the dry. 2. Design: Reinforcement shall be installed as an assembly. No reinforcement (except dowel) shall be placed within 1 in. of metal casing. Concrete cover shall be not less than 2 in. if no permanent casing is used, and shall be not less than 3 in. if in severe exposure. 3. Installation: Prevent distortion or injury of piles already in use. 4. Inspection: Previous to placing of concrete, the shell and other unfilled space of each pile shall be inspected.	
70-10	Rolled Structural Steel Pipes	70-10.1 The steel shall conform to Chap.74, and shall be of "H" form. The flange projection shall not exceed 14 times the min. thickness of metal in either the flange or the web. The nominal flange width shall be not less than 8 in. Flanges and webs shall have a min nominal thickness of 3/8 in. 70-10.2 Splices in steel pipes shall develop the strength of the pile in compression, tension, bending and shear. 70-10.3 The max compressive stress in the steel shall not exceed 12,000 psi. 70-10.4 If the steel is exposed to the air or other corrosive agents, 1/16 in. shall be deducted from the thickness of the metal in computing the allowable load. Protective measures shall be employed if serious deterioration can occur.	745.0	Structural Steel Pipes	1. Steel: Shall have min. nominal thickness of 3/8 in. When of H section, flange projection shall be not more than 14 times the minimum thickness of metal. 2. Splices: Shall comply with Section 737.7. 3. Protection: Piles shall be protected under the conditions of Section 738.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1109.7	Concrete-Filled Pipe Piles	(a) Materials: The pile shall conform to RS 11-8 [Annex A5]. Concrete shall conform to 1004.0. (b) Minimum dimensions: Provisions for pipes installed open-ended and with ends closed are given. (c) Installation: Pipe shells shall be cleaned after driving. After driving and cleaning the pipe, open-ended piles shall be reseated to full bearing by redriving to the resistance indicated in Table 11-4 [Annex B1] until the penetration on redriving is less than 2". Pipes shall be inspected before filling with concrete. Placing of concrete fill in pipe shells shall conform to the requirements for cast-in-place piles.	27-712	Same		
1109.8	Caisson Piles	(a) Description: Caisson piles shall denote concrete filled pipe piles that are socketed into bedrocks of class 1-65, 2-65 or 3-65 and constructed with steel cores. (b) Materials: Requirements for pipe, shell, concrete and steel cores are given. (c) Design of rock socket: Shall be predicted on the sum of the allowable bearing pressure on the bottom of the socket plus bond along the sides of the socket. Provisions for the allowable bearing pressure and bond stress are given. (d) Spacing and minimum dimensions: Requirements for minimum diameter, shell thickness, depth of socket for a caisson and the center-to-center spacing are given. (e) Installation: Provisions are given for the installation of the steel shell, the socket, the steel core, and concrete and grout. Provisions for water leakage are also given.	27-713	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
70-9	Con-crete-Filled Steel Piles	70-9.1Construction. Steel pipes shall comply with ASTM for welded and seamless steel pipe piles (A252-55). Pipe to be driven open-ended shall have a min. nominal outside diameter of 10.75 in. Minimum nominal wall thickness for diameters less than 14 in. shall be 0.25". For diameter of 14 in. or more, the minimum wall thickness shall be 0.375 in. Pipe to be driven close-ended shall have a steel end of approved design. Minimum outside diameter shall be 10.75 in. Minimum wall thickness for diameters less than 14 in. shall be 0.125 in. For diameters of 14 in. or more, the minimum wall thickness shall be 0.2 in. If wall thicknesses are less than these values, the piles shall be considered as cast-in-place concrete piles. 70-9.2 The maximum compressive stress in concrete shall not exceed 40 % of the ultimate strength of the concrete. Maximum compressive stress in the steel pipe shall not exceed 12,000 psi. 70-9.3 Durability. If the steel pipe is exposed to the air or other corrosive agents, 1/16 in. steel shall be deducted from the thickness of the metal in computing the allowable load. Suitable approved protective measures against deterioration shall be employed if serious deterioration can occur.	743.0	Steel Pipe and Tapered Tubular Piles	1. Concrete strength: Concrete shall have a minimum compressive strength of 2500 psi at 28 days. 2. Steel pipe: Shall conform to Appendix C [Annex A5]. 3. Design: Reinforcement shall be installed as an assembly or may consist of 1 or more rolled structural shape cores. A minimum clearance of 1" shall be maintained between the reinforcement and enclosing shell. 4. Minimum thickness: The minimum wall thickness of all load bearing pipe, tube and shell shall be 1/10". 5. Splices: Shall comply with Section 737.7 and insure true alignment and load transmission.	
			744.0	Drilled Caissons	1. Construction: Shall consist of a shaft section of concrete-filled pipe extending to bed rock with an uncased socket drilled into the bed rock which is filled with concrete thoroughly bonded to the rock wall. 2. Steel shell: Shall be steel pipe with a minimum yield point of 33 ksi fitted with an approved cutting shoe and structural cap. None but the top section of the pipe shall be less than 40 ft long. The minimum diameter shall be 24 in., and the minimum shell thickness shall be 5/16 in. 3. Concrete fills: Shall be controlled concrete, with a min. compressive strength of 3500 psi at 28 days, deposited with a slump of $\leq$ 6 in. 4- Rock socket: Shall be drilled in sound rock, and shall be thoroughly cleaned. The concrete fill shall be deposited in the dry. The depth of the socket shall be adequate to develop the full load-bearing capacity within the limitations of Table 15 [Annex B5]. 5. Reinforcing core: Structural steel core used for reinforcement shall not exceed in area 25 % of the gross caisson section. Minimum clearance between core and shell shall be 2 in. In all cases, not less than 1 in. concrete covering shall be provided. 6. Driving precautions: No drilled caissons shall be driven more than 2 % of the length out of plumb. 7. Spacing: The minimum center-to-center spacing between caissons when no steel core is used shall be twice the diameter of the shell; when reinforced with a core, such spacing shall be not less than 2.5 times the diameter.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
1109.9	Composite Piles	Composite piles include those consisting of two types of pile joined together. Provisions for the allowable load and the joint between two components are given.	27-714	Same		
Sub-Article 1110.0 Underpinning			***Article 11 Underpinning***			
1110.1	General Requirements	Where support of adjacent structures is required, such support may be provided by underpinning, sheeting, and bracing.	27-715	Same		
1110.2	Use of Rock Support in Lieu of Underpinning	Existing structures founded at a level above the level of adjacent new construction may be supported on hard rock in lieu of underpinning, the use of sheeting and bracing, or the construction of retaining walls provided that the safety of the construction can be substantiated.	27-716	Same		
Sub-Article 1111.0 Stability			***Article 12 Stability***			
1111.1	General	The possibility of overturning and sliding of the building shall be considered.	27-717	Same		
1111.2	Factor of Safety	(a) Overturning: Minimum safety factor against overturning of the structure shall be 1.5. Stability against overturning shall be provided by the dead load of the building, by the allowable uplift capacity of piling, by anchors, by the weight of soil directly overlying footings provided that such soil cannot by excavated without recourse to major modification of the building, or by the combination of these factors. (b) Sliding: Minimum safety factor against sliding shall be 1.5. Resistance to lateral load shall be provided by friction between the foundation and the underlying soil, by passive earth pressure, by batter piles, or by plumb piles. Detailed provisions are given for specific resistance mechanisms.	27-718	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments
70-11	Special Type Piles	The use of types of piles not specifically mentioned in Sections 70-6 to 70-10 including composite piles, and the use of piles under conditions not specifically covered shall be permitted, subject to compliance with the provisions of Chapters 72, 73, 74.	746.0	Composite Piles	1. Design: Composite piles consisting of 2 or more approved pile types shall be designed to meet the conditions of installation. 2. Limitation of load: The maximum load shall be limited by the capacity of the weakest section. 3. Splices: Splices between concrete and steel or wood section shall be designed to prevent separation of the sections both before and after the concrete portion has set, and to insure alignment and transmission of total pile load. Splices shall be designed to resist upheaval during driving of adjacent piles and shall develop the full compressive strength and not less than 50 % of the strength in tension and bending of the weaker section.	
			747.0	Special Piles and Caissons	Types of piles or caissons not covered in the Basic Code shall be permitted provided that sufficient test data, design and construction information is filed.	

Table 7–4. Foundations (continued).

NYC Building Code (1968)			NYC Building Code (2001)		NY State Building Construction Code (1964)	
Sub-Article 1112.0 Inspection			***Article 13 Inspection***			
1112.1	General	The applicable provisions of C26-106.0 shall apply.	27-719	Same		
1112.2	Boring Operation	Boring operations shall be subjected to controlled inspection. Detailed provisions are given for the inspection.	27-720	The section title changed to "Boring and Test pit operations"; In the following text, "boring and test pit" replaced "boring".		
1112.3	Piling	The installation of all piles shall be subjected to controlled inspection. Detailed provisions are given.	27-721	Same		
1112.4	Footings, Foundation Piers, Foundation Walls and Pile Caps	Provisions of 1105.1 shall apply.	27-722	Same		
1112.5	Subgrade for Footings, Foundation Piers, and Foundation Walls	The soil materials directly undrlying footing, foundation piers, and foundation walls shall be inspected by an architect or engineer after excavation and immediately prior to construction of the footings. Detailed provisions are given.	27-723	Same		
1112.6	Construction Required for or Affecting the Support of Adjacent Properties or Buildings	All construction or excavation required for or affecting the support of adjacent properties or buildings shall be subject to controlled inspection.	27-724	Same		

Municipal Code of Chicago (1967)			BOCA Building Code - Basic Code (1965)			Comments

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Annex A1
REFERENCE STANDARDS OF 1968 NEW YORK CITY BUILDING CODE

A1.1 REFERENCE STANDARDS

RS 9	**Loads**
RS 9-1	Minimum Unit Design Dead Loads for Structural Design Purposes. Unit design dead loads are shown in Exhibit RS 9-1.
RS 9-2	Minimum Requirements for Uniformly Distributed and Concentrated Live Loads. Minimum uniformly distributed and concentrated live loads are shown in Exhibit RS 9-2.
RS 9-3	AASHO 1965, *Standard Specification for Highway Bridges*.
RS 9-4	AREA 1967, *Specification for Steel Railway Bridges*.
RS 9-5	Minimum Design Wind Pressures. Provisions for wind pressures are shown in Exhibit RS 9-5.

RS 10	**Structural Work**
RS 10-1	Masonry. Requirements for unreinforced masonry are given.
RS 10-2	USASI A-41.2 1960, *Building Code Requirements for Reinforced Masonry*.
RS 10-3	ACI 318 1963, *Building Code Requirements for Reinforced Concrete*.
RS 10-4	ACI 525 1963, *Requirements for Thin-Section Precast Concrete Construction*.
RS 10-5	AISC 1963, *Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings*.
RS 10-6	AISI 1962, *Specification for the Design of Light Gage Cold-Formed Steel Structural Members*.
RS 10-8	NLMA 1962, *National Design Specification for Stress-Graded Lumber and Its Fastenings*.
RS 10-9	Plywood Construction
RS 10-10	ASCE 1963, *Suggested Specifications for Structures of Aluminum Alloy*, 6061-T6 and 6062-T6.
RS 10-11	ASCE 1963, *Suggested Specifications for Structures of Aluminum Alloy*, 6063-T5 and 6063-T6.
RS 10-12	USASI A59.1 1954, *American Standard Specifications for Reinforced Gypsum Concrete*.
RS 10-15	ACI 506 1966, *Recommended Practice for Shotcreting*.

RS 10-17 ASTM-C 39 1966, *Standard Method of Test for Compressive Strength of Molded Concrete Cylinders*.

RS 10-18 CS 253 1963, U.S. *Commercial Standard for Structural Glued-Laminated Lumber*.

RS 10-21 ASTM C 192 1962, *Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory* (tentative).

RS 10-44 ASTM-C 494 1967, *Specifications for Chemical Admixtures for Concrete* (tentative).

RS 10-45 Report of Committee 334, Concrete Shell Design and Construction, of the American Concrete Institute, *ACI Journal*, Proc. V 61, No. 9, Sept. 1964.

RS 10-65 ACI 613A 1959, *Recommended Practice for Selecting Proportions for Structural Lightweight Concrete*.

RS 11 Foundations

RS 11-4 AWPA C4 1965, *Standard for the Preservative Treatment of Poles by Pressure Processes*.

RS 11-7 ASTM D 25 1958, *Standard Specification for Round-Timber Poles*.

RS 11-8 ASTM A 252 1963T, *Specification for Welded and Seamless Steel Pipe Poles*.

A1.2 EXHIBITS

Exhibit RS 9-1 Minimum Design Dead Loads

REFERENCE STANDARD RS 9-1

MINIMUM UNIT DESIGN DEAD LOADS FOR STRUCTURAL DESIGN PURPOSES

WALLS AND PARTITIONS (unplastered)—	Weight (psf)
Clay brick—	
High absorption (per 4 in. wythe)	33
Low absorption (per 4 in. wythe)	45
Concrete brick—	
4 in.	46
4 in. lightweight aggregate	33
8 in.	89
8 in. lightweight aggregate	68
12 in.	130
12 in. lightweight aggregate	98
Sand-lime brick—	
per 4 in. wythe	38
Solid concrete block—	
4 in.	40
4 in. lightweight aggregate	27
8 in.	67
8 in. lightweight aggregate	48
12 in.	108
12 in. lightweight aggregate	72
Hollow concrete block—	
4 in.	30
4 in. lightweight aggregate	20
8 in	53
8 in. lightweight aggregate	38
12 in.	85
12 in. lightweight aggregate	55
Solid gypsum block—	
(per in. thickness)	6
Hollow gypsum block—	
2 in.	9.5
4 in.	12.5
6 in.	18.5
Clay tile, load bearing—	
4 in.	24
8 in.	42
12 in.	58
Clay tile, non-load bearing—	
2 in.	11
4 in.	18
8 in.	34
12 in.	46
Facing tile—	
2 in.	16
6 in.	29
8 in.	41
Split terra cotta furring tile—	
1½ in.	8
2 in.	10
3 in.	12
Glass block—	
4 in.	20

PLASTER PARTITIONS—	Weight (psf)
2 in. thick, solid cement plaster on metal lath	25
2 in. thick, solid gypsum plaster on metal lath	18
Metal studs, any lath, and ¾ in. gypsum plaster, both sides	18
Wood studs, any lath, and ¾ in. gypsum plaster, both sides	19

Exhibit RS 9-1 Minimum Design Dead Loads (Continued)

EQUIVALENT UNIFORM PARTITION LOADS

Partition weight (plf)	*Equivalent Uniform Load (psf) (To be added to floor dead and live loads)*
50 or less	0
51 to 100	6
101 to 200	12
201 to 350	20
Greater than 350	20 plus a concentrated live load of the weight in excess of 350 plf.

PLASTER ON MASONRY SURFACES –	
Gypsum, with sand aggregate, per in.	8.5
Gypsum, with lightweight aggregate, per in.	4
Gypsum, with wood fibers, per in.	6.5
Cement, with sand aggregate, per in.	10
Cement, with lightweight aggregate, per in.	5
FLOOR FINISHES (Excluding fill or base) –	
Resilient flooring (asphalt tile, linoleum, etc.)	2
Asphalt block, 2 in.	24
Wood block, 3 in.	10
Hardwood flooring, ⅞ in.	4
Softwood sub-flooring, per in.	3
Plywood sub-flooring, ½ in.	1.5
Ceramic or quarry tile, 1 in.	12
Terrazzo, 1 in.	12
Slate, 1 in.	15
Cement, 1 in.	12
FLOOR FILL –	
Cinders, no cement, per in.	5
Cinders, with cement, per in.	9
Sand, per in.	8

FLOORS – WOOD JOIST CONSTRUCTION
(With double layer wood flooring – no ceiling)

	Total Weight (psf)	
Joint Sizes (in.)	*12 in. Joist Spacing*	*16 in. Joist Spacing*
2 x 6	6	5
2 x 8	6	6
2 x 10	7	6
2 x 12	8	7
3 x 6	7	6
3 x 8	8	7
3 x 10	9	8
3 x 12	11	9
3 x 14	12	10

CEILINGS (including suspension system) –	Weight (psf)
Plaster on tile or concrete – see "Plaster on Masonry Surfaces"	
Suspended metal lath and gypsum plaster, ¾ in.	9
Suspended metal lath and cement plaster, ¾ in.	11
Suspended acoustical tile	2
ROOF AND WALL COVERINGS –	
Clay roofing tiles	14
Built-up roofing:	
3-ply	1.5
5-ply	2.5
Gravel, ¼ to ⅝ in.	4

(Continued on next page)

Exhibit RS 9-1 Minimum Design Dead Loads (Continued)

Slag, ¼ to ⅝ in.	3
Crushed rock, ¼ to ⅝ in.	4.5
Aluminum sheet:	
0.050 in. thick, flat	0.72
0.032 in. thick, corrugated	0.55
0.032 in. thick, V-Beam	0.58
Steel, 20 gauge, protected V-Beam	2.3
Tin Sheet, 28 gauge	1
Asbestos-cement, corrugated roofing, ⅜ in.	4
Fiberboard, ½ in.	0.8
Gypsum sheathing, ½ in.	2
Wood sheathing, per in.	3
Wood shingles, in place	3
Asphalt shingles, in place	6
Asbestos-cement shingles, in place	4
Cement tile, ⅜ in. in place	16
Stucco (cement), per in.	10
Slate, 3/16 in. in place	7
Slate, ¼ in. in place	10
Skylight, metal frame, ⅜ in. wire glass	10
MISCELLANEOUS MATERIALS –	
Glass –	Weight (psf)
single strength	1.2
double strength	1.6
plate, wired or structured, ⅛ in.	1.6
insulating, double ⅛ in. plates w/air space	3.5
insulating, double ¼ in. plates w/air space	7.1
Insulation –	
fiber glass, per in.	1.5
foam glass, per in.	0.8
Urethane, 1 in.	1.0
2 in.	1.2
cork, per in.	1.0
vegetable fiber boards, per in.	1.5
bats and blankets, per in.	0.5
vermiculite, loose fill – 0.6 pcf	
expanded polystyrene – 1.0 pcf	
Marble, interior, per in.	14
Plastic, acrylic, ¼ in.	1.5
Slate, per in.	15
	Weight (psf)
Asphaltic concrete	144
Cast-stone masonry (cement, stone, sand)	144
Cinder fill	57
Concrete, plain (other than expanded aggregates) –	
cinder	108
slag	132
stone (including gravel)	144
Reinforced concrete –	
Add 6 pcf to unit weights shown for plain concrete	
Cork, compressed	14

(Continued on next page)

Exhibit RS 9-1 Minimum Design Dead Loads (Continued)

Earth	100
Masonry, ashlar –	
granite	165
limestone (crystalline)	165
limestone (oolitic)	135
marble	173
sandstone (bluestone)	144
Masonry, rubble w/mortar –	
granite	153
limestone (crystalline)	147
limestone (oolitic)	138
marble	156
sandstone (bluestone)	137
Masonry, dry rubble –	
granite	130
limestone (oolitic)	125
marble	130
sandstone (bluestone)	110
Terra cotta, architectural –	
voids filled	120
voids empty	72
Timber, seasoned –	
pine, Douglas fir, and similar species	35
oak, elm, and similar species	45

