CONCRETE TECHNOLOGY

TH-4

6th SEM

CIVIL ENGG.

Under SCTE&VT,Odisha

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CHAPTER-1
CONCRETE AS A CONSTRUCTION MATERIAL

- **TOPICS TO BE COVERED:-**
- GRADES OF CONCRETE
- ADVANTAGES & DISADVANTAGES OF CONCRETE

Concrete:-

Concrete is produced by mixing cement, fine aggregate ,& coarse aggregate & water and mixed with water in a definite proportion.

Among different building materials , concrete is the best material come to beam.

Concrete is composed of inorganic material called aggregate, gravel, sand etc. Cementing together with some water .

Concrete is very strong in compression & weak in tension

Advantages Of Using Concrete :-

- It has a very high compressive strength. The strength of concrete can be increased or decreased by using suitable proportion of its ingredients.
- It is free from corrosion & weathering effects and hence superior to other building materials like wood, steel, etc. In compare to steel it is generally economical.
- It acts as a good fire proofing material.
- It binds with steel ,so that concrete can be reinforced with steel to form reinforced concrete
- The structures made out of reinforced concrete are very rigid & have a low maintenance cost.
- It has long service life.

Disadvantages of concrete:-

- It is weak in tension & cracks easily when subjected to tensile stress.
- It requires the form work to be kept for many days. The cost of form work varies from 30 to 40 %of total cost.
- It is not completely impervious.
- It shrinks and set up shrinkage stress.
- **Grades Of Concrete :-**

Designation of grade of concrete.	**Proportion**	**Applications**	**Specified characteristics compressive strength of 28days in N/mm^2 (f_{ck})**	**Permissible stress in compression in N/mm^2 (bending σ_{cbc})**
M_5	1:5:10	Ordinary	-	-

		concrete		
$M_{7.5}$	1:4:8	Ordinary concrete foundation	-	-
M_{10}	1:3:6	Lean concrete foundation	10	3
M_{15}	1:2:4	General purposes, flooring , base foundation	15	5
M_{20}	1:1.66:3.33 or 1:1.5:3	RCC beam, column, footing, slab	20	7
M_{25}	1:1:2	Water tank, u/s face dam	25	8.5
M_{30}	-	-	30	10
M_{35}	-	-	35	11.5

*******The End*******

CHAPTER-2
CEMENT

- **TOPICS TO BE COVERED:-**
  - **Composition of cement**
  - **Hydration of cement**
  - **Water cement ratio**
  - **Compressive strength**
  - **Fineness of cement**
  - **Set5ting time**
  - **Soundness**
  - **Types of cement**

Cement:-

The natural cement is obtained by burning & crushing the stones containing clay, carbonate of lime & some amount of carbonate of magnesia.

- ➔ The clay content in such stones is about 20 to 40 %.
- ➔ The colour of natural cement is brown.

Composition of ordinary cement:-

Following are the composition of ordinary cement.

Ingredient	**per cent**	**Range**
Lime (CaO)	62	62 to 67
Silica (SiO2)	22	17 to 25
Alumina (Al2O3)	5	3 t0 8
Calcium sulphate (CaSO4)	4	3 to 4
Iron oxide (Fe2O3)	3	3 to 4
Magnesia (MgO)	2	0.1 to 3
Sulphur (S)	1	1 to 3
Alkalise	1	0.2 to 1

***Function of cement ingredient*:-**

Following are the function of ingredient of cement.

a) Lime (CaO)
b) Silica (SiO_2)
c) Alumina (Al_2O_3)
d) Calcium sulphate($CaSO_4$)
e) Iron oxide(Fe_2O_3)
f) Magnesia (MgO)
g) Sulphur (S)

h) Alkalies

a) **lime (CaO):-**

- This is the most important ingredient of cement.
- The excess lime makes the cement unsound & causes the cement to expand & disintegrate.
- If lime is in deficiency, the strength of cement is decreased & it causes cement to set quickly.

b) **Silica (SiO_2):-**

- This is also an important ingredient of cement & it gives strength to the cement.
- If silica is present in excess the strength of cement is increased, but at the same time its setting time is prolonged.

c) **Alumina (Al_2O_3):-**

- This ingredient gives quick setting property to the cement.
- If it is present in excess, it weakens the cement.

d) **Calcium sulphate($CaSO_4$):-**

- This ingredient is in the form of gypsum.
- Its function is to increase the initial setting property.

e) **Iron oxide(Fe_2O_3):-**

- This ingredient gives colour, hard ness & strength to the cement.

f) **Magnesia (MgO):-**

- If magnesia is present in small quantity, it gives colour & hardness to the cement.
- If it is present in excess, it makes the cement unsound.

g) **Sulphur (S):-**

- A very small amount of sulphur is useful for making sound cement.
- If it is in excess, it causes the cement unsound.

h) **Alkalies** :-

- If alkali is present in excess, they cause a no. of troubles such as efflorescence.

Types of cement:-

Following are the different types of cement

i. Acid resistance cement
ii. Blast furnace cement
iii. Coloured cement
iv. Expanding cement
v. High alumina cement
vi. Hydrophobic cement

vii. Low heat cement
viii. Hydrophobic cement
ix. Quick setting cement
x. Rapid hardening cement
xi. Sulphate resisting cement
xii. White cement

i. <u>Acid resistance cement:-</u>

➔ An Acid resistance cement is composed of acid resistance aggregate such as quartzite, additive such as sodium flu silicate, aqueous solution of soluble gas.

➔ The binding material of acid resistance cement is soluble gas.

➔ This cement is used acid resistance & heat resistance coatings of installation of chemical industry.

ii. **<u>Blast furnace cement</u>**:-

➔ In this cement, the slag obtained from blast furnace is used.

➔ The slag is a waste product in the manufacture of pig iron & it contains basic elements of cement namely lime, silica, alumina.

➔ It proves economical as slag, which is a waste product.

➔ This cement is durable but it is not suitable for use in dry area.

iii. <u>Coloured cement:-</u>

➔ The cement of desired colour is obtained by intimately mixing mineral pigment with ordinary cement.

➔ The amount of colouring material may vary from 5 to 10 %.if this per cent exceeds 10 % the strength of cement is affected.

➔ The chromium oxide gives green colour, cobalt oxide gives blue colour, and iron
oxide in different proportion gives brown, red, yellow colour. The manganese dioxide gives black or brown colour cement.

➔ The colour cement is used for finishing of floors.

iv. <u>Expanding cement:-</u>

➔ This type of cement is produced by adding expanding medium like sulpho-aluminate, & a stabilising agent to the ordinary cement.

➔ This cement is used for construction for repairing the damaged concrete surface.

v. <u>High alumina cement:-</u>

➔ This type of cement is produced by grinding clinkers formed by calcing bauxite & lime.

➔ It is costly. It cannot be used for mass construction as it evolves great heat and it sets quickly.

vi. Hydrophobic cement:-

➔ This type of cement contains admixture which decreases the wetting ability of cement grains.

➔ The usual hydrophobic admixtures are acidol, petrolatum etc.

➔ This cement is used for construction of concrete structures.

vii. **Low heat cement**:-

➔ The considerable heat is produced during the setting action of cement.

➔ In order to reduce the amount of heat, this type of cement is used.

➔ It is mainly used for mass concrete work.

viii. Pozzuolana cement:-

➔ The pozzuolana is volcanic powder. The percentage of pozzuolana should be between 10 to 30.

➔ It is cheap.

➔ It is used in sewage works & for laying concrete under water.

ix. Quick setting cement:-

➔ This cement is produced by adding a small percentage of aluminium sulphate & by finely grinding the cement.

➔ This cement is used to lay concrete under static or running water.

x. **Rapid hardening cement**:-

➔ The initial & final setting time of cement is same as ordinary cement.

➔ It is light in weight.

➔ This cement requires short period of curing.

Xi Sulphate resisting cement:-

➔ In this cement the percentage of tri calcium aluminate is kept below 5% & it results in the increase in resisting power against sulphate.

➔ This cement is used for structures which are likely to be damaged by severe alkaline condition such as canal lining, culvert etc.

xii . **White cement**:-

➔ This type of cement is prepared from such raw materials which are practically free from colouring oxides of iron, manganese, or chromium.

➔ It is more costly than ordinary cement.

➔ White cements are used for fixing of marbles.

Properties of cement:-

Following are the properties of cement.

- ❖ It gives strength to the masonry.
- ❖ It is an excellent binding material.
- ❖ It is easily workable.
- ❖ It possesses a good plasticity.

❖ It stiffens or hardens early.

Testing of quality of cement:-

Following are the standard test for cement.

A. Fine ness test.
B. Compressive strength test.
C. Tensile strength test.
D. Consistency test.
E. Setting time test.
F. Sound ness test.

A. Fine ness test:-

This test is carried out to check proper grinding of cement. The fineness of cement particles are determined by sieve test.

Procedure:-

- In this test, first 100 gm. of cement is taken.
- Then it is continuously passed for 15 minutes through standard BIS 90 micron sieve.
- The residue is then weighed & this weight should not be more than 10 % of the original weight.

B. Compressive strength test:-

This test is carried out to determine the compressive strength of cement.

Procedure:-

❖ Take required quantity of cement & sand proportion 1:3, and then required quantity of water i.e. 40 % of cement is added to it for preparation of mortar.

❖ The mortar is placed in moulds in the form of cube of size 76 or 70.6 mm.

❖ Then it is compacted in vibrating machine for 2 minutes.

❖ Then the moulds are placed in damp cabin for 24 hours.

❖ The specimens are removed from the mould & they are submerged in clean water for curing.

❖ The cubes are then tested in compressive testing machine at the end of 3 days & 7 days.

❖ The compressive strength at the end of 3 days should not be less than 115 Kg/cm^2 or 11.50 N/mm^2 .And that at the end of 7 days should not be less than 175 Kg/cm^2 or 17.50 N/mm^2.

Setting time test:-

This test is carried out to detect the deterioration of cement due to storage. The test is carried out to determine the initial & final setting time of cement.

Initial setting time test:-

Procedure:

- First 300 gm. of cement is taken. Then it is mixed with percentage of water which is determined in the consistency test.
- The cement paste is filled with vicat mould.
- The square needle of cross section of 1 mm x 1 mm is attached to the moving rod of vicat apparatus.
- The needle is quickly released & it is allowed to penetrate the cement paste.
- In the beginning the needle penetrates completely.
- It is then taken out .the procedure is repeated at regular intervals till the needle does not penetrate completely.
- The needle should penetrate up to about 5 mm from the bottom.
- The initial setting time is the interval between the addition of water to cement & the stage when needle does not penetrate completely.
- The initial setting time period for ordinary cement should be 30 minutes.

Final setting time test:-

Procedure:-

- First 300 gm. of cement is taken. Then it is mixed with percentage of water which is determined in the consistency test.
- The cement paste is filled with vicat mould.
- Then the needle with annular collar is attached to the moving rod of vicat apparatus.
- The needle is gently released. The time at which the needle makes an impression on test block & the collar fails to do so is noted.
- The final setting time is the difference between the times at which water was added to cement.
- The final setting time period for ordinary cement should be about 10 hours.

