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Internal Assessment Test 1 – Mar. 2019 Solutions

Sub:	Concrete Technology				Sub Code:	17CV44	Branch:	Civil Engg
Date:	06.03.19	Duration:	90 min's	Max Marks: 50	Sem / Sec:	4 A & B		OBE

Answer any FIVE FULL Questions — MARKS | CO | RBT

1 (a) How cement is manufactured by wet process? Give flow chart. [10] CO1 L2

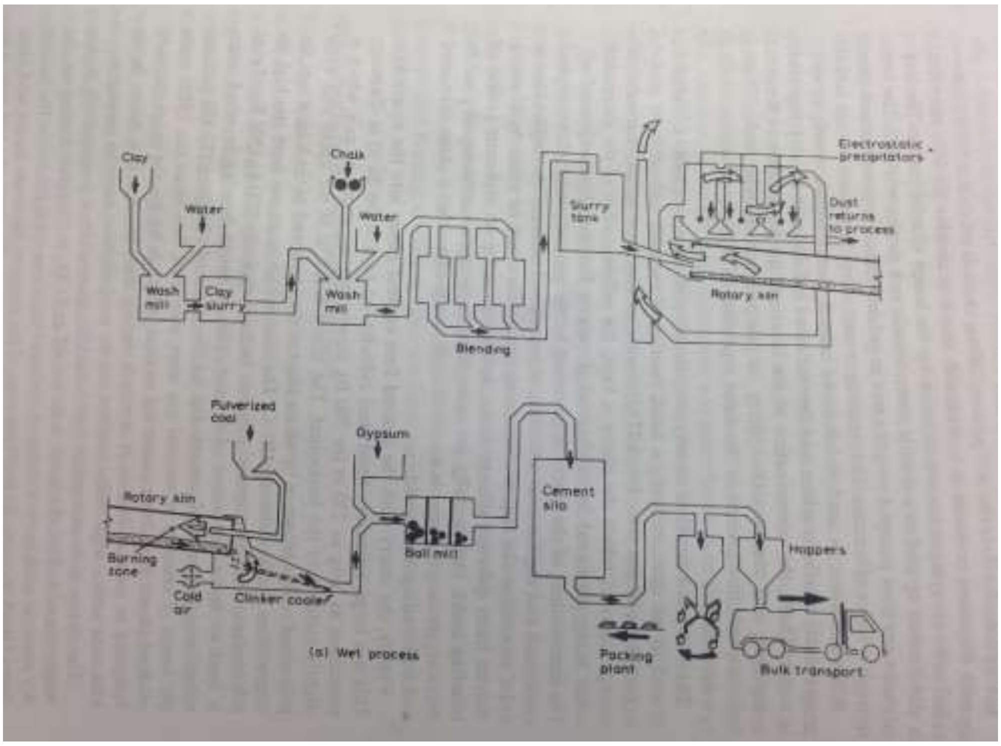
Manufacturing Process:

Main ingredients used in the manufacture of cement are:

- Limestone or chalk (Calcareous materials, consists Calcium)
- Clay, shale (Argillaceous materials, consists Silica and Alumina)
- Marl (a mixture of Calcareous and Argillaceous materials)

Limestone (CaCO3) and Clay are two main raw materials used for manufacturing Portland cement clinker. Clays have various amount of SiO2 and Al2O3.

The process of manufacture of cement consists essentially of grinding the raw materials, mixing them intimately in certain proportions and burning in large rotary kiln at a temperature of up to about 1450^{0}C when material sinters and partially fuses into balls known as clinkers. The clinker is cooled and ground to a fine powder, with some gypsum added, the resulting product is the commercial Portland cement so widely used throughout the world.



2 (a) Explain hydration process of cement with relevant chemical reactions and graphs. [10] CO1 L2

Hydration of cement

When Portland cement is mixed with water its chemical compound constituents undergo a series of chemical reactions that cause it to harden. This chemical reaction with water is called "hydration". Each one of these reactions occurs at a different time and rate. Together, the results of these reactions determine how Portland cement hardens and gains strength.

