CEMENT CONCRETE

By
P SWATHI
Assistant Professor
Department of Civil Engineering

Contents

- Introduction
- Properties of cement Concrete
- Materials used in R.C.C. Work
- Characteristics of concrete
- Production of cement concrete

Introduction

- The cement concrete is a mixture of cement, sand, pebbles or crushed rock and water, which, when placed in the skeleton of forms and allowed to cure, becomes hard like a stone.
- The cement concrete has attained the status of a major building material in all branches of modern construction because of the following reasons :

(i) It can be readily moulded into durable structural items of various sizes and shapes at practically no considerable labour expenditure.

(ii) It is possible to control the properties of cement concrete within a wide range by using appropriate ingredients and by applying special processing techniques – mechanical. Chemical and physical.

(iii) It is possible to mechanise completely its preparation and placing processes.

(iv) It possesses adequate plasticity for the mechanical working.

Properties of Cement Concrete

- It has a high compressive strength.
- It is free from corrosion and there is no appreciable effect of atmosphere agents on it.
- It hardens with age and the process of hardening continues for a long time after the concrete has attained sufficient strength. It is this property of cement concrete which gives it a distinct place among the building materials.
- It is proved to be more economical than steel. This is due to the fact that sand and pebbles or crushed rock, forming the bulk of cement concrete, to the extent of about 80 to 90%, are usually available at moderate cost. The formwork, which is of steel or timber, can be used over and over again or for other purposes after it is removed.
- It binds rapidly with steel and as it is weak in tension, the steel reinforcement is placed in cement concrete at suitable places to take up the tensile stresses. This is termed as the Reinforced Cement Concrete or simply R.C.C.

- Under the following two conditions, it has a tendency to shrink ;

(a) There is initial shrinkage of cement concrete which is mainly due to the loss of water through forms, absorption by surfaces of forms, etc.,

(b) The shrinkage of cement concrete occurs as it hardens. This tendency of cement concrete can be minimized by proper curing of concrete.

- It has a tendency to be porous. This is due to the presence of voids which are formed during and after its placing. The two precautions necessary to avoid this tendency are as follows :

(a) There should be proper grading and consolidating of the aggregates.

(b) The minimum water – cement ratio should be adopted.

- It forms a hard surface, capable of resisting abrasion.
- It should be remembered that apart from other materials, the concrete comes to the site in the form of raw materials only. Its final strength and quality depend entirely on local conditions and persons handling it. However the materials of which concrete is composed may be subjected to rigid specifications.

Materials Used In R.C.C. Work

(1) **Cement :** Before the introduction of ordinary Portland cement, the lime was used as a cementing material. Most of the cement concrete work in building construction is done with ordinary portland cement a t present. Cement are used under certain circumstances. The cement should comply with all the standard requirements.

(2) **Aggregates :** These are the inert or chemically inactive materials which form the bulk of cement concrete. These aggregates are bound together by means of cement. The aggregates are classified into two categories; *fine and coarse*

- ✓ The material which is passed through BIS test sieve no. 480(4.75mm) is termed as a fine aggregate. Usually, the natural river sand is used as a fine aggregate. But at places, where natural sand is not available economically, the finely crushed stone may be used as a fine aggregate.
- ✓ The material which is retained on BIS test no. 480 is termed as a coarse aggregate. The broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate.
- ✓ The aggregates to be used for cement concrete work should be hard, durable and clean. The aggregates should be completely free from lumps of clay, organic and vegetable matter, fine dust, etc., The presence of all such debris prevents adhesion of aggregates and hence reduces the strength of concrete.

(3) Steel : The steel reinforcement is generally in the form of round bars of mild steel. The diameter of bars vary from 5 mm to 40 mm. Sometimes the square bars or twisted bars are used as steel reinforcement. For road slabs and such other constructions, the reinforcement may also consist of sheets of rolled steel of suitable thickness.

(4) Water : This is the least expansive but most important ingredient of concrete. The water, which is used for making concrete, should be clean and free from harmful impurities such as oil, alkali, acid, etc. In general, the water which is fit for drinking should be used for making concrete.