F. Sound ness test:-

This test is carried out to detect the presence of combined lime in cement.

Procedure:-

- This test is carried out with the help of Le chatelier apparatus. It is consists of a brass mould of diameter 30 mm &height 30 mm. There is a split in mould & it does not exceed 0.5 mm.
- Two indicators with pointed ends are provided with the spilt.
- The cement paste is prepared .the percentage of water is taken as determined in the consistency test.
- The mould is placed on a glass plate & it is filled by cement paste.
- At top another glass plate is covered .A small weight is placed at top & then submerged in water for 24 hours & a temperature between 24° C to 35° C.

- The distance between the points of indicator is noted.
- The mould is again placed in water and heat is applied for 30 minutes.
- The mould is removed from water & it is allowed to cool down.
- The distance between the points of indicator is again measured.
- The difference between the two readings indicates the expansion of cement & it should not exceed 10 mm.

Water- cement ratio:-

The ratio of the amount of water to the amount of cement by weight is known as water cement ratio.

- ➔ The strength & quality of concrete of primarily depends upon this ratio.
- ➔ The quantity of water is usually expressed in litres per bag of cement.
- ➔ And hence the water cement ratio reduces to the quantity of water required in litres per kg of cement as 1 litre of water weighs 1 kg.
- ➔ It is found that the water required is about 0.5 to 0.6 times the weight of cement.

The important points to be observed in connection with the water cement ratio are:-

➔ The minimum quantity of water should be used to have reasonable degree of workability. The excess water occupies space in concrete & on evaporation; the voids are created in concrete. Thus the excess water affects considerably the strength & durability of concrete. In other wards the strength of concrete is inversely proportional to the water cement ratio.

➔ The water cement ratio for structures which are exposed to weather should be carefully d4ecided. For structures which are regularly wetting & drying, the water cement ratio by weight should be 0.45 & 0.55 for thin sections & mass concrete respectively. For structures which are continuously in water, the water cement ratio by weight should be 0.55 & 0.65 for thin sections & mass concrete respectively.

➔ Weight of water in concrete= 28 % of the weight of the cement + 4 % of the weight of total aggregate.

Or weight of water in concrete = 30 % of the weight of the cement + 5 % of the weight of total aggregate.

CHAPTER-3
AGGREGATE

TOPICS TO BE COVERED:-

- **Classification & characteristics of aggregate**
- **Deleterious substances in aggregates**
- **Fineness modulus**
- **Grading of aggregate**

Classification of aggregate:-It is divided in to two catagories

1. Natural aggregate
2. Artificial aggregate

1.Natural aggregate:-These aggregates are usually obtained from natural deposits of sand and gravel or from quarries by cutting rocks.The cheapest among them are the natural sand & gravel to their present size by natural agents, such as water, wind and snow etc.The river deposits are the most common and are of good quality.

2.Artificial aggregate:- The most widely used artificial qaggregates are clean broken bricks and air cooled fresh blast furnace slag.The broken bricks of good quality provide a satisfactory aggregate for the mass concrete & are not suitablr for reinforced concrete work if the crushing strength of brick is less than 30 to 35 Mpa.

Classification according to size:-

According to size the aggregate is classified as fine aggregate, coarse aggregate7 all in aggregate

Fine aggregate:-It is the aggregate most of which passes through a 4.75mm IS sieve . Sand is generally considred to have a lower size limit of about 0.07mm .Material between 0.06mm and 0.002mm is classified asm silt , and still smaller particles are called clay.

Coarse aggregate:-The aggregates most of which are retained on the 4.75mm IS sieve and contain only that much of fine material is termed as coarse aggregate. The grade coarse aggregate is described by its nominal size, i.e. 40mm, 20mm, 16mm and 12.5mmetc.

For example:-a graded aggregate of nominal size 12.5mm means an aggregate most of which passes the 12.5mm IS sieve.

All-in-aggregate:-Sometimes combined aggregates are available in nature comprising different fractions of fine and coarse aggregatees, are known as all- in-aggregate.

Classification according to shape:-The aggregate may be classified as rounded, irregularor partly rounded , angular or flaky.

Rounded aggregate:-The aggregate with rounded particles (river or seashore gravel) has minimum voids ranging from 32 to 33 percent.It gives minimum ratio of surface area to the volume, tbhus requiring minimum cement paste to make good concrete. Disadvantages is that the interlocking between its particles is less and hence the development of the bond is poor, making it unsuitable for high strength concrete and pavements.

Irregular aggregate:-The aggregate having partly rounded particles has higher percentage of voids ranging from 35 to 38 .It requires more cement paste for a given workabolity.

Angular aggregate:-The aggregate with sharp, angular and rough particles has a maximum percentage of voids ranging from 38 to 40. The interlocking between the particles is good, there by providing a good bond.

Flaky aggregate:-An aggregate is termed as flaky when its least dimension is less than three fifth of its mean dimension.The mean dimension of the aggregate is the average of the sievesizes through which the particles pass and are retained.

Classification based on unit weight:-

According to their unit weights as normal weight, heavy weight, and light weight aggregate.

Normal – weight aggregate:-The commonly used aggregates i.e. sands and gravels, crushed rocks such as granite, basalt, quartz, sand stone and lime stone and brick ballast etc. have specific gravities between 2.5 & 2.7 , unit weight ranging from 23 to 26 KN/m^3 and crushing strength at 28 days between 15 to 40Mpa are termed normal – weight concrete.

Heavy weight or High density aggregate:-Some heavy weight aggregates such as barite n, ferro- phosphorus , goethite, hematite,ilmentite, limonite.

Concretes having unit weight of about 30, 31 , 35, 38, 40, 47, 57 KN/m^3 can be produced by using typical goethic, limonite, barite, magnetite, hematite, ferro-phosphorus & scrap iron, respectively.

Light weight aggregate:-The light –weight aggregates having unit weight up to 12 KN/m^3 are used to manufacture the structural concrete and masonry blocks for reduction of the self weight of the structure.

The main requirement of the light – weight aggregate is its low density, some specifications limit the unit weight to 12KN/m^3 for fine aggregate and approximately 10KN/m^3 for coarse aggregates for the use in concrete.

Characteristics of aggregates:-

An aggregate to be used in concrete must be clean, hard, strong, properlyshaped and well graded.

1. **Particle shape & texture:-**The physical characteristics such as shape, texture, and roughness of aggregates, significantly influence the mobility(i.e. the workability) of fresh concrete and the bond between the aggregate and the mortar phase.

- The surface texture is a measure of the smoothness or toughness of the aggregate.
- The surface texture is a measure of the smoothness or roughness of the aggregate.
- The surface texture may be classified as glassy, smooth, granular. Rough, crystalline, porous and honey combed.

2. **Specific gravity:0-**

- It is defined as the ratio of the mass of solid in a goven volume of sample to the mass of an equal volume of water at the same temperature.Since the aggregate generally contains voids, there are different types of specific gravity.
- The average specific gravity of majority of natural aggregates lie between 2.5 and 2.8

3. **Porosity and absorption of aggregate:-**

- Due to the presence of air bubbles which are entrapped in a rock during its formation or an account of the decomposition of certain constituent minerals by atmospheric action, minute holes or cavities are formed in it which are commonly known as pores.

Deleterious substances in aggregate:-

The materials whose presence may be adversely affect the strength , workability and long –term performance of concrete are termed as deleterious materials. Depending upon their action, the deleterious substances found in the aggregate can be divided in to three broad catagories:-

- Impurities interfering with the process of hydration of cement.
- Coatings preventing the development of good bond between aggregate and the cement paste.
- Unsound particles which are weak or bring about chemical reaction between the aggregate and cement paste.

➢ The clay and other fine materials , such as silt and crusher dust may be present in the form of surface coatings which interference with the bond between the aggregate and the cement paste.

➢ A good bond is essential for ensuring satisfactory strength & durability of concrete, the problem of coating of impurities is an important one.

➢ The soft & loosely adherent coating can br removed by washing.The well bonded chemically stable coatings have no harmful effect except that the shrinkage may be increased.

➢ The silt and the fine dust , if present in excessive amounts, increase the specific surface of the aggregate and hence the amount of water required to wet all particles in the mix , there by reducing the strength and durability of concrete.

Fineness modulus:-

➢ The fineness modulus is a numerical index of fineness , giving some idea of the mean size of the particles present in the entire body of the aggregate. The determination of the fineness modulus consists of dividing a sample of aggregate in to fractions of different sizes by sieving through a set of standard test sieves taken.

➢ Each fraction contains particles between definite limits. The limits being the opening sizes of standard test sieves. The material retained on each sieve after sieving represents the fraction of aggregate coarser than the sieve in question but finer than the sieve above. The cumulative % retained on the sieves divided by 100 give the fineness modulus.

➢ The fineness modulus can be regarded as a weighted average size of a sieve on which material is retained, and the sieves being counted from the finest . Ex- a fineness modulus of 6.0 can be interpreted to mean that the sixth sieve, i.e. 4.75mm is the average size. The value of fineness modulus is higher for coarser aggregate . For the aggregates commonly used , the fineness modulus of fine aggregate varies from 2.0 & 3.5 , for coarse aggregate it varies from 5.5 & 8.0 & from 3.5 to 6.5 for all – in aggregate.

Grading of aggregate:- The particle size distribution of an aggregate is termed as determined by sieve analysis is termed as grading of aggregate.

CHAPTER-4
WATER

Topics to be covered:-

- Quality of water for mixing
- Water for curing

Quality of mixing water:-

- Generally , cement requires about three- tenth of its weight of water for hydration .
- Hence minimum water- cement ratio required is 0.30. But the concrete containing water in this proportion will be very harsh and difficult to place.
- The water cement ratio is influenced by the grade of concrete , nature & type of aggregates, the workability and durability, etc.
- The water used for the mixing and curing of concrete should be free from injurious amounts of deleterious materials.

Curing water:-

- It is necessary for the water to be uniformly distributed through out the mass of concrete.
- In structural members, there is inevitably some loss of water by evaporation from the surface.
- Consequently , hydration may effectively proceed in the interior of the member but, near the surface , there is an inadequate amount of water in the capillaries so that penetration by curing water is highly desirable.
- Sea water should not be used as mixing water for hydraulic – cement concrete works containing corrodible embedded ferrous metals, particularly in the tropics.
- How ever , under unavoidable circumstances it may be used for mixing and curing in plain concrete after due evaluation of possible disadvantages and consideration of the use of appropriate cement system.

******THE END******

COMPACTING FACTOR

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959. The apparatus used is Compacting factor apparatus.

Procedure to determine workability of fresh concrete by compacting factor test.

i) The sample of concrete is placed in the upper hopper up to the brim.
ii) The trap-door is opened so that the concrete falls into the lower hopper.
iii) The trap-door of the lower hopper is opened and the concrete is allowed to fall into the cylinder.
iv) The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane blades.
v) The concrete in the cylinder is weighed. This is known as weight of partially compacted concrete.
vi) The cylinder is filled with a fresh sample of concrete and vibrated to obtain full compaction. The concrete in the cylinder is weighed again. This weight is known as the weight of fully compacted concrete.

