# UNIT-3: CONCRETE

QUESTION1. Explain the slump cone test in details for the determination of workability of fresh concrete. (Win-22, Marks-4)

ANS: Procedure of slump cone test:

1. Clean and apply oil to inner surface of slump cone and place it on non-porous plate.

2. Fill the freshly mixed concrete into cone in four layers. Tamp each layer 25 times using round headed rod. Remove the excess concrete using trowel.

3. Now lift the cone vertically using both handles, so that concrete will subside down in one of the form i.e. true, shear or collapse slump.

4. Calculate the slump height of concrete as height of cone minus height of concrete subsidence.

5. The degree of workability based on slump height is defined as per following.

| Slump Height | Degree OF Workability |
|---|---|
| 0 to 25 mm | Very Low |
| 25 to 50 mm | Low |
| 50 to 100 mm | Medium |
| 100 to 175 mm | High |
| More than 175 mm | Very High |

QUESTION 2. Illustrate the effect of following properties of coarse aggregate on compressive strength of concrete:- i) Size of aggregate ii) Shape of aggregate (Win-22, Marks-4)

Ans: Effect of properties of coarse aggregates on compressive strength ofconcrete:

i) **Size of aggregate:** If coarse aggregate particles are of large size (say 20 mm) in concrete mixture , then concrete becomes harsh and only strength may reduce due to honey combing. But if coarse aggregate are of smaller sizes only (say 10 mm). Then ultimate strength of concrete will be lesser. Therefore coarse aggregate with combination of both sizes (i.e. 10 and 20 mm) will give better workable concrete with more compressive strength.

ii) **Shape of aggregate:** If shape of coarse aggregate is angular, then there is good interlocking of aggregate particles. Hence it gives more compressive strength. But if shape of coarse aggregate is sub-angular or sub-rounded, then compressive strength reduces due to less bonding between particles.

QUESTION 3. State the necessity of supervision of concreting operations and precautions to be taken to avoid the wastage of material (Win-22, Marks-4)

Ans: **Necessity of supervision for concreting operation:**

1. Supervision is necessary to complete all concretingoperations in standard manner.

2. It is necessary to avoid any type of delay in concrete work.

3. It is also beneficial to reduce wastage of concrete during concreting.

4. It is required to get overall quality in concrete work at site.

5. Supervision becomes essential in maintaining smooth flow of concreting operations at each stage of project.

6. It found very effective in controlling bad workmanship.

**Precautions to be taken to avoid the wastage of material:**

1. Proper proportioning of mix is to be done so as to avoid excess use of any constituent of concrete.

2. Weigh batching should be adopted as volume batching being not accurate due to improper consideration of water content and specific gravity of aggregate.

3. Concrete should be transported quickly before its setting.

4. Quantity of material should be accurately estimated.

5. Formwork should be checked. It should be strong enough to carry the weight of concrete without bulging.

QUESTION 4. State any four effects of excess on silt on properties of concrete (Win-22, Marks-4)

Ans: **Workability of concrete:** It is the ability of concrete for its easy handling in various concreting operations viz. mixing, transportation, placing and compacting, is called as workability of concrete.

**Factors affecting workability :**

1. Water content (W/C ratio)
2. Mix proportions of concrete
3. Size of aggregate
4. Shape of aggregate
5. Surface texture of aggregate
6. Grading of aggregate
7. Use of admixtures
8. Method of mixing of concrete

QUESTION 5. Explain in details the ultrasonic pulse velocity test and technique of measuring pulse velocity through concrete. (Win-22, Marks-4)

Procedure of measuring ultrasonic pulse velocity as per I.S.13311:

1. Identify the target concrete surface and clean it properly. Then define two end points of application of ultrasonic pulses. Note down the path length L in mm between two ends. (Generally 100-150mm)

2. Apply one of the acoustical coupling materials i.e. grease or oil to both the points of the concrete.

3. Attach the transmitter and receiver end of transducer to the identified concrete surface in one of the form given in figure below.

4. Generate the ultrasonic pulses or waves of 50 to 60 kHz using electro-acoustical or ultrasonic pulse generator; so that it will pass through the transmitter end attached to concrete and will reach to receiver end depending upon homogeneity of concrete mass.

5. Note down the time of travel i.e. transit time (T) of these waves displayed on display unit of electronic timing device in seconds.

6. Calculate the ultrasonic pulse velocity (V) of transmitted waves as V=(L/T) in Km/s.

7. Repeat all above steps at other locations to calculate the average ultrasonic pulse velocity of all such observations.

