PART - B

PAVEMENT CONSTRUCTION

UNIT - 5

EQUIPMENT IN HIGHWAY CONSTRUCTION: Various types of equipment for excavation, grading and compaction – their working principle, advantages and limitations. Special equipment for bituminous and cement concrete pavement and stabilized soil road construction. 6 Hours

INTRODUCTION

Highway engineering project involves different types of equipment for Earth Excavation, Earth moving, and Earth cutting, grading, and hauling of excavated earth, aggregate spreader, roller, binder sprayer and paver finisher etc...

1. EXCAVATION EQUIPMENT:
   a. Dipper or Power shovel
   b. Dragline
   c. Clamshell
   d. Hoe

2. COMPACTION EQUIPMENT:
   a. Smooth wheel roller
   b. Pneumatic type roller
   c. Sheepsfoot roller
   d. Vibratory roller
   e. Hand operated vibratory roller

3. EARTH MOVING EQUIPMENT:
   a. Dozer
   b. Grading
   c. Wheel Loader
   d. Hydraulic Excavator
   e. Scraper
4. SPECIAL EQUIPMENT FOR CEMENT CONCRETE AND BITUMEN PAVEMENT:
   a. Batching plant
   b. Mixers
   c. Concrete Pumps
   d. Mini Mixers
   a. Paver finisher
   b. Hot mix plant or Bitumen mixer
   c. Bitumen sprayer
   d. Bitumen storage equipment

TRACTORS
Tractor is a multipurpose machine. It includes light models used for agricultural and small hauling works. It is versatile equipment having a variety of uses in road construction, such as To pull rippers and rooters. To pull towed scrapers. To pull sheepsfoot rollers. To push load scrapers. To pull towed pneumatic rollers
There are two main types of tractors:
   1. Crawler type
   2. Pneumatic wheel type
Crawler tractors have a low maximum speed, around 10kmph and are used primarily where high speeds are sacrificed in order to obtain good traction and high draw-bar pull. They are also preferred where the ground is not firm. Crawler mounted dozers have a digging and travelling with load speed of about 2.5kmph.
Pneumatic wheeled tractors are used for moving at high speeds (up to 50kmph) on firm ground. Pneumatic wheeled dozers have a digging and travelling with load speed of about 4 to 5 kmph. Now a days wheeled tractor units are used commonly for all earth moving jobs.

TRACTOR DOZERS
A tractor dozer, popularly called bull-dozer, is a tractor with a 3-3.5m long, 0.9-1.2m height blade mounted in front of it. If the blade of the equipment is set at angle, it is called an angle dozer. The blade of some dozers can be tilted in the vertical plane to a tilt of about 1 in 10. The equipment is versatile and can perform the following operations:
1. Clearing and grubbing land of vegetation and tree stumps.
2. Removing top soil from borrow areas.
3. Moving earth for short distances, say up to 100m.
4. Box- cutting a formation for laying pavement layers.
5. Opening up pilot road formations in steep hill sides to such a width that other equipment can move in and complete the work.
6. Spreading earth in layers.

Type of dozers:

**Angle dozer**: Meant to push its loads at an angle of approximately $30^0$ to the direction of travel of the tractor.
Specially useful in side-hill work where the material is to be piled in a long wind row to one side of the line of travel.

**Tilt dozer**: Designed such that the blade can be tilted by raising one corner up to 10inches above the other so that the machine can open up an excavation in hard ground or start excavation for a ditch or a trench.

**Tree dozer**: It has a V-blade at the front end attachment so that trees can be pushed by the upper frame of the blade while the lower edge is fitted with a stumper that can drive into the root.

**SCRAPERS**

Scrapers dig their own load, as they move forward. They combine the operations of digging, loading, hauling and discharging. There are main three operators is there:

**Bowl or Bucket**: The bowl is the loading and carrying component of a scraper. It has a cutting edge that extends horizontally across its front bottom edge. The bowl is lowered for loading and raised during travel.

