TVET CERTIFICATE III in MASONRY

CONCRETE TECHNOLOGY

MASCT301

Apply concrete technology

Competence

Credits:8

Learning hours:80

Sector: construction

Sub-sector: Masonry

Module Note Issue date: October, 2020

Purpose statement

This core module describes the skills, knowledge and attitude required by a learner to prepare work area and produce a concrete on the construction site. It also presents the procedures of concrete batching and mixing according to the standards.

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Learning Unit 1 – Prepare materials

LO 1.1 – Identify types of concrete

- ***Topic 1: Introduction and definition of concrete***

Concrete is a construction material which is composed of three materials, these being cement, water and aggregates. Sometimes, an admixture, this being an additional material, is added in order to change or modify certain properties of concrete.

The chemically active constituent of concrete is cement. The reactivity of cement is only guaranteed and achieved on mixing it with water. Aggregates do not have a role to play in the chemical reactions within concrete but they are very useful because they act as economic filler materials with good resistance to volume changes, which changes occur in concrete after mixing. Another important aspect of aggregates is that they improve the durability of concrete. Concrete is considered as a structure material which means that a mixture of 3 materials such as cement aggregates (fine + coarse), water and admixture if needed.

Alternatively, the definition of concrete in concrete technology: it is a mixture of 2 materials such as cement paste, aggregates (fine + coarse) and admixture if needed.
In a properly proportioned and compacted concrete, the proportions of the different constituents are given below:

- Cement paste (Cement + Water): 20 - 40 percent
- Aggregates (Course + Fine): 60 – 80 percent
- Voids: 1 – 2 percent

ADVANTAGES OF CONCRETE

Concrete is having the following advantages as well as disadvantages:

- ❖ Concrete has high compressive strength
- ❖ It is free from corrosion and there is no appreciable effect of atmospheric agent on it.
- ❖ It hardens with age and the process of hardening contains for long time after the concrete has attained strength.
- ❖ It is provided to be more economical than steel.
- ❖ It binds rapidly with steel but it is weak in tension. (weak in tension is a disadvantage)
- ❖ Under some condition, it has a tendency to shrink (tendency to shrink is a disadvantage)

- Concrete tends to be porous. (disadvantage)
- It forms hard surface, capable of resisting to abrasion.
- Concrete can be taken to a site in form of raw materials.

- <u>Topic 2: Identification of Types of concrete</u>

A) PLAIN CONCRETE

Plain concrete, commonly known as mass concrete, is intimate mixture of binding (cement or lime or polymer), fine aggregate, coarse aggregate and water.

This can be easily molded to desired shape and size before it loses plasticity and hardens. Plain concrete is strong in compression but very weak in tension.

B) REINFORCED CEMENT CONCRETE

Actually, concrete is good in resisting compression forces but weak in resisting tension forces. Hence reinforcement is provided in the concrete wherever tension stress in expected. The best reinforcement is steel bars, since tensile strength of steel is quite high and the bond between steel bars of 6mm to 32mm of diameter and concrete is good.

As the elastic modulus of steel is high for the mass extension the force resisted by steel is high compared to concrete.

However, in tensile zone, hair cracks in concrete are unavailable. Reinforcements are usually in the form of mild steel or ribbed steel bars of 6mm to 32mm diameter.

A cage of reinforcements is prepared as per the design requirement, kept in a formwork and then green or wet concrete is poured. After the concrete hardens, the formwork is removed the composite material of steel and concrete is called R.C.C acts as structural member and can resist tensile as well as compression stresses very well.

B.1.PROPERTIES OF R.C.C/ REQUIREMENT OF R.C.C

- It should be capable of resisting expected tensile, compressive, bending and shear forces
- It should not show excessive deflection and spoil service ability requirement.
- These should be proper cover to the reinforcement, so that the corrosion is prevented.
- The hair cracks developed should be within the permissible limit
- It is a good fire resistant material
- When it is fresh, it can be moulded to any desired shape and size

- Durability is very good
- R.C.C structure can be designed to take any load

B.2.Uses of RCC

It is a widely used building material; some of its important uses are listed below:

1. R.C.C is used as a structural element, the common structural element in a building where R.C.C is used are:
    - Footing
    - Column
    - Roofs and slabs
    - Stairs
2. R.C.C is used for the construction of storage structure like:
    - Water tanks
    - Dams
    - Beams
    - Silos and bunkers
3. It is used for the construction of big structures like
    - Bridges
    - Retaining walls
    - Under water structures
4. It used for pre-casting work
    - Rail way sleepers
    - Electric poles
5. It used in constructing tall structures like:
    - Multi stored building
    - Towers
    - Chimneys
6. It is used for paving
    - Roads
    - Airports

C) PRE-STRESSED CONCRETE (P.S.C)

Strength of concrete in tension is very low and hence it is ignored in R.C.C. design. Concrete in tension is acting as a cover to steel and helping to keep steel at desired distance thus in R.C.C lot of concrete is not properly utilized.

Pre-stressing the concrete is one of the method of utilizing entire concrete the principle of pre-stressed concrete is too introduce calculated compressive stresses in the zones wherever tensile stresses are expected in the concrete structural elements.

P.S.C is commonly used in the construction of bridges, large, column, slabs and roofs and in electric pile.

The material used in PSC is high tensile steel and high strength steel.

5. **Fiber-reinforced concrete (frc)**. Plain concrete possesses deficiencies like low tensile strength, limited ductility and low resistance to cracking. The cracks develop even before loading. After loading micro cracks widen and propagate, exposing concrete to atmospheric actions. If closely spaced and uniformly dispersed fibers are provided while mixing concrete, cracks are arrested and static and dynamic properties are improved.

Fibre reinforced concrete can be defined as a composite material of concrete or mortar with discontinuous and uniformly distributed fibres. Commonly used fibres are of steel, nylon, asbestos, glass, carbon and polypropylene. The length to lateral dimension of fibres range from 30 to 150. The diameter of fibres vary from 0.25 to 0.75 mm. Fibre reinforced concrete is having better tensile strength, ductility and resistance to cracking.

Uses of FRC

1. For wearing coat of air fields, roads and refractory linings.
2. For manufacturing precast products like pipes, stairs, wall panels, manhole covers and boats.
3. Glass fibre reinforced concrete is used for manufacturing doors and window frames, park benches, bus shelters etc.
4. Asbestos FRC sheets are commonly used as roofing materials.

