USN :

CMR Institute of Technology, Bangalore
DEPARTMENT OF CIVIL ENGINEERING
I - INTERNAL ASSESSMENT

Semester: 4-CBCS 2018
Subject: CONCRETE TECHNOLOGY (18CV44)
Faculty: Mr Ruchir

Date: 20 May 2021
Time: 01:00 PM - 02:40 PM
Max Marks: 50

Answer any 5 question(s)

Q.No		Marks	CO	PO	BT/CL
1	What are Bogue's compounds? Briefly explain their contribution towards gaining of strength of cement.	10	CO1	PO1	L2
2	List Different types of cement. Explain properties and application of any two types cement in detail.	10	CO1	PO1	L2
3	What is admixture? Explain any two Chemical admixtures in detail	10	CO1	PO1	L2
4	Write the chemical composition of cement. Explain with flow chart for dry process of manufacture of cement	10	CO1	PO1	L2
5	Explain the importance of Source, Size, Shape, Texture, and Grading of aggregate.	10	CO1	PO1	L2
6	What are mineral admixtures? Explain the importance and effect of Fly ash and GGBS on Concrete	10	CO1	PO1	L2

IAT 1 Scheme and solution- Concrete Technology (18CV44)

<table>
<tr><th>Sl.No</th><th>Solution</th><th>marks</th></tr>
<tr><td>1</td><td>The following are termed as Bouges compound
<table>
<tr><th>Compound</th><th>Formula</th><th>Shorthand form</th><th>% by weight[1]</th></tr>
<tr><td>Tricalcium aluminate</td><td>$Ca_3Al_2O_6$</td><td>C_3A</td><td>10</td></tr>
<tr><td>Tetracalcium aluminoferrite</td><td>$Ca_4Al_2Fe_2O_{10}$</td><td>C_4AF</td><td>8</td></tr>
<tr><td>Belite or dicalcium silicate</td><td>Ca_2SiO_5</td><td>C_2S</td><td>20</td></tr>
<tr><td>Alite or tricalcium silicate</td><td>Ca_3SiO_4</td><td>C_3S</td><td>55</td></tr>
<tr><td>Sodium oxide</td><td>Na_2O</td><td>N</td><td rowspan="2">)
)Up to 2</td></tr>
<tr><td>Potassium oxide</td><td>K_2O</td><td>K</td></tr>
<tr><td>Gypsum</td><td>$CaSO_4.2H_2O$</td><td>$C\underline{S}H_2$</td><td>5</td></tr>
</table>
These compounds contribute to the properties of cement in different ways
<u>Tricalcium aluminate, C3A</u>:-
It liberates a lot of heat during the early stages of hydration, but has little strength contribution. Gypsum slows down the hydration rate of C_3A. Cement low in C_3A is sulphate resistant.
<u>Tricalcium silicate, C_3S:-</u>
This compound hydrates and hardens rapidly. It is largely responsible for portland cement's initial set and early strength gain.
<u>Dicalcium silicate, C_2S:</u>
C_2S hydrates and hardens slowly. It is largely responsible for strength gain after one week.
<u>Ferrite, C_4AF:</u>
This is a fluxing agent which reduces the melting temperature of the raw materials in the kiln (from 3,000° F to 2,600° F). It hydrates rapidly, but does not contribute much to strength of the cement paste.

By mixing these compounds appropriately, manufacturers can produce different types of cement to suit several construction environments.</td><td>10</td></tr>
<tr><td>2</td><td>1. Ordinary Portland Cement (OPC)
2. Portland Pozzolana Cement (PPC)
3. Rapid Hardening Cement
4. Quick setting cement</td><td>10</td></tr>
</table>

5. Low Heat Cement
6. Sulfates resisting cement
7. Blast Furnace Slag Cement
8. High Alumina Cement
9. White Cement
10. Colored cement
11. Air Entraining Cement
12. Expansive cement
13. Hydrographic cement

[1] Cement-Rapid Hardening Cement (IS 8041–1990)

