CBCS SCHEME

USN | | | | | | | | | | |

18CV733

Seventh Semester B.E. Degree Examination, Feb./Mar. 2022
Pavement Materials and Construction

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Briefly explain the basic classification of aggregates. **(05 Marks)**

b. Write a note on aggregate blending to meet the specified gradation. **(05 Marks)**

c. Explain and indicate the suitability of following tests on the selection of proper aggregates for various pavement constructions with their permissible limits:
i) Aggregate impact test
ii) LOS Angles abrasion test. **(10 Marks)**

OR

2 a. Explain the manufacturing process of bitumen with a neat sketch. **(10 Marks)**

b. Explain the following tests conducted on bituminous binders with neat sketches:
i) Penetration test
ii) Softening point test. **(10 Marks)**

Module-2

3 a. Explain briefly the preparation of emulsion and types of emulsions. **(10 Marks)**

b. What are cutbacks? How are they prepared? Mention types of cutbacks with applications of each type. **(10 Marks)**

OR

4 a. What is stripping of bitumen? Briefly explain the mechanism of stripping and mention the methods of improving adhesion. **(10 Marks)**

b. List out types of adhesion tests. Explain in brief about immersion trafficking test with neat diagram. **(10 Marks)**

Module-3

5 a. Explain the mechanical properties of Bituminous mix. **(10 Marks)**

b. Explain briefly Marshall method of Bituminous mix design. **(10 Marks)**

OR

6 a. The specific gravities and weight proportions for aggregate and bitumen are as under for the preparation of Marshall mix design. The volume and weight of one Marshall mix design. The volume and weight of one Marshall specimen was found to be 475CC and 1100gm. Assuming absorption of bitumen in aggregate is zero, find V_v, V_b, VMA and VFB.

Item	Aggregate	Aggregate 2	Aggregate 3	Aggregate 4	Bitumen
Weight (gm)	825	1200	325	150	100
Special gravity	2.63	2.51	2.46	2.43	1.05

(12 Marks)

b. Explain how the optimum bitumen content is determined. **(08 Marks)**

Module-4

7 a. With neat sketch, explain i) Dragline ii) Power shovel. **(10 Marks)**

b. Discuss the suitability of different compacting equipments. Briefly explain working principle of sheeps foot rollers, with neat sketch. **(10 Marks)**

OR

8 a. Enumerate the steps involved in the formation of embankment. **(10 Marks)**

b. Write short notes on:
i) Desirable properties of subgrade soil
ii) Quality control tests for subgrade construction. **(10 Marks)**

Module-5

9 a. Explain the material specification, construction procedure for water Bound Macadam roads. **(10 Marks)**

b. Write a note on construction of Dense Bituminous Macadam pavement. **(10 Marks)**

OR

10 a. With the neat figures, explain the following types of joints in rigid pavements:
i) Expansion joint
ii) Contraction joint
iii) Longitudinal joint. **(12 Marks)**

b. Differentiate between flexible and rigid pavements. **(08 Marks)**

* * * * *

Pavement Materials and Construction - 18CV733

1a: Briefly explain the basic classification of aggregates (5 M)

Aggregates are classified into following types.

a) Natural Aggregates

b) Artificial Aggregates

Natural Aggregates: Those aggregates derived from natural rocks.

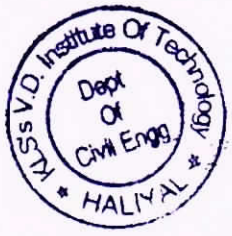
Artificial Aggregates: Those, which are derived from waste of metallurgical process.

Petrological classifications:

a) Igneous rocks

b) Sedimentary rocks

c) Metamorphic rocks.



Igneous rocks: Are obtained from molten magma from volcanic erruption.

Sedimentary rocks: Are formed primarily either by the depsit insoluble residue from the disinfection of existing rocks.

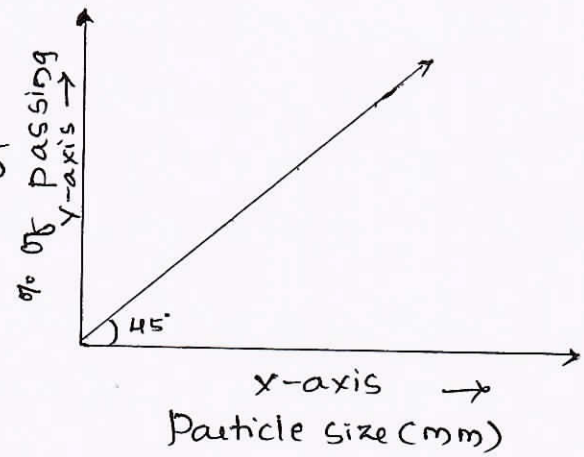
Metamorphic rocks: Igneous or sedimentary rocks that have been subjected to heat and pressure sufficient to change their mineral structure.

1b. Write a note on aggregate blending to meet the specified gradation (5M).

In order to get the good bonding between the aggregates or soil, there should be a very good proportion of different particle size in given sample. If the proportion of particles are good then bonding will be good, which leads to a very good strength.

In order to bare this well proportioning many blending methods are there in practice. Out of all this "Rothfutch's" method is considered as the best method.

Graphical representation of "Rothfutch's method".



1c. Explain and indicate the suitability of the following tests on the selection of proper aggregates for various pavement construction with their permissible limits. (10 M)

a). Aggregate impact test

b). Los angles abrasion test.