Exhibit RS 9-2 Minimum Live Loads

REFERENCE STANDARD RS 9-2

MINIMUM REQUIREMENTS FOR UNIFORMLY DISTRIBUTED AND CONCENTRATED LIVE LOADS

UNIFORMLY DISTRIBUTED LIVE LOADS

Occupancy or Use of Spaces	*Live load (psf)*
Assembly spaces	
Drill rooms	150
Assembly spaces having fixed seats, including auditorium areas in churches, schools, theaters, courthouses, lodges, lecture halls, and similar buildings	60[a]
Dance floors, restaurant serving and dining areas, mess halls, museums, gymnasiums, skating rinks, promenades, and roof gardens	100
Private assembly spaces, including conference rooms and card rooms	50
Stadium, grandstand, and reviewing stand seating areas	100
Other assembly spaces	See note [d]

(Continued on next page)

Exhibit RS 9-2 Minimum Live Loads (Continued)

Balconies	
Exterior	See note [b]
Interior (as required for occupancy or use)	
Mezzanines (as required for occupany or use)	
Catwalks	30
Corridors	
(1) Corridors in schools	100
(2) Corridors, elevators, and stairs in office buildings (other than first floor lobbies)	75
(3) Corridors serving first floor elevator lobbies, auditoriums, and similar areas of public assembly	100
(4) Other (same as that required for the occupancy of the area being served)	
Elevator machine rooms (see Reference Standard RS-18)	
Equipment rooms, including pump rooms, generator rooms, transformer vaults, and areas for switch gear, ventilating, air conditioning, and similar electrical and mechanical equipment	75
Fire escapes	
Multiple dwellings	40
Others	100
Hospitals	
Operating rooms, laboratories, and service areas	60
Rooms and wards	40
Personnel areas	40
Other (as required for occupany or use of the area)	
Libraries	
Reading and study room areas	60
Stack areas (see Storage)	
Other (as required for occupancy or use of the area)	
Lobbies and similar areas	100
Manufacturing and repair areas	100
Marquees	60
Office areas (not including record storage areas)	50
Parking areas	
For passenger cars, provided that the clear headroom at the entrance does not exceed 8 ft.	50
Penal institutions	
Cell blocks	40
Other (as required for occupancy or use of the area)	
Plaza areas (open) accessible to the public (including landscaped portions)	100
Recreation areas	
Bowling alleys (alleys only)	40
Poolrooms	75
Other (see assembly areas)	

(Continued on next page)

Exhibit RS 9-2 Minimum Live Loads (Continued)

Residential areas	
Dormitories	
Non-partitioned	60
Partitioned	40
Dwellings	
Multi-family units	
Apartments	40
Public rooms (as required for occupancy or use)	
One- and two-family units	
First floor	40
Upper floors and habitable attics	30
Uninhabitable attics	20[c]
Hotels	
Guest rooms	40
Public rooms (as required for occupancy or use)	
Schools	
Classrooms	40
Shops (automotive and press shops)	100
Shops (others)	60
Other (as required for occupancy or use of the area)	
Stairs and exit passages (same as Fire escapes)	
Storage	
Light	100
Warehouse	150
Stores	
Wholesale sales	100
Retail sales	
Basement and first floor	100
Upper floors	75
Telephone equipment rooms	80
Theaters	
Dressing rooms	40
Projection room	100
Stage floor	150
Toilet areas	40

***Notes:**

a Uniform load shall be applied to the gross floor area.

b 150 per cent of live load on adjoining occupied area, but not more than 100 psf.

c Live load need be applied to joists or to bottom chords of trusses or trussed rafters only in those portions of attic space having a clear height of 42 in. or more between joist and rafter in conventional rafter construction; and between bottom chord and any other member in trussed or trussed rafter construction. However, joists or the bottom chords of trusses or trussed rafters shall be designed to sustain the imposed dead load or 10 psf, whichever is greater, uniformly distributed over the entire span.

d Live loads for assembly spaces other than those described in this reference standard shall be determined from the occupant load requirements as established by section 27-358 using the formula 100/net floor area per occupant but shall not be less than 50 psf nor more than 100 psf.

(Continued on next page)

Exhibit RS 9-2 Minimum Live Loads (Continued)

CONCENTRATED LIVE LOADS

Use or Location	*Load (lbs.)*[a]	*Remarks*
Elevator machine room floor		See Reference Standard RS-18
Gratings, checkered plates and similar metal decks	200 (on area of 1.0 sq. in.)	Nonconcurrent with uniform live load.
Floor registers and similar floor insets	250 (on area of 2 ft. x 2 ft.)	Nonconcurrent with uniform live load.
Parking areas – passenger vehicles accommodating nine passengers, or less	2,500 (on area of 20 sq. in.) For slab or deck design	The concentrated load may be assumed to represent the reaction of a jack placed under one end of the vehicle. Omit uniform live load in area (6 ft. x 9 ft.) representing one half the vehicle, adjacent to the point of load concentration.
	1,500 (each wheel)	To be used in lieu of uniform live load in stalls of mechanized garages where there is no slab or deck.
Parking areas – trucks, buses and passenger vehicles accommodating more than nine passengers	150 per cent of maximum wheel load with vehicle loaded (on area of 20 sq. in.)	Same as for Parking areas – passenger vehicles accommodating nine passengers, or less.
Floor of office areas	2,000	Nonconcurrent with uniform live load.
Resident and multiple dwellings	200 (on area of 4.0 sq. in.)	Nonconcurrent with uniform live load.
Scuttles and skylight ribs	200	Nonconcurrent with uniform live load.
Steel joists -- for each individual joist	800 (for trussed joists apply at a panel point)	Nonconcurrent with uniform live load.
Roofs	250 (on area of 2 ft. x 2 ft.)	Nonconcurrent with uniform live load. Not applicable for awnings, canopies, and similar constructions where access by persons is difficult and not intended.

(Continued on next page)

Exhibit RS 9-2 Minimum Live Loads (Continued)

Stair and fire escape treads	300 (on area 1 ft. wide by depth of the tread and spaced at 3 ft. center-to-center)	Nonconcurrent with uniform live load.
Boiler rooms	3,000	The concentrated load of 3,000 lbs. may be assumed to represent the weight of minor items of equipment (pumps, etc.) in temporary locations during installation. In addition provision shall be made for supporting the weight of the empty boiler at pertinent locations on the floor to provide for replacement of the boiler.

Note:

a Except when otherwise indicated loads are assumed to be applied over an area 2½ ft. x 2½ ft.

Exhibit RS 9-5 Minimum Design Wind Pressures

REFERENCE STANDARD RS 9-5
MINIMUM DESIGN WIND PRESSURES

1. DESIGN WIND PRESSURES ON STRUCTURAL FRAMES. – Minimum design pressures due to wind acting on vertical surfaces shall be in accordance with table RS 9-5.1, and minimum design pressures acting normal to horizontal or inclined surfaces shall be in accordance with table RS 9-5.2. The occurrence of the pressures on vertical, horizontal, and inclined surfaces of the building shall be considered as simultaneous.

TABLE RS 9-5.1 DESIGN WIND PRESSURES ON VERTICAL SURFACES

Height Zone (ft. above curb level)	*Design Wind Pressure on Vertical Surfaces (psf of projected solid surface)*	
	Structural Frame	*Panels Glass*
0-50 (signs and similar constructions of shallow depth only.)	15	–
0-100	20	30
101-300	25	30
301-600	30	35
601-1000	35	40
Over 1000	40	40

TABLE RS 9-5.2 DESIGN WIND PRESSURES ON HORIZONTAL AND INCLINED SURFACES

Roof Slope	*Design Wind Pressure Normal to Surface*
30 degrees or less	Either pressure or suction equal to 40 per cent of the values in Table RS 9-5.1 over the entire roof area
More than 30 degrees	Windward slope – pressure equal to 60 per cent of values in Table RS 9-5.1.
	Leeward slope – suction equal to 40 per cent of values in Table RS 9-5.1.

(Continued on next page)

Exhibit RS 9-5 Minimum Design Wind Pressures (Continued)

2. WALL ELEMENTS. – For design of mullions, muntins, girts, panels, and other wall elements (including their fastenings), other than glass panels, the wind pressure acting normal to wall surfaces shall be 30 psf or a 20 psf suction, for all height zones up to 500 ft. These values shall be deemed to include allowance for gust pressures. For height zones over 500 ft., the applicable design pressures shall be specially investigated, but shall not be less than the values indicated in table RS 9-5.1.

3. ROOF ELEMENTS. – The wind pressures acting on purlins, roofing, and other roof elements (including their fastenings) supporting small contributory areas of wind presentment shall be 1½ times the values given in table RS 9-5.2.

4. OTHER BUILDING ELEMENTS. – Minimum wind pressures to be used in the design of other building elements shall be the values in table RS 9-5.1 multiplied by the following shape factors given in table RS 9-5.3.

TABLE RS 9-5.3 SHAPE FACTORS

Construction	*Shape Factor*
Signs (and their supports), or portions thereof, having 70 per cent or more of solid surface	1.5
Signs (and their supports), or portions thereof, having less than 70 per cent of solid surface	2.0
Tanks, cooling towers, and similar constructions	1.5
Upright, circular cylindrical surfaces	0.7
Square and rectangular chimneys	1.5

For special structures such as curved and saw-toothed roofs, guys and cables, open trussed structures, parallel solid girders, and spheres, the design wind pressure shall be determined on the basis of recognized engineering analysis or by test.

5. EAVES AND CORNICES. — Eaves, cornices, and overhanging elements of the building shall be designed for upward pressures of twice the values given in table RS 9-5.1.

6. WIND LOAD BY MODEL TEST. — In lieu of the design wind pressures established in sections 1 and 2 of this reference standard, and subject to review and approval of the commissioner, design wind pressures may be approximated from suitably conducted model tests. The tests shall be predicated on a basic wind velocity of 80 mph at the 30 ft. level, and shall simulate and include all factors involved in considerations of wind pressure, including pressure and suction effects, shape factors, functional effects, gusts, and internal pressures and suctions.

Annex A2
REFERENCE STANDARDS OF 2001 NEW YORK CITY BUILDING CODE

A2.1 REFERENCE STANDARDS

RS 4-5 *Floodproofing Non-Residential Structures and Coastal Construction Manual*

FEMA 55/February 1986 - *Design and Construction Manual for Residential Buildings in Coastal/High Hazard Areas*

FEMA 85/ September 1985 - *Manufactured home installation in flood hazard areas*

FEMA 102/May 1986 - *Floodproofing non-residential structures*

RS 9 Loads

RS 9-1 Same as in 1968 New York City Building Code, which is given in Annex A1.

RS 9-2 Same as in 1968 New York City Building Code, which is given in Annex A1.

RS 9-3 AASHTO 1983, *Standard Specification for Highway Bridges*, 13th Edition and 1984, 1985, 1986 Interim Specifications.

RS 9-4 AREA 1987, *Specification for Steel Railway Bridges*, Chapter 15, Steel Structures, Manual for Railway Engineering.

RS 9-5 Same as in 1968 New York City Building Code, which is given in Annex A1.

RS 9-6 Earthquake Loads. ICBO 1988 with 1990 Accumulative Supplement, *Uniform Building Code*, Section 2312, amended as in Exhibit RS 9-6 of Annex A2.

RS - 10 Structural Work

RS 10-1A Masonry. Requirements for Unreinforced masonry are given.

RS 10-1B Masonry - ACI 530 1992/ASCE 5-92, *Building Code Requirements for Masonry Structures*, as modified. (Modifications are provided in the reference standard.)

- ACI 530.1-92/ASCE 6-92, *Specifications for Masonry Structures*, as modified.

RS 10-2 Reinforced Masonry - ACI 530-92/ASCE 5-92, *Building Code Requirements for Masonry Structures*, as modified. (Modifications are provided in the reference standard.)

- ACI 530.1-92/ASCE 6-92, *Specifications for Masonry Structures*, as modified.

RS 10-3 Reinforced Concrete. ACI 318 1983, *Building Code Requirements for Reinforced Concrete*.

RS 10-3 ACI 318 1989, *Building Code Requirements for Reinforced Concrete.*

RS 10-4 ACI 318, 1963 and applicable sections of ACI 318-83.

RS 10-4 Precast Concrete and Prestressed Concrete - ACI 318 1989; MNL-120-1985.

RS 10-5A AISC-1989, *Specifications for Structural Steel Buildings - ASD and Plastic Design.*

RS 10-5B AISC-LRFD 1993, *Load and Resistance Factor Design Specifications for Structural Steel Buildings.*

RS 10-5C UBC Section 2723, 1990, *Uniform Building Code*.

RS 10-6 AISI 1986, *Specifications for the Design of Cold-Formed Steel Structural Members*.

RS 10-8 AF&PA 1991 and its 1991 Supplement with 1993 Revisions.

RS 10-9 Plywood Construction

RS 10-10 AA SAS 30-1986, *Specifications for Aluminum Structures*.

RS 10-11 ASTM B 209-1988, *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate*.

ASTM B 308-1988

ASTM B 429-1988

RS 10-12 AF&PA Span Tables for Joists and Rafters 1993 and its Supplement

RS 10-15 Same as in 1968 New York City Building Code.

RS 10-17 ANSI/ASTM C 39-1984

RS 10-18 ANSI/AITC A190.1-1992; AITC 117-1987; AITC 117-1988

RS 10-21 ANSI/ASTM C 192-1981

RS 10-44 ANSI/ASTM C 494-1986

RS 10-45 ACI-ASCE-334

RS 10-65 ACI 211.2-1981

RS-11 Foundations

RS 11-4 AWPA C4 -1988

RS 11-7 ANSI/ASTM D 25; ASTM-D2899-1986

A2.2 EXHIBITS

Exhibit RS 9-6 Earthquake Loads

REFERENCE STANDARD RS 9-6
EARTHQUAKE LOADS

UBC SECTION 2312-1990
Earthquake Regulations with Accumulative Supplement
MODIFICATIONS—The provisions of UBC Section 2312 shall be subject to the following modifications. The subdivisions, paragraphs, subparagraphs and items are from this section.

Subdivision (a) General.

Paragraph 1. Minimum seismic design.

Delete this paragraph and substitute the following:

"The following types of construction shall, at a minimum, be designed and constructed to resist the effects of seismic ground motions as provided in this section:

new structures on new foundations;

new structures on existing foundations; and

enlargements in and of themselves on new foundations. Buildings classified in New York City occupancy group J-3 and not more than three stories in height need not conform to the provisions of this section.

The Commissioner may require that the following types of construction be designed and constructed to incorporate safety measures as necessary to provide safety against the effects of seismic ground motions at least equivalent to that provided in a structure to which the provisions of this section are applicable:

new buildings classified in occupancy group J-3 and which are three stories or less in height; and

enlargements in and of themselves where the costs of such enlargement exceeds sixty percent of the value of the building.

Pursuant to section 27-191 of the code the Commissioner shall have the authority to reject an application for a building permit which fails to comply with the requirements of this section."

Subdivision (b) Definitions.

Delete the definitions of the following terms and substitute the following new definitions:

(Continued on next page)

Exhibit RS 9-6 Earthquake Loads (Continued)

"ECCENTRIC BRACED FRAME (EBF) is a steel-braced frame designed in conformance with reference standard RS 10-5C.

ESSENTIAL FACILITIES are those structures which are necessary for emergency operations subsequent to a natural disaster.

STORY DRIFT is the displacement of one level relative to the level above or below, including translational and torsional deflections."

Add the following definition before "SHEAR WALL":

"REINFORCED MASONRY SHEAR WALL is that form of masonry wall construction in which reinforcement acting in conjunction with masonry is used to resist lateral forces parallel to the wall and which is designed using reinforcement in conformance with Chapter 7 of reference standard RS 10-2."

Delete the definitions of the five frames under the SPACE FRAME paragraph and substitute the following stand-alone definitions:

"INTERMEDIATE MOMENT-RESISTING FRAME (IMRF) is a concrete frame designed in accordance with the requirements of Chapters 1 through 20 and Sections 21.1, 21.2 and 21.9 of reference standard RS 10-3.

MOMENT-RESISTING FRAME is a frame in which members and joints are capable of resisting forces primarily by flexure.

ORDINARY MOMENT-RESISTING FRAME (OMRF) is a moment-resisting frame conforming to the requirements of Chapters 1 through 20 of reference standard RS 10-3 or reference standard RS 10-5A and RS 10-5C but not meeting the special detailing requirements for ductile behavior.

SPECIAL MOMENT-RESISTING FRAME (SMRF) is a moment-resisting frame conforming to reference standards RS 10-3 or RS 10-5A and RS 10-5C and specially detailed to provide ductile behavior by complying with the requirements of Chapters 1 through 20 and Sections 21.1 through 21.8 of reference standard RS 10-3 or reference standards RS 10-5A and RS 10-5C.

VERTICAL LOAD-CARRYING FRAME is a frame designed to carry all vertical gravity loads."

Subdivision (d) Criteria Selection.

Paragraph 1. Basis for design.

Delete the word "zoning" in the first sentence and delete the last sentence.

Paragraph 2. Seismic Zones.

Delete the title and paragraph and substitute the following:

"2. Seismic Zone. The seismic zone factor, Z, for buildings, structures and portions thereof in New York City shall be 0.15. The seismic zone factor is the effective zero period acceleration for S_1 type rock."

Paragraph 3. Site geology and soil characteristics.

Delete the title and paragraph and substitute the following:

"3. Site geology, soil characteristics and foundations.

A. General.

Soil profile type and site coefficient, S, shall be established in accordance with Table No. 23-J.

B. Liquefaction.

(i) Soils of classes 7-65, 8-65, 10-65 and non-cohesive class 11-65 below the ground water table and less than fifty feet below the ground surface shall be considered to have potential for liquefaction.

(ii) The potential for liquefaction of level ground shall be determined on the basis of Standard Penetration Resistance (N) in accordance with Figure No. 4;

Category A: Soil shall be considered liquefiable.

Category B: Liquefaction is possible.

Soil shall be considered liquefiable for structures of Occupancy Categories I, II and III of Table No. 23-K.

Category C: Liquefaction is unlikely and need not be considered in design.

At any site the highest category of liquefaction potential shall apply to the most critical strata or substrata.

(iii) Liquefiable soils shall be considered to have no passive (lateral) resistance or bearing capacity value during an earthquake. An analysis shall be submitted by an engineer which demonstrates, subject to the approval of the Commissioner, that the proposed construction is safe against liquefaction effects on the soil.

(iv) Where liquefiable soils are present in sloped ground or over sloped nonliquefiable substrata and where lateral displacement is possible, a stability analysis shall be submitted by an engineer which demonstrates, subject to the approval of the Commissioner, that the proposed construction is safe against failure of the soil.

C. Foundation Plates and Sills.

Foundation plates or sills shall be bolted to the foundation or foundation wall with not less than one-half inch nominal diameter steel bolts embedded at least seven inches into the concrete or masonry and spaced not more than six feet apart. There shall be a minimum of two bolts per piece with one bolt located within twelve inches of each end of each piece. A properly sized nut and washer shall be tightened on each bolt to the plate.

D. Foundation Interconnection of Pile Caps and Caissons.

Individual pile caps and caissons of every structure subjected to seismic forces shall be interconnected by ties. Such ties shall be capable of resisting, in tension or compression, a minimum horizontal force equal to the product of ZI/4 and the larger column vertical load at the end of each tie.

Exception: Other approved effective methods of foundation interconnection may be used where it can be demonstrated by an analysis that equivalent restraint and relative displacement can be provided."

Paragraph 5, subparagraph C, Irregular structures.

Delete the entire last sentence in item (i).

Paragraph 6, subparagraph E, Dual system.