Compacting factor = (Weight of partially compacted concrete)/(Weight of fully compacted concrete)

VEE-BEE TEST

To determine the workability of fresh concrete by using a Vee-Bee consistometer as per IS: 1199 – 1959. The apparatus used is Vee-Bee consistometer.

Procedure to determine workability of fresh concrete by Vee-Bee consistometer.

i) A conventional slump test is performed, placing the slump cone inside the cylindrical part of the consistometer.

ii) The glass disc attached to the swivel arm is turned and placed on the top of the concrete in the pot.
iii) The electrical vibrator is switched on and a stop-watch is started, simultaneously.
iv) Vibration is continued till the conical shape of the concrete disappears and the concrete assumes a cylindrical shape.
v) When the concrete fully assumes a cylindrical shape, the stop-watch is switched off immediately. The time is noted.The consistency of the concrete should be expressed in VB-degrees, which is equal to the time in seconds recorded above.

FLOW TABLE TEST APPARATUS :-

OBJECTIVE

For determination of consistency of concrete where the nominal maximum size of aggregate does not exceed 38 mm using flow table apparatus.

EQUIPMENT & APPARATUS

- Flow table

Flow Table

PROCEDURE

1. Before commencing test, the table top and inside of the mould is to be wetted and cleaned of all gritty material and the excess water is to be removed with a rubber squeezer.
2. The mould is to be firmly held on the centre of the table and filled with concrete in two layers, each approximately one-half the volume of the mould and rodded with 25 strokes with a tamping rod, in a uniform manner over the cross section of the mould.

3. After the top layer has been rodded, the surface of the concrete is to be struck off with a trowel so that the mould is exactly filled.
4. The mould is then removed from the concrete by a steady upward pull.
5. The table is then raised and dropped from a height of 12.5 mm, 15 times in about 15 seconds.
6. The diameter of the spread concrete is the average of six symmetrically distributed caliper measurements read to the nearest 5 mm.

CALCULATION

The flow of the concrete is the percentage increase in diameter of spread concrete over the base diameter of the moulded concrete, calculated from the following formula.

$$\text{Flow}(\%) = \frac{\text{Spread dia.(cm) - 25}}{25} \times 100$$

REPORT

The flow measured is to be reported in terms of percentage.

SAFETY & PRECAUTIONS

- Use hand gloves, shoes at the time of test.
- Keep the mould & flow table clean, dry & free from sticking concrete.
- Keep the vertical shaft lubricated with light oil.
- Keep the contact faces of the flow table top & supporting frame oiled.
- Keep the hand wheel, the adjustable shaft & universal joint.

Workability of Fresh Concrete by Slump Test

Procedure to determine workability of fresh concrete by slump test.

i) The internal surface of the mould is thoroughly cleaned and applied with a light coat of oil.

ii) The mould is placed on a smooth, horizontal, rigid and nonabsorbent surface.

iii) The mould is then filled in four layers with freshly mixed concrete, each approximately to one-fourth of the height of the mould.

iv) Each layer is tamped 25 times by the rounded end of the tamping rod (strokes are distributed evenly over the cross section).

v) After the top layer is rodded, the concrete is struck off the level with a trowel.

vi) The mould is removed from the concrete immediately by raising it slowly in the vertical direction.

vii) The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured.

viii) This difference in height in mm is the slump of the concrete.

Reporting of Results

The slump measured should be recorded in mm of subsidence of the specimen during the test. Any slump specimen, which collapses or shears off laterally gives incorrect result and if this occurs, the test should be repeated with another sample. If, in the repeat test also, the specimen shears, the slump should be measured and the fact that the specimen sheared, **should be recorded.**

Typical Questions

Ques 1. What is the ideal value of slump?

Answer 1 In case of a dry sample, slump will be in the range of 25-50 mm that is 1-2 inches. But in case of a wet concrete, the slump may vary from 150-175 mm or say 6-7 inches. So the value of slump is specifically mentioned along the mix design and thus it should be checked as per your location.

Slump depends on many factors like properties of concrete ingredients – aggregates etc. Also temperature has its effect on slump value. So all these parameters should be kept in mind when deciding the ideal slump

Ques 2. How does a superplasticizer effect the slump of concrete?

Answer 2 Value of Slump can be increased by the addition of chemical admixtures like mid-range or high-range water reducing agents (super-plasticizers) without changing the water/cement ratio.

Ques 3. How much time one should take to raise the cone?

Answer 3 Once the cone is filled and topped off [excessive concrete from top is cleared] raise the cone within 5-10 seconds.

Ques 4. What are the dimensions of the cone used in Slump Test?
Answer **3** The dimensions are
Top Diameter – 10cm
Bottom Diameter – 20cm
Height – 30cm

Workability Requirements

In general, concrete tends to lose its workability at a faster rate when the slump measurement reaches the threshold value of 100mm, unless some special technology is used.

So, workability required at site shall be determined based on

- Type of Structure
- Method of Placing
- Speed of Placing
- Method and Speed of Compaction
- Manpower available to handle the concrete

- The mix shall be cohesive and uniform for any given workability, lower or higher.
- Since the usage of admixture decides the workability and workability retention and not water, higher workability can be achieved without increasing water to cement ratio. Hence strength and durability of the structures can get enhanced even at higher workability

3. Factors affecting the choice of mix proportions

The various factors affecting the mix design are:

3.1. Compressive strength:- It is one of the most important properties of concrete and influences many other describable properties of the hardened concrete. The mean compressive strength required at a specific age, usually 28 days, determines the nominal water-cement ratio of the mix. The other factor affecting the strength of concrete at a given age and cured at a prescribed temperature is the degree of compaction. According to Abraham's law the strength of fully compacted concrete is inversely proportional to the water-cement ratio.

3.2. Workability

The degree of workability required depends on three factors. These are the size of the section to be concreted, the amount of reinforcement, and the method of compaction to be used. For the narrow and complicated section with numerous corners or inaccessible parts, the concrete must have a high workability so that full compaction can be achieved with a reasonable amount of effort. This also applies to the embedded steel sections. The desired workability depends on the compacting equipment available at the site.

3.3. Durability

The durability of concrete is its resistance to the aggressive environmental conditions. High strength concrete is generally more durable than low strength concrete. In the situations when the high strength is not necessary but the conditions of exposure are such that high durability is vital, the durability requirement will determine the water-cement ratio to be used.

3.4. Maximum nominal size of aggregate

In general, larger the maximum size of aggregate, smaller is the cement requirement for a particular water-cement ratio, because the workability of concrete increases with increase in maximum size of the aggregate. However, the compressive strength tends to increase with the decrease in size of aggregate. IS 456:2000 and IS 1343:1980 recommend that the nominal size of the aggregate should be as large as possible.

3.5. Grading and type of aggregate :-

The grading of aggregate influences the mix proportions for a specified workability and water cement ratio. Coarser the grading leaner will be mix which can be used. Very lean mix is not desirable since it does not contain enough finer material to make the concrete cohesive. The type of aggregate influences strongly the aggregate-cement ratio for the desired workability and stipulated water cement ratio. An important feature of a satisfactory aggregate is the uniformity of the grading which can be achieved by mixing different size fractions.

3.6. Quality Control

The degree of control can be estimated statistically by the variations in test results. The variation in strength results from the variations in the properties of the mix ingredients and lack of control of accuracy in batching, mixing, placing, curing and testing. The lower the difference between the mean and minimum strengths of the mix lower will be the cement-content required. The factor controlling this difference is termed as quality control.

1. **Mix design** is a process of selecting suitable ingredients and determining their relative proportions with the objective of producing **concrete** of having certain minimum workability, strength and durability as economically as possible.

CHAPTER-11

SPECIAL CONCRETE

TOPICS TO BE COVERED:-

- **Ready mix concrete**
- **High performance concrete**
- **Silica fume concrete**
- **Shot-crete concrete**
- **gunitting**

Ready-mix concrete:-This concrete that is manufactured in a factory or batching plant, according to a set recipe, and then delivered to a work site, by truck mounted in–transit mixers. This results in a precise mixture, allowing specialty concrete mixtures to be developed and implemented on construction sites. The first ready-mix factory was built in the 1930s, but the industry did not begin to expand significantly until the 1980s, and it has continued to grow since then.

Ready-mix concrete is sometimes preferred over on-site concrete mixing because of the precision of the mixture and reduced work site confusion. However, using a pre-determined concrete mixture reduces flexibility, both in the supply chain and in the actual components of the concrete.

Ready-mix concrete is also referred as the customized concrete products for commercial purpose. Ready-mix concrete, or RMC as it is popularly called, refers to concrete that is specifically manufactured for delivery to the customer's construction site in a freshly mixed and plastic or unhardened state. Concrete itself is a mixture of Portland cement, water and aggregates comprising sand and gravel or crushed stone. In traditional work sites, each of these materials is procured separately and mixed in specified proportions at site to make concrete. Read-mix concrete is bought and sold by volume - usually expressed in cubic meters (cubic yards in the US).

Ready-mix concrete is manufactured under controlled operations and transported and placed at site using sophisticated equipment and methods. In 2011, there were 2,223 companies employing 72,924 workers that produced RMC in the United States.[1]

High performance concrete:-

High performance concrete is a concrete mixture, which possess high durability and high strength when compared to conventional concrete. This concrete contains one or more of cementious materials such as fly ash, Silica fume or ground granulated blast furnace slag and usually a super plasticizer. The term 'high performance' is somewhat pretentious because the essential feature of this concrete is that it's ingredients and proportions are specifically chosen so as to have particularly appropriate properties for the expected use of the structure such as high strength and low permeability. Hence High performance concrete is not a special type of concrete. It comprises of the same materials as that of the conventional cement concrete. The use of some mineral and chemical admixtures like Silica fume and Super plasticizer enhance the strength, durability and workability qualities to a very high extent.

High Performance concrete works out to be economical, even though it's initial cost is higher than that of conventional concrete because the use of High Performance concrete in construction enhances the service life of the structure and the structure suffers less damage which would reduce overall costs.
Concrete is a durable and versatile construction material. It is not only
Strong, economical and takes the shape of the form in which it is placed, but it is also aesthetically satisfying. However experience has shown that concrete is vulnerable to deterioration, unless precautionary measures are taken during the design and production. For this we need to understand the influence of components on the behavior of concrete and to produce a concrete mix within closely controlled tolerances.
The conventional Portland cement concrete is found deficient in respect of :

- Durability in severe environs (shorter service life and frequent maintenance)
- Time of construction (slower gain of strength)
- Energy absorption capacity (for earthquake resistant structures)
- Repair and retrofitting jobs.

Hence it has been increasingly realized that besides strength, there are other equally important criteria such as durability, workability and toughness. And hence we talk about 'High performance concrete' where performance requirements can be different than high strength and can vary from application to application.