8. Aggregate Impact test :

Laboratory test conducted to check the toughness value of aggregate.

- Aggregate passing through 12.5 mm siere & retaining on 10mm siere are taken.
- Aggregates retaining on 10mm are taken in measuring cylinder in 3-layers - 25 blows / Layers → W_1 taken
- Cafer aggregates from measuring cylinder are transfered to test cylinder level.
- Rammer weight of 13.5 to 14.0 kg with falling weight 380 mm taken & 15 blows are given.
- Now crushed aggregates are made to pass through 2.36 mm siere → W_2 taken = Final weight of aggregat

$$\text{Impact value} = \frac{W_2}{W_1} \times 100 = \_\_\_\_\_ \%.$$

IRC recomendation :

0-10 % — Exceptionally strong
10-20 % — Very strong
20-30 % — Surface course
> 35 % — Weak for pavement sufac.

The aggregate impact value should less than 30% for any layer in the pavement construction.

ψ. Los Angels abrasion test:

Laboratory test is conducted to check Hardness property of the coarse aggregate.

Grades like A, B, C, D, E, F and G are considered

Initial weight of aggregate and metal spheres are taken based up on grade of the aggregate, Even the no. of machine revolutions.

Eg: For grade A: 5000 gms of aggregate, 110 spheres and 500 rotations are given. Followed other grades.

a). All the set up is done, above materials like 5kg as W_1 gms.

b). Material W_1 gms is put in abrasion machine, proper number of spheres are added as per the grades and revolutions are given.

c). After all the process aggregates are taken out and passed through 1.7mm siere – W_2 gms

Hardness value = $\frac{W_2}{W_1} \times 100$ = _____ %.

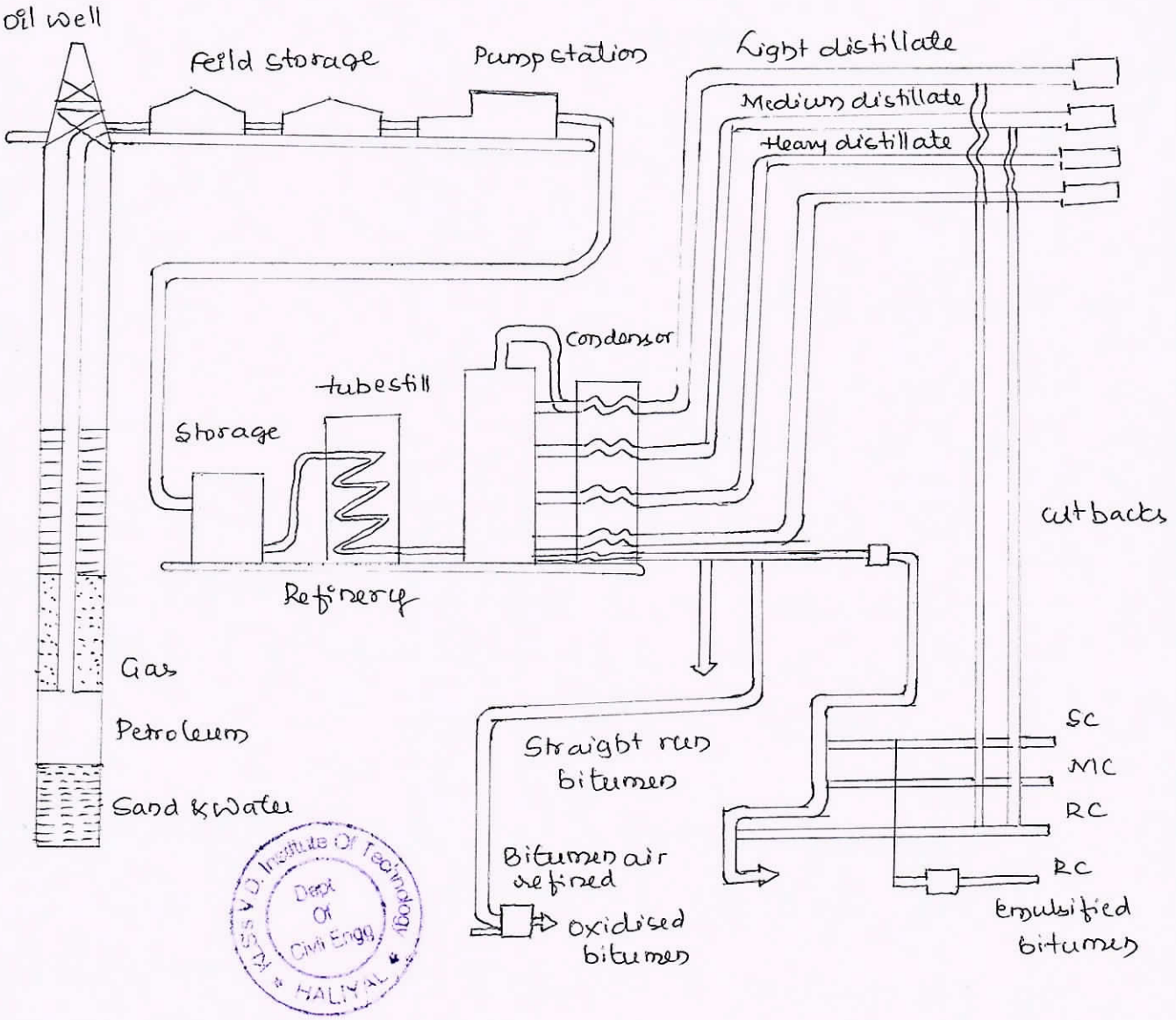
IRC Specifications:

Up to 30% – High quality pavement like Bituminous concrete

CC and DDM – Up to 35%.