Delete items (ii) and (iii) and substitute the following:

"Resistance to lateral load is provided by shear walls or braced frames and a moment-resisting frame (SMRF, IMRF or OMRF). The moment-resisting frames shall be designed to independently resist at least 25 percent of the design base shear. The shear walls or braced frames shall be designed to resist at least 75 percent of the cumulative story shear at every level. Overturning effects may be distributed in accordance with item (iii) below.

The two systems shall be designed to resist the total design base shear in proportion to their relative rigidities considering the interaction of the dual system at all levels."

Paragraph 7. Height limits.

Delete this paragraph.

Paragraph 8. Selection of lateral force procedure.

Delete paragraph 8 and substitute the following:

"8. Selection of lateral force procedure. All structures shall be designed using either the static lateral force procedure of Section 2312(e) or using the dynamic lateral force procedure of Section 2312(f). In addition, the dynamic lateral force procedure shall be considered, but is not required, for the design of the following:

A. Structures over 400 feet in height.

B. Irregular structures.

C. Structures located on Soil Profile Type S_4 which have a period greater than 1 second. The analysis should include the effects of soils at the site and should conform to Section 2312(f)2."

Paragraph 9, subparagraph C, Irregular features.

Delete the subparagraph and substitute the following:

"C. Irregular features. Only structures having either vertical irregularities Type D or E as defined in Table No. 23-M or horizontal irregularities Type D or E as defined in Table No. 23-N shall be designed to meet the additional requirements of those sections referenced in the tables."

Paragraph 10. Alternate procedures.

Add at the end of the paragraph the words "when such procedures are consistent with this standard and subject to the approval of the Commissioner."

Subdivision (e) Minimum Design Lateral Forces and Related Effects.

(Continued on next page)

Exhibit RS 9-6 Earthquake Loads (Continued)

Paragraph 1. General, subparagraph A.
Add the words "parking structures" before the word "storage" in the first sentence.
Paragraph 1. General, Subparagraph C.
Delete this subparagraph.
Paragraph 2, subparagraph A, Design base shear.
Change the value for the minimum ratio of C/R_w shown at the end of this subparagraph to "0.050".
Paragraph 2, subparagraph B, Structure period.
Delete the values in item (i) for C_t and substitute the following:
"$C_t = 0.035$ for concrete and steel moment-resisting frames.
$C_t = 0.030$ for eccentric braced frames.
$C_t = 0.030$ for dual systems where the building height exceeds 400 feet or 0.020 for heights less than 160 feet and varies linearly from 0.020 to 0.030 for building heights from 160 to 400 feet.
$C_t = 0.020$ for all other structures."
Delete the sentence immediately after "$C_t = 0.020$ for all other structures" and substitute the following:
"Alternately, the value of T for structures with concrete or masonry shear walls may be taken as $0.1 (h_n)^{3/4} / \sqrt{A_c}$."
Paragraph 3, subparagraph C, Combinations along different axes.
Delete this subparagraph.
Paragraph 6. Horizontal torsional moments.
Delete the fourth paragraph starting with the words "Where torsional irregularity exists" and ending with the words "considered for design."
Paragraph 7, Overturning, subparagraph B.
Delete the words "Seismic Zones 3 and 4" at the beginning of this subparagraph.
Delete item (iii) and substitute the following:
"(iii) Such columns shall meet the detailing or member limitations of reference standard RS 10-3 for concrete and reference standard RS 10-5C for steel structures."
Paragraph 7, subparagraph C.
Delete this subparagraph and substitute the following:
"C. For regular buildings, the force F_t may be omitted when determining the overturning moment to be resisted at the foundation-soil interface."
Paragraph 8. Story drift limitation.
Change the value for the minimum ratio of C/R_w shown at the end of this paragraph to "0.050".
Paragraph 9. P-delta effects.
Delete the last sentence of this paragraph.
Paragraph 10. Vertical component of seismic forces.
Delete this paragraph in its entirety and substitute the following:
"10. Vertical component of seismic forces. Horizontal cantilever components shall be designed for a net upward force of $0.05 W_p$."
Subdivision (f) Dynamic lateral force procedure.
Paragraph 2. Ground motion.
Add the following at the end of subparagraph A.:
"For soil type S_4 profile, see B. below."
Add the following at the end of subparagraph B.:
"The design of all structures located on a soil type S_4 profile shall be based on properly substantiated site-specific spectra."
Paragraph 5, subparagraph C, Scaling of results.
Add after the word "procedures" in the first sentence, the words "including the appropriate Importance Factor, I,".
Delete item (i) and substitute the following:
"(i) The base shear shall be increased to the following percentage of the value determined from the procedures of Section 2312(e), including consideration of the minimum value of C/R_w, except that the coefficient C, for a period T greater than 3 seconds, may be calculated as 1.80 S/T:
(a) 100 percent for irregular buildings; or
(b) 90 percent for regular buildings, except that the base shear shall not be less than 80 percent of that determined from Section 2312(e) using the period, T, calculated from Method A."
Paragraph 5, subparagraph D, Directional effects.
Delete the words "and prestressed elements" in the second sentence and delete the word "Alternately" at the start of the third sentence.
Paragraph 5, subparagraph F, Dual systems.
Delete this subparagraph and substitute the following:
"F. Dual Systems. Where the lateral forces are resisted by a dual system, as defined in Section 2312(d)6E above, the combined system shall be capable of resisting the base shear determined in accordance with this section. The moment-resisting frame, shear walls and braced frames shall conform to Section 2312(d)6E. The moment-resisting frame may be analyzed using either the procedures of Section 2312(e)4 or those of Section 2312(f)5."
Paragraph 6. Time history analysis.
Add the following words at the end of the sentence: "and the results shall be scaled in accordance with Section 2312(f)5C".
Subdivision (h) Detailed Systems Design Requirements.
Paragraph 1. General.
Delete the words "Chapters 24 through 28" in the fourth sentence of the first paragraph and insert the words "reference standard RS 10".
Delete the words "in Seismic Zones 2, 3 and 4" in the second and fourth paragraphs.
Paragraph 2, subparagraph A, General.
Delete the words "Chapters 24 through 27" at the end of this subparagraph and insert the words "reference standard RS 10".
Paragraph 2, subparagraph C, Connections.
Delete this subparagraph.
Paragraph 2, subparagraph D, Deformation compatibility.
Delete the words "to the reinforcing steel" from the last sentence.
Paragraph 2, subparagraph G, Concrete frames.
Delete this subparagraph and substitute the following:
"G. Concrete frames. Concrete frames required by design to be part of the lateral force resisting system shall, at a minimum, be intermediate moment-resisting frames, except as noted in Table 23-0."
Paragraph 2, subparagraph H, Anchorage of concrete or masonry walls.
Delete the words "Section 2310" in the fifth line and insert the words "reference standards RS 9-6, 10-1B and 10-2".
Paragraph 2, subparagraph I, Diaphragms.
Delete items (iv), (v) and (vi).
Paragraph 2, subparagraph J, Framing below the base.
Delete the words "Chapters 26 and 27" in the third line and insert the words "reference standards RS 10-3 and RS 10-5C".
Paragraph 2, subparagraph K, Building separations.
Delete this subparagraph and substitute the following:
"K. Building Separations. All structures shall be separated from adjoining structures. Separation due to seismic forces shall allow for 1 inch displacement for each 50 feet of total building height. Smaller separation may be permitted when the effects of pounding can be accommodated without collapse of the building."
Subdivision (i) Nonbuilding Structures.
Paragraph 4. Other nonbuilding structures.
Delete in the first sentence of item (iii) the word "national" and insert the word "reference", and delete the words "seismic zones and" in the paragraph following item (iii).
Subdivision (j) Earthquake-recording Instrumentations.
Delete this subdivision.
Table No. 23-I, Seismic Zone Factor Z.
Delete this table and substitute the following new table:

(Continued on next page)

Exhibit RS 9-6 Earthquake Loads (Continued)

TABLE NO. 23-I
SEISMIC ZONE FACTOR Z

ZONE	NEW YORK CITY
Z	0.15

Table No. 23-J. Site Coefficients.
Delete this table and notes and substitute the following new table and notes:

TABLE NO. 23-J
SITE COEFFICIENTS

TYPE	DESCRIPTIONS	FACTOR
S_0	A profile of Rock materials of class 1-65 TO 3-65	0.67
S_1	A soil profile with either: (a) Soft Rock (4-65) or Hardpan (5-65) or similar material characterized by shear-wave velocity greater than 2500 feet per second, or (b) Medium Compact to Compact Sands (7-65) and Gravels (6-65) or Hard Clays (9-65), where the soil depth is less than 100 feet.	1.0
S_2	A soil profile with Medium Compact to Compact Sands (7-65) and Gravels (6-65) or Hard Clays (9-65), where the soil depth exceeds 100 feet.	1.2
S_3	A total depth of overburden of 75 feet or more and containing more than 20 feet of Soft to Medium Clays (9-65) or Loose Sands (7-65, 8-65) and Silts (10-65), but not more than 40 feet of Soft Clay or Loose Sands and Silts.	1.5
S_4	A soil profile containing more than 40 feet of Soft Clays (9-65) or Loose Sands (7-65, 8-65), Silts (10-65) or Uncontrolled Fills (11-65), where the shear-wave velocity is less than 500 feet per second.	2.5

Notes:

1. The site S Type and corresponding S Factor shall be established from properly substantiated geotechnical data with the classes of materials being defined in accordance with Section 27-675 (C26-1103.1) of the administrative code of the City of New York.
2. The soil profile considered in determining the S Type shall be the soil on which the structure foundations bear or in which pile caps are embedded and all underlying soil materials.
3. Soil density/consistency referred to in the table should be based on standard penetration test blow counts (N-values) and taken as: (a) for sands, loose - where N is less than 10 blows per foot, medium compact - where N is between 10 and 30, and compact - where N is greater than 30 blows per foot; and (b) for clays, soft - where N is less than 4 blows per foot, medium - where N is between 4 and 8, stiff to very stiff - where N is between 8 and 30, and hard - where N is greater than 30 blows per foot.
4. When determining the type of soil profile for profile descriptions that fall somewhere in between those provided in the above table, the S Type with the larger S factor shall be used.
5. For Loose Sands, Silts or Uncontrolled Fills below the ground water table, the potential for liquefaction shall be evaluated by the provisions of Section 2312(d)3.

Table No. 23-K, Occupancy Categories.

Add the words "Buildings for schools through secondary or day-care centers - capacity more than 250 students" below the words "Fire and police stations" in the Essential Facilities category, and delete those words from within the Special Occupancy Structure Category.

Add in item III Special Occupancy Structure to the words, "All structures with occupancy > 5000 persons", the words "excluding Occupancy Group E buildings".

Table No. 23-O, Structural Systems.
Delete this table and notes and substitute the following new Table No. 23-O and notes.

TABLE NO. 23-O
STRUCTURAL SYSTEMS

BASIC STRUCTURAL SYSTEM	LATERAL LOAD-RESISTING SYSTEM DESCRIPTION	R_w
A. Bearing Wall System	1. Light-framed walls with shear panels	
	a. Plywood walls for structures three stories or less	8
	b. All other light-framed walls	6
	2. Shear Walls	
	a. Concrete	6
	b. Reinforced masonry	5
	3. Light steel-framed bearing walls with tension-only bracing	4
	4. Braced frames where the bracing carries gravity load	
	a. Steel	6
	b. Concrete	4
	c. Heavy timber	4
B. Building Frame system	1. Steel eccentric braced frame (EBF)	10
	2. Light-framed walls with shear panels	
	a. Plywood walls for structures three stories or less	9
	b. All other light-framed walls	7
	3. Shear Walls	
	a. Concrete	8
	b. Reinforced masonry	6
	4. Concentric braced frames	
	a. Steel	8
	b. Concrete	8
	c. Heavy timber	8
C. Moment-Resisting Frame System	1. Special moment-resisting frames (SMRF)	
	a. Steel	12
	b. Concrete	12
	2. Concrete intermediate moment-resisting frames (IMRF)	8
	3. Ordinary moment-resisting frames (OMRF)	
	a. Steel	6
	b. Concrete[4]	4
D. Dual System	1. Shear Walls	
	a. Concrete with SMRF	12
	b. Concrete with Steel OMRF	6
	c. Concrete with concrete IMRF	9
	d. Concrete with concrete OMRF	5
	e. Reinforced masonry with SMRF	8
	f. Reinforced masonry with steel OMRF	6
	g. Reinforced masonry with concrete IMRF	7
	2. Steel eccentric braced frame	
	a. With steel SMRF	12
	b. With steel OMRF	6
	3. Concentric braced frames	
	a. Steel with steel SMRF	10
	b. Steel with steel OMRF	6
	c. Concrete with concrete SMRF	9
	d. Concrete with concrete IMRF	6

Notes:

1. Basic structural systems are defined in Section 2312(d)6.
2. See Section 2312(e)3 for combinations of structural systems.
3. See Sections 2312(d)8C and 2312(d)9B for undefined systems.
4. Prohibited with S_3 or S_4 soil profiles or where the height exceeds 160 feet.

(Continued on next page)

Exhibit RS 9-6 Earthquake Loads (Continued)

Table No. 23-P, Horizontal Force Factor C_p.
Delete this table and notes and substitute the following new Table No. 23-P and notes:

Table No. 23-P
HORIZONTAL FORCE FACTOR C_p[1]

ELEMENTS AND STRUCTURES, NONSTRUCTURAL COMPONENTS AND EQUIPMENT	VALUE OF C_p
I. Part of Portion of Structure	
1. Walls, including the following:	
a. Unbraced (cantilevered) parapets.	2.00
b. Other exterior walls above street grade[2].	0.75
c. All interior bearing walls.	0.75
d. All interior nonbearing walls and partitions around vertical exits, including offsets and exit passageways.	0.75
e. Nonbearing partitions and masonry walls in areas of public assembly > 300 people.	0.75
f. All interior nonbearing walls and partitions made of masonry in Occupancy I, II and III.	0.75
g. Masonry or concrete fences at grade over 10 feet high.	0.50
2. Penthouses (defined in article 2 of subchapter 2 of chapter 1 of title 27 of the building code) except where framed by an extension of the building frame	0.75
3. Connections for prefabricated structural floor and roof elements other than walls (see above) with force applied at center of gravity.	0.75
4. Diaphragms[3].	
II. Nonstructural Components	
1. a. Exterior ornamentation and appendages including cornices, ornamental statuaries or similar pieces of ornamentation.	2.00
b. Interior ornamentation and appendages in areas of public assembly including cornices, ornamental statuaries or similar pieces of ornamentation.	2.00
2. Chimneys, stacks, trussed towers and tanks on legs.	
a. Supported on or projecting as an unbraced cantilever above the roof more than one-half its total height.	2.00
b. All others, including those supported below the roof with unbraced projection above the roof less than one-half its height, or braced or guyed to the structural frame at or above its center of mass.	0.75
3. Exterior signs and billboards.	2.00
III. Equipment and Machinery[4]	
1. Tanks and vessels (including contents), including support systems and anchorage.	0.75

Notes:

1. See Section 2312(g)[2] for additional requirements for determining C_p for nonrigid equipment or for items supported at or below grade.
2. See Section 2312(h)2D(iii) and Section 2313(g)2.
3. See Section 2312(h)2I.
4. Equipment and machinery include such items as pumps for fire sprinklers, motors and switch gears for sprinkler pumps, transformers and other equipment related to life-safety including control panels, major conduit ducting and piping serving such equipment and machinery.

Figure No. 3, Normalized Response Spectra Shapes.
Delete the Figure No. 3 and insert the New Figure 3 and Table No. 23-R.

TABLE NO. 23-R
SPECTRAL ACCELERATION
IN FRACTION OF G
5% DAMPING

T-SEC	S_0	S_1	S_2	S_3
.01	0.150	0.150	0.150	0.150
.02	0.150	0.150	0.150	0.150
.05	0.375	0.283	0.262	0.244
.075	0.375	0.375	0.336	0.303
.090	0.375	0.375	0.375	0.334
.112	0.375	0.375	0.375	0.375
.267	0.375	0.375	0.375	0.375
.40	0.250	0.375	0.375	0.375
.48	0.208	0.313	0.375	0.375
.60	0.167	0.250	0.300	0.375
1.00	0.100	0.150	0.180	0.225
2.00	0.050	0.075	0.090	0.113
3.00	0.033	0.050	0.060	0.075

Note: This table presents acceleration (g) versus natural period (seconds) to facilitate the presentation of spectra in log-log form.

(Continued on next page)

Exhibit RS 9-6 Earthquake Loads (Continued)

FIGURE NO. 3
NORMALIZED RESPONSE SPECTRA
5% DAMPING

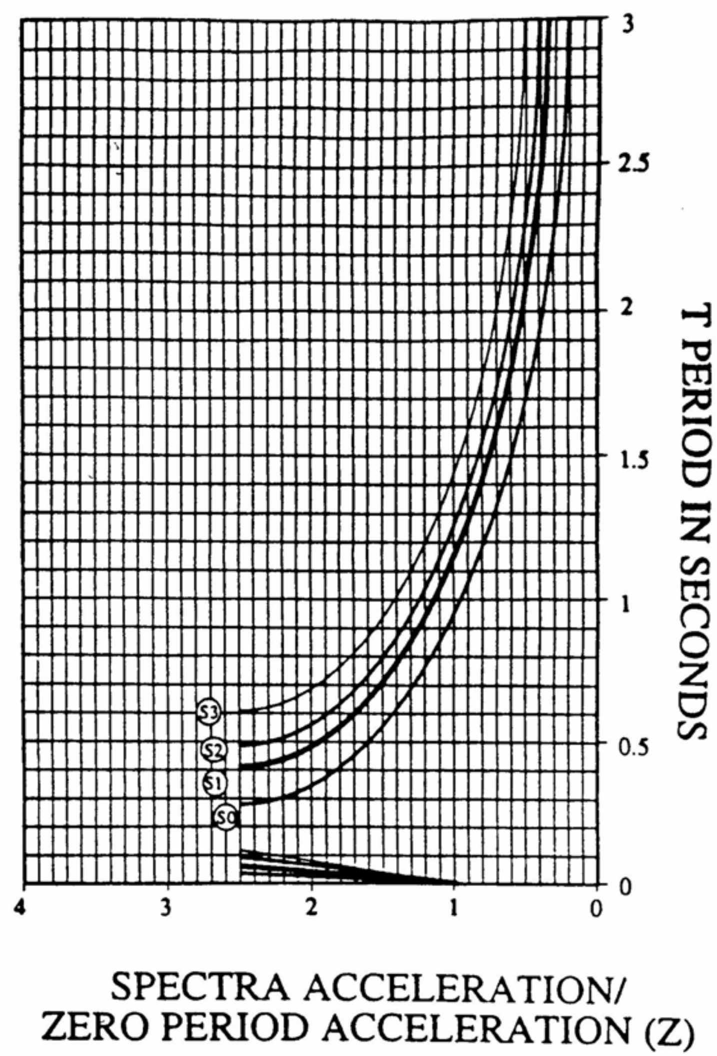
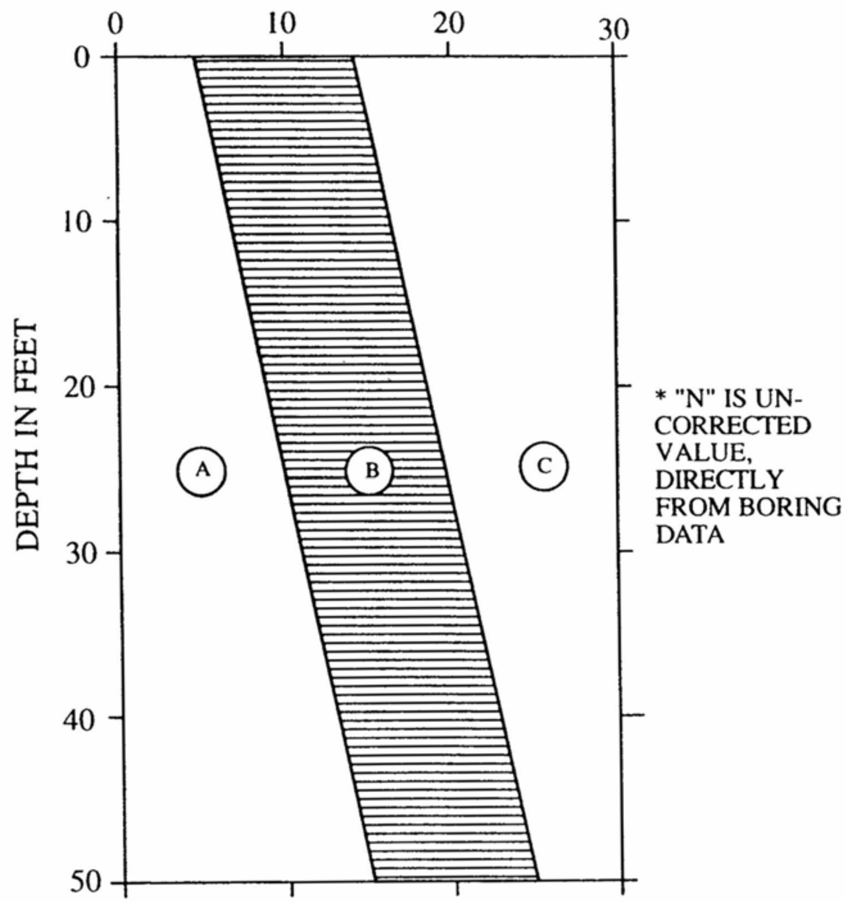


FIGURE NO. 4
"N" IN BLOWS PER FOOT*



CATEGORY A: PROBABLE LIQUEFACTION
CATEGORY B: POSSIBLE LIQUEFACTION
CATEGORY C: LIQUEFACTION UNLIKELY

Annex A3
REFERENCE STANDARDS OF 1964 NEW YORK STATE BUILDING CONSTRUCTION CODE

A3.1 INTRODUCTION

The *Generally Accepted Standards Applicable to Structural Requirements*, given in A3.2, was published by the New York State Building Code Council for the State Building Construction Code dated January 2, 1968. This is the oldest copy the Department of State Codes Division (NY) has available at this time (November 2003).

