6.1 Bituminous materials

Bituminous materials

- Highway pavements are constructed of either **asphaltic concrete** or **Portland cement concrete** and ultimately rest on native soil.
- **Bituminous materials** are used widely all over the world in highway construction
  - These hydrocarbons have adhesive properties.
  - They are found in **natural deposits** or are obtained as a product of the **distillation of crude petroleum** as other organic materials.
  - The bituminous materials used in highway construction are either <u>asphalts</u> or <u>tars</u>.

Bituminous materials

- **Tars** are resides from the destructive distillation of organic substance such as coal.
  - Tars are not nowadays used extensively as binders for highway pavements.
- **Asphaltic** materials are obtained from
  - Seeps or pools of **natural deposits** or
  - as a product of the **distillation of crude petroleum**.

Bituminous materials

- **Sources of Asphalt:**
  1. **Natural deposits**
     » It occur as either native asphalt or rock asphalt.
     » The largest deposit of native asphalt is known to have existed in Iraq several thousand years ago**.**
     » The largest natural deposit of bitumen in the world is the Pitch Lake of southwest Trinidad
     a. **Native asphalt:**
        - It was at one time used extensively as binders in highway construction.
     b. **Rock asphalt:**
        - It is a natural deposit of sandstone or limestone rocks filled with asphalt.

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Bituminous materials

2. **Petroleum Asphalt**

» The asphaltic materials obtained from the distillation of petroleum are in the form of different types of asphalts including:

- Asphalt cements, slow-curing liquid asphalts, medium-curing liquid asphalts, rapid-curing liquid asphalts and asphalt emulsions.

» The quantity of asphalt obtained from crude petroleum is dependent on **the American Petroleum Institute (API) gravity of the petroleum**.

» Crude petroleum with Low API gravity has large quantities of asphalt

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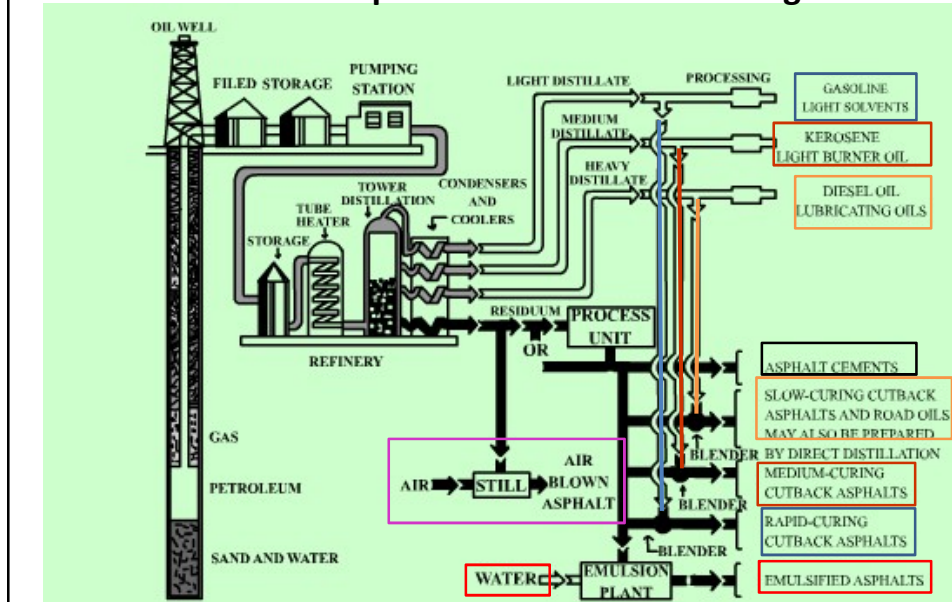
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Petroleum Asphalt / Refining Processes

- It can be divided into two main groups
  - Fractional distillation
  - Destructive distillation (cracking)

1. **Fractional distillation** processes involve the separation of the different materials in the crude petroleum without significant changes in the chemical composition of each material.

  - It removes the different volatile materials in the crude oil at successively higher temperatures until the petroleum asphalt is obtained as residue.

    » Steam or a vacuum is used to gradually increase the temperature.

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Petroleum Asphalt / Refining Processes

A Schematic Example of a Petroleum Distilling Plant

Petroleum Asphalt / Refining Processes

2. **Destructive distillation.** Cracking processes are used when larger amounts of the light fractions of materials (such as motor fuels) are required.

   – Intense heat and high pressures are applied to produce chemical changes in the material.

   – The asphalt obtained from cracking is not used widely in paving,

     • because it is more susceptible to weather changes than that produced from fractional distillation.

Types and Uses of Bituminous Binders

- **It is necessary to describe the different bituminous binders and identify the type of construction for which each is used.**
- Bituminous binders can be classified into:
  - **Asphalt cement,**
  - **Asphalt cutbacks,**
  - **Emulsified asphalt.**
- **Blown asphalt and road tars** are also other types of bituminous material that now are not used commonly in highway construction.

Types and Uses of Bituminous Binders

1. **Asphalt cements**
   » These are obtained after separation of lubricating oils.
   » They are <u>semisolid hydrocarbons</u> with certain physiochemical characteristics that make them good cementing agents
   » They are <u>very viscous</u>
   » When used as a binder for aggregates in pavement construction, it is necessary to <u>heat</u> both the aggregates and the asphalt cement prior to mixing the two materials

Types and Uses of Bituminous Binders

1. Asphalt cements

» The design of asphalt cement is dependent on its <u>penetration and viscosity</u>.

• Both of give an indication of the <u>consistency</u> of the material at a given temperature.

» The penetration is the distance in 0.1mm that a standard needle will penetrate a given sample under specific conditions of loading, time, and temperature.

