Generic Stucco

Product Selection and Description

Stucco is cement plaster that can be used to cover exterior wall surfaces. Both portland cement and masonry cement are used for the base and finish coats of stucco exterior walls. The densities of the different types of stucco coats for portland cement (for a base coat Type C plaster, finish coat Type F plaster) and masonry cement (for a base coat Type MS plaster, finish coat Type FMS plaster) are shown in the Table below. Since no data on relative market shares of portland cement and masonry cement stucco were available, life cycle data for the two stucco types were averaged for use in the BEES model. Thus, each generic stucco coat (base or finish) is represented by an average of the corresponding portland cement and masonry cement coats.

Table 1: Density of Stucco by Type

Type of Stucco	*Density kg/m^3 (lb/ ft^3)*
Portland Cement Base Coat C	1 830 (114.18)
Portland Cement Finish Coat F	1 971 (122.97)
Masonry Cement Base Coat MS	1 907 (118.98)
Masonry Cement Finish Coat FMS	2 175 (135.69)

The BEES model assumes a functional unit of 1 ft^2 of stucco applied to a frame construction (stucco applied over metal lath). This generally requires a 3-coat covering totaling 2.22 cm (7/8 in) in thickness. Coats 1 and 2 are each 0.95 cm (3/8 in) thick and the finish coat is 0.32 cm (1/8 in) thick.

Flow Diagram

The flow diagrams that follow show the major elements of the production of portland cement stucco and masonry cement stucco exteriors.