High Performance Concrete can be designed to give optimized performance characteristics for a given set of load, usage and exposure conditions consistent with the requirements of cost, service life and durability. The high performance concrete does not require special ingredients or special equipments except careful design and production. High performance concrete has several advantages like improved durability characteristics and much lesser micro cracking than normal strength concrete.

Any concrete which satisfies certain criteria proposed to overcome limitations of conventional concretes may be called High Performance Concrete. It may include concrete, which provides either substantially improved resistance to environmental influences or substantially increased structural capacity while maintaining adequate durability. It may also include concrete, which significantly reduces construction time to permit rapid opening or reopening of roads to traffic, without compromising long-term servicibility. Therefore it is not possible to provide a unique definition of High Performance Concrete without considering the performance requirements of the intended use of the concrete.

American Concrete Institute defines High Performance Concrete as "A concrete which meets special performance and uniformity requirements that cannot always be achieved routinely by using only conventional materials and normal mixing, placing and curing practices". The requirements may involve enhancements of characteristics such as placement and compaction without segregation, long-term mechanical properties, and early age strength or service life in severe environments. Concretes possessing many of these characteristics often achieve High Strength, but High Strength concrete may not necessarily be of High Performance .A classification of High Performance Concrete related to strength is shown below.

Compressive strength (Mpa)	50	75	100	125	150
High Performance Class	I	II	III	IV	V

SELECTION OF MATERIALS

The production of High Performance Concrete involves the following three important interrelated steps:

- Selection of suitable ingredients for concrete having the desired rheological properties, strength etc
- Determination of relative quantities of the ingredients in order to produce durability.
- Careful quality control of every phase of the concrete making process.

The main ingredients of High Performance Concrete are

Cement

Physical and chemical characteristics of cement play a vital role in developing strength and controlling rheology of fresh concrete. Fineness affects water requirements for consistency. When looking for cement to be used in High Performance Concrete one should choose cement containing as little C_3A as possible because the lower amount of C_3A, the easier to control the rheology and lesser the problems of cement-super plasticizer compatibility. Finally from strength point of view, this cement should be finally ground and contain a fair amount of C_3S.

Fine aggregate

Both river sand and crushed stones may be used. Coarser sand may be preferred as finer sand increases the water demand of concrete and very fine sand may not be essential in High Performance Concrete as it usually has larger content of fine particles in the form of cement and mineral admixtures such as fly ash, etc. The sand particles should also pack to give minimum void ratio as the test results show that higher void content leads to requirement of more mixing water.

Coarse aggregate

The coarse aggregate is the strongest and least porous component of concrete. Coarse aggregate in cement concrete contributes to the heterogeneity of the cement concrete and there is weak interface between cement matrix and aggregate surface in cement concrete. This results in lower strength of cement concrete by restricting the maximum size of aggregate and also by making the transition zone stronger. By usage of mineral admixtures, the cement concrete becomes more homogeneous and there is marked enhancement in the strength properties as well as durability characteristics of concrete. The strength of High Performance Concrete may be controlled by the strength of the coarse aggregate, which is not normally the case with the conventional cement concrete. Hence, the selection of coarse aggregate would be an important step in High Performance Concrete design mix.

Water

Water is an important ingredient of concrete as it actively participates in the chemical reactions with cement. The strength of cement concrete comes mainly from the binding action of the hydrated cement gel. The requirement of water should be reduced to that required for chemical reaction of unhydrated cement as the excess water would end up in only formation of undesirable voids in the hardened cement paste in concrete. From High Performance Concrete mix design considerations, it is important to have the compatibility between the given cement and the chemical/mineral admixtures along with the water used for mixing.

Chemical Admixtures

Chemical admixtures are the essential ingredients in the concrete mix, as they increase the efficiency of cement paste by improving workability of the mix and there by resulting in considerable decrease of water requirement.
Different types of chemical admixtures are

- Plasticizers
- Super plasticizers
- Retarders
- Air entraining agents

Placticizers and super placticizers help to disperse the cement particles in the mix and promote mobility of the concrete mix. Retarders help in reduction of initial rate of hydration of cement, so that fresh concrete retains its workability for a longer time. Air entraining agents artificially introduce air bubbles that increase workability of the mix and enhance the resistance to deterioration due to freezing and thawing actions.

Mineral admixtures

The major difference between conventional cement concrete and High Performance Concrete is essentially the use of mineral admixtures in the latter. Some of the mineral admixtures are

- Fly ash

- Silica fumes
- Carbon black powder
- Anhydrous gypsum based mineral additives

Mineral admixtures like fly ash and silica fume act as puzzolonic materials as well as fine fillers, thereby the microstructure of the hardened cement matrix becomes denser and stronger. The use of silica fume fills the space between cement particles and between aggregate and cement particles. It is worth while noting that addition of silica fume to the concrete mix does not impart any strength to it, but acts as a rapid catalyst to gain the early age strength.

BEHAVIOUR OF FRESH CONCRETE

Introduction:

The behavior of fresh High Performance Concrete is not substantially different from conventional concretes. While many High Performance Concretes exhibits rapid stiffening and early strength gain, other's may have long set times and low early strengths. Workability is normally better than conventional concretes produced from the same set of raw materials. Curing is not fundamentally different for High Performance Concrete than for conventional concretes although many High Performance Concretes with good early strength characteristics may be less sensitive to curing.

Workability

The workability of High Performance Concrete is normally good, even at low slumps, and High Performance Concrete typically pumps very well, due to the ample volume cementitious materials and the presence if chemical admixtures. High Performance Concrete has been successfully pumped even up to 80 storeys. While pumping of concrete, one should have a contingency plan for pump breakdown. Super workable concretes have the ability to fill the heavily reinforced sections without internal or external vibration, without segregation and without developing large sized voids. These mixtures are intended to be self-leveling and the rate of flow is an important factor in determining the rate of production and placement schedule. It is also a useful tool in assessing the quality of the mixture. Flowing concrete is, of course, not required in all High Performance Concrete and adequate workability is normally not difficult to attain.

Setting time

Setting time can vary dramatically depending on the application and the presence of set modifying admixtures and percentage of the paste composed of Portland cement. Concretes for applications with early strength requirements can lead to mixtures with rapid slump loss and reduced working time. This is particularly true in warmer construction periods and when the concrete temperature has been kept high to promote rapid strength gain.

The use of large quantities of water reducing admixtures can significantly extend setting time and therefore reduce very early strengths even though strengths at more than 24 hours may be relatively high. Dosage has to be monitored closely with mixtures containing substantial quantities of mineral admixtures so as to not overdose the Portland cement if adding the chemical admixture on the basis of total cementitious material.

BEHAVIOUR OF HARDENED CONCRETE

Introduction:

The behavior of hardened concrete can be characterized in terms of it's short term and long term properties. Short-term properties include strength in compression, tension and bond. The long-term properties include creep, shrinkage, behaviour under fatigue and durability characteristics such as porosity, permeability, freeze-thaw resistance and abrasion resistance.

Strength

The strength of concrete depends on a number of factors including the properties and proportions of the constituent materials, degree of hydration, rate of loading, method of testing and specimen geometry. The properties of the constituent materials affect the strength are the quality of fine and coarse aggregate, the cement paste and the bond characteristics. Hence, in order to increase the strength steps must be taken to strengthen these three sources.

Testing conditions including age, rate of loading, method of testing and specimen geometry significantly influence the measured strength. The strength of saturated specimens can be 15 to 20 percent lower than that of dry specimens. Under impact loading, strength may be as much as 25 to 35 percent higher than under a normal rate of loading. Cube specimens generally exhibit 20 to 25 percent higher strengths than cylindrical specimens. Larger specimens exhibit lower average strengths.

Strength development

The strength development with time is a function of the constituent materials and curing techniques. An adequate amount of moisture is necessary to ensure that hydration is sufficient to reduce the porosity to a level necessary to attain the desired strength. Although cement paste in practice will never completely hydrate, the aim of curing is to ensure sufficient hydration. In general, a higher rate of strength gain is observed for higher strength concrete at early ages. At later ages the difference is not significant.

Compressive strength

Maximum practically achievable, compressive strengths have increased steadily over the years. Presently,28 days strength of up to 80Mpa are obtainable. However, it has been reported that concrete with 90-day cylinder strength of 130 Mpa has been used in buildings in US. The trend for the future as identified by the ACI committee is to develop concrete with compressive strength in excess of 140 Mpa and identify its appropriate applications.

Tensile strength

The tensile strength governs the cracking behavior and affects other properties such as stiffness; damping action, bond to embedded steel and durability of concrete. It is also of importance with regard to the behavior of concrete under shear loads. The tensile strength is determined either by direct tensile tests or by indirect tensile tests such as split cylinder tests.

DURABILITY CHARACTERISTICS

The most important property of High Performance Concrete, distinguishing it from conventional cement concrete is it's far higher superior durability. This is due to the refinement of pore structure of microstructure of the cement concrete to achieve a very compact material with very low permeability to ingress of water, air, oxygen, chlorides, sulphates and other deleterious agents. Thus the steel reinforcement embedded in High Performance Concrete is very effectively protected. As far as the resistance to freezing and thawing is concerned, several aspects of High Performance Concrete should be considered. First, the structure of hydrated cement paste is such that very little freezable water is present. Second, entrained air reduces the strength of high performance concrete because the improvement in workability due to the air bubbles cannot be fully compensated by a reduction in the water content in the presence of a superplasticizer. In addition, air entrainment at very low water/cement ratio is difficult. It is, therefore, desirable to establish the maximum value of the water/cement ratio below which alternating cycles of freezing and thawing do not cause damage to the concrete. The abrasion resistance of High Performance Concrete is very good, not only because of high strength of the concrete but also because of the good bond between the coarse aggregate and the matrix which prevents differential wear of the surface. On the other hand, High Performance Concrete has a poor resistance to fire because the very low permeability of High Performance Concrete does not allow the egress of steam formed from water in the hydrated cement paste. The absence of open pores in the structure zone of High Performance Concrete prevents growth of bacteria. Because of all the above- reasons, High Performance Concrete is said to have better durability characteristics when compared to conventional cement concrete.

WHEN TO USE HPC

High Performance Concrete can be used in severe exposure conditions where there is a danger to concrete by chlorides or sulphates or other aggressive agents as they ensure very low permeability. High Performance Concrete is mainly used to increase the durability is not just a problem under extreme conditions of exposure but under normal circumstances also, because carbon di oxide is always present in the air .This results in carbonation of concrete which destroys the reinforcement and leads to corrosion. Aggressive salts are sometimes present in the soil, which may cause abrasion. High Performance Concrete can be used to prevent deterioration of concrete. Deterioration of concrete mostly occurs due to alternate periods of rapid wetting and prolonged drying with a frequently alternating temperatures. Since High Performance Concrete has got low permeability it ensures long life of a structure exposed to such conditions.

