STABILIZATION

BY

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STABILIZATION

- **Soil Stabilization** is the alteration of **soils** to enhance their physical properties.
- It is required when the soil available for construction is not suitable for the intended purpose.
- **Stabilization** can increase the shear strength of a **soil** and/or control the permeability and compressibility of a **soil**, thus improving the load bearing capacity of a sub-grade to support pavements and foundations.

STABILIZATION METHODS

There are different stabilization methods used now a days……

- Mechanical Stabilization
- Cement Stabilization
- Chemical/ Lime Stabilization
- Bitumen Stabilization
- Soil Stabilization by adding fines
- Soil Stabilization by Removing fines

STABILIZATION IN SITE

MECHANICAL STABILIZATION

- Mechanical Stabilization is also known as **granular stabilization.**
- Mechanical stabilization is the process of improving the properties of soil by changing its **gradation**.
- Two or more types of natural soils are mixed to obtain a composite material which is superior to any of its components.

MECHANICAL STABILIZATION

For the purpose of Mechanical stabilization the soils are subdivided into two categories…

- Aggregates: These are soils which have a granular bearing skeleton and have particle size larger than 75µ.
- Binders: These are the soils which have particles smaller than 75µ size. They do not posses the bearing skeleton.

MECHANICAL STABILIZATION

MECHANICAL STABILIZATION

- The **Aggregates** consist of strong , well-graded, angular particles of sand and gravel which provide internal friction and incompressibility to the soil.
- The **Binders** provide cohesion and imperviousness to the soil. These composed of clay and silt.
- The quantity of binder should be sufficient to provide plasticity to the soils but it should not cause swelling.
- The blended soil should posses both internal friction and cohesion.

MECHANICAL STABILIZATION

- The material should be workable during placement.
- When properly placed and compacted , the blended material becomes mechanically stable.
- The load bearing capacity is increased.
- The resistance against the temperature and moisture changes is also improved.

MECHANICAL STABILIZATION

The Mechanical stability of mixed soil depends upon the following factors…

- Mechanical Strength of Aggregate.
- Mineral Composition.
- Gradation.
- Plasticity Characteristics.
- Compaction.

MECHANICAL STABILIZATION

Mechanical Strength of Aggregate:

- The mixed soil is stable if the aggregates used have high strength.
- However, if the mixture is properly designed and compacted, even the aggregates of relatively low strength can provide good mechanical stability.

Mineral Composition:

- Mechanical stability depends on the minerals in it.
- The minerals should be weather resistant.

MECHANICAL STABILIZATION

Gradation:

- The gradation of the mixed soil should be such that the voids of the coarser particles are filled with the finer particles so that high density is obtained.
- According to Fuller, the maximum density is obtained if particle size distribution satisfies

$$p = (d/D)^{0.50} * 100$$ where

p=percentage of the soil mixture passing sieve size of d,

D=maximum particle size

- It is found by experience that to obtain sufficient cohesion , it is necessary to have greater proportion of material passing 75μ.
- Generally the ideal mixture would include 25% of binder.

MECHANICAL STABILIZATION

Plasticity Characteristics:

- Soils with high liquid limit and plasticity index are suitable as binders for soils used for surfacing.
- They obtain greater cohesion and better moisture retention capacity.
- For soils used in base courses, the requirement of plasticity characteristics are quite different from those surfacing.
- The soils in the base course should have low plasticity to avoid excessive accumulation of water and resulting loss of strength.
- As far as possible them the maximum use of locally available soils should be made for economy.

MECHANICAL STABILIZATION

Compaction:

- The mechanical stability of stabilized soil mass depends upon the degree of compaction attained in the field.
- Normally the compaction is done at or near the optimum water content.

MECHANICAL STABILIZATION

Use of Mechanical Stabilization:

- It is the simplest method of the stabilization.
- It is generally used to improve the sub-grades of relatively low bearing capacity.
- It is extensively used in the construction of bases, sub-bases and surfacing of roads.