- It may be noted that sometimes the ingredients other than above are added in concrete to give it certain improved qualities or for changing different physical properties in its fresh and hardened stages. These ingredients or substances are known as the admixtures. The addition of an admixture may improve the concrete with respect to its strength, hardness, workability, water – resisting power, etc.,

Characteristics of Concrete

1. Proportioning Concrete

- The process of selection of relative proportions of cement, sand, coarse aggregate and water, so as to obtain a concrete of desired quality is known as the proportioning concrete.
- The theory of formation of concrete is based on this phenomena of formation of voids.
- When coarse aggregate is placed, such voids are formed. When fine aggregate i.e., sand is added, it occupies these voids.
- Further, when finely powdered cement is added, it occupies the voids of sand particles.
- Finally, when water is added, it occupies very fine voids between the cement particles. During the process of setting, a chemical reaction takes place between water and cement.
- This results in an absolutely solid substance, known as the concrete.
- There are various methods for determining the volumetric proportions of various components of concrete.

- In arbitrary method of volumetric proportions, the proportions of cement, sand and coarse aggregate are fixed arbitrarily.
- Usually, the fine coarse ratio is 1:2.
- Thus the general expression for the proportions of cement, sand and coarse aggregates is **1:n:2n** by volume.
- The concrete as per BIS:456:1978 is designated in 7 grades, namely M10, M15, M20, M25, M30, M35 and M40. The letter M refers to the mix and the number indicates the specified compressive strength of that mix at 28 days expressed in MPa.
- For lean concrete bases and simple foundations for masonry walls, M5 and M7.5 grades of concrete may be used.
- These mixes need not be designed.
- The grades of concrete lower than M15 are not to be used in R.C.C. Work**.**
- For general guidance, the nominal mixes correspond approximately to the different grades as follows :

M5 – 1:5:10 M7.5 – 1:4:8 M10 – 1:3:6 M15 – 1:2:4

M20 – 1:1.5:3 M25 – 1:1:2

2. Grading of Aggregates

- In order to obtain concrete of denser quality, the fine and coarse aggregates are properly graded. The grading of fine aggregates is expressed in terms of BIS test sieves nos. 480, 240, 120, 60, 30 and 15.
- The grading of fine aggregates has a marked effect on the uniformity, workability and finishing qualities of concrete.
- The grading of coarse aggregates may be varied through wider limits than those of sand without appreciable effect on the workability of concrete.
- In general, it can be stated that it is difficult to provide satisfactory grading of coarse aggregates than of sand. The grading limits for fine aggregates are shown below.

	Percentage by weight passing through sieve	
BIS Sieve	Natural or Crushed gravel sand	Crushed stone sand
No. 480[4.75 mm]	95-100	90-100
No. 240	70-95	60-90
No. 120	45-85	40-80
No. 60	25-60	20-50
No. 30	5-30	5-30
No. 15	0-10	0-15

3. Water – Cement Ratio

- The water in concrete has to perform the following two functions :

(i) The water enters into chemical action with cement and this action causes the setting and hardening of concrete.

(ii) The water lubricates the aggregates and it facilitates the passage of cement through voids of aggregates. This means that water makes the concrete workable.

- It is found theoretically that water requires for these two functions is about 0.50 to 0.60 times the weight of cement.
- This ratio of the amount of water to the amount of cement by weight is termed as the water – cement ratio and the strength and quality of concrete primarily depend upon this ratio.

- The important points to be observed in connection with water – cement ratio are as follows :

✓ The minimum quantity of water should be used to have reasonable degree of workability. The excess water occupies space in concrete and on evaporation, the voids are created in concrete. Thus the excess water affects considerably the strength and durability of concrete. In general, it may be states that addition of one extra litre of water to the concrete of one bag of cement will reduce its strength by about 1.47 N/mm2. In other words, **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 decided. For instance, for structures which are regularly wetting and drying, the water – cement ratio by weight should be 0.45 and 0.55 for thin sections and mass concrete respectively. For structures which are continuously under water, the water – cement ratio by weight should be 0.55 and 0.65 for thin sections and mass concrete respectively.