Up to 40% – for GSB and bituminous layers

2a Explain the manufacturing process of bitumen with the neat sketch.



1). Crude petroleum from the oil well is pumped to feild storage and then pumping station.

2). From the pumping station bitumen is stored in storage tank to tubestill after that bitumen is taken to condensor from the condensor the bitume obtained as residue at the bottom of the condensor.
Following products are collected like light distillate, medium distillate and heavy distillate.

3). When a volatile is added to bitumen various cut back are collected.

26. Explain the following tests conducted on bituminous binder with the neat sketches.

i). Penetration test

ii). Softening point test

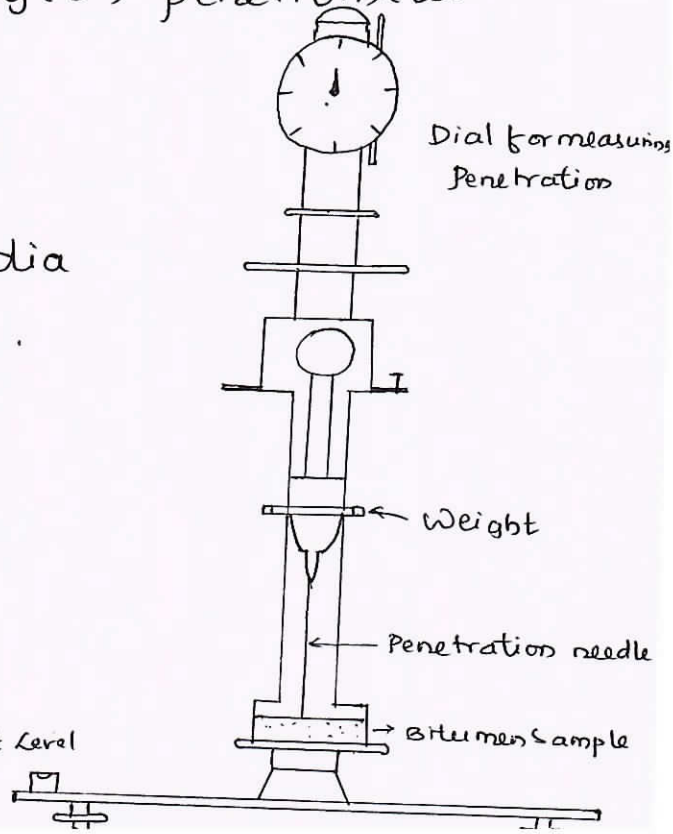
i). Penetration test :

a). known quantity of bitumen is taken and heated till it softens.

b). Hot bitumen is transfered to penetrometer testing mould & kept in water for one hour before testing. But after pouring it is kept at room tempreture for one day.

c). Definate weight of needle is attached to penetrometer and made to penetrate for 5 secs.

d). Penetration is carried out for 3 times and avg value is taken from dial guage on penetrometer.



IRC Specifications :

Grades of bitumen used in India are 30/40, 60/70 and 80/100.

a). Softening Point test:

As bitumen is crude oil product it is obtained from destructive distillation of crude oil.

Bitumen doesnot have boiling point, it has softening point.

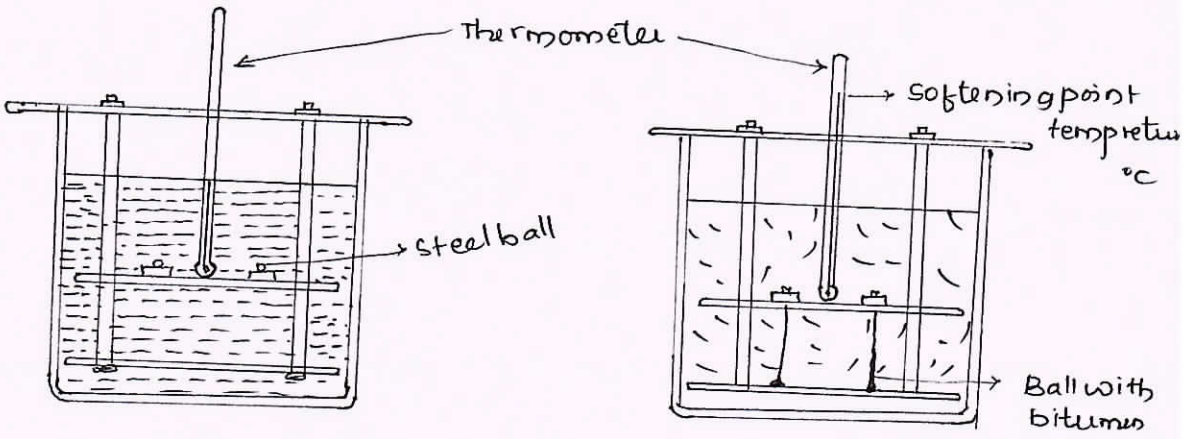
a). Like other construction material, we are having different types in it. Similarly bitumen is also classified with different types.

b). Bitumen grades are classified as 30/40, 60/70 and 80/10 based on bitumen grade, softening point varies.

c). Apparatus consist of beaker with magnetic stirrer and sensor.

d). Bitumen is filled in a test ring and above which metal sphere ball is placed and the whole arrangement is inserted in a beaker consisting of water.

e). Tempreture is adjusted & when bitumen falls down to the bottom plate respective tempreture is noted and average tempreture is noted as softening point tempreture = _____ °c



3a Explain briefly the preparation of emulsions and types of emulsions.