A3.2 GENERALLY ACCEPTED STANDARDS

Generally Accepted Standards
applicable to
Structural Requirements

ADHESIVES

FS,	Adhesive, Casein-Type, Water-and Mold-Resistant, MMM-A-125b, 1964
FS,	Adhesive, Urea-Resin-Type (Liquid and Powder), MMM-A-188b, 1960
MIL,	Adhesive, Phenol and Resorcinol Resin Base (for Marine Service Use) MIL-A-22397, 1960 with 1964 amendment

ALUMINUM

AA,	Aluminum Construction Manual, Section A, Specifications for Structures of Aluminum Alloys, 1963

CONCRETE AND CONCRETE UNITS

ACI,	Building Code Requirements for Reinforced Concrete, ACI 318-63
ACI,	Minimum Standard Requirements for Precast Concrete Floor and Roof Units, ACI 711-58
ASTM	Various Specifications as listed in Section 410 of Building Code Requirements for Reinforced Concrete, ACI 318-63

FOUNDATIONS AND PILES

USAS,	Building Code Requirements for Excavations and Foundations, A56.1-1952, excluding Section 5-1.3(f), note 5
ASCE,	Pile Foundations and Pile Structures, Manual of Engineering Practice, No. 27, 1946
NFPA,	Construction and Protection of Piers and Wharves, No. 87, 1963
AISI,	Pile Foundations, 1963, sections 3.4.2(a), 4, 5.1, and 5.2 only

MASONRY MATERIALS

USAS,	Building Code Requirements for Masonry, A41.1-1953
USAS,	Specifications for Gypsum Plastering, A42.1-1964
USAS,	Specifications for Portland Cement Stucco, A42.2-1946
USAS,	Specifications for Interior Lathing and Furring, A42.4-1955
USAS,	Specifications for Reinforced Gypsum Concrete, A59.1-1954
USAS,	Specifications for the Application and Finishing of Wallboard, A97.1-1965
ASTM,	Specifications for Quicklime for Structural Purposes, C 5-59

(Continued on next page)

A3.2 Generally Accepted Standards (Continued)

ASTM, Specifications for Natural Cement, C 10-64
ASTM, Specifications for Gypsum, C 22-50
ASTM, Specifications for Concrete Aggregates, C 33-67
ASTM, Specifications for Structural Clay Load-Bearing Wall Tile, C 34-62
ASTM, Specifications for Gypsum Wallboard, C 36-67
ASTM, Specifications for Gypsum Partition Tile or Block, C 52-54
ASTM, Specifications for Concrete Building Brick, C 55-66T
ASTM, Specifications for Structural Clay Non-Load-Bearing Tile C 56-62
ASTM, Specifications for Building Brick (Solid Masonry Units from Clay or Shale), C 62-66
ASTM, Specifications for Calcium Silicate Facebrick, C 73-67
ASTM, Specifications for Hollow Load-Bearing Concrete Masonry Units, C 90-66T
ASTM, Specifications for Masonry Cement, C 91-67
ASTM, Specifications for Ready-Mixed Concrete, C 94-67
ASTM, Specifications for Hollow Non-Load-Bearing Concrete Masonry Units, C 129-64T
ASTM, Specifications for Hydraulic Hydrated Lime for Structural Purposes, C 141-67
ASTM, Specifications for Aggregate for Masonry Mortar, C 144-66T
ASTM, Specifications for Solid Load-Bearing Concrete Masonry Units, C 145-66T
ASTM, Specifications for Portland Cement, C 150-67
ASTM, Specifications for Air-Entraining Portland Cement, C 175-67

ASTM, Specifications for Hydrated Lime for Masonry Purposes, C 207-49
ASTM, Specifications for Mortar for Unit Masonry, C 270-64T
ASTM, Specifications for Lightweight Aggregates for Structural Concrete, C 330-64T

SHEATHING

ASTM, Specification for Gypsum Sheathing Board, C 79-67
FS, Insulation Board, Thermal and Insulation Block, Thermal, LLL-I-535 (1), 1962

SIGNS AND OUTDOOR DISPLAY STRUCTURES

USAS, Building Code Requirements for Signs and Outdoor Display Structures, A60.1-1949

STEEL AND IRON

Formed Steel

AISI, Specifications for the Design of Light Gage Cold-Formed Steel Structural Members, 1962

Reinforcement for Concrete

Reinforcement (ASTM Specifications) as listed in Building Code Requirements for Reinforced Concrete, ACI 318-63, Sections 405 and 410

(Continued on next page)

A3.2 Generally Accepted Standards (Continued)

Structural Steel and Iron

AISC,	Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, adopted April, 1963
AISC,	Specifications for Structural Joints using ASTM-A325 or A 490 Bolts, Approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation, September, 1966
ASTM,	Specification for Gray Iron Castings, A 48-64
ASTM,	Specification for Welded and Seamless Steel Pipe, A 53-67
ASTM,	Specifications for Welded Wrought-Iron Pipe, A 72-66
ASTM,	Specifications for Welded and Seamless Steel Pipe Piles, A 252-63T
SJI,	Standard Specifications and Load Tables-Open Web Steel Joists, 1967

WOOD

APA,	Plywood Design Specifications, Nov. 1966
ASTM,	Methods for Establishing Structural Grades of Lumber, D 245-64T
ASTM,	Methods of Conducting Strength Tests of Panels for Building Construction, E 72-61
CS,	Wood Shingles: Red Cedar, Tidewater Red Cypress, California Redwood, CS 31-52
CS,	Hardwood Plywood, CS 35-61
CS,	Structural Glued Laminated Timber, CS 253-63
NFPAssn.	National Design Specification for Stress-Grade Lumber and Its Fastenings, 1962
NFPAssn.	Working Stresses for Stress-Grade Lumber, Supplement No. 1, 1967, to Wood Structural Design Data, Vol. 1, 1957
NFPAssn.	Plank-and-Beam Framing for Residential Buildings, Wood Construction Data No. 4, 1961
NFPAssn.	Heavy Timber Construction Details, Wood Construction Data No. 5, 1961
PS,	U.S. Product Standard PS-1-66 for Softwood Plywood

Wood Treatment

DA,	Subterranean Termites, Their Prevention and Control in Buildings, Home and Garden Bulletin No. 64, January 1960
FS,	Primer, Paint, Exterior (Undercoat for Wood, Ready-Mixed, White and Tints), TT-P-25c, 1965
FS,	Wood Preservative; Treating Practices, TT-W-571g(1), 1962 (AWPA specifications and instructions are referenced)

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Annex A4
REFERENCE STANDARDS OF 1967 CHICAGO MUNICIPAL CODE

A4.1 REFERENCE STANDARDS

Standards that represent Accepted Engineering Practice in the Chicago Municipal Code are listed in the following table.

(a) Foundations.	
Piles—Timber.	ASTM D25-55
Piles—Welded and Seamless. Steel Pipe	ASTM A252-55
Piles—Wood Preservative.	
Treatment Douglas Fir	AWPA-C1-1958
Southern Pine	AWPA-C3-1958
Creosoted Treatment	AWPA-C12-1951
(b) Masonry.	
American Standard Building Code. Requirements for Masonry-Miscellaneous Publication 211	USDC-NBS-July 15, 1954
(c) Wood.	
National Design Specifications for Stress—Grade Lumber and Its Fastenings	NLMA-1957
Glues—For Laminated and Built-up Members	FSMMM-A-188
Plywood—Douglas Fir	NBS-CS45-55
Plywood—Hardwood	NBS-CS-35-56
Plywood—Western Softwood	NBS-CS122-56
(d) Reinforced Concrete.	
Building Regulations for Reinforced Concrete	ACI-318-63
(e) Reinforced Gypsum.	
Reinforced Gypsum Concrete	ASA-A59.1-1954
(f) Steel and Metals.	
Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.	AISC-1963
Light Gage Cold-Formed Steel Design Manual.	AISI-1962
Commentary on the 1962 edition of Light Gage Cold-Formed Steel Design Manual.	AISI-1962
Pile Foundations.	AISI-1963
Open Web Steel Joists—Standard Specifications and Load Tables A.I.A File No. 13G.	SJI-1963
(g) Plastering.	
Including American Standard Specifications for Gypsum Plastering and Interior Lathing and Furring—	A42.1-1955 and A42.4-1955
Standard Specifications for Portland Cement Stucco and Portland Cement Plastering	ASA-A 42.2-1946 ASA-A42.3-1946
(h) Single Family Dwellings.	
Minimum Property Requirements for Properties of One or Two Family Living Units Located in the State of Illinois, Sections 402, 403, 406, 408 and 410 to 414 inclusive, except 'Note' to, and paragraph 3 of, section 406-G shall not apply. See section 68-5(b) which excepts FHA requirement 406-E.-4a.	FHA-1947

(Continued on next page)

(i) **Abbreviations.**

ACI	American Concrete Institute.
AISC	American Institute of Steel Construction.
AISI	American Iron and Steel Institute.
ASA	American Standards Association.
ASTM	American Society for Testing Materials.
AWPA	American Wood Preservers Association.
FHA	Federal Housing Administration.
FS	Federal Specifications.
GA	Gypsum Association.
NBS	National Bureau of Standards, Department of Commerce.
NLMA	National Lumber Manufacturers Association.
SJI	Steel Joist Institute.
USDC	United States Department of Commerce.

[Amend. Coun. J. 1-20-50, p. 5758; 10-8-52, p. 3243; 1-26-53, p. 4184; 5-28-58, p. 7799; 11-7-58, p. 8380; 11-18-59, p. 1167; 11-15-63, p. 1244, 1245.]

Annex A5
REFERENCE STANDARDS OF 1965 BOCA BUILDING CODE

A5.1 REFERENCE STANDARDS

Appendix A	Accredited Authoritative Agencies.
Appendix B	Accepted Engineering Practice Standards. The accepted engineering practice standards relevant to Structural provisions are given in Exhibit B of Annex A5.
Appendix C	Material Standards. Relevant standards are given in Exhibit C of Annex A5.
Appendix D	Structural Unit Test Standards. Relevant standards are given in Exhibit D of Annex A5.
Appendix E	Structural Assembly Test Standards. Relevant standards are given in Exhibit E of Annex A5.
Appendix F	Durability Test Standards. Relevant standards are given in Exhibit F of Annex A5.
Appendix G - I	Fire related.
Appendix J	Unit Design Dead Loads for Structural Design Purposes. Minimum Design Dead loads are given in Exhibit J of Annex A5.
Appendix K	Unit Working Stresses for Ordinary Materials. Given in Exhibit K of Annex A5.
Appendix K-11	Earthquake Load Design. Detailed requirements are given in Exhibit K-11 of Annex A5.
Appendix K-12	Glass Design Criteria.

A5.2 EXHIBITS

Exhibit B Accepted Engineering Practice Standards

APPENDIX B

ACCEPTED ENGINEERING PRACTICE STANDARDS

See also appendixes, C, D, E, F, and G for standards on specific materials or tests of units or assemblies, some of which include engineering practice standards for specific applications.

High Hazard materials handling and storage; fire protection devices; heating equipment rules, specifications and standards .... NFPA
National Fire Codes; Handbook of Fire Protection; standards and reports .... NFPA
Technical bulletins of building construction data .... HHFA

CONCRETE

Floor and Roof Units, Precast Concrete—Minimum Standard Requirements for .... ACI 711—1958
Gypsum Concrete, Reinforced—Specifications for .... ASA A 59.1—1954
Reinforced Concrete—Building Code Requirements for .... ACI 318—1963
Reinforced Concrete Structures, Manual of Standard Practice for Detailing .... ACI 315—1965
Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction, Recommended Practices for .... AWS D 12.1—61

MASONRY

Lime-Cement Stucco—Standard Specifications for .... ASA A 42.5—1960
Marble, Exterior Thin Veneer—Specifications for .... ASA A 94.2—1961
Marble, Exterior Thin, in Curtain or Panel Walls—Specifications for .... ASA A 94.3—1961
Marble, Interior—Specifications for .... (See **INTERIOR FINISHES**)
Masonry—Standard Requirements for .... ASA A 41.1—1953
Reinforced Masonry—Standard Requirements for .... ASA A 41.2—1960

METALS

Aluminum Construction, Manual, Section A—Specifications for Structures of Aluminum Alloys .... AA—1963

STEEL

Cold-Formed Steel .... (See **Light Gage Cold-Formed Steel**)
Design, Fabrication and Erection of Structural Steel for Buildings
—Specifications for .... AISC—1963
—Architectural Exposed Structural Steel—Specifications for .... AISC—1960
—Structural Joints Using ASTM A 325, or A 490 Bolts—Specifications for .... AISC—1964
Gas Systems for Welding and Cutting .... (See **FIRE PROTECTION AND SAFETY PRACTICES**)

Light Gage Cold-Formed Steel
—Design Manual .... AISI—1962
—Structural Members—Specifications for the Design of .... AISI—1962

Steel Joist, Open Web
Steel Joist Construction, Open Web—**Long Span or LA Series**—Standard Specifications for .... AISC-SJI—1961
—J Series and H Series—Specifications and Load Tables for .... SJI-AISC—1965
—Longspan or LH Series, Standard Specifications .... SJI—AISC—June 21—1962
Structural Steel .... (See **Design Fabrication and Erection of**)
Welding in Building Construction, Code for .... AWS—1963

WOOD AND WOOD PRODUCTS

How to Design a Pole-Type Building .... AWPI—1965
Lumber, Stress Grade .... (See Stress Grade Lumber)
Lumber, Structural Glued Laminated—Inspection Manual for .... AITC—200—63
Plywood, Fir—Technical Data Handbook .... DFPA—1960
Plywood Beams—Specifications for Design and Fabrication of .... DFPA Spec. No. BB-8—1963
Plywood Folded Plates—Specifications for Fabrication of .... DFPA Spec. No. FP-62—1962
Plywood-Lumber Structural Assemblies—Specifications for Design of .... DFPA Spec. No. 1—1964
Plywood Panels, Curved—Specifications for Design of .... DFPA Spec. No. CP-8—1963
Plywood Panels—Flat with Stressed Covers—Specifications for Design and Fabrication of .... DFPA Spec. No. SS-8—1963
Pressure Treated Timber Foundation Piles for Permanent Structures .... AWPI—1965
Stress Grade Lumber and Its Fastenings—National Design Specifications for .... NLMA—1962
Structural Design Data—Wood .... NLMA—1957
Timber Construction Standards .... AITC—100—1962
Wood Handbook .... USDA Handbook No. 72—1955

UNCLASSIFIED-MISCELLANEOUS

Building Codes—Administrative Requirements for .... ASA A 55.1—1948
Building Construction—Safety Code for .... ASA A 10.2—1944
Building Materials—Coordination of Dimensions of .... ASA A 62.1—1957
Fibrous Glass Air Duct—Standard for .... NIMA Feb. 1, 1965
Floor and Wall Openings, Railings, and Toe Boards—Safety Code for .... ASA A 12—1932
Floors—Waterproofing of .... NFPA 92—1937
Flue Linings—Sizes of .... ASA A 62.4—1947
Fuel Oils—Classification of .... USDC CS 12—1948
Homes—Prefabricated .... USDC CS 125—1947
Light and Ventilation—Standards for .... ASA A 53.1—1946
Loads, Minimum Design—Standards for .... ASA A 58.1—1955
Signs and Outdoor Display Structures—Standards for .... ASA A 60.1—1949
Welding in Building Construction, Code for .... (See **METALS—STEEL**)

Exhibit C Material Standards

APPENDIX C

MATERIAL STANDARDS

See also appendix D for standards for tests of specific materials.