- Hydration starts as soon as the cement and water are mixed.
- The rate of hydration and the heat liberated by the reaction of each compound is different.
- Each compound produces different products when it hydrates.
- Tricalcium silicate (C3S). Hydrates and hardens rapidly and is largely responsible for initial set and early strength. Portland cements with higher percentages of C3S will exhibit higher early strength.
- Tricalcium aluminate (C3A). Hydrates and hardens the quickest. Liberates a large amount of heat almost immediately and contributes somewhat to early strength. Gypsum is added to Portland cement to retard C3A hydration. Without gypsum, C3A hydration would cause Portland cement to set almost immediately after adding water.
- Dicalcium silicate (C2S). Hydrates and hardens slowly and is largely responsible for strength increases beyond one week.
- Tetracalcium aluminoferrite (C4AF). Hydrates rapidly but contributes very little to strength. Its use allows lower kiln temperatures in Portland cement manufacturing. Most Portland cement color effects are due to C4AF. **06**

Reactions of Hydration

• 2C3S + 6H = C3S2H3 + 3Ca(OH)2
(100 + 24 = 75 + 49)

• 2 C2S + 4H = C3S2H3 + Ca(OH)2
(100 + 21 = 99 + 22)

• C3A + 6H = C3AH6
[C3A + CaSO4 . 2H2O = 3Cao. Al2O3. 3CaSO4. 31H2O] **02**
Calcium Sulfoaluminate

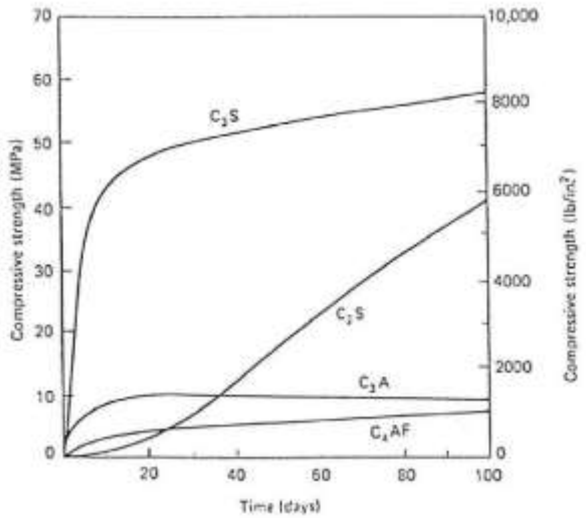


Fig 1.4 Strength gain of cement phases

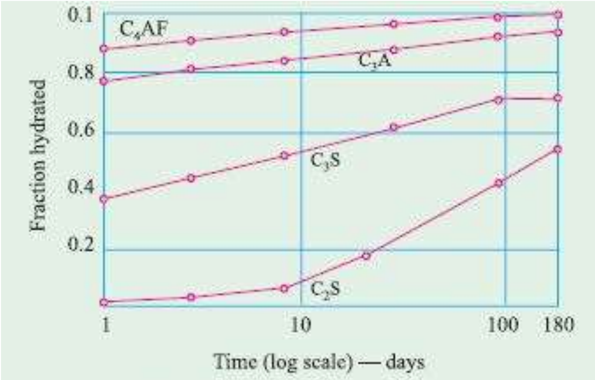


Fig. 1.3. Rate of Hydration of Pure Compounds.

02

Fig 1.5 Rate of Hydration of cement

3 (a) **List different types of cement and explain any two of them in detail.** [10] CO1 L2

Types of portland cement

The Portland cement is the most basic and the most commonly used cement in the world the Portland cement was formerly known as ordinary Portland cement and is made by adding gypsum into the clinker.

1. Ordinary Portland Cement (Type I)
2. Rapid Hardening or High Early Strength Portland Cement (Type III)
3. Quick Setting Cement
4. Low Heat Portland Cement (Type IV)
5. Sulphate Resistant Portland Cement (Type V)
6. Hydrophobic Cement
7. High Alumina Cement
8. Portland Slag Cement
9. Air Entraining Portland Cement (Type I-A, II-A, III-A)
10. Pozzolana Portland Cement
11. Supersulphated Cement
12. Masonry Cement
13. Expansive Cement
14. White Cement **05**

1. Rapid Hardening or High Early Strength Portland Cement (Type III)

- Gains strength faster than OPC. In 3 days develops 7 days strength of OPC with same water cement ratio.
- After 24 hours – not less than 160 kg/cm2
- After 72 hours – not less than 275 kg/cm2
- Initial and final setting times are same as OPC.
- Contains more tri-calcium silicate (C3S) and finely ground.
- Emits more heat during setting, therefore unsuitable for mass concreting.
- Lighter and costlier than OPC. Short curing period makes it economical.
- Used for structures where immediate loading is required, where formwork is required to be removed early for reuse elsewhere, In cold weather concrete where the rapid rate of development of strength reduces the vulnerability of concrete to the frost damage. **2.50**

2. Pozzolana Portland Cement

- OPC clinker and Pozzolana (Calcined Clay, Surkhi and Fly ash) ground together.
- Properties same as OPC.
- Produces less heat of hydration and offers great resistance to attacks of Sulphates and acidic waters.