**Apron or Lip**: The apron is the front wall of the bowl. It is independent of the bowl. It is raised during the loading and dumping operations to enable the material to flow into or out of the bowl. The apron is lowered during hauling to prevent material spillage.

**Ejector or Tail gate**: The ejector is the rear vertical wall of the bowl. The ejector is in the rear position during and hauling. During spreading, the ejector is activated and moves forward, providing positive discharge of the material in bowl.

The working principle of scraper is a cutting blade, which can be raised or lowered up to 20cm, is pulled through the earth causing it to travel up the face of the blade into the bowl of the
scraper. Some of the earth falls forward into a carrying apron. When the bowl is full, the aprons are lowered to prevent spillage and the cutting edge is raised. After hauling, the material is dumped by lowering the cutting edge to the desired height above the fill and opening the front apron. Two type of scrappers Towed and Motorized scrapers. Towed scrapers are available in size of 7-12cum and used for short hauling, say 150-500m, at a maximum speed of 10kmph. Motorized scrapers of size up to 25cum and haul for 500-1500m with 30kmph speed.

USES
1. Better loading ability in loose free flowing material
2. It can operated independently.
3. Additional of ripper teeth to cutting hard compacted mate.

GRADERS
It principally consist a blade below a framework. The blade be lowered, lifted or rotated. Graders are used for a number of purposes:
1. For spreading heaped earth into layers.
2. For shaping the cross-section during construction.
3. For maintaining the cross-section of embankment.
4. For maintaining gravel surface.

Graders are of two types Towed and Motorized. The towed grader is by a tractor and is usually made in small size.

Motor grader has a blade of about 3.5m, but its effective length during spreading becomes 2.75m. The blade can be set at any angle (360° horizontal) and some time vertically tilted depend upon work. A 100-110HP motor grader is a popular size. The normal grading speed is 3kmph. The output of a grader for spreading the earth, which is achieved generally in 4 passes, is about 1300sqm per hour, assuming 65% operating efficiency and a 50min working hour. Assuming a normal compacted thickness of layer of 15cm, the output in terms of compacted volume becomes about 200cum per hour.
APPLICATION
1. used for leveling or finishing earth work, making and maintaining project roads, construction of air fields and land reclamation.
2. the rollers can be attached to the rear, to compact the graded surface.
3. used in material mixing, hard surface cutting and snow clearance.
4. used particularly base course spreading, leveling bank cutting etc.

EXCAVATION EQUIPMENT

1. Dipper or Power shovel
These are used primarily to excavate earth & load into trucks or tractor pulled wagons. They are capable of excavating all classes of earth, except solid rock without prior loosening. They are mounted on crawlers tracks or mounted on rubber tyred wheel crawler mounted shovels have very low speeds which permit them to operate on soft ground. Single engine self propelled units are powered & operated from the excavator cab.

Working principle is digging above the machine base level to upwards. It consists of mounting cab, boom, dipper stick & dipper. When shovel is in correct position near the earth, the dipper is lowered to the floor of the pit, with the teeth pointing into the face. To start the machine a crowding force is applied through the shipper shaft & at the sometime tension is applied to the hoisting line to pull the dipper up the face of pit. If the depth of the face is deep considering the type of soil & the size of the dipper the dipper will be filled as it reaches the top of the face. If the depth of face is shallow it’ll not be possible to fill the dipper completely without excessive crowding & hoisting tensions. This subjects the equipment to excessive strains & reduces the output of the unit. If the depth of the face is greater than required to fill the dipper when operating under favorable crowd & hoist. It’ll be necessary to reduce the depth of penetration of the dipper into the face if the full face is to be excavated. The pit will be excavated after the upper portion of the face is removed.
APPLICATION
1. It can effectively operate from a lower level where it stands & depth of face to be excavated is not too shallow.
2. It carries large load and loading effect is very good for trucks.
3. If blasted rock is to be excavated the large size dipper will handle bigger rocks. If the material to be excavated is hard & tough, the dipper of the large shovel which exists higher pressures will handle the material more easily.