CONCRETE

Aggregates, Concrete Specifications for ....ASTM C 33—64
Aggregates, Lightweight, for Structural Concrete—
Specifications for ....ASTM C 330—64T
Aggregates, Lightweight, for Concrete Masonry Units—
Specifications for ....ASTM C 331—64T
Aggregates, Lightweight, for Insulating Concrete—
Specifications for ....ASTM C 332—61
Bar Supports, Wire, in Reinforced Concrete Construction—
Simplified Practice Recommendation for ....USDC SP 4687
Floor and Roof Units, Precast Concrete—
Minimum Standard Requirements for ....ACI 711—58
Forms for Concrete Joist Construction Floors....USDC R 87—32
Forms for Two-Way Concrete Joist Floor and Roof Construction....USDC R 265—63
Gypsum Concrete—Specifications for ....ASTM C 317—64
Masonry Units—Concrete ....(See MASONRY)
Natural Cement—Specifications for ....ASTM C 10—64
Portland Cement, Air-Entraining—Specifications for....ASTM C 175—64
Portland Cement—Specifications for ....ASTM C 150—64
Ready-Mixed Concrete—Specifications for ....ASTM C 94—64
Reinforcing ....(See METALS)
Roofs and Slabs-On-Grade, Vermiculite Concrete—
Specifications for ....ASA A 122.1—1965
Waterproof Paper for Curing Concrete—Specifications for....ASTM C 171—63

FIRE PROTECTION

Fire Retardant Properties of Treated Textile Fabrics—
Specifications for ....ASTM D 626—55T

INTERIOR FINISHES

Adhesive—Water Resistant Organic, for Installation of
Clay Tile ....USDC CS 181—52
Aggregates, Inorganic, for use in Gypsum Plaster—
Specifications for ....ASTM C 35—62
Gypsum and Gypsum Products, Chemical Analysis of—
Standard Methods for ....ASTM C 471—61
Gypsum Board Products and Gypsum Partition Tile or Block,
Physical Testing of—Standard Methods for ....ASTM C 473—62
Gypsum Lath—Specifications for ....ASTM C 37—54
Gypsum Plasters—Specifications for ....ASTM C 28—63
Gypsum Plasters and Gypsum Concrete, Physical Testing of—
Standard Methods for ....ASTM C 472—64
Gypsum Wallboard—Specifications for ....ASTM C 36—64
Lime, Hydrated, Normal Finishing—Specifications for ....ASTM C 6—49
Lime, Hydrated, Special Finishing—Specifications for ....ASTM C 206—49
Quicklime and Hydrated Lime—Methods of Physical
Testing of ....ASTM C 110—58
Quicklime for Structural Purposes—Specifications for ....ASTM C 5—59

(Continued on next page)

Exhibit C Material Standards (Continued)

MASONRY

Aggregate, Fine—Method of Test for Measuring Mortar-Making Properties of	ASTM C 87—63T
Aggregate for Masonry Grout—Specification for	ASTM C 404—61
Aggregate for Masonry Mortar—Specifications for	ASTM C 144—62T
Brick, Building (Solid Masonry Units Made from Clay or Shale)—Specifications for	ASTM C 62—62
Brick, Concrete Building—Specifications for	ASTM C 55—64T
Brick, Facing (Solid Masonry Units Made from Clay or Shale)—Specification for	ASTM C 216—64
Brick, Sand-Lime Building—Specifications for	ASTM C 73—51
Cement, Masonry—Specifications for	ASTM C 91—64
Clay Facing Tile, Structural—Specification for	ASTM C 212—60
Clay Floor Tile, Structural—Specification for	ASTM C 57—57
Clay Load-Bearing Wall Tile, Structural—Specification for	ASTM C 34—62
Clay Non-Load-Bearing Screen Tile, Structural—Specification for	ASTM C 530—63T
Clay Non-Load-Bearing Wall Tile, Structural—Specification for	ASTM C 56—62
Concrete Masonry Units, Hollow Load Bearing—Specifications for	ASTM C 90—64T
Concrete Masonry Units, Hollow Non-Load Bearing—Specifications for	ASTM C 129—64T
Concrete Masonry Units, Solid Load Bearing—Specifications for	ASTM C 145—64T
Dry-set Portland Cement Mortar	ASA A 118.1—1959
Glazed Units:—Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units—Specifications for	ASTM C 126—62
Gypsum Partition Tile and Block—Specifications for	ASTM C 52—54
Lime, Hydrated, for Masonry Purposes—Specifications for	ASTM C 207—49
Limes	(See INTERIOR FINISHES)
Mortar and Grout for Reinforced Masonry—Specification for	ASTM C 476—63
Mortar for Unit Masonry—Specification for	ASTM C 270—64T
Portland Cement—Specification for	(See CONCRETE)

METAL

Alloy Steel Bolts, Quenched and Tempered, for Structural Steel Joints—Standard Specifications for	ASTM A 490—65
Alloy Steel Bolts, Quenched and Tempered, for Structural Steel Joints—Standard Specifications for	ASTM A 490—65
Alloy Steel Sheets and Strip, Regular Quality Hot-Rolled and Cold-Rolled—Specification for	ASTM A 506—64
Aluminum-Alloy Bars, Rods, Shapes and Tubes—Standard Specification for	ASTM B 221—64
Aluminum-Alloy Bars, Rods and Wire—Standard Specifications for	ASTM B 211—64
Aluminum-Alloy Die and Hand Forgings—Standard Specification for	ASTM B 247—64
Aluminum-Alloy Pipe—Standard Specifications for	ASTM B 241—64
Aluminum-Alloy Sheet and Plate—Standard Specifications for	ASTM B 209—64
Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded—Standard Specifications for	ASTM B 308—64
Aluminum-Alloy Drawn Seamless Tubes—Standard Specifications for	ASTM B 210—64
Aluminum-Alloy Round Welded Tubes—Standard Specifications for	ASTM B 313—63
Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes—Tentative Specifications for	ASTM B 285—61T
Aluminum-Alloy Rivet and Cold Heading Wire and Rods—Standard Specifications for	ASTM B 316—64
Aluminum-Base Alloy Die Castings—Standard Specifications for	ASTM B 85—60
Aluminum-Base Alloy Permanent Mold Castings—Standard Specification for	ASTM B 108—64
Aluminum-Base Alloy Sand Castings—Standard Specification for	ASTM B 26—64
Aluminum Sliding Glass Doors—Specifications for	AAMA 402.4—1965
Aluminum Windows—Specifications for	AAMA 302.4—1965

(Continued on next page)

Exhibit C Material Standards (Continued)

METAL *(Continued from previous page)*

Reinforcement, Steel Wire, Cold-Drawn, for Concrete—Specifications for	ASTM A 82—62T
Reinforcement, Deformed Steel Wire for Concrete	ASTM A 496—64
Reinforcement, Welded Deformed Steel Wire Fabric for Concrete	ASTM A 497—64
Reinforcement—Steel Wire, Welded Fabric, for Concrete—Specifications for	ASTM A 185—64
Rivet Steel, Structural—Specifications for	ASTM A 141—58
Rivet Steel, Structural, High-Strength—Specifications for	ASTM A 195—59
Rods, Gas Welding, for Iron and Steel—Specifications for	ASTM A 251—46T
Seven-Wire Stress-Relieved Strand, Uncoated, for Prestressed Concrete—Specification for	ASTM A 416—64
Uncoated Stress-Relieved Wire for Prestressed Concrete—Specification for	ASTM A 421—65
Sheet Piling, Steel—Specification for	ASTM A 328—65
Steel for Bridges and Buildings—Specifications for	ASTM A 7—61T
Steel Plate, Sheet and Strip, Corrosion-Resisting Chromium—Specification for	ASTM A 176—63
Steel Plate, Sheet and Strip, Corrosion-Resisting Chromium-Nickel—Specification for	ASTM A 167—63
Steel Sheets and Strip, High Strength Low Alloy Hot-Rolled	ASTM A 375—64
Structural Steel—Specifications for	ASTM A 36—63T
Structural Steel, High Strength—Specifications for	ASTM A 440—63T
Structural Steel, High Strength Low Alloy—Specifications for	ASTM A 242—64T
Structural Steel, High Strength Low Alloy Manganese Vanadium—Specifications for	ASTM A 441—64T
Steel Structural Rivets—Specification for	ASTM A 502—65
Structural Steel with 42,000 psi Minimum Yield Point (½ in. Maximum Thickness)—Specification for	ASTM A 529—64

PLUMBING AND PIPING

Asbestos-Cement Non-Pressure Sewer Pipe—Specifications for	ASTM C 428—64T
Asbestos-Cement Pressure Pipe—Specifications for	ASTM C 296—64T
Brass Pipe, Seamless Red Brass—Specification for	ASTM B 43—62
Cast Iron Pipe	
—Pressure—Specifications for	ASTM A 377—57
—Soil Pipe and Fittings—Specifications for	ASTM A 74—42
Clay Pipe	
—Drain Tile—Specifications for	ASTM C 4—62
—Extra Strength—Specifications for	ASTM C 200—59T
—Sewer, Standard Strength Ceramic Glazed or Unglazed—Specifications for	ASTM C 261—60T
—Sewer, Standard Strength—Specifications for	ASTM C 13—57T

(Continued on next page)

Exhibit D Structural Unit Test Standards

APPENDIX D

STRUCTURAL UNIT TEST STANDARDS

See also appendixes B and C for engineering practice standards and material standards which contain unit test methods.

CONCRETE

- Coarse Aggregates, Resistance to Abrasion of Small Size, by use of the Los Angeles Machine—Method of Test for ....ASTM C 131—64T
- Fine and Coarse Aggregates, Sieve or Screen Analysis of—Method of Test for ....ASTM C 136—63
- Graded Coarse Aggregates, Abrasion of, by Use of the Deval Machine—Method of Test for ....ASTM D 289—63
- Concrete, Obtaining and Testing Drilled Cores and Sawed Beams of—Methods of ....ASTM C 42—64
- Concrete Compression and Flexure Test Specimens in the Laboratory—Method of Making and Curing ....ASTM C 192—62T
- Concrete, Molded Cylinders—Method of Test for Compressive Strength of ....ASTM C 39—64
- Lightweight Insulating Concrete, Compressive Strength—Test for ....ASTM C 495—62T
- Concrete Masonry Units—Method of Sampling and Testing.. ....ASTM C 140—63T
- Concrete Masonry Units, Hollow Load Bearing—Specifications for ....ASTM C 90—64T
- Concrete, Masonry Units, Solid Load Bearing—Specifications for ....ASTM C 145—64T
- Concrete, Hardened Portland Cement—Method of Test for Cement Content of ....ASTM C 85—54
- Concrete, Ready Mixed—Specifications for ....ASTM C 94—64
- Sands for Concrete—Method of Test for Organic Impurities in........ASTM C 40—60

INTERIOR FINISHES

- Gypsum and Gypsum Products, Chemical Analysis of—Standard Methods for ....ASTM C 471—61
- Gypsum Board Products and Gypsum Partition Tile or Block, Physical Testing of—Standard Methods for ....ASTM C 473—62
- Gypsum Concrete—Specifications for ....ASTM C 317—64
- Gypsum Formboard—Specifications for ....ASTM C 318—55
- Gypsum Lath—Specifications for ....ASTM C 37—54
- Gypsum Plasters—Specifications for ....ASTM C 28—63
- Gypsum Plasters and Gypsum Concrete, Physical Testing of—Standard Methods for ....ASTM C 472—64
- Gypsum Sheathing Board—Specifications for ....ASTM C 79—54
- Gypsum Wallboard—Specifications for ....ASTM C 36—64
- Insulation Board, Structural, Made from Vegetable Fibers—
  - Methods of Testing ....ASTM C 209—60
  - Specifications for ....ASTM C 208—60
- Lime ....(See **MASONRY**)

MASONRY

- Aggregate for Masonry Mortar—Specifications for ....ASTM C 144—62T
- Brick, Concrete Building—Specifications for ....ASTM C 55—55
- Brick—Methods of Testing and Sampling ....ASTM C 67—62
- Cement, Masonry—Specifications for ....ASTM C 91—64
- Concrete Masonry Units ....(See **CONCRETE**)
- Glazed Units—Ceramic Glazed Structural Clay Facing Tile, Facing Bricks, and Solid Masonry Units—Specifications for ....ASTM C 126—62
- Lime and Limestone Products—Methods of Sampling, Inspection, Packing and Marking of ....ASTM C 50—57
- Lime, Hydrated and Quick—Methods of Physical Testing of ....ASTM C 110—58
- Lime, Hydraulic Hydrated for Structural Purposes—Specifications for ....ASTM C 141—61
- Mortars, Hydraulic Cement—Method of Test for Compressive Strength of (Using 2 in. cube Specimens)........ASTM C 109—64
- Mortars, Hydraulic Cement—Method of Test for Tensile Strength of ....ASTM C 190—63
- Stone, Natural Building—Methods of Test for Absorption and Bulk Specific Gravity of ....ASTM C 97—47
- Stone, Natural Building—Method of Test for Compressive Strength of ....ASTM C 170—50
- Stone, Natural Building—Methods of Test for Modulus of Ruptures of ....ASTM C 99—52
- Tile, Structural Clay—Methods of Sampling and Testing ....ASTM C 112—60

METALS

- Cast Iron—Method of Testing Compression of ....ASTM A 256—46
- Metallic Materials—Methods of Tension Testing of ....ASTM E 8—61T

UNCLASSIFIED MISCELLANEOUS

- Cement, Hydraulic—Methods of Sampling ....ASTM C 183—64T
- Cement, Natural—Specifications for ....ASTM C 10—64
- Cement, Portland—Specifications for ....ASTM C 150—64
- Plastics Under Load—Method of Test for Deformation of ....ASTM D 621—64
- Tile, Clay Drain—Specification for ....ASTM C 4—62

WOOD AND WOOD PRODUCTS

- Timber, Small Clear Specimens—Method of Testing........ASTM D 143—52
- Timbers in Structural Sizes—Methods of Static Tests of ....ASTM D 198—27
- Veneer, Plywood and Other Glazed Veneer Construction—Methods of Testing ....ASTM D 805—63

Exhibit F Durability Test Standards

APPENDIX F

DURABILITY TEST STANDARDS

See also appendixes C, D and E for tests of individual materials or unit assemblies.

CONCRETE AND CONCRETE AGGREGATE

Concrete, Aggregate—Method of Tests for Voids in ....ASTM C 30—37
Concrete, Air Content of Freshly Mixed, by the Pressure Method—Method of Test for ....ASTM C 231—62
Concrete, Weight per Cubic Foot, Yield and Air Content of—Method of Test for ....ASTM C 138—63
Organic Impurities in Sand for Concrete—Method of Test for............ASTM C 40—60

MASONRY AND MASONRY PRODUCTS

Ceramic Glazed Structural Clay Facing Tile, Facing Brick and Solid Masonry Units—Specifications for (Autoclave Test) ....ASTM C 126—62
Freezing and Thawing Tests (See Specifications for Materials)
—Bricks—Methods of Sampling and Testing ....ASTM C 67—62
—Drain Tile—Specifications for ....ASTM C 4—62
—Structural Clay Tile—Methods of Sampling and Testing ....ASTM C 112—60

PLASTICS

Accelerated Weathering Tests of Plastics—Recommended Practice for ....ASTM D 795—57T
Water Absorption of Plastics—Method of Test for ....ASTM D 570—63

ROOFING AND SIDING

Asphalt Roll Roofing, Cap Sheets, and Shingles—Methods of Testing ....ASTM D 228—64
Bituminous Materials, Accelerated Weathering Test of—Recommended Practice for ....ASTM D 529—62
Felted and Woven Fabrics Saturated with Bituminous Substance for Use in Waterproofing and Roofing—Methods of Sampling and Testing ....ASTM D 146—59

UNCLASSIFIED MISCELLANEOUS

Fibre Building Boards—Method of Accelerated Aging..............................NBS BMS 4—38
Fibre Building Boards—Method of Accelerated Aging ....ASTM D 1037—63T
Gypsum Products, Wood Fibre Content in—Method of Test for ....ASTM C 26—59
Textile Fabrics—Method of Test for Water Resistance of ....ASTM D 583—63

Exhibit J Unit Design Dead Loads for Structural Design Purposes

APPENDIX J

UNIT DESIGN DEAD LOADS FOR STRUCTURAL DESIGN PURPOSES

WALLS AND PARTITIONS (Unplastered)	Pounds per Square Foot
12 inch common brick	120
12 " pressed brick	130
12 " sand-lime brick	105
12 " hollow concrete block—Stone Aggregate	74
Lightweight	55
10 " hollow concrete block—Stone Aggregate	62
Lightweight	46
8 " hollow concrete block—Stone Aggregate	50
Lightweight	36
6 " hollow concrete block—Stone Aggregate	42
Lightweight	36
4 " hollow concrete block—Stone Aggregate	27
Lightweight	20
12 " solid concrete block—Stone Aggregate	108
Lightweight	72
10 " solid concrete block—Stone Aggregate	84
Lightweight	62
8 " solid concrete block—Stone Aggregate	67
Lightweight	48
6 " solid concrete block—Stone Aggregate	50
Lightweight	37
4 " solid concrete block—Stone Aggregate	45
Lightweight	34
12 " combination brick and clay tile	80
8 " " " " " "	60
12 " combination brick and concrete block	90
8 " " " " " "	72
12 inch load-bearing clay tile	60
8 " " " " "	40
6 " " " " "	36
4 " " " " "	24
10 " non-load-bearing clay tile	40
8 " " " " " "	36
6 " " " " " "	30
4 " " " " " "	20
3 " " " " " "	18
2 " " " " " "	11
8 " non-load-bearing hollow concrete block	40
6 " " " " " " "	30
4 " " " " " " "	20
T.C. 1½ inch split terra cotta furring	8
2 inch split terra cotta furring	10
3 " " " " "	12
6 " hollow gypsum block	24
5 " " " "	18
4 " " " "	15
3 " " " "	10

(Continued on next page)

Exhibit J Unit Design Dead Loads for Structural Design Purposes (Continued)

	Pounds per Square Foot
4 inch solid gypsum block	24
3 " " " "	18
2 " " " "	12
4 " glass block	18

	Pounds per Cubic Foot
Cast stone solid	144
Granite ashlar	168
Limestone ashlar	168
Marble ashlar	168
Sandstone ashlar	156
Rubble stone masonry	156
Terra cotta architectural (filled)	120
Terra cotta architectural (unfilled)	72
Concrete, stone (plain)	144
Concrete, stone (reinforced)	150
Concrete, cinder	108
Fill, cinder	60
Earth (dry)	96
Earth (damp)	108
Earth (wet)	120
Cork	15
Timber, Ash	40
Timber, Douglas Fir	36
Timber, Cypress	30
Timber, Hemlock	30
Timber, Oak	48
Southern Pine, Short Leaf	36
Southern Pine, Long Leaf	48
Redwood	28
Spruce	30

PLASTER WORK	Pounds per Square Foot
Gypsum (one side)	5
Cement (one side)	10
Gypsum on wood lath	8
Gypsum on metal lath	8
Gypsum on plaster board or fiber board	8
Cement on wood lath	10
Cement on metal lath	10

SUSPENDED CEILINGS	Pounds per Square Foot
Cement on wood lath	12
Cement on metal lath	15
Gypsum on wood or metal lath	10

LATH AND PLASTER PARTITIONS	Pounds per Square Foot
2 inch solid cement on metal lath	25
2 " solid gypsum on metal lath	18
2 " " " on gypsum lath	18
2 " metal studs gypsum & metal lath both sides	18
3 " " " " " " " " "	19
4 " " " " " " " " "	20

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Exhibit J Unit Design Dead Loads for Structural Design Purposes (Continued)

	Pounds per Square Foot
6 inch wood studs plaster and wood lath, both sides	18
6 " " " " " metal lath, both sides	18
6 " " " " " plaster boards, both sides	18
6 " " " unplastered gypsum board, both sides (dry wall)	10

FLOOR AND ROOF CONSTRUCTION	Pounds per Square Foot
Cinder fill per inch depth	5
Cinder concrete per inch depth	9
Stone concrete per inch depth	12
Floor finish tile per inch depth	12
Cement finish per inch depth	12
Gypsum slabs per inch depth	4
Precast concrete plank per inch depth (as determined by test)	
Hardwood flooring per inch depth	4
Underflooring per inch depth	3
Linoleum	2
Asphalt tile	2

ROOFS AND ROOFING	Pounds per Square Foot
Metal Skylights	10
3-ply roofing	4
4 " "	5
5 " "	6
Wood sheathing (1")	3
Plywood sheathing (5/16")	1
Corrugated iron roofing	3
Formed steel decking	3
Slate tile roofing	10
Cement tile	16
Spanish tile	20
Shingles, asbestos	6
Shingles, asphalt	6
Shingles, wood	6

Exhibit K Unit Working Stresses for Ordinary Materials

APPENDIX K

UNIT WORKING STRESSES FOR ORDINARY MATERIALS

Unless otherwise specified herein, the allowable working stresses for ordinary materials, as defined in sections 701 and 722, shall be reduced ten (10) per cent below the recommended values of the accepted engineering standards listed in appendix B. When the structural material is identified in regard to manufacture and grade and the identification is accompanied by satisfactory mill tests or the strength and stress grade of the materials are otherwise confirmed to the satisfaction of the building official, the allowable working stresses may be increased to comply with the accepted engineering standards.