A bitumen emulsion is liquid in which a substantial amount of bitumen is suspended in a finely divided conditions in an aqueous medium and stablized by means of one or more suitable materials.

Two common methods followed for the preparation of emulsions are colloid mill method and high speed mixer method. The manufactured emulsion is stored in air tight drums. Bitumen emulsion shall be homogeneous and it should not show undispersed bitumen after thorough mixing within one year from the date of manufacture

Five types of bitumen emulsions are prepared

a). Rapid setting RS-1 and RS-2
b). Medium setting type MS
c). Slow setting type SS-1 and SS-2.

3b. What are cutbacks? How are they prepared? Mention types of cutbacks with application of each type.

cutback bitumen is obtained by blending bitumen binder with suitable volatile diluents or solvent in the required proportions to reduce its velocity to the desired range.

cutback bitumen is a modified bitumen with addition of volatiles.

Types of cutback with applications:

a). Rapid curing: classified as BIS, on the basis of initial kinematic viscosity into a four grades with designations RC-70, RC-250, RC-800 and RC-3000 in increasing order of initial velocity.

b). Medium curing: Medium curing (MC) cutback bitumen is classified on the basis of initial viscosity into five grades MC-30, MC-70, MC-250 and MC-800 in the increasing order of viscosity.

c). Slow curing: Slow curing (SC) cutbacks are classified as SC-70, SC-250, SC-800 and SC-3000.

4a What is stripping of bitumen? Briefly explain the mechanism of stripping

The process of detachment of coated binder from the aggregate due to the presence of water.

Mechanism of stripping:

The displacement of one liquid by another on a solid surface arises from the physic-chemical force acting in the system.

Most sand stones have surfaces that are electrically charged for example: Silica, a common constituent of igneous rocks, possesses a great negative surface charge resulting from the presence in the surface of

oxygen atoms. which are not fully satisfied electrically.

Generally, the constituents of bituminous binders have little polar activity being largely composed of high molecular weight hydrocarbons. The bound between bituminous binder and stone is therefore primarily due to relatively weak dispersion forces. The polar liquid water on the other hand is strongly attracted to the charged coal, stone surfaces by orientation forces.

4b. List out the types of adhesion tests. Explain in brief about immersion trafficking test with neat diagram.

Adhesion test: It is desirable that there should be a reliable method of determining in the laboratory whether bituminous binder will adhere to the aggregate or not.

Types of adhesion tests:

a). Static immersion test
b). Dynamic immersion test.
c). Chemical immersion test
d). Mechanical immersion test.
e). Immersion trafficking test.
f). Coating tests.

Immersion trafficking test :→

The test may be carried out on circular track machines on where traffic is simulated by reciprocating wheels. which pass over the specimen

Immersion trafficking test:

This consist of three tyred wheels each 8 inch. in diameter and 2 inch wide which traverse through specimens of road materials. The wheel travel with reciprocate motion of frequency 25 cycles/minute and stroke about 11 inch.

Each wheel is loaded to give total weight 30lb/sq.inch bearing on the specimen.

Specimen contained in perforated metal moulds 1¼ inch deep and 12 inch long & 4 inch wide, mounted horizontally on a water bath so that water level is well above the top of specimen.

The road material is compacted in moulds under Standard condition, and cured for a short time before immersion.

The temperature of water bath when the test carried out is normally 40°C, the specimen before the commencement of test shall be placed in the water bath for one hour.

The method which is adopted to measure stripping is that the time necessary to produce failure. If the depth of penetration of the wheels into the specimen of road material is recorded with time, it is found that at first there is a small & steady compaction of the specimen under the loaded wheels and then suddenly there is a sharp break in the curve where the wheels penetrate into the specimen.

5a. Explain the mechanical properties of bituminous mix.

Bitumen should have following mechanical properties.

a). Good Adhesion: A suitable binder must combine all construction materials and make it as single unit. Bitumen should highly adhesive.

b). Water proof: Mainly, bitumen is used in exposed works like road construction, water proofing etc. It has to tackle different climatic conditions. Including rain. It should be insoluble in water.

c). Strength: through minerals or filler material are the main bearing components. Bitumen should also have sufficient strength to resist different live loads.

d). Durability: Bitumen should bind all construction materials together for a long time in adverse weather conditions.

e). Versatile: Bitumen should show a versatile nature. It must be workable during the construction phase and must be rigid in operation phase.

f). Economy: Bitumen must be economical to use although the cost of the bitumen depends up on the grade, it should available cheaply.