LIMITATIONS OF POWER SHOVEL
1. The cost of transporting a large shovel is higher than for a smaller one.
2. Not possible to excavate soil below ground.
3. Distance between foot & digging is less and not well suitable for wet soil.
4. If high output rate is needed in the project a large shovel must be used.
5. More shovels rotation required.

DRAGLINE:
In dragline, larger booms are provided, which allows digging & dumping over long distances as compared to the power shovel. It is most suitable for excavating the channels & canal, can handle wet material & suitable for excavation under water. One advantage of dragline is machine...
can be positioned on a higher elevation where trenches are excavated. It can dig materials below its track level & can handle only soft material. Capacity of the dragline is indicated by the bucket capacity measured in cum & generally available in 1 to 15 cum capacities.

Working principle of dragline is by 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. Dragline consists of the boom, bucket, hoist cable, dump cable & drag line. Excavating is accomplished by pulling the bucket towards the machine while regulating the digging depth by means of the tension maintained in the hoist cable. When the bucket is filled, the operator takes in on the hoist. The bucket is so constructed that it’ll not dump its contents until it is desired. Hoisting, swinging & dumping of the loaded bucket follow in that order then the cycle is repeated. Dumping is accomplished by releasing the drag cable.

Draglines have following types of buckets,

**Light:** These are suitable for loose, dry soils, sand & gravel.

**Medium:** These are used for clays & compacted gravel….etc. where bucket teeth penetrates with difficulty.

**Heavy:** These buckets are used for handling hard materials & broken rocks.

It is necessary to consider the weight of the bucket, since weight of the bucket with weight of the material in it is determined by the boom strength.

**APPLICATION**

1. Below ground level is excavated easily.
2. Where close trimming is required.
3. It swing horizontally at any angle and loading process is quick.
LIMITATIONS
1. keep bucket teeth sharp and built up to the proper size.
2. dig in layers, not in ditches.
3. keep digging surface sloped up towards shovel.
4. swing bucket unit with load cause twisted.

CLAM SHELL
It is a machine having most of the characteristics of dragline & crane in common. Clam shell consists of a bucket of two halves or shell which is hinged together at top. The shells may be attached to the shovel-crane units or at the boom of a drag line. 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. This equipment is useful for excavation of soft to medium materials and loose material at or below existing ground surface.

APPLICATION
1. Where digging or dumping in a vertical plane i.e., below at or above ground level is required.
2. For digging trenches.
3. Where materials relatively soft or medium hard.
4. For charging the materials in a bin or a stock pile.
5. Where accurate dumping is required.

HOE
This equipment also known as drag shovel or pull shovel. The equipment has ability to penetrate even the toughest of material. Due to this ability these are commonly used in quarries which have tough digging conditions & one prom to flooding. As the name itself indicates digging of the earth is done by dragging or pulling of the earth is done by dragging or pulling of the bucket towards machine whereas in power shovel bucket makes outward strokes while digging.
This shovel consists of bucket & stick, a jack boom, the stick in hoe is hinged by a pin with a boom as shown in the figure & thus enables to take any desired turn best suited for digging or dumping operations. The lower end of the stick carries the bucket, while the upper end comes a
sheave having a hoist cable supported on a jack boom at the other end & passes on to the hoist drum. Therefore when a pull is applied to a hoist cable, the reaction at the hinge enables boom with stick to move up or down. Thus the boom can take any position in vertical plane.

APPLICATION

1. For digging the trenched, footings or basements.
2. To dig materials which is hard.
3. When excavation is required below the ground level & digging done at the short span.
4. When close trimming is required during excavation.