1. **Cellular concrete**

It is a light weight concrete produced by introducing large voids in the concrete or mortar. Its density varies from 3 kN/m^3 to 8 kN/m^3 whereas plain concrete density is 24 kN/m^3. It is also known as aerated, foamed or gas concrete.

Properties of cellular concrete:

It has the following properties:

1. It has low weight.
2. It has good fire resistance.
3. It has good thermal insulation property.
4. Thermal expansion is negligible.
5. Freezing and thawing problems are absent.
6. Sound absorption is good.
7. It has fewer tendencies to spall.

Uses of Cellular Concrete

1. It is used for the construction of partition walls.
2. It is used for partitions for heat insulation purposes.
3. It is used for the construction of hollow filled floors.

LO 1.2 – Select ingredients

- Topic 1: Appropriate selection of Materials for concrete

Depending upon the **proportion of ingredient,** strength of concrete varies.

It is possible to determine the proportion of the ingredients for a particular strength by mix design procedure. In the absence of mix design, the ingredients are proportioned as 1:1:2, 1:1:1 is the ratio of weights of cement to sand to coarse aggregate.

In proportioning of concrete it is kept in mind that voids in coarse aggregates are filled with sand and the voids in sand are filled with cement paste. Proportion of ingredients usually adopted for various works are shown in Table 1.1.

Table 1.1. Proportion of cement, sand and coarse aggregates in concrete

S. No.	*Proportion*	*Nature of Work*
1	1:1:2	For machine foundation, footings for steel columns and concreting under water.
2	1:1(½) :3	Water tanks, shells and folded plates, for other water retaining structures.

3	1:2:4	Commonly used for reinforced concrete works like beams, slabs, tunnel lining, bridges
4	1:3:6	Piers, abutments, concrete walls, sill of windows, floors.
5	1:4:8	Mass concretes like dam, foundation course for walls, for making concrete blocks.

1. CEMENT

Cement is a widely used constructional material. Cement is described as a material that has adhesive and cohesive properties that makes it capable of bonding fragments into a compact mass. Many types of cement are currently available in the market. Each type of cement is used under certain conditions due to its special properties.

The cement powder when mixed with water forms a paste. This paste acts like glue and hold or bonds the aggregate together.

There are six major types of cement

- ✓ Type GP (general purpose Portland cement)
- ✓ Type GB (General purpose blended cement)
- ✓ Type HE (High early strength cement)
- ✓ Type LH (Low Heat cement)
- ✓ Type SR (Sulfate Resisting Cement)
- ✓ Type SL (Shrinkage Limited cement)

Each types of cement will produce concrete with different properties. The most common types of cement used are **type GP** and **type GB**

Blended cements contain Portland cement and more than 5% of fly ash, ground slag silica fume, or a combination of these.

II.1.1 STORAGE

Cement should be stored off the ground in a well-aired, clean and dry place. Wrapping the cement bags in plastic sheets gives extra protection; bulk cement will normally be stored in silos.

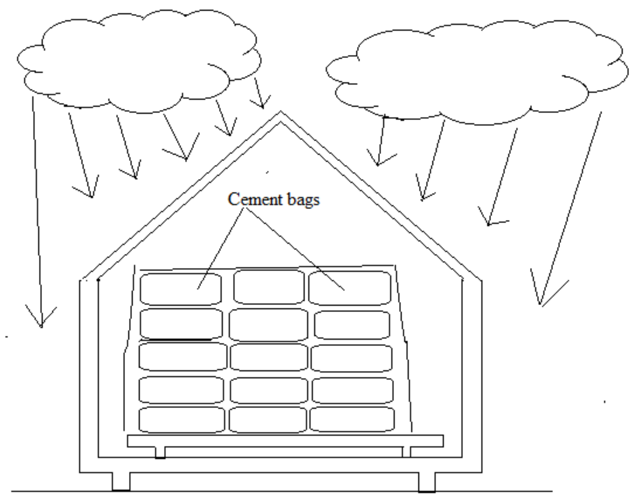


Fig: cement storage

Testing of cement:

- Field test method
- Laboratory test method

Field test

It is important that you carry out field tests of your cement sample before use on your sites to know if the cement is good or bad. You can carry out these field tests as follows:

- When you put your hand into a bag of cement, you will receive a cool feeling.
- When you open a bag of cement, take a careful look at the cement powder. The cement powder should not have any visible lumps.
- The color of Ordinary Portland Cement powder is greenish-grey.
- When you take a pinch of cement powder and feel it between your fingers, the cement should give a smooth feeling.
- When you take a sample of cement powder and throw it inside a bucket full of water, the cement particles should first float for some time before they sink into the bucket.

The above tests should satisfy the engineer to agree that the cement sample is good.

Laboratory tests

A cement sample is tested in the laboratories to ascertain its quality according to the British standard 12 for the following:

- Fineness
- Chemical composition
- Strength
- Setting time
- Soundness

Chemical composition of cement

The raw materials used for the manufacture of cement consist mainly of lime, silica, alumina and iron oxide. Those oxides interact with one another in the kiln at high temperature to form more complex compound. The relative proportions of these oxide compositions are responsible for influencing various properties of cement in addition to rate of cooling and fineness of grinding.

Approximate oxide composition limits of OPC

Oxide	Per cent, content
Cao	60-67
Sio_2	17-25
AL_2O_3	3.0-8.0
Fe_2O_3	0.5-6.0
Mg O	0.1-4.0
Alkalis (K_2O,Na_2O)	0.1-1.3
SO_3	1.3-3.0

PROPERTIES OF CEMENT

❖ **Strength**

The compressive strength of hardened cement is the most important of all properties. Therefore, it is not surprising that the cement is always tested for its strength at the laboratory before the cement is used in important works. Strength tests are not made on neat cement paste because of difficulties of excessive shrinkage and subsequent cracking.

❖ **Setting time**

The setting time of cement when tested shall be as follows:

Initial setting time: not less than 45 minutes

Final setting time: not more than 10 hours

Definitions:

Setting times of cement: It is a term used to describe the stiffening of the cement paste.

Setting of cement: It refers to a change from a fluid state to a rigid state. Although during setting, the cement paste acquires some strength. For practical purpose, it is important to distinguish setting from hardening which refers to the gain of strength of a cement paste.