5b. Explain briefly Marshall method of Bituminous mix design?

a) Specified or desired gradation of mixis selected from the recommended samples at (gradation) for particular type of pavement material (Layer).

b) Representative samples of aggregate at different sizes proposed to be used in the project are collect from site of the crusher.

c) Sieve analysis is carried out on the samples of the aggregates collected and proportion in which they should be mixed to obtain desired gradation is determined.

d) The specific gravity of the coarse aggregates and fine aggregates and the bituminous binder used are determined.

e) Adequate quantity of aggregates and mineral fillers are collected and mixed in desired proportions of (3) above.

f) Five or six bitumen contents to be used in the trial mixes are selected so as to cover at least two values each below and above probable estimated value of OBC.

g) Marshall stability test specimens are prepared by compacting in the mould with specified number of blows (75 no's each side) using the different percentage of bitumen content.

5). The weight and mean dimension or volume are determine on each specimen.

8). The values of percentage of air voids (Vr), voids in mineral aggregates (VMA) and the voids filled with bitumen (VFB) are calculated for specimen prepared.

6a. The specific gravities and weight proportions for aggregate and bitumen are under for the preparatio of Marshall mix design. The volume and weight of one Marshall mix design. The volume and weight of one Marshall specimen was found to be 475 cc and 1100gm. Assuming absorption of bitumen in aggregate is zero, find Vr, V_b, VMA and VFB.

Iteam	Ag-1	Ag-2	Ag-3	Ag-4	Bitumen
Wt(gm)	625	1200	325	150	100
Sp.Gr	2.63	2.51	2.46	2.43	1.05

$$G_t = \frac{625+1200+325+150+100}{\frac{625}{2.63}+\frac{1200}{2.51}+\frac{325}{2.46}+\frac{150}{2.43}+\frac{100}{1.05}} = \frac{1100}{475} = 2.316$$

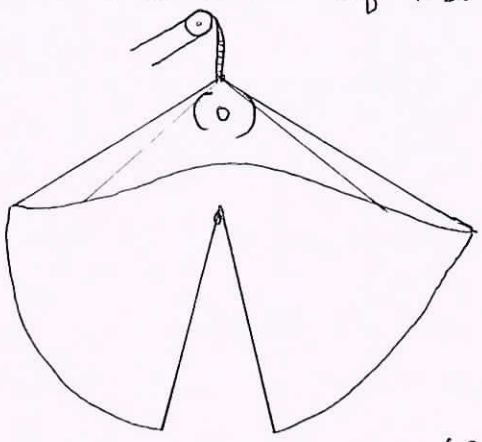
$$V_r = \frac{(G_t - G_m)}{G_t} \times 100 = \frac{2.406 - 2.316}{2.406} \times 100 = 3.741\%$$

$$V_b = \frac{\frac{W_b}{G_b}}{\frac{W_1+W_2+W_3+W_b}{G_m}} = \frac{100}{1.05} \times \frac{2.316}{1100} = 20.052\%$$

$$VMA = V_r + V_b = 3.741 + 20.05 = 23.793\%$$

$$VFB = \frac{V_b}{VMA} \times 100 = \frac{20.052}{23.793} \times 100 = 84.277\%$$

and then pulled back towards the base of the machine

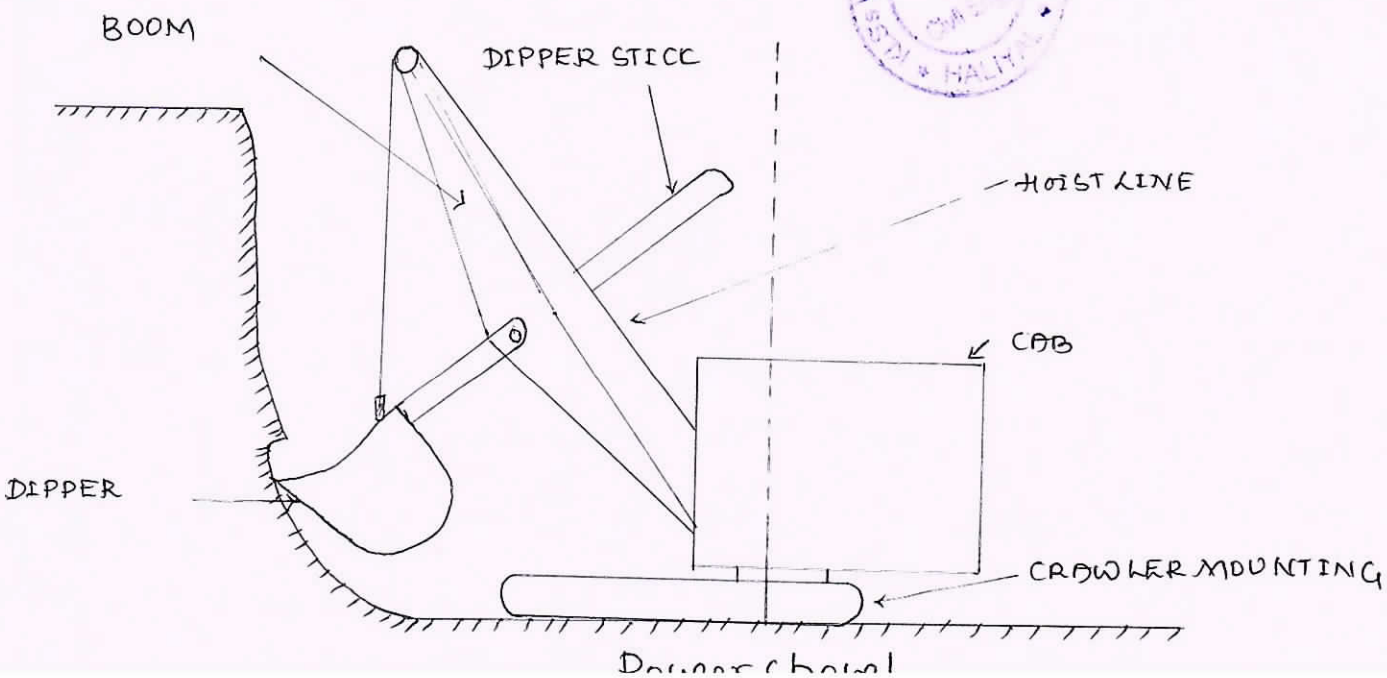


Dragline

b). Power Shovel :