APPLICATIONS:

High strength and superior durability characteristics of High Performance Concrete have already been utilized in many structural applications in various countries. Some of the applications of High Performance Concrete are:

Bridges –Joigny (France), Greatbelt (Denmark), Akkegawa (Japan), Willows (Canada)

High rise buildings-Water tower plaza (US), Nova Scotia (Canada)

Tunnels-La Bauma and Villejust (France), Manche (UK)

CONCRETE

Concrete :-

It is obtained by mixing cementing materials water and aggregate and sometimes admixtures in required Properties. The mixture when placed in forms and allowed to cure hardness in to a rock like mass in known as concrete. In a concrete mix the cementing material and water form a paste called water cement paste, which in addition to filling the voids fine aggregates.

Grades of concrete :-

Concrete is generally graded according to its compressive strength. The various grades of concrete as stipulated in IS 456-2000 and Is 1343-1980 are given below. In the designation of concrete mix the later refers to the mix and the number to the specified characteristics strength of 150 mm work cubes at 28 days express in MPA or (m/mm2). The concrete of grade M5 and M7.5 is suitable for lean concrete bases simple foundations for masonry walls and other simple or temporary rain forced concrete constructions. The concrete of grade lower than M15 is not suitable for reinforced concrete works and grade of concrete lower than M30 are concrete work PCC work.

Group	Ordinary Concrete	Standard Concrete	High Strength concrete
Grade designation	M10/M15/M20/M25	M30/M35/M40/M45	M50/M55/M60 /M65/M70/M75/M80
Specified Characteristics of Strength 28 day in map	10 15 20 25	30 35 40 45 50	55 60 65 70 75 80

Advantages of concrete :-

Concrete as a construction materials has the following advantages.

* Concrete is economical in the long run as compared to other engineering materials cement.
* Concrete possess a high compressive strength and corrosive and to weathering effect are minimal. When properly prepared its strength is equal to that of a hard natural stone.
* The green or newly mixed concreted can be easily handled and melded or formed in to virtually any shape or size according to specifications.
* It is strong in compression and has animist structural application in combination with steel reinforcement concrete and steel have approximately equal w-efficient of thermal expansion.
* Concrete can even be sprayed on and field in to fine calks for repairs by the uniting process.
* Concrete can be pumped and hence it can be in difficult positions also.
* It is durable and fire resistance and required very little maintained.

Disadvantages of concrete :-

The following are the disadvantages of concrete .

* Concrete has low tensile strength and hence crack easily.
* Frees concrete shrinks or drying and harden concrete expands on wetting prevision.
* Concrete expands and contracts with the changes in temperature.
* Concrete under subtend loading under goes keep resulting in the reduction on the prestige in the protest concrete construction.

* Concrete in not interlay impervious to moisture of and contains soluble slots which may cause efflorescence.
* Concrete is liable to disintegrate by alike and sulphate attack.
* The lack of ductility in hidden in concrete as a material is disadvantages with respect to earth queue resistance design.

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PROPERTIES OF HARDEMED CONCRETE

Compressive strength :-

Cubes, cylinders, Prisms are three types, of compression test specimens used to determine the compressive strength on testing machine. The cubes are usually up loom and 150 mm side the cylinders are 150mm diameter by 300mm height.

* The specimens are east cured and tested as per standards prescribed for such test. When cylinders are used they have to be suitable cupped before the test an operation not required when other types of specimens are tested.
* The compressive strength given by different specimens for the same concrete mix are different. The cylinders and prisms of a ratio of height or length to the lateral dimensions of to may give a strength of about 75 to 85% of the cube strength of normal strength of concrete.

Flexural strength :-

The determination of flexural tensile strength is essential to estimate the load at which the concrete members may crack.

* The flexural tensile strength at failure or the modulus of rupture is thus determined and used when necessary its knowledge is

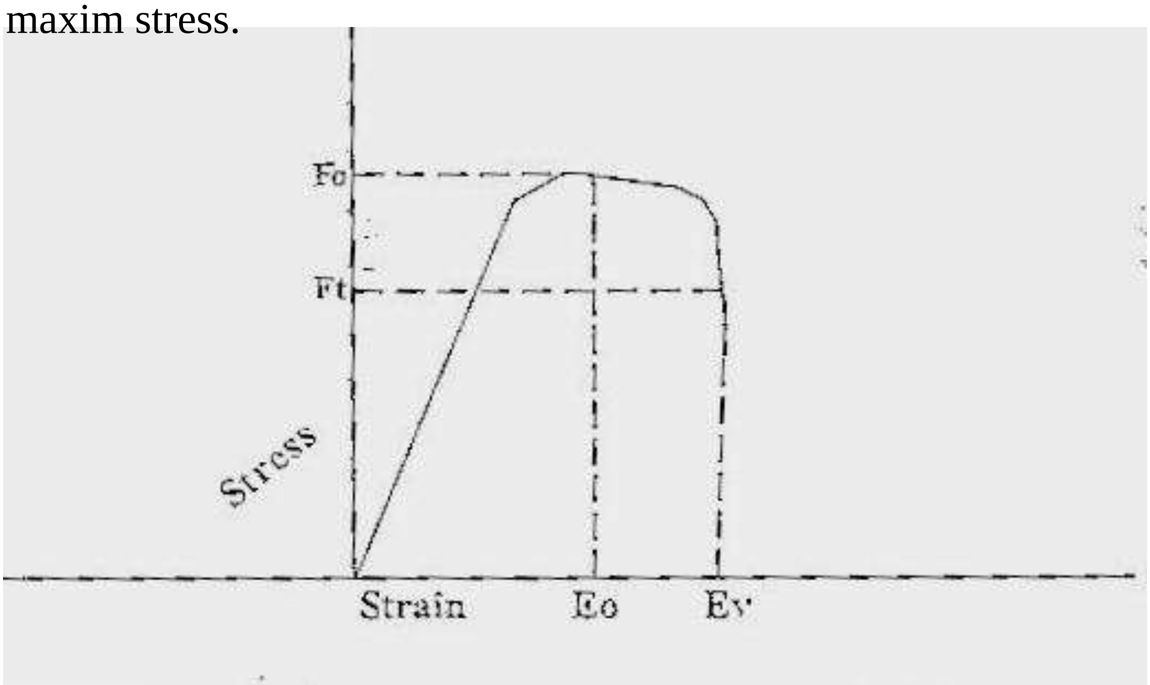
useful in the design of pavement slabs airfield run ways as flexural tension is critical in these case.

* The modulus of rupture is determined by testing standard test specie men's of 150x500mm over a span of 600mm or 100x100x500 mm over a span of 40 mm under symmetrical two points loading. The modulus of rupture is determine from the moment at failures as fro = m/z.

Stress and strain Characteristics of concrete :-

The relation is firefly linear in the initial stage but subsequently becomes non-linear reaching a maximum value then a descending portion is obtained before concrete finally fails. The curve is usually obtained by testing a cylinder with a height to lateral dimension ratio of at least two the test being conducted under a uniform rode of stress.

If a uniform rate of stress is adopted it will not be possible to obtained the descending portion of stress and strain curve beyond the maxim stress.



An equation representing the stress and strain curve completely should satisfy the following condition.

(i) At F=0, E = 0 and dot/do =Et (Young's modulus)

(ii) At f = f0, E = Eo and df/ dE = 0

(iii) At f=ft, E = Ev .

Modulus of elasticity :-

The modulus of elasticity of concrete would be a properly for the case when the material is treated as elastic. It we consider the stress strain curve of the first cycle the modulus could be defined as initial tangent modulus.

* In the laboratory determination of the modulus elasticity of concrete a cylinder is loaded or unloaded for 3 or 4 cycles. The stress strain curve is plotted after residual strain has become almost negligible and the average slope of stress and strain is taken.

For normal weight of concrete.

Ec = 1.25, Ed =19.

For light weight of concrete

Ec = 1.04, Ed = 4.1

Positions ratio :-

It is determine as the ratio of to longitudinal strain in compression test and may very form 0.13. to 0.21.

The positions tattoo ( ) can be determined

from m = (v2/) = 1-m /

Where V = Place velocity.

n = Resonant frequency of long itudinal vibration in Hz.

L = Distance between transducers.

The value of positions ratio as determined by dynamic test is slightly higher and ranges from 0.20 to 0.25.

Shrinkage :-

Shrinkage a contraction suffered by concrete even in the absence of load.

Tow types of shrinkage recognised namely plastic and drying shrinkage.

(i) Plastic Shrinkage :-

The hydration of cement concrete cause a reduction in the volume of system of water to an extend of about 1% of the volume of dry cement. This contraction is plastic strength and agree vetted due to loss of water by evaporation for surface of concrete particularly under hot climates and high winds. This can result in surface cracking.

(ii) Drying shrinkage :-

The shrinkage that takes place after the concrete has set and hardened is called drying shrinkage and most of it takes place in the 1st few months with drawl of water from concrete stored in saturated air voids causes drying shrinkage.

Creep of concrete :-

The in crease of strain in concrete with due under sustained stress is termed creep.

When the sustained load is removed the strain decreases immediately by an amount equal to the elastic strain at the given edge. This instanious recovery is then followed by a gradual decreases in strain called creep recovery. Which is a part of total creep strain suffered by the concrete. If a loaded concrete specimen is views has been subjected to a constant strain the creep decreases the stress progressively with time. This is called relaxation.

Permeability of concrete :-

When excess water in concrete evaporates it leaves voids inside the concrete element creating capillaries. Which are directly related to the concrete porosity and permeability. Permeability is governed by porosity which in turn is a direct consequent of the water cement ratio of the concrete mix .

Durability of concrete :-

A durable concrete is one that per form satisfactorily under anticipated expose condition during its service life span. The materials and mix proportion used and should be such as to maintain its integrating and if applicable to protect emended metal from corrosion.

One of the main characteristics influencing the durability of concrete is its permeability. To the ingress of water oxygen carbon dioxide, chloride, sulphate and other potentially deleterious substances.

Sulphate attack :-

Sulphates are generally found in ground water and sub-soil, Sea water also contain large quantity of sulphates, calcium, sodium, magnesium and ammonium sulphate are harmful to concrete as they can lead to increase in the concrete volume and consequently cracking calcium sulphate reacts with calcium aluminates present in cement hydrides forming an expensive zips in presence of illuminate and may in turn lead to the formation of efflorescence. Magnesium sulphates reacts with cement compound de-composing the cement itself and subsequently producing kips for minimising the danger of sulphate attack low C_3 content recommended.

Acid attack :-

Concrete structures are also use for storing liquids some of when are harmful for concrete. For damp conditions So_2 and Co_2 and other acid fumes present in the atmosphere affect concrete by dissolving and removing part of set cement. In fact no Portland cement is acid resistant. Concrete is also attack by water containing free Co2. Sewerage water is also very slowly causes decoration of concrete.

EFFLORESCENCE :-

The water leaking through cracks or fact joints or through the areas are poorly compacted porous concrete dissolved some of the readily soluble calcium hydro-onside and other solids and after evaporation leases calcium carbonate as white deposits on the surface of concrete resulting from the coaching of calcium hydro-oxide and subsequent carbonation and evaporation are termed efflorescence. Un washed seashore aggregate efflorescence.