The softest grade used for highway pavement construction has a penetration value of 200 to 300

Penetration Test for Bituminous Materials (Asphaltic Cement)

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Types and Uses of Bituminous Binders

1. Asphalt cements

Table 4.1 Typical Uses of Asphalt

Typical Uses of Asphalt — Type Of Construction	Viscosity Graded-Original					Viscosity Graded-Residue					Penetration Graded				
	AC-40	AC-20	AC-10	AC-5	AC-2.5	AR-16000	AR-8000	AR-4000	AR-2000	AR-1000	40-50	60-70	85-100	120-150	200-300
Asphalt-Aggregate Mixtures															
Asphalt Concrete and Hot Laid Plant Mix															
Pavement Base and Surfaces															
Highways		X	X	X	X	X	X	X	X	X		X	X	X	X
Airports		X	X	X			X	X				X	X	X	
Parking Areas		X	X			X	X	X				X	X		
Driveways		X	X				X	X				X	X		
Curbs	X	X	X			X	X				X	X	X		
Industrial Floors	X	X				X	X				X	X			
Blocks	X										X				
Groins	X	X									X	X			
Dam Facings	X	X									X	X			
Canal and Reservoir Linings	X	X									X	X			

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Types and Uses of Bituminous Binders

2. Asphalt Cutbacks

» They are used mainly in cold-laid plant mixes, road mixes (mixed-in-place), and as surface treatments.

A) *Slow-Curing Asphalts* (SC)

» It can be obtained directly as slow-curing straight run asphalts through the distillation of crude petroleum, or "cutting back" asphalt cement with a heavy distillate **such as diesel oil**.

» They have <u>lower viscosities</u> than asphalt cement and are very slow to harden.

Types and Uses of Bituminous Binders

2. Asphalt Cutbacks

A) *Slow-Curing Asphalts* (SC)

» Slow-curing asphalts usually are designated as SC-70, SC-250, SC-800, or SC-3000,

• where the numbers relate to the approximate kinematic viscosity in centistokes at 60C (140F).

Saybolt Viscosity Test (Petroleum Products at Specified
Temperatures between 70° and 210° F)

Types and Uses of Bituminous Binders

2. **Asphalt Cutbacks**

B) *Medium-Curing Cutback Asphalts (MC)*

» These asphalts are produced by fluxing, or cutting back, the residual asphalt with **light fuel oil or kerosene**.

» **The term medium refers to the medium volatility (تطاير) of the kerosene-type diluter used**.

» Medium-curing asphalts harden faster than slow-curing liquid asphalts

» It can be used for the construction of pavements bases, surfaces, and surface treatments

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Types and Uses of Bituminous Binders

2. **Asphalt Cutbacks**

C) *Rapid-Curing Cutback Asphalts (RC)*

» It is produced by blending asphalt cement with a petroleum distillate that will easily evaporate (**Gasoline**)

• to facilitate a quick change from the liquid at time of application to the consistency of the original asphalt cement.

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Types and Uses of Bituminous Binders

3. Emulsified Asphalts

» **These are produced by breaking asphalt cement, usually of 100-250 penetration range, into minute particles and dispersing them in the water with an emulsifier.**

» In general Asphalt emulsions therefore consist of:

- asphalt, which make up about 55% to 70% by weight
- water
- an emulsifying agent, which in some cases may contain a stabilizer

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Types and Uses of Bituminous Binders

3. Emulsified Asphalts

» These minute particles have like electrical charges and therefore do not coalesce (تكتل).

» **Asphalt emulsions generally are classified as anionic (-), cationic (+), or nonionic(neutral).**

» The anionic and cationic asphalts generally are used in highway maintenance and construction,

- although it is likely that the nonionics may be used more frequently in the future

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Types and Uses of Bituminous Binders

3. Emulsified Asphalts

» Each of these categories is further divided into:

- **rapid-setting (RS),**
- **medium-setting (MS),**
- **slow-setting (SS).**

» **A cationic emulsion is identified by placing the letter "C".** **Example → CRS-2**

Types and Uses of Bituminous Binders

3. Emulsified Asphalts

» **Emulsified asphalts are used in <u>cold-laid</u> plant mixes and road mixes** (mixed-in- place) for several purposes, including

- the construction of highway pavement surfaces and bases and in surface treatments.

» **Anionic emulsions (-)**: more effective in treating aggregates containing electropositive charges (such as limestone)

» **Cationic emulsions (+)**: more effective with electronegative aggregates (siliceous material).

Types and Uses of Bituminous Binders

4. Blown Asphalts

» Blown asphalt is obtained by <u>blowing air</u> through the semisolid residue obtained during the latter stages of the distillation process.

» The process involves stopping the regular distillation while the residue is in the liquid form and then transferring it into a tank known as a *converter.*

» The material is maintained at a high temperature while air is blown through it. This is continued until the required properties are achieved.

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Types and Uses of Bituminous Binders

4. Blown Asphalts

» Blown asphalts are relatively stiff compared to other types of asphalts

» It can maintain a firm consistency at the maximum temperature normally experienced when exposed to the environment.

» Blown asphalt generally is not used as a paving material.

• However, **it is very useful as a roofing material, for automobile undercoating, and as a joint filler for concrete**

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Types and Uses of Bituminous Binders

5. Road Tars

> **Tars are obtained from the destructive distillation (التقطير) of organic materials as coal.**

> Their properties are significantly different from petroleum asphalts.

- More sensitive to weather conditions than similar grades of asphalts,
- Set more quickly when exposed to the atmosphere.

> Tars now <u>are rarely used for highway pavements</u>