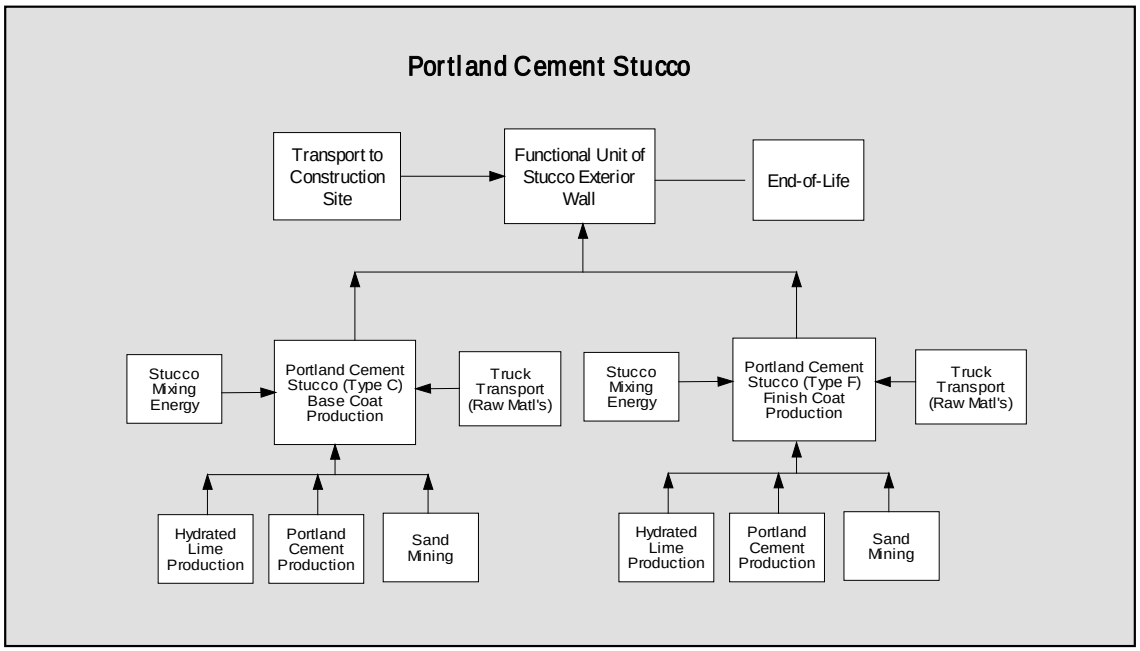

Figure 1: Portland Cement Stucco System Boundaries

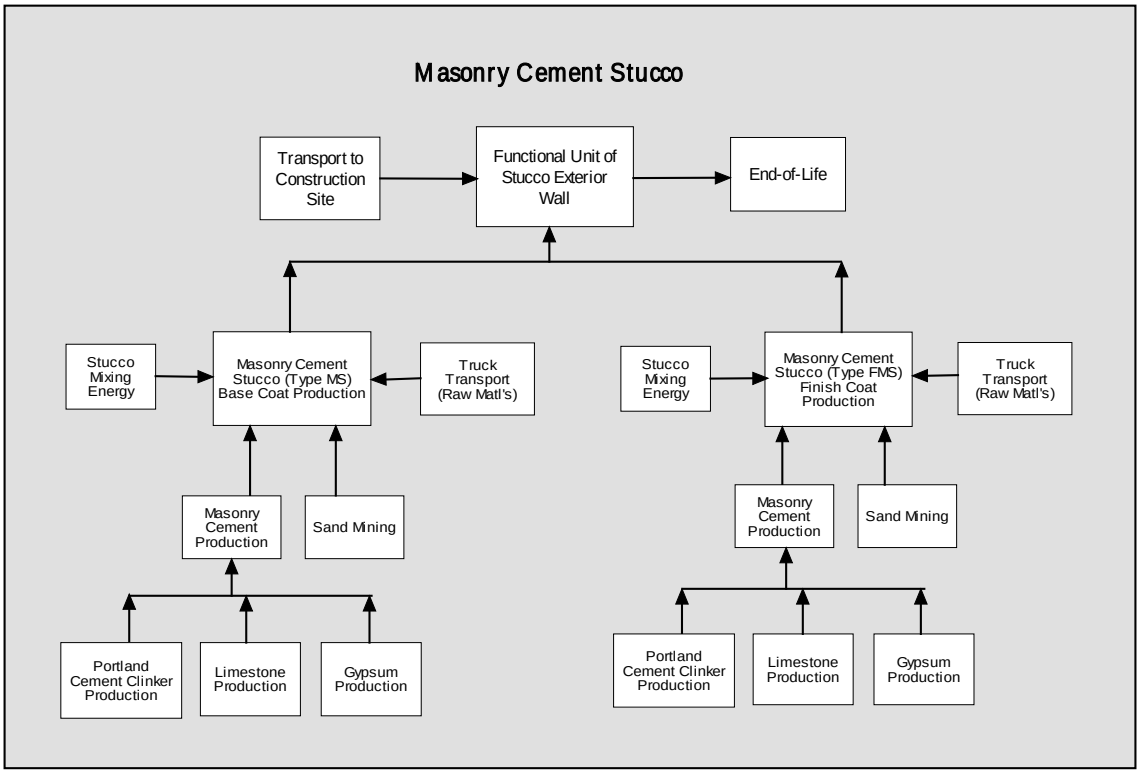

Figure 2: Masonry Cement Stucco System Boundaries

Raw Materials

The material composition of portland cement and masonry cement base coat and finish coat stuccos is shown in the following Table.[1]

Table 2: Stucco Constituents

Constituent	***Cementitious Materials (volume fraction)***			***Sand (volume fraction of cementitious material)***
	Portland Cement	***Masonry Cement***	***Lime***	
Base Coat C	1		1.125	3.25
Finish Coat F	1		1.125	3
Base Coat MS		1		3.25
Finish Coat FMS		1		3

Masonry Cement Production. The raw material use for masonry cement is based on Type N masonry cement, and its constituents are shown below.

Table 3: Masonry Cement Constituents

Constituent	***Mass Fraction (%)***
Portland Cement Clinker	50.0
Limestone	47.5
Gypsum	2.5

[1] Based on ASTM Specification C926-94.

Production of raw material inputs for masonry cement (limestone and gypsum) and stucco (sand and lime) are based on data from the U.S. LCI Database and the SimaPro database. The energy requirements for masonry cement production are based on the energy required to grind and mix the masonry cement constituents, as follows.

