CMR INSTITUTE OF TECHNOLOGY

Internal Assessment Test 3 –Nov. 2018

Scheme and Solution

Sub:	Pavement Materials and Construction					Sub Code:	10CV763	Branch:	Civil
Date:	22/11/2018	Duration:	90 mins	Max Marks:	50	Sem/Sec:	VII (Parallel Class)		

1. Explain Aggregate Impact Test in detail with a neat sketch and IS specifications.

Aim: To determine the impact value of the given aggregate

Apparatus:

Aggregate impact apparatus
IS sieves (12.5 mm, 10.0 mm and 2.36 mm)
Cylindrical measure and cylindrical cup
Weighing balance.
Tamping rod.

Theory:

Toughness is the property of a material to resist impact. Due to traffic loads the road stones are subjected to the pounding action or impact and there is possibility of stones breaking into smaller pieces. The road stones should therefore be tough enough to resist fracture under impact. A testdesigned to evaluate the toughness of stones i.e. the resistance of the stones to fracture under repeated impacts may be an impact test for road aggregate.

The aggregate impact value indicates a relative measure of the resistance of an aggregate to a sudden shock or an impact, which in some aggregate differs from its resistance to a slow compressive load. The method of tests specifies the procedure for determining the aggregate impact value of coarse aggregate.

1. Take clean and dry aggregate and sieve on IS 12.5 mm and 10.00 mm sieve.
2. Collect the aggregate passing IS 12.5mm sieve and retained on IS 10.0 mm Sieve.
3. Find the weight of empty cylindrical measure. Let the weight be ‘a’ g.
4. Fill the aggregate in the cylindrical measure in three layers, tamping each layer 25 times with the rounded end of the tamping rod.
5. Roll the tamping rod over aggregate surface and remove excess aggregate, if any.
6. Find the weight of the cylindrical measure with aggregate. Let the weight be ‘b’ g. Thus the weight of aggregate = W1 = (b-a)
7. Transfer all the aggregate from the cylindrical measure to the test cylinder in one layer and tamp the layer 25 times with the rounded end of the tamping rod.
8. Fix the test cylinder firmly to the base of the impact tester.
9. Adjust the height of fall of the plunger to 380+ 5mm and set the blow counter to zero.
10. Lift the plunger gently and allow it to drop. This is one blow. Give 15 such blows.
11. Take out the test cylinder and sieve the crushed material on IS 2.36 mm sieve. Find the weight

of material passing the sieve. Let weight be W2 g.
12. Find the weight of aggregate retained on this sieve. Let the weight be W3 g.
Then, Aggregate impact value = W2 / W1 * 100 %
And percentage of dust = W3 / W1* 100 %

Tabular Column

Weight of empty cylindrical measure = ‘a’ g.
Weight of cylindrical measure + Aggregate = ‘b’ g
Initial weight of aggregate = (b-a)= W1 g
Weight of aggregate passing IS 2.3 mm sieve after test = W2 g
Weight of aggregate retained on IS 2.36 mm sieve after test = W3 g
Aggregate impact value = W2 / W1 * 100 %
Percentage of dust = W3 / W1* 100 %

Result

The Impact value of given aggregate sample is = ………….. %

2. Explain the procedure of determining the optimum bitumen content for a bituminous mix by the Marshall test.

Marshall Mix design

The Marshall stability and flow test provides the performance prediction measure for the Marshall mix design method. The stability portion of the test measures the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute. Load is applied to the specimen till failure, and the maximum load is designated as stability. During the loading, an attached dial gauge measures the specimen's plastic flow (deformation) as a result of the loading.

The flow value is recorded in 0.25 mm (0.01 inch) increments at the same time when the maximum load is recorded. The important steps involved in marshal mix design are summarized next.

4.3.1 Specimen preparation

Approximately 1200gm of aggregates and filler is heated to a temperature of 175oC to 190oC. Bitumen is heated to a temperature of 121 125oC with the first trial percentage of bitumen (say 3.5 or 4% by weight of the material aggregates) to the heated aggregates and thoroughly mixed at temperature of 154oC to 160oC. The mix is placed in a preheated mould and compacted by a rammer with 50 blows on either side at temperature of 138oC to 149oC. The weight of mixed aggregates 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. Number of trials is predetermined.

4.3.2 Determine the properties of the mix

The properties that are of interest include the theoretical specific gravity Gt, the bulk specific gravity of the mix Gm, percent air voids Vv, percent volume of bitumen Vb, percent void in mixed aggregate VMA and percent voids filled with bitumen VFB.