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QUALITY AND CONTROL OF CONCRETE

<u>Factors causing the variations in the quality of concrete</u> :-

The main factor causing variation in concrete quality are as follows.

<u>Personal</u> :-

The basic requirement of the success of any quality control plan is the availability of experienced knowledgeable and treed personal and all levels. The sight engineer should be able to comprised the specification stipulation to infarct quality must be a display imbibed in the mind and they should be strong motivation in the everything right the first time.

<u>Materials equipment and workmanship</u> :-

For uniform quality of concrete the ingredients should performable be used from a single source. When ingredients from different sources are used the strength and other characteristics of materials are likely to change and therefore they should only be used proper evaluation and testing.

Grading minx side, shape and moisture contain of aggregate are the measure soirées of variability.

* The aggregate should be free from impurities and deleterious materials.
* The water, used for mixing concrete should be free from silt organic matter alkali and suspended impurities sulphate and chloride in water should not exceed and permissible limit.
* The cement should be tested initially once form each sources of supply and subsequently once every two months.

They equipment used for batching, mixing variation should be right capacity. Weight bathed should be frequent change for there accuracy. Mixtures performance should be check for conformity to the requirement of the relevant standard concrete be mix for the required time bath under mixing and over mixing should be avoided. The vibrations should have the required frequency and amplitude of vibration.

The green concrete should be handled, transported and placed in such a manner that it does not get segregated. The time interval of mixing and placing the concrete should be reduced to the minimum possible. Adequate cheering is essential for handling and development of strength of concrete which depends upon shape and sire of member temperature, and humidity condition type of cement and the mix proportion. Generally the long term compressive strength of concrete moist cured for only 3 days of 7 days sill be about 60% or 80% respectively of the one moist cured for 28 days or more.

Field quality control :-

The field control that is inspection and testing play a vital role in the overall quality contract plan. Inspection could be of two types.

(i) Quality control inspection and

(ii) Acceptance inspection.

For refitted operation early inspection is vital and once the plant has stabilise occasional checks may be sufficient to ensure continued seats factory results. The apparitions which are not of repetitive type would required on the other hand more constant.

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PRODUCTION OF CONCRETE

Production of Concrete:-

The design of a satisfactory mix proportion is by it self no guarantee of having achieved the object of quality concrete work. The batching, mixing, transportation placing com pact ion finishing and curing are very complimentary operations to obtain desired good quality concrete.

* The aim of quality control is to ensure the production of concrete of uniform strength in such a way that there is a continuous supply of concrete delivered to the place of depositions. Each batch of which is as nearly like the other batches as possible. The production of concrete of uniform quality involves the following five definable phase.

(i) Batching or measurement of materials.

(ii) Mixing of concrete.

(iii) Transportation.

(iv) Placing, compaction and finishing of concrete.

(v) Curing.

Batching of materials :-

A proper and accurate measurement of all materials used in the productions of concrete is essential to ensure uniformity of Proportions and aggregate grading in successive batches. For most of the large and important jobs the batching of materials in usually done by weighing. In weight batching the weight of surface must be taken in to account. The factors affecting the choice of proper batching systems are.

(i) Sire of job.

(ii) Required production rate.

(iii) Required standards of batching performance.

The production capacity of a plant is determined by the material handling system, the become size, the batcher size, and the plant mixer size and their number available.

Manual Batching :-

In this short of patching all operations of weighing and batching of concrete ingredients are done manually. Manual batching is acceptable for small jobs having no batching rate.

Semiautomatic Batching :-

This batching is one in which the aggregate bin gates for charging batchers are opened by manually operated switches.

The system contains interlocks which prevents batcher charging and discharging occurring simultaneously.

Automatic Batching :-

Automatic batching is one in which all scales for the materials are electrically activated by a single switch and complete autographic records are made of the weight of each material in each batch.

Mixing of concrete materials :-

The object of mixing is to coat the surface of all aggregate particles with cement paste and to bland all the ingredients of concrete in to a uniform mass. The mixing action of concrete thus involves two operations :-

(i) A general blending of difference particle sizes of the ingredients to be uniformly distributed through out the concrete mass and

(ii) A vigorous robbing action of cement pastel on to the surface of inert aggregate particles. Concrete mixing is normally done by mechanical means called mixer, but sometimes the mixing of concrete is done by bond. Machine mixing is more efficient and economical compared to hand mixing.

(i) The tilting type mixture.

(ii) The non-texting type mixture.

(iii) The pan or stirring mixture.

Transportation of concrete :-

Concrete from the mixture should be transported to the point where it has to be placed as rapidly as possibility by a method which prevent segregation or loss of ingredients. The concrete has to be placed before setting has commenced. Attempts have been made to limit the time lapse between mixing and compaction with in the forms.

The specifications however, permit a maximum of two hours between the introduction of mixing water to the cement and aggregate and the discharge if the transported in a truck mixture or agitator. In the absence of an agitator, this figure is reduced to one hour only. All these however pre same that the temperature of concrete. When deposited is not less than 5.c or more than 32 % c. It has been established that delays in planning concrete after the so called initial set has taken place are not ingenious and may give increased compressive strengths, Provided the concrete retains adequate work ability to allow full compaction.

The requirements to be fulfilled during transportations are.

(i) No segregation or separation of materials in the concrete and .

(ii) Concrete delivered at the point of placing should be uniform and of proper consistency.

The prevention of segregation is the most important consideration in handling and transportation concrete. The segregation should be prevented and not corrected after its occurrence. The concrete being a non-homogeneous composite of materials of widely differing particle size and specific gravities. is subjected to internal, and external forces during transportation and placing tending to separate the dissimilar constituents.

Segregation can be prevented by ensuring that the direction of all during the damping or dropping of concrete is vertical. When the discharge is at an angle the larger aggregate is thrown to the far side of the container being charged and the mortar is collected at the near side thus resulting in segregation.

The plan required for transporting the concrete varies according to the size of the job and the level at which the concrete is to be placed. The principal methods of transporting concrete from the mixer are the following

(i) Barrows.
  (a) Wheel barrows and hand cards.
  (b) Power barrows and powered haggis or dumpers.
(ii) Tippers and lorries
(iii) Truck mixer and agitator corries.
(iv) Dump buckets.
(v) The manorial system or trolleys or rails.

The most commonly used method of transporting concrete by the hand pans passing from hand to hand is slow, wasteful and expensive. It concrete is to be placed at or below the mixer level, steel wheel barrows are a better mode of transportation. Concrete can be discharged from the wheel barrows to the required point. The average quantity that can be carried in one wheel barrow is about 35 litters (80kg). Sometimes for relatively bigger jobs, power barrows, which are motorised version of wheel barrows are used.

Dumpers and ordinary open steel body tipping lorries can be used economically for hoops of up about 5 km. These lorries are suitable only for dry mixes to avoid difficulties used by segregation and consolidation.

It is essential that the lorry body by water height to prevent loss of fineness. The concrete has to be covered with tarpaulins to prevent the concrete being exposed to sun wind and rain. If the haul is long. agitators have to be used to prevent segregation. White using this method it is necessary to see that.

(i) The entire mixer batch is placed in the bucket and

(ii) Segregation is prevented while filling the bucket.

For transporting ready mixed concrete truck mixers and agitator rise are used. The manorial system is useful when the ground conditions are not suitable for normal. Wheeled traffic. In the manorial system, the concrete be tripped directly into the formwork.

Basically the system consist of a power wagon mounted on a single rack capable of a travelling speed of 90% m/min, The engine may be diesel or petrol powered without a driver.

Placing of concrete :-

The method used in placing concrete in its final position have an important effect on its homogeneity, density and behaviour in service.

The secure good concrete. It is necessary to make certain preparation before placing. The forms must be examined for correct alignment and adequate rigidity, to withstand the weight of concrete impact loads during construction without undue deformation. The forms must also be schemed for tightness to avoided any loss of mortar which may result in honey-combing. Before placing the concrete, the inside of the forms are cleaned and treated with a relies agent to facilitate their removal when concrete is set.

<u>Compaction of concrete</u> :-

During the manufacture of concrete a considerable quality of air is entrapped and during its transportation there is a possibility of practical segregation taking place. If the endeared air is not removed and the segregation of course aggregate not corrected, concrete may be porous, non-homogeneous and of reduced strength. The process of removal of entrapped air and of uniform placement of concrete to form a homogeneous dense mass is termed compaction.

The presence of even 5% voids in hardened concrete left due to in complete compaction may result in a decrease in compressive strength by about 35% compaction is necessary for the following reasons.

(i) The internal friction between the particles forming the concrete bent concrete and reinforcements and formwork makes it difficult to spread the concrete from coming in cubes contact with the reinforcements there by landing to poor bond between the reinforcement and surrounding concrete. The compaction helps to over come the above frictional forces.

(ii) Friction can also be reduced by adding more water than combine with cement. The water in excess to that required to hydrate the cement fully forms water voids which have as harmful an effect in reducing strength as air voids, nevertheless, it is preferable to used slightly more water than run the risk of securing in adequate compaction. The compaction recued to voids to minimum.

Compaction method :-

The compaction of the concrete can be achieved in four ways.

(i) Hand ridding.

(ii) Mechanical vibrations.

(iii) Centrifugation or spinning and

(iv) High pressure and shock.

The choice of a particular technique of compaction of concrete factors.

(i) The type of structural element

(ii) The properties of concrete mix, particularly its water cement ratio.

(iii) The desired properties of the hardened concrete i.e. strength, durability and water tightness etc.

(iv) The duration of the production process and the rate of the out put in the case of precast concrete products.

1. Hand Roding :-

Roding is the process of ramming the concrete manually with a heavy feat-faced tool. The Roding action is effective for a depth of concrete equal to five times, the maximum size of aggregate. The road should penetrate to the full depth of the concrete layer. The compaction should continue consul the cement mortar speeds on the surface of the concrete. Fact Roding produced better compaction that hand ridding.

2. Mechanical vibrations :-

Vibrations is the commonly used method of compaction of concrete. The oscillations are in the form of simple harmonic motion. The mechanical vibrations can be impacted by means of vibrators. Which are operated with the help of an electric motor

3. Centrifugation or spinning :-

The method is used in the production of laments. Which are circulate in cross-section. The amount of concrete is feed in to the mould, the spinning process. The speed is slowly reduced and dry cement is sprinkled in small quantity such that any face water on the surface does not increases the total water cement ratio. A round rod is held against the two end rings to finish the surface. The initial water cement ration for effective compaction without serration should be between 0.35 and 0.04.

4. Vibropressing :-

The method comprises applying external pressure from the top and vibration from below the mould. The vibration tables can be used for this purpose. The excess water added during the mixing is forced out due to large pressure.

Curing :-

The water in capillaries may gear lost due to evaporation. It this water is retained by some means or in other words if the water is continuously available, the chemical action can be continued as long as all the cement is hydrated. The process by which the loss of water from concrete is prevented is known as curing. Curing is usually done in one of the following ways.

