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Final Assignment

subject :- Pavement Material Engineering.

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Question No # 1.

Why do we carry out Granular (Physical stabilization?

Answer :- Soils with greater size than 0.075mm are designated as medium to coarse grained soils.

- These soils when compacted form a granular bearing skeleton through a network of grain to grain contact point that is able to transfer load without Permanent deformation
- Provide frictional resistance, bears volume stability.

They may also contain material with Particle size less than 0.075mm without violating the requirement given above if:

(1) the volume of silt clay size (<0.075mm) fraction plus that of the water, normally required to satisfy the Capillary and Physiochemical sorption capacity does not exceed the volume pore space left by the stable continous granular skeleton: and

(2) the ratio of the size of the smallest bearing grain to that of largest silt clay particle is such as to cause no detrimental interference of grain-grain contact to granular skeleton.

Stabilization of soil is Granular stabilization.

The Objective is to obtain a well proportioned mixture with continous ~~Plass~~ graded (well graded) and desired Plasticity

Granular stabilization involves mixing of two or materials to modify the engineering properties such as California bearing radio (CBR), the Particle size distribution, Plasticity Index (PI).

Granular stabilization is used in construction of Base, sub-base & surface courses of Pavement.

The requirements for composition of mixtures intended for uses as bases generally differ from those for use as wearing surfaces.

Question No #2.

How do we carry Granular Stabilization considering Granulometry and Collametry Fabric, Soil Binder, Collameritics, Specification of gradation and seletion of Soil elements ? —:

Answer:- Granulometry is the measurement of the size distribution in a collection of grains.

The pore volume and the size of the pores formed by the granular skeleton determine the transition of a Particular Soil to one with or without a bearing skeleton.

Fundamentals of Granulometry are applied to establish quantitative definitions of granular skeleton with effective Compactness.

- Grain - Size distribution that Yield minimal porosity values with small densification effort are best presented by Talbot formula:

$S = (d/d_{max})^m$ where

S = weight Percent of Particles with diameter less than d.

d_{max} = maximum Particle diameter in mixture.

m = exponent determined empirically.

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... The factor m varies between 0.11 & 0.66.
→ Us. Bureau of Public road recommends 0.45 as the best overall value for m.

Soil-binder :-

Soil binders are material applied to the soil surface to temporarily prevent water induced erosion of exposed soil.

Soils with granular bearing skeleton in densified states possesses volume stability & frictional resistance. They may require.

(i) Bonding or cementation.
- Increase in Cohesion.
- Decrease in Permeability or Water storage Capacity (If deficient in fines).

Such bonded soils belong to class of 'Concretes' if the maximum particle size is larger than opening of No 4 sieve or Mortars if largest Particles of fine sand size or the size of Opening are of No 40 sieve.

Complete replacement of natural soil binder in a clay bonded stabilized gravel (clay concrete) by Portland cement produces Portland cement Concrete.

Partial replacement leads to system that possess properties intermediate between those of clay Concrete & a Portland Cement concrete.

Similarly Partial replacement of Portia Soil binder by asphalt leads to water Proof granular Soil Stabilization.

The soil binder tend to surround the coarse grain Particles and form bonding bridges between Particles such that the granular System attains rigidity and stability. The strength of such a System is dependent on strength of the cement & on the shear resistance at the cement Particle interface, as well as on the strength of granular network.

Collameritics:-

Properties of Particles

Physical

(i) Granulometry.

Laws of arrangement & Packing as function of size, gradation.

(ii) Mechanical.

strength, toughness abrasion resistance

(B) Physio chemical & chemical.

(i) Interaction & bonding with cementing agents

(ii) Reactivity with deleterious substances

Properties of Cementig Agents.

A) Inorganic

(i) Simple, Gypsum

(ii) Complex

Sorel - hydraolic & other cements.

(iii) clay & binder Soil.

B) Organic.

(i) Bituminous

Asphalt, Pitches.

(ii) Natural & synthetic resins.

Specifications on Gradation & Selection of Soil elements.

In Nature more frequently No. we get the desired mixtures

- By addition of Proper proportions of aggregates or fine
- Treatment with water proofing of cementig material.

