IAT-2, Scheme and Solutions

Sub:	Concrete Technology					Sub Code:	15CV44	Branch:
Date:	17.03.18	Duration:	90 min's	Max Marks:	50	Sem / Sec:	4 A & B	

Question Number 6(a) is mandatary and select any 3 from remaining questions.

Use of IS10262 2009 is permitted.

MARKS

1 (a) Briefly explain the effect of fly ash and Silica fume on fresh and hardened state properties of concrete. [10]

Fly ash: The finely divided residue resulting from the combustion of ground or powdered coal. Fly ash is generally captured from the chimneys of coal-fired power plants; it has POZZOLANIC properties, and is sometimes blended with cement for this reason.

Fly ash includes substantial amounts of silicon dioxide (SiO2) (both amorphous and crystalline) and calcium oxide (CaO). Toxic constituents include arsenic, beryllium, boron, cadmium, chromium, cobalt, lead, manganese, mercury, molybdenum, selenium, strontium, thallium, and vanadium.

Fly ash is the most common artificial pozzolana, the fly ash particles are spherical and have very high fineness : the vast majority of particles have a diameter between less than 1 micrometer to 100 micrometer, and the specific surface of flyash is usually between 250 to 600m^2/kg. The high specific surface means the material is readily available for reaction with calcium hydroxide.

Addition of flyash in concrete helps to improve many properties of concrete in fresh and hardened state of concrete. In fresh state of concrete addition of flyash leads to production of a fatty mix which helps in improving workability, reducing segregation and bleeding. Secondary hydration caused by flyash produces more amount of CSH gel and reduces soluble Calcium hydroxide in concrete which will improves strength of the concrete in later ages and reduces permeability of concrete which leads to inhibiting alkali-aggregate reaction, and enhancement of sulfate resistance. In addition use of flyash leads reduced heat evolution during the process of hydration.

Pozzolanic:

When cementing material reacts with water the following reaction take place:

$C_2S + H = CSH + CH$

$C_3S + H = CSH + CH$

CSH is responsible for strength while CH(Calcium hydroxide) is a soluble material reacts and dissolves in water leaving behind pores. So when admixture is added

SiO_3 or $Al_2O_3 + CH = CSH$

Thus, it reduces the amount of CH & increase CSH

Silica Fume

Siica fume, also referred to as microslica or condensed silica fume, is another material that is used as an artificial pozzolaric admixture. It is a product resulting from reduction of high purity quartz with coal in an electric arc furnace in the manufacture of silicon or ferrosilicon alloy. Silica fume rises as an oxidised vapour. Condensed silica fume is essentially silicon dioxide (more than 90%) in noncrystalline form. Since it is an airborne material like fly ash, it has spherical shape. It is extremely fine with particle size less than 1 micron and with an average diameter of about 0.1 micron, about 100 times smaller than average cement particles. Silica fume has specific surface area of about 20,000 m2/kg, Because of its extreme fineness and high silica content, Silica Fume is a highly effective pozzolanic material.

Pozzolanic Action. Microsilica is much more reactive than fly ash or any other natural pozzolana. Most research workers agree that the C - S - H formed by the reaction between microsilica and Ca(OH)2 appears dense and amorphous.

2 (a) What are accelerators and retarders? Explain. [10]

Accelerating Admixtures (Accelerators):
An admixture which, when added to concrete, mortar, or grout, increases the rate of hydration of hydraulic cement, shortens the time of set in concrete, or increases the rate of hardening or strength development.

Accelerators may be used when concrete is to be placed at low temperatures, in the manufacture of precast concrete (where a rapid removal of formwork is desirable), reduction of required period of curing, earlier placement of structure in service.

Calcium chloride is the most effective accelerator and gives both set and hardening characteristics. Calcium chloride is effective in accelerating the hydration of the calcium silicates, mainly C3S, possibly by a slight change in the alkalinity of the pore water or as a catalyst in the reaction of hydration. But it has one serious defect: the presence of chloride ions in the vicinity of steel reinforcement or other embedded steel is highly conducive to corrosion. For this reason, it should not be used in concrete where any steel will be embedded but may be used in plain unreinforced concrete. Chloride-free accelerators are typically based on salts of **nitrate, nitrite, formate and thiocyanate**. Hardening accelerators are often based on high range water reducers, sometimes blended with one of these salts. Accelerating admixtures have a relatively limited effect and are usually only cost effective in specific cases where very early strength is needed for, say, access reasons. They find most use at low temperatures where concrete strength gain may be very slow so that the relative benefit of the admixture becomes more apparent.