Initial setting time of cement paste: Is regarded as the time elapsed between the moments that the water is added to the cement, to the time that the paste starts losing its plasticity.

Final setting time of cement paste: It is defined as the time interval between the moment the ware is added to the cement, and to the time when the cement has completely lost its plasticity and has gained sufficient firmness to resist certain definite pressure.

False set of a cement paste: It is the abnormal premature stiffening of the cement within a few minutes of mixing with water. There is no noticeable heat evolved in this process.

- **Soundness**

The cement when tested for soundness shall not have an expansion of more than 10mm. It is important that cement after setting does not undergo any noticeable change in volume. An excessive change in volume expansion of a cement paste after setting shows that the cement paste is unsound. It means that it is not suitable for the production of concrete.

In general, the effects of using unsound cement may not be seen for some considerable period of time, but usually show themselves in cracking and disintegration of the concrete surface. The unsoundness in cement is due to the presence of excess of lime than that could be combined with acidic oxide at the kiln or due to the inadequate burning. The chief test of soundness is the Le Chatelier and Autoclave tests. The expansion carried out should not be more than 10mm in the Le Chatelier test and 0.8 per cent in Autoclave test.

The unsoundness may be reduced by:

- limiting the MgO(Magnesiumoxide) content to less than 0.5 per cent

- fine grading
- allowing the cement to aerate for several days , and
- through mixing

2. AGGREGATES

Aggregates are the important constituents in concrete. They give body to the concrete, reduce the shrinkage and affect the economy. The more fact that the aggregates occupy70-80 per cent of the volume of concrete, their impact on various characteristics and properties is undoubtedly considerable. To know about the concrete it is very essential that one should know about aggregates which constitute major volume in concrete.

Its selection and proportioning should be given careful attention in order to control the quality of the concrete structure.

TYPES OF AGGREGATES:

- **Natural aggregate:** they are extracted from the soil but without undergoing any modification in their internal structures.
- **Artificial aggregate:** they also come from the soil but result is a mix of physical or chemical modification operated on them. This process of obtaining artificial aggregate can be done by crushing them into the small sizes needed on the site. classification of aggregate according to

SIZE	**SHAPE**	**TEXTURE**	**UNIT WEIGHT**
Coarse	Rounded	Smooth	Normal
Medium	Irregular	Rough	Heavy
Fine	Angular	Granular	Light
	Elongated	Crystalline	

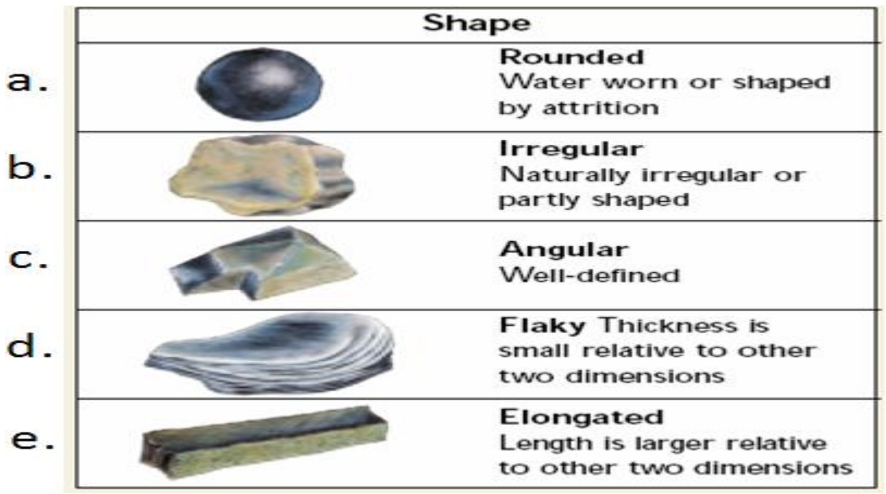


Figure: types of aggregates according to shape

Remark: Rounded aggregates give a more workable mix. Angular aggregates make concrete harder to place, work and compact but can make a strong concrete

PROPERTIES AND CHARACTERISTICS OF AGGREGATES

Aggregate should be:

- ✓ **Strong and hard:** a strong, harder aggregate will give a strong final concrete. Never use a crumble or flakey rock like sandstone.
- ✓ **Durable:** to resist wear, tear and weathering.
- ✓ **Chemically inactive:** the aggregate don't react with the cement
- ✓ **Clean:** dirt or clay sticking to the aggregates will weaken the bond between paste and aggregates.
- ✓ **Well graded:** aggregates should range in size so that they fit together well. This gives a strong and denser concrete.
- ✓ **Tough:** not easily broken or crushed

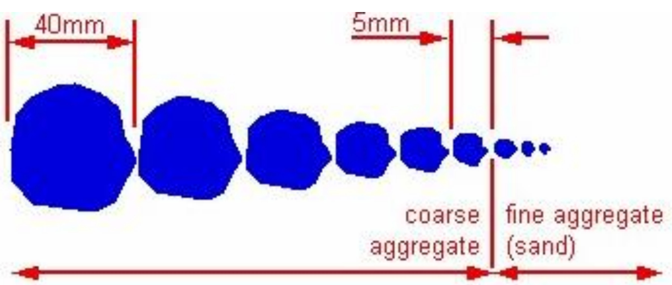


Fig: well graded aggregate.

Storage

Aggregate should be stored where they will stay clean, separated from other materials and dry. If aggregates are very wet use less water in the mix.

3. WATER

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and the quality of water is required to be looked into very carefully. A popular rule of water for mixing concrete is that, if water is fit for drinking is fit for making concrete. This does not appear to be a true statement for all conditions. Some waters containing a small amount of sugar would be suitable for drinking but not for mixing concrete and conversely water suitable for making concrete may not necessarily be fit for drinking. Some specifications require that if the water is not obtained from a source that has proved satisfactory, the strength of concrete or mortar made with questionable water should be compared with similar concrete or mortar made with pure water. To best way to see if a particular source of water is suitable for mixing concrete or not, is to make concrete with this water and compare its 7 days and 28 days strength with companion cubes made with distilled water. If the compressive strength is up to 90 percent, the source of water may be accepted. Don't use sea water as it may rust the steel reinforcement in the concrete.