CEMENT STABILIZATION

- Cement stabilization is done by mixing pulverized soil and Portland cement with water and compacting the mix to attain a strong material.
- The material obtained by mixing soil and cement is known as soil-cement.
- The soil-cement becomes a hard and durable structural material as the cement hydrates.

CEMENT STABILIZATION

Types of Soil-Cement: Generally 3 types of soil-cements are there..

1. Normal Soil-Cement:

- Cement: 5-14% by volume.
- Water : Should be sufficient to satisfy the hydration requirements of cement and workability.
- Normal soil-cement is quite weather resistant and strong.
- Used for stabilizing sandy and low plasticity soils.

CEMENT STABILIZATION

2. Plastic Soil-Cement:

- Cement: 5-14% by volume.
- Water : More water to have wet consistency similar to that of plastering mortar.
- Can be placed on steep or irregular slopes where it is difficult to use normal road making equipment.
- Used for water proof lining of canals and reservoirs.
- Used for protection of steep slopes against erosive action of water.

CEMENT STABILIZATION

3. Cement Modified Soil:

- Cement: Less than 5% by volume.
- It is a semi hardened product of soil and cement.
- It reduces the swelling characteristics of the soil.
- Use of cement modified soils is limited.

CEMENT STABILIZATION

CEMENT STABILIZATION

Factors affecting Cement Stabilization:

1.Type of soil

2. Quantity of cement

3. Quantity of Water

4. Mixing, compaction and curing

5. Admixture

1.Type of soil:

- Granular soils with sufficient fines are ideally suited for cement stabilization.
- They can be easily mixed and pulverized.
- They require least amount of cement.
- Silty and clayey soils can produce satisfactory soil-cement, but those with high clay content are difficult to pulverize.

CEMENT STABILIZATION

Factors affecting Cement Stabilization:

1.Type of soil

2. Quantity of cement

3. Quantity of Water

4. Mixing, compaction and curing

5. Admixture

2.Quantity of Cement:

- Well graded sand - 5%
- Poorly graded sand - 9%
- Non-Plastic silts – 10%
- Plastic clays – 13%
- The actual quantity of cement required is obtained from laboratory tests.

CEMENT STABILIZATION

Factors affecting Cement Stabilization:

1.Type of soil

2. Quantity of cement

3. Quantity of Water

4. Mixing, compaction and curing

5. Admixture

3. Quantity of Water:

- The quantity of water used must be sufficient for hydration of cement and silt clay cement and for making the mix workable.
- Water used should be clean and free from harmful salts, alkalies, acids or organic matter.

CEMENT STABILIZATION

Factors affecting Cement Stabilization:

1.Type of soil

2. Quantity of cement

3. Quantity of Water

4. Mixing, compaction and curing

5. Admixture

4. Mixing ,Compaction and Curing:

- The success of cement stabilization depends mainly on through mixing. If not it becomes non-homogeneous , weak product.
- Soil-cement should be protected against loss of moisture by providing a thin bitumen coating. Some times with water proof paper, moist dirt.
- Compaction is done as for soil alone.
- For better results , Fine- grained : Wet of Optimum

  Coarse-grained : Dry of optimum

CEMENT STABILIZATION

Factors affecting Cement Stabilization:

1.Type of soil

2. Quantity of cement

3. Quantity of Water

4. Mixing, compaction and curing

5. Admixture

5. Admixture:

- To increase the effectiveness of cement as stabilizer , admixtures are sometimes added to soil-cement.
- Admixture may permit a reduction in the cement quantity.
- Lime and Calcium chloride- For clays and soils containing harmful organic matter.
- Fly ash act as pozzolana-dune sand
- Sodium carbonate and sodium sulphates are also used as admixtures.

CEMENT STABILIZATION

Construction Methods:

1. Mix in place Method: In this method construction mixing of soil-cement is done at the place where it would be finally placed.

