Ans Q#01 (Part-01)

SOIL STABILIZATION:

Soil stabilization is the alteration of soils to enhance their physical properties. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil to improve the load bearing capacity of a sub-grade to support pavements and foundations.

Granular stabilization is a combination of physical and chemical stabilization methods in which granular bearing skeleton is modified with pore-filling and/or cementing natural and extraneous materials (clay and other concretes and mortars)

major uses of soil stabilization are listed below

(1) To improve adverse ground conditions to facilitate economic development of an area that is lifting economically a region out of mud or sand

(2) To provide bases and surfaces for secondary and rural roads where primary roads are in existance

(3) To provide bases for paved surfaces where crushed gravel and rocks normally employed are not available economically.

(4) For city and suburban streets where the noise-absorbing and elastic properties of certain stabilised soil systems are a definite advantage over other methods

(5) For military and other emergencies where an area must be made trafficable within a short period of time.

Granular stabilization is used in construction of base, sub-base and surface courses of paved facilities. The primary objective is to obtain a well-proportioned mixture of particles with continuous gradation and the desired plasticity.

Ans Q#01 (Part 02)

Granular Stabilization can be carried out through the following techniques

* GRANULOMETRY AND COLLAMETRY:

Fundamental of Granulometry are applied to establish quantitative definitions of granular skeleton with effective compactness.

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.

Talbot formula is used to present Grain-size distribution that yield minimal porosity values with small densification effort.

According to Talbot formula

$$S = \left(\frac{d}{d_{max}}\right)^m$$

where

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

d_{max} = maximum particle diameter in the mixture

m = exponent determined emphirically. the factor m varies between 0.11 and 0.68. the best overall value for m is 0.45 and is normally recommended.

* SOIL BINDER:

Soils with granular bearing skeleton in the densified state possesses volume stability and frictional resistance. Such soil may require bonding (cementation), increase in cohesion and decrease in permeability or water storage capacity.

Complete replacement of natural soil binder in a clay-bonded stabilized gravel (clay concrete) by Portland cement produces portland cement concrete while 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 water proofed 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.

* COLLAMERITICS:

Collameritic is combination of two words
Colla = glue, meros = particle

Soils with granular bearing skeleton in the densified state possesses volume stability and frictional resistance. Such stabilized granular soils belong to Collameritic systems. In the terminology of material science, such bonded soils belong to the class of Concrete or mortar.

* SPECIFICATIONS AND ON GRADATION AND SELECTION OF SOIL ELEMENTS:

The desired mixtures can be obtained by addition of proper proportions of the aggregates or fines and treatment with waterproofing of cementing material.

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

The choice of method for establishing a granular bearing skeleton depends on the soil and other material available, intended use and special properties desired in the stabilized system and time constraints for planning and construction

Soil Binder and water are the two elements that create the adhesion and bonding between the coarse grains and provide the continuity of the structure by filling in the voids of the bearing skeleton.

During dry weather, shrinkage of soil binder develops tensile forces on the surfaces of the coarse grains, which has the desirable effects of increased compression on the granular skeleton.

During wet weather, swelling of the soil binder might be desirable, as it would reduce the permeability and retard penetration of water.

Q # NO (02)
Part # 01

How would you identify aggregate referring to Naturally occurring materials, Igneous Rocks, Sedimentary Rock, Metamorphic and Residual material transported deposits?

Aggregate is the major component of materials used in road making It is used granular bases and sub-bases, Bituminous Courses and Cement Concrete Pavements.

Aggregates can be obtained from two sources

(1) Naturally Occurring Deposits
(2) Artificially or Industrially prepared deposits

Aggregates can be identified on the basis of

(1) → Origin
(2) → Mode of formation & Deposition
(3) → Density
(4) → Shape
(5) → Surface Texture

the majority of aggregates used in road construction are obtained from naturally occuring deposits.

Natural aggregates for road-making are obtained from rock of the following geological groups

* **IGNEOUS ROCKS:**

Igneous rocks posses 95% of earth's

crust and are formed by the cooling of molten material.

* SEDIMENTARY ROCKS :-
5% of earth's crust and 75% of earth's surface is composed of sedimentary rocks and are formed by deposition of granular material.

* METAMORPHIC ROCKS:
Metamorphic rocks are igneous or sedimentary rocks that have undergone transformations due to heat and pressure

* RESIDUAL MATERIALS :-
Residual materials may be either weathered or unweathered and generally occur in large deposits and are obtained by quarrying.

* TRANSPORTED DEPOSITS:
Transported deposits are weathering product found in stream beds, sand and gravel bars and alluvial fans.

Q#03

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.

This concept had revolutionized the road building science.

MACADAM BASES - TYPES:

→ Water Bound Macadam
→ Dry Bound Macadam
→ Wet mix Macadam
→ Penetration Macadam

* 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 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 courses is thus primarily due to the thorough mechanical interlock in the aggregate particles and cohesion between the aggregate particles due to the cementitious film of

soil-moisture binder.

Materials of water Bound Macadam are listed as below

① Course Aggregate consist of either broken stone aggregates or over burnt bricks

② Screening (Choke) consist of moorum and other mixtures

③ Binding material consist of limestone Dust, PI ⇒ 6

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. 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.

Screening material may be dispensed within case of soft aggregates such as kankar, laterite, brick ballast etc.

The water bound macadam is constructed by spreading loose metal which gives a consolidated thickness of 75 mm to 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.

* WET-MIX MACADAM :→

Wet-mix macadam is a specification in which a well-graded aggregate is mixed with water in a mechanical mixer and the resultant mixture is laid by pavers and compacted.

In wet-mix macadam, 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 of wet-mix macadam is well-graded.

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 %. The moisture content is usually in the range 2-5% by weight.

The mixing can be done in a suitable mechanical mixer. Specially designed mixers can be fabricated for this specification.

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

* DIFFERENCE BETWEEN WATER BOUND AND WET MIX MACADAM:

(1) The main advantage of wet-mix macadam is that it is composed of a well-graded mixture, hence good interlock and high stability is ensured.

(2) 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.

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

(4) Wet-mix macadam is slightly costlier than water-bound macadam. The specification involves the use of mixing plant and paver. On the other hand, water-bound macadam has been traditionally a labour-oriented specification

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

Q# (04)

Part # 01 Discuss in detail the Bituminous Materials - Manufacturing?

The word Bitumen is sanskirt word "jatu" stands for Pitch, In latin it means pertaining to Pitch while in French it is used as "BITUMEN". In English the same word was transferred from French

Bitumen is a class of black or dark-coloured (solid, semi-solid or viscous) cementitious substances, natural or manufactured, composed principally of high molecular weight hydrocarbons found in Asphalts, Tars, Pitches and Asphaltites are typical.

The major methods used for the production of Bituminous materials are

1) Atmospheric Distillation
2) Distillation at Reduced Pressure
3) Air Blowing
4) Solvent Refining

Early refinary 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 of 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

Q#NO (04)
Part #02

Asphalts are complex mixtures of hydrocarbons, varying, in the case of semi-solid asphalt cements from low molecular weight (approx 300) materials to very high molecular weight materials (larger than 5000).

the chemical composition of the materials will vary in the different molecular weights ranges, depending upon the crude oil source.

According to Simpson, composition of Bitumen consist of

Carbon	70-85 %
Hydrogen	7-12 %
Nitrogen	0-1 %
Sulfur	1-7 %
Oxygen	0-5 %

and small amounts of metals either dispersed in the form of oxides and salts or in metal containing organic compounds