Highway Engineering Laboratory

Experiment No. : 1

Getting to know Pavement Materials

Dr. Hamza Alkuime

1

Experiment No.1: Getting to know Highway Materials

Goals

1. Getting to know asphalt cement, liquid asphalt, and asphalt mixture
2. Study asphalt behavior under different conditions
3. Review of fundamental statistical concepts

2

2

Pavement Materials & Design

1. Asphalt Materials

1.1 Getting to know Asphalt Materials

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3

Asphalt Cement

Image source: https://theasphaltpro.com/articles/age-the-binder-properly-for-testing/

4

Liquid Asphalt

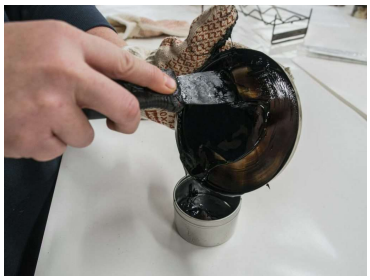

Image source: https://civiljungle.com/difference-between-asphalt-and-tar/

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Asphalt Mixture

Hot Mix | Parklea Sand and Soil (parkleasandsoil.com.au)

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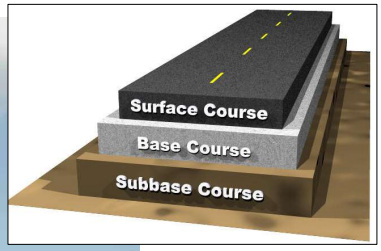

Image source: http://gilsoniteco.com/2018/02/22/gilsonite-binder-grade/

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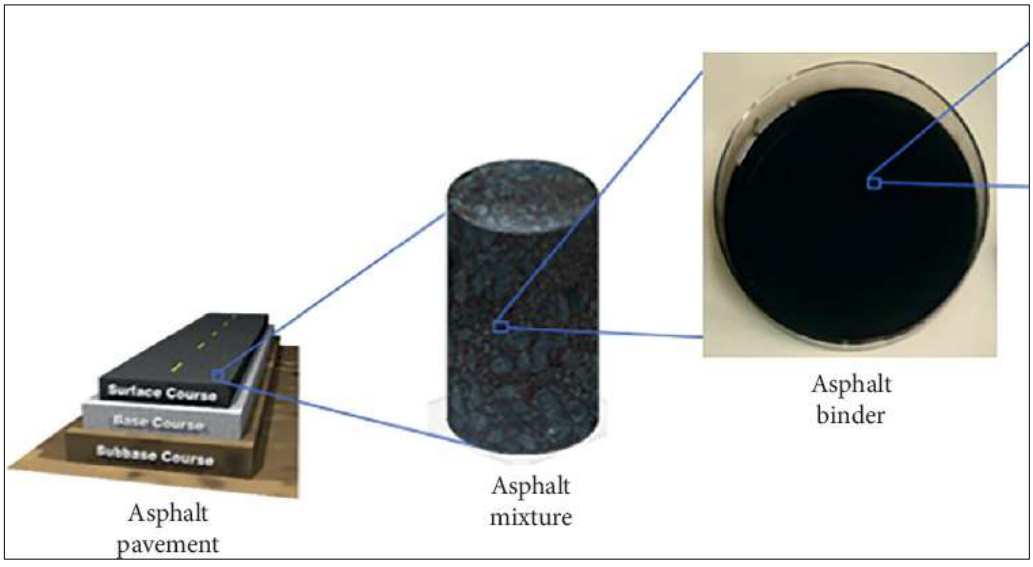

Qu, X., D. Wang, L. Wang, Y. Huang, Yue Hou and M. Oeser. "TheState-of-the-ArtReviewonMolecularDynamics Simulationof Asphalt Binder." (2018).