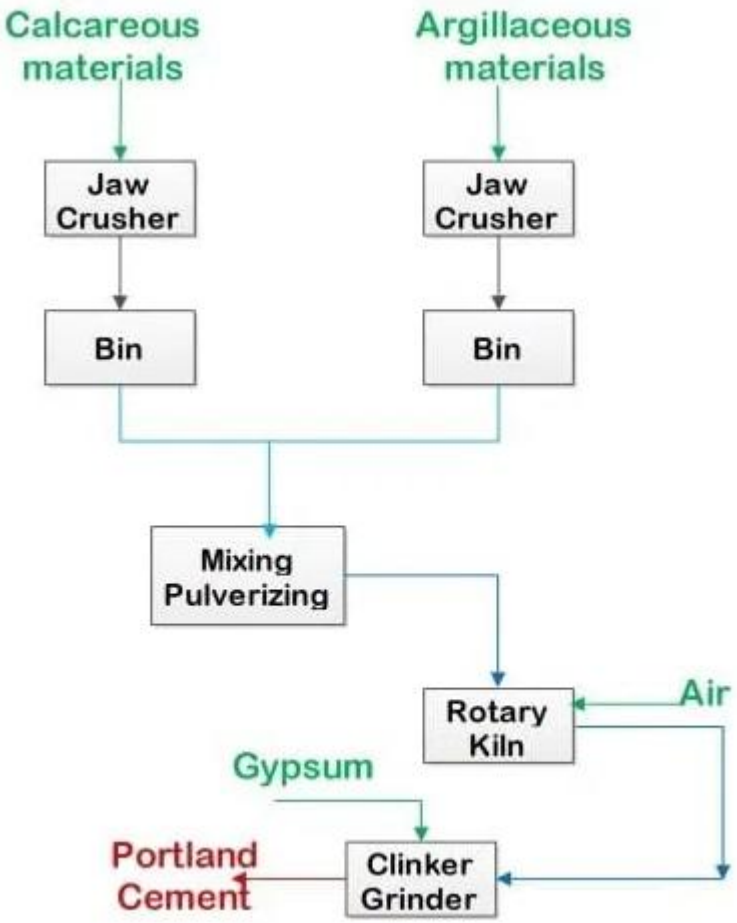
- This cement is similar to ordinary Portland cement.
- As the name indicates it develops strength rapidly and as such it may be more appropriate to call it as high early strength cement.
- Rapid hardening cement develops at the age of three days, the same strength as that is expected of ordinary Portland cement at seven days.
- The rapid rate of development of strength is attributed to the higher fineness of grinding (specific surface not less than 3250 sq. cm per gram) **and higher C3S and lower C2S content.**
- A higher fineness of cement particles expose greater surface area for action of water and also higher proportion of C3S results in quicker hydration.
- Rapid hardening cement gives out much greater heat of hydration during the early period. Therefore, rapid hardening cement should not be used in mass concrete construction.
- The use of rapid heading cement is recommended in the following situations:
- In pre-fabricated concrete construction.
- Where formwork is required to be removed early for re-use elsewhere,
- Road repair works,
- In cold weather concrete where the rapid rate of development of strength reduces
- the vulnerability of concrete to the frost damage.

[2] Extra Rapid Hardening Cement

- Extra rapid hardening cement is obtained by intergrinding **calcium chloride with rapid hardening Portland cement.**
- The normal addition of calcium chloride should not exceed **2 percent by weight** of the rapid hardening cement.
- It is necessary that the concrete made by using extra rapid hardening cement should be transported, placed and compacted and finished within about 20 minutes.
- It is also necessary that this cement should not be stored for more than a month.
- Extra rapid hardening cement accelerates the setting and hardening process.
- A large quantity of heat is evolved in a very short time after placing. The acceleration of setting, hardening and evolution of this

<table>
<tr><td></td><td>large quantity of heat in the early period of hydration makes
• the cement very suitable for concreting in cold weather,
• The gain of strength will disappear with age and at 90 days the strength of extra rapid hardening cement or the ordinary portland cement may be nearly the same.
• There is some evidence that there is small amount of initial corrosion of reinforcement when extra rapid hardening cement is used,
• but in general, this effect does not appear to be progressive and as such there is no harm in using extra rapid hardening cement in reinforced concrete work.</td><td></td></tr>
<tr><td>3</td><td>➢ Admixtures are the material, other than
⦿ Cement
⦿ Water
⦿ Aggregates
Which are used as an ingredient of concrete and is added to batch immediately before or during mixing.
1.Plasticizers(Water Reducing Agents)
⦿ The organic substances or combinations of organic and inorganic substances, which allow a reduction in water content for the given workability, or give a higher workability at the same water content, are termed as plasticizing admixtures.
⦿ Plasticizers are also called high range water reducers.
⦿ In order to produce stronger concrete, less water is added (without "starving" the mix), which makes the concrete mixture less workable and difficult to mix, necessitating the use of plasticizers or water reducers are used.
2. Retarders
A retarder is an admixture that slows down the chemical process of hydration so that concrete remains plastic and workable for a longer time than concrete without the retarder.
⦿ Retarders are used to overcome the accelerating effect of high temperature on setting properties of concrete in hot weather concreting.
⦿ Very useful when concrete has to be place in very difficult conditions and delay may occur in transporting and placing.
⦿ Gypsum and Calcium Sulphate are well known retarders.
⦿ Other examples are: starches, cellulose products, sugars, acids or salts of acids</td><td>10</td></tr>
<tr><td>4.</td><td>Chemical Composition of cement
<table>
<tr><th>Compound</th><th>Formula</th><th>Shorthand form</th><th>Percent content</th></tr>
<tr><td>Calcium oxide (lime)</td><td>Ca0</td><td>C</td><td>60–67</td></tr>
<tr><td>Silicon dioxide (silica)</td><td>SiO_2</td><td>S</td><td>17–25</td></tr>
<tr><td>Aluminum oxide (alumina)</td><td>Al_2O_3</td><td>A</td><td>3.0–8.0</td></tr>
<tr><td>Iron oxide</td><td>Fe_2O_3</td><td>F</td><td>0.5–6.0</td></tr>
</table></td><td>10</td></tr>
</table>