Workability

- The term workability is used to describe the **ease with which the concrete is handled, transported and placed between the forms with minimum loss of homogeneity**.
- The workability, as a physical property of concrete alone irrespective of a particular type of construction, can be defined as the amount of useful internal work necessary to produce full compaction.
- If the concrete mixture is too wet, the coarse aggregates settle at the bottom of concrete mass and the resulting concrete becomes of non-uniform composition.
- If the concrete mixture is too dry, it will be difficult to handle and place it in position.
- Both these conflicting conditions should be correlated by proportioning carefully various components of concrete mixture.
- The important facts in connection with workability are as follows :

1) If more water is added to attain the required degree of workmanship, it results into concrete of low strength and poor durability.

2) If the strength of concrete is not to be affected, the degree of workability can be obtained :

(a) By slightly changing the proportions of fine and coarse aggregates, in case the concrete mixture is too wet, and

(b) By adding a small quantity of water cement paste in the proportion of original mix, in case the concrete mixture is too dry.

3) A concrete mixture for one work may prove to be too stiff or too wet for another work. For instance, the stiff concrete mixture will be required in case of vibrated concrete work while wet concrete mixture will be required for thin sections containing reinforcing bars.

4) The workability of concrete is affected mainly by water content, water-cement ratio and aggregate – cement ratio.

5) The workability of concrete is also affected by the grading, shape, texture and maximum size of the coarse aggregates to be used in the mixture.

In order to measure the workability of concrete mixture, the various tests are developed. The tests such as flow test and compacting test are used in great extent in laboratory. The slump test, which is commonly used in the field.

Production of Concrete

- Concrete production is the process of mixing together the various ingredients – water, aggregate, cement and any additive, to produce concrete.
- Concrete production is time – sensitive.
- Once the ingredients are mixed, workers must put the concrete in place before it hardens.
- In modern usage, most concrete production takes place in a large type of industrial facility called a concrete plant, or often a batch plant.
- In general, concrete plants come in two main types, ready mix plants and central mix plants.
- A ready mix plant mixes all the ingredients except water, while a central mix plant mixes all the ingredients including water.

Mixing the materials of Concrete

- The process of rolling, folding and spreading of particles is known as the mixing of concrete.
- The materials of concrete should be mixed thoroughly so that there is uniform distribution of materials in the mass of concrete.
- The thorough mixing also ensures that cement water paste completely covers the surface of aggregates.
- The mixing of materials of concrete can be done either with hand or with the help of a machine.

(1) Hand Mixing : For hand mixing, the materials are stacked on a water-tight platform, which may be either of wood, brick or steel.

The materials should be thoroughly mixed, at least 3 times in dry condition before water is added. The prepared mix should be consumed in 30 minutes after adding water. The mixing by hand is allowed in case of small works or unimportant works where small quantity of concrete is required. For important works, if hand mixing is to be adopted, it is advisable to use 10% more cement than specified.

(2) Machine mixing : For machine mixing, all the materials of concrete including water, are collected in a revolving drum and then the drum is rotated for a certain period. The resulting mix is then taken out of the drum.

- ✓ Mixing the materials of concrete with the help of machines is more efficient and it produces concrete of better quality in a short time.
- ✓ The time of mixing in mixer and the speed of the mixer are very important factors in deciding the strength of concrete which is formed.
- ✓ The mixing time should be at least one minute and preferably two minutes. The speed of the mixer is recommended by the manufacturers of the mixer.
- ✓ The concrete discharged should be consumed within 30 minutes.

Transporting and Placing of Concrete

- ✓ The concrete, as it comes out of the mixer or as it is ready for use on the platform, is to be transported and placed on the formwork.
- ✓ The type of equipment to be used for transport of concrete depends on the nature of work, height above ground level and distance between the points of preparation and placing of concrete.
- ✓ For ordinary building works, the human ladder is formed and concrete conveyed in pans from hand to hand.
- ✓ For important works, the various mechanical devices such as dumpers, truck mixers, buckets, chutes, belt conveyors, etc., may be used.
- ✓ The two important precautions necessary in the transportation of concrete are as follows :

1) The concrete should be transported in such a way that there is no segregation of the aggregates.
2) Under no circumstances, the water should be added to the concrete during its passage from mixer to the formwork.