4. Admixtures

Classification of admixtures

Chemical composition of admixtures has a very wide range. Depending upon the functions and composition, admixtures are mainly divided in to two main types. These are;

1. Mineral admixtures (finely ground solid material)
2. Chemical admixtures (water soluble compounds)

Mineral admixtures and chemical admixtures are the extra ingredients other than water, cement, aggregates and fibers. These are added to the concrete batch plant during batch mixing or at the start when other quantities are added. Admixtures offer very favorable effects to the properties of fresh or hardened concrete only if proper use of admixtures is made possible.

Admixtures enhanced the workability of fresh concrete with lesser amount of water than the required one. In this case concrete will have more strength, because water aids in workability but in the same manner it has a negative effect on the strength of concrete. Therefore, finish-ability of concrete also becomes noticeable.

Mineral Admixtures

Mineral admixtures are the fine ground solid materials I.e. Fly ash, slag and silica fume. It is added to the concrete generally in larger amount than any other type. Because mineral admixtures have an ability to enhance workability as well as finish-ability of freshly laid concrete.

Mineral admixtures are the waste products of industries. Hence by using in concrete, maximum sustainability can be achieved. It also supports in reducing thermal cracking in concrete by reducing heat of hydration. At the end we can say that this type of admixtures enhances the durability and serviceability of concrete.

Chemical Admixtures

Chemical admixtures are the admixtures that are added to concrete in a very small amount for a specific function to concrete. If chemical admixtures are added more than the defined than it has a very wide range of negative effects on the properties of fresh as well as hardened concrete. Chemical admixtures are more likely to be added as a water reducing admixtures, as a retarding setting time, accelerating setting time, as a super plasticizer or added as an air-entrainment.

2.2.2. Types of admixtures

Admixture is defined as a material other than water, aggregates and hydraulic cement and other additives used as on ingredient of concrete or mortar and added to the batch immediately before or during its mixing to modify one or more of the properties of concrete in the plastic or hardened state.

Reasons for Using Admixtures

Admixtures are used to modify the properties of concrete or mortar to make them more suitable for the work at hand or for economy or for such other purposes as saving energy. Some of the important purposes for which admixtures are used are

To modify properties of fresh concrete, mortar and grout so as to:

Increase workability without increasing water content or decrease water content at the same workability.

Retard or accelerate time of initial setting.

Reduce or prevent settlement.

Modify the rate or capacity for bleedings.

Reduce segregation.

Improve pumpability.

Reduce the rate of slump loss.

To modify the properties of hardened concrete, mortar and grout so as to:

Retard or reduce heat evaluation during early hardening.

Accelerate the rate of strength development at early ages.

Increase strength (compressive, tensile or flexural).

Increase durability or resistance to severe condition of exposure.

Decrease permeability of concrete.

Increase bond of concrete to steel reinforcement.

Increase bond between existing and new concrete.

Inhibit corrosion of embedded metal.

Produce colored concrete or mortar

When to Use Concrete Admixtures

When properties cannot be made by varying the composition of basic material.

To produce desired effects more economically.

Unlikely to make a poor concrete better.

Not a substitute for good concrete practice.

How to Use Concrete Admixtures

Check job specification

Use the correct admixture

Never use one from an unmarked container.

Keep containers closed to avoid accidental contamination.

Add the correct dosage.

Avoid adding ‘a little bit extra

Best if added to the mixing water

Manufacturer’s recommended dosage is usually adequate

Types of Admixtures

a) Accelerating admixtures

b) Retarding admixtures

c) Water-reducing admixtures

d) Air-entraining admixtures

e) Super plasticizing admixtures

Accelerating Admixtures.

Accelerating admixtures are used for quicker setting times of concrete. It provides higher early strength development in freshly cast concrete.

Main uses of Accelerating Concrete Admixtures

These admixtures are suitable for concreting in winter conditions

During any emergency repair work

In case of early removal of formwork

Disadvantages of Accelerating Concrete Admixtures

It has increased drying shrinkage

It offers reduced resistance to sulphate attack

high risk of corrosion of steel – not permitted in reinforced concrete

It is more expensive and less effective

Retarding Admixtures.

The function of retarding concrete admixture is to delay or extend the setting time of cement paste in concrete. These are helpful for concrete that has to be transported to long distance in transit mixers and helpful in placing the concrete at high temperatures, specially used as grouting admixture and water reducers results in increase of strength and durability.

Water Reducing Concrete Admixture

A certain amount of the water is added to concrete to make the concrete place able and to ignite the hydration reaction of Portland cement. Over 50% of the water have no useful effect and have direct results in drying shrinkage, durability, and the strength of concrete.

Water reducing admixture added to the concrete reduce the water demands of the mix, maintain the workability, increase the strength, reduce the cost, reduce bleeding, reduce segregation, reduce honeycombing, reduce cracking and permeability, increase bond strength of concrete to steel, and reduce drying shrinkage.

Super Plasticizers Admixtures

These are the second generation admixture and also called as Super plasticizers. These are synthetic chemical products made from organic sulphonates of type RSO3, where R is complex organic group of higher molecular weight produced under carefully controlled condition.

Air Entraining Admixture

Air entraining concrete admixture is used primarily to increase the resistance of freezing and thawing. They also supply greater resistance to deicing chemicals, improve workability, lower water demands for a particular slump, reduce the amount of fine aggregate needs in the mixture, reduce segregation and bleeding, increase durability.

- <u>Topic 2: Proper Grading of aggregates and Bulking of sand</u>

Grading of Aggregates:

Grading of aggregates consists of proportionating the fine and coarse aggregates in such a ratio, so as to get strongest and densest mix with the least amount of cement.

Grading the aggregates is so graded as to have minimum voids when mixed with all ingredients, and water should render a concrete mass of easy workability.

The grading of aggregates is done by the following methods

(i) **By trail** – In this method, proportionating of aggregates as to give heaviest weight for same volume, yield the densest concrete

(ii) **By finesse modules method** (sieve analysis method): in this method, the samples of both coarse and fine aggregates are passed through a set of nine standard sieve and the percentage of sample retained on each of the said sieves is determined. The total of these percentages divided by 100 gives the finesses modulus of sample

(iii) **By minimum voids method:** This method is based on the fact, that so obtain dense concrete the quantity of cement should also be slightly in excess of voids more that the fine aggregates. In this method the voids in the fine and coarse aggregates are separately found out with the help of graduated cylinder and water. The percentage of voids I aggregate, "X" given by the equation.

