~~Excel Index~~ :- Section-B

Unit-III (Highway Construction: Non Bituminous Pavement)

Pg.-412 Excavation Equipments

1) Bull Dozer and Scraper:→

They may be used for shallow excavation work and for hauling the earth for relatively short distances. Bulldozer may be used for clearing site, opening up pilot roads, moving earth for short haul distances of about 100m and also in several other jobs.

Scraper is considered as one of the useful earth-moving equipments as it is self operating - it can dig, haul and discharge the material in uniformly thick layers. However scrapers are not capable of digging very stiff material.

2) Power Shovel:→

It is used primarily to excavate earth of all classes except rock and to load it into wagons. These may be mounted on crawler tracks and so they can move at low speeds.

3) Dragline:→

It is used to excavated soft earth and to deposit in nearby banks or to load into wagons. Dragline may

also be mounted on crawler. It can operate on natural ground while excavation from a pit with the buckets, thus it is not necessary for the dragline to go into the pit in order to excavate. The bucket is thrown out from the dragline on the top of the earth to be excavated and then pulled back towards the base of the machine.

4) Clam Shell:→

It consists of a bucket of two halves or shell which are hinged together at top. The shells may be attached to the shovel-crane units or at the bottom of a dragline. The open clam-shell bucket is thrown on the top of the loose material to be dug and as the bucket is lifted, the two halves close entrapping the material into the bucket.

(5) Hoe:→

It is an excavating equipment of the power-shovel family. It is meant to excavate below the natural surface where the machine is stationed and is capable of having precise control of depth of excavation at close range work.

⊠ Soil or Field Compaction :→

By Compacting the soil, the particles are mechanically constrained to be packed more closely, by expelling part of the air voids. Compaction increases the density and stability, reduces settlement and lowers the adverse effect of moisture. Hence proper compaction of fills, subgrade, sub-base, and base course are considered essential for proper highway construction.
The various factors influencing soil compaction include the moisture content, amount and type of compaction, soil type and stone content.

Compacting Equipment

i) Rollers :→

The principle of rollers is the application of pressure, which is slowly increased and then decreased. The various types of rollers which are used for compaction are :-

(a) Smooth Wheeled Rollers

There are two types of smooth wheeled rollers, one three-wheeled or mecadam rollers, and the other tandem rollers. The gross weight of the former type range between 4 to 18 tonnes. The Compacting efficiency

of the smooth wheeled roller depends on the weight, width and diameter of each roller.

(b) Pneumatic Tyred Roller :-
In this type, a number of pneumatic wheels are mounted on two or more axles, under a loading platform. These rollers are pulled by tractors. These are considered to be most suitable to compact nonplastic silts and fine sands.

(c) Sheepsfoot Roller :→
This type of roller consists of hollow steel cylinder with projecting feet. The weight of the roller can be increased by filling the drum with wet soil. These may be pulled by tractors.

(2) Rammers :→
These are useful to compact relatively small areas and where the roller cannot operate such as compaction of trenches, foundation and slopes. The output rammer is much lower than that of roller.

(3) Vibrator :→

Vibrators are most suited for compacting dry cohesionless granular material. There are also vibrator mounted roller to give the combined effects of rolling and vibration.

(4) Watering (Jetting and ponding) :→

It is considered to be an efficient method of compacting cohesionless sands. Watering heavily and rolling by smooth wheel of pneumatic tyred roller may also give adequate compaction of cohesionless sands.

☒ Construction Procedure of WBM

1) Preparation of foundation for receiving the WBM curve :-

The foundation for receiving the new layer of WBM may be either the subgrade or sub-base or base course. This foundation layer is prepared to the required grade and camber and the dust and either loose materials are cleaned. On existing road surfaces, the depressions and pot-holes are filled and the corrugations are removed by scarifying and reshaping the surface of the required grade

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2) Provision of Lateral Confinement:-
Lateral confinement is to be provided before starting WBM construction. This may be done by constructing the shoulders to advance, to a thickness equal to that of the computed WBM layer and by trimming the inner sides vertically.

3) Spreading of Coarse Aggregates:-
The coarse aggregates are spread uniformly to proper profile to even thickness upon the prepared foundation and checked by templates. The WBM course is generally constructed to compacted thickness of 7.5 cm except in the case of WBM sub-base course using coarse aggregate grading no.1 which of 10 cm compacted thickness.

4) Rolling:-
After spreading the coarse aggregates properly, compaction is done by a three wheeled power roller of capacity 6 to 10 tonnes.
Rolling is started from the edges, the roller being run forward and backward until the edges are compacted. The run of the roller is then gradually shifted towards the centre line of road, uniformly overlapping

each preceding rear wheel track by one half width. This process is repeated by rolling from either edge towards the centre line until adequate compaction is achieved.

4) Screening:-
After the coarse aggregates are rolled adequately, the dry screenings are applied gradually over the surface to fill the interstices in three or more applications. Dry rolling is continued as the screening are being spread and brooming carried out.

5) Sprinkling and Grouting:-
After screening, the surface is sprinkled with water, swept and rolled. Wet screenings are swept into the voids using hand brooms.

6) Application of Binding Material:-
After the application of screening and rolling, binding material is applied at a uniform and slow rate at two or more successive thin layers. After each application of binding material, the surface is copiously sprinkled with water and wet slurry swept with brooms to fill the voids.

