Asphalt with GSB88 Seal-Bind Maintenance

Product Selection and Description

The design of an asphalt parking lot pavement is dependent on the projected weight of traffic, the soil conditions at the site, and environmental conditions. Common asphalt parking lots consist of between 5 cm and 10 cm (2 in and 4 in) thick Hot-Mix Asphalt (HMA), which contains, on average, 15 % Recycled Asphalt Pavement (RAP). RAP is obtained from the millings of HMA surface lots or roadways and is typically hauled back to the HMA plant for reuse. The HMA pavement material is typically placed over a 15 cm (6 in) crushed aggregate base. In colder climates, additional fill material that insulates against frost-susceptible soils may be added below the base aggregate. The maintenance product assessed for this BEES paving alternative is GSB88 Emulsified Sealer-Binder produced by Asphalt Systems, Inc. of Salt Lake City, Utah. GSB88 Emulsified Sealer-Binder is a high-resin-content emulsifier made from naturally occurring asphalt and is applied to base asphalt every four years to prevent oxidation and cracking.

For the BEES asphalt parking lot model, a 0.09 m^2 (1 ft^2) surface with 8 cm (3 in) thick paving is studied. The amount of material used is 16.4 kg (36.2 lb) of HMA, 30.6 kg (67.5 lb) of crushed stone, and 12 installments of the GSB88 sealer-binder, at 0.374 kg (0.82 lb) each, over 50 years.

Flow Diagram

The flow diagram below shows the major elements of the production of this product system as it is currently modeled for BEES.

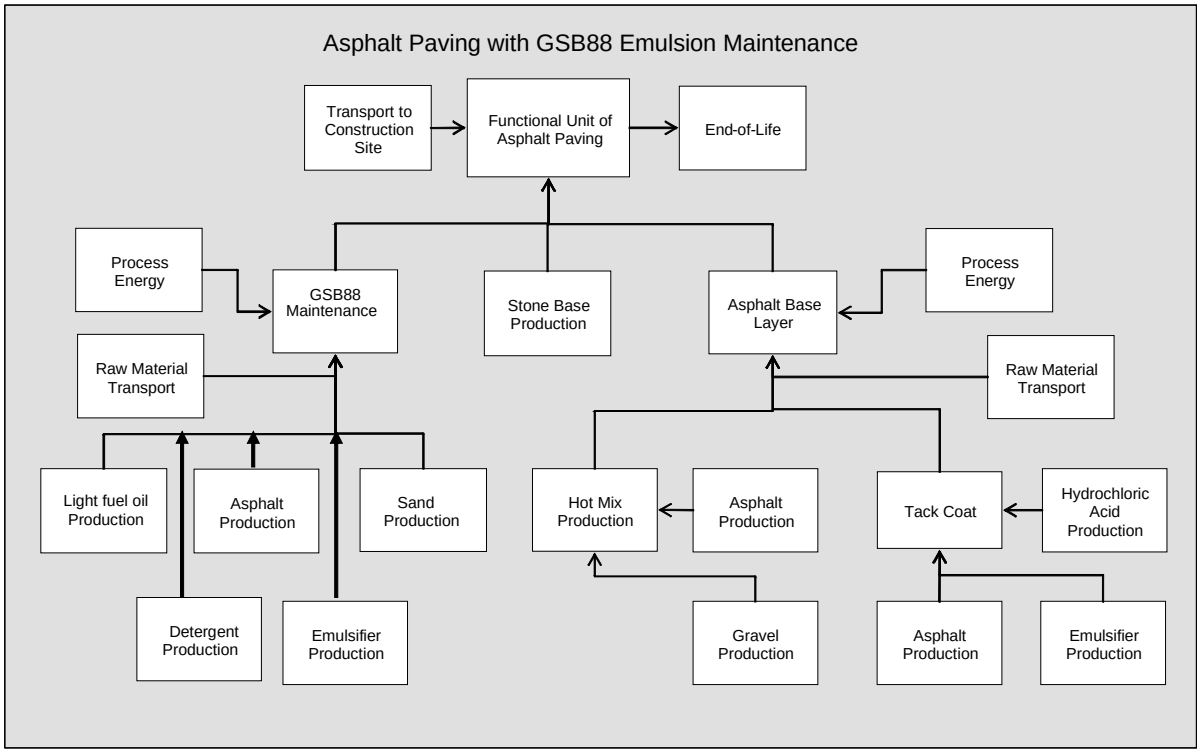

Figure 1: Asphalt Paving with GSB88 Emulsified Sealer-Binder Maintenance System Boundaries

Raw Materials

The composition of asphalt paving is shown in the Table below, and the production of its raw materials is based on data from both the U.S. LCI Database and the SimaPro database. The 15 % RAP in HMA reduces virgin asphalt binder requirements (by approximately 1 %) and reduces crushed stone (aggregate) amounts by approximately 14 %. The emulsifier is composed of asphalt with water and a small amount of surfactant.