COMPARISON

<table>
<thead>
<tr>
<th>Point of consideration</th>
<th>Dipper shovel</th>
<th>Dragline</th>
<th>Backhoe</th>
<th>Clamshell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation in hard soil or rock.</td>
<td>good</td>
<td>Poor</td>
<td>Good</td>
<td>good</td>
</tr>
<tr>
<td>Operation in wet soil or mud.</td>
<td>poor</td>
<td>Fair</td>
<td>Poor</td>
<td>fair</td>
</tr>
<tr>
<td>Distance b/w footing and digging.</td>
<td>small</td>
<td>Long</td>
<td>Small</td>
<td>long</td>
</tr>
<tr>
<td>Loading efficiency into the vehicles.</td>
<td>Very good</td>
<td>Fair</td>
<td>Good</td>
<td>Precise but slow</td>
</tr>
<tr>
<td>Digging level.</td>
<td>At or above footing level</td>
<td>Below footing level</td>
<td>Below footing level</td>
<td>At or above footing level</td>
</tr>
<tr>
<td>Cycle time as compared to dipper shovel</td>
<td>-</td>
<td>More</td>
<td>Slightly more</td>
<td>High</td>
</tr>
</tbody>
</table>
COMPACCIÓN EQUIPAMIENTO

1. Three-wheeled road roller
This is the most common rolling equipment and is versatile in applications. It is diesel powered; the diameter of the front roll is around 105cm, its width being around 100cm. The diameter of the rear roll is around 145cm, its width being around 50cm. The rolling width is around 2m. The front roll gives a load of around 35-40 kg/cm width and the rear roll gives a load of 70-80 kg/cm width. The speed of rolling is in the range 1.5-6.0 kmph. The output of a three wheel roller, 8-10 T, for various jobs. The smooth wheel roller is suitable to roll a wide range of soil, preferably granular soil and pavement materials for the various layers. Generally 6-12 passes are needed.

2. Pneumatic tyred roller
Pneumatic tyred rollers consist of a box mounted over two axle, the rear axle having one more wheel than the front and the wheels of the front axles so arranged that they are located in plan in b/w the rear wheels. Generally there are four wheel in front and five at rare. Weight is in the range of 12-45 tonnes. The roller is suitable for compacting non-plastic soils and silty soils. The optimum speed is 4kmph. Pneumatic tyred rollers are also used for intermediate rolling of dense asphaltic concrete. Rolling of 12-18 T is used. The tyre pressure should be a minimum of 0.5 MN/m². The no. of passes required is about 8-12.

3. Sheepsfoot rollers
Sheepsfoot rollers consist of hollow circular drums of steel 1.2-1.5m long and 0.9-1.2m dia, with legs or tamping feet on the circumferential area at the rate of 12-18 per square meter of area. The tamping feet on the drums are staggered into rows. The rollers can be ballasted with water or wet soil. The weight of a single drum is in the range 1200-1800kg when empty and 2200-2800kg when ballasted. A tractor of 45HP can pull a single drum. A speed of 4 kmph is common. Sheepsfoot rollers are suitable for cohesive soil and the moisture content of the soils should be preferably near their plastic limit. The no. of passes of sheepsfoot rollers depends upon the type of soil, moisture content and density desired. Generally 8-16 passes are needed. Using a
sheepsfoot compactor has one definite benefit. Because the top lift of soil is always being fluffed, the process helps aerate and dry out wet clays and silts.

But the disadvantages of sheepsfoot compactors are numerous. The loose top-lift material can act as a sponge when it rains and slow the compaction process. The loose material also slows hauling units that deposit fill material, so haul cycle times are increased.

4. **Vibratory rollers**

Vibratory rollers have become very popular in highway engineering applications in recent years with the growing need to compact pavement layers and subgrade to high density. Compacting to such high density by static roller is very difficult and costly. Since vibratory rollers induce oscillations, they are able to 1. Achieve break-down of internal friction between particles of road construction materials and 2. Bring about better orientation of particles caused by cyclic deformation. Both cohesive and non-cohesive materials can be compacted by vibratory rollers. Vibratory rollers are used for compacting soils and granular layers, a frequency of 1500-2500 vibrations per minute and amplitude of 0.8-1.5mm are recommended.