- Used in marine works and mass concreting.
- Ultimate strength is more than OPC but setting timings are same as OPC. **2.50**

4 (a) What are fine aggregates? Write a short note on [10] CO2 L2

1. Desirable properties of fine aggregates.

Those aggregates which pass through Is sieve size 4.75 mm and retained on 150micron sieve can be called as fine aggregates. **2.00**

Desirable properties:

1. It should be clean and coarse.
2. It should be free from any organic or vegetable matter; usually silt content should not exceed 5% per cent by weight of sand.
3. It should be chemically inert.
4. It should contain sharp, angular, and rounded grains.
5. It should not contain salts which attract moisture from the atmosphere. BULKING OF SAND The increase in the volume of sand due to the presence of moisture is known as bulking of sand. This is due to the fact that moisture forms a film of water around the sand particles and this results in an increase in the volume of sand. The extent of bulking depends on the grading of sand. The finer the material the more will be the increase in volume for the given moisture content. For a moisture content of 5–8 per cent, the increase in volume may be about 20–40 per cent depending upon the gradation of sand
6. It should be well graded, i.e., it should contain particles of various sizes in suitable proportions.
7. It should be strong and durable.
8. It should be free from any organic or vegetable matter; It should be clean and free from coatings of clay and silt.

   Sand should not contain any harmful impurities such as iron, pyrites, alaklies, salts, coal or other organic impurities, mica, shale or similar laminated materials, soft fragments, sea shale in such form or in such quantities as to affect adversely the hardening, strength or durability of the mortar/concrete. The maximum quantities of clay, fine silt, fine dust and organic impurities in the sand / marble dust shall not exceed the following limits: (a) Clay, fine silt and fine dust when determined in accordance within not more than 5% by mass in IS 2386 (Part-II), natural sand or crushed gravel sand and crushed stone sand. (b) Organic impurities when determined in color of the liquid shall be lighter in lighter in accordance with IS 2386 (Part –II) than that specified in the code **04**

2. Alternatives to river sand.

1.26 ALTERNATIVES TO RIVER SAND

Sand is a vital ingredient in making two most used construction materials viz. and mortar.Traditionally River sand, which is formed by natural weathering of r years, is preferred as fine aggregate. The economic development fuelling the growth and housing generates huge demand for building materials like sand. The indiscri sand from riverbeds is posing a serious threat to environment such as erosion banks, triggering landslides, loss of vegetation on the bank of rivers, lowering water table etc. Hence, sand mining from riverbeds is being restricted or banned b Controlling extraction along rivers has caused the illegal activities to spread into hillsi creating public hazards such as landslide, deep ponds, and hanging cliffs. This san fields (popularly known as filter sand), in addition to depleting the fertile top soil, in of concrete / mortar.

The construction sector in India contributes to over 7% of the GDP and it more than 70% of India's infrastructure (for 2030) is yet to be built. An increasing will drive the demand for newly built environments, and hence for sand as part of coming years. Low availability of sand is driving the examination of alternate mate similar characteristics, for use in construction-related applications. Sand mad sedimentary rocks is perceived as one such alternative. Crushed-stone sand o sand' is produced by crushing rocks to a grade comparable to natural sand. The p from crushed rock is said to be similar (or often better) to riverbed sand.

Some of the alternatives to river sand are;

- Manufactured Sand
- Fly Ash/ Bottom Ash/Pond Ash
- Copper Slag
- Filtered Sand
- Sea Sand
- Slag Sand
- Crushed Waste Glass
- Recycled Aggregate/Construction and demolition waste aggregate etc.

1.26.1 Manufactured Sand

Manufactured sand is crushed aggregates produced from hard granite stone w shaped with grounded edges, washed and graded with consistency to be used a river sand.

5 (a) What are different laboratory tests conducted on coarse aggregates in the laboratory? Explain any two of them in detail. [10] CO2 L2

i) Crushing value ii) Impact value iii) Abrasion value

iv) Flakiness and elongation index test v) Specific gravity test

vi) Water absorption test etc….

