Student NAME: Shoaib Ur Rehman
Student I.D: 15265
Subject: Pavement material Engineering

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Q1(1) Ans:

Soils with particle size greater than 0.75 mm are designated as a medium to coarse grained soils. These soils when compacted from a granular bearing skeleton through a network of grain to grain contact that can

→ Tranfer load without permanent Deformation
→ Provide frictional Resistance
→ Bear volume Stability

Stabilization of this class of soils is designated "Granular Stablization".

Furthermore it involves preparation of mixture of soil Aggregate consisting of

→ Stone, Gravel and sand and containing silt clay
→ Computed to maximum density to obtain high Strength

P.T.O

stability and durability in weather conditions. Granular Stabilization is used in construction of Base Sub base and surface courase of paved facilities. Furthermore the Primary objective is to obtain as well proportioned mixture of particles with continous gradation (well graded) and the desired plasticity."

END

Q 1(2) Ans:

1) Granulometry and collametry:

The pore volume and size of pore formed by the granular skelton determine the transition of a particular soil to one with and 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 desification effort

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are best presented by the talbot formula.

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

=> where S = weight precent of the particles with diameter less than d.

-> d max = maximum particle diameter in the mixture

-> n = expoment determined empirically

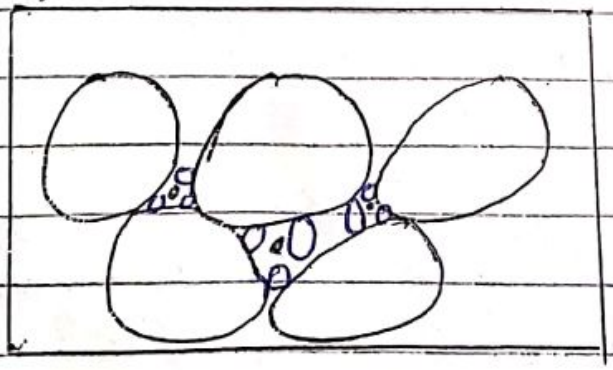
-> The factor n varies b/w 0.11 and 0.66

-> U.S Bureau of Public Roads recommends 0.45 as the best over all value for n.

2) Fabrics:

we define it diricatly by its figure

Ideal



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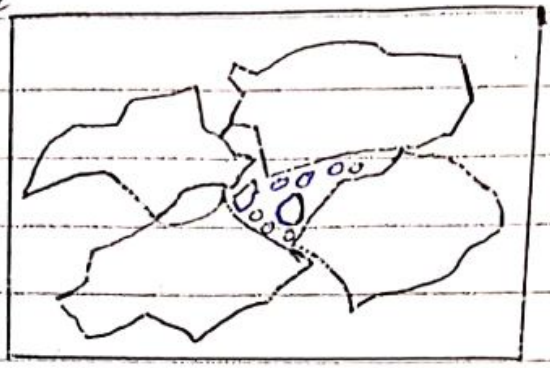
Actual



3) Soil Binder

The soil binder or the cementing materials tends to surround the coarse grain particles such that the granular system attains rigidity and stability. The strength of such a system is dependent on the strength of cement and on the shear resistance at cement particle interface as well as on the strength of granular network. It belong to the group of "Mortars" where the largest particle are of fine and size of the size of opening of No 40 Seieve (0.425 mm)

Complet replacement of natural soil binder is a clay bonded stabilized gravel (clay concrete) by portland cement produces portland cement concrete. P.T.O

Partial replacement leads to system that posses properties intermediate b/w those of clay concrete and portland cement concrete. Similarly partial replacement of the soil binder by asphlt lead to waterproofed granular soil stabilization and complete replacement by bitumen and filler leads to Bituminous concrete.

4) Callametrics

Soils with granular bearing skelton in the densified state passesses volume stability and frictional resistance.

They may require

→ Bonding or cementation

→ increase in cohesion

→ Decrease in permeability or water storage capacity (if deficient in fines)

Such stabilized granular soil belong to the class of callametrics (Colla = glue, metros = particles) system.

P.T.O

5) Specification of ~~Coal~~ gradation and selection of soil elements.

The properties of final mixture are generally controlled and judge by gradation the liquid limit and the plasticity index.

A granular bearing skelton may be established by several different methods

The choice depends on

→ The soil and other material available

→ Inteded use and special properties desired in the stabilized system.

