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MID TERM ASSIGNMENT

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Q1(1) Why do we carry out Granular (Physical) stabilization?

Answer

Soil stabilization aims at improving soil strength and increasing resistance to softening by water through bonding the soil particles together, water proofing the particles or combination of the two (Sherwood, 1993). Usually, the technology provides an alternative provision structural solution to a practical problem. Soils with particle sizes greater than 0.075 mm 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 points that is able to

Transfer load without Permanent Deformation

Provide Frictional Resistance υ Bears Volume Stability

They may also contain material with particle sizes less than 0.075mm without violating the requirements given above if:

(1) the volume of the silt-clay size (< 0.075 mm) fraction plus that of the water, normally required to satisfy the capillary and physicochemical sorption capacity, does not exceed the volume of the pore space left by the stable continuous granular skeleton; and

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

Stabilization of this class of soils is designated “Granular Stabilization”

Q1 (2) How do we carry out Granular (Physical) stabilization considering Granulometry and Collametry, Fabric, Soil Binder, collameritics and Specifications of gradation and selection of soil elements?

Granulometry

Granulometry is the measurement of the size distribution in a collection of grains. Granulometry (morphology), granulometry computation using the morphological opening operation. Optical Granulometry, computation of granulometries from images, and its use in mines. Measurement of grain sizes or particle sizes.

Fundamentals of Granulometry are applied to establish quantitative definitions of granular skeleton with effective compactness. Grain-size distributions that yield minimal porosity values with small densification effort are best presented by the Talbot formula

$s=(d/dmax)\ m$

where s = weight percent of the particles with diameter less than d.

dmax = maximum particle diameter in the mixture

m = exponent determined empirically

The factor m varies between 0.11 and 0.66.

U.S. Bureau of Public Roads recommends 0.45 as the best overall value for m.

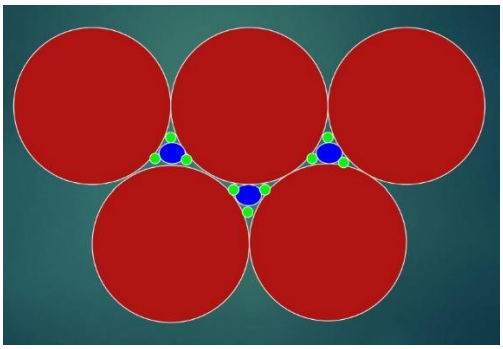
Callomatetry:

Soils with granular bearing skeleton in the densified state possesses 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 soils belong to the class of Collameritic. In the terminology of materials science, such bonded soils belong to the class of: Concrete if the maximum particle size is larger than the openings of No. 4 sieve (4.76 mm), Mortars if the largest particles are of fine sand size or the size of the openings of No. 40 sieve (0.425 mm).

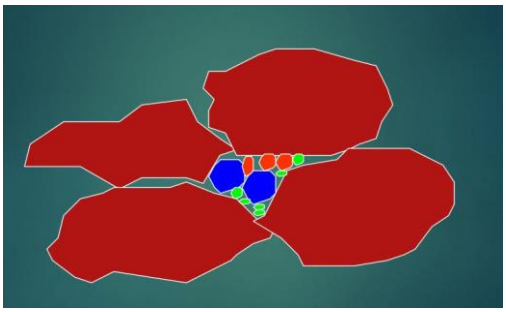
Fabric

This fabric is one of the most commonly used geotextiles for road stabilization, ground stabilization and aggregate separation. Made of polypropylene, the geotextile is UV resistance as well as being resistant to commonly encountered soil chemicals, mildew and insects. Non-biodegradable.

Ideal



Actual



Soil binder

Soil Binder
The latter type of materials are also called "soil binder."
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 systems that possess properties intermediate between those of Clay Concrete and a Portland Cement Concrete.
Similarly, partial replacement of the soil binder by asphalt leads to waterproofed granular soil stabilization, and complete replacement by bitumen and filler leads to
Bituminous Concrete.
The soil binder or the cementing materials tend to surround the coarse-grain particles and/or form bonding bridges between particles such that the granular system attains rigidity and stability. The strength of such a system is dependent on the strength of the cement and on the shear resistance at the cement-particle interface, as well as on the strength of the granular network.

Collamatrics

TABLE 9.2 COLLAMERITICS—THE SCIENCE OF COMPOSITION AND PROPERTIES OF NONMETALLIC CONSTRUCTION MATERIALS[a].