Test for determination of aggregate crushing value

The "aggregate crushing value" gives a relative measure of the resistance o to crushing under a gradually applied compressive load. With aggregates crushing value' 30 or higher, the result may be anomalous and in such cases th fines value" should be determined and used instead.

The standard aggregate crushing test is made on aggregate passing a 12.5 and retained on 10 mm I.S. Sieve. If required, or if the standard size is not availa upto 25 mm may be tested. But owing to the nonhomogeneity of aggregates the results will not be comparable with those obtained in the standard test.

Aggregate Crushing Value A

About 6.5 kg material consisting of aggregates passing 12.5 mm and retained on 10 mm sieve is taken. The aggregate in a surface dry condition is filled into the standard cylindrical measure in three layers approximately of equal depth. Each layer is tamped 25 times with the tamping ord and finally levelled off using the tamping rod as straight edge. The weight of the sample contained in the cylinder measure is taken (A). The same weight of the sample is taken for the subsequent repeat test.

The cylinder of the test appartus with aggregate filled in a standard manner is put in position on the base-plate and the aggregate is carefully levelled and the plunger inserted horizontally on this surface. The plunger should not jam in the cylinder.

The appartus, with the test sample and plunger in position, is placed on th testing machine and is loaded uniformly upto a total load of 40 tons in 10 min load is then released and the whole of the material removed from the cylinder a 2.36 mm I.S. Sieve. The fraction passing the sieve is weighed (B).

$$\text{The aggregate crushing value} = \frac{B}{A} \times 100$$

where, B = weight of fraction passing 2.36 mm sieve,

A = weight of surface-dry sample taken in mould.

The aggregate crushing value should not be more than 45 per cent for a for concrete other than for wearing surfaces, and 30 per cent for concrete us surfaces such a runways, roads and air field pavements.

Test for determination of 'ten per cent fines value'

The sample of aggregate for this test is the same as that of the sample used crushing value test. The test sample is prepared in the same way as describ cylinder of the test appartus is placed in position on the base plate and the test in thirds, each third being subjected to 25 strokes by tamping rod. The aggregate is carefully levelled and the plunger inserted so that it rests horiz surface.

The appartus, with the test sample and plunger in position is placed in th testing machine. The load is applied at a uniform rate so as to cause a total pen plunger in 10 minutes of about:

15.00 mm for rounded or partially rounded aggregates (for example uncr

20.0 mm for normal crushed aggregates, and

24.0 mm for honeycombed aggregates (for example, expanded shales a

These figure may be varied according to the extent of the rounding or ho

After reaching the required maximum penetration, the load is released a of the material removed from the cylinder and sieved on a 2.36 mm I.S. Si passing the sieve is weighed and the weight is expressed as a percentage of the test sample. This percentage would fall within the range 7.5 to 12.6, but if it does not, a further test shall be made at a load adjusted as seems appropriate to bring the percentage fines with the range of 7.5 to 12.5 per cent. Repeat test is made and the load is found out which gives a percentage of fines within the range of 7.5 to 12.5

$$\text{Load required for 10 per cent fines} = \frac{14 \times X}{Y + 4}$$

where, X = load in tons, causing 7.5 to 12.5 per cent fines.

Y = mean percentage fines from two tests at X tons load.

Aggregate Impact Val

Test for determination of aggregate impact value

The aggregate impact value gives relative measure of the resistance of an aggregate to sudden shock or impact. Which in some aggregates differs from its resistance to a slow compressive load.

The test sample consists of aggregate passing through 12.5 mm and retained on 10 I.S. Sieve. The aggregate shall be dried in an oven for a period of four hours at a tempera of 100°C to 110°C and cooled. The aggregate is filled about one-third full and tamped v 25 strokes by the tamping rod. A further similar quantity of aggregate is added and tam in the standard manner. The measure is filled to over-flowing and then struck off level. The weight of the aggregate in the measure is determined (weight *A*) and this weigh aggregate shall be used for the duplicate test on the same material.

The whole sample is filled into a cylindrical steel cup firmly fixed on the base of machine. A hammer weighing about 14 kgs. is raised to a height of 380 mm above the u surface of the aggregate in the cup and allowed to fall freely on the aggregate. The sample shall be subjected to a total 15 such blows each being delivered at an interval o less than one second. The crushed aggregate is removed from the cup and the whole is sieved on 2.36 mm I.S. Sieve. The fraction passing the sieve is weighed to an accura 0.1 gm. (weight *B*). The fraction retained on the sieve is also weighed (weight *C*). If the weight (*B* + *C*) is less than the initial weight *A* by more than one gm the result sha discarded and a fresh test made. Two tests are made.