**COMPARISON**

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>Compaction equipment</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Smooth wheel roller</td>
<td>1. Earth rolling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Soil stabilization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Rolling granular base</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Rolling surface dressing, premix carpet, mix</td>
</tr>
<tr>
<td></td>
<td></td>
<td>seal, bituminous macadam, built-up-spray grout.</td>
</tr>
<tr>
<td>2</td>
<td>Sheepsfoot roller</td>
<td>1. Rolling cohesive soils</td>
</tr>
<tr>
<td>3</td>
<td>Pneumatic tyred roller</td>
<td>1. Rolling non-plastic silty and silty soils</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Intermediate rolling of asphaltic concrete</td>
</tr>
<tr>
<td>4</td>
<td>Vibratory roller</td>
<td>1. Compacting sand and cohesionless soil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Compacting all type of soils for obtaining high</td>
</tr>
</tbody>
</table>
densities
3. Compacting granular bases and sub-bases to obtain high densities
4. Compacting bituminous bases and surfaces to obtain high degree of compaction

|   | Hand operated vibratory rollers | 1. Compacting sand and cohesionless soil
2. Compacting in restricted space. |
---|---------------------------------|---------------------------------|

SPECIAL EQUIPMENT FOR BITUMEN AND CEMENT CONCRETE PAVEMENT

1. **Bitumen storage equipment:**
   Bitumen is stored in drums or in special bulk handling depots. The capacity of one drum is 155-162 kg of bitumen. The bitumen tank-lorry has a capacity in the range of 6-12 T. A pump with a capacity of about 200-300 liters per minute is provided. The tank is adequately insulated and arrangement for heating and pumping is provided.

2. **Bitumen boilers:**
   Bitumen boilers are needed for heating bitumen obtained in packed form. Boilers of a wide range of capacity are available. 100-10,000 liters capacity boilers are standardized by ISI.

3. **Bitumen pressure distributors:**
   A bitumen pressure distributor is a tank of capacity 5000-20,000 liters mounted on a lorry, having oil-fired burners and a pump. Bitumen can be applied at a pressure on to the road surface in connection with specifications like surface dressing, grouted macadam, built-up-spray grout, seal coat, tack coat etc. The quantity of bitumen can be accurately controlled by a metering device and also with speed at which vehicle operates.

4. **Bituminous Hot-Mix Plants:**
   In a batch mixing plant, various sizes of hot aggregates in storage bins are withdrawn in predetermined quantities to make one ‘batch’ before mixing with a predetermined quantity of bitumen. It comprises the following:
a. **Cold aggregate storage bins of different aggregate sizes:** These should be at least four in number, with discharge gates to control the flow of aggregates of different sizes in the desired amounts.

b. **Conveyor and cold elevator:** The cold aggregate feeding system discharges onto a conveyor in pre-set quantities to give the required grading and then into the cold elevator which discharges into the dryer.

c. **Dryer:** The main functions of a dryer are (i) removal of moisture from the aggregates, and this vapour is drawn off by the draught (ii) to heat the aggregate so that they are of the right temperature for mixing with bitumen in the pug mill.

d. **Temperature measuring device:** It is essential for the control of quality of the mix

e. **Hot elevators:** These consist of a system of bucket elevators housed within a covered chamber.

f. **Hot screening unit:** The hot materials carried by the elevators are discharged over a multi-deck vibrating table screen which separates the different aggregate fractions into the different hot bins.

g. **Hot aggregate bins:** These are the temporary storage for the hot aggregates of different sizes. They have discharge gates opening at the bottom.

h. **Fill silo:** Because of its fineness, the filler material is stored separately in a filler silo and, after weighing, the hopper discharges the filler material into the mixer, generally after bitumen has been admitted into the mixer.