The Properties of final mixture are generally controlled and Judged by gradation, liquid limit & PI.

Soil binder & water:- are two elements that create the adhesion and bonding between the coarse grains and provide continuity of the structure by strengthened & stabilized by added cohesion.

During Dry Weather:- Shrinkage of soil binder develop tensile forces on the surface of the coarse grains. which has the desirable effect of increased compression on granular skeleton.

During Wet Weather:- Swelling of soil binder might be desirable as it would reduce the Permeability and retard Penetration of water.

→

→ Astm & AASHTO Specification.

→ Formulae for mixing of Aggregates.

Fabric :-

The geo synthetics used in transportation industry are geotextiles geogrids etc. The major function of geo synthetic material in relation with transportation engineering are seperation reinforcement, drainage acts as liquid barrier. The Principal use of geo textile has been as a seperator during the construction of roadworks and in area of stabilization. In Providing filtration and drainage, it aids in improving sub-surface drainage and allows the dissipation of excess subgrade pore pressure caused by traffic loading.

Question No#2.

(i) How would you (being a material expert) identify aggregate referring to naturally occuring materials, Igneous rock, sedimentary rock Metmorphic & residual material & transported deposits?

Answer:- Normally we identify Aggregates on the bases of.

(i) Origin (composition)
(ii) Mode of formation & Deposition.
(iii) Density (Intra-Particle voids
(iv) Shape
(v) Surface textore.

Natural occuring Materials:-

The majority of aggregate used in road construction are obtained from naturally occuring deposits.
Natural aggregates for road making are obtained from rock of the following gedogical groups.

Igneous Rock (95% of Earth's crust)
which are formed by cooling
molten mater.

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Sedimentary Rock:- (5% of earth crust & 75% of Earth space) . which are formed by deposition of granular material

Metamorphic rock:-

which are igneous or sedimentary rocks that have undergone transformations due to heat & pressure

Residual materials:- which may be either weathered or unweathered, generally occur in large deposits and are obtained by quarrying

Transported Deposits:- are found, e.g in stream beds, sand & gravel bars and alluvial fans.

Question No # 2 (II

Answer:- field Investigations for concrete materials prior to construction are chiefly confined to

- Prospecting for aggregates and exploration and Sampling of available deposits.

Judgement and thoroughness in conducting Pre-liminary field investigation are usually reflected in the durability and economy of

completed structure.

- Awareness of the effect of different Properties of aggregate on behaviour of Pavement layer is must for investigation team.

Aggregate Sources:

- Natural.
- Rock.

Natural deposits :- Stream / River deposits
Glacial deposits, Talus deposits.

Prospect sources.

Existing Sources. :- Information is obtained from Geological maps, Soil Survey maps.
Aerial Photograph, Satellites.

Aggregate Prospecting:

* Shallow deposits
* Rock Quarries.

Shallow deposits: A grid of test Pits / trenches are driven.

Representative Sampling.

- From diffent depth
- From bottom & side.

Rock Quarries :- A grid of borehole are made & containing large sized holes & the samplig type must be core sampling

Question No#3

Mc-Adam a Scotish engineer ....? What are Macadam bases types and discuss water bound Macadam & Wet Mix Macadam? Also Elaborate the difference.?

Answer :- Mc. Adam was a Scotish engineer who introduced, in the early nineteenth century, the idea of constructing roads composed of small sizes stones held together by means of a binding material.

This Concept had ~~revol~~ revolutionized the road building Science then aided as it was by the invention of the stone crusher in 1858 by blake, the steam road roller by Aveling in 1867 and use of bituminous material.

Macadam Bases TYPes.

Water bound Macadam :- (WBM) if the stones materials are held byether by addition of water and filler.

Dry bound Macadam :- If the aggregates are held together by mechanical interlock only.

Wet Mix Mecadam :- If graded stones are mixed with water and compacted.

Penetration Macadam:- If a bituminous material is sprayed over the stones & allowed to penetrate into the course and by Premix macadam if the bituminous material is mixed with the aggregates prior to laying.