2. Plant Mix Method:

a) Stationary Plant

b) Travelling Plant

- A travelling plant can move along the length of the road under construction.

BITUMEN STABILIZATION

- Bitumen is a complex organic matter which is obtained by fractional distillation or evaporation of petroleum crude.
- Tar is obtained by destructive distillation of organic matter (means heating of organic matter without air).
- It is referred as wood tar or coal tar.
- Asphalt is a substance containing a high percentage of bitumen and some inert matter like alumina, silicate.
- Asphalt cannot be added directly to the soil because of it is viscous. Its fluidity can be increased by
  - Cutback
  - Emulsions
  - Heating

BITUMEN STABILIZATION

- Any organic soil which can be mixed with asphalt is suitable for bituminous stabilization.
- In cohesion less soil asphalt binds the soil particles together and thus serves as a bonding or cementing agent.
- In cohesive soil asphalt protects the soil by plugging its voids and water proofing.
- It helps the cohesive soils to maintain low moisture content and to increase the bearing capacity.
- The amount of bitumen required generally between 4 to 7%.
- The actual amount is determined by trail.

BITUMEN STABILIZATION

- TYPES OF SOIL BITUMEN:

According to Highway Research Board of USA, there are four types of soil-bitumen.

1. .Soil-bitumen(proper): This is a water proof, cohesive soil system.

- It is suitable when the soil has plastic limit of less than 18% and liquid limit of less than 40%.
- The maximum size of particle should not greater than 1/3 of the compacted thickness of the soil-bitumen.
- The quantity of bitumen varies from 4-7% of the dry weight.

BITUMEN STABILIZATION

- TYPES OF SOIL BITUMEN:

2. Sand Bitumen:

- This is a bitumen stabilized cohesion less soil system.
- The sand should be free from vegetable matter and lumps of clay.
- It should not contain more than 25% of finer than 75μ for dune sands and not more than 12% in other types of sand.
- The amount of bitumen varies from 4-10%

BITUMEN STABILIZATION

- TYPES OF SOIL BITUMEN:

3. Water-Proof clay concrete:

- In this system a soil possessing a good gradation is water proofed by a uniform distribution of 1-3% of bitumen.
- Soil of three different gradations have been recommended.
- The percentage passing 75μ sieve varies between

  i) 8-12%

  ii) 10-16% and

  iii) 13-30%.

BITUMEN STABILIZATION

- TYPES OF SOIL BITUMEN:

4. Oiled Earth:

- In this system a soil consisting of silt-clay material is made water proof by spraying bitumen in two or three applications.
- Slow or medium curing bitumen or emulsions are used.
- The bitumen penetrates only a short depth of the soil.
- The amount of bitumen required is about 5 liters per square meter of the soil surface.

BITUMEN STABILIZATION

- FACTORS AFFECTING BITUMINOUS STABILIZATION:

1. Type of Soil:

- Bituminous stabilization is very effective in stabilizing sandy soils having little or no fines.
- If a cohesive soil has the plastic limit less than about 20% and the liquid limit less than 40%, it can be effectively stabilized.
- How ever plastic clays cannot be properly treated because of the mixing problems and require large quantity of asphalt.
- Fine grained soils in arid regions having high PH value and contain dissolved salts do not respond well.

BITUMEN STABILIZATION

- FACTORS AFFECTING BITUMINOUS STABILIZATION:

2. Amount of Asphalt:

- The quality of bitumen-stabilized soil improves with the amount of asphalt up to a certain limit.
- If the amount of asphalt is excessive , it results in highly fluid mixture that cannot be properly compacted.

3. Mixing: The quality of product improves with more through mixing.

4. Compaction:

- The dry density of bitumen soil depends on the amount and type of compaction.
- The maximum dry density occurs at a volatile content of 8%.
- For samples cured and immersed in water, the maximum strength occurs at a moulding volatile content corresponding to the maximum compacted density.