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8

Pavement Materials & Design

1. Asphalt Materials

1.4 Classification

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9

Classification

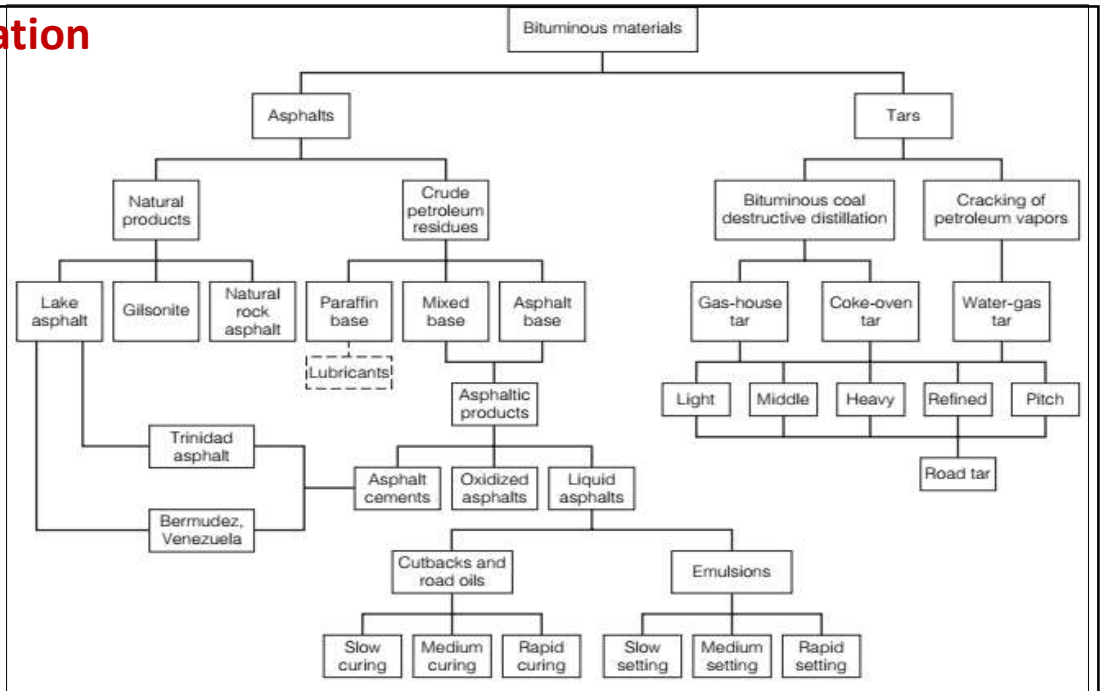

FIGURE 9.1 Classification of bituminous materials (Goetz and Wood, 1960).

10

Classification

Asphalt VS. Tars

- Tar
  - *is a dark brown or black viscous liquid of hydrocarbons and free carbon, obtained from a wide variety of organic materials through destructive distillation.*
- Tar can be produced from
  - *Coal*
  - *Wood*
  - *Petroleum*
- Therefore,
  - *the chemical composition of tar varies, though it is always made of organic matter of some sort.*

A tar-like substance can be produced from corn stalks by heating them in a microwave

Image source: https://civiljungle.com/difference-between-asphalt-and-tar/

11

11

Classification

Tars from wood

https://www.youtube.com/shorts/__fWKu2kmx8

12

Classification

Tars from wood

https://www.youtube.com/watch?v=tt1hLXGepTA

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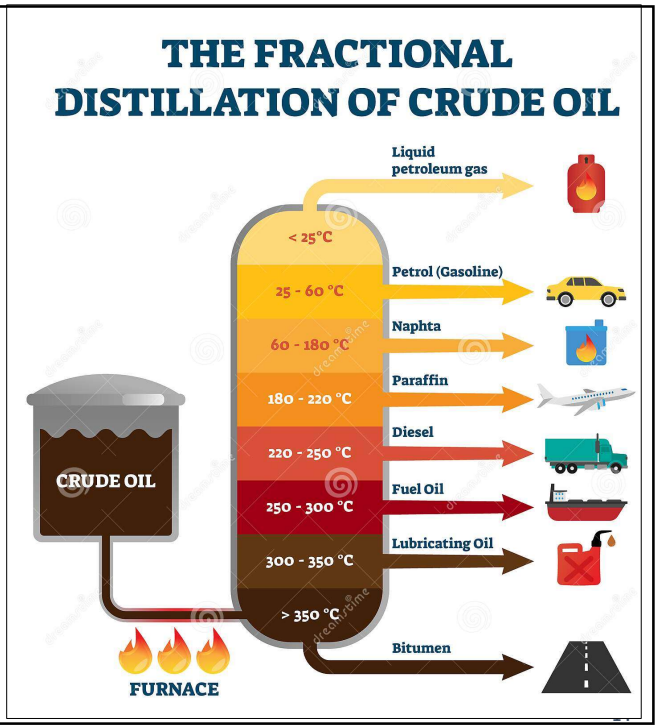
13