1. Most curing :-

Exposed surface of concrete shall be kept continuously in west condition for at least seven days. from the date of placing of concrete prelist concrete members can be immersed in water.

2. Member curing :-

The concrete may be coated with approved curing compounds. This method is used where water is in short supply or in hot water conditions.

3. **<u>Steam curing</u> :-**

Steam curing under pressure is very costly as it requires pressure chambers. Steam curing reduces the bond strength of concrete steam curing is used only for achieving 50% to 75% of the strength in a short period.

<u>Curing period</u> :-

To develop design strength, the concrete has to be cured for up to 28 days. As the rate of hydration and hence the rate of development of strength reduces with time, it is not worth while to cure for full period of 28 days.

Is : 456-200 stipulate a minimum of 7 days moist curing. While Is : 7861 (Part-1) - 1976 stipulates a minimum of 10 days under not weather conditional. High, early strength of cement can be cured for half the periods suggested for OPC. For pozzolna or best furnace - slag cements the curing period should be increased.

<u>FORMWORK</u> :-

The formwork or shuttering may be defined as moulds of timber or same other material into which the freshly mixed concrete is poured at the site and which hold the concrete till it sets. From lining and sheathing plus all necessary supporting members. bracing hardware and fasteners.

Concrete construction practice directly affected formwork requirements. A good formwork should be strong, stiff, smooth and leak. As the cost of formwork may be the other order of 2% of the cost of project.

Requirements of formwork :-

Quality:-

The formwork is designed and built accurately. So that the desired (shape, size , position and finished of cost concretes is obtained and thus.

(a) All linear in the formwork should be true and the surface be plane. So that the cost of finishing the surface of concrete on removal of shuttering is the least.

(b) The formwork should be leak proof.

Safety :-

The formwork is built substantially so that it is strong enough to support the dead and live loads during construction without collapse or danger to workmen or the structure. The joints in the formwork should be rigid to minimise the building twisting or sagging due to dead and live loads. Excessive deformation may disfigure the surface of the concrete.

Economy :-

The formwork should be built efficiently to save time and money for the constrictor and owner a like. After the concrete has set. the formwork should be easily strippable without damage so that it can be used repeatedly.

Types of formwork

Timber formwork :-

The timber used for formwork should be cheap easily available and easy to work manually and on machines. A good timber for formwork should be light for easy handling and lifting. stiff for not giving excessive deflections usually for form knots, knot holes, bad flows, etc. Which may cause failure. The timber used should not be green as it would then become dry and shrink and at the same time not too dry as it would absorb water form concrete. Partially seasoned timber is the most suitable.

<u>Plywood formwork</u> :-

Plywood sheets bound with synthetic resin adhesive are being widely used now a days. The thickness of play varies from 3 to 18mm. slices less than 6mm stick are used for lining the timber formwork get neat and smooth surface finished and as a formwork for curved, Surface. The common slices are (1200 x 1200) mm to (300 x 3000) mm. The finishing of forms is rapid is rapid and economical. It does not warp, swell and shrink during the setting of concrete.

<u>Steel formwork</u> :-

Steel formwork are commonly employed for big projects where the forms are to be reputedly used. The steel forms can be easily fabricated and do not required may adjustments as the units are standardised. These prove to be economical and are best suited for circular columns and flat slab construction. Joints can be used from wall to wall to support the steel beams used for stiffening the plates. Square steel plant of 500 mm size are generally used. Light steel sheet panels of 500mm size and stiffened with angles are also available.

Stripping of form :-

The removal of forms after the concrete has set is termed stripping of forms. The stripping or striking of forms should produced in a definite order. The formwork should be so designed and constructed as to allow them to be stripped in the desired order. The period up to which the forms must be left in place before they are stripped is called stripping time. The factors affecting the stripping time are the position of the forms the loads coming on the elements immediately after stripping, temperature of the atmosphere, the subsequent leads coming on the elements, etc.

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INSPECTION AND TESTING

Introduction:-

The testing of reprehensive concrete doesn’t represent the quality of the actual in place concrete and quality control can not be regarded as a more testing of three concrete clubs at 28 days, in fact to avoid inferior concrete being placed the control, is to be carried out much before any cubes become available for testing. There are 3 basic categories of concrete testing namely.

(i) Quality control :-

It is normally carried out by the contractor in indicate adjustment necessary to ensure an acceptable supplied material.

(ii) Compliance testing :-

It is performed by the engineer according to an agreed plan to the check compliance with the specifications.

(iii) Secondary testing :-

This test is performed on the hardened concrete in situations. Where there is doubt about the reliability of control and compliance results or they are an available or in appropriate as in an old structure.

Workability test :-

The workability of concrete should be measured at frequent intervals during the progress or work by means of slump test compacting factor test or Vie - Bee consistency test as per Is-1199 to 1959 specification to the ball penetration test.

The slump test is of real value as a field control of the makes to maintain the uniformity between different batches and supposedly similar concrete. The compacting factor test is more accurate than the slump test and the results are reproducible. This test may be performed for a wide range of workability that is for concrete mines of a high to very low work abilities. (CFO. 92 to 0.68). The Vie-Bee test is suitable for low and very low work abilities.

Air void analysis testing :-

It is measured the total air contain of fresh concrete doesn't provide information about bubble size and air distribution through out the volume of concrete. Which is vital for adequate freeze thaw performance on the other hand the only available standardised method to determine the air void system is to perform test on harden concrete. Which typically takes several wings to complete which is too late from corrective measures to be taken.

Micro wave water content test :-

Water content of as deliver concrete as always been a source of speculation and un certainty water in excess the mix design amount can have a direct negative impact on the strength quality and durability of concrete. Since better quality control optimization of materials in the mix design and high performance concrete, are specified for construction projects it has become critical that accurate control the water content of a concrete mix be enforced.

Maturity test :-

The strength of a concrete mix that has been properly consolidated and cured is a function of its edge and temperature history longer curing periods and higher curing temperature load to increase strength development. The maturity method of testing recognizes this combined effect of time and temperature and provide a basic for estimating the in-site strength gain a of concrete by monetary temperature over a period.

Acceptance testing of hardened concrete:-

The test on the hardened concrete curried out to check its compliance with specifications asses the quality of concrete in the struepulated the load curing capacity and the strength of concrete at a particular location in the structure.

Ultrasonic test of hardened concrete :-

The ultrasonic pulse velocality (UPV) method basically involved the measurement the velocity of electronic pluses passing through concrete from a transmitting transducer to a receiving transducer. The method is based on the principal that the velocity of pulse passing through concrete is primarily depends upon the density and the elastic properties of the materials and is depended up geometry of the component. The density and elastic properties are in term related to the quality and strength of the material the pulse velocities a range from about 3 to 5 kipper see.

Impact echo testing :-

The non destructive impact echo method uses transient stress or sound waves generated in the concrete a masonry by an elastic low energy mechanical impact source or impact or consisting of hardened steel balls mounted on springs rods. The stress waves that propagate with in the member are reflected by dies continuous like flows or air interfaces with in the member and the external boundaries of the member.

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SPECIAL CONCRETE

MASS CONCRETE :-

A concrete placed in massive structure like dams, canal locks, bridge piers etc can be termed mass concrete. A large size aggregate (up to 150 max m size) and a low slump (stiff consistency) are adopted to reduces the quality of cement in the mix to about 5 days per cubic method of mass concrete.

The high temperature of mass concrete due to the heat of hydration may lead to extensive and serious shrinkage cracks. The shrinkage cracks can be prevented by using low heat cement and by continuous curing of concrete.

Silica fume concrete :-

Silica fume is a by product of the reduction upright quartz with coal electric are furnaces in the production of Ferro-silicon method. Because of its extreme fineness and high glass content, silica-fume is a very efficient poiiolanic materialise it is able to react efficiently with the hydration products of Portland cement in concrete.'

Silica, fume is generally more efficient in concretes having water - cement ratios. The silica fume has an efficiency factor of 3 to 4. This means that 1 kg of silica, fume can replace 3 to 4 kg cement in concrete without changing the compressive strength of concrete.

Silica fume in concrete can be used for the following purposes.

(i) To conserve cement.

(ii) To produce ultra high strength concrete.

(iii) To concrete alkali silica reaction.

(iv) To reduce chloride associated corrosion and sulphate attack.

(v) To increase early age strength of flays/slag concrete.

SHOTCRETE OR GUNITING :-

Shotcrete is mortar or very fine concrete deposited by jetting it with high velocity on to a prepared surface as the system has different proprietary names in different countries such as Blastcrete concrete offers advantages over conventional concrete in a variety of new construction and repair works. Concrete as frequently more economical than conventional concrete because of less formwork requirements requiring only a small portable plant for manufacture and placement. It is capable of excellent bonding with a number of materials and this may be an importance consideration.

Concrete has wide applications in different constructions such as thin over-head vertical or horizontal surfaces, particularly the curved of folded sections, canal, reservoir and tunnel lining. Swimming pools and other water retaining structures and pressurised tracks shotcrete is very useful for the restoration and repair of concrete structures fire damaged structures and water proofing of walls.

Uniting :-

Gummite also known as a dry process shotercte, uses air pressure to convey dry material from machine through hose to nozzle where water is added. The technique of depositing very thin layers of mortar in each pass of the nozzle than that available with the concrete is termed grunting.

The grunting can effectively by used for the repair of dams, spillways, bridge, piers, sewerage pipes and water mains and for protection of canal banks. It has been extensively used for the protection of steel guiders from corrosion etc and watery roofing of reservoir and tunnels.

FERROCEMENT :-

Ferro cement may be considered as a type of thin reinforced concrete construction where cement mortar matrix is reinforced with may layers of continuous and relatively small diameter wire mesh reinforcement over the endive surface, and sometimes over the entire volume of the matrix provides a very high resistance against cracking.

Applications :-

Ferro cement combines easy mould ability of concrete to any desired shape lightness tenacity and toughness of steel plates. Due to very high tensile strength to-weight ratio and superior cracking behaviour the fibrocement is an attractive material for light and water light structure and other portable structures, such as mobile homes. The other specialised applications include water tanks and detailed soies and bins boat hills, biogas, holder pipes, folded plates and shell roofs, floor, units, kiosks, service core units wind tunnels, modular housing, swimming pool and permanent forms of concrete columns.

FIBRE REINFORCED CONCRETE

Introduction :-

The fibres help to transfer loads at the internal microckalks such as concrete is called fibre reinforced concrete. Thus the fibre reinforced concrete is a composite material essentially consisting of conventional concrete or mortar reinforced by fine fibres.

The major factors affecting the characteristics of fibre-reinforced concrete are water cement ratio personages of fibre diameters and length of fibres. The fibres restrain the shrinkage and creep movements of unreinforced matrix. However fibres have been found to be more effective in controlling compression creep than tensile creep of unreinforced matrix.