8. Determine the overall quality of concrete based on calculated ultrasonic pulse velocity by using table given below.

Specification for deciding the quality of concrete by Ultrasonic pulse velocity as per I.S.13311 (part 1 and 2)

| Velocity (Km/s) | Quality of concrete | Comp. Strength (N/mm$^2$ ) |
|---|---|---|
| 4.5 and above | Very good | S > 40 |
| 3.5 to 4.0 | Good | S = 25 -40 |
| 3.0 to 3.5 | Medium | S = 10 - 20 |
| 2.0 to 3.5 | Poor | S = 4 - 10 |
| 2.0 and below | Very poor | S < 4 |

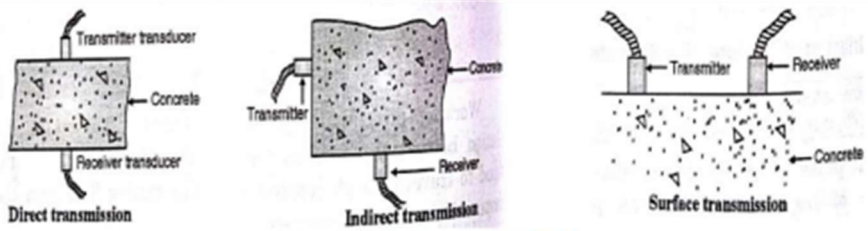


**Fig. :Techniques of UPVT**

**Techniques of Ultrasonic Pulse Velocity Test:**

1. **Direct transmission:** The transmitting and receiving transducers are placed on opposite surfaces of the concrete slab. This will give maximum sensitivity and provide a well-defined path length.

2**. Indirect transmission:** The transmitting and receiving transducers are placed on adjacent surfaces of the concrete slab.

3. **Surface transmission:** The transmitting and receiving transducers are placed on same surfaces of the concrete slab.

QUESTION 6. Discuss the Non-destructive testing of concrete. List the various methods of NDT and explain any one in brief (Win-22, Marks-4)

Ans: **Non-destructive testing of concrete:**

The testing of concrete in which concrete need not to break physically to determine its properties, is called as Non-Destructive Testing (NDT). The strength can be tested without physical breaking of concrete; hence it is safe. It can give internal flaws, cavities and homogeneity details of concrete within short period. It avoids wastage of concrete, hence becomes economical up to certain extent. It is applicable in any type and position of concrete members shows wide applicability. Its results are simple and easy to interpret.

**List of methods of NDT:** 1. Ultrasonic Pulse Velocity test 2. Rebound Hammer Test

3. Radioactive method 4. Nuclear method

5. Electrical method 6. Magnetic method

**Rebound Hammer Test:**

1. Initially the plunger of rebound hammer is kept touching to the target concrete surface

2. Then the tubular casing of hammer is pushed towards concrete, so that the spring gets wind up around the plunger

3. Now release the mass attached to plunger using dash-pot, so that hammer will impact on concrete surface and rebound back depending on strength of concrete.

4. Due to backward motion of hammer, pointer on graduated scale will move in same direction.

5. Observe the distance travelled by pointer/rider on graduated scale as Rebound Number.

6. If this rebound Number is less, the strength of concrete will be less, But if it is more, then concrete possess sufficient strength.

QUESTION 7. State Duff Abraham's law for water cement ratio (Win-22, Marks-2)

Ans: **Duff Abraham's Law for water cement ratio:** For workable concrete, the compressive strength of concrete depends on water cement ratio.

QUESTION 8 State principle of ultrasonic pulse-velocity test on concrete.

(Win-19, Marks-2)

Ans: **Principle of ultrasonic pulse-velocity test:** The working principle of ultrasonic pulse velocity test is as follows: The electronically generated mechanical pulses of specific frequency pass though concrete mass and travel time of waves is measured to determine the ultrasonic pulse velocity and related quality of concrete.

QUESTION 9 Calculate quantity of water to be added for casting cubes in laboratory by 12.5 kg cement if w/c ratio 0.45. (Win-19, Marks-4)

Ans: As w/c = (weight of water / weight of cement)

w/c = (Ww / Wc)

0.45 = (Ww / 12.5)

Ww = (0.45x12.5)

Ww = 5.625 kg or 5.625 Litres

QUESTION 10 Suggest the minimum grade of concrete for following exposure condition.

i) RCC work ii) Water retaining structure iii) Sea water construction

iv) Pre-stressed concrete (Win-19, Marks-4)

Ans: i) RCC work = M 15

ii) Water retaining structure = M 30

iii) Sea water construction = M 20 for PCC and M 30 for RCC

iv) Pre-stressed concrete = M 40

QUESTION 11 Draw concreting operation chain in sequence. (Win-19, Marks-4)