X = (V1 – V2) x 100

V2

Where v1, volume of water filled

Where v2, volume of aggregates.

(iv) **By arbitrary standards**: It is a commonly adopted method of propitiating the aggregates in a concrete mix

for small works of moderate importance. This method is not recommended for large works or important works in this method, the volume of cement, sand and coarse aggregates are taken in the proportion of 1: n:2n respectively. The quantity of water to be used a varied suit the workability descried.

Ex: 1:1:2 M250 rich mix for columns, beams

1:1:3 – M200 Water retaining structures etc.

1:3:6 – M150 slab's columns roads etc.

1:3:6 – M100 – foundations,

1:4:8 - For mass concrete.

- Topic 3: Discussion on water cement ratio principles and Concrete batching

Water Cement Ratio:

The compressive strength decreases, in general, with increasing water cement ratio and vice versa.

Hence, when minimum water is used just to ensure complete hydration of the cement, the resulting concrete will give maximum compressive strength on proper compaction.

Introduction to concrete ingredients batching

Concrete is made from raw materials such as cement, natural and manufactured aggregates, water and at times concrete additives (chemicals). It is worth noting that cement and aggregates are manufactured or obtained from natural solid stone, which is quarried, crushed, screened and processed to give the required physical and chemical properties.

In general, it is a process of combining all ingredients of concrete as per the mix design. Batching and mixing are extremely important parts of mortar and concrete manufactures they influence properties of concrete both in plastic as well as in hardened stages. Also, it is one of the important processes, which is to be done to obtain a quality concrete. Many processes are carried out in various parts of the world with many changes and different equipment

- **Batching of materials**

There are three modes of batching generally adopted for cement and aggregates. They are as follows:

1. **Random volumetric batching** with absolute no control on the size and shape of containers used resulting in large errors and variations. Cement is batched assuming each bag contains 50 kg.

2. **Proper volumetric batching** of all ingredients, using measured boxes (forms) and with control of filling them to brim and leveling. Sometimes cement is batched by volumetric measure or weighed.

3. **Proper weighing** is done of all ingredients either using a weigh batcher or utilizing the weighing system on the batching mixing plant.

1. Volumetric Batching

For volumetric batching, it is convenient to make steel or wooden boxes of various sizes/ volumes. It is generally preferred to have boxes of various sizes readily available at the site so that any adjustment, which is required to be made by way of change in mix design or due to bulkage of sand, can be done easily.

3. **Weigh batching**

Weigh batching is done in modern concrete batching and mixing plants, which have very sophisticated automatic microprocessor, controlled batching arrangements. Not only the aggregates are batched in correct proportion but also their moisture content is automatically determined and necessary corrective action taken so that mix has correct consistency as desired.

It is often observed that due to poor control at site head loads of different types of aggregates are put simultaneously resulting in chaotic batching. It is also necessary to control the loading of the aggregates so that exact weight of particular size of aggregates is added till the pointer shows the correct indication.

Learning Unit 2 – Produce concrete

LO 2.1 – Select tools and equipment

- Topic 1: Concreting tools and equipment

Introduction

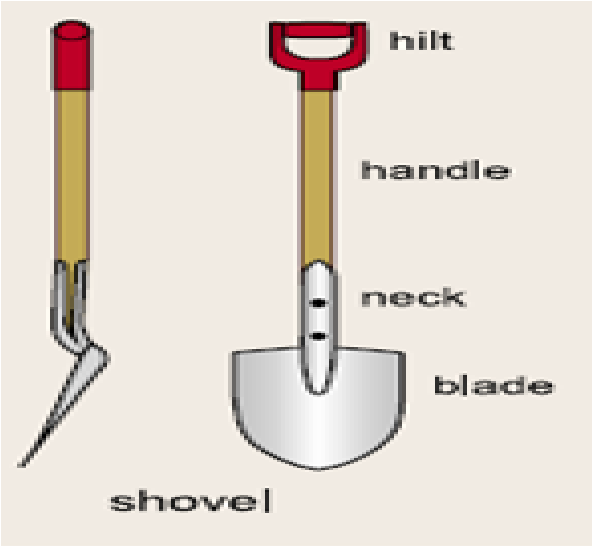
After the collection of concrete ingredients, the following steps are involved in the concreting:(i) Batching (ii)Mixing(iii)Transporting &placing and (iv)Compacting.

WORKS	TOOLS & EQUIPMENT WHICH
1. Batching	i. **A gauge box**: is made with wooden plates, its volume being equal to that of one bag of cement. ii. ***Weight Batching:*** A weighing platform is used in the field to pick up correct proportion of sand and coarse aggregates. Large weigh batching plants have automatic weighing equipment. **! sometime wheelbarrow and bucket are usually used in place of the gauge box**
2. Mixing	Mixer. Trowel, spade, etc.
3. Transporting and placing	Equipment ▪ Ready-mix truck ▪ Dump truck ▪ Concrete pump ▪ Crane and bucket ▪ Power buggy ▪ Wheel barrow ▪ Helicopter ▪ Conveyor belt ▪ Truck and chute
4. Compacting.	Vibrators
5. Leveling	• Straight-edge • Sprit level • Grinders • Etc.

Classification of tools and equipment for concrete works

1. **Mixing tools**

Mixing: To produce uniform and good concrete, it is necessary to mix cement, sand and Coarse aggregate, first in dry condition and then in wet condition after adding water. Usually when we say mixing tools we are focusing in Hand Mixing. Mixing of concrete is done in two ways such as:
Hand mixing: Is process of mixing concrete manual. The use of traditional material like **shovels, spades, hoes,** is provided to produce flesh concrete.