5.3.3 Theoretical specific gravity of the mix Gt

Theoretical specific gravity Gt is the specific gravity without considering air voids, and is given by:
where, W1 is the weight of coarse aggregate in the total mix, W2 is the weight of aggregate in
the total mix, W3 is the weight of filler in the total mix, Wb is the weight of bitumen in the total
mix, G1 is the apparent specific gravity of coarse aggregate, G2 is the apparent specific gravity

of fine aggregate, G3 is the apparent specific gravity of filler and Gb is the apparent specific gravity of bitumen,

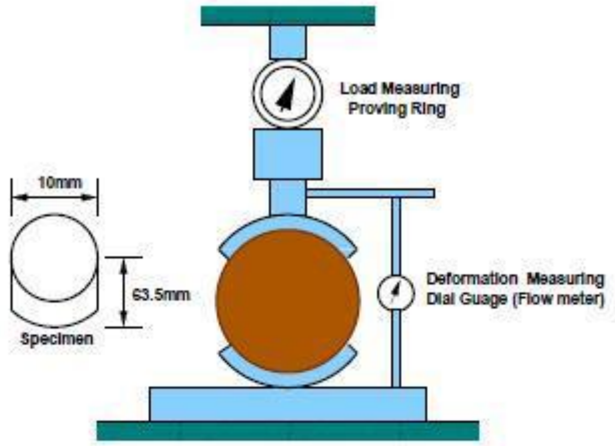

Figure 26:1: Marshall Mould

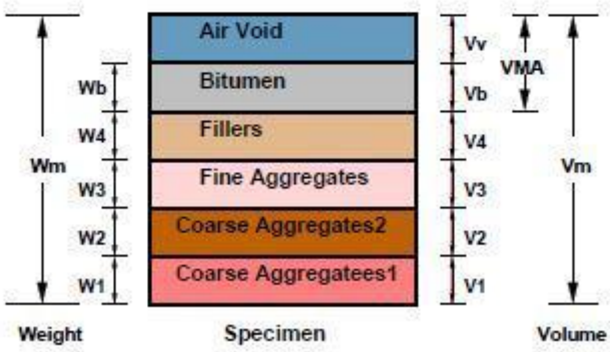

Figure 26:2: Marshall Mould

5.3.4 Bulk specific gravity of mix Gm

The bulk specific gravity or the actual specific gravity of the mix Gm is the specific gravity considering air void sand is found out by:

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

where, Wm is the weight of mix in air, Ww is the weight of mix in water,

5.3.5 Air voids percent Vv

Air voids Vv is the percent of air voids by volume in the specimen and is given by:

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

where Gt is the theoretical specific gravity of the mix, given by equation 1. and Gm is the bulk or actual specific gravity of the mix given by equation 2.

5.3.6 Percent volume of bitumen Vb

The volume of bitumen Vb is the percent of volume of bitumen to the total volume and given by

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

where, W1 is the weight of coarse aggregate in the total mix, W2 is the weight of _ne aggregate in the total mix, W3 is the weight of filler in the total mix, Wb is the weight of bitumen in the total mix, Gb is the apparent specific gravity of bitumen, and Gm is the bulk specific gravity of mix given by equation 2.

5.3.7 Voids in mineral aggregate VMA

Voids in mineral aggregate VMA is the volume of voids in the aggregates, and is the sum of air voids and volume of bitumen, and is calculated from

VMA = Vv + Vb

where, Vv is the percent air voids in the mix, given by equation 3. and Vb is percent bitumen content in the mix, given by equation 4. (26.4).

5.3.8 Voids filled with bitumen V FB

Voids filled with bitumen V FB is the voids in the mineral aggregate frame work filled with the bitumen, and is calculated as:

where, Vb is percent bitumen content in the mix, given by equation 4. and VMA is the percent voids in the mineral aggregate, given by equation 5.

5.4 Determine Marshall stability and flow

Marshall stability of a test specimen is the maximum load required to produce failure when the specimen is preheated to a prescribed temperature placed in a special test head and the load is applied at a constant strain (5 cm per minute). While the stability test is in progress dial gauge is used to measure the vertical deformation of the specimen. The deformation at the failure point expressed in units of 0.25 mm is called the Marshall flow value of the specimen.

5.5 Prepare graphical plots

The average value of the above properties are determined for each mix with different bitumen content and the following graphical plots are prepared:

1. Binder content versus corrected Marshall stability

2. Binder content versus Marshall flow

3. Binder content versus percentage of void (Vv) in the total mix

4. Binder content versus voids filled with bitumen (V FB)

5. Binder content versus unit weight or bulk specific gravity (Gm)

5.6 Determine optimum bitumen content

Determine the optimum binder content for the mix design by taking average value of the following three bitumen contents found form the graphs obtained in the previous step.

