

ASPHALT CHEMISTRY

Highway and Transportation Engineering

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First Class
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Lecture 1

Definitions and Classification of Asphalt

Definitions

The Dictionary Definition

Asphalt: A bituminous substance, found in many parts of the world, a smooth, hard, brittle, black or brownish-black resinous mineral, consisting of a mixture of different hydrocarbons; called also mineral pitch, Jew's pitch and in the Old Testament 'slime'.

Oxford English Dictionary

Bitumen: Originally, a kind of mineral pitch found in Palestine and Babylon, used as mortar, etc. The same as asphalt, mineral pitch, Jew's pitch, Bitumen Judaicum.

- In modern scientific use, the generic name of certain inflammable substances, native hydrocarbons more or less oxygenated, liquid, semi-solid and solid, including naphtha, petroleum, asphalt, etc. Elastic Bitumen: Mineral Caoutchouc or Elaterite.

Oxford English Dictionary

Bituminous materials: a class of black or dark-colored (solid, semi-solid or viscous) cementitious substances, natural or manufactured, composed

principally of high molecular weight hydrocarbons, of which asphalts, tars, pitches, and asphaltites are typical.

ASTM D8-97-2000

Asphalt: A natural or artificial mixture of bitumen with mineral matter

Bitumen: The heaviest fraction of petroleum; it can be petroleum bitumen or natural bitumen

RILEM Technical Committees, 1992 (Organic Binders)

Asphalt: is a substance that causes particles of sand, gravel and crushed stone to stick together to form a pavement.

Highway Engineer

(Straight run) Asphalt (with the exception of natural asphalt) is a residue of petroleum or a product of solvent extraction of petroleum. It is a complex mixture of thousands of different organic compounds mutually dissolved or dispersed.

Petroleum Chemist

And Finally the Correct Statement about Bitumen

The word bitumen may, therefore, be strictly defined as a generic term that is used to designate a class of minerals as they occur in nature . . .

They all consist principally of compounds of carbon and hydrogen, but often contain compounds of nitrogen, sulphur and oxygen, and in the solid forms, compounds of iron and alumina.

Peckham (1895), Chemist, Department of Finance, City of New York.

Why Two Different Names, Bitumen and Asphalt?

- In Europe, asphalt means a mixture of aggregates and bitumen. (Lake Asphalt in Trinidad!!!)
- In North America, asphalt means bitumen.



Hard (Low penetration)



Soft (High penetration)

Background

Asphalt is a complex mixture of many different hydrocarbons. The asphalt constituents are classified into three categories: Oils; Resins; and Asphaltenes.

1. Oils are the light compounds in asphalt which have the lowest molecular weights (24-800) and have a large number of side chains and few rings. Accepted criteria for the oil classification are molecules with carbon/hydrogen atom number ratios less than 0.6 that are soluble in hexane.
2. Resins are intermediate molecular weights compounds (800-2000). It is important to note that resins can contain sulfur and nitrogen. Resins are polar, have a carbon/hydrogen ratio between 0.6-0.8 and are soluble in light petroleum naphtha.
3. Asphaltenes are the highest molecular weights compounds (1800-8000) with aromatic ring structures, few side chains and carbon/hydrogen ratio greater than 0.8. Asphaltenes contain the trace elements which may react with potential polymers and are soluble in carbon-tetrachloride. An average asphalt sample has an asphaltenes/resin/oil weight ratio of approximately 23/27/50 as example and asphaltene content is higher for harder asphalts.

The engineering properties of asphalt binders are directly related to the quantity and the quality of asphaltenes percent and the nature of the dispersion medium, oils and resins.

Uses of Bitumen from Prehistoric to Modern times -Pavements

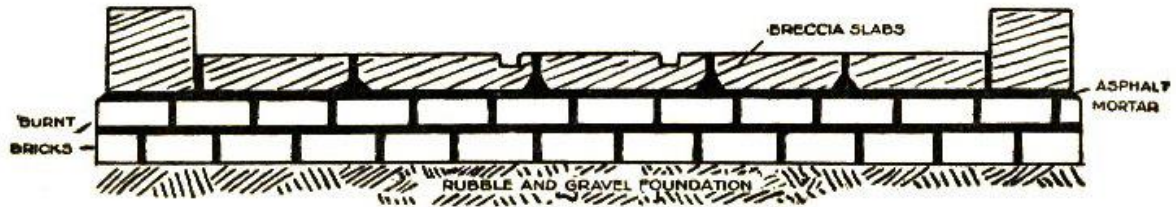


Fig. 10.
Processional road in Temple of Ishtar at Assur (1 : 40).