Properties of the Particles	*Properties of the Cementing Agents*	*Examples of Cemented Systems*
A. Physical I. Granulometry Laws of arrangement and packing as functions of size, gradation and shape factors II. Mechanical Strength, toughness abrasion resistance B. Physicochemical and chemical I. Interaction and bonding with cementing agents II. Reactivity with deleterious substances in environment	A. Inorganic I. Simple Gypsum and lime plasters II. Complex Sorel-, hydraulic and other cements III. Clay and binder soil B. Organic I. Bituminous Asphalts, pitches, tars II. Natural and synthetic resins and other polymers III. Gums, glues of various types, etc.	1. Mortars with inorganic and organic cements including natural and artificial sand stones 2. Concretes Portland cement, bituminous, resinous, clay, etc., including naturally cemented conglomerates 3. Plastics Powder, paper-, cloth-, and fiber-filled; also natural wood in which cellulose fibers are bonded together by lignin

[a] After Winterkorn (1955a).

Exceptions to Gradation Requirements

Cases may occur in which certain natural materials that do not meet gradation requirements may develop satisfactory CBR values in the prototype . υ Exceptions to the gradation requirements are permissible when supported by adequate in-place CBR tests on similar construction that has been in service for several years.

Q2 (1) How would you (being a material expert) identify aggregate referring to Naturally occurring materials, Igneous Rocks, Sedimentary Rock, Metamorphic and Residual material and transported deposits?

A study of the Types of Aggregates, Their Properties and Tests is of great importance to a highway engineer.

Aggregates can be obtained from two sources,

Naturally Occurring Deposits
(1a) Processed Material
(1b) Blends of Natural or Processed Materials.
(1c) Stabilized Materials
(2) Artificially or Industrially Prepared Deposits (synthetic)

Aggregates can be identified on the basis of

(1) Origin (Composition)
(2) Mode of Formation & Deposition
(3) Density (Intra-particle voids)
(4) Shape
(5) Surface Texture

Igneous rocks (95% of Earth's Crust)

Igneous rock, any of various crystalline or glassy rocks formed by the cooling and solidification of molten earth material. Igneous rocks are formed from the solidification of magma, which is a hot (600 to 1,300 °C, or 1,100 to 2,400 °F) molten or partially molten rock material Examples of intrusive igneous rocks are diorite, gabbro, granite, pegmatite, and peridotite. Extrusive igneous rocks erupt onto the surface, where they cool quickly to form small crystals.

Sedimentary rocks

Sedimentary rocks are types of rock that are formed by the accumulation or deposition of small particles and subsequent cementation of mineral or organic particles on the floor of oceans or other bodies of water at the Earth's surface. Sedimentation is the collective name for processes that cause these particles to settle in place.

Metamorphic rocks

Metamorphic rocks arise from the transformation of existing rock types, in a process called metamorphism, which means "change in form". The original rock is subjected to heat and pressure, causing profound physical or chemical change

They can be formed by pressures deep inside the Earth, by tectonic processes such as continental collisions, or when they are heated up by an intrusion of hot molten rock called magma from the Earth's interior. The coastline of Brazil is made up of metamorphic rocks.

Residual Materials

The residual deposits are the insoluble products of rock weathering which have escaped distribution by transporting agencies, and which still mantle the rocks from which they have been derived.

Parent materials that are predominantly composed of consolidated rock are termed residual parent material. The consolidated rocks consist of igneous, sedimentary, and metamorphic rock, etc.

Transported Deposits

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

Q2 (2) . In aggregate investigation Material sourcing is referred to Field investigation. Discuss Material sourcing in detail.

Field Investigation for concrete materials prior to construction are chiefly confined to

Material sourcing

There are two main types of material sourcing

1 Natural Aggregate

2 Rock Quarries

1 Natural Aggregate

Aggregates are the most important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. Natural aggregates are inert granular materials such as sand, gravel stone or crushed stone that are used with a binding medium i.e. water, bitumen, portland cement, lime, etc. to form compound materials i.e. asphalt concrete and portland cement concrete.

Natural Deposits

Stream/River Deposits

Glacial Deposits

Fluvial Glacial Deposits

Talus Deposits

Wind Blown Deposits

Prospect Sources

Existing Sources

Information is obtained from

Geological Maps

Soil Survey Maps

Aerial Photographs

Satellite Imageries

2 Rock Quarries

Shallow Deposits

A grid of test pits/trenches

Representative Sampling

from different depths

from bottom and sides

Typical of the average properties

Existing Sources

Deep Deposits

Q 3 Mc-Adam was a Scottish engineer who introduced, in the early nineteenth century, the idea of constructing roads composed of small size stones held together by means of a binding material? What are the Macadam bases types and discuss the Water bound Macadam and Wet Mixing Macadam in detail Bound, also elaborate the difference between Water bound Macadam and Wet Mixing Macadam?