K-1. MASONRY STRESSES

K-1-A. Mortar for Unit Masonry.—Mortar for unit masonry shall comply with either the proportion specifications as set out in section 816.2, or shall meet the property specifications of the accepted engineering standard listed in appendix C. Unless laboratory data are presented to show that the mortar meets the requirements of the property specifications, the proportion specifications shall govern.

K-1-B. Compressive Stresses.—Except as permitted in other sections of the Basic Building Code, the compressive stresses in masonry shall not exceed the following values:

Allowable compressive stresses gross cross-sectional area (except as noted)

Type of Masonry and Grade of Masonry Unit (psi gross area)	Type of Mortar			
	M	S	N	O
	psi	psi	psi	psi
Solid masonry of brick and other solid units of clay or shale; sand lime or concrete:				
8000 plus psi	400	350	300	200
from 4500 to 8000 psi	250	225	200	150
from 2500 to 4500 psi	175	160	140	100
from 1500 to 2500 psi	125	115	100	75
Grouted masonry of solid masonry units:				
from 4500 to 8000 psi	350	275	200	......
from 2500 to 4500 psi	275	215	155	......
from 1500 to 2500 psi	225	175	125	......
Solid masonry of solid concrete masonry units:				
1800 plus psi	175	160	140	100
from 1200 to 1800 psi	125	115	100	75
Masonry of hollow units	85	75	70	......
Hollow walls (cavity or masonry bonded)*				
Solid masonry units				
2500 plus psi	140	130	110	----
from 1500 to 2500 psi	100	90	80	......
Hollow masonry units	70	60	55	----
Stone ashlar masonry				
Granite	800	720	640	500
Limestone or marble	500	450	400	325
Sandstone or cast stone	400	360	320	250
Rubble stone, coursed, rough or random	140	120	100	80

*On gross cross-sectional area of wall minus area of cavity between wythes. The allowable compressive stresses for cavity walls are based upon the assumption that the floor loads bear upon but one (1) of the two (2) wythes. Where hollow walls are loaded concentrically, the allowable stresses may be increased by twenty-five (25) per cent

Exhibit K Unit Working Stresses for Ordinary Materials (Continued)

K-1-C. Shear and Tensile Stresses.—Except as permitted in other sections of the Basic Building Code, the allowable shear or tensile stresses in unreinforced brick masonry shall not exceed the following values:

Allowable stresses in shear or tension in flexure for unreinforced brick masonry*

Construction	Allowable Working Stresses, psi Gross Cross-Sectional Area, Except as Noted	
	Mortar	
	Type M or S	Type N
Single wythe walls of solid clay masonry units; or walls of grouted brick masonry	36	28
Solid walls, brick and other solid clay masonry units, masonry bonded or metal tied	28	20
Cavity and masonry-bonded hollow walls, brick and brick**	28	20

*Allowable stresses apply to brick and other solid clay masonry units laid in portland cement-lime-sand mortars. If other masonry units or mortars are used, allowable stresses for such masonry construction shall be established by tests specified in section 803.

**Net area.

K-2. REINFORCED CONCRETE STRESSES

The allowable working stresses for ordinary materials shall be based on the following proportions by dry volumetric measurement and maximum water content per sack of cement in accordance with the standard building code requirements for reinforced concrete specified in appendix B subject to the ten (10) per cent reduction prescribed for ordinary materials.

28-day strength of concrete in pounds per square inch	*Concrete proportions*	*Gallons of water per sack of cement*
2000	1:5½	7½
2500	1:4½	6¼
3000	1:3½	6

K-3. REINFORCED GYPSUM CONCRETE STRESSES

When ordinary materials are used, the allowable working stresses shall be based on the following proportions, measured dry by weight with sufficient water to make a plastic mix that will fill the forms: 100 per cent neat calcined gypsum; 97 per cent gypsum and 3 per cent wood chips, shavings or fibers; and 87.5 per cent gypsum and 12.5 per cent wood chips, shavings or fibers; with ultimate compressive strengths of 1,800, 1000 and 500 pounds per square inch respectively.

The working stresses shall not exceed the values prescribed in the standard for reinforced gypsum concrete listed in appendix B subject to the ten (10) per cent reduction prescribed for ordinary materials.

(Continued on next page)

Exhibit K Unit Working Stresses for Ordinary Materials (Continued)

K-4. STEEL REINFORCEMENT STRESSES

The allowable working stresses for reinforcement specified in the standard building code requirements for reinforced concrete listed in appendix B shall be used in all reinforced construction, including reinforced concrete, reinforced gypsum concrete and all forms of reinforced masonry subject to the ten (10) per cent reduction specified for ordinary, unidentified materials except as follows:

Type of Steel Element	*Maximum stress in pounds per square inch*
High Yield Strength Steel (50 per cent of Yield Point)	30,000
Steel Pipe, Concrete-filled (45 per cent of Yield Point)	16,000

K-5. STRUCTURAL STEEL STRESSES

When ordinary materials which are not identified as to manufacture and grade are used, the allowable working stresses specified in the standard for the design, fabrication and erection of structural steel listed in appendix B shall be reduced ten (10) per cent.

K-6. CAST STEEL STRESSES

The allowable working stresses for cast steel in compression and bearing shall be the same as those specified for structural steel and shall not exceed seventy-five (75) per cent of the values specified for all other applicable stresses in the standard.

K-7. CAST IRON STRESSES

	Maximum stress in pounds per square inch
Tension	3,000
Extreme Tension (Fiber Stress in Bending)	3,000
Extreme Compression (Fiber Stress in Bending)	16,000
Shear	3,000
Column Compression	$9{,}000 \text{ minus } 40\frac{l}{r}$

Ratio $\frac{l}{r}$ not to exceed seventy (70)

K-8. OPEN-WEB STEEL JOIST STRESSES

The allowable working stresses specified for open-web steel joists shall be in accordance with the standard specifications for steel joist construction listed in appendix B. For all other steel joists, unless otherwise specifically approved and identified, the allowable working stresses specified by the standard shall be reduced ten (10) per cent.

K-9. FORMED STEEL CONSTRUCTION STRESSES

The allowable working stresses for light gage formed steel structural members shall be based on the following grades of flat rolled carbon steel with yield points of 25,000, 30,000 and 33,000 pounds per square inch as specified in the standard specification for the design of light gage steel structural members listed in appendix B, subject to a reduction of ten (10) per cent on all stress values for ordinary materials.

K-10. LUMBER STRESSES

When the grade of lumber is not identified as provided in section 722 for controlled materials, the maximum allowable working stresses for the species of lumber used shall be determined in accordance with the principles for stress grade lumber as set forth in the National Design Specification for Stress-Grade Lumber and Its Fastenings.

Exhibit K-11 Earthquake Load Design

K-11. EARTHQUAKE LOAD DESIGN

When required to withstand lateral forces under section 719.0 buildings and structures shall be designed in accordance with the following sections according to the zone in which they are located on the seismic probability map in table 14C.

K-11-A. Application of Provisions.—These lateral force requirements are intended to make buildings earthquake-resistive. The provisions apply to the buildings as a unit and also to all parts thereof, including the structural frame or walls, floor and root systems, and other structural features. In specific cases, they may be interpreted or added to as to detail by rulings of the building official in order that the intent shall be fulfilled.

K-11-A-1. Additions.—Where applicable, every addition to an existing building or structure shall be designed and constructed to resist and withstand the forces provided for herein, and in any case where an existing building or structure is increased in height all portions thereof affected by such increased height shall be reconstructed to resist and withstand the forces provided for herein.

K-11-A-2. Alterations.—Where applicable, no existing building or structure shall be altered or reconstructed in such a manner that the resistance to the forces provided for herein will be less than that before such alteration of reconstruction was made; provided, however, that this provision shall not apply to non-bearing partitions, and shall not apply to other minor alterations which are made in compliance with all requirements of the Basic Code.

K-11-B. Plans and Design Data.—Where earthquake loads are applicable, a brief statement of the following items shall be included with each set of plans filed:

(a) A summation of the dead and live load of the building, floor by floor, which was used in figuring the shear for which the building is designed.

(b) A brief description of the bracing system used, the manner in which the designer expects such system to act and a clear statement of any assumptions used. Assumption as to location of all points of counterflexure in members must be stated.

(c) Sample calculation of a typical bent or equivalent. For combined stresses due to the lateral forces and other loads, the allowable unit stresses and the allowable load in connections may be increased as provided in section 720.0.

K-11-C. Lateral Force Requirements.—Where earthquake loads are applicable, every building or structure and every portion thereof, except as exempted in section 719.1 shall be designed and constructed to resist stresses produced by lateral forces as provided herein. Stresses shall be calculated as the effect of a force applied horizontally at each floor or roof level above the foundation. The force shall be assumed to come from any horizontal direction.

K-11-C-1. Bracing Systems.—All bracing systems both horizontal and vertical shall transmit all forces to the resisting members and shall be of sufficient extent and detail to resist the horizontal forces provided for herein and shall be located symmetrically about the center of mass of the building or the building shall be designed for the resulting rotational forces about the vertical axis.

(Continued on next page)

Exhibit K-11 Earthquake Load Design (Continued)

K-11-C-2. Junctures Between Wings.—Junctures between distinct parts of buildings, such as wings which extend more than twenty (20) feet from the main portion of the building, shall be designed at the juncture with other parts of the building for rotational forces, or the juncture may be made by means of sliding fragile joints having a minimum width of not less than eight (8) inches. The details of such joints shall be made satisfactory to the building official.

K-11-D. Horizontal Force Formula.—The horizontal force shall be calculated according to the following formula:

$$F = CW$$

Where

F = the horizontal force in pounds.

W = the total dead load, tributary to the point under consideration, except for warehouses and tanks, in which case W shall equal the total live load tributary to the point under consideration. Machinery or other fixed concentrated loads shall be considered as part of the dead load.

C = a numerical constant as shown in table 14B and section K-11-D-1 to K11-D-3 inclusive.

TABLE 14B.—HORIZONTAL FORCE FACTORS

Part or Portion	Value of C in Zone 1*	Direction of Force
Floors, roofs, columns and bracing in any story of a building or the structure as a whole**	0.15*** $N + 4\frac{1}{2}$	Any direction horizontally
Bearing walls, non-bearing walls, partitions, free standing masonry walls over 6 ft. in height	.05 With a minimum of five pounds per sq. ft.	Normal to surface of wall
Cantilever parapet and other cantilever walls, except retaining walls	.25	Normal to surface of wall
Exterior and interior ornamentations and appendages	.25	Any direction horizontally
When connected to or part of a building: towers, tanks, towers and tanks plus contents, chimneys, smokestacks and penthouses	.05	Any direction horizontally
Elevated water tanks and other tower-supported structures not supported by a building	.03	Any direction horizontally

*For zones, see table 14C. For requirements in zones see section K-11-D-1 to K-11-D-3 inclusive.
**Where specified wind load would produce higher stresses, this load shall be used in lieu of the factor shown. (See section 720.0.)
***N is number of stories above the story under consideration, provided that for floors or horizontal bracing, N shall be only the number of stories contributing loads.

K-11-D-1. Requirements for Zone 1.—Where earthquake loads are applicable to buildings or structures in Zone 1 on map in table 14C, the value of "C" shall be as shown in table 14B.

K-11-D-2. Requirements for Zone 2.—Where earthquake loads are applicable to buildings or structures in Zone 2 on map in table 14C, the value of "C" shown in table 14B shall be doubled.

K-11-D-3. Requirements for Zone 2.—Where earthquake loads are applicable to buildings or structures in Zone 3, on map in table 14C, the value of "C" shown in table 14B shall be multiplied by four (4).

K-11-D-4. Location of Zones.—For the purpose of determining the value of "C" in table 14B, the map in table 14C shall govern.

(Continued on next page)

Exhibit K-11 Earthquake Load Design

K-11-E. Foundation Ties.—Where earthquake loads are applicable in the design of buildings, other than lightly loaded structures of type 2 and 4 construction, where the foundations rest on piles or on soil having a safe bearing value of less than two thousand (2000) pounds per square foot, the foundations shall be completely interconnected in two directions approximately at right angles to each other. Each such interconnecting member shall be capable of transmitting by both tension and compression at least ten (10) per cent of the total vertical load carried by the heavier only of the footings or foundations connected. The minimum gross size of each such member if of reinforced concrete shall be twelve (12) inches by twelve (12) inches and shall be reinforced with not less than the minimum reinforcement specified elsewhere in the Basic Code. If the interconnecting members are of structural steel, they shall be designed as provided elsewhere in the code, and encased in concrete. A reinforced concrete slab may be used in lieu of interconnecting tie members, providing the slab thickness is not less than one forty-eighth (1/48) of the clear distance between the connected foundations; also providing the thickness is not less than six (6) inches.

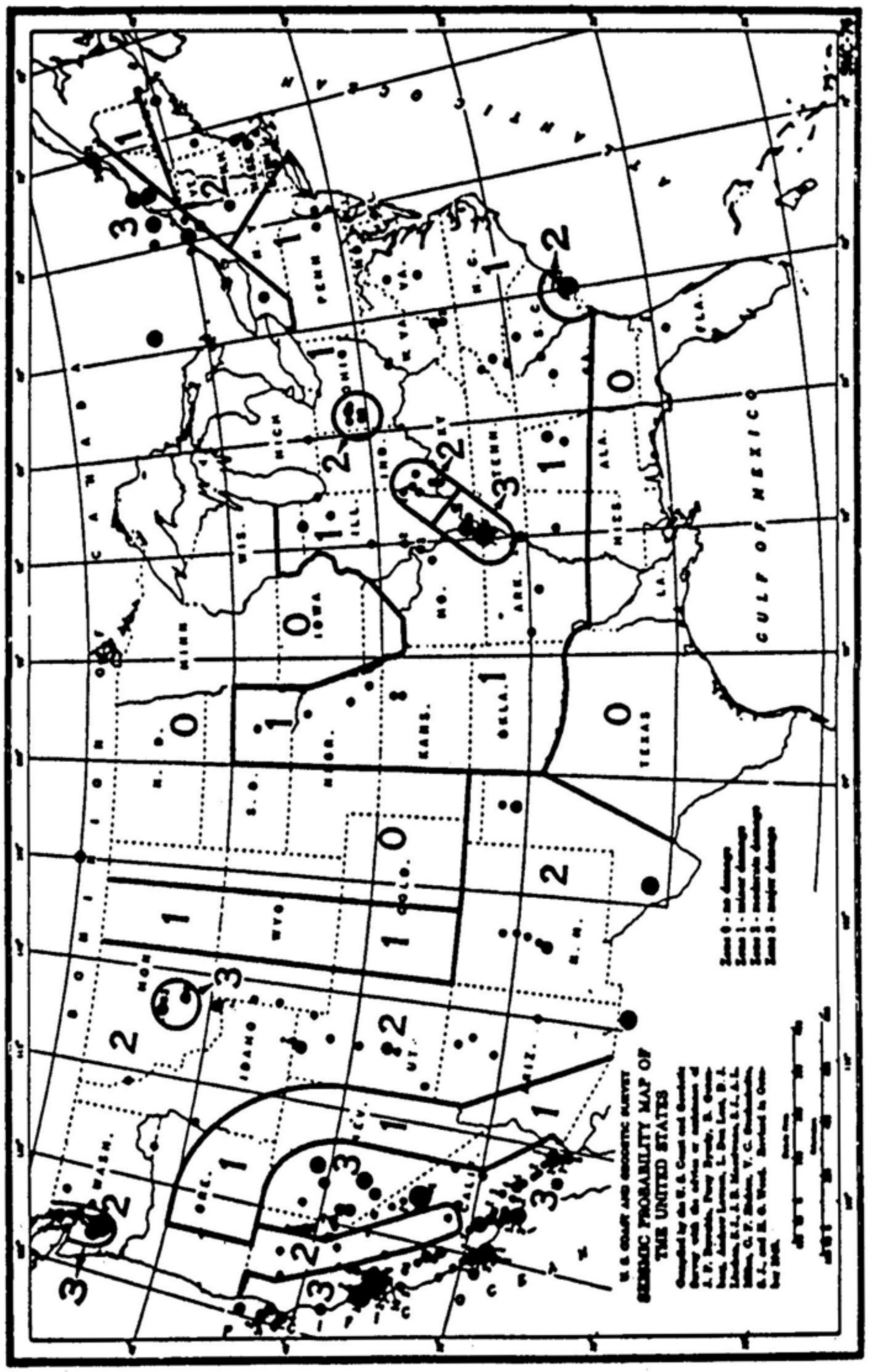
Interconnecting slabs shall be reinforced with not less than eleven-hundredths (.11) square inch of steel per foot of slab in a longitudinal direction and the same amount of steel in a transverse direction. The bottom of such slab shall not be more than twelve (12) inches above the tops of at least eighty (80) per cent of the piers or foundations. The footings and foundations shall be tied to the slab in such manner as to be restrained in all horizontal directions.

K-11-F. Bonding and Tying.—Where earthquake loads are applicable, cornices and ornamental details shall be bonded into the structure so as to form an integral part of it. This applies to the interior as well as to the exterior of the building.

K-11-F-1. Veneer Ties.—Veneer ties shall be of sufficient strength to support four times the weight of the attached veneer.

K-11-G. Overturning Moment.—In no case shall the calculated overturning moment of any building or structure due to the forces provided for herein exceed two-thirds (⅔) of the moment of stability of such building or structure. Moment of stability shall be calculated using the same loads as used in calculating the overturning moment for wind forces.

TABLE 14C.—SEISMIC PROBABILITY MAP OF THE UNITED STATES



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Annex B1
TABLES IN 1968 NEW YORK CITY BUILDING CODE

B1.1 EXHIBITS

TABLE 9-1 Percentage of Live Load

Contributory Area (Sq. ft.)	Ratio of Live Load to Dead Load [a]		
	0.625 or less	1	2 or more
149 or less	100	100	100
150-299	80	85	85
300-449	60	70	75
450-599	50	60	70
600 or more	40	55	65

Note:

a. For intermediate values of live load/dead load, the applicable percentages of live load may be interpolated.

TABLE RS 9-5.1 DESIGN WIND PRESSURES ON VERTICAL SURFACES

Height Zone (ft. above curb level)	*Design Wind Pressure on Vertical Surfaces (psf of projected solid surface)*	
	Structural Frame	*Panels Glass*
0-50 (signs and similar constructions of shallow depth only)	15	—
0-100	20	30
101-300	25	30
301-600	30	35
601-1000	35	40
Over 1000	40	40

TABLE RS 9-5.2 DESIGN WIND PRESSURES ON HORIZONTAL AND INCLINED SURFACES

Roof Slope	*Design Wind Pressure Normal to Surface*
30 degrees or less	Either pressure or suction equal to 40 per cent of the values in Table RS 9-5.1 over the entire roof area
More than 30 degrees	Windward slope – pressure equal to 60 per cent of values in Table RS 9-5.1. Leeward slope – suction equal to 40 per cent of values in Table RS 9-5.1.