2. Machine Mixing: In large and important works machine mixing (**concrete mixer**) is preferred. This equipment is provided to speed up the work. Some of concrete mixer are as follow:

i. **Concrete mixer truck:** is used to transport and mix concrete until to the construction site. They can be filled with dry materials and water and mixing takes place during transportation.

ii. **Small concrete mixer:** are those concrete mixers which it rotated drum charge and discharge concrete during mixing. This concrete mixer is divided into:

- JZR 350 Diesel concrete mixer
- JZR 500 Diesel concrete mixer
- JZC 50 Mobile concrete mixer
- JZC 250 Concrete mixers with lift
- Horizontal concrete mixer

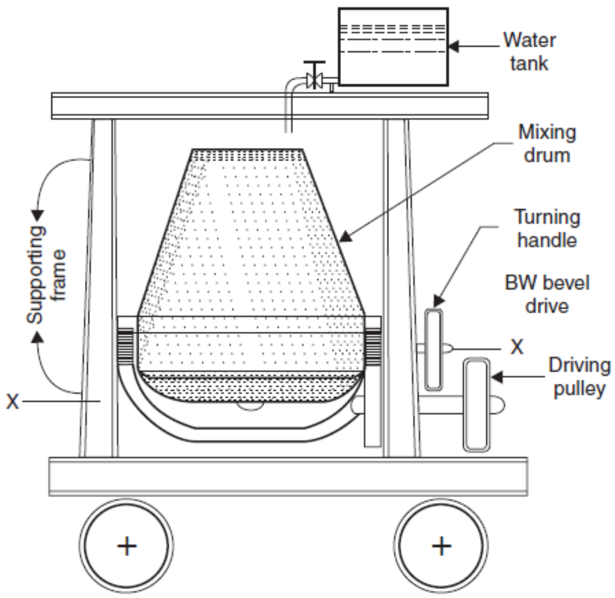
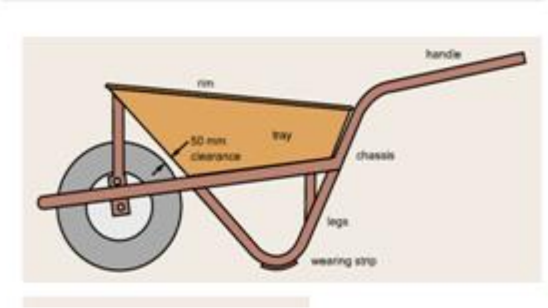


Fig. 3.2. Concrete mixer

3. Transporting and placing tools and equipment

Transporting and Placing of Concrete. After mixing concrete should be transported to the final position. In small works it is transported in **iron pans** from hand to hand of a set of workers. **Wheel barrow and hand carts** also may be employed. In large scale concreting **chutes** and **belt conveyors** or **pipes with pumps** are employed. In transporting care should be taken to see that segregation of aggregate from matrix of cement do not take place.



Wheelbarrow   head pan.

4. **Mix plant:** Mix plants are broadly divided into two main types of concrete plant which are dry mix plant and wet mix plant, and also plants that contain both a transit mix side and central mix side.

   Concrete plants: Is equipment that combines various ingredients to form concrete.

Tools and equipment used in concrete

1. Mixer
2. Wheelbarrow
3. Vibrators
4. Floats blades and toweling blades
5. Trowels
6. Edges
7. Brooms
8. Grinders
9. Etc ……

- <u>Topic 2: Safety tools and equipment</u>

Introduction to PPE used in concrete work

During many everyday tasks, including research, teaching, practical work, Students may be exposed to chemical, physical, biological or environmental hazards. The aim of the school is to ensure that where persons are exposed to hazards they are provided with, and trained in the use of, personal protective equipment (PPE) in accordance with the Personal Protective Equipment at Work Regulations. For the concrete work also the workers may face same problems which may cause them the injury.

However, PPE should only be used following an appropriate risk assessment and as a last means of controlling the hazard. Separate policies exist covering risk assessment and hazard control. This booklet provides guidance on the PPE regulations and information on the responsibilities of various individuals within the University.

Definition of PPE

PPE is defined as “all equipment (including clothing affording protection against the weather) which is intended to be worn or held by a person at work and which protects them against one or more risks to their health or safety”. PPE is equipment that will protect the users against health or safety risks at work.

This does not include ordinary working clothes such as uniforms which do not have a specific health or safety function, nor does it apply to equipment used whilst playing competitive sport. However, equipment required for the safety of a sports instructor does fall within the category of PPE, for example, a life jacket for a canoeing instructor.

GUIDANCE ON THE SELECTION OF SPECIFIC PPE **AND THEIR USE**

The following sections provide more detailed information on selection of specific PPE. Some relevant literature and websites for further information or purchase of materials are also listed Within these subsections.

1 Hand Protection

Gloves should be worn when handling:

- Hazardous materials;
- Toxic chemicals;
- Corrosive materials;
- Materials with sharp or rough edges; and
- Very hot or very cold materials.

N.B. It is recommended that latex gloves are not used where reasonably practicable as it is known that latex can cause allergic skin responses.

Selecting gloves for use with chemicals

Simply stating “gloves required” is **NOT ACCEPTABLE** as a risk assessment – the **type** of glove required **must** also be specified. When handling chemicals in the laboratory, disposable vinyl or nitrile examination gloves are generally sufficient to protect against accidental splashes or contact.

If there is going to be greater length of time in contact with or immersion in the substance, gloves should be carefully selected based upon their chemical compatibility, breakthrough and degradation times. Glove selection - the following properties should be taken into account when selecting the type of glove to be used:

Degradation – the change in one or more physical properties of the glove upon contact with the chemical. This is usually reported in a chemical compatibility chart as E (excellent), G (good), F (fair), P (poor), NR (not recommended) or NT (not tested).

Breakthrough time – the time between initial contact of the chemical on the surface of the glove and the analytical detection of the chemical on the inside of the glove. Given on a chemical compatibility chart in minutes.
Permeation rate – the rate at which the chemical passes through the glove once breakthrough has occurred and equilibrium is reached. This is usually reported as 0 (if there is no breakthrough), Slow, Medium or Fast.

Many companies selling gloves will also provide a glove chart of usage with a large number of Chemicals. These may be found in the catalogues. Some also offer a glove selection service. Before use, gloves should be examined for defects that may affect performance. During use, do not touch anything else (such as hair, door handles etc.) other than the materials needing to be handled as this causes contamination.

For information on the protective gloves to be used with specific chemicals you should seek guidance from the manufacturer.

Selecting gloves for other purposes

Gloves should be selected as a result of the hazard identification and risk assessment. The risk assessment must specify the type of glove required, for example:
• Rubber gloves for washing up e.g. Marigold gloves;
• Leather gloves if there is a danger of cutting or stabbing e.g. handling broken glass;
• Chain mail gloves for heavy duty pieces of cutting equipment e.g. boning out meat.

As in the case of selection of gloves for chemical usage, other considerations such as dexterity, size and allergy should be taken into account. Examine for defects prior to use and inform your supervisor if there are any problems. Gloves should be well maintained and stored in the appropriate place.

