CONCRETE TECHNOLOGY

MODULE - 2

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WORKABILITY → It is defined as that property of freshly mixed concrete or mortar which determines the ease and homogeneity with which it can be mixed, placed, compacted and finished.

Ease → It is related to rheology of fresh concrete which includes performance parameters of stability, mobility and compactibility.

Workability of fresh concrete is a complex system of two critical parameters.

i) Consistency – It is the relative mobility or ability of a freshly mixed concrete to flow and the usual measurements are: slump for concrete, flow for mortar or grout and penetration resistance for neat cement paste.

Major factors affecting the consistency are:-

Water content, cement content and its characteristics, air content, temperature, plasticity of the cement paste, aggregate content and its characteristics, mixing conditions, chemical admixtures and mineral additives used.

ii) Homogeneity – It means uniform and stable distribution of cement aggregate and water and resistance to segregation in a critical

physical property of plastic concrete.

Measurement of Workability

(i) Slump cone test
(ii) Compacting factor test
(iii) Vee-Bee consistency test
(iv) Flow test.

Factors affecting Workability.

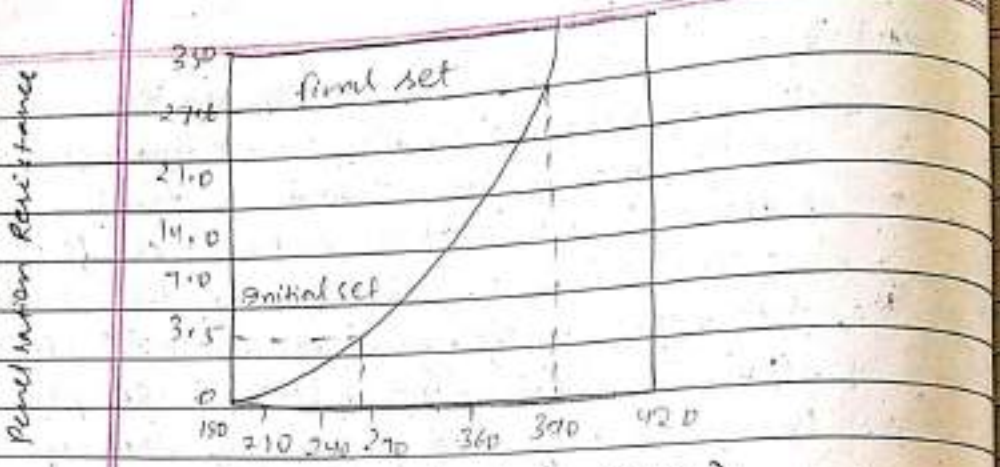
(i) Influence of mix proportions.
(ii) Influence of aggregate properties.
(iii) Influence of admixtures.
(iv) Effect of environmental conditions.
(v) Effect of time.

SETTING TIME OF CONCRETE

Setting time of cement concrete depends upon the W/C ratio, temperature conditions, type of cement, use of mineral admixture, use of plasticize in particular retarding plasticizer.

* Setting parameter of concrete is more of practical significance for site engineers than setting time of cement.
* Setting time of concrete is found by penethometer test. This method of test is covered by IS 8142 of 1976 and ASTM-C-403.

* The apparatus consist of a container which should have minimum lateral dimension of 150 mm and minimum 150 mm depth.
* A device is provided to measure the force required to cause penetration of the needle.
* Sieve the concrete sample in 4.75 mm sieve and fill in the container. Compact the mortar by rodding, tapping rocking or by vibrating. Level the surface and keep it covered to prevent the loss of moisture.
* Insert a needle of appropriate size. Gradually and uniformly apply a vertical force downwards on the apparatus until the needle penetrates to a depth of 25 ± 1.5 mm as indicated by the scribe mark.
* The time taken to penetrate 25 mm depth could be about 10 sec. Record the force required to produce 25 mm penetration and the time of inserting from the time water is added to cement.
* Calculate the penetration resistance by dividing the recorded force by the bearing area of the needle. This is the penetration resistance.
* For the subsequent penetration avoid the area where the mortar has been disturbed. The clear distances should be two times the diameter of the bearing area.
* Needle is inserted at least 25 mm away from the wall of container.
* Initial → 30 min.
* Final → 6 to 10 hours.