Consolidation of Concrete

- The term consolidation of concrete is used to mean the compaction between aggregate and aggregate; between aggregate and reinforcement; and between aggregate and forms.
- The main aim of consolidation of concrete is **to eliminate air bubbles and thus to give maximum density to the concrete**.
- An intimate contact between concrete and reinforcement is ensured by proper consolidation.
- The importance of consolidation of concrete can be seen from the fact that a presence of 5% of voids reduces 30% strength of concrete.
- The process of consolidation of concrete can be carried out either with hand or with the help of vibrators.

Curing of Concrete

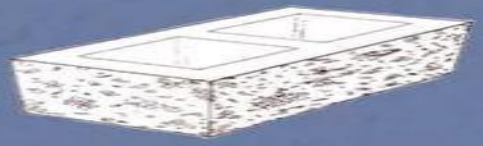
- The concrete surfaces are kept wet for a certain period after placing of concrete so as to promote the hardening of cement.
- It consists of a control of temperature and of the moisture movement from and into the concrete.
- ***Purposes*** or ***Objects*** of curing of concrete are :

1) The curing protects the concrete surfaces from sun and wind.
2) The presence of water is essential to cause the chemical action which accompanies the setting of concrete. Normally, there is an adequate quality of water at the time of mixing to cause hardening of concrete. But it is necessary to retain water until the concrete has fully hardened.
3) The strength of concrete gradually increases with age, if curing is efficient. This increase in strength is sudden and rapid in early stages and it continues slowly for an indefinite period.
4) By proper curing, the durability and impermeability of concrete are increased and shrinkage is reduced.
5) The resistance of concrete to abrasion is considerably increased by proper curing.

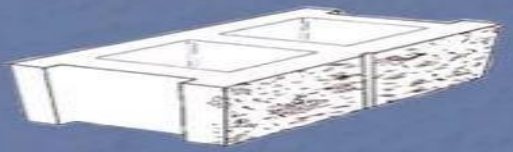
Masonry Units

- Concrete masonry units are a versatile, environmentally friendly building product that can be used for a wide variety of applications.
- With the variety of shapes and sizes available, they can be used as part of an attractive exterior design, as well as to add interest to interior walls.
- Concrete block is made from Portland cement, aggregates and water. It is also known as a concrete masonry unit(CMU).
- As a building material, concrete offers several attractive characteristics to designers and builders, including durability, Easy to install, Fireproof, Low maintenance and Decorative finishes available or may be ornamented after installation.
- The standard(nominal) size of a concrete block(stretcher block) is 8” X 8” X 16”, the actual size is 7 5/8” X 7 5/8” X 15 5/8” the block is produced to this size to account for mortar joints.
- The block itself is slightly shorter in order to accommodate the mortar used to secure it in place.

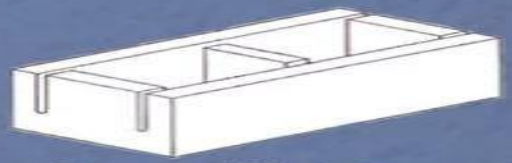
A Few Types of Blocks:



