# 5.4 FERROCEMENT

Ferrocement (or Ferro-concrete) is defined as a composite construction material, consisting of cement mortar applied to both sides of a thin wire mesh.

## Materials for Ferrocement

1. **Cement and Fine aggregate (Mortar Mix)**
   - Mortar mix 1:2
   - Water/Cement ratio – 0.3 to 0.5
2. **Skeletal Steel**
   - Forms the skeleton of the structure
   - 3 to 8 mm steel rods are used
   - Used in the form of tied reinforcement or welded wire fabric
   - Used to impart structural strength in case of boats, barges etc
   - Reinforcement should be free from dust, rust and other impurities
3. **Reinforcing Mesh**
   - Consists of galvanized steel wires of diameter 0.5 to 1.5 mm, spaced at 6 to 20mm c/c.
   - Available as woven/interlocking mesh and welded mesh
   - Welded wire mesh has hexagonal or rectangular openings
   - Expanded-metal lath is also used
   - Made from carbon, glass etc.
4. **Water**
5. **Admixture**
6. **Coating**

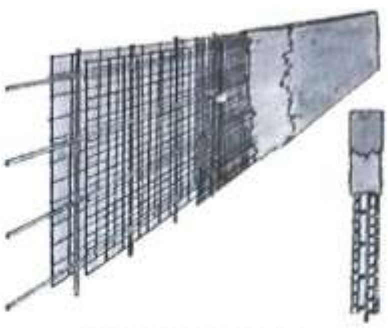
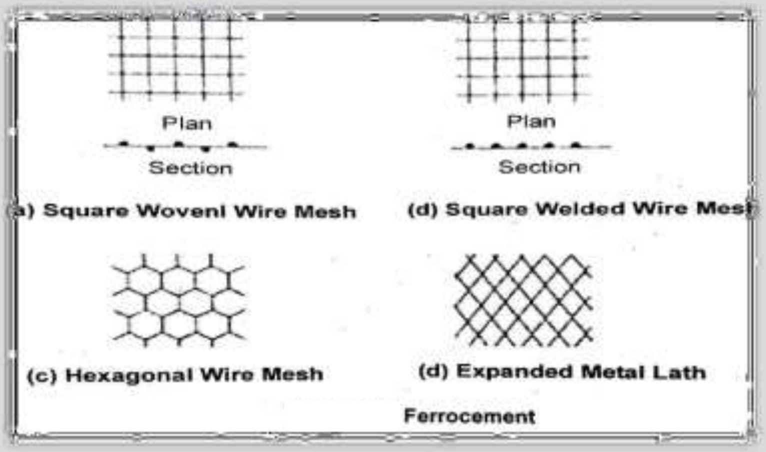


*Fig. 5.4. FerroCement*




### Process of Ferrocement Construction

- ✓ Fabricating the skeletal framing system
- ✓ Applying rods and meshes
- ✓ Plastering
- ✓ Curing



### Properties of Ferrocement

- ➢ Highly versatile form of reinforced concrete
- ➢ It's a type of thin reinforced concrete construction, in which large amount of small diameter wire meshes uniformly throughout the cross section.
- ➢ Wire mesh may be metal or suitable material.
- ➢ Instead of concrete, Portland cement mortar is used.
- ➢ Strength depends on two factors, quality of cement mortar and quantity of reinforcing materials used.

### Advantages of Ferrocement

- ❖ Easily available materials.
- ❖ Fabricated into any desired shape.
- ❖ High strength
- ❖ More durability and are cheaper than steel and wood
- ❖ Heavy machineries or techniques required.

- ❖ High corrosion resistance
- ❖ Low labour skill required.
- ❖ Ease of construction, low weight and long lifetime (Low strength to weight ratio)
- ❖ Low construction material cost.
- ❖ Low maintenance cost.
- ❖ Better resistance against earthquake.
- ❖ Execution time at work site is less.
- ❖ Good fatigue behavior
- ❖ Ability to undergo large deflection
- ❖ Improved impact resistance and toughness
- ❖ High fire resistance
- ❖ High Impermeability

**Disadvantages of Ferrocement**

- Structures can be punctured by collision with pointed objects.
- Corrosion of the reinforcing materials due to the incomplete coverage of metal by mortar.
- It is difficult to fasten to Ferrocement with bolts, screws, welding and nail etc.
- Large no. of labors required.
- Cost of semi-skilled and unskilled labors is high.
- Tying rods and mesh together is especially tedious and time consuming.
- Excessive shrinkage due to higher cement content.
- Needs constant curing for a period of 7 days to avoid any shrinkage cracks
- Low shear strength
- Susceptibility to stress rupture failure



Applications of Ferrocement in Construction

- ✓ Building and structural applications
  - Housing Applications (used as planks for shelves)
  - Residential and Public Buildings
  - Water supply and Sanitary Installations (sewage manhole covers etc.)