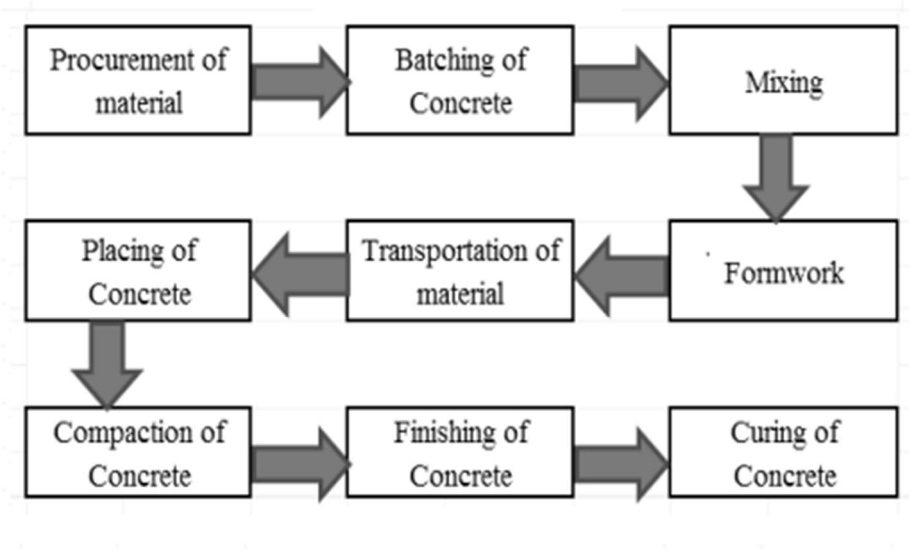


**Fig.: Concreting Operations in Sequence**

QUESTION 12 Describe the procedure for determination of workability by compaction factor method. (Win-19, Marks-4)

Ans: **Procedure for determination of workability by compaction factor method:**

The procedure of determining the workability of concrete using compaction factor as per IS: 1199-1959 is as follows.

1. Take the freshly mixed concrete of any specific grade and fill it in upper hopper of compaction factor test apparatus with trap door 1 (TD1)in closed position.

2. After filling the upper hopper, open the TD1 and allow the concrete to free fall from upper hopper into lower hopper through dropping height 200mm with TD2 in closed position.

3. Now, immediately open TD2 and allow to free fall the concrete again from lower hopper into cylinder through same dropping height.

4. Repeat above steps till the cylinder fills with concrete completely. Take the weight of this partially compacted concrete as W1 gm.

5. Remove the concrete from the cylinder and fill it with same grade of concrete by properly compacting with vibration.

6. Take the weight of this fully compacted concrete as W2 gm.

7. Calculate the compaction factor of given concrete by using CF = (W1 / W2)

8. Depending upon calculated C.F., the degree of workability can be designated as follows.

| Sr. No. | Compaction Factor | Degree of Workability |
|---|---|---|
| 1 | 0.78 | Very low |
| 2 | 0.85 | Low |
| 3 | 0.92 | Medium |
| 4 | 0.95 | High |

QUESTION 13 Define bleeding. Suggest any two ways by which bleeding can be avoided. (Win-19, Marks-4)

Ans: **Bleeding:** It is one form of segregation in which water gets accumulated over settled concrete mass, called as bleeding.

**Prevention of Bleeding:** The bleeding can be avoided by following ways.

1. Bleeding can be prevented by selecting appropriate w/c ratio as per IS 456:2000, so that water content w.r.t. other materials can be maintained.

2. It can be also avoided by adopting proper CA/FA ratio; so that fine aggregate will not be more than coarse aggregate causing bleeding.

3. Mixing of concrete should be done using mixers to achieve homogeneity. Homogeneous mixture avoids chances of bleeding.

4. Excessive compaction by over vibration should be avoided to reduce bleeding effect.

QUESTION 14 State the importance of NDT and state working principle of Rebound hammer. (Win-19, Marks-4)

ANS: **Importance of NDT:**

1. The strength can be tested without physical breaking of concrete; hence it is safe.

2. It can give internal flaws, cavities and homogeneity details of concrete within short period.

3. It avoids wastage of concrete, hence becomes economical up to certain extent.

4. It is applicable in any type and position of concrete members shows wide applicability.

5. Its results are simple and easy to interpret.

**Working principle of Rebound hammer:** Rebound hammer test method is based on the principle that the rebound of an elastic mass attached to plunger i.e. rebound number depends on the hardness of the concrete surface against which the mass strikes. If the rebound of hammer is more, it indicates surface is hard, solid and dry. But if rebound of hammer is less, then tested concrete may be soft, porous and moist.

QUESTION 15. Define Concrete Mix Design. Write four objectives of concrete mix design (Win-22, Marks-4)

**Concrete Mix Design:** The process or method of determining the quantity and proportions of materials required for particular grade of concrete is called as Concrete Mix Design.