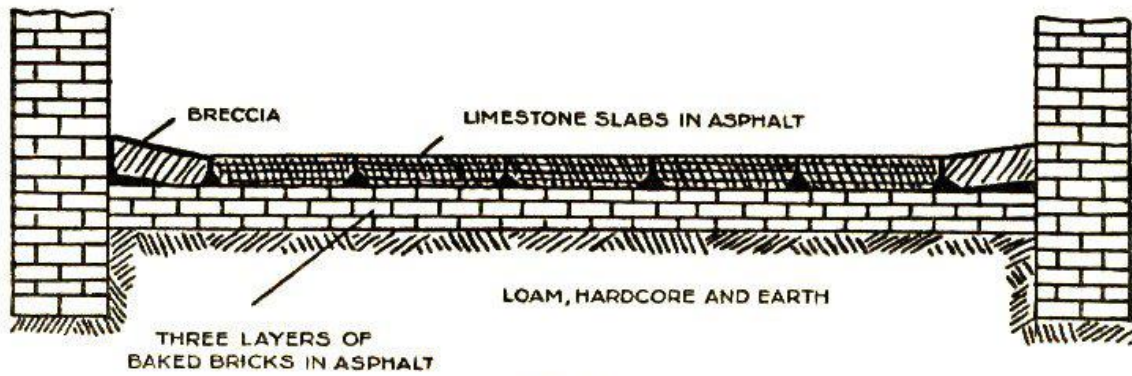
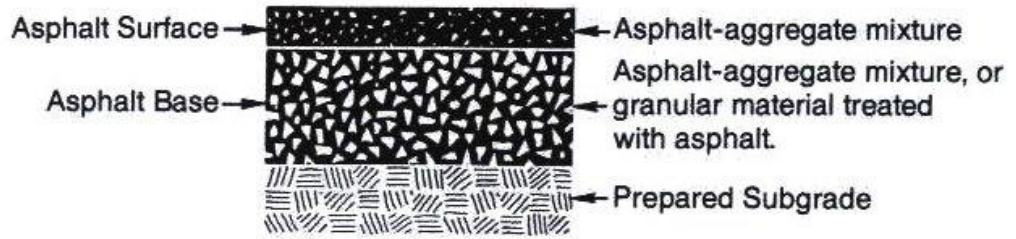


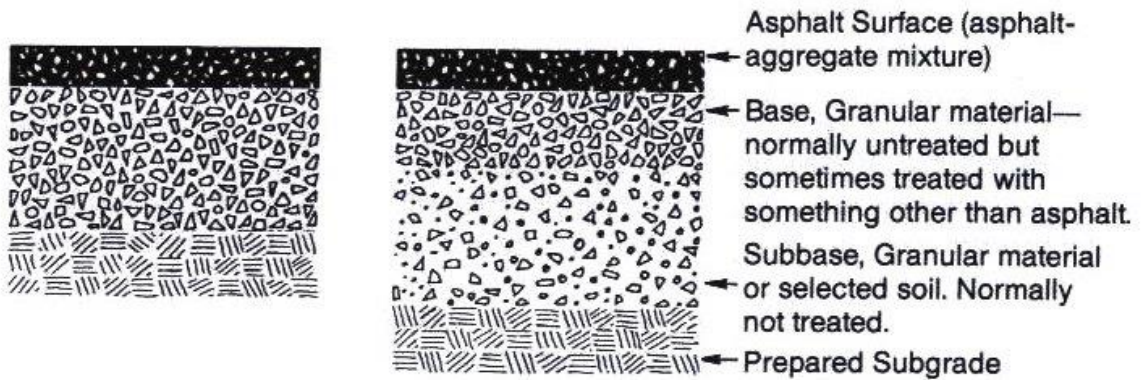
Fig. 11.
Processional road "Aiburshabu" in Babylon (1 : 60).

Uses of Bitumen from Prehistoric to Modern times – A typical pavement cross-section used now

Full-Depth Asphalt Pavement



Asphalt Pavement With Untreated Base (and Subbase)



Asphalt Pavement With Portland Cement Concrete or Combined Portland Cement Concrete and Asphalt Base