- Industrial structures.
- Electrical installations (Boxes for water and Electrical meters)
- Low cost housing

✓ Other structures

- Boats, Fishing Vessels,
- Barges, Cargo tugs,
- Catamarans, Yachts and Flotation buoys etc.

✓ Marine applications

✓ Agricultural applications

✓ Rural energy applications

✓ Anticorrosive membrane treatment.

✓ Transportation structures.

✓ Miscellaneous applications

- Pipes
- Swimming pools
- Curved benches for parks etc.

## 5.7 HIGH PERFORMANCE CONCRETE

High Performance Concrete (HPC) is defined as the concrete which possesses high strength, high workability, high modulus of elasticity, high density, high dimensional stability, high resistance to chemical attacks and low permeability.

Normal concrete has low strength and low elastic modulus values which are due to,

1. Heterogeneous nature of the structure of the material.
2. Partially porus
3. Weak transition zone.

**Properties of HPC**

- Early strength for 24 hours should be more than 35 Mpa.
- Very early strength for 4 hours should be more than 17.5 Mpa
- Compressive strength should be more than 70 Mpa
- High degree of impermeability to prevent ingress of water/air/$CO_2$/$SO_4$ etc.
- High resistance to sulphate attack
- Smooth structured surface
- Absence of micro-cracking
- High level of corrosion resistance
- High electrical resistivity
- High chemical resistivity
- High resistance to abrasion, erosion, and cavitation.

**Applications of HPC**

- ✓ Pavements
- ✓ Bridges
- ✓ High Rise Structures
- ✓ Hydro – Power Structures, etc.

## Advantages of using HPC

- Reduction in member size and direct savings in the concrete volume saved.
- Reduction in the self-weight and super-imposed DL and smaller foundations.
- Reduction in form-work area and cost and high early age gain in strength.
- Construction of High – rise buildings.
- Longer spans and fewer beams for the same magnitude of loading.
- Reduced axial shortening of compression supporting members.
- Reduction in the number of supports and the supporting foundations.
- Reduction in the thickness of floor slabs and supporting beam sections
- Superior long-term service performance under static, dynamic and fatigue loading.
- Low creep and shrinkage.
- Greater stiffness as a result of a higher modulus of elasticity ($E_c$)
- Higher resistance to freezing and thawing, chemical attack
- Improved long term durability and crack propagation.
- Reduced maintenance and repairs.
- Smaller loss in value as a fixed cost.



## Disadvantages of HPC

- The initially higher construction prices to be expected with the use of any new technology
- Quality control concerns related to various material selection, testing methods in use and the number of tests.
- Instabilities concerns that could result from reduced stiffness
- Fire resistance concerns

## 5.3 HIGH STRENGTH CONCRETE

Concrete is classified, based on the compressive strength

- ✓ Normal strength concrete
- ✓ High strength concrete (HSC)- more than 35MPa
- ✓ Ultra strength concrete (USC)- more than 100MPa

**Methods of manufacture of HSC**

- ➢ Re-vibration
- ➢ Uses of admixtures
- ➢ High-speed slurry mixing
- ➢ Sulphur impregnation
- ➢ Prevention of cracks
- ➢ Uses of cementitious aggregates
- ➢ Re-seeding



**1. Re-vibration**

- ❑ The controlled vibration increases the strength of concrete, up to strength of HSC.

**2. Uses of admixtures**

- ❑ By using the water reducing agents the strength of concrete will be increased.

**3. High speed slurry mixing**

- ❑ In this method cement and water mixture is prepared first and then the aggregate is blended of cement paste.
- ❑ Water saved in the vigorous blending of cement paste

**4. Prevention of cracks**

- If 2% to 3% of fine aggregate is replaced by polythene or polystyrene lenticular pieces 0.025 mm thick and 3 mm to 4mm in diameter, will result in the increase of concrete strength
- By this method, the high strength up to 100 Mpa can be achieved.

**5. Sulphur-filling or impregnation**

- By impregnating low strength porous concrete by sulphur, sufficient high strength concrete has been produced.