7) Setting and Drying :-
After final compaction, the WBM course is allowed to set over-night. On the next day the 'hungry' spots are located and are filled with screenings or binding material, lightly sprinkled with water if necessary, are rolled. No traffic is allowed till the WBM layer sets and dries out.

☒ Mechanics of Soil Stabilization:-
The term soil stabilization means the improvement of the stability or bearing power of the soil by the use of controlled compaction, proportioning and or the addition of suitable admixture or stabilizers.
The basic principles in this may be stated as:
(i) evaluating the properties of given soil
(ii) deciding the method of supplementing the lacking property of by the effective & economical method
(iii) designing the stabilized soil mix for intended stability and durability values.
(iv) considering the construction procedure by adequately compacting the stabilized layers.

Changes :-

(a) Increase in stability, change in the properties like density or swelling, change in physical characteristics.

(b) Change in chemical properties

(c) Retaining and desired minimum strength by water proofing.

Methods :-

(1) Mechanical soil stabilization

(2) Soil-cement))

(3) Soil-lime))

(4) Soil-bitumen))

(1) Mechanical Soil Stabilization

Correctly proportioned materials when adequately compacted to get a mechanically stable layer, the method is called mechanical stabilization. The two basic principles are:

(i) Proportioning (ii) Compaction.

Construction Procedure

1) Materials

2) Equipment

Steps :-

(i) The subgrade is prepared.

(ii) The materials are mixed to the desired proportion as per design.

(iii) The existing moisture content is checked by a rapid method and additional water required is spread and the material is re-mixed

(iv) The wet mix is spread to the desired grade and compacted by rollers. Rolling is started from the edges and with adequate longitudinal overlap, it is continued up to centre. Rolling is continued till adequate compaction is achieved.

When two layers such as base course and surface course are to be constructed, the process is repeated with appropriate proportions of mixes.

(v) Field Control tests : Two tests are necessary are

(a) determination of moisture content of the mix before compaction

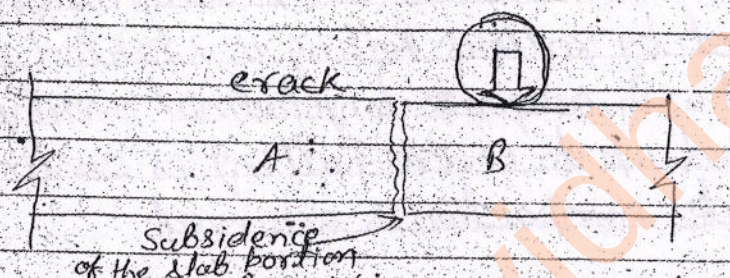
(b) determination of density during and just after compaction.

(vi) The stabilized road is opened to traffic after the compacted layer hardens by drying.

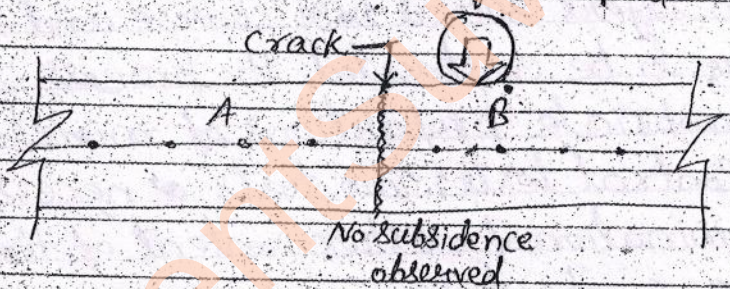
Note :- All methods have same steps as in cement concrete pavement

✱ Reinforced ~~Cement~~ Concrete Pavements

The reinforcement used in cement concrete pavements is in form of welded wire fabric or bar mats. The function of reinforcement is to hold the cracked slab portions together and thus not to allow them to open up any more. Sufficient load transfer across the crack is effected due to the reinforcement.



(a) No reinforcement



(b) With Reinforcement

The function of reinforcement is more or less similar to the dowel bars in contraction joints and tie bars to withstand tensile forces due to the movement of slabs and the frictional resistance between the bottom fibre of the concrete and the subgrade.

In order to obtain the maximum advantage, it is suggested that greater quantity of the reinforcement should be placed in the longitudinal direction.

✱ Prestressed Concrete Pavements :→

The prestressed pavement can be built in continuous length upto 120 m without joints. Elimination of joints without including cracks in the pavement could be considered advantageous. To accommodate higher loads, there is obvious tendency of increasing the thickness. It may be realized that an increase in the thickness gives rise to a greater temperature differential of the slab and also greater frictional resistance. A thick slab is therefore undesirable as well as costly.

Following are few observations for the design:

(a) Length: A length upto about 120 m can be prestressed for the pavement.

(b) Width: A width of 3.6 m is desirable and a longitudinal joint should be provided.

(c) Thickness: The maximum recommended thickness is ~~15 cm~~ 15 cm.

(d) Stress magnitudes: A minimum value of 22 kg/m^2 is recommended.

Prestressing is applied either by pre-tensioning or post-tensioning. For highway pavement, post-tensioning

system has been used.
The construction of prestressed concrete pavements is difficult job and needs a skilled team.