Water Bound Macadam:-

Water bound Macadam may be defined as a dense and compact course of a road pavement

→ Composed of stone aggregates

→ bound together by a thin film of cementing medium consisting of fine mineral filler (such as stone screening or gravel) with cementitious properties and

→ Containing a minimum laden moisture to impart to the binder necessary cohesive and adhesive properties to enable it to bind the aggregates together. The strength of a water-bound macadam course is thus Primarily due to through interlock in the aggregate Particles.

Materials.

Coarse Aggregates:-

Broken stone Aggregates

→ Hard varieties such as granite, Basalt.

→ Softer varieties such as sand stone.

Screening (Choke)

Moorum other mixtures.

Binding Material (Soil binder)

Limestone Dust, PI => 6.

Sizes & Grading Requirements of Coarse Aggregate:-

The main source of the strength is the mechanical interlock structure in the aggregate.

Well graded aggregates : can only be obtained by crusher.

Requirement of screenings & Binding Materials:-

The screening also known as choke materials fill in the voids left in the coarse aggregates after they are consolidated and help to cement the stone aggregate.

Screening should be properly graded and have some Plastic material in them to impart cementious Propaties.

- Thickness of courses :- WBM is constructed by spreading loose metal which gives a consolidated thickness of 75mm - 100mm. A compacted layer less than 75mm thickness is not desirable and compacted layer above than 100 mm, is equally undesirable.

Construction :-

Spreading Metal
- Manual method
- Mechanical Method

Rolling of Aggregates :-
Dry rolling, wet rolling.

— Application of screening.
— Application of Binding material.

Wet Mix Macadam :- W.M.M is a specification in which a well graded aggregate is mixed with water in a mechanical mixer and resultant mixture is laid by Pavers and compacted.

→ The aggregate is generally crusher run and includes fines also. Because of close

grading, the course will have good interlock with excellent density.

Grading :-

well graded

Moisture Content :-

The OMC for mixing is determined by conducting a suitable density Test. The moisture content during mixing is maintained at this Optimum ± 0.5 percent The M.C is usually in range 2-5% by weight.

Construction :- The mixing can be done in a suitable mechanical mixer. Specially designed mixers can be fabricated for this specification. Other wise a bituminous macadam plant can be used.

→ Ordinary concrete mixer can also be used. Laying is done by paver - finishers and compaction by 8 - 10 ton smooth wheel roller.

Difference b/w Water bound & Wet Mix Macadam.

The advantage of wet mix macadam over water bound macadam is that it is

composed of a well graded mixture. This ensure good interlock and high stability.

→ The Operation of laying is much simpler than that of water bound macadam. where the screenings and binders have to be added in stages and forced into voids. If a crusher run material is used there is no possibility of Plastic fines entering into the mixture.

The compaction is greatly fascilatated by the moisture added which lubricates the individual particles.

One disadvantage of W.M.M is that it is slightly costlier than water bound Macadam. This is because the specification involves the use of mixing plant and Power. On the other hand W.B.M has been traditionally a labour-oriented Specification.

The aggregate for wet mix. Macadam will have to be crusher run, whereas the aggregates for W.M.M are generally hand broken.

Question No #4

(i) Discuss in detail bituminous Materials manufacturing?

