5.5 Stability Analysis of Retaining Wall:

Introduction:

Stabilization incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance. Stabilization is used for a variety of engineering works, the most common application being in the construction of road & air- field pavements, where the main objective is to increase the strength or stability of soil & to reduce the construction cost by making best use of the locally available materials.

1.Mechanical stabilisation:

- Mechanical stabilization involves two operations :
  - (i) changing the composition of soil by addition or removal of certain constituents
  - (ii) Densification or compaction .the particle size distribution and composition are the important factors governing the engineering behaviour of a Soil. Significant changes in theproperties can be made by addition or removal of suitable soil fractions. For mechanical stabilizations where the primary purpose is to have a soil resistant to deformation and displacement under the loads, soil materials can be divided in two fractions: The granular fraction retained on a 75 microns

IS sieve and the fine soil fraction passing a 75 –microns sieve. The granular fraction imparts strength and hardness. The fine fraction provides cohesion or binding property, water – retention capacity and also acts as a filler for the voids of the coarse fraction.

2.Cement stabilization:

a).Soil cements and its influencing factors

- The soil stabilized with cement (Portland) is known as soil cement.
- The cementing action is believed to be the result of chemical reaction of cement with the siliceous soil during hydration. The binding action of individual particles through cement may be possible only in coarse-grained soils .in fine grained,

cohesive soils, only some of the particles can be expected to have cement bonds, and the rest will be bonded through natural pollution. The important factors affecting soil cement are: nature of soil, cement content, condition of mixing, compaction and curing and admixtures.

b)Construction methods

The normal construction sequence for soil – cement bases is as follow:

(i) shaping the sub-grade and scarifying the soil,

(ii) Pulverising the soil,

(iii) addition and mixing cements,

(iv) adding and mixing water,

(v) compacting,

(vi) finishing,

(vii) curing and

(viii) adding wearing surfacing.

There are three methods of carrying out these operations:

(i) mix-in place method,

(ii) travelling plant method and

(iii) stationary plant method.

3.Lime stabilization:

Hydrated (or slaked) lime is very effective in treating heavy, plastic clayey soils . Lime may be used alone, or in combination with cement, bitumen or fly ash. Sandy soils can also be stabilized with these combinations. Lime has been mainly used for stabilizing the road bases and sub- grades on addition of lime to soil , two main types of chemical reactions occurs:

i. Alteration in the nature of absorbed layer through Base Exchange phenomenon,
ii. Cementing or puzzolanic action. Lime reduces the plasticity index of highly plastic soils making them more friable and easy to be handled and pulverized. The plasticity index of soils of low plasticity generally increases. There is generally and increase in the optimum water content and a decrease in the maximum compacted

density, but the strength and durability increase.

4.Bitumen stabilization:

Asphalts and tars are the bituminous materials which are used for stabilization of soil, generally for pavement construction. These materials are normally too viscous to be incorporated directly with soil .the fluidity of asphalts is increased by either heating, emulsifying or by cut-back process. Tars are heated or cut back. The bituminous materials when added to a soil impart cohesion or binding action and reduced water absorption. Thus either the binding action or the water proofing action or both the actions, may be utilized for stabilization. depending upon these actions and the nature of soils , bitumen stabilization is classified under the following four types :

(i) sand-bitumen ,

(ii) (ii)soil-bitumen

(iii) (iii) water-proofed mechanical stabilization and

(iv) (iv) oiled earth

5.Chemical stabilization:

There are a great many chemicals which are used for stabilization. Only the chemicals which are commonly used for stabilizing moisture in the soil and for cementation of particles will be described here,

1. Calcium chloride
2. Sodium chloride
3. Sodium silicate

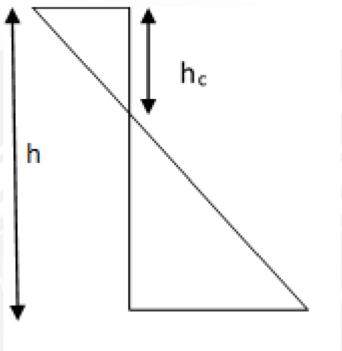
6.Stabilization by heating

Heating a fine grained soil to temperature of the order of 400-600®c causes irreversible changes in clay minerals. The soil becomes non – plastics, less water sensitive and non- expansive. Also the clay clods get converted into aggregates. Soil can be baked in kilns, orin –situ downwards draft slow moving furnaces. The artificial aggregates so produced can be used for mechanical stabilization.

7.Electrical stabilization:

The stability or shear strength of fine-grained soils can be increased by draining them withthe passage of direct current through them. The process is also known as electro-osmosis. Electrical drainage is accompanied by electro- chemical composition of the electrodes and the deposition of the metal salts in the soils pores. There may also be some changed in the structure of soil. The resulting cementing of soil due to all these reactions, is also knownas electro-chemical hardening and for these purpose the use of aluminium anodes is recommended.

Tension cracks :



In clay under undrained condition at climatic temperature variation and due to water drain in season"s soil volume shrinkage, cause compression due to soil self weight, surcharge and live load, cause tensile stress and spilt or fracture in the clay mass especially.

Hence in figure the depth of the tension zone was given the symbol h_c. It is possible for cracks to develop over this depth and a value for h_c is obtained as

From active earth pressure theory, $h_c = 2C / \gamma$

Different modes of failure of retaining wall:

1. Failure against sliding
2. Failure against overturning
3. Failure against bearing capacity

Failure against sliding

- Ths soil in front of the wall provides active and passive pressure resistance as the wall tends to slide.
- Use of a key beneath the base provides additional sliding stability.

- The sliding resistance along the base $F_R = \mu R$, where R includes all the vertical forces, including the vertical components of P_a, acting at the base and μ the coefficient of wall friction.

$$\text{Factor of safety} = \frac{\text{Sum of resisting force}}{\text{Sum of driving force}} =$$

- Factor of safety against sliding should be atleast 1.5 for sandy soil and 2.0 for clayey soil.

Failure against overturning:

- For a wall to be stable the resultant thrust must be within the base. Most walls are so designing that the thrust is within the middle third of the wall base. It is to avoid lossof contact of base with soil.

$$\text{Factor of safety} = \frac{\text{Sum of resisting force}}{\text{Sum of overtuning force}}$$

- Overturning is usually considered with respect to toe and the factor of safety should beat least 1.5 for sandy soil and 2.0 for clayey soil. The resisting moments are normally due to vertical component of all the forces namely weight of wall, weight of soil overbase, vertical component active pressure and passive pressure.

Failure against Bearing Capacity:

$$\text{Factor of safety} = \frac{\text{Allowable bearing pressure}}{\text{Maximum contact pressure}}$$

- Vertical load causes uniform contact pressure at the base. Over turning moment causescompressive pressure at toe and tensile pressure at heel. The sum contact pressure is maximum at toe. Factor of safety against bearing capacity should be atleast 2.5 for sandy soil and 3.0 for clayey soil.