⇒ Time constrain for planning and construction

The following are the different methods

1) Soil Binder and water
2) During dry weather
3) During wet weather

The above are the three main methods which we use this.

END

Q2(1) Ans:

As a material expert we identify aggregate referring to naturally occuring material from the following geological groups.

- Naturally occuring materials

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

- Igneous Rocks (95% of Earth Crust):

Igneous rock are formed by the cooling of molten material

- Sedimentary Rocks (5% Earth Crust and 75% of Earth Surface):

Sedimentry rocks are formed by the deposition of granular material.

- Metamorphic Rocks

metamorphic rocks are igenous or sedimentary rocks that have undergone tranformation due to heat and pressure. The weathering product may be of two genral types.

P.T.O

→ Residual Materials

which may be either weathered or unweathered generally occur in large deposits and are obtained by quarrying.

→ Transported Deposits

Transported deposits are found for example in stream beds, sand and gravel and alluvial fans.

END

Q2(2) Ans:

Field investigation for concrete material prior to construction are chiefly confined to.

- Properting for Aggregate
- Exploration and sampling of Available Deposits.

Judgement and throughness in conducting preliminary field investigation are usually reflected in the Durability and Economy of completed structure.

Awarness of the effect of different properties

P.T.O

of the aggregate on the behaviour of pavement layers are must for the investigation Team

material Sources are mainly

1) Natural deposits
2) Rock Queries

In Natural deposits we have

→ Stream / River deposits
→ Glacial deposits
→ Fluvial deposits
→ Talus deposits
→ Wind - blown deposits.

we already Some existing known Sources from where we obtained the required materials, for new Sources we need

→ Soil Survey maps
→ Geological maps
→ Aerial photographs
→ Satellite imageries.

END

Q3 Ans: Types of Macadam Bases:

1) water bound Macadam
2) Dry bound macadam
3) wet mix macadam
4) penetration macadam

1) Water Bound Macadam:

It is defined as a dense and compact course of road pavement.

→ composed of Stone aggregate
→ Bound together by a thin film of cementing medium consisting of fine mineral filler (such as Stone screenings or gravel) with cementitious properties
→ containing a minimum laden moisture to impart to the binder necessary cohesive and adhesive properties to enable it to bind the aggregate together.

The Strength of a water bound macadam course is thus

→ primarily due to through mechanical interlock in the aggregate particles.

P.T.O

→ Cohesion b/w the aggregate particles due to the cementitious film of soil moisture binder material used in WBM are

→ Coarse aggregate
Broken Ston Aggregate (Hard varieties Such as granite, Basalt, Diorite, Quartzite, etc) and (Softe varieties such as sandstone, limestone, kankar laterite etc)
→ over burnt Bricks
→ Moorum other mixture
→ Binding materials (soil binder)
→ Limestone Dust

2) Wet Mix Macdam
→ Wet Mix macadam is a Specification in which a well graded aggreate is mixed with water in a mechanical mixer and the resultant mixture is laid by Pavers and compacted.
→ The aggregate is generally crusher run and includes fines also. Because of the close grading the course will have a good interlock with excellent density.

P.T.O

It is well graded.

→ The optimum moisture content for mixing is determined by conducting suitable density tests. The moisture content is usually in the range 2.5% by weight

→ Construction.

The mixing can be done in suitable mechinal mixer. Specially designed mixers can be fabricated for this specification. otherwise a bituminous macadam plant can be used. ordinary concrete mixes can also be used. Laying is done by paver finishers and compaction by 8- to tons smoth wheel rollers

Difference b/w water bound Macadam and wet mix macadam.

1) The main advantage of wet mix macadam over water bound macadam is that it is composed of well graded mixture. This ensure good interlock

P.T.O

2) Addition of water while mixing facilitates the handling of the mixture. The operation of laying is much simpler then that of water bound macdam. where the screenings and binding material have ~~no~~ to be added in stages and forced into voids. if crusher-run material is used there is no possibility of plastic fines entering into the mixture.

3) The compaction is greatly facilitated by moisture added which lubricates the individual particles.

4) one disadvantage of the wet mix macadam is that it is slightly costlier than water bound macdam. This is because the specification involves the use of mixing plant and paver

5) The aggregate for wet mix macadam will have to be crusher run whereas the aggregate for water bound macdam are generally hand broken.

E.N.D P.T.O

Q 4 (1) Ans:

Bituminous material Manufacturing.