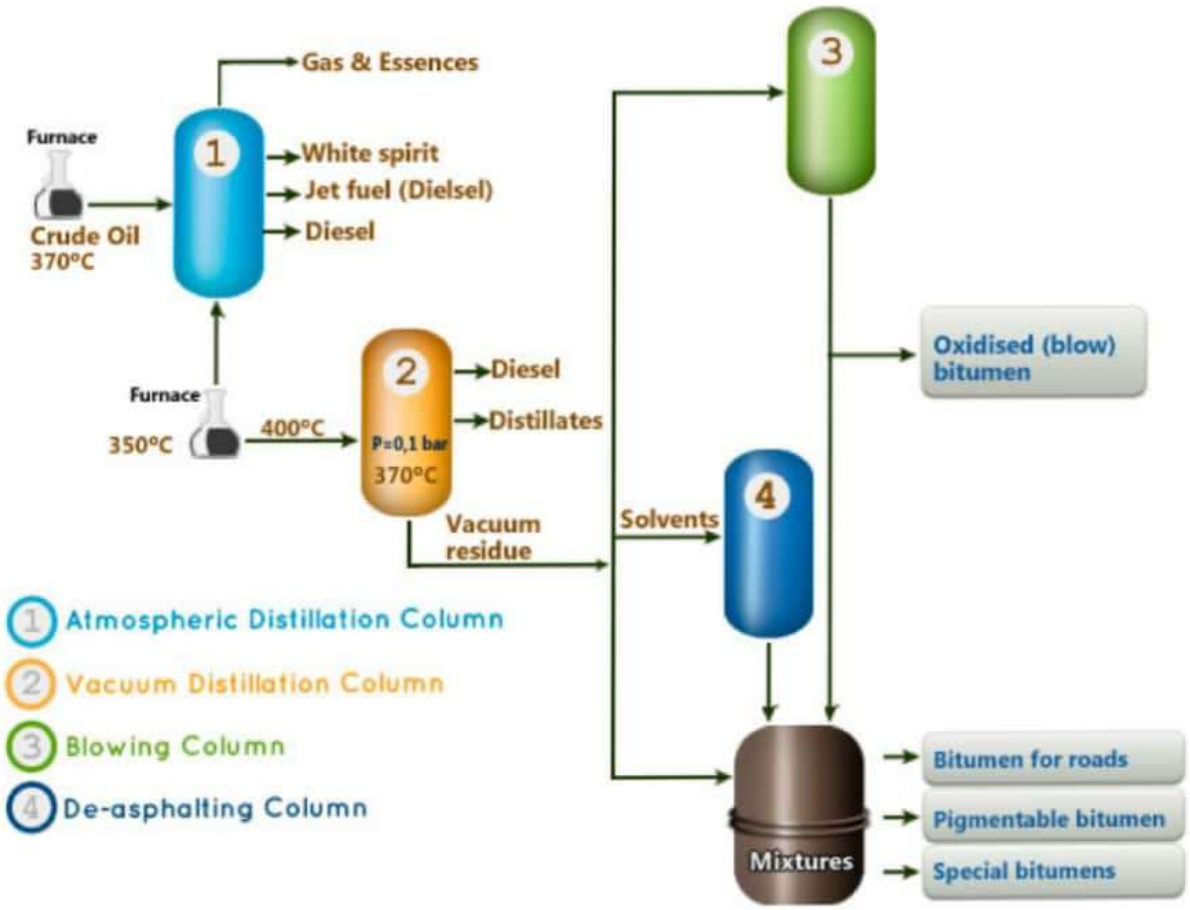
Answer :- Bituminous material is obtained by refining crude oil. Its colour is black or ~~water~~ dark and is very viscous. There are two methods by which the bitumen is produced (i) By straight run vaccum

(ii) By Perception from residual fractions by propane or butane solvent deasphalting.