1) Types of Macadm bases type

1) Water Bound Macadam

2) Dry Bound Macadam

3) Wet Mix Macada

4) Penetration Macadam

2) Water Bound Macadam

Water Bound Macadam (WBM) is a dense and compact course of a road pavement composed of stone aggregates held together by a film consisting of gravel or screenings with a minimum amount of water. (WBM) if the stone materials are held together by the addition of water and filler

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 screenings 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 the thorough mechanical interlock in the aggregate particles. Cohesion between the aggregate particles due to the cementitious film of soil-moisture binder.

Materials

Coarse Aggregate

Broken Stone Aggregates

Hard varieties such as Granite, Basalt, Diorite, Quartzite, etc.

Softer varieties such as Sandstone, Limestone, Kankar, Laterite etc.

Over-burnt Bricks

Screening (Choke)

Moorum, Other Mixtures

Binding Material (Soil Binder)

Limestone Dust, PI => 6

Size and Grading Requirements of Coarse Aggregates

The main source of strength of a water-bound macadam surface is due to the mechanical interlock in the aggregates and it is thus apparent that the aggregates should be well graded.

Well graded aggregates can be obtained only by a crusher whereas hand breaking can yield single size aggregates.

For soft aggregates such as kankar, laterite or brick ballast which get crushed excessively under roller, the grading is not very important

Requirements of Screenings and Binding Material

The screenings, also known as "choke" materials, fill in the voids left in the coarse aggregates after they are consolidated and help to cement the stone aggregates together

To effectively perform these functions, the screenings should be properly graded and also should have some plastic material in them to impart cementitious properties.

Excess of plasticity is harmful since, 'under the influence of moisture, the material may lose its stability.

Screening materials may be dispensed with in case of soft aggregates such as kankar, laterite, brick ballast etc.

Thickness of courses

The water-bound macadam is constructed by spreading loose metal which gives a consolidated thickness of 75 mm-100 mm. A compacted layer less than 75 mm thickness is not desirable and a compacted layer more than 100 mm is equally undesirable.

If the thickness of the base is more than the above value, the construction is done in multiple layers.

CONSTRUCTION

Spreading metal

Manual Method

Mechanical Method

Rolling of Aggregates

Dry Rolling

Wet Rolling

Application of Screenings

Application of Binding Material

2) **Wet Mix Macadam**

Wet Mix Macadam consist of laying spreading and compacting of clean, crushed, well-graded granular materials on a prepared and approved Granular sub-Base. The material is well mixed with water and rolled to a dense mass. If graded stones are mixed with water and compacted.

Wet-Mix macadam is a specification in which a wellgraded aggregate 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 good interlock with excellent density.

Grading

Well-Graded

Moisture content

The optimum moisture content for mixing is determined by conducting suitable density tests. The moisture content during mixing is maintained at this optimum ± 0.5 per cent. The moisture content is usually in the range 2-5% by weight. Wet Mi

Construction

The mixing can be done in a suitable mechanical mixer. Specially designed mixers can be fabricated for this specification. Otherwise, a bituminous macadam plant can be used.

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

3) Difference between Water bound Macadam and Wet Mixing Macadam

The main advantage of wet-mix macadam over water-bound macadam is that it is composed of a well-graded mixture. This ensures good interlock and high stability.

Addition of water while mixing facilitates the handling of the mixture. The operation of laying is much simpler than that of water-bound macadam, where the screenings and binding material 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 facilitated by the moisture added which lubricates the individual particles. υ One disadvantage of the wet-mix macadam is that it is slightly costlier than water-bound macadam. This is because the specification involves the use of mixing plant and paver. On the other hand, water-bound macadam has been traditionally a labour-oriented specification.

The aggregates for wet mix macadam will have to be crusherrun, whereas the aggregates for water-bound macadam are generally hand-broken.

Q 4(1) Discuss in detail the Bituminous Materials-Manufacturing?

Bituminous Materials-Manufacturing

Petroleum Bitumen, normally called "Bitumen" or "Asphalt" is produced by refining crude oil. Used as a binder in road-building products, it is a very viscous, black or dark brown material. ... Finally, Bitumen is obtained by vacuum distillation or vacuum flashing of atmospheric residue from the vacuum distillation column.