**6. Use of cementitious aggregate**

- A kind of aggregate known as ALAG.
- Using ALAG as aggregate, concrete gives strength up to 125 Mpa with w/c ratio 0.32.



**7. Seeding**

- In this method, a small quantity of finely powdered- fully hydrated Portland cement is added to the fresh concrete mix.

### 5.3.1 FIBRE REINFORCED CONCRETE

Fibre reinforced concrete (FRC) is the concrete containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented.

**Advantages of FRC**

- Increased durability.
- High bond strength.
- Reduction in shrinkage and shrinkage cracks.
- Improved fatigue strength.
- Better toughness.

- Low permeability.
- Increased tensile strength.
- Reduced air voids and water voids.
- High resistance to creep
- Reinforced concrete itself is a composite material, where the reinforcement acts as the strengthening fibre and the concrete as the matrix. It is therefore imperative that the behavior under thermal stresses for the two materials be similar so that the differential deformation of concrete and the reinforcement are minimized.
- Act as crack arrester.

**Effect of fibres in concrete**

- To control plastic shrinkage cracking and drying shrinkage cracking.
- Lower the permeability.
- Decreases the flexural strength of concrete.
- Increases the tensile strength of concrete.
- Decreases the workability.
- Increases the impact strength.



**Different types of fibres in concrete**

- ➢ Steel fibres (steel fibre reinforced concrete)
- ➢ Polypropylene fibres (Polypropylene fibres reinforced concrete, PFRC)
- ➢ Glass fibres(Glass fibres reinforced concrete, GFRC)
- ➢ Asbestos fibres
- ➢ Carbon fibres
- ➢ Organic fibres

**Steel fibres**

- ✓ Most common type of fibres used in FRC.
- ✓ Size varies from 0.25 mm to 0.75 mm.

- ✓ Used to improve the flexural, impact and fatigue strength.
- ✓ Used in Road Pavement constructions, Air fields, Bridge decks, thin shells and flooring.
- ✓ Reduces little workability of the concrete.

**Plastic fibres**

- ✓ Having high tensile strength and low Young's Modulus.
- ✓ Examples: Poly – propylene, Nylon, Acrylic, Aramid and Polyethylene.

**Glass fibres**

- ✓ Available in three forms, i.e., Rovings, Strands and Woven (or chopped strand) mats.
- ✓ Adding 2% of fibres in concrete increase the flexural strength double

**Asbestos fibres**



- ✓ Mineral fibre
- ✓ Maximum length of fibre in limited to 10mmm.
- ✓ Tensile strength of concrete varies from 560 k/m to 980 $N/mm^2$

**Carbon fibres**

- ✓ Possess high tensile strength and Young's Modulus.
- ✓ Increases the compressive strength.
- ✓ High cost material.

**Organic fibres**

Organic fibre such as polypropylene or natural fibre may be chemically more inert than either steel or glass fibres. Organic fibres are also cheaper, especially if natural. A large volume of vegetable fibre may be used to obtain a multiple cracking composite. The problem of mixing and uniform dispersion may be solved by adding a super plasticizer.

**Applications of FRC**

- ✓ Pavements and floors
- ✓ Water retaining structures.
- ✓ Blast resisting structures
- ✓ Pre cast products (Pre cast pipes, boats, wall panels etc.)
- ✓ Wearing surface to existing bridges / culverts.
- ✓ Repairs and rehabilitation works.

**5.3.3 SLURRY INFILTRATED FIBRE CONCRETE (SIFCON)**

- ✓ This is the type of fibre concrete in which steel fibre bed is prepared and cement slurry is infiltrated.
- ✓ In normal fibre reinforced concrete , fibres are mixed with wet concrete and placed
- ✓ As against this, cement slurry is in filtrated into the fibre –packed bed in caser of SIFCON
- ✓ SIFCON has higher ductility and impact resistance when compared with normal FRC.
- ✓ With this technique, macro-fibre contents up to 20% by volume can be achieved
- ✓ With a consequent enormous increase in both flexural load carrying capacity and toughness.
- ✓ With such high fibre volume, a very high compressive strength is also achieved.
- ✓ SIFCON can be used for blast resistance structures and burglar proof safe vaults in banks and residential buildings.

## 5.8 POLYMER CONCRETE

Polymer concrete is a special composite concrete, in which a polymer binder mixed with aggregates together form the concrete. It is used in construction projects to provide added strength.

Polymer concrete provides very good resistance against corrosion and minimal chemical reactivity, commonly used in areas subjected to heavy wear and high loadings such as car parks, roadways and industrial areas.