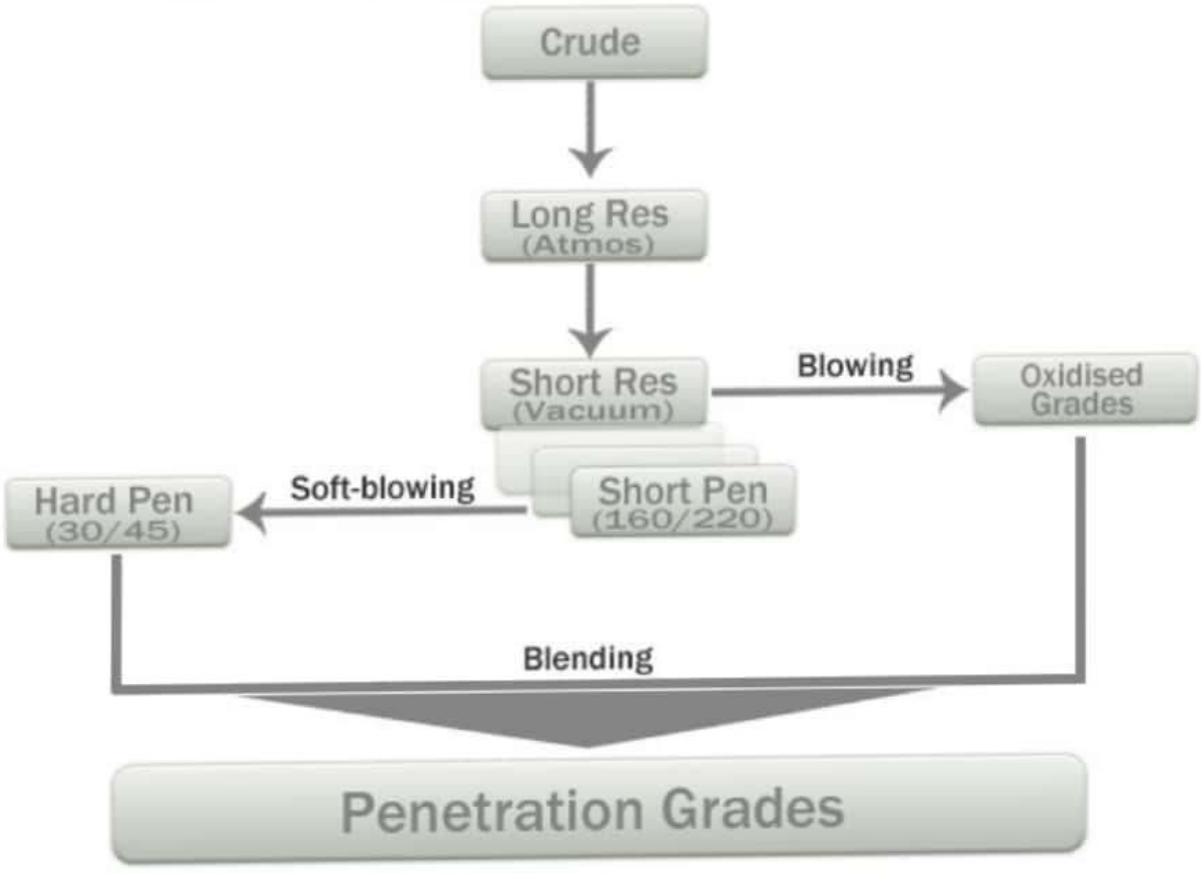
In the first method the crude oil is kept at about 60c at storage tank from a storage tank it is Pumped. The temperature is increased through a heat exchanger System typically to 200c. by exchanging heat

gained from the cooling of newly gained products in the refining process. Crude oil is further heated to 300c. and thus Partly evaporated to atmospheric distillation Column where the Physical Separation occor the lighter Component rise and heariest are settled below & pass through 2nd colum called vaccom distillation column. Finally bitumen is obtained from vaccom column by flushing of atmospheric residue. while in the 2nd method the bitumen obtained has some properties ~~than~~ that obtained from crude oil processed and from the mode of Operation in the vaccume unit. The grade of bitumen depend upon the amount of ~~vo~~ volatile materials.

Standard Bitumen Production Scheme



Typical Bitumen Production Scheme



Question No # 4 (II)

Chemical Composition in Bitumen.

Answer :- The chemical composition of Bitumen varies due the component varying which depend upon the crude oil and the processes used during refining and blinding. Bitumen is a complex mixture of hydro-carbons containing of chemical compounds of high molecular weight, generally higher than 5000.

The smaller size is approximately 300 Daltons while the largest has not yet concluded. The figure below indicates the molecular weight distribution of four Penetration asphalt cement. It has the same consistency with specific temperature, 77 f (25 C) and different size distribution. these materials will react differently with different temperature and will behave different.

Element Analysis :- The molecule in the Bitumen is the combination of alkanes, cyclokanes, aa etc. Containig Carbon nitrogen Oxygen, hydrogen Sulphur.