2 Respiratory Protective Equipment (RPE)
Respiratory protection may be required against
• Gases, vapors and fumes
• Dusts and aerosols
• Biological agents etc.
The need for RPE will be identified through carrying out a **COSHH risk assessment.**

PPE comes in 2 categories;
1. Filters of contaminants (respirators); and
2. Those which supply clean air from an independent source.

RPE must be selected carefully to ensure it gives adequate protection. The following aspects should be taken into account:
• The toxicity of the agent
• The size of the particle
• The amount of movement involved in the task and working conditions
• The individual, e.g. face shape, presence of beard, glasses etc. and
• The Workplace Exposure Limit (WEL) of the substance and contaminant levels.

3 Eyes and Face Protection
Face and eye protection must be worn when there is a danger of splashing, sparks, explosion, Ionizing radiation, etc. Protection comes in the form of:

Safety spectacles like normal spectacles but tougher lens material with side shields to prevent impact from flying debris. The lenses in these may be corrective if required.

Safety goggles these are completely sealed around the eye area. Also impact resistant and should be used if there is the possibility of splashes from chemicals. The lenses cannot be made corrective although normal spectacles may be worn under them.

Face shields these are used when working with high volumes of hazardous materials or in more dangerous situations to protect against splashes and flying debris. There are several British Standards for different eye protection and these standards (the BS EN numbers) will give guidance on the hazards different types of eye protection will protect against.

4 Hearing protection
Noise is measured in units called decibels (dB (A)). It should be noted that dB (A) is a logarithmic scale thus a change of approximately 3 dB(A) is the equal to a doubling of noise levels. University guidance on the measurement of noise and how to control noise levels is given in the University publication entitled 'Health and Safety - Codes and Guidance'.

Exposure to noise during various processes can result in temporary or permanent deafness if the appropriate precautions are not taken. Hearing is at risk during the following:
• Constant noise above 80db for an 8 hours work period;
• Impact noise ; and
• Explosive noise.
Ear protection comes in the form of:
Ear plugs - which fit inside the ear canal, may not be suitable for people with a history of ear problems.
Canal caps - soft rubber caps attached to a headband which presses them into the openings of the ear canal.
Ear muffs – Hard plastic cups with sound absorbent filling which fit over the ears and are sealed to the head by cushions. They are pressed to the head by means of a head band or some special fittings attached to some types of safety helmet.

5 Head Protection

Head protection of the appropriate type should be used at any time where there is a significant risk of head injury. Head protection includes:

• Industrial safety helmets;

• Scalp protectors (bump caps); and

• Caps, hairnets etc. (excluded in the following guidance)

Head protection should:

• Be of an appropriate shell size for the wearer; and

• Have an easily adjustable headband, nape and chin strap.

Industrial safety helmets **must not** be subjected to chemicals or an environment which could reduce strength (such as excessively hot, humid or in direct sunlight). Helmets **must** be replaced when the helmet has received a severe impact including being dropped (even if no damage is visible), or when cracks or deep scratches appear or when the 'Use by' date is exceeded.

7 Body protection

Protective clothing should be worn to protect against:

• Hazardous substances;

• Machinery parts; and

• Extreme conditions.

Where the user is only exposed to minor splashes and spills, standard lab coats, over coats or aprons are sufficient. Where the danger is greater, the appropriate protection material must be selected.

Function of PPE

- It reduces employment exposed to the hazards.
- It avoids accident on the workplace.
- It provides the security to the users.
- It contributes to the production in the working areas.
- Etc

Types of PPE for concrete works:

 Helmet
 Gloves
 Goggles
 Dust mask
 Overall
 Safety shoes

Helmet: it protects a head and reduce accident for heard when some things shoot on it.

Gloves: Protect hand when working on hazardous materials or when it can cause the injury to hand. Ex. Cement, steel bars, etc….

Goggles: Face and eye protection must be worn when there is a danger of splashing, sparks, explosion, Ionizing radiation. It protects eyes in order to work safely.

Dust mask: this is designed to protect the respiratory diseases.

Overall: it protects the user against hazard substance and other chemical attack.

Safety shoes: it helps to protect feet in dangerous area.

LO 2.2 – Prepare works area

- Topic 1: Proper Cleaning out of mixing area

Cleaning out mixing area: Remove all sorts of wastes (organic, minerals)
For achieving the good concrete, we must clean the mixing area for avoiding the defect in concrete
And to get the uniform concrete color
The effect
Some defects are obvious only to a trained eye, others, such as cracking, are obvious to anyone. Some common defects, their causes and how to prevent and repair them are explained below.

❖ COLOUR VARIATION

Variations in colour across the surface of concrete may appear as patches of light and dark.

Causes

- Uneven or variable compaction and curing conditions
- Addition of excess water
- Segregation of materials (in coloured concrete)
- Variable colour dosage.

Prevention

Use uniform concrete mix and use consistent placing, compacting, finishing and curing procedures. Do not use driers.

Repair

Many colour variations from workmanship will be permanent. To hide the variation a SURFACE COATING can be applied.

Rectification of colour variation from stains is a very difficult operation and may need repeated gentle treatments with a weak acid.

❖ CRAZING:

A network of fine cracks across the surface of concrete.

Causes:

Crazing is caused by minor surface shrinkage in rapid drying conditions (i.e low humidity and high temperatures, or alternate wetting and drying).

Prevention:

Use an evaporative retarder and initiate curing immediately after finishing the concrete.

Repair

Repair may not be necessary because crazing will not weaken concrete. If the appearance is unacceptable, a surface coating of paint or other overlay sealer can be applied to hide the cracks.

❖ DUSTING

A fine powder on the concrete surface which comes off on your fingers

Causes

- Finishing before the bleed water has dried.
- Finishing during the rain.
- Not curing properly or the surface is drying too quickly.
- Concrete of too low a grade for the end use (e.g. subject to severe abrasion).

Prevention

Let any bleed water dry up before troweling or, in cold conditions, remove the water. Cure correctly.

Protect concrete from drying out too quickly in hot or windy conditions.

For harsh conditions use a stronger concrete.

Do not add excess water before placing.

Repair

Where surface dusting is minimal, the application of a surface hardener can be beneficial. If the surface is showing significant wear, it is essential to remove all loose material by grinding or scraping the surface to a sound base and then applying a suitable topping, if required.