The major method used for the production of asphalts/bitumin is following

-> Atmospheric Distillation
-> Distillation at Reduced pressure
-> Air Blowing
-> Solvent Refining

Early refinery methods consisted of a simple distill in a retort with attached condenser. The producer was to pump quantity of crude oil into the ress and apply heat to the bottom causing the lower boiling point fraction to boil off leaving a residue which depending on the type of crude could be axle grease bunker fuel oil or asphalt. only certain types of crude containing relative high asphalt contents could be used for the production of asphalt by this method.

D. I. D

The consistency of the material is controlled by
-) Temperature
-) Quantity of steam
-) pressure
-) Amount of Reflux
-) Type of crude
-) Rate of time of processing.

It is often not economical for refinery to produce asphlt to a number of paving grades directly. Hence blending is utilized.

Refineries may stok two grades asphlts one at each end of the viscosity Spectrum and blend to produce intermediate grades.

Relatively high flash distillates have also been used as blending materials with hard asphlts.

Tar obtain from the destructive distillation of bituminous coal is a crude Tar which must undergo further refinement to obtain road tar.

END

P.T.O

Q4(2) Ans

Asphalts are complex mixtures of Hydrocarbons. Hydrocarbons are compounds that contain Carbon and hydrogen. Moreover the chemical composition of the materials will in all probability vary in the different molecular weight ranges depending upon the crude oil source.

Some generalization can be made however with regard to the Chemical composition of the Semi Solid materials. According to Simson they generally consist of

- Carbon (70 85%)
- Hydrogen (7 12%)
- Nitrogen (0 1%)
- Sulfur (1 7%)
- oxygen (0 5%)
- And small amount of metals either dispersed in the form of oxides and salts or in metal

P.T.O

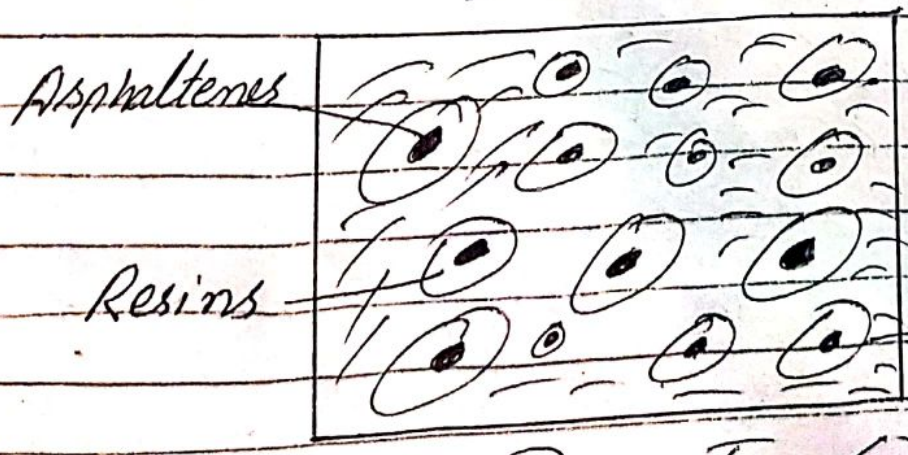
containing organic compounds
The lighter molecur weight
material contain a considerable
amount of carbon and hydrogen
in the form of chain type
or asphaltic organic compounds.
As the molecular weight
increases the tendency toward
ring type (naphthenic or aromatic)
organic compound is more
apparent with side
chains attached to the
ring section. The very high
molecular weight compound consist
primarily of the ring type
material with very few
side chain of the aliphatic
variety present. It is in the
higher molecular weight
ranges where the other
elements mentioned above
For convenience the
wide spectrum of organic
compound contained in
an asphalt at separated
into number of components
one commonly used classification
state that asphalts can be
separated.

P.T.O

→ Asphaltenes (High molecular weight material and of Aromatic Nature. Asphaltenes have been defined by ASTM as the components of the bitumen in petroleum products malthas asphalts cements and solids native bitumen which are soluble in carbon disulfide but insolubl in paraffin napthas)

→ Resin (intermediate molecul weight materials and contains more side chains then asphaltenes)

→ Oil (they are the lighter molecular weight materials in the asphalt and generally have large number of chains in proportions to the number of Rings



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It should be emphasized at this point that the asphaltes resins and oil are not three distinct compound. Rather there exists a range in molecular weights in the oil fraction the resin fration and the asphaltes fration. moreover the composition of the material in each fration and in each asphlt will vary depending upon the crude source and method manufacturing.

END