Table represents —

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Elements	%age
Carbon	(70–85%)
Hydrogen	(7–12.1.)
Nitrogen	(0–1.1).
Sulphur	(1–7.1.)
Oxygen	(0-5%)

PAH Contents of Bitumen:

Aromatic hydrocarbons	PAH in bitumen (PPm)
Nepthaline	2.5 –3.0
Floorene	0.3 –0.5
Phenthanl	0.3 – 7.3
anthracene	BDL – 2.0

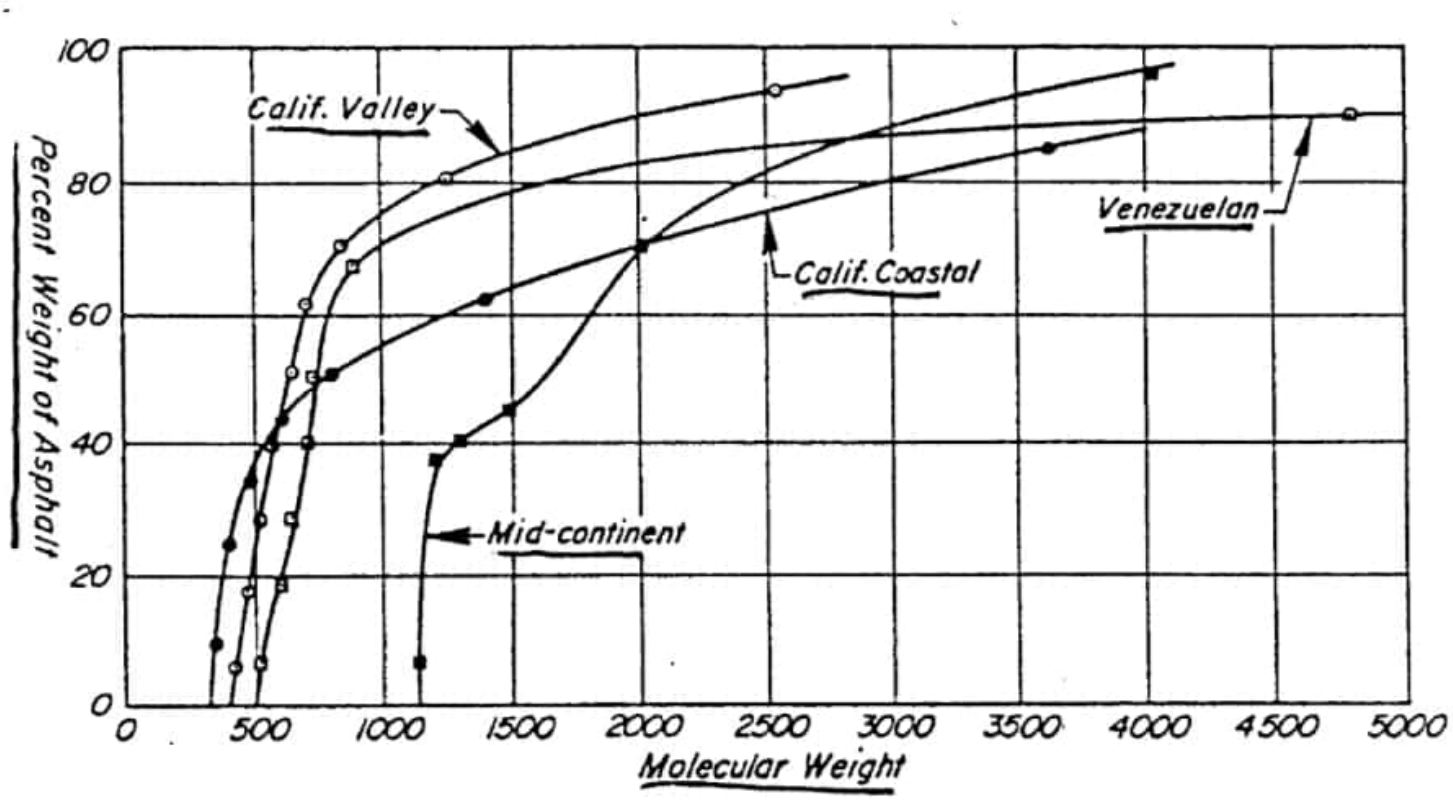

FIGURE 1.14 - MOLECULAR WEIGHT DISTRIBUTION OF FOUR 200 PEN. ASPHALT CEMENTS. (after Griffin, Simpson and Miles)