TABLE RS 9-5.3 SHAPE FACTORS

Construction	*Shape Factor*
Signs (and their supports), or portions thereof, having 70 per cent or more of solid surface	1.5
Signs (and their supports), or portions thereof, having less than 70 per cent of solid surface	2.0
Tanks, cooling towers, and similar constructions	1.5
Upright, circular cylindrical surfaces	0.7
Square and rectangular chimneys	1.5

*** TABLE 10-1 INSPECTION OF MATERIALS AND ASSEMBLIES**

Materials	*Elements That Shall be Subject to Controlled Inspection*[a,b,d]	*Elements That Are Not Subject to Controlled Inspection*[a,c,d]
Steel	None	All structural elments and connections.
Concrete	Materials for all structural elements proportioned on the basis of calculated stresses 70 per cent or greater, of basic allowable values. See Article 5 for specific requirements relating to "quality control of materials and batching."	(1) All materials for structural elements proportioned on the basis of calculated stresses less than 70 per cent of basic allowable values. (2) Concrete materials for: (a) Short span floor and roof construction proportioned as per section 27-610. (b) Walls and footings for buildings in occupancy group J-3. (3) Metal reinforcement.
Aluminum	None	All structural elements and connections.
Wood	None	All structural elements and connections.
Reinforced gypsum concrete	None	All structural elements.
Masonry	None	All structural elements.
Other	Requirements as may be established in other articles of this code or by the commissioner.	

Notes:

[a] For general provisions relating to inspection see section 27-132.

[b] All structural materials and assemblies subject to controlled inspection shall be tested and/or inspected at their place of manufacture and evidence of compliance with the provisions of this subchapter shall be provided as stipulated in articles four through twelve.

[c] Mill, manufacturer's and supplier's inspection and test reports will be accepted as evidence of compliance with the provisions of this code for all structural materials and assemblies not subject to controlled inspection.

[d] Basic allowable stress values as referenced herein shall denote allowable stress value without increase for infrequent stress conditions as established in this code or in the applicable reference standard for the material or element in its proposed use.

*TABLE 10-2 INSPECTION OF METHODS OF CONSTRUCTION

Materials	*Operations on Structural Elements That Shall be Subject to Controlled Inspection* [a,b,d]	*Operations on Structural Elements That Are Not Subject to Controlled Inspection* [a,c,d]
Steel	(1) Welding operations and the tensioning of high strength bolts in connections where the calculated stresses in the welds or bolts are fifty per cent or more of basic allowable values. (2) Connection of fittings to wire cables for suspended structures, except where cables together with their attached fittings are proof-loaded to not less than fifty-five per cent of ultimate capacity.	(1) Welding operations and the tensioning of high strength bolts in connections where the calculated stresses in the welds or bolts are less than fifty per cent of basic allowable values. (2) All other fabrication and erection operations not designated for controlled inspection.
Concrete	Except for those operations specifically designated in this table as not subject to controlled inspection, for all concrete, the operations described in subdivision (a) of section 27-607 shall be subject to controlled inspection.	(1) All operations relating to the construction of members and assemblies (other than prestressed members) which involve the placement of a total of less than fifty cubic yards of concrete and wherein said concrete is used at levels of calculated stress seventy per cent or less of basic allowable values. (2) Placing and curing of concrete for all: (a) Short span floor and roof construction as per section 27-610. (b) Walls and footings for buildings in occupancy group J-3. (3) Size and location of reinforcement for walls and footings for buildings in occupancy group J-3. (4) All other operations not described in subdivision (a) of section 27-607.
Aluminum	Welding operations in connections where the calculated stresses in the welds are fifty per cent or more of the basic allowable values.	(1) Welding operations in connections where the calculated stresses in the welds are less than fifty per cent of basic allowable values. (2) All other fabrication and erection operations not designated for controlled inspection.
Wood	Fabrication of glued-laminated assemblies and of plywood components.	All other operations not designated for controlled inspection.
Reinforced Gypsum Concrete	None	All operations incident to the fabrication and placement of structural elements.
Reinforced Masonry	(1) Fabrication of prefabricated units. (2) Placement and bedding of units, sizes of members, including thickness of walls and wythes; sizes of columns; the size and position of reinforcement, in place, and provisions for curing and protection against freezing for all reinforced masonry construction unless such operations are specifically not designated for controlled inspection.	[(1) All operations relating to the construction of members and assemblies which involve the placement of a total of less than fifty cubic yards of masonry and wherein said masonry is used at levels of calculated stress seventy per cent or less of basic allowable values.] [(2)] *(1)* All masonry work for buildings in occupancy group J-3. [(3)] *(2)* All mixing of mortar. [(4)] *(3)* All other operations not designated for controlled inspection.
Unreinforced Masonry	Placement and bedding of units and sizes of members including thickness of walls and wythes; sizes of columns; *cleanouts;* and provisions for curing and protection against freezing for all masonry construction proportioned on the basis of structural analysis as described in section four of reference standard RS 10-1B, unless such operations are specifically not designated for controlled inspection. *(Amended by Local Law 17/1995, eff. 2/21/96. Matter in italics eff. 2/21/96.)*	[(1) All operations relating to the construction of members and assemblies which involve the placement of a total of less than fifty cubic yards of masonry and wherein said masonry is used at levels of calculated stress seventy per cent or less of basic allowable values.] [(2)] *(1)* All masonry work for buildings in occupancy group J-3. [(3)] *(2)* All mixing of mortar. [(4)] *(3)* All other operations not designated for controlled inspection. *(Amended by Local Law 17/1995, eff. 2/21/96. Matter in brackets eff. only until 2/21/96. Matter in italics eff. 2/21/96.)*
Piling	See provisions of subchapter 11.	
Other	Requirements as may be established in other subscriptions of this code.	

Notes:

[a] For general provisions relating to inspection, see section 27-132.

[b] All construction operations designated for controlled inspection shall be inspected by the architect or engineer designated for controlled inspection during the performance of such operation.

c Certification by the fabricator or erector, as applicable, will be accepted as evidence of compliance with the provisions of this code for all construction operations not subject to controlled inspection.

[d] Basic allowable stress values as referenced herein shall denote allowable stress value without increase for infrequent stress conditions as established in this code or in the applicable reference standard for the material or element in its proposed use.

Table 10-3 Minimum Cement Factor

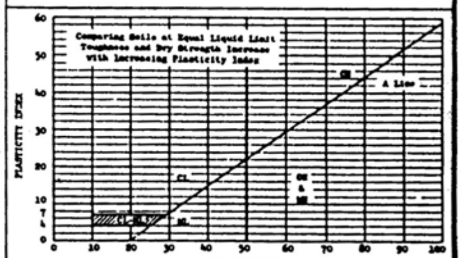
Specified Comprehensive Strength in 28 Days (f'_c)-psi	Minimum Bags of Cement Cubic Yard of Concrete (all aggregates)
2,000	5.00
2,500	5.25
3,000	5.75
3,500	6.50
3,750	6.75
4,000	7.00
5,000	7.50
Over 5,000	Permitted only by Method II

Table 11-1 Unified Soil Clarification

TABLE 11-1—UNIFIED SOIL CLASSIFICATION (Including Identification and Description)

Major Divisions (1)	(2)		Group Symbols (3)	Typical Names (4)	Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights) (5)	Information Required for Describing Soils (6)	Laboratory Classification Criteria (7)		
Coarse-grained Soils. More than half of material is larger than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.	Gravels. More than half of coarse fraction is larger than No. 4 sieve size. (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size)	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions, and drainage characteristics.	Use grain-size curve in identifying the fractions as given under field identification.	Determine percentages of gravel and sand from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse-grained soils are classified as follows: Less than 5% GW, GP, SW, SP. More than 12% GM, GC, SM, SC. 5% to 12% Borderline cases requiring use of dual symbols.	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.				Not meeting all gradation requirements for GW
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixture.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).	Give typical name; indicate approximate percentages of sand and gravel, maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses.			Atterberg limits below "A" line or PI less than 4. Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).				Atterberg limits above "A" line with PI greater than 7
	Sands. More than half of coarse fraction is smaller than No. 4 sieve size.	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.				$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			SP	Poorly graded sands or gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.	Example: Silty sand, gravelly; about 20% hard, angular gravel particles 1/2-in. maximum size; rounded and subangular sand grains, coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).			Not meeting all gradation requirements for SW
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).				Atterberg limits above "A" line or PI less than 4. Limits plotting in hatched zone with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).				Atterberg limits above "A" line with PI greater than 7

Major Divisions (1)	(2)	Group Symbols (3)	Typical Names (4)	Identification Procedures on Fraction Smaller than No. 40 Sieve Size: Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)	Information Required for Describing Soils (6)	Laboratory Classification Criteria (7)
Fine-grained Soils. More than half of material is smaller than No. 200 sieve size.	Silts and Clays. Liquid limit is less than 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions.	Use grain-size curve in identifying the fractions as given under field identification. See plasticity chart.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium		
		OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight	Give typical name; indicate degree and character of plasticity; amount and maximum size of coarse grains; color in wet condition; odor, if any; local or geologic name and other pertinent descriptive information; and symbol in parentheses.	
	Silts and Clays. Liquid limit is greater than 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium		
		CH	Inorganic clays of high plasticity, fat clays.	High to very high	None	High		
		OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium	Example: Clayey silt, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML).	
Highly Organic Soils		Pt	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.				



PLASTICITY CHART

For laboratory classification of fine-grained soils

(1) Boundary classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder. (2) All sieve sizes on this chart are U. S. standard.

FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (crushing characteristics)

After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air-drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (consistency near plastic limit)

After particles larger than the No. 40 sieve size are removed, a specimen of soil about one-half inch cube in size, is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

Adopted by Corps of Engineers and Bureau of Reclamation, January 1952

Table 11-2 Allowable Soil Bearing Pressures

Class of Material	Description See Note (1)	Basic Allowable Bearing Values (Tons per sq. ft.)—See Notes (10), (11) and (12)	
1-65	Hard Sound Rock	60	See Notes (2) and (8).
2-65	Medium Hard Rock	40	See Notes (2) and (8).
3-65	Intermediate Rock	20	See Notes (2) and (8).
4-65	Soft Rock	8	
5-65	Hardpan	—	See Notes (3) and (8).
6-65	Gravel and Gravel Soils (Soil Groups GW, GP, GM & GC and soils of Soil Groups SW, SP, and SM containing more than 10% of material retained on a No. 4 sieve)	—	See Notes (4) and (8) and (9).
7-65	Sands (other than Fine Sands) (Soil Groups SW, SP & SM but containing not more than 10% of material retained on a No. 4 sieve)	—	See Notes (5), (8) and (9).
8-65	Fine Sand	—	See Notes (6), (8) and (9).
9-65	Clays and Clay Soils (Soil Groups SC, CL & CH)		
	Hard	5	See Note (7).
	Medium	2	See Note (7).
	Soft	See Sec. C26-1103.5.	
10-65	Silts and Silt Soils (Soil Groups ML & MH)		
	Dense	3	
	Medium	1.5	
	Loose	See Sec. C26-1103.5.	
11-65	Nominally Unsatisfactory Bearing Materials	See Sec. C26-1103.5.	

Notes:

(1) Classification.—The soil classifications indicated in this table are those described in section 1103.1. Where there is doubt as to the applicable classification of a soil stratum, the allowable bearing pressure applicable to the lower class of material to which the given stratum might conform shall apply unless the conformance to the higher class of material can be proven by laboratory or field test procedures.

(2) Allowable bearing pressure on rock.—The tabulated values of basic allowable bearing pressures apply only for massive rocks or, for sedimentary or foliated rocks, where the strata are level or nearly so, and, then only if the area has ample lateral support. Tilted strata and their relation to nearby slopes or excavations shall receive special consideration.

(3) Allowable bearing pressure on hardpan.—For hardpan consisting of well cemented material composed of a predominantly granular matrix and free of lenses of fine grained material and inclusions of soft rock, the basic allowable bearing pressure shall be 12 tons per sq. ft. For hardpan consisting of poorly cemented material or containing lenses of fine grained material, inclusions of soft rock, or a fine grained matrix, the basic allowable bearing pressure shall be 8 tons per sq. ft.

(4) Allowable bearing pressure on gravel and gravel soils.—Values of basic allowable bearing pressure shall be as follows:

(a) For soils of Soil Groups GW, GP, GM, and GC:

Compact, well graded material—10 tons per sq. ft.

Loose, poorly graded material—6 tons per sq. ft.

Intermediate conditions—Estimate by interpolation between indicated extremes.

(Continued on next page)

Table 11-2 Allowable Soil Bearing Pressures (Continued)

(b) For soils of Soil Groups SW, SP, and SM, containing more than 10% of material retained on a No. 4 sieve:

Compact, well graded material—8 tons per sq. ft.

Loose, poorly graded material—4 tons per sq. ft.

Intermediate conditions—Estimate by interpolation between indicated extremes.

(5) Allowable bearing pressure on sands.—The basic allowable bearing pressure shall be determined from the resistance to penetration of the standard sampling spoon. The basic allowable bearing pressure in tons per square foot shall equal 0.10 times N but not greater than 6 tons per square foot, nor less than 3 tons per square foot. The appropriate value for the penetration resistance at various areas of the site shall be made by averaging the measured resistance within a depth of soil below the proposed footing level equal to the width of the footing. Where the average values so obtained do not vary by more than 25 per cent of the minimum of the average values over the site of the proposed building, the lowest average value shall be used for the design of the entire building. Where the variation exceeds 25 per cent, the allowable bearing pressure shall be predicated on the lowest average value unless appropriate measures are taken to avoid detrimental amounts of differential settlements of the footings. Where the design bearing pressure on soils of class 7-65 exceeds 3 tons per square foot, the embedment of the loaded area below the adjacent grade shall not be less than 4 feet and the width of the loaded area not less than 3 feet, unless analysis shall demonstrate the proposed construction to have a minimum factor of safety of 2.0 against shear failure of the soil.

(6) Allowable bearing pressure on fine sand.—The basic allowable bearing pressure shall be determined from the resistance to penetration of the standard sampling spoon. The basic allowable bearing pressure in tons per square foot shall equal 0.10 times N but not greater than 4 tons per square foot nor less than 2 tons per square foot, except that, for loose materials (resistance to penetration of the standard sampling spoon 10 blows per foot or less), where the foundation is subjected to vibratory loads from machinery or similar cause, the indicated basic values shall not apply. The allowable bearing pressure shall be established by analysis applying accepted principles of soil mechanics and a report of such analysis satisfactory to the commissioner shall be submitted as a part of the application for the acceptance of the plans.

(7) Allowable bearing pressure on clays and clay soils.—The bearing capacity of medium and hard clays and clay soils shall be established on the basis of the strength of such soils as determined by field or laboratory tests and shall provide a factor of safety against failure of the soil of not less than 2.0 computed on the basis of a recognized procedure of soils analysis, shall consider probable settlements of the building, and shall not exceed the tabulated maximum values.

(8) Increases in allowable bearing pressure due to embedment of the foundation.—(a) The basic allowable bearing values for rock of classes 1-65, 2-65 and 3-65 shall apply where the loaded area is on the surface of sound rock. Where the loaded area is below the adjacent rock surface and is fully confined by the adjacent rock mass and provided that the rock mass has not been shattered by blasting or otherwise is or has been rendered unsound, these values may be increased 10 per cent of the base value for each foot of embedment below the surface of the adjacent rock surface in excess of one foot, but shall not exceed twice the basic values. (b) The basic allowable bearing values for soils of classes 5-65 through 8-65 determined in accordance with notes (3), (4), and (5) above, shall apply where the loaded area is embedded 4 ft. or less in the bearing stratum. Where the loaded area is embedded more than 4 ft. below the adjacent surface of the bearing stratum, and is fully confined by the weight of the adjacent soil, these values may be increased 5 per cent of the base value for each foot of additional embedment, but shall not exceed twice the basic values. Increases in allowable bearing pressure due to embedment shall not apply to soils of classes 4-65, 9-65, 10-65, or 11-65.

(9) Increase in allowable bearing pressure for limited depth of bearing stratum.—The allowable bearing values for soils of classes 6-65, 7-65 and 8-65 determined in accordance with this table and the notes thereto (including note (8)), may be increased up to one-third where the density of the bearing stratum below the bottom of the footings or the tips of the piles increases with depth provided that: (a) The bearing stratum is not underlain by materials of a lower class. (b) The allowable bearing value of the soil material underlying the bottom of the footings or the tips of the piles increases at least 50 per cent within a depth below the footing or the tips of the piles which is not greater than the width of the footing or the width of the polygon circumscribing the pile group.

Table 11-4—Minimum Driving Resistance and Minimum Hammer Energy for Steel H-Piles, Pipe Piles, Precast and Cast-in-Place Concrete Piles and Composite Piles (other than timber)

Pile Capacity (tons)	Hammer[b] Energy (ft. lbs.)	Friction Piles (blows/ft.)	Minimum Driving Resistance[a, d, e]: Piles Bearing on Hardpan (Soil Class 5-65) (blows/ft.)	Non-Displacement Piles Bearing on Decomposed Rock (Soil Class 4-65) (blows/ft.)	Displacement Piles Bearing on Decomposed Rock (Soil Class 4-65) (blows/ft.)	Piles Bearing on Rock (Soil Classes 1-65, 2-65, & 3-65)
Up to 20	15,000	19	19	48	48	
	19,000	15	15	27	27	
	24,000	11	11	16	16	
30	15,000	30	30	72	72	
	19,000	23	23	40	40	
	24,000	18	18	26	26	
40	15,000	44	50	96	96	
	19,000	32	36	53	53	
	24,000	24	30	34	34	
50	15,000	72	96	120	120	5 Blows per ¼ inch (Minimum hammer energy of 15,000 ft. lbs.)
	19,000	49	54	80	80	
	24,000	35	37	60	60	
	32,000	24	25	40	40	
60	15,000	96		240	240	
	19,000	63		150	150	
	24,000	44		100	100	
	32,000	30		50	50	
70 & 80	19,000 24,000 32,000		5 Blows per ¼ inch (Minimum hammer energy of 15,000 ft. lbs.)	5 Blows per ¼ inch (Minimum hammer energy of 19,000 ft. lbs.)		
100						
Over 100						

NOTES:

[a] Final driving resistance shall be the sum of tabulated values plus resistance exerted by non-bearing materials. The driving resistance of non-bearing materials shall be taken as the resistance experienced by the pile during driving, but which will be dissipated with time and may be approximated as described in Section C26-1107.1(c)(1)a.

[b] The hammer energy indicated is the rated energy.

[c] Sustained driving resistance—where piles are to bear in soil classes 4-65 and 5-65, the minimum driving resistance shall be maintained for the last 6 inches, unless a higher sustained driving resistance requirement is established by load test. Where piles are to bear in soil classes 6-65 through 10-65, the minimum driving resistance shall be maintained for the last 12 inches unless load testing demonstrates a requirement for higher sustained driving resistance. No pile need be driven to a resistance to penetration (in blows per inch) more than twice the resistance indicated in this table, nor beyond the point at which there is no measurable net penetration under the hammer blow.

[d] The tabulated values assume that the ratio of total weight of pile to weight of striking part of hammer does not exceed 3.5. If a larger ratio is to be used, or for other conditions for which no values are tabulated, the driving resistance shall be as approved by the commissioner.

[e] For intermediate values of pile capacity, minimum requirements for driving resistance may be determined by straight line interpolation.

Table 11-5 Minimum Driving Resistance and Hammer Energy for Timber Piles

Pile Capacity (tons)	Minimum Driving Resistance (blows-in.) to be added to driving resistance exerted by non-bearing materials [a, c, d]	Hammer Energy (ft.-lbs.)[b]
Up to 20	Formula in Note [d] shall apply	7,500-12,000
Over 20 to 25		9,000-12,000
		14,000-16,000
Over 25 to 30		12,000-16,000 (single-acting hammers)
		15,000-20,000 (double-acting hammers)
Greater than 30[e]		

NOTES:

[a] The driving resistance exerted by non-bearing materials is the resistance experienced by the pile during driving, but which will be dissipated with time and may be approximated as described in Section C26-1107.1(c)(1)a.