1. Binder content corresponding to maximum stability

2. Binder content corresponding to maximum bulk specific gravity (Gm)

3. Binder content corresponding to the median of designed limits of percent air voids (Vv) in the total mix (i.e. 4%)

3. A sample of bituminous mix prepared for Marshall test for a height of 6.35cm and diameter of 10.16cm. The weights of the compacted specimen are 1174.4g in air and 668.4g in water. Calculate (i) Gt (ii) Gm (iii) Vv (iv) Vb (v) VMA (vi) VFB

Material	**Specific Gravity**	**Mix composition % by total weight**
CA	2.58	52
FA	2.72	34.6
Filler	2.7	7.4
Binder	1.02	6

Theoretical Sp. gravity $= G_t = \dfrac{100}{\dfrac{\%W_1}{G_1} + \dfrac{\%W_2}{G_2} + \dfrac{\%W_3}{G_3} + \dfrac{\%W_b}{G_b}}$

$$= \frac{100}{\frac{52}{2.58} + \frac{34.6}{2.72} + \frac{7.4}{2.7} + \frac{6}{1.02}}$$

$G_t = 2.41$

$$\text{Bulk specific gravity of the sample} = \frac{\text{Wt of sample}}{\text{Volume of sample}}$$

$$= \frac{1174.6}{(1174.6 - 668.4)}$$

$$= 2.32.$$

$$\%\ \text{Air voids} = \frac{G_t - G_m}{G_m} \times 100$$

$$= \frac{2.41 - 2.32}{2.41} \times 100$$

$$= 3.73.$$

$$V_b = \frac{W_b}{G_b} \times \frac{G_m}{100} \times 100 = \frac{6}{1.02} \times 2.32 = 13.64$$

$$VMA = V_v + V_b = 3.73 + 13.64$$

$$VMA = 17.37$$

$$VFB = \frac{V_B}{VMA} \times 100$$

$$= \frac{13.65}{17.37} \times 100$$

$$VFB = 78.54\ \%$$

4. Explain the procedure of construction of rigid pavements.

Construction method

a) Preparation of subgrade and sub base –

- No soft pots are present in subgrade or sub base.
- It should extent atleast 30cm on either side of width to be connected.
- Subgrade is properly drained; minimum modulus of subgrade reaction is

5.54Kg/Cm 2. The layers should be kept moist when cement concrete is placed.

- Water proof paper may also be used when CC is laid directly.

b) Placing of Forms –

- The steel or wooden forms are used.

The steel forms are M.S. Channel sections and their depts. Is equal to thickness of pavement and length atleast 3m except on curves < 45m radius.

- Wooden forms are dressed on side, these have minimum base width of 100n for slab thickness or 20cm.
- The forms are jointed neatly and are set with exactness to the required grade and alignment.

c) Batching of Material & Mixing –

- The proportioned mixture is placed into holper in weigh batching plant.
- All batching of material is done on the basis of one or more whole bags of cement, wt of one bag is 50 kg or unit wt of cement is taken as 1440Kg/m
- The mixing of concrete is done in batch mixer. So that uniform distribution, uniform is color and homogenous mix is obtained.
- The batch of cement, fine aggregate and coarse aggregate is led together into the mixer. Water for mixing is introduced into the drum within fifteen seconds of mixing.

d) Transportation & Placing of Concrete –

- The cement concrete is mixed in quantities required for immediate use.
- It should be seen that no segregation of materials results while transporting.
- Spreading is done uniformly; certain amount of redistribution is done with shovels.

e) Compaction & Finishing –

- The surface of pavement is compacted either by means of power driven finishing machine or by vibrating hand screed.
- Areas where width of slab is small, hand consolidation and finishing is adopted.
- The concrete is further compacted by longitudinal float. It is help parallel to carriage way and passed gradually from one site to other.
- The slab surface is tested for its grade and level with straight edge.
- Just before the concrete becomes hard, the surface is belted with two ply canvas belt.

- Broom finish is given with fibre broom brush and it is done perpendicular to centerline of pavement.
- Before concrete develop initial set, the edges of slab are carefully finished with an edging tool.

Curing of cement concrete –

➢ Initial curing – The surface of pavement is entirely covered with burlap cotton or jute mats prior to placing it is saturated with water and wet side is placed on pavement.

➢ Final curing – Curing with wet soil exposed edges of slabs are banked with soil berm. A blanket of sandy soil free from stones is placed. The soils is thoroughly kept saturated with water for 14 days.