In summary, a hardening accelerator may be appropriate for strength gain up to 24 hours at low temperature and up to 12 hours at ambient temperatures. Beyond these times, a high range water reducer alone will usually be more cost-effective.

Retarding Admixtures (Retarders):

The function of retarder is to delay or extend the setting and hardening time of cement paste in concrete. These are helpful for concrete that has to be transported to long distance, and helpful in placing the concrete at high temperatures.

When water is first added to cement there is a rapid initial hydration reaction, after which there is little formation of further hydrates for typically 2–3 hours. The exact time depends mainly on the cement type and the temperature. This is called the **dormant period** when the concrete is plastic and can be placed. At the end of the dormant period, the hydration rate increases and a lot of calcium silicate hydrate and calcium hydroxide is formed relatively quickly. This corresponds to the setting time of the concrete. Retarding admixtures delay the end of the dormant period and the start of setting and hardening. This is useful when used with plasticizers to give workability retention.

Retarders are useful in concreting in hot weather, when the normal setting time is shortened by the

higher temperature, and in preventing the formation of cold joints. In general they prolong the setting and hardening time during which concrete can be transported, placed, and compacted.
They are also used in grouting oil wells. Oil wells are sometimes taken up to a depth of about 6000 meter deep where the temperature may be about 200^0C.
Retarders are sometimes used to obtain exposed aggregate look in concrete look in concrete. The retarder sprayed to the surface of the formwork, whereas the rest of the concrete gets hardened. On removing the formwork after one day or so, the unhardened matrix can be just washed off by a jet of water which will expose the aggregates.

Perhaps the most commonly known retarder is calcium sulphate (gypsum). It is interground to retard the setting of cement. The appropriate amount of gypsum to be used must be determined carefully for the given job. Use of gypsum for the purpose of retarding setting time is only recommended when adequate inspection and control is available, otherwise, addition of excess amount may cause undesirable expansion and indefinite delay in the setting of concrete.
In addition to gypsum there are number of other materials found to be suitable for this purpose. They are: starches, cellulose products, sugars, acids or salts of acids. These chemicals may have variable action on different types of cement when used in different quantities. Unless experience has been had with a retarder, its use as an admixture should not be attempted without technical advice. Any mistake made in this respect may have disastrous consequences.

Common sugar is one of the most effective retarding agents used as an admixture for delaying the setting time of concrete without detrimental effect on the ultimate strength. Addition of excessive amounts will cause indefinite delay in setting. At normal temperatures addition of sugar 0.05 to 0.10 per cent have little effect on the rate of hydration, but if the quantity is increased to 0.2 per cent, hydration can be retarded to such an extent that final set may not take place for 72 hours or more.

3 (a) Define workability. What are the factors which affect the workability of concrete [10]

CONCRETE TECHNOLOGY Code: 15CV44

IA-2.

(Solutions & Scheme of Evaluation)

IAT-2

1(a) Workability

It is defined as the property of fresh concrete which determines the amount of internal work (or) useful work for 100% compaction of concrete. (02 marks)

The factors affecting the workability are:

1) Water content.

If the water content in the concrete increases, the fluidity of the concrete increases. If the water content is more in concrete, the workability increases. (01 marks)

2) Mix proportion.

Aggregate / cement ratio is the most influencing factor of workability. If the concrete is lean, less ~~plast~~ amount of plastic concrete for lubrication. If the concrete is rich, the more amount of plastic concrete can be used, it increases the workability. (01 marks)

3) Size of the aggregates.

If the size of aggregates in concrete is more, the surface area of ~~agg~~ aggregates is less, less water content ~~content~~ can be used. If the size of aggregates is less, the surface area is more, more water content should be used. Larger size aggregates will give ~~high~~ more workability. (01 marks)

4) shape of the aggregates.

If The Aggregates of Angular, enlonga-ted or flaky will give harsh surface on concrete. Rounded aggregates are smooth which gives more workability.

(1) Marks

5) Texture of the aggregates.

If the surface of concrete is harsh, that consumes more water. If the surface of concrete is smooth, it consumes less water content which gives more workable structure.

(1) Marks

6) Grading

If the surface of concrete is compacted it gives even & uniform surface. Proper grading should be done by removing (or) closing air voids with proper coatings.

(1) Marks

7) Admixtures.

If Admixtures alters some specific properties of concrete. Then it gives more workable, structures. By using plasticizes and superplasticizers, the concrete structures can be more workable.

(1) Marks

8) Temperature.

If the temperature is high, the rate of hydration is less, the ratio of hydration increases & if the temperature decreases.