In contract to reinforcing bars in reinforced concrete which are continuous and carefully placed in the structure to optimise their performance the fibres are dis continuous and are generally rendomly distributed throughout the concrete matrix. The fibres are likely to be considerably more expensive than the conventional steel rods. The fibre reinforced concrete is not likely to replace conventional reinforced concrete.

PLOYMER CONCRETE COMPOSITES (PCCS)

Polymer concrete composites are obtained by the combined processing of polymeric meteoric materials with some or all of the ingredients of the cement concrete composites polymer concrete can be classified as follows.

Polymer impregnated concrete (PIC)

In polymer impregnated concrete low viscosity liquid monomer or polymers are partially or completely impregnated in to the pore systems of hardened cement composts and are then polymerised.

Application in irrigation structure :-

The effect of cavitations and erosion in dams and others hydraulic structures can be catastrophic conventional peptides of the damage are expensive and huge losses may be caused due to loss of benefits from irrigation power generation flood control, etc. In such cases the polymer impregnated treatment may be cost effective. The concrete may be removed from the place of server damage and the damaged are patched, dried and treated by impregnation.

Resin or polymer concrete :-

Polymer concrete is a composite where in the polymer replaces the cement, water matrix in the cement concrete. It is manufactured in manner similar to that of cement concrete monomers or per-polymers are added to the graded aggregate and the mixture is thoroughly mixed by hand or machine. The thoroughly mixed polymer concrete material is cast in maids of wood, steel or aluminium, etc to the required shape or form.

polymer concrete have good potential as repairer material and for overlays. This sand filled overlays reduces water permeability and chloride penetration. Polymer concrete can be use for treating the sluice ways and stilling has of the dam.

Polymer concrete pipes have been used for transporting a variety of chemicals for carrying effluents and waste water etc.

Polymer concrete can be used in rock boths. If provides necessary corrosion protection to ground anchors. Polymer concrete posses good electrical properties and can be used for high voltage insulator application. Electrical structures such as poles for electrical transmission lines have been manufactured from polymer concrete.

Polymer modified concrete (PMC) :-

Polymer modified concrete (PCM) more specifically called polymer cement concrete is a composite botched by in corpora ting a polymeric material in to concrete during the mixing stages. Polymer added should not interface with the hydration process polymer are insoluble in water their addition can only be in the form of emulsion or dispersion or latex. The hydrated cement and the polymer film formed due to the curing of the polymeric material constitute an penetrating matrix that binds the aggregate.

Depending upon the type of modifier, polymer modified cement concrete can be subdivided as

(i) Latex - modified cement concrete (LMMC).

(ii) Prepolymer- modified cement concrete(PMCC).

Polymer cement concrete (PCC)

PCC is used for flooring in food processing and chemical industrials in wear-resistant floors and in elects over steel bridges. Due to the early development of strengths it is suited for repairer of sea defence structure.

The development of polymer-concrete composite has opened up the possibility of extending the very range of applicability of concrete like composites. It has become possible to tailor a polymer concrete composite to meet the requirements of any given applications.

Polymer concrete composites are very cost effective in applications requiring high digress of durability and chemical resistance and where so for costlier material and composites have been employed.

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DETERIORATION OF CONCRETE AND ITS PREVENTION

Introduction :-

Though concrete is quite strong mechanically. It is highly susceptible to chemical attack and thus concrete structures get damaged and even fail unless some measured are adopted to counter out deterioration of concrete and there by increasing the duality of the concrete structure.

Types of deterioration :-

Deterioration of concrete is caused not only by acids in the form of water solutions or acids on dissolving in water, but by salt solutions and even by allies.

There are 3 types of deterioration.

(i) Decompositions of concrete :-

In this form the decomposition of concrete is caused by action of liquids. Which are able to dissolve the ingredients of hardened concrete.

(ii) Chemical reaction :-

In this form of destruction a chemical instruction between hardened cement constituents and a solution takes place.

(iii) Crystachization :-

This form of destruction involves accumulation crystallization and polymerization of reaction product which increases the volume of solid phase which the pore structure of concrete.

Prevention of concrete Deterioration :-

An increase in the water cement ratio above 0.45 or 0.50 is found to increase the permeability of cement paste exponentially. In addition the cement content should be such that to ensure sufficient alkalinity to provide passive environment against corrosion of reinforcement. In the concrete for marina environment or in sea water applications a minimum cement content of 350 kg/m3 or more is required more over the water-cement ratio and cement content must provide enough paste to overfill. The void content of aggregates depends upon the type and nominal maximum size of aggregate used e.g crushed rock and rounded river gravels of 20mm nominal size have approximately 27 and 22 percentage of aggregate voids cement content of 40 kg/m3 and water cement ratio of 0.45 will produce paste volume of 30% which is sufficient to overfill the voids of crushed rock.

The concrete in sea water or exposed directly should be at least of M20 grade in case of plain concrete and M25 in case of reinforced concrete.

As the addition of hydraulic additives reduces the rate of leaching considerably their addition will also be helpful in the prevention of deterioration of concrete.

Deterioration of concrete can also be prevented by treating concrete with solutions of salts layer of cilium salts less soluble than calcium hydroxide. This can be accomplished by treating the surface with solution of 3% fluosilic acid 5% oxalic acid and saturated solution of moncalcium phosphate.

Corrosion of Reinforcement :-

Concrete normally provides a high degree of protection against corrosion to embedded steel reinforcement. In addition concrete of low water, cement ratio and well carried has a low permeability which minimizes penetration of corrosion inducing agents like oxygen, chloride ion, carbon dioxide and water.

Sometimes, the 1st evidence of distress is the brown staining of a concrete around the embedded steel. Thus brown staining resulting from rusting or corrosion of the steel permeating to the concrete surface without cracking of the concrete but usually is accompanied by cracking steel corrosion not only eases distress beacuse of staining, cracking and revelling of the concrete but may also cause structural failure resulting from the reduced L/S and hence reduced tensile force capacity of the steel this normally being more critical within pressurising bars. To understand the corrosion phenomenon of embedded reinforcement, it is imperative to study the corrosion of steel itself.

EFFECTS OF CORROSION :-

The distress due to corrosive action may be in the form of deep pitting and a serve less c/s of reinforcement. A combination of high stress and intense corrosion will produce stress concentrations that may result in rupture of the reinforcement. The corrosion of embedded steel can be minimized by using the following recommendation.

(i) For the reinforced - concrete member totally immersed in sea-water the cover should be increased by 40mm beyond the specified for normal condition. In the case of high - strength concretes of grade m_{25} or above, the additional thickness of cover specified over ma reduced to half.

(ii) The additional cover thickness ranging from 15to50mm beyond the value for normal conditions. may be Provided. When the surface of the concrete member are exposed to the action of harmful chemicals (e.g concrete in contact with soil contaminated with such chemicals) saline atmosphere laid vapours, sulphurous smoke etc. However the total cover is limited to 75mm.

(iii) To reduce the corrosion of reinforcement. the chloride ions in the concrete should be limited to its threshold or critical value. The total amount of chloride ions in concrete should be limited to 0.60% .

(iv) In the case of an excessively aggressive environment, or where for practical reasons it is not possible to meet the requirement of cover and quality considered.

(v) However, the sacrificial protection provided by wafting the reinforcement with either a metallic or non-metallic material has been found to satisfactory. Irrespective of the type, it is essential that the coating should completely evoke, the bar and should remain unbroken.

(v) The concrete surface coating providing a barrier at the surface. Which penetrate and seat the pores of protection waterproof membranes are also being extensively used.

REPAIR TECHNOLOGY FOR CONCRETE STRUCTURE

Introduction:-

Though concrete is a relatively durable building material, it may suffer damage or distress during its service life due to a number of reasons. Because of the varying conditions under which it is produced at various locations. The quantity of concrete suffers occasionally either during production or during service conditions resulting in distress.

Sometimes distress in a structure is brought about by poor construction over loads. The other cause may be drying shrinkage, thermal stress, weathering, Chemical reaction and corrosion of reinforcement.

Symptoms and Diagnosis of Distress :-

In addition to minor structural defects outlined above, the other distress can be observed in the form of cracks, spelling and scaling of concrete is the most common indication of the distress in a concrete structure. It may affect appearance only, or indicate significant structural distress or lack of durability. Cracks may represent the total extent of the damage, or they may point to problems of greater magnitude. These in turn may cause corrosion of reinforcement due to the entry of moisture and angel.

Cracking of concrete structural can never be totally eliminated but the practitioner should be a were of the causes, evaluation technique and the methods of repair. The approach of diagnosis of the problem of cracking should be identical to that of a doctor to the parent. Treatment of cracks involves detection, diagnosis and remedy. Before remedies are sought correct diagnosis will decide weather satisfactory repair is possible. The development of cracks and their repair is a perpetual problem involving considerable cost and in convenience to the occupants.

The cracks in a structure are broadly classified in to two categories, superficial cracks and structural cracks. The structural cracks may be active and dormant. A crack where a movement as the crack where no movement occurs is termed dormant or state.

The following information may help in diagnosing the cracks:-

(i) Whether the crack is new or old.

(ii) Typed the crack i.e. whether it is active or dormant.

(iii) Whether it appears on the opposite face of the member also.

(iv) Pattern of the cracks.

(v) Soil condition type of foundation used sign of movement of ground if any.

(vi) Observation on the similar structures in the same locality.

(vii) Study of specification methods of construction used and the test results at the site it any.

(viii) Views of the designer, builder , occupations of the building if any and

(ix) Whether during which the structure has been constructed. The immediate cause of deterioration may be a chemical action or corrosion of reinforcement. The incompatible dimensional changes caused by drying shrinkage and thermal movement daring and after the hardening period may also cause cracks in concrete member.

Repair of cracks :-

Once the cracked structure has been evaluated and the cause of cracking established a suitable repair procedure may be selected which takes there causes in to account.

(i) Pre-treatment of surface and reinforcement.

(ii) Application of repair material.

Cracking of concrete due to different reasons :-

There are many reasons of cracking of concrete like.

(i) Cracking due to chemical reaction:-

The important ingredients in concrete is cement it is a alkaline product. So it will react with acids acidic compounds present in moisture.

Due to this reaction the concrete, may crack as a result of expensive reactions between aggregate containing active silica and alkali derived from cement hydration, admixture external soirees.

* The alkali silica relation results in the formation of a swelling gels which tends to draw to draw water from other portions of concrete.

(ii) **Cracking due to weathering:-**

The various envirmrntal factors cause cracking in concrete like.

(a) Freckling and thawing.

(b) Wetting and drying.

(c) Heating and cooling.

* The damage from freezing and thawing is the most common weather related physical deterioration.

(iii) **Cracking due to corrosion of reinforcement :-**

It is the most frequent cause of damage to reinforced concrete structure.

* The corrosion of steel produces from oxides and hydroxides, which have a volume causes high radical bursting stresses around reinforcing bars and results in local radial cracks.

(iv) **Cracking due to poor constriction practices:-**

Poor construction practices such as adding water to concrete to improve workability lack of wiring, inadequate form support, inadequate compaction and arbitrary placement of construction joints, can result in cracking in concrete structure.

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