[b] The hammer energy indicated is the rated energy.

[c] Sustained driving resistance.—Where piles are to bear in Soil Classes 4-65 and 5-65, the minimum driving resistance shall be maintained for the last six inches, unless a higher sustained driving resistance requirement is established by load test. Where piles are to bear in Soil Classes 6-65 thru 10-65, the minimum driving resistance measured in blows per inch shall be maintained for the last 12 inches unless load testing demonstrates a requirement for higher sustained driving resistance. No pile need be driven to a resistance to penetration (in blows per inch) more than twice the resistance indicated in this Table nor beyond the point at which there is no measurable net penetration under the hammer blow.

[d] The minimum driving resistance shall be determined by the following formula:

$$P = \frac{2W_h H}{s + 0.1} \quad \text{or} \quad P = \frac{2E}{s + 0.1}$$

where:

P = Allowable pile load in pounds.

W_p = Weight driven in pounds.

W_h = Weight of striking part of hammer in pounds.

*** TABLE 11-6 BASIC MAXIMUM PILE LOADS**

Type of pile	*Basic maximum pile load (tons)*
Caisson piles	No upper limit
Open-end pipe (or tube) piles bearing on rock of classes 1-65, 2-65, and 3-65	18 in. O.D. and greater – 250 less than 18 in. O.D. – 200
Closed-end pipe (or tube) piles, H piles, cast-in-place concrete and compacted concrete piles bearing on rock of classes 1-65, 2-65, and 3-65	150
Piles (other than timber piles) bearing on soft rock (class 4-65)	
1) Displacement piles such as pipe, cast-in-place concrete, and compacted concrete piles	60
2) Non-displacement piles such as open-end pipe and H piles	80
Piles (other than timber piles) bearing on hardpan (class 5-65) overlying rock	100
Piles (other than timber piles) that receive their principal support other than by direct bearing on soils of classes 1-65 to 5-65	60
Timber piles	
Bearing in soils of classes 1-65 to 5-65	25
Bearing in soils of classes 6-65 to 10-65	30

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Annex B2
TABLES IN 2001 NEW YORK CITY BUILDING CODE

B2.1 EXHIBITS

In addition to all the tables listed correspondingly in Annex B1, the following table is added in the 2001 New York City code.

TABLE 10-3.A

Specified compressive strength in twenty-eight days (f 'c) pounds per square inch	*Minimum pounds of cement per cubic yard of concrete*	*Maximum permissible total volume of water, U.S. gallons per cubic yard of concrete*
2000	520	40
2500	560	41
3000	610	42

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Annex B3
TABLES IN 1964 NEW YORK STATE BUILDING CONSTRUCTION CODE

B3.1 EXHIBITS

TABLE C 304-2.2. (I-833)——UNIFORMLY DISTRIBUTED AND CONCENTRATED LIVE LOADS

Occupancy or use	Uniformly distributed loads, psf	Concentrated loads in pounds
C1 Business		
Business machine equipment	100	
Office space	50 [1]	
C2 Mercantile		
Stores, shops for display and sale		
Retail		
On ground floor	100	
On upper floors	75	
Wholesale	120	
C3 Industrial		
Bakeries	150	
Laundries	100	
Manufacturing or processing	125	
Light manufacturing, assembly, etc.	75	
C4 Storage		
Cold Storage		
No overhead system	400	12,000
Overhead system		
Floor	150	2,000
Roof	250	2,000
Light storage	120	
Heavy storage	250	
Paper	[2]	
C5 Assembly		
Assembly halls, auditoriums, balconies, club rooms, dance halls, exhibition halls, grandstands, gymnasiums, lodge rooms, museums, restaurants, shelters for air raids, stadiums, theaters		
Aisles, crossovers, lobbies, vomitories	100	
Main floors, balconies		
Fixed seats	60 [3]	
Movable seats	100	
Dressing rooms	40	
Projection rooms	100	
Stage floors	150	
Colleges, schools (exclusive of dormitories)		
Classrooms	60	
Laboratories	60	
Lecture halls		
Fixed seats	60	
Movable seats	100	
Places of worship		
Fixed seats	60	
Movable seats	100	
C6 Institutional		
Hospitals		
Clinics	60	
Corridors, above first floor	40	
Examination rooms	60	
Laboratories, dark rooms	100	
Operating rooms	60	
Private rooms	40	
Public space	75	
Solariums	60	
Wards	40	
X-ray rooms, transfer rooms, control spaces	100	
Nurseries	40	
Orphanages, infirmaries	40	
Penal institutions, police lockups, reformatories		
Cell blocks	40	
Shops	80	

TABLE C 304-2.2. (I-833)——UNIFORMLY DISTRIBUTED AND CONCENTRATED LIVE LOADS——Continued

Occupancy or use	Uniformly distributed loads, psf	Concentrated loads in pounds
Spaces common to above occupancies		
Air conditioning space	200	2,000
Corridors		
First floor	100	2,000
Other floors	(4)	2,000
Elevator machine rooms	(5)	300
Exitways	100	
Fan rooms	100	
Garages and ramps, open deck parking structures:		
Cars, passenger	50 [6]	2,000 [10]
Busses, trucks, mixed usage	175	12,000 [10]
Incinerator charging floor	100	
Kitchens (other than domestic)	100	
Ladders		250 [11]
Laboratories	100	
Libraries		
Reading rooms	60	
Stacks	(7)	
Lobbies	100	2,000 [12]
Locker rooms	75	
Marquees	60	
Promenades	60	
Rest rooms	60	
Roofs used as promenades	60	
Other roofs	(8)	200
Sidewalks over vaults	300	12,000 [10]
Skylight screens		100 [13]
Stairways	100 [9]	
Terraces, yards, for pedestrians	60	
Toilet rooms	60	
Vaults, in office space	250	2,000
Workshops	80	

[1] Dead load is to be increased by 20 psf for possible shifting of masonry partitions.

[2] 50 psf per foot of clear story height.

[3] Grandstands, 100 psf; see section C 304-9e for horizontal impact loads.

[4] Unless noted elsewhere in this table, 100 psf; corridors within a tenancy not less than occupancy served.

[5] For loads, see section C 304-11.

[6] Where clear height of garage entrance exceeds 7 feet, load for busses, trucks and mixed usage shall be used.

[7] 20 psf per foot of height, with a minimum of 150 psf.

[8] See section C 304-10c for minimum imposed loads for roofs.

[9] Stringers of stairs need be designed only for uniform load.

[10] Or actual wheel load increased 50 per cent for imact, whichever is larger.

[11] Side rails of ladders need be designed only for 80 pounds at center of every rung, applied simultaneously.

[12] For any building where a floor safe may be brought into building.

[13] Skylight screens to have ¾-inch to 1-inch mesh; upper screen to be 4 to 10 inches above glass and to overhang an identical amount. No uniform load need be figured.

TABLE C 304-3. (II-833)——SNOW LOADS [1]
In pounds per square foot

Zone numbers on snow map	Roof slope from horizontal [2]					
	0°	20°	30°	40°	50°	60° or more
20 [4]	20	18	11	6	2	0
25 [4]	25	22	14	7	3	0
30	30	27	17	9	3	0
35	35	31	20	10	4	0
40	40	35	23	12	4	0
45	45	40	25	13	5	0
50	50	44	28	15	5	0
60	60	53	34	18	6	0
70 [3]						
80 [3]						
90 [3]						

[1] For minimum imposed loads, see section C 304-10c.

[2] For slopes between those tabulated, compute loads by straight-line interpolation.

[3] For snow zones 70, 80, and 90 on snow map, use same tabular values as for zone 60.

[4] For snow zones 20 and 25 on snow map, use same tabular values as for zone 30.

SNOW MAP OF NEW YORK STATE

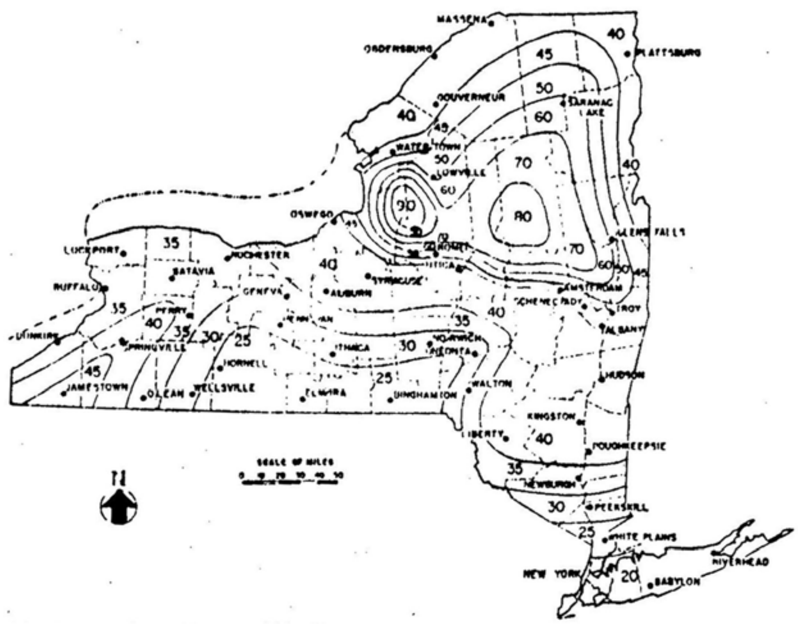

TABLE C 304-4a. (III-833)——WIND LOADS: WALLS, EAVES, CORNICES, TOWERS, MASTS AND CHIMNEYS

In pounds per square foot

At height above grade, in feet	Walls[1]	Eaves and cornices[2]	Towers, masts and chimneys
501 to 600[3]	34	68	60
401 to 500	33	66	58
301 to 400	32	64	56
201 to 300	30	60	53
101 to 200	28	56	49
61 to 100	24	48	42
41 to 60	21	42	37
26 to 40	18	36	32
16 to 25	15	30	26
0 to 15	12	24	21

[1] Exterior walls shall be capable of withstanding wind load on both the interior and exterior surfaces, acting non-simultaneously. Tabular values are for square or rectangular structures. For structures hexagonal or octagonal in plan, use projected area and multiply tabular values by 0.8; for structures round or elliptical in plan, use projected area and multiply values by 0.6. For tents, the wind pressure shall be 10 psf on the projected area.

[2] Load acting upward.

[3] For heights above grade greater than 600 feet, add 1 psf to load for walls for each interval or part of interval of 200 feet above 600 feet; for eaves and cornices, and towers, masts and chimneys, corresponding loads are in proportion to those for walls.

TABLE C 304-4b. (IV-833)——WIND LOADS: ROOFS
In pounds per square foot

Mean elevation of roof above grade level in feet	Direction of load[1]	Slope from horizontal[2]			
		0° to 20°	20° to 30°	30° to 60°	Over 60°
501 to 600[3]	Downward	8	8	8 to 24	24
	Upward	29	29 to 24	24	24
401 to 500	Downward	8	8	8 to 23	23
	Upward	28	28 to 23	23	23
301 to 400	Downward	7	7	7 to 22	22
	Upward	27	27 to 22	22	22
201 to 300	Downward	7	7	7 to 21	21
	Upward	25	25 to 21	21	21
101 to 200	Downward	6	6	6 to 20	20
	Upward	24	24 to 20	20	20
61 to 100	Downward	5	5	5 to 17	17
	Upward	20	20 to 17	17	17
36 to 60	Downward	5	5	5 to 15	15
	Upward	19	19 to 15	15	15
21 to 35	Downward	5	5	5 to 14	14
	Upward	17	17 to 14	14	14
0 to 20	Downward	5	5	5 to 11	11
	Upward	14	14 to 11	11	11

[1] Downward and upward loads act non-simultaneously.
[2] For slopes between 20° and 30° with wind acting upward, and between 30° and 60° with wind acting downward, compute loads by straight-line interpolation.
[3] For heights above grade greater than 600 feet, add 1 psi to upward load for 0° to 20° slope for each interval or part of interval of 200 feet above 600 feet; for upward loads on other slopes, and downward loads on all slopes, corresponding loads are in proportion to those for upward load for 0° to 20° slope.

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Annex B4
TABLES IN 1967 CHICAGO MUNICIPAL CODE

B4.1 EXHIBITS

TABLE 68-4.1. MINIMUM DESIGN WIND PRESSURES FOR BUILDINGS AND OTHER STRUCTURES.

	Height Zone (feet)	*Wind Pressure (lbs. per sq. ft.)*
Buildings	Less than 300	20
	Above 300	Add 0.025 lb. per foot for each foot above 300
Towers, Tanks and Chimneys	Less than 200	20
	Above 200	Add 0.025 lb. per foot for each foot over 200
Solid Signs	Less than 100	30
	Above 100	Add 0.025 lb. per foot for each foot above 100
Open Signs	For all heights	Increase wind pressure established for solid signs by 1/3

TABLE 70-2.4 (a). BEARING VALUES OF SOILS

Type of Soil	*Maximum Pressure Pounds per Square Foot*
Sand—compact and clean	5,000
Sand—silty and compact	3,000
Inorganic silt—compact	2,500
Clay—very soft	500
Clay—soft	1,500
Clay—stiff	2,500
Clay—tough	3,500
Clay—very tough	4,500
Clay—hard	6,000
Gravel	6,000
Hardpan	12,000
Solid rock	200,000
Organic soil	0
Filled ground or loam	500

TABLE 72-2 (A).

MAXIMUM ALLOWABLE UNIT STRESSES

(POUNDS PER SQUARE INCH)

Species and Commercial Grade	Extreme fiber stress and tension parallel to grain (ft.)	Horizontal Shear (v)	Compression across grain (f'c)	Compression parallel to grain** (fc)	Modulus of Elasticity E
Cypress	1300	120	300	900	1,200,000
Douglas Fir	1300	100	325	1200	1,600,000
Plywood (Fir)					
Built up Section	1500	100 35*	400	1500	1,600,000
Laminated Timber	1100	75	400	1500	1,600,000
Hemlock	1000	90	350	1100	1,400,000
Oak	1300	120	600	1000	1,500,000
Redwood	1100	75	300	1000	1,200,000
Southern Pine					
Longleaf	1300	120	450	1000	1,600,000
Shortleaf	1100	120	400	900	1,600,000
Spruce					
Sitka or Eastern	1000	75	300	800	1,200,000

*Shear in plane of piles. **For L/D of eleven or less.

Annex B5
TABLES IN 1965 BOCA BASIC BUILDING CODE

B5.1 EXHIBITS

TABLE 13.—MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

Use	Pounds per square foot
Alleys, driveways, yards and terraces	
Pedestrian	100
Vehicular	250
Armories and drill rooms	150
Assembly:	
Fixed seats	60
Removable or no seats	100
Balcony (exterior)	100
Bowling alleys, pool rooms and similar recreational areas	75
Class Rooms	60
Fixed seats	60
Removable seats	100
Cornices	75
Corridors:	
Hotels, hospitals and multi-family dwellings	60
One- and two-family dwellings	40
Serving public rooms in hotels	100
Corridors and entrance hallways other than residential buildings	100
Corridors (other than those specifically designated):	
Private	Same as occupancy served.
Public	100
Court rooms	100
Dance halls and gymnasiums	100
Dwellings:	
Dwelling units (Multi-family dwellings)	40
First floor	40
Second floor and habitable attic	30
Uninhabitable attics	20(c)
Elevator machine rooms	100
Garages and stables, passenger cars not exceeding, 6,000 lbs. wt.	75
Garages, buses and trucks not exceeding 20,000 lbs. wt.: (b)	
Columns, beams and girders	120
Floor slabs	175
Grandstands, reviewing stands and bleachers	100
Hospitals:	
Operating rooms	60
Private rooms	40
Wards	40
Libraries:	
Reading rooms	60
Stack rooms	150(a)
Loft buildings and light manufacturing	125
Manufacturing:	
Heavy	Not less than actual loads.
Light (See Loft buildings . . .)	
Marquees	75
Office buildings:	
Lobbies	100
Rooms	50
Penal institutions: cell blocks	40
Parking structures, passenger cars only:	
Parts of floor accessible to wheel loads	75
Parts of floor not accessible to wheel loads	50
Restaurants and public dining rooms	100
Reviewing stands and bleachers (See Grandstands . . .)	
Sidewalks	250
Skating rinks	75
Stairs, fire escapes and exitways	100
Storage warehouse:	
Heavy	250
Light	125
Stores and shops:	
Retail, and banking rooms	100
Grade floor	75
Upper floors	125
Wholesale	
Theatres:	
Aisles, corridors and lobbies	100
Balconies	60
Orchestra floors	60
Stage floors	150

Note a. Minimum 150 lb./sq. ft. but not less than actual weight of loaded shelves.
Note b. For garages for vehicles exceeding 20,000 lbs. wt.: See sec. 707.2.
Note c. Live load need be applied to joists or to bottom chords of trusses or trussed rafters only in those portions of attic space having a clear height of forty-two (42) inches or more between joist and rafter in conventional rafter construction; and between bottom chord and any other member in trussed or trussed rafter construction. However, joists or the bottom chords or trusses or trussed rafters shall be designed to sustain the imposed dead load or ten pounds per square foot (10 p.s.f.), whichever be greater, uniformly distributed over the entire span.

TABLE 14.—CONCENTRATED LOADS

Location	Pounds
Elevator machine room grating (on area of 4 sq. in.)	300
Finish light floor plate construction (on area of 1 sq. in.)......	200
Garages, pleasure cars	2000
Garages, trucks (not less than 150 per cent maximum wheel load)	——
Office floors	2000
Scuttles and skylight ribs	200
Sidewalks	8000
Stair treads (on center of tread)	300

Exhibit B5-1 External Wind Pressure on Roofs

EXTERNAL WIND PRESSURE ON ROOFS

Ratio of Side-wall Height to Building Width	Flat Roofs	Windward Slope of Roofs				Leeward Slope
		Less than 1:12	1:12 to 4.05:12	4.05:12 to 6:12	6:12 to 12:12	All Slopes
0.2	—.60	—.60	—.06	.12	.19	—.50
0.4	—.60	—.60	—.33	.01	.09	—.50
0.6	—.60	—.60	—.49	—.20	—.06	—.50
0.8	—.60	—.60	—.57	—.30	—.18	—.50
1.0 or more	—.60	—.60	—.60	—.39	—.28	—.50

For all roof surfaces having a slope greater than 12:12 the same wind forces as for vertical surfaces shall be assumed.

TABLE 15.—PRESUMPTIVE SURFACE BEARING VALUES OF FOUNDATION MATERIALS

Class of material	Tons per square foot
1—Massive crystalline bed rock including granite, diorite, gneiss, trap rock, hard limestone and dolomite	100
2—Foliated rock including bedded limestone, schist and slate in sound condition	40
3—Sedimentary rock including hard shales, sandstones, and thoroughly cemented conglomerates	25
4—Soft or broken bed rock (excluding shale), and soft limestone .	10
5—Compacted, partially cemented gravels, and sand and hardpan overlying rock	10
6—Gravel and sand-gravel mixtures	6
7—Loose gravel, hard dry clay, compact coarse sand, and soft shales	4
8—Loose, coarse sand and sand-gravel mixtures and compact fine sand (confined)	3
9—Loose medium sand (confined), stiff clay	2
10—Soft broken shale, soft clay	1.5