(1) Marks

5 (a) List the different laboratory tests conducted to measure workability. Briefly discuss any one of them in detail with the help of a neat sketch. [10]

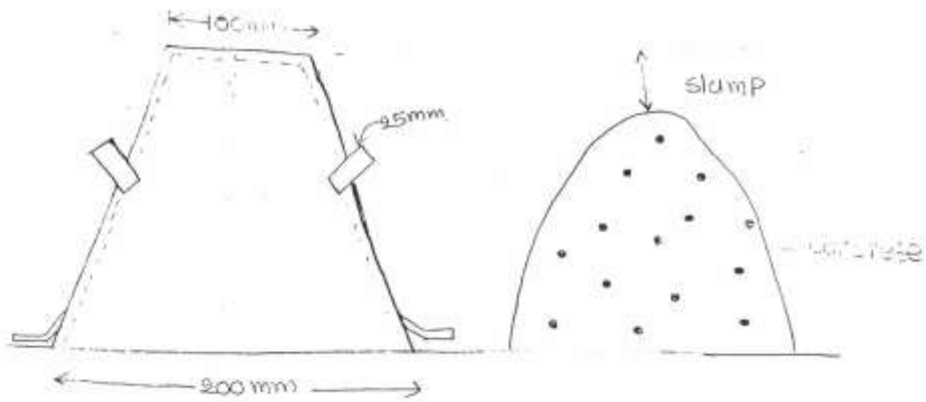
2(a) The laboratory tests conducted to measure workability are :-

1. slump test.
2. compaction factor test.
3. vee - Bee consistency test.
4. Flow test.

(2) Marks

1) slump test.

slump test is used to determine the workability of concrete. The test is preferred for Medium slump concrete. The apparatus ~~of~~ required for slump test are Frustum cone with top diameter 100 mm & bottom diameter 200 mm. & Total diameter is 300mm & concrete is required.



procedure for the slump test is:

1) The ~~interal~~ internal surface of the mould is thoroughly cleaned.

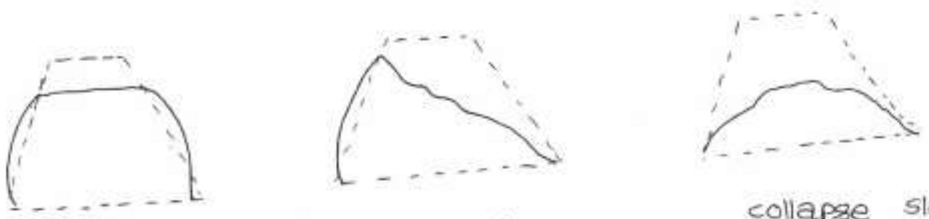
2) The Mould should be placed in smooth, horizontal & uniform surface to get corrected slump value.

3) Mixed concrete is poured into Mould & place it on horizontal surface. ~~Measu~~

4) By removing or lifting the mould, the ~~slum~~ concrete attains a subside. The subsidence is called slump. The slump value can be measured as the difference in level b/w height of Mould & the highest point on the slump. It gives the slump values.

6 Marks

Slumps are 3 types:



True slump — shear slump — collapse slump

1 Marks

1) True slump
It is a preferable slump for concrete to used. The two sides with highest point.

2) Shear slump
The one side of the cone slides down is called shear slump. It is measured as the difference in level b/w Height of slump & highest point of cone.

1 Marks

6 (a) Design the concrete mix for M35 grade concrete with the following data. [20] CO6

a) Grade designation	: M35
b) Type of cement	: OPC 43 grade confirming to IS 8112
c) Max nominal size of aggregates	: 20 mm
d) Minimum cement content	: 340 kg/m^3
e) Maximum water cement ratio	: 0.45
f) Workability	: 75 mm (slump)
g) Exposure condition	: Very severe (for reinforced concrete)
h) Method of concrete placing	: Pumping
i) Degree of supervision	: Good
j) Type of aggregate	: Rounded gravel
k) Maximum cement content	: 450 kg/m^3
l) Chemical admixture type	: Superplsticiser
m) Specific gravity of cement	: 3.15
n) Chemical admixture	: Superplasticiser conforming to IS 9103
o) Specific gravity of C A	: 2.65
F A	: 2.65
p) Sand confirming to	:Zone-I