Classification

Asphalt V.S. Tars

- Asphalt
  - It is obtained by partial distillation of crude petroleum

Image source: https://civiljungle.com/difference-between-asphalt-and-tar/



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Refinery Operation

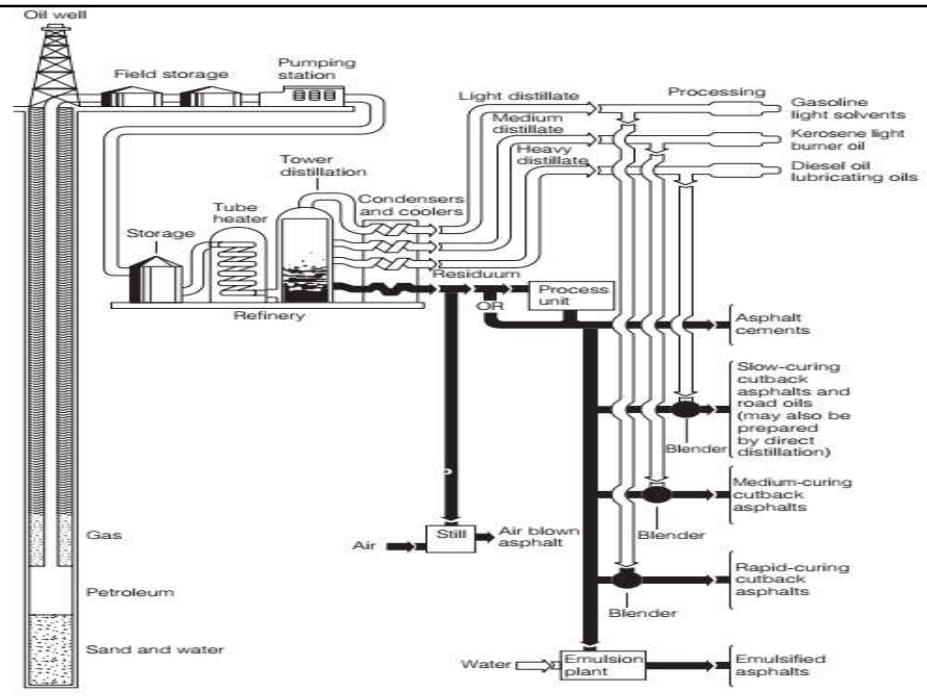

FIGURE 9.2 Distillation of crude petroleum (The Asphalt Institute, 2007).

15

Pavement Materials & Design

1. Asphalt Materials

1.1 Asphalt Types : Asphalt Cement

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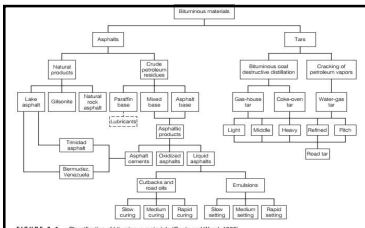
16



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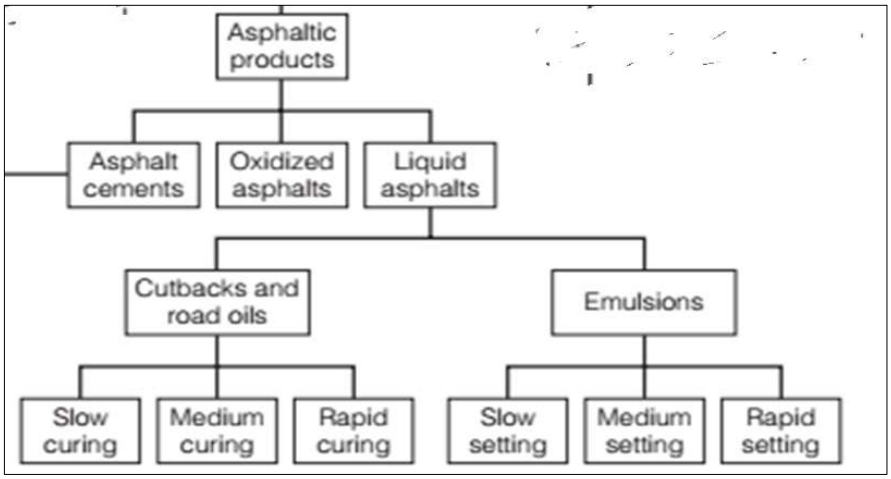