Manufacturing Processes

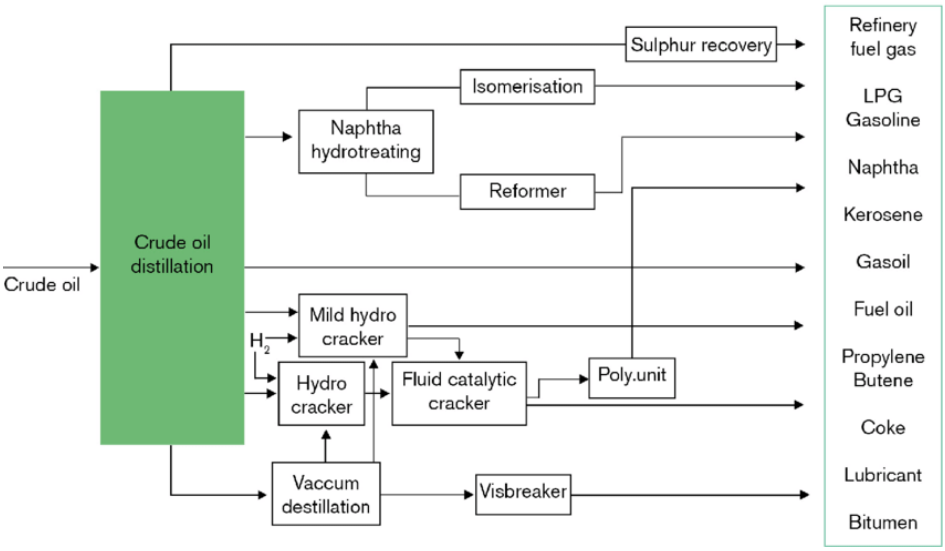
The major methods used for the production of asphalts υ Atmospheric Distillation Distillation at Reduced Pressure

Air Blowing

Solvent Refining

Early refinery methods consisted of a simple distillation in a retort with attached condenser. The procedure was to pump a quantity of crude oil into the vessel and apply heat to the bottom causing the lower boiling point fractions 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 productions of asphalt by this method.

Distillation remains by far the most common process.



The consistency of the material is controlled by

(1) Temperature

(2) Quantity of Steam

(3) Pressure

(4) Amount of Reflux

(5) Type of Crude

(6) Rate or Time of Processing

It is often, not economical for a refinery to produce asphalt to a number of paving grades directly. Hence, blending is utilized. Refineries may stock two grades of asphalt: 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 asphalts.

Q4(2). Bituminous Materials-Chemistry is referred to chemical composition of bitumen. Elaborate in detail.

Asphalts are Complex Mixtures of Hydrocarbons, Hydrocarbons are compounds that contain carbon and hydrogen

Composition of Bitumen

Materials in bituminous family are:

1) Tar:

Coal tar is a brown or dark black liquid of high viscosity, which smells of naphthalene and aromatic hydrocarbons. Being flammable, coal tar is sometime used for heating or to fire boilers. It can be used in coal tar soap, and is used in medicated shampoo to kill and repel head lice, and as a treatment for dandruff.

Depending upon its source of origin, TAR is classified as:

2) Coal Tar:

It is the liquid by-product of the distillation of coal to make coke. The gaseous by-product of this process is commonly known as town gas. It is used for coating of wooden poles and sleepers, iron poles.

3) Wood Tar:

It is obtained by the distillation of resinous wood. Wood tar contains creosote and as such has strong preservative properties. Search for "resin" in the above search box.

4) Mineral Tar:

It is obtained by the distillation of bituminous shale.

5) Coal Tar Pitch:

It is the residue of the direct distillation of crude tar produced by the high temperature carbonization of coal. It is used as a water proofing compound in

masonry, steel and timber structure. It is also used for water proofing concrete structures.

Chemical Composition of Bitumen:

Molecular weight wise, bitumen is a mixture of about 300 - 2000 chemical components, with an average of around 500 - 700. Elementally, it is around 95% carbon and hydrogen (± 87% carbon and ± 8% hydrogen), and up to 5% sulfur, 1% nitrogen, 1% oxygen and 2000ppm metals. Bitumen's are composed mainly of highly condensed polycyclic aromatic hydrocarbons. They also contain several elements, a number of which are toxic.

Chemical Components in bitumen are:

1. Asphaltenes
2. Resinous components (polar aromatics)
3. Non-polar aromatics (naphthene aromatics) and
4. Saturates

Table 1. Elemental analysis of bitumens from various sources[27]

Element	Range
Carbon, %w	80.2 - 84.3
Hydrogen, %w	9.8 - 10.8
Nitrogen, %w	0.2 - 1.2
Sulphur, %w	0.9 - 6.6
Oxygen, %w	0.4 - 1.0
Nickel, ppm	10-139
Vanadium, ppm	7-1590
Iron, ppm	5-147
Manganese, ppm	0.1 - 3.7
Calcium, ppm	1-335
Magnesium, ppm	1-134
Sodium, ppm	6-159