The ratio of the weight of fines formed to the total sample weight in each t expressed as percentage.

Therefore, Aggregate Impact Value = $\frac{B}{A} \times 100$

where, B = weight of fraction passing 2.36 mm I.S. Sieve.

A = weight of oven-dried sample.

The aggregate impact value should not be more than 45 per cent by weig aggregates used for concrete other than wearing surfaces and 30 per cent by weig concrete to be used as wearing surfaces, such as runways, roads and pavements.

Test for determination of aggregate abrasion value

Indian Standard 2386 (Part IV) of 1963 covers two methods for finding out the ab value of coarse aggregates: namely, by the use of Deval abrasion testing machine and use of Los Angeles abrasion testing machine. However, the use of Los Angeles abrasion machine gives a better realistic picture of the abrasion resistance of the aggregate. This n is only described herein.

Table 3.21 gives the detail of abrasive charge which consists of cast iron spheres spheres approximately 48 mm in diameter and each weighing between 390 to 445

Table 3.21. Specified Abrasive Charge

Grading	*Number of spheres*	*Weight of charge (gm*
A	12	5000 ± 25
B	11	4584 ± 25
C	8	3330 ± 20
D	6	2500 ± 15
E	12	5000 ± 25
F	12	5000 ± 25
G	12	5000 ± 25

The test sample consist of clean aggregate which has ben dried in an ov
110°C and it should conform to one of the gradings shown in Table 3.22.

Table 3.22. Gradings of Test Samples

Sieve Size		Weight in gm. of Test Sample For G					
Passing	Retained on	A	B	C	D	E	
mm	mm						
80	63	-	-	-	-	2500	
63	50	-	-	-	-	2500	
50	40	-	-	-	-	5000	5
40	25	1250	-	-	-	-	5
25	20	1250	-	-	-	-	
20	12.5	1250	2500	-	-	-	
12.5	10	1250	2500	-	-	-	
10	6.3	-	-	2500	-	-	
6.3	4.75	-	-	2500	-	-	
4.75	2.36	-	-	-	5000	-	

Test sample and abrasive charge are placed in the Los Angeles Abrasion testing machine and the machine is rotated at a speed of 20 to 33 rev/min. For gradings *A, B, C* and *D*, the machine is rotated for 500 revolutions. For gradings *E, F* and *G*, it is rotated 1000 revolutions. At the completion of the above number of revolution, the material is discharged from the machine and a preliminary separation of the sample made on a sieve coarser than 1.7 mm IS Sieve. Finer portion is then sieved on a 1.7 mm IS Sieve. The material coarser than 1.7 mm IS Sieved is washed, dried in an oven at 105° to 110°C to a substantially constant weight and accurately weighed to the nearest gram.

The difference between the original weight and the final weight of the test sample is expressed as a percentage of the original weight of the test sample. This value is reported as the percentage of wear. The percentage of wear should not be more than 16 per cent for concrete aggregates.

Typical properties of some of the Indian aggregate sample are shown in table 3.23.

Los Angeles Abrasion T

6 (a)	Explain the importance of size, shape and texture of coarse aggregates on desirable properties of concrete.	[10]	CO2	L2

Size of aggregates

The largest maximum possible size of the 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 largest maximum size 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 conditions:

(i) Thickness of section: (ii) Spacing of reinforcement; (iii) Clear cover; (iv) Mixing, handling and placing techniques.

Generally, the maximum size of aggregate should be as large possible within the limits specified, but in any case not greater than one fourth of the minimum thickness of the member. Rubbles 160 mm size or upto any reasonable size may be used in plain concrete. In such concrete, called plum concrete. For heavily reinforced concrete member the nominal maximum size of the aggregate should usually restricted to 5mm less than minimum clear distance between the main bars or 5mm less than clear minimum cover to the reinforcement whichever is smaller.