i. **Bitumen supply arrangement:** bitumen is pumped into a special bucket of known weight and weighed on a scale or it may be measured in volume by a meter.

j. **Measuring and mixing of aggregate and bitumen:** The aggregate is drawn from hot bins in predetermined quantities and dropped into a pug mill mixer in batches; the required amount of bitumen is added and mixed with aggregate. The hot aggregates and the hot bitumen are thoroughly mixed in the pugmill mixer.

k. **Discharge into truck or hot storage silo:** After the mixing operation has been completed, the final mixture is discharged from the bottom of the pug mill mixer directly to the hauling truck below or taken to a hot storage silo for temporary storing the mix, before hauling.
5. **Paver finisher:**
A paver finisher is indispensable for laying hot-mix hot-laid bituminous specifications. The equipment is self-propelled and is capable of laying the bituminous material to any desired thickness and partially compact it by means of a vibrating screed. The paver has a hopper into which the rear-dump trucks can discharge the mix. The paver may be crawler mounted (tracked) or equipped with rubber tyres which permit a greater degree of freedom for movement. The crawler-mounted machines are more stable and can support greater width of the screed. The screed width can be adjusted, generally in the range 2 to 5m. The bituminous mix discharged for a tipper lorry into the receiving hopper in the front portion of the paver is carried along the conveyor through flow control gates to the augers which distribute the material in front of the screed, to the full width of the screed. A strike of beam, which also tamps the mat, controls the layer thickness. The paver finisher operates at speeds 1.5-10m/min. A speed of 3-5m/min will be found generally acceptable. The width of the mat can be adjusted in the range 2-5m. The cross-profile can be controlled by adjusting the screws of the strike-off beam. Paver finisher of capacity 45-75 T/hr are generally used for roadwork.

1. **Batching and mixing plants:**
The ingredients for concrete are always proportioned by weight in a weigh batching equipment. Mixing of concrete is done by concrete mixers which are available in a variety of sizes, mixing is continued for a period of not less than one and half minutes after all the materials are introduced. Tilting drum type mixers are available in small sizes, whereas not-tilting drum type mixers are available in large sizes.

2. **Transportation, placing and compaction concrete:**
Generally, 5 to 10 m³ tippers are ideal for transportation and placing concrete. Concrete discharged on the carriageway is spread over the whole width with the help of screw spreader. Concrete paver finisher consists of spreading, consolidating, screening, finishing, texturing and curing operation. Slip form pavers are much heavier and more powerful equipments which move on tracks compared to the fixed form machines. A typical slip form train consists of paver,
intended for spreading the mix over the width of the carriageway, a finisher which vibrates, forms an appropriate mould and finishes the surface and lastly, a piece of equipment capable of texturing and spraying the curing compound. Slip form paving is more popular than fixed form paving.

STABILIZED SOIL ROAD CONSTRUCTION

The soil stabilization means the improvement of stability or bearing power of the soil by the use of controlled compaction, proportioning and/or the addition of suitable admixture or stabilizers.

BASIC PRINCIPLES OF SOIL STABILIZATION

Evaluating the properties of given soil
Deciding the lacking property of soil and choose effective and economical method of soil stabilization

NEED FOR SOIL STABILIZATION
1. Designing the Stabilized soil mix for intended stability and durability values
2. Limited Financial Resources to provide a complete network Road System to build in conventional method
3. Effective utilization of locally available soils and other suitable stabilizing agents.
4. Encouraging the use of Industrial Wastages in building low cost construction of roads.

METHODS OF SOIL STABILIZATION
1. Mechanical Stabilization
2. Soil Cement Stabilization
3. Soil Lime Stabilization
4. Soil Bitumen Stabilization
5. Lime Fly ash Stabilization
1. Mechanical Stabilization
   a. This method is suitable for low volume roads i.e. Village roads in low rainfall areas.
   b. This method involves the correctly proportioning of aggregates and soil, adequately compacted to get mechanically stable layer
   c. The Basic Principles of Mechanical Stabilization are Correct Proportioning and Effective Compaction.