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17

Asphalt types

Paving asphalt

- Asphalt most commonly used in flexible pavement construction can be divided into:

Asphalt cement (binder)

Emulsified asphalt

Cutback asphalt

Image source https://vaasphalt.org/liquid-asphalt/

Images soure https://pavementinteractive.org/sweet-emulsion-how-asphalt-and-water-combine/

https://www.wataniyagroup.com/productsdetail/11

18

18

1.1 Asphalt Materials

Asphalt cement

19

19

Asphalt cement

Observe the following for the given sample:

- ❑ The color of the sample ?
- ❑ The state of matter at room temperatures?
- ❑ The consistency of the sample ?
- ❑ Do you think the materials can be applied to prepare the mixture at this state. Explain your answer.
- ❑ Does it have good adhesive characteristics ? Explain your answer.

https://www.proroadglobal.com/en/performance-grade-asphalt-cement-polymer-modified-bitumen/

20

20

Asphalt cement

- Observe the following for the given sample:
  - *The color of the sample ? a dark-coloured petroleum-like*
  - *The consistency of the sample ? sticky liquid to a glossy solid*
  - *The state of matter ? Semisolid*
  - *Do you think the materials can be applied to prepare the mixture at this state. Explain your answer.*
    - No. It should be heated

https://www.proroadglobal.com/en/performance-grade-asphalt-cement-polymer-modified-bitumen/

21

21

Asphalt cement

- Asphalt can be described as a dark-coloured petroleum-like material that has a consistency ranging from sticky liquid to a glossy solid.

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22

22

Asphalt types

Asphalt cement

- At room temperatures,
  - *asphalt cement is a semisolid material that cannot be applied readily as a binder without being heated*

23

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Asphalt types

Asphalt cement

- Asphalt cement has excellent adhesive characteristics as compared to the liquid asphalt (cutback and emulsified asphalt),
  - *which make it a superior binder for pavement applications*

https://correctiveasphalt.com/wp-content/uploads/2018/08/10_Fog-Seal-and-Rejuvenator-Seal-Benefits-and-Differences_Brownridge.pdf

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24

Asphalt types

Asphalt cement

- Asphalt cements are used mainly in the manufacture of Hot-mix Asphalt (HMA)

https://www.youtube.com/shorts/jX599SteBWM https://www.youtube.com/shorts/qXHfcBxioY

25

Pavement Materials & Design

1. Asphalt Materials

1.2 Asphalt Cement behavior

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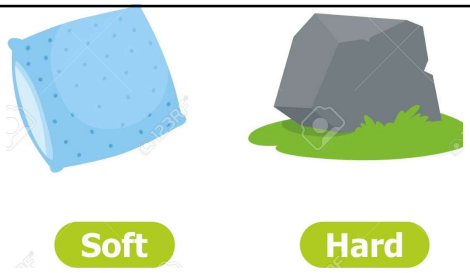
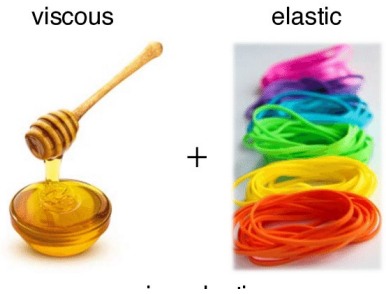
26

Asphalt cement

Materials response (deformation)?