Aggregates are divided into two categories from consideration of size (i) Coarse aggregates and (ii) Fine aggregates. The size of aggregate bigger than 4.75mm is considered as coarse aggregate and whose size is 4.75mm and less is considered as fine aggregate. **04**

Shape and surface texture of aggregates

The shape of aggregate is an important characteristic since it affects the workability of concrete. It is difficult to measure the shape of irregular shaped aggregates. Not only the type of parent rock but also the type of crusher used also affects the shape of the aggregate produced. Good Granite rocks found near Bangalore will yield cuboidal aggregates. Many rocks contain planes of jointing which is characteristics of its formation and hence tend to yield more flaky aggregates. The shape of the aggregates produced is also dependent on type of crusher and the reduction ratio of the crusher. Quartzite which does not possess cleavage planes tend to produce cubical shape aggregates. From the standpoint of economy in cement requirement for a given water cement ratio rounded aggregates are preferable to angular aggregates. On the other hand, the additional cement required for angular aggregates is offset to some extent by the higher strengths and some times greater durability as

a result of greater Interlocking texture of the hardened concrete. Flat particles in concrete will have objectionable influence on the workability of concrete, cement requirement, strength and durability. In general excessively flaky aggregates make poor concrete. while discussing the shape of the aggregates, the texture of the aggregate also enters the discussion because of its close association with the shape. Generally round aggregates are smooth textured and angular aggregates are rough textured. Therefore some engineers argue against round aggregates from the point of bond strength between aggregates and cement. But the angular aggregates are superior to rounded aggregates from the following two points:

Angular aggregates exhibit a better interlocking effect in concrete, which property makes it superior in concrete used for road and pavements. The total surface area of rough textured angular aggregate is more than smooth rounded aggregates for the given volume. By having greater surface area, the angular aggregates may show higher bond strength than rounded aggregates. The shape of the aggregates becomes all the more important in case of high strength and high performance concrete where very low water/cement ratio is required to be used. In such cases cubical aggregates are required for better workability.

Surface texture is the property, the measure of which depends upon the relative degree to which particle surface are polished or dull, smooth or rough. Surface texture depends upon hardness, grain size, pore structure, structure of the rock and the degree to which the forces acting on it have smoothened the surface or roughened. Experience and laboratory experiments have shown that the adhesion between cement paste and the aggregate is influenced by several complex factors in addition to the physical and mechanical properties. 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 another aggregate particle. It will therefore permit denser packing because of enhanced workability.

Aggregate:Shape and Surface Texture

Ideal aggregates:
- spherical or cubical
- round shape, fine porous surface
- reduced particle interaction (friction)
- results in good workability and good surface area for bonding
- natural sands are good examples of this

Non Ideal aggregates:
- angular
- elongated
- flaky or rough
- high particle interaction
- requires more cement paste to achieve workability
- results in increased cost

Rounded: Good workability, low water demand, poor bond
Irregular: Fair workability, low water demand
Angular: Increased water demand, good bond
Elongated : May lack cohesion and require increased fines
Flaky: Aggregate stacks give workability problems

Coarse Aggregate Texture

Glassy.
Smooth.
Granular.
Crystalline
Honeycombed and porous.

• Depends on: rock hardness, grain size, porosity, previous exposure.
• Aggregate shape and texture affect the workability of fresh concrete through their influence on cement paste requirements.
• Sufficient paste is required to coat the aggregates and to provide lubrication to decrease interactions between aggregate particles during mixing.
• Ideal particle is one close to spherical in shape (well rounded and compact) with a relatively smooth surfaces (natural sands and gravels come close to this ideal).
• More angular shapes - rough surfaces – interfere with the movement of adjacent particles (less workable) –They also have a higher surface –to –volume ratio – more paste.
• Flat or elongated aggregates should be avoided.
• Rough surface requires more lubrication for movement (crushed stone).
• Shape can influence strength by increasing surface area available for bonding with the paste.
• Rough surfaces –improve mechanical bond.
• Irregular aggregates (angulars) –higher internal stress concentrations –easier bond failure.

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<u>Answer any FIVE FULL Questions</u>

		MARKS	CO	RBT
1 (a)	How cement is manufactured by wet process? Give flow chart.	[10]	CO1	L2
2 (a)	Explain hydration process of cement with relevant chemical reactions and graphs.	[10]	CO1	L2
3 (a)	List different types of cement and explain any two of them in detail.	[10]	CO1	L2
4 (a)	What are fine aggregates? Write a short note on 1. Desirable properties of fine aggregates. 2. Alternatives to river sand.	[10]	CO2	L2
5 (a)	What are different laboratory tests conducted on coarse aggregates in the laboratory? Explain any two of them in detail.	[10]	CO2	L2
6 (a)	Explain the importance of size, shape and texture of coarse aggregates on desirable properties of concrete.	[10]	CO2	L2