OR

The stepwise procedure to find the quantities of materials required for particular grade of concrete is called as Concrete Mix Design.

**Objectives of concrete mix design:**

1. To achieve a specified compressive strength of concrete.
2. To reduce wastage of concrete by correct proportioning.
3. To achieve economy by selecting appropriate ingredients.
4. To maintain workability of concrete mix throughout work.
5. To obtain maximum possible yield per bag of cement.
6. To ensure less defects and enhanced durability of concrete.

QUESTION 16. Explain the laboratory procedure to determine the compressive strength of concrete cubes as per IS 516-1959 w.r.to following points:-

i) Preparation of test specimen ii) Procedure of testing

iii) Interpretation of results (Win-22, Marks-4)

**Procedure to determine the compressive strength of concrete:-**

**i) Preparation of test specimen:**

1. Take concrete cube mould of 15cm side and apply oil to internal surface of mould.
2. Prepare the fresh concrete mixture of required specific grade and fill it in cube mould by properly compacting it using tamping rod. Prepare the two more cubes in similar manner.
3. Compact each cube on table vibrator to remove air voids for 5 minutes.
4. Keep all the compacted moulds at room temperature for 24 hrs for initial hardening and at relative humidity 90%.
5. Remove cube moulds and keep cement cubes under fresh water i.e. in curing tank for curing for 1, 3, 7, 14, 21, 28 days.

**ii) Procedure of testing:** 6. Remove cube from water after required curing period and keep it under Compression Testing Machine (CTM) for testing.

7. Apply compressive load at a rate of 4 Tonnes/min for 10 minutes or till failure of cube. Note down the failure load in N shown by red pointer in dial gauge.

8. Finally calculate compressive strength of cube as failure load in N by cross sectional area of cube in mm2 .

9. The average of three test results can be considered as average compressive strength in N/mm2 or MPa.

iii) **Interpretation of results:** 1. The calculated result of compressive strength gives the idea about the grade of concrete. If concrete possess strength 23 N/mm2 or 23 MPa, then the grade of concrete will be designated as M20 i.e. M=Mix; and 20 = 20 N/mm2 .

2. Similarly, strength of concrete lies in between 25 and 30 MPa, i.e. say 28.5 N/mm 2 ; then the grade of concrete is considered to be M25.

3. It means that the lower value than the test result value is used to designate the grade of tested concrete.

4. In other words, when we test the known grade say M25, then the test result value should be come out more that the requirement. Otherwise such concrete is rejected and casted concrete is needed to demolish.

## QUESTION 17. Explain the method of concrete mix design procedure by I.S. method as IS-10262 (Win-19, 4-Mark)

**Procedure of IS method of concrete mix design:** The concrete mix design is done by IS 10262-2009 using following steps

1. Calculation of target mean strength: The concrete mix design is done for specific target strength which is calculated first by using formula,

f'ck = fck + t.S

where, f'ck = target mean strength after 28 days fck = characteristics compressive strength at 28 days S = standard deviation from IS 456 t = tolerance factor from IS 456

2. Selection of water-cement ratio: The w/c ratio is selected from the graph of generalized relationship between w/c ratio and compressive strength. The selected w/c ratio is checked against the limiting w/c ratio and lower of two is adopted.

3. Selection of water content: The maximum water content per cubic meter of concrete with nominal maximum size of aggregate s finalized in this step. The water content adopted is used for computing cement content in next step.

4. Calculation of cementitous material content: From adopted w/c ratio and selected maximum water content the quantity of cementious materials is calculated. It is checked against the minimum cementitous content for durability requirement ad larger of the two values is adopted as cement content.

5. Calculation of coarse aggregate proportion: The volume of coarse aggregate per unit volume of total aggregate is chosen in this step based on nominal maximum size of aggregate

6. Selection of combination of coarse aggregate fractions: The different sizes viz. 10 mm , 20 mm , 25 mm are taken in proportion from grading , confirming in table 2 of IS 383

7. Calculation of fine aggregate proportion: From above steps, absolute volume of all ingredients of concrete the mix proportion is calculated for said mix design of concrete.

## QUESTION 18 Write any four factors affecting concrete mix design

(Win-19, Marks-4)

**Factors affecting concrete mix design:** The concrete mix design procedure affects by the following factors.

1. Maximum water-cement ratio

2. Minimum cement content

3. Maximum nominal size of aggregate

4. Workability in terms of slump

5. Exposure conditions

6. Maximum temperature at the pouring point

7. Early age and ultimate strength requirement

8. Grading zone of fine aggregate

9. Type of admixture to be used

10. Specific gravity of all ingredient material