Power shovel is used primarily to excavate earth of all classes except rock and to load it into wagons. Power shovel may be mounted on crawler track and so they are stable and can move at low speeds.

The power shovel can effectively operate to excavate earth from a lower level where it stands. As the dipper moved upwards, the cutting edge can excavate even stiff earth, the bottom of the shoveer can swing and the excavated material can be dumped into wagons.



Power shovel

6b. Explain how the optimum bitumen content is determined.

Marshall stability and flow test provides the performance prediction measure for the marshall mix design method.

Approximately 1200gm of aggregates and filler is heated to a tempreture of 175°c to 190°c. Bitumen is heated to a tempreture 121°C to 125°c with first trial % of bitumen (say 3.5 or 4%) to the heated aggregates and thoroughly mixed at tempriture 154°c & 160°c. The mix is placed in preheated mould and compacted by rammer with 50 blows on either side at tempreture 138°c to 149°c. The weight of mixed aggregate taken for the preparation of the specimen may be suitably altered to obtain a compacted thickness of 63.5 ± 3 mm. Vary the bitumen content in the next trial by 0.5%. and repeat the above procedure.

Following parameters to be calculated

$$G_t = \frac{W_1 + W_2 + W_3 + W_b}{\frac{W_1}{G_1} + \frac{W_2}{G_2} + \frac{W_3}{G_3} + \frac{W_b}{G_b}}$$

Bulk specific gravity mix

$$G_m = \frac{W_m}{W_m - W_w}$$

Air voids present V_v

$$V_v = \frac{(G_t - G_m)}{G_t} 100$$

volume of bitumen

$$V_b = \frac{\frac{W_b}{G_b}}{\frac{W_1 + W_2 + W_3 + W_b}{G_m}}$$

7a. With the neat sketch, explain a). Dragline b). Power shovel.

a). Dragline:

Dragline is a type of excavation equipment. It is used to excavate soft earth and to deposit in near by banks or to load into wagons. Dragline may be mounted on a crawler track.

The basic parts and operation of dragline are shown in the figure. The bucket is thrown out from the dragline on the top of the earth to be excavated

7b. Discuss the suitability of different compacting equipments. Briefly explain working principles of sheep foot roller with neat sketch.

Soil compaction is achieved in the feild either by rolling, ramming or by vibration.
Compacting equipments may be classified as Rollers, rammers and vibrators.

Based on the type of soil different compacting equipment are used.

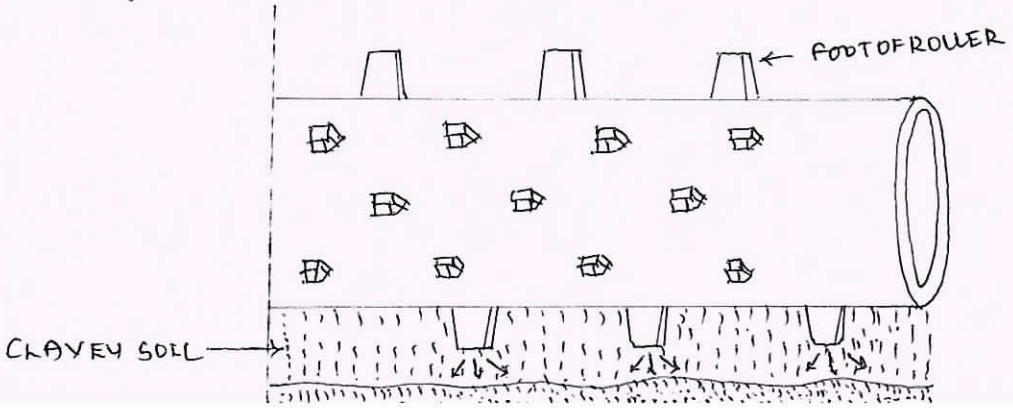
Rollers: Application of the pressure on the layer

Rammers: Hand operating equipment for smaller area.

Vibratory rollers: Application of dynamic and Static weight.

Working principle of sheep foot roller:

This type of roller consist of hollow steel cylinder with projecting feet. The weight of the roller can be increased by falling the drum with wet soil. Sheep foot roller of different weight, diameter and width are available, also there are differe shapes & sizes of the feet. The sheep foot roller may be pulled by tractors.