Factors Affecting Mechanical Stabilization

1. Mechanical Strength of aggregates
2. Gradation
3. Properties of the Soil
4. Presence of Salts
5. Compaction

Mechanical Strength
When the soil is used in small proportion to fill up the voids the crushing strength of aggregates is important

Gradation
A well graded aggregate soil mix results in a mix with high dry density and stability values

Properties of soil
A mix with Plasticity Index, results poor stability under soaking conditions. Hence it is desirable to limit the plasticity index of the soil

Presence of Chemicals
Presence of Salts like Sulphates and mica are undesirable
Presence of Calcium Chloride is Beneficial

Compaction
Effective Compaction is desirable to produce high density and stability mix.
2. Soil Cement Stabilization
1. Soil Cement is an intimate mix of soil, cement and water, compacted to form a strong base course.
2. Cement treated or cements modified soil refers to the compacted mix when cement is used in small proportions to impart some strength.
3. Soil Cement can be used as a sub-base or base course for all types of Pavements

Factors affecting soil cement stabilization
1. Soil
2. Cement
3. Pulverisation and Mixing
4. Compaction
5. Curing
6. Additives

3. Soil Lime Stabilization
1. Soil- Lime has been widely used as a modifier or a binder
2. Soil-Lime is used as modifier in high plasticity soils
3. Soil Lime also imparts some binding action even in granular soils

Factors affecting Properties of Soil-Lime
1. Generally increase in lime content causes slight change in liquid limit and considerable increase in Plasticity index
2. The rate of increase is first rapid and then decreases beyond a certain limit
3. The point is often termed as lime fixation point
4. This is considered as design lime content

4. Soil- Bituminous Stabilization
1. The Basic Principles of this stabilization are Water Proofing and Binding
2. By Water Proofing inherent strength and other properties could be retained
3. Most Commonly used materials are Cutback and Emulsion
4. Bitumen Stabilized layer may be used as
5. Sub-base or base course for all the roads

5. Lime fly ash stabilization
   1. A mixture of fly ash and soil when stabilized using lime is called lime flyash stabilization.
   2. This material can be used for constructing sub base or base course of rural roads.
   3. This would be particularly attractive where fly ash is easily available.

6. Lime fly ash bound macadam
   1. In conventional WBM, low plastic materials, with screenings are used as filler materials.
   2. Filler is made up of a mixture of lime, fly ash and moorum in suitable proportion improves the performance.
   3. This is termed s LFBM
   4. The load bearing capacity of LFBM will be superior to that of WBM.

1. Explain the procedure of the compacting equipment’s used for highway construction?
   Mention its specific uses.
2. List any four types of equipment’s used for i) Grading ii) Compaction and explain any one equipment for each.
3. Explain the working principle of i) Power shovel ii) Drag line with neat sketch iii) scrapers iv) pavers.
4. Mention the equipment’s used for excavation in the construction of bituminous pavements. Explain any two, with neat sketches. For wet mix macadam.
5. List various equipment s used for the road construction. State the merits and demerits of any three sophisticated equipment.
6. Explain any one test procedure of quality control test used to evaluate adequacy of sub base compaction.
7. List and explain types of compacting equipment used for highway construction. Bring out advantages and disadvantages of sheep foot rollers.

8. Mention any four types of equipment’s used for i) excavation ii) cement concrete pavement construction and explain any one equipment for each.

9. Describe the specification and working principle of a paver finisher.

10. Enumerate the steps in the preparation of subgrade. How is the adequacy of the compaction in the field evaluated?

**TEXT BOOKS:**


**REFERENCES BOOKS:**


2. RRL, DSIR, ‘Soil Mechanics for Road Engineers’, HMSO Publication.

3. Relevant IRC codes and MoRT & H specifications.