Polymer concrete, (Artificial Granite), is a composite material consisting of dry aggregate fillers and a monomer system, polymerized in place by catalyzed peroxide decomposition. The components of polymer concrete are gravel, sand and calcium carbonate bound together with a polymer resin.

**Types of polymer concrete**

1. Polymer Concrete (PC)
2. Polymer Cement Concrete (PCC)
3. Polymer Impregnated Concrete (PIC)



**Polymer Concrete (PC)**

- ✓ In PC, polymer/monomer is employed to act as binder in place of cement.
- ✓ The monomer and aggregate are mixed together and the monomer is polymerized after placement of concrete in position.

**Application**

- Nuclear power plants
- Kerb stones
- Prefabricated structural element
- Precast slabs for bridge decks
- Roads
- Marine works
- Pre-stressed concrete

- Irrigation works
- Sewage works
- Waterproofing of buildings
- Food processing buildings etc.

**Polymer Cement concrete (PCC)**

- PCC is produced by incorporating an emulsion of a polymer (or) a monomer on OPC.
- The ingredients consisting cement, aggregates and monomer are mixed with water and monomer in the concrete mix is polymerized after placing concrete in position.

The resultant concrete has empowered:

i. Strength
ii. Adhesion
iii. Chemical resistance
iv. Impact resistance
v. Abrasion resistance



**Application:**

- Marine works

**Polymer Impregnated Concrete (PIC)**

- PIC is hardened Portland cement concrete that has impregnated with a monomer.
- In this case, the cement concrete is cast and cured in the conventional manner.
- After the concrete product gets hardened, air from its voids is removed. The concrete product is then finally subjected to polymerization by radiation (or) by heat treatment.

**Applications:**

- Precast slabs for bridge decks
- Roads
- Marine structures

## 5.8.1 GEOPLOYMER CONCRETE

Geopolymer concrete is an innovative, eco-friendly and special concrete, which is made from utilization of waste materials such as fly ash and ground granulated blast furnace slag (GGBS). Fly ash is the waste product generated from thermal power plant and ground granulate blast furnace slag is generated as waste material in steel plant.

**Composition of Geopolymer concrete**

- Fine aggregates and coarse aggregates as required for normal concrete.
- GGBS – A byproduct of steel plant
- Fly ash – A byproduct of thermal power plant
- Alkaline activator solution for GPCC as explained above. Catalytic liquid system is used as alkaline activator solution. (It is a combination of solutions of alkali silicates and hydroxides, besides distilled water. The role of alkaline activator solution is to activate the geo-polymeric source materials containing Si and Al such as fly ash and GGBS.



**Mechanical properties of Geopolymer concrete**

- Compressive strength – up to 70 $N/mm^2$
- Strength gains and faster than ordinary portland cement concrete
- Drying shrinkage – les, compared to cement concrete. This makes it well suited for thick and heavily restrained concrete structural members
- Low heat of hydration in comparison with cement concrete.
- Fire resistance is better than OPC concrete
- Very high acid resistance when tested under exposure to 2% and 10% sulphuric acids.
- High Chloride resistance, and hence it provides better protection to reinforcement steel from corrosion as compared to traditional cement concrete.

**Applications of Geopolymer Concrete**

- ✓ Construction of Pavements
- ✓ Retaining Walls

- ✓ Water Tanks
- ✓ Precast Bridge Decks

**Factors affecting the compressive strength of Geopolymer Concrete**

- ❖ Silicon oxide ($SiO_2$) to aluminum oxide ($Al_2O_3$) ratio by mass
- ❖ Activator liquid to source material (fly ash) ratio by mass
- ❖ Concentration of sodium hydroxide NaOH liquid measured in terms of Molarity (M)
- ❖ Sodium silicate to sodium hydroxide liquid ratio by mass
- ❖ Curing temperature in the range of $30^o$ to $90^oC$
- ❖ Curing time in the range of 6 to 48 hours.
- ❖ Water content in the mixture.

## 5.5 READY MIX CONCRETE

- ✓ Concrete prepared at plant or in track mixers and delivered to the construction site is called ready mix concrete [RMC]. It is particularly useful in congested sites or in road construction, where the space requirement for material storage and preparing the concrete is inadequate.