8a. Enumerate steps involved in the formation of embankment

The various steps involved in the construction of a highway embankment are listed below.

a). Clearing and grubbing to remove the vegetation, roots and other organic matter.

b). Recompaction of the ground that supports the embankment to the specified density.

c). Selected soil is spread and compacted in layers to form the embankment as specified.

d). Selected soil is spread and compacted in layers to form the subgrade.

e). Excavation for the longitudinal side drains.

f). Construction of cross-drainage structures.

g). Laying of drainage, layer-cum granular sub base course in layers, over the subgrade.

h). Building up the shoulders in layers.

i). In case of flexible pavement, construction of base course layer, in the case of rigid pavements construction of lean concrete base course.

j). In case of flexible pavements, construction of bituminous binder and surface course layers in the case rigid pavements construction of concrete slab and the specified joints.

k). Finishing the work as specified.

8b. Write a short notes on:

i) Desirable properties of subgrade soil:

a) Stability: Subgrade soil should posess very high stability such that it should take much (heavy) load on it.

b) Incompressibility: should not get compressed, under heavy loading.

c) Permanency of strength: When resistance capacity is more, than it indicates strength is highee.

d) Min. change in volume: Soil should posess various technical aspects. Expansive soil can easily change their volume after the release of load.

e) Good drainage: It should posess good drainage quality usually granular soil holds the above property.

ii) Quality control tests for subgrade soil:

a) Tests so as to check the values of Liquid limit, plasticity index, free swell index, soluble sulphate content, Organic matter and compacted density.

b) Laboratory compaction test: To check OMC and MDD of soil.

c) Feild moisture content to be identified to calculate amount of water to be added to achieve OMC.

d). After adding additional water to achieve OMC feild water content is again checked to ensure OMC.

e). After soil layer is adequately rolled, the feild density and the moisture content are determined.

f). CBR - California Bearing Ratio is also checked on the soil to confirm the CBR value of the soil at 2.5mm penetration.

9a. Explain the material specification, construction procedure for water Bound Maccadam roads.

General: Water Bound Maccadam is the construction known after the name of John Maccadam.

Material: The material used in the WBM construction consist of i). Coarse aggregates ii). Screening
iii). Binding materials.

Coarse aggregates: Crushed aggregates or broken stones are used.

a). For sub base,: LOS value < 50% and Impact value < 40%

b). For base course: LOS < 40% and Impact value < 30%.

c). For suface course: LOS < 40% & Impact value < 30%.

Grading of aggregates: Grade - 1, 2 & 3.

Size range mm	Sieve size mm	Passing the sieve by wt	Range mm	Sieve (mm)	Passing %	Range mm	Sieve mm	Passing %
	125	100		90	100		63	100
	90	90-100		63	90-100		53	90-100
90-45	63	25-60	63-45	53	25-75	53-22.4	45	65-90
Grade-1	45	0-15	Grade-2	45	0-15	Grade-3	22.4	0-10
	22.4	0-5		22.4	0-5		11.2	0-5

Screening: The screening are used to fill up the voids in the compacted layer of coarse aggregates.

Binding material: Binding material consisting of fine grained material passing 0.425mm sieve.

Construction steps:

a). The foundation for recieving the new layer of WBM may be either the subgrade or subbase or base course

b). The dust and other loose materials are cleared.

c). Lateral confinement is to be provided before starting WBM construction.

d). The coarse aggregates are spread uniformly to proper profile to uniform thickness.

e). The layer is compacted by a three wheeled power roller of 8-10 tonnes capacity.

f). After coarse aggregate are rolled, dry screenings are applied gradually.

g). After application of screening sprinkled with water.

h). Binding materials are applied at a uniform & slow rate.

i). After final compaction, the layer is allowed to dry over night.

j). After the WBM layer is fully dry, WBM course is opened for traffic.

9b. Write a note on construction of Dense Bituminous Maccad Pavement.

Construction:

a). The recive surface on which the dense graded bituminous mix is to be laid is prepared by patching the pot holes sealing the cracks and filling up the depression, a geo synthetic layer or stress absorbing layer may be laid if required.

b). If the profile correction required exceeds 40mm, a profil corrective course is laid separately using a mechanical paver and is compacted, If the correction required is less than 40mm, the pavement layer is spread with provision for the additional quantity of the mix to meet profile correcti requirement.

c). The laying of DBM work to be taken up during dry weather.

d) The receiving surface is cleaned with a mechanical broom.

e). The DBM mix is prepared in a mixer under standard temperature and taken to site.

f). The mix is spread using a hydrostatic paver finisher with sensor at a specified paving temperature.

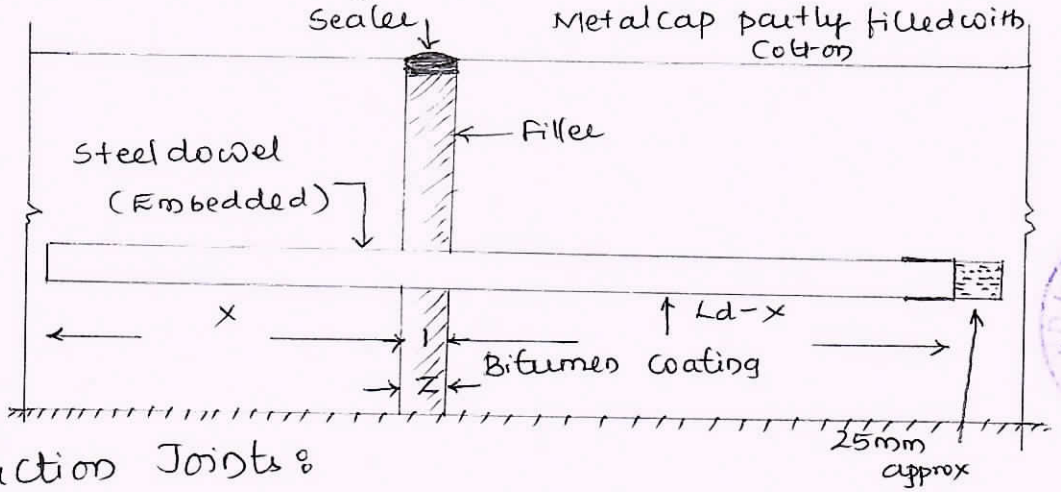
g). The rolling is started as soon as laying is done for short stretches, rolling is done in three stages with the pressure more than 5.6 kg/cm^2.