- ❑ Solid/ liquid
- ❑ Hard/Soft ?
- ❑ Elastic/Viscous ?





https://www.proroadglobal.com/en/performance-grade-asphalt-cement-polymer-modified-bitumen/

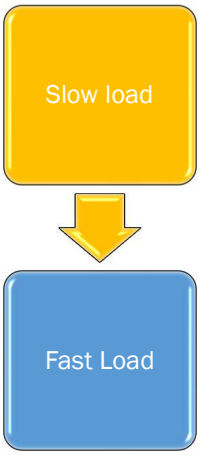
27

27

Asphalt cement

Observe the variation in following characteristics for the give samples with the identified condition

- ❑ The state of matter ?
  - ➢ *Solid/ liquid*
- ❑ The consistency of the sample ?
  - ➢ *Hard/Soft ?*
- ❑ Materials behavior like (deformation)?
  - ➢ *Elastic/ Viscous ?*



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28

Asphalt cement

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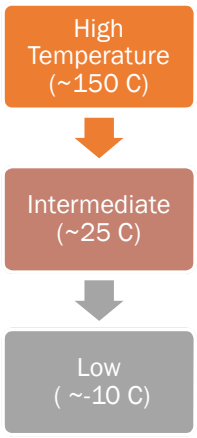

https://www.proroadglobal.com/en/performance-grade-asphalt-cement-polymer-modified-bitumen/

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29

Asphalt cement

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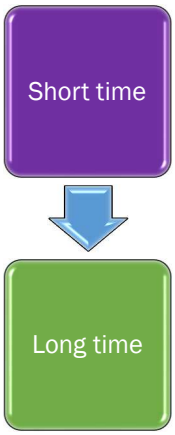

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30

Asphalt cement

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- ❑ The consistency of the sample ?
  - ➢ *Hard/Soft ?*
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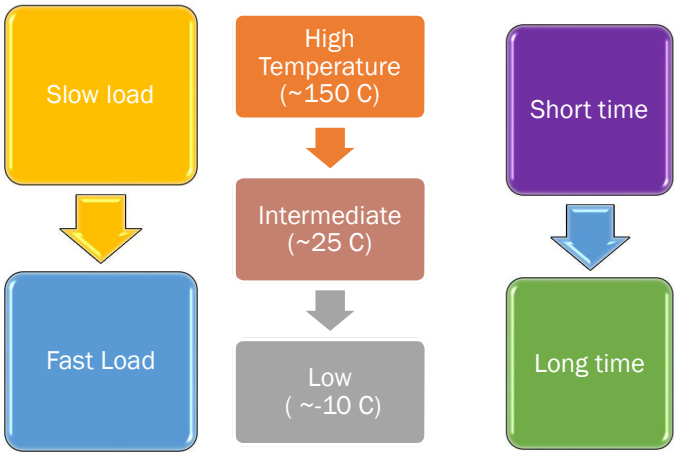
  - ➢ *Elastic/ Viscous ?*



https://www.proroadglobal.com/en/performance-grade-asphalt-cement-polymer-modified-bitumen/

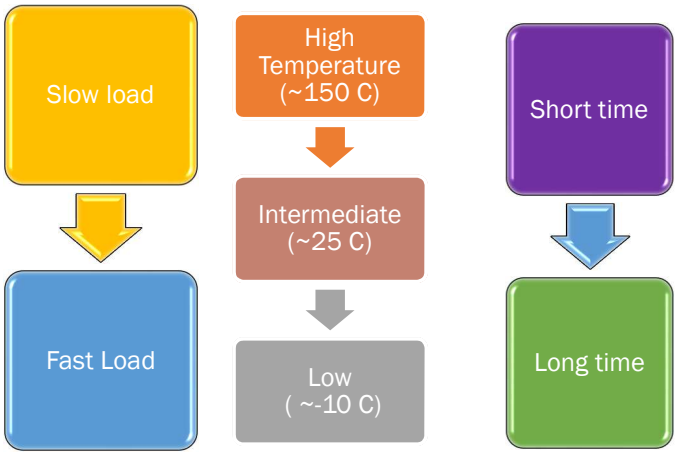
31

31

Asphalt cement

Observe the variation in following characteristics for the give samples with the identified condition

- ❑ What is the worst conditions for the asphalt mixture. Explain your answer.