### Advantages of RMC

- Low cost
- High durability
- Can be manufactured for desired strength
- No quality control required as in case of concrete prepared in site
- Useful in congested sites or in road constructions
- RMC plants continuously produces concrete with uniform quality. Durability and strength , in each batch
- It creates an efficient operation at job sites, regarding the work, alignment and finishing etc.
- It eliminates the time spent by the supervisors in estimating the quantity of raw materials.
- It reduces, labour required to handle and mix the materials etc.
- It eliminates the space requirement for platform and storage of raw materials.
- No excess material presents at the end of the work
- No waiting time for laying the concrete and concrete is available all the time.
- RMC is an economical product , if used in larger quantities
- A mixer is not needed to be purchased or rented or leased for use.
- Desired strength can be achieved by altering the mix proportion and quality standard can be maintained.

# STATIONARY READY MIX PLANT

## 5.2SELF COMPACTING CONCRETE

Self-compacting concrete has no vibration is required for the concrete, which can flow around obstructions, reinforcement and fill the formwork completely under its own self weight.

### Advantages of SCC

- SCC offers good strength equally with the other concrete
- No strength reduction due to improper compaction
- Repairs and finishing of concrete is not necessary
- Good workability and durability
- Reducing time, cost, man power etc.

### Classification of SCC



- ❑ Powder type SCC
- ❑ Viscosity modifying admixture type SCC
- ❑ Combination modifying admixture type SCC

### Requirements of SCC

- ➢ Filling ability

Filling ability of SCC is defined as the ability, to flow into and fill completely all space within the formwork, under its own weight.

- ➢ Passing ability

It is the ability of SCC to flow through the congested reinforcements without segregation and bleeding.

- ➢ Segregation resistance

The ability of SCC to remain homogeneous in composition during transport and placing.

**Manufacturing of SCC**

Step 1: Materials requirement

Step 2: Mixing

Step 3: Placing

Step 4: Curing

**I. Materials for SCC**

**a) Cement**

OPC with 43 or 53 grades may be used.

**b) Aggregates**

Aggregate of size 10mm to 20mm are preferred.



**c) Mineral admixtures**

The mineral admixtures are either inert filters or reactive in nature. Inert filters include Quartz powder and limestone. Reactive mineral include the GGBFS.

**d) Water**

Ordinary portable water

**e) Air entraining agent** – To improve the workability

**f) Viscosity modifying agents** – To improve the stability

**g) Retarders** – To control the setting.

**II. Mixing**

Any suitable method for mixing the raw materials for SCC can be used.

**III. Placing**

- ✓ The vertical free fall distance should not be more than 2m.
- ✓ The height of pour lifts should not be more than 0.3m.
- ✓ The permissible distance of horizontal flow from the point of discharge should be within 10m.

## IV. Curing

In SCC the concrete dry faster than the ordinary concrete and hence quick drying may cause plastic shrinkage. Hence, initial curing should be started as quick as possible to reduce the shrinkage crakes.

**Mix design of SCC**

1. Determination of desired air content.
2. Determination of coarse aggregate
3. Determination of fine aggregate
4. Design of paste composition
5. Determination of maximum water to powder ratio
6. Determination to super – plasticizer dosage in mortar
7. Assessment of properties by standard tests.



**Tests for SCC**

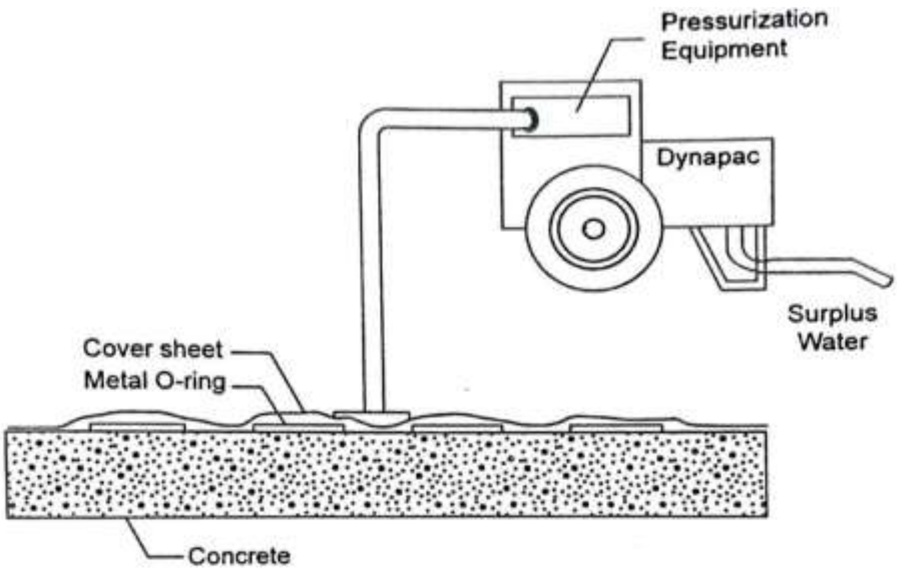
| Property | Test |
|---|---|
| Flowability | Slump Flow Test<br>L-Box Test<br>Orimet Test |
| Passing ability | J-Ring Test |
| Filling ability | V-Funnel Test<br>U-Box Test<br>Fill of (or Kajima) Test |
| Workability | Orimet Test |
| Segregation Resistivity | GTM screen Stability Test |