h). The compacted density is checked by taking 150mm diameter core samples. The density achieved shall preferably be 92% of theoretical maximum density of the mix, so that the initial voids in the mix is about 4-6% and due to traffic induced secondary compaction during the design life.

10a. With the neat figures, explain the following types of joints in a rigid pavements.

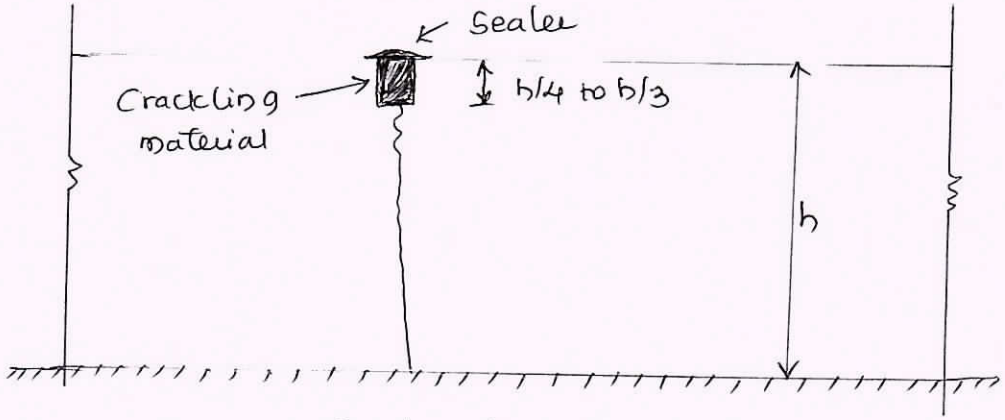
a). Expansion Joint:

A transverse expansion joints are provided in CC pavement at desired intervals or at identified locations during construction of the CC pavement with a gap of 20 to 25 mm between the slabs. Dowel bars are installed during the construction for the purpose of 'load transfer' from one slab to the adjacent slab, across the expansion joi



b). Contraction Joints:

Contraction joints are dummy joints formed by cutting grooves of specified depth, on the top of the slab and fine shrinkage cracks are developed in the lower portion at these locations during the initial curing period of the concrete.

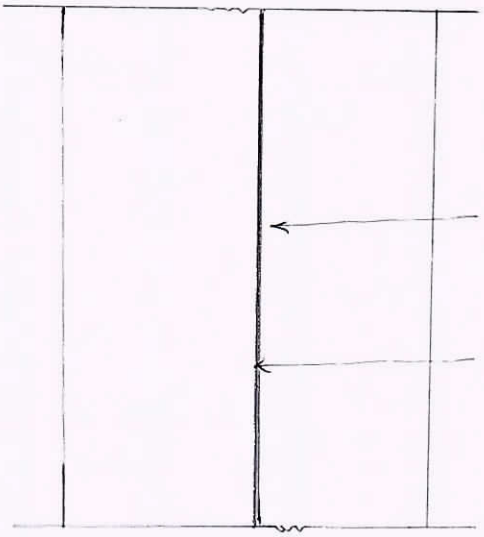


Contraction Joint.

iii). Longitudinal Joint:

Longitudinal joints are generally provided at transver Spacing of 3.5 or 3.75 m, coinciding with the traffic lane marking. Longitudinal joints are also formed as dummy joints similar to the contraction joints.

The Longitudinal joints are formed by cutting narrow Longitudinal grooves up to the specified depth on the top of the CC slab along the identified Longitudinal line



Longitudinal Joints

10b Differentiate between Flexible and Rigid pavement

~~Flexible~~ Pavement (Rigid)	~~Rigid~~ Pavement (Flexible)
1). Design precision is much more precise because of flexural strength	Design precision is less as the designare empeirical in nature.
2). Life span of pavement is up to 40 years with less maintainance.	Life span of pavement is up to 15-20 years with high maintenance
3). Maintenance is less	Maintainance is more

4).	Initial cost more	Initial cost is less
5).	Stage of construction is less traffic is allowed after complete construction Curing.	construction is more in numbers traffic is allowed after every stage of construction.
6).	Availability of material is high as cement is a manufactured product of calcined rock.	Scarcity of petroleum product. Availability of material is less
7).	Penetration of water is Less. Joints should be sealed properly.	Penetration of water is more Compared to rigid pavement
8).	Rigid pavement is a good road is costly to construct but once constructed then maintance is less	Overall flexible pavement require more maintenance than the rigid pavement.

Prof Harsha A. Jadhav

HEAD
Dept. of Civil Engg.
KLS V.D.I.T., Haliyal

Dean, Academics
KLS VDIT, HALIYAL