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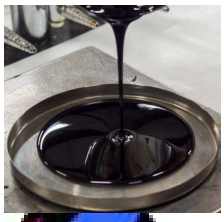
32

l behavior of materials

e Dependency



viscous fluid

elastic solid

-30 25 135

Temperature, °C

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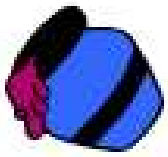
33



viscous fluid

elastic solid

-30 25 60 135

Temperature, °C

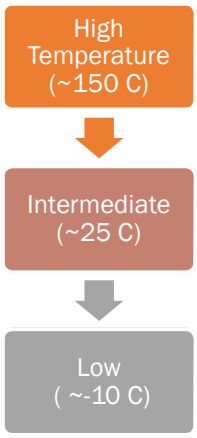
34

34

Asphalt cement

Observe the variation in following characteristics for the give samples with the identified condition

- At which temperature the asphalt binder can be applied to asphalt mixture.
  - *Explain your answer.*



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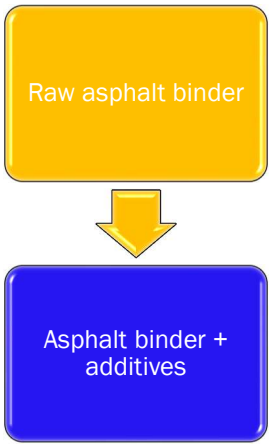
35

35

Liquid Asphalt

Observe the variation in following characteristics for the give samples with the identified condition

- The state of matter ?
  - *Solid/ liquid*
- The consistency of the sample ?
  - *Hard/Soft ?*
- Materials behavior like (deformation)?
  - *Elastic/ Viscous ?*

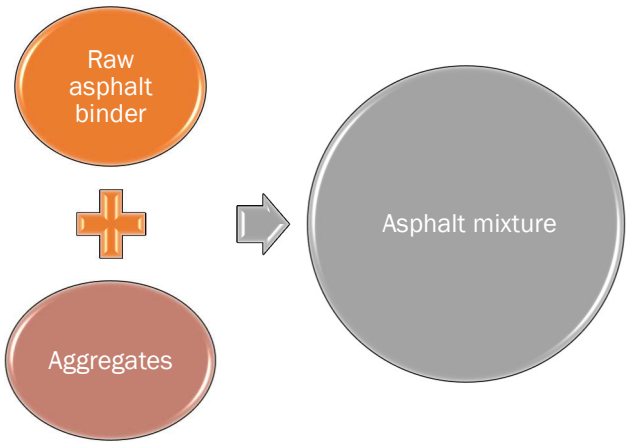


https://www.proroadglobal.com/en/performance-grade-asphalt-cement-polymer-modified-bitumen/

36

36

Asphalt Mixture



https://www.proroadglobal.com/en/performance-grade-asphalt-cement-polymer-modified-bitumen/

37

37

Pavement Materials & Design

Asphalt Materials

Asphalt Types : Liquid Asphalt

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38

Asphalt Mixture

Observe the variation in following characteristics for the give samples with the identified condition

- ❑ The state of matter ?
  - ➢ *Solid / liquid*
- ❑ The consistency of the sample ?
  - ➢ *Hard/Soft ?*
- ❑ Materials behavior like (deformation)?
  - ➢ *Elastic/ Viscous ?*

https://www.proroadglobal.com/en/performance-grade-asphalt-cement-polymer-modified-bitumen/

39

39

Asphalt - Methods to Liquify

1. Heating
   - ➢ *Temporarily reduces viscosity*
2. Dissolving in Solvent
   - ➢ *Cutback Asphalts (type and amount of solvent determines properties and classification)*
3. Emulsifying with Water
   - ➢ *Emulsified Asphalts (electro-chemical charge, setting characteristics, liquid*
   - ➢ *viscosity and consistency of cured residue determines properties and classification)*

https://www.youtube.com/watch?v=rKkwXFYgGFE

40

Asphalt types

Cutback asphalt

- Cutback asphalt = AC + Petroleum solvent

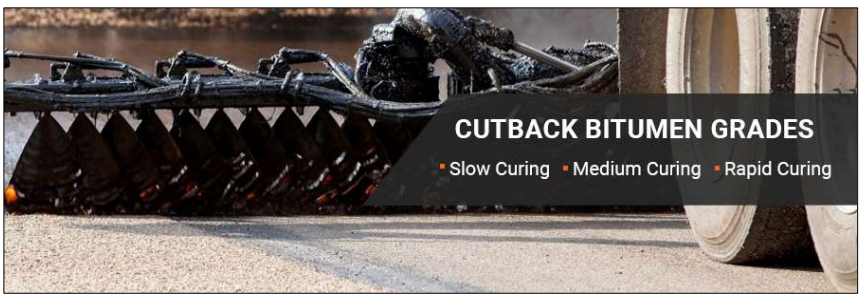
41

41

Asphalt types

Cutback asphalt

- A liquid asphalt which are manufactured by adding (cutting back) petroleum solvents to asphalt cement
  - *Cutback asphalt = AC + Petroleum solvent*
- They are made to reduce the asphalt viscosity for lower application temperature
- Application to aggregate or pavement causes the **solvent to escape by evaporation**, thus leaving the asphalt cement residue on the surface