Table 1: Hot Mix Asphalt Constituents

Constituent	*Mass Fraction (layer)*	*Mass Fraction (components)*
Hot Mix Asphalt	**99.5 %**	--
Gravel		81 %
Asphalt binder		4 %
RAP		15 %
Tack Coat	**0.5 %**	--
Asphalt		66 %
Water		33 %
Emulsifier		1.1 %
HCl		0.2 %

Raw materials used in the GSB88 sealer-binder include water, asphalt, sand, light fuel oil, detergent, emulsifier, and hydrochloric acid (HCl).[1] These materials, too, are based on data from the U.S. LCI Database and the SimaPro database.

Manufacturing

Energy Requirements and Emissions. The energy requirements for HMA production are provided in the Table below, and represent a weighted average of requirements for production in counterflow drum (85 %) and batch mix (15 %) plants.

Table 2: Energy Requirements for Hot Mix Asphalt Production

Energy Carrier	*MJ/kg (Btu/lb)*
Diesel	0.017 (7.3)
Natural Gas	0.29 (124.7)
Total	**0.307 (132)**

Emissions from the production of the upstream, or raw, materials and energy carriers are from the U.S. LCI Database. Emissions associated with the manufacture of asphalt are based on U.S. EPA AP-42 emission factors. The primary emissions from HMA production are particulates (PM) and volatile organic compounds (VOC); these are averaged on a weighted basis between counterflow drum (85 %) and batch mix (15 %) production technologies, as shown below.

Table 3: Emissions from Hot Mix Asphalt Production

Production Process	*PM g/kg (lb/ton)*	*VOC g/kg (lb/ton)*
Counterflow Drum	0.07 (0.14)	0.016 (0.032)
Batch Mix	0.0225 (0.45)	0.0041 (0.0082)
Weighted average	**0.0629 (0.1258)**	**0.0143 (0.02843)**

Transportation. Transport of the HMA raw materials to the production site is accomplished by trucking, over an average distance of 48 km (30 mi).

Waste. The manufacturing process generates no waste materials as all materials are utilized in the HMA

[1] Detailed information on product composition is not provided to protect manufacturer confidentiality.

pavement.

Transportation
Transport of HMA by heavy-duty truck to the construction site is modeled as a variable of the BEES system.

Installation
New asphalt pavements are placed directly on graded and compacted aggregate base or subgrade. A truck carrying HMA paving material from the plant backs up to a paver and dumps the material into a hopper or a material transfer vehicle, which agitates the asphalt mix to keep the aggregate from segregating and to help ensure a uniform temperature. The paver lays a smooth mat of material, then a series of compactors make the material more dense. These compactors may include vibratory or static steel wheel rollers or rubber tire rollers. If multiple layers are placed or the parking lot is overlaid, the pavement surface is cleaned (typically by brooming) and then a distributor truck puts down a tack coat. The energy requirements for installation of an asphalt parking lot are provided in the following Table, with all diesel data based on the U.S. LCI Database.

Table 4: Energy Requirements for Asphalt Pavement Installation

Installation Process	*Energy Carrier*	*MJ/ft^2*
Site Preparation and Stone Base Placement	Diesel Equipment	0.7
Asphalt Binder Course Installation	Diesel Equipment	0.96
Asphalt Wearing Course Installation	Diesel Equipment	0.48
	Total	**2.14**

Use
Asphalt parking lot pavement is assumed to have a useful life of at least 50 years with application of GSB88 sealer-binder maintenance every 4 years. The energy required for each maintenance application is provided in the following Table.

Table 5: Energy Requirements for GSB88 Sealer-Binder Maintenance

Maintenance Process	*Energy Carrier*	*MJ/ft^2*
GSB88 Sealer-Binder Application	Diesel Equipment	9.45 E-4

End of Life
At end of life, asphalt paving is typically overlaid rather than replaced if the land is going to remain in use as a parking lot. The HMA is generally removed and recycled, however, if the land is going to be used for a different purpose. For BEES, the product is removed at end of life.

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, "Hot Mix Asphalt Plants," Volume I: Section 11.1, *AP-42: Compilation of Air Pollutant Emission Factors*, (Washington, DC: U.S. Environmental Protection Agency, April 2004). Found at: http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s01.pdf.

Industry Contacts
Howard Marks, Director of Regulatory Affairs, National Asphalt Paving Association (2005)
Mr. Gail Porritt, Asphalt Systems, Inc. (2002)