Quion Corner Unit



Stretcher With Score Unit

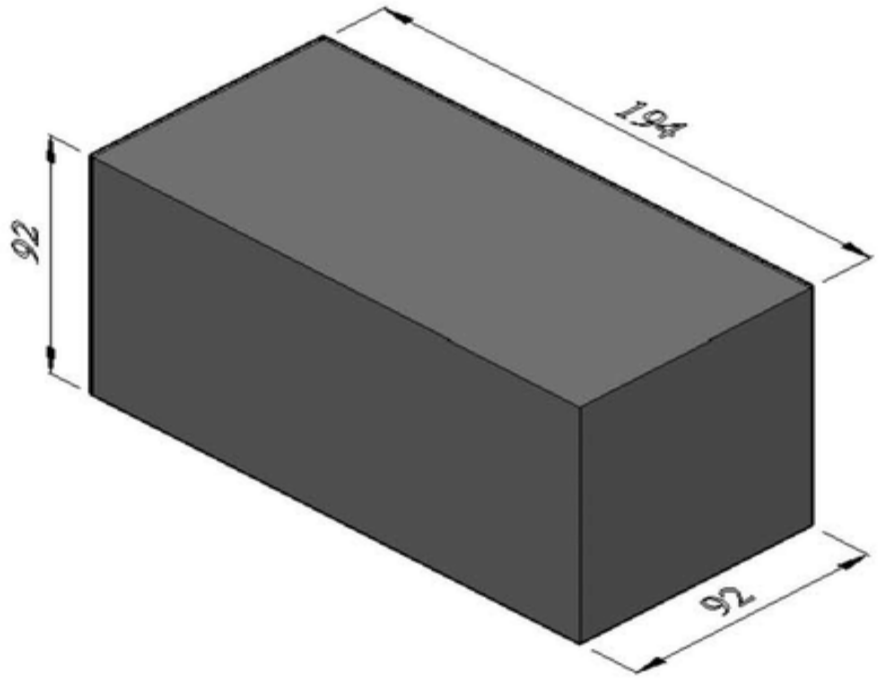


Open Bottom Bond Beam Unit

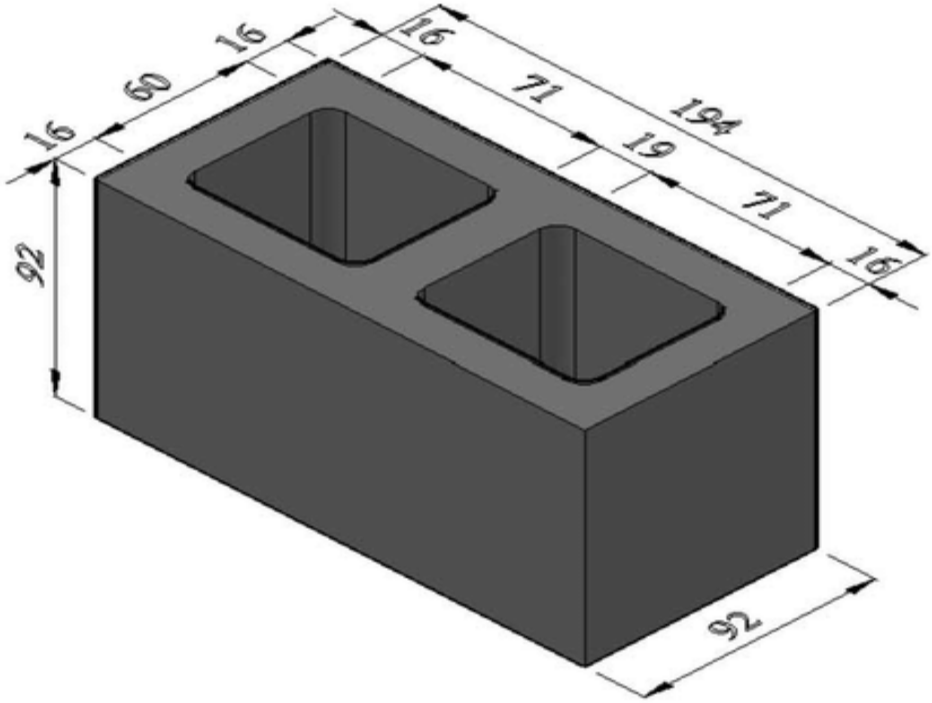
Bullnose Stretcher Unit

Split Flute "L" Corner Unit

Split Wide Stretcher Unit



(a)



(b)

Typical uses for Concrete Block

- Concrete block is a popular construction material due to its versatility. It can be used for several applications, such as :
- Foundation walls
- Basement Walls
- Partition walls
- Exterior walls
- These blocks can be finished with a number of coatings, which can be used to prevent water from penetrating the concrete and help with efflorescence.
- Some of these types of coatings include : Cement paints, Latex paints, Oil – based paints etc.,
- The specific type of coating will depend on the specific function of the block, where it will be used, if the coating needs to be UV resistant and breathable, etc.,


THANK YOU