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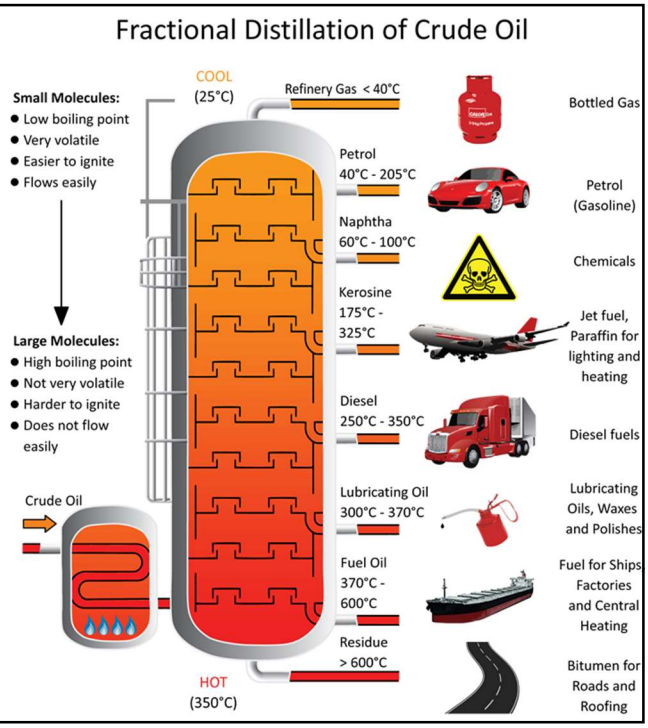
42

Asphalt types

Cutback asphalt

Based on the relative rate of evaporation, cutback asphalts are divided into

1. Rapid –Curing (RC)
   - *Produced by adding a high volatility solvent (generally gasoline or naphtha)*
2. Medium – Curing (MC)
   - *Produced by adding an intermediate volatility solvent (generally kerosene)*
3. Slow-Curing (SC) (or road oils)
   - *Produced by adding a low volatility solvent (generally diesel or other gas oils)*



43

Asphalt types

Emulsified asphalt (emulsion)

- It's a mixture of asphalt cement, water, and emulsifying agent (e.g., soap)
  - *1-2% by volume*
- It classified as liquid asphalts because
  - *they are liquid at ambient temperatures*
- Emulsions are made to
  - *reduce the asphalt viscosity for lower application temperatures*

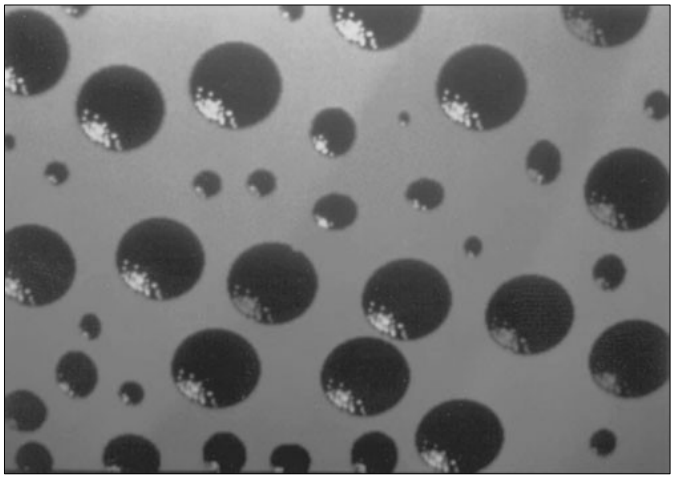


Photo of magnified asphalt emulsion showing minute droplets of asphalt cement dispersed in a water medium.

44

44