In impervious membrane method, use of impervious membrane which does not impart a slippery surface to the pavement is used. Liquid is applied under pressure with a spray nozzle to cover the entire surface with a uniform film. It hardness within 30 minutes after its application.
The liquid applied immediately after surface finishing.
When the concrete attains the required strength or after 28days of curing the concrete road is opened to traffic.

5. Enumerate the steps in the preparation and construction of an embankment.

Construction Procedure –

➢ **Setting out –** After the site has been cleared, the work should be setout. The limits of embankment are marked by fixing batter pegs on both sides at regular intervals. The subgrade should be wider than the design dimension so that surplus material may be trimmed.

➢ **Dewatering –** If the foundation of the embankment is in area with stagnant water, it is feasible to remove it by bailing out or pumping.

➢ **Stripping & Storing top soil –** In localities where most of the available embankment materials are not conductive to plant growth, the top soil from all areas of cutting shall be stripped to specified depths not exceeding 150mm & stored in stock piles of height not exceeding 2m for covering embankment slopes.

➢ **Compacting ground supporting embankment / subgrade** – where necessary, the original ground shall be leveled to facilitate placement of first layer of embankment,

scarified, mixed with water and then compacted by rolling so as to achieve minimum dry density as given in table. In case difference in subgrade level and ground level is less than 0.5m & the ground does not have 97% relative compaction, the ground shall be loosened upto a level 0.5m below the subgrade level, watered & compacted in layers to not less than 97% of dry density.

Table 1 – Density requirements of embankment & subgrade materials

Sl. No.	Type of Work	Max lab dry unit weight when tested as per IS – 2720
1	Embankment upto 3m height, not subjected to extensive flooding	Not less than 15.2 KN/cum
2	Embankment exceeding 3m height or embankments of any height subject to long period of inundation.	Not less than 16.0 KN/cum
3	Subgrade & earthern shoulders / verger / backfill	Not less than 17.5 KN/cum

Table 2 – Compaction requirements for embankment & subgrade

Sl. No.	Type of Work	Relative Compaction s % of max lab dry density
1	Subgrade & earthern shoulders	Not less than 97
2	Embankment	Not less than 95
3	Expansive soils Subgrade & 500mm portion just below the subgrade. Remaining portion of embankment.	Not allowed. Not less than 90.

In high embankments, resting of suspect foundation as reveled by borehole logs shall be carried
out in a manner and to the desired depth.

➢

Spreading material in layers & bringing to appropriate moisture content –
a. The embankment & subgrade material shall be spread in layers of uniform thickness not exceeding 200mm compacted thickness over the entire width of embankment by mechanical means, finished by a motor grader & compacted.
b. Moisture content of the material shall be checked at this site of placement prior to commencement of compaction, water shall be sprinkled from a water tanker filled with sprinkler capable of applying water uniformly.
c. Moisture content of each layer should be checked with respect to table – 1 in accordance with IS – 2720.
d. Clods or hard lumps of earth shall be broken to have max size of 75mm when placed in embankment & max size of 50 mm when placed in subgrade.
e. Embankments & other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths.
f. Whenever fills is to be deposited against the face of a natural slope, steeper than 1 verticle on 4 horizontal, such faces shall be benched.

Compaction –
a. Smooth wheeled, vibratory, pneumatic tyred, sheep foot or pad foot rdlers of suitable size and capacity should be used for different types & grades of materials.
b. Mostly compaction will be done with vibratory roller of 80 to 100KN static weight or heavy pneumatic tyred roller.
c. Each layer of the material shall be thoroughly compacted to the densities in table – 1, subsequent layers should be laid only after the finished layer has been tested.
d. The measurement of field dry density is recorded by nuclear moisture / density guage.
e. When density measurement revel any soft areas in embankment, further compaction is carried out.

Drainage – The surface of embankment at all times during construction shall be maintained at such across fall as will shed water and prevent pending.

- **Repairing of damages caused by rain / spillage of water –**

a. The soil in the affected portion shall be removed in such areas before next layer is laid & refilled in layers & compacted using small vibratory roller, plate compactor or power rammer to achieve the required density.
b. Tests shall be carried out to ascertain the density requirements of the repaired area.

Finishing operations –
a. It shall include the work of shaping & dressing the shoulders / verge / road bed & side slopes to conform to alignment, levels, cross sections & dimensions.
b. Both the upper & lower ends of side slopes shall be rounded off & to merge the embankment with adjacent terrain to improve appearances.
c. The top soil, removed & conserved earlier shall spread over the fill slopes, before spreading the slopes should be roughened and moistened slightly to provide bond and is provided t a depth of 75mm to 150mm for plant growth.
d. When earthwork is completed, the road area shall be cleared of all debris & ugly scars.6666