SEGREGATION

It can be defined as the separation of the constituent materials of concrete.

If CA separate from the rest ingredient of concrete then this tendency is known as segregation.

* Such concrete is not only going to be weak lack of homogeneity is also going to induce all undesirable properties in the hardened concrete.

Segregation is of 3 types

I. CA separating out or settling from the rest of the matrix.
II. The paste or matrix separating out from C.A.
III. Water separating out from the rest of the material being a material of lowest

out to the surface of the concrete being of the lowest specific gravity among all ingredients of concrete.

Due to bleeding water comes up at the top surface sometimes along with water, cement also comes to the surface.

* This formation of cement paste at the surface is known as 'laitance'. Due to this the surface of slabs and pavements will not have good wearing quality.

Laitance produce dust in summer and mud in rainy season. The top surface has a higher water content and also devoid of aggregate matter.

* If W/C ratio is more than 0.7 the bleeding channel will remain continuous and unsegmented. These continuous bleeding channels are responsible for permeability of the concrete structures.

Bleeding water percentage = $\frac{\text{Total quantity of bleeding water}}{\text{Total quantity of water in the sample of concrete}}$.

specific gravity.

A well made concrete, taking into consideration various parameters such as grading, size, shape and surface texture of aggregate with optimum quantity of water makes a cohesive mix. Such concrete will not exhibit any tendency for segregation.

* The cohesive and fatty characteristics of matrix do not allow the aggregate to fall apart at the same time, the matrix itself is sufficiently contained by the aggregate.
* Similarly water also does not find it easy to move out freely from the rest of the ingredients.
* Segregation is difficult to measure quantitatively, but it can be easily observed at the time of concreting operation.

2 types of segregation can occur :-

1) The separating out of coarser particles in a dry mix, termed segregation.
2) Separation of cement paste from the mix in the case of lean and wet mixes called bleeding.

BLEEDING

It is sometimes referred as water gain. It is a particular form of segregation in which some of the water from the concrete comes

MIXING AND VIBRATION OF CONCRETE

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Mixing of concrete can be done by two ways :-

i) Dry mix ii) Wet mix .

* First mix cement, fine aggregate and coarse aggregate in mixture . Give a complete mix of these dry ingredient .
* Then add the water in dry mix and make the paste and form the concrete .
* The dry mix help to maintain homogeneity in concrete mix .

Vibration of concrete

Vibration in concrete is done for compaction . In compaction the air voids and water voids will be removed from concrete .

Some methods are adopted for compaction

(a) Hand compaction .
i) Rodding ii) Ramming iii) Tamping .

(b) Compaction by Vibration .
i) Internal vibrator (Needle vibrator)
ii) Formwork vibrator (External Vibrator)
iii) Table vibrator
iv) Platform vibrator
v) Surface vibrator (screed vibrator)
vi) Vibratory Roller .

(c) Compaction by ~~pressure~~ pressure and jolting .
(d) Compaction by spinning .

MANUFACTURE OF CONCRETE

Production of quality concrete requires meticulous care exercised at every stage of manufacture of concrete.

The various steps involved are :-

(a) Batching - The measurement of materials for making concrete is k/a batching. There are 2 methods of batching :-

(i) Volume batching (ii) Weight batching.

(i) VOLUME BATCHING - It is not a good method in proportioning the material because of the difficulty it offers to measure granular material in terms of volume.
Volume of the moist sand in a loose condition weighs much less than the same volume of dry compacted sand.

(ii) WEIGHT BATCHING - It is the correct method of measuring the materials. Use of weight system in batching facilities accuracy, flexibility and simplicity.

(b) MIXING - Thorough mixing of the materials is essential for the production of uniform concrete. The mixing should ensure that the mass becomes homogeneous, uniform in colour and consistency.

(i) Hand Mixing (ii) Machine Mixing.

(d) PLACING CONCRETE – The precautions to be taken and methods adopted while placing concrete in the under mentioned situations will be discussed

(i) Placing concrete within earth mould – Eg foundation concrete for a wall or columns.