Table 4: Energy Requirements for Masonry Cement Manufacturing

Fuel Use	*Manufacturing Energy*
Electricity	0.196 MJ/kg (409.55 Btu/lb)

The only emissions from masonry cement production, aside from those due to the production of the portland cement, are CO_2 emissions from the additional lime used to make the masonry cement. According to the U.S. Greenhouse Gas Inventory:[2]

> "During the cement production process, calcium carbonate ($CaCO_3$) is heated in a cement kiln at a temperature of about 1 300 ^oC (2 400 ^oF) to form lime (i.e., calcium oxide or CaO) and CO_2. This process is known as calcination or calcining. Next, the lime is combined with silica-containing materials to produce clinker (an intermediate product), with the earlier by-product CO_2 being released to the atmosphere. The clinker is then allowed to cool, mixed with a small amount of gypsum, and used to make portland cement. The production of masonry cement from portland cement requires additional lime and, thus, results in additional CO_2 emissions. Masonry cement requires additional lime over and above the lime used in clinker production. In particular, nonplasticizer additives such as lime, slag, and shale are added to the cement, increasing its weight by approximately five percent."

In the BEES model, lime accounts for approximately 47.5 % percent of the added weight. An emission factor for this added lime can then be calculated by multiplying this value by the emission factor for lime calcining, resulting in a factor of 0.44 kg (0.97 lb) CO_2 per kg lime. The following Table reports the final CO_2 emission factor in terms of emissions per kg masonry cement produced.

Table 5: Emissions from Masonry Cement Manufacturing

Air Emission	*Emission Factor per kg Masonry Cement*
Carbon Dioxide (CO2)	0.0209 kg (0.0461 lb)

Portland Cement Production. BEES documentation on the production of portland cement can be found under Generic Portland Cement Concrete Products.

Transportation. A small percentage of the above raw materials, assumed to be 10 %, may be transported more than 3 219 km (2 000 mi). When this is the case, transport is assumed to be by rail. Otherwise, transport is assumed to be an average of 322 km (200 mi), by truck.

Manufacturing
Stucco is "manufactured" at the point of use of the material. See the section below on "Installation."

Transportation
The stucco raw materials are transported to the building site via diesel truck. The distance transported is a

[2] U.S. Environmental Protection Agency, "Cement Manufacture (IPCC Source Category 2A1)," Chapter 4.2, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004*. (Washington, DC: U.S. Environmental Protection Agency, April 2006). pp. 4-8 to 4-9.

variable in the BEES model.

Installation

Stucco is assumed to be mixed in a 5.9 kW (8 hp), gasoline powered mixer with a stucco flow rate of 0.25 m^3/h (9 ft^3/h), running for 5 min. The stucco is applied manually to the building, so no energy or environmental impacts are assumed at this installation step. A small amount of waste, approximately 1 %, is assumed to be generated during the installation process.

A lath made of 100 % recycled steel may be used as a surface for the applied stucco. The amount of steel used per surface area of stucco applied varies according to application. Lath is used on wood and metal frame walls; typically 0.15 kg (1/3 lb) is used per ft^2 of wall area.

While sheathing, weather resistive barriers, and other ancillary materials may be required to complete the exterior wall system, these materials are not included in the system boundaries for BEES exterior wall finishes.

Use

With general maintenance, a properly installed stucco exterior will have a useful life of 100 years. Maintenance will vary greatly with weather conditions, but is usually minimal. Crack repairs are done manually. Maintenance is not included within the boundaries of the BEES model.

End of Life

Approximately one-third of U.S. stucco production is used in commercial projects, typically over masonry or steel studs. At end of life, it is assumed that stucco and lath installed on commercial buildings in urban areas are recycled. No data are available on recycling of stucco or lath from residential applications; it is assumed that none of this residential material is recycled.

References

Life Cycle Data

National Renewable Energy Laboratory (NREL): *U.S. Life-Cycle Inventory Database*. 2005. Golden, CO. Found at: http://www.nrel.gov/lci/database.

PRé Consultants: *SimaPro 6.0 LCA Software*. 2005. The Netherlands.

U.S. Environmental Protection Agency, "Cement Manufacture (IPCC Source Category 2A1)," Chapter 4.2, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004*. (Washington, DC: U.S. Environmental Protection Agency, April 2006). pp. 4-8 to 4-9

Industry Contacts

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