Assume any other data required suitably

6 (a) Design the concrete mix for M35 grade concrete with the following data. [20] CO6

a) Grade designation	: M35
b) Type of cement	: OPC 43 grade confirming to IS 8112
c) Max nominal size of aggregates	: 20 mm
d) Minimum cement content	: 340 kg/m^3
e) Maximum water cement ratio	: 0.45
f) Workability	: 75 mm (slump)
g) Exposure condition	: Very severe (for reinforced concrete)
h) Method of concrete placing	: Pumping
i) Degree of supervision	: Good
j) Type of aggregate	: Rounded gravel
k) Maximum cement content	: 450 kg/m^3
l) Chemical admixture type	: Superplsticiser
m) Specific gravity of cement	: 3.15
n) Chemical admixture	: Superplasticiser conforming to IS 9103
o) Specific gravity of C A	: 2.65
F A	: 2.65
p) Sand confirming to	:Zone-I

Assume any other data required suitably

A-3 TARGET STRENGTH FOR MIX PROPORTIONING

$$f'ck = fck + 1.65\ s$$

Where

f'ck = Target average compressive strength at 28 days,

fck = Characteristic compressive strength at 28 days,

s= Standard deviation

From Table 1 standard deviation, s = 5 N/mm^2

Therefore target strength = 35 + 1.65 x 5 = 43.25 N/mm^2

A-4 SELECTION OF WATER CEMENT RATIO

From Table 5 of IS:456-2000, maximum water cement ratio = 0.45

Based on experience adopt water cement ratio as 0.40

0.4 < 0.45, hence ok

A-5 SELECTION OF WATER CONTENT

From Table-2, maximum water content = 186 liters (for 25mm – 50mm slump range and for 20 mm aggregates)

Estimated water content for Rounded gravel = 186 -25 = 161liters

Estimated water content for 75 mm slump = 161 + 3/100 x161 = 165.83 liters

As superplsticiser is used, the water content reduced up to 20 percent and above

Based on trials with SP water content reduction of 29 percent has been achieved.

Hence the water content arrived = 165.83 x 0.85 =140.95 liters

A-6 CALCULATION OF CEMENT CONTENT

Water cement ratio = 0.40

Cement content = 140.95/0.40 = 352.38 kg/m^3

From Table 5 of IS: 456, minimum cement content for severe exposure condition = 340 kg/m3

352.38 kg/m3 > 320 kg/m3, hence OK

A-7 PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE CONTENT

From Table 3, volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone I) for water-cement ratio of 0.50 =0.60

In the present case w/c= 0.40. The volume of coarse aggregate is required to be increased to

decrease the fine aggregate content. As w/c ratio is lower by 0.10, increase the coarse aggregate volume by 0.02 (at the rate of -/+ 0.01 for every +/- 0.05 change in water cement ratio).

Therefore, corrected volume of coarse aggregate for w/c of 0.40 =0.62.

Note: In case the coarse aggregate is not angular, then also the volume of CA may be required to be increased suitably based on experience

For pumpable concrete these values should be reduced by 10 percent

Therefore volume of coarse aggregate = 0.62 x 0.9 = 0.56

Volume of fine aggregate content = 1- 0.56 = 0.44

A-8 MIX CALCULATIONS

The mix calculations per unit volume of concrete shall be as follows

a) Volume of concrete = 1 m3

b) Volume of cement = [352.38/3.15] x [1/1000] = 0.112 m^3

c) Volume of water = [140.95/1] x [1/1000] = 0.141 m^3

d) Volume of chemical admixture = [7.7/1.145] x [1/1000] = 0.007 m^3

(SP 2%by mass of cementitious material)

e) Volume of all in aggregates (E) =a – (b + c + d)

= 1 – (0.112 + 0.141 + 0.007) = 0.74 m^3

f) Mass of coarse aggregates = E x Volume of CA x specific gravity of CA

= 0.74 x 0.56 x 2.65 x 1000 = 1098.16 kg

g) Mass of fine aggregates = E x Volume of FA x specific gravity of FA

= 0.74 x 0.44 x 2.65 x 1000 = 862.84 kg

A-9 MIX PROPORTIONS FOR TRIAL NUMBER 1

Cement = 353 kg/m^3

Water = 141 kg/m^3

Fine aggregate = 863 kg/m^3

Coarse aggregates = 1099 kg/m^3

Chemical admixture = 7.7 kg/m^3

Water cement ratio = 0.4

Aggregates are assumed to be in SSD. Otherwise corrections are to be applied while calculating the water content. Necessary corrections are also required to be made in mass of aggregates.

A-10 The slump shall be measured and the water content and dosages of admixture shall be adjusted for achieving the required slump based on trials, if required. The mix proportions shall be reworked for the actual water content and checked for durability requirements.

A-11 Two more trials having variation of ± 10 percent of water cement ratio in **A-10** shall be carried out keeping water content constant, and a graph between three water cement ratios and their corresponding strengths shall be plotted to work out the mix proportions for the given target strength for field trials. However, durability requirements shall be met.