(ii) Placing concrete in layers within timber or steel shutter. Eg mass concrete in dam construction or construction of concrete abutment

(iii) Placing concrete within large earth mould or timber Plank formwork – Eg Road slab and Air field slab.

(iv) Placing concrete within usual from work – Eg columns, beams and floors.

(v) Placing Concrete under water.

(e) COMPACTION OF CONCRETE

It is the process adopted for expelling the entrapped air from the concrete. In the process of mixing, transporting and placing of concrete air is likely to get entrapped in the concrete.

The following methods are adopted for compacting the concrete.

(a) Hand Compacting

(i) Redding (ii) Ramming (iii) Tamping

(b) Compaction by Vibration

HAND MIXING :- It is practised for small scale unimportant concrete works. As the mixing cannot be thorough and efficient, it is desirable to add 10% more cement to cater for the inferior concrete produced by this method.

MACHINE MIXING - Mixing of concrete is almost invariably carried out by machine for reinforced concrete work & for medium or large scale mass concrete work. Machine mixing is not only efficient, but also economical when the quantity of concrete to be produced is large.

(c) TRANSPORTING - Concrete can be transported by a variety of methods and equipments. The precaution to be taken while transporting concrete is that the homogeneity obtained at the time of mixing should be maintained while being transported to the final place of deposition.

The methods adopted for transportation of concrete :

a) Mortar Pan
b) Wheel Barrows, Hand cart
c) Crane, Bucket and Ropeway
d) Truck Mixer and Dumpers
e) Belt conveyors
f) Pump and Pipe line
g) Skip and Hoist
h) Transit mixer
i) Helicopters
j) Chute

i) Internal Vibrator (Needle Vibrator)
ii) Formwork Vibrator (External Vibrator)
iii) Table Vibrator
iv) Platform Vibrator.
v) Surface Vibrator.
vi) Vibratory Roller.

c) Compaction by Pressure and jolting.
d) Compaction by spinning.

(F) CURING OF CONCRETE

Curing methods may be divided broadly into four categories.

a) Water Curing b) Membrane Curing.
c) Application of heat d) Miscellaneous.

QUALITIES of MIXING WATER

If water is fit for drinking it is fit for making concrete. This does not appear to be a true statement for all conditions.

HARDENED CONCRETE

ABRAM'S LAW — Duff Abrams discovered the direct relationship between water to cement ratio and strength i.e lesser the water used higher the strength of the concrete, since too much water leaves lots of pores in the cement paste.

* According to Abram's law, the strength of fully compacted concrete at a given age and normal

temperature is inversely proportional to water cement ratio.

* Here the water to cement ratio is the relation of the water to the cement in the mixture.
* For most applications, water to cement should be between 0.4 & 0.5 lower for lower permeability & higher strength.

MATURITY OF CONCRETE

Since the strength of concrete depends on both the period of curing (i.e. age) and temperature during curing. The product (Period x temperature) is called maturity of concrete.

* The strength of concrete at any maturity can be expressed as the percentage of strength for the maturity of concrete cured at 18°C for 28 days. i.e (18 + 10) x (28 x 24)
= 18800°C hrs.

CURING OF CONCRETE

The concrete continues gaining strength with time provided sufficient moisture is available for the hydration of cement which can be assured only by creation of favourable conditions of temp and humidity.

This process of creation of an environment during a relatively short period immediately after the placing and compaction of the

concrete favourable to the setting and the hardening of concrete is termed curing.

RELATION BETWEEN COMPRESSIVE AND TENSILE STRENGTH

* In reinforced concrete construction the strength of the concrete in compression is only taken into consideration.
* But the design of concrete pavement slabs is often based on the flexural strength of the concrete.
* As measurements and control of compressive strength in field are easier and more convinient it has been customary to find out the comp strength for the different conditions and to correlate this comp strength to flexural strength.
* Having established a satisfactory relationship between flexural and compressive strength, pavement can be designed for a specified flexural strength value, or this value could be used in any other situations, when required.
* The ratio of the two strengths depends on general level of strength of concrete.
* In other words for higher compressive strength shows higher tensile strength, but rate of increase of tensile strength is of decreasing order.