❖ RAIN DAMAGE

The surface has bits washed away or many small dents.

Causes

- Heavy rain while concrete is setting or rainwater being allowed to run across the concrete surface.

Prevention:

Don't place concrete if rain looks likely. If concrete has already been placed and rain looks likely, cover it and prevent water from running across it.

Repair

If the concrete has not hardened and damage is minimal the surface can be refloated and re-trowelled taking care not to work excess water into the surface.

If the concrete has hardened it may be possible to grind or scrape off the damaged surface layer and, if required, apply a topping layer of new concrete or a repair compound. This may not always be possible and should be done only on expert advice.

❖ SPALLING

When the slab edges and joints chip or break leaving an elongated cavity.

Causes

- Edges of joints break because of heavy loads or impact with hard objects.
- As concrete expands and contracts the weak edges may crack and break.
- Entry of hard objects, such as stones, into joints may cause spalling when the concrete expands.
- Poor compaction of concrete at joints.

Prevention

Design the joints carefully.

Keep heavy loads away from the joints and edges until the concrete has hardened.

Ensure proper compaction.

Keep joints free from rubbish.

Repair

For small spalled areas: scrape, chip or grind away the weak areas until you reach sound concrete, making sure you brush any loose material off the slab. Then refill the area with new concrete or repair mortar (after applying a bonding agent to the old concrete if necessary). Compact, finish and cure the new patch carefully. Care should be taken that all joints are maintained and not filled.

For large spalled areas: seek expert advice

❖ EFFLORESCENCE

A white crystalline deposit sometimes found on the surface of concrete.

Causes

- Water with dissolved mineral salts collect on the concrete surface, as water evaporates salt deposits are left on the surface.
- Excess bleeding may also result in efflorescence.

Prevention

Use clean, salt-free water and washed sands. Avoid excessive bleeding.

Repair

Remove efflorescence by dry brushing and washing with clean water. Do not use a wire brush. If this fails to remove the deposit, wash with a dilute solution of hydrochloric acid.

❖ HONEYCOMBING

Coarse, stony surface with air voids.

Causes

- Poor compaction, segregation during placing or paste leakage from forms.
- A poor concrete mix with not enough fine aggregate causing a stony mix.
- Workability too low.

Prevention

Use a better mix design. Take care during placing concrete to avoid segregation. Compact concrete properly. Good watertight formwork.

Repair

If honeycombing occurs only in a thin surface layer it can be rendered (ie applying a layer of mortar). If honeycombing occurs to a greater depth, the concrete may need to be removed and replaced.

❖ BLISTERING

Blisters are hollow, low-profile bumps on the concrete surface filled with either air or bleed water.

Causes

They are caused when the fresh concrete surface is sealed by premature trowelling, trapping air or bleed water under the surface layer.

This is more likely to occur in thick slabs or on hot, windy days when the surface is prone to drying out.

Prevention

After placing, screeding and floating leave the concrete as long as possible before trowelling, If blisters are forming, delay trowelling as long as possible and take steps to reduce evaporation by using an evaporative retarder.

LO 2.3 – Mix concrete

- Topic 1: Appropriate Hand mixing and Machine mixing of concrete

The mixing of materials is essential for the production of uniform concrete. The mixing should ensure that the mass becomes homogeneous, uniform in color and consistency. There are two methods adopted for mixing concrete: Hand mixing and Machine mixing.

Hand mixing: It is practiced for small scale unimportant concrete works. As the mixing cannot be thorough and efficient, it is desirable to add 10 per cent more cement to cater for the inferior concrete produced by this method.

Hand mixing should be done over an impervious concrete or brick floor of sufficiently large size to take one bag of cement. Spread the measured quantity of coarse and fine aggregates in alternate layers. Pour the cement on the top of it, and mix them dry by a shovel, turning over and over again until uniformity of color is achieved then add water. This operation is continued till such time a good uniform; homogeneous concrete is obtained. Water in small quantity should be added towards the end of the mixing to get the just required consistency. At that stage, even a small quantity of water makes difference.

Procedure for proper hand mixing:

- ✓ Spread the measured quantity of sand in a layer of about 10 cm on the mixing platform.
- ✓ Place the cement on top of the sand and mix the two thoroughly together until the form an even color.
- ✓ Pile the mixture into a heap and make a hollow in the middle.
- ✓ Pour in water slowly in small quantities and mix until a smooth paste is formed.
- ✓ Add now the correct amount of aggregate and mix until every aggregate is properly coated.

Machine Mixing: Mixing of concrete is almost invariably carried out by machine, for reinforced concrete work and for medium or large scale mass concrete works. Machine is not only efficient, but also economical, when the quantity of concrete to be produced is large. Many types of mixers are available for mixing concrete. They can be classified as batch-mixers and continuous mixers. Batch mixers produce concrete, batch by batch with time interval, whereas continuous mixers produce concrete continuously without stoppage till such time the plant is working. In this case, materials are continuously fed, continuously mixed and continuously discharged. This type of mixers is used in large works such as dams. In normal works, it is the batch mixers that are used.

Procedure for machine mixing:

- ✓ Measure the quantities of each ingredient
- ✓ First add the aggregates and some amount of water, then the cement, then the sand
- ✓ Mix and add more water until the right consistency is reached
- ✓ Empty the mixer completely when discharging each batch.
- ✓ Clean the concrete mixer thoroughly on completion.

The machine mixing may be done as detailed below:

- First of all, the concrete mixer should be wetted inside of the drum.
- After that Cement, sand and coarse aggregate shall be placed in the portable concrete mixer in required proportion.
- The dry materials shall be mixed in the mixing machine. After this, correct quantity of water shall be added gradually while the machine is in motion.
- You must mix concrete for minimum two minutes after all materials are in the drum.
- If there is after unloading from the mixer, the concrete shall be remixed.

Mixing Time: Concrete mixers are generally designed to run at a speed of 15 to 20 revolutions per minutes. For proper mixing it is seen that about 25 to 30 revolutions are required in a well-designed mixer. If concrete is mixed for relatively long time, it is uneconomical from the point of view of rate of production of concrete and fuel consumption. Therefore, it is of importance to mix the concrete for such duration which will accrue optimum benefits. It is seen from the experiments that the quality of concrete in terms of compressive strength will increase with the increase in the time of mixing, but for mixing time beyond two minutes, the improvement in compressive strength is not very significant.

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