	Magnesium Oxide	MgO	M	0.1–4.0
	Sulphate	SO_3	S	1.3–3.0
	Alkalies	(K2O, Na2O)		0.4–1.3



Manufacture of cement by Dry process

5. **Aggregates from Igneous Rocks** — 10

Most igneous rocks make highly satisfactory concrete aggregates because they are normally hard, tough and dense. The igneous rocks have massive structure, entirely crystalline
or wholly glassy or in combination in between, depending upon the rate at which they were
cooled during formation. They may be acidic or basic depending upon the percentage of silica content. They may occur light coloured or dark coloured. The igneous rocks as a class are the most chemically active concrete aggregate and show a tendency to react with the alkalies in cement

Aggregates from Sedimentary Rocks

The quality of aggregates derived from sedimentary rocks will vary in quality depending upon the cementing material and the pressure under which these rocks are originally compacted. Some siliceous sand stones have proved to be good concrete aggregate. Similarly, the limestone also can yield good concrete aggregate

	Aggregates from Metamorphic Rocks Both igneous rocks and sedimentary rocks may be subjected to high temperature and pressure which causes metamorphism which changes the structure and texture of rocks.Metamorphic rocks show foliated structure. Many metamorphic rocks particularly quartizite and gneiss have been used for production of good concrete aggregates. **Size** The largest maximum size of aggregate practicable to handle under a given set of conditions should be used. Perhaps, 80 mm size is the maximum size that could be conveniently used for concrete making. Using the largest possible maximum size will result in (i) reduction of the cement content (ii) reduction in water requirement (iii) reduction of drying shrinkage However, the maximum size of aggregate that can be used in any given condition may be limited by the following (i) Thickness of section; (ii) Spacing of reinforcement; (iii) Clear cover; (iv) Mixing, handling and placing techniques conditions **Shape** The shape of aggregates is an important characteristic since it affects the workability of concrete.From the standpoint of economy in cement requirement for a given water/cement ratio, rounded aggregates are preferable to angular aggregates. But the angular aggregates are superior to rounded aggregates from the following two points of view-1) Angular aggregates exhibit a better interlocking effect in concrete, which property makes it superior in concrete used for roads and pavements. 2) The total surface area of rough textured angular aggregate is more than smooth rounded aggregate for the given volume. By having greater surface area, the angular aggregate may show higher bond strength than rounded aggregates. **Texture** • Surface texture is the property, the measure of which depends upon the relative degree to which particle surfaces are polished or dull, smooth or rough. • Surface texture depends on hardness, grain size, pore structure, structure of the rock, and the degree to which forces acting on the particle surface have smoothed or roughend it. • *As surface smoothness increases, contact area decreases, hence a highly polished particle will have less bonding area with the matrix than a rough particle of the same volume.* • A smooth particle, however, will require a thinner layer of paste to lubricate its movements with respect to other aggregate particles. It will, therefore, permit denser packing for equal workability and hence, will require lower paste content than rough particles. • It has been also shown by experiments that rough textured aggregate develops higher bond strength in tension than smooth textured aggregate.	
6	Mineral admixtures refer to the finely divided materials which are added to obtain specific engineering properties of cement mortar and concrete.	10

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Fly ash

- It is obtained from coal fired power plants.
- Fly ash is generally captured by Electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys from boilers.

It is also known as coal ash:

- There are two ways that the fly ash can be used:
  - one way is to inter grind certain percentage of fly ash with cement clinker at the factory to produce Portland pozzolana cement (PPC) and
  - the second way is to use the fly ash as an admixture at the time of making concrete at the site of work.

The latter method gives freedom and flexibility to the user regarding the percentage addition of fly ash

Effect on fresh concrete:

- **The setting time is increased when fly ash is used.**
- **Workability and flow of concrete are increased due to the spherical shape of the fly ash particles, which lends a ball-bearing type effect on the concrete mixture.**
- **Bleeding and segregation are usually reduced for well-proportioned fly ash concrete.**
- **The paste volume is increased when mass replacement of cement by fly ash is done.**

GGBS

- Blast furnace slag is a by-product of the extraction of iron from iron ore. Coke and limestone are added as fluxes inside the blast furnace.
- In India, we produce about 7.8 million tons of blast furnace slag.
- Chemical composition of GGBFS – The amount of CaO(40%) in slag determines its cementitious properties.
- Silicon dioxide 30-38%
- Aluminium oxide 15-25%.
- Apart from delaying the initial set, slag does not significantly alter the fresh concrete properties.
- The workability of slag concrete is similar to an equivalent PC concrete, primarily because slag possesses the same level of fineness as PC.
- The rate of strength gain is slowed down considerably when cement is replaced by slag.
- The ultimate strengths with slag are generally improved;
- The durability is also improved with the replacement of cement by slag.