### 5.2.1 VACUUM CONCRETE

- Vacuum concrete is the special type of concrete in which the excess water is removed for improving concrete strength
- Water is removed by use of vacuum mats connected to a vacuum pump.

**Procedure of vacuum concrete**

The vacuum is applied through porous mats connected to a vacuum pump. A vacuum mat consists of a plywood backing with a vacuum chamber formed out of expanded metal and faced with e fine gauge and fabric covering. Each mat is fitted with a valve controlled outlet for connection to a vacuum pump. The final water cement ratio before setting is thus reduced vacuum concrete has a higher strength and also density a lower permeability and a greater durability.




*Vacuum concreting*

**Advantages of vacuum concrete**

- The final strength of concrete is increased by about 25%.
- The permeability of concrete is sufficiently decreased.
- Vacuum concrete stiffens very rapidly so that that form – works can be removed within 30 minutes. Of casting even on columns of 20ft. High.
- The bond strength of vacuum concrete is about 20% higher.

- The density of vacuum concrete is higher.

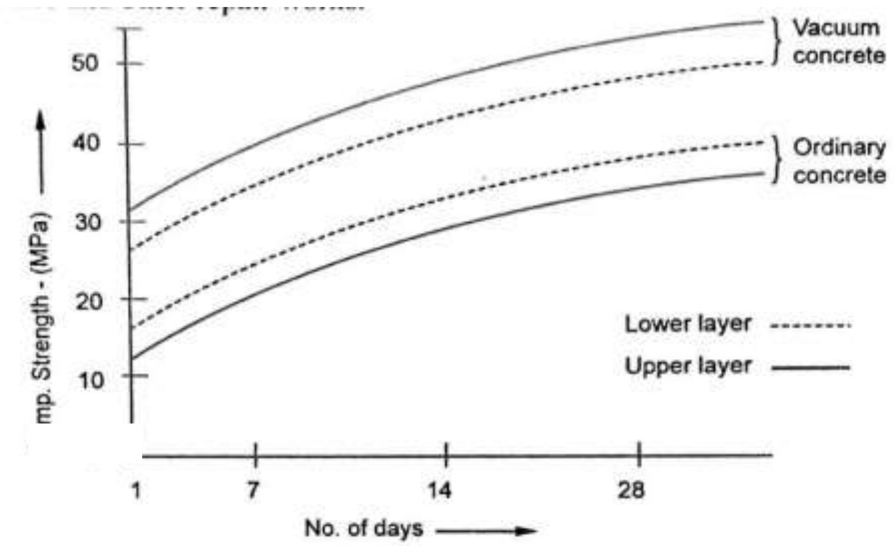



*Fig. 5.3. Strength Comparison of Vacuum concrete with Ordinary Concrete*

# 5.6 SHOTCRETE

- Shotcrete or gunite is the mortar or fine concrete that is applied over a surface by pneumatically, at a high velocity.

**Advantages of shotcrete**

- Less formwork requirements
- Requires small plants for manufacturing
- Easy placement
- Required strength can be attained easily
- The shotcrete layer can be made very strong by applying pneumatic pressure
- 3 cm to 5 cm thickness of shotcrete lining is sufficient
- Shotcrete lining does not need expansion and construction joints
- Shotcrete can be applied even on uneven base successfully
- Shotcrete can be used for repair of disintegrated and leaking lining etc.
- Shotcrete can be applied at least from distance of 1 m , hence it is very useful to apply lining while tunneling



**Disadvantages of shotcrete**

- ✓ The success of shotcrete depends on the performance of the operator
- ✓ The cost of construction of shotcrete is more than ordinary concrete of same proportion and same thickness
- ✓ It is less durable than ordinary lining of the same thickness
- ✓ Its lining in canals is damaged very soon due to settlement, shrinkage and hydrostatic pressure etc
- ✓ To obtain perfect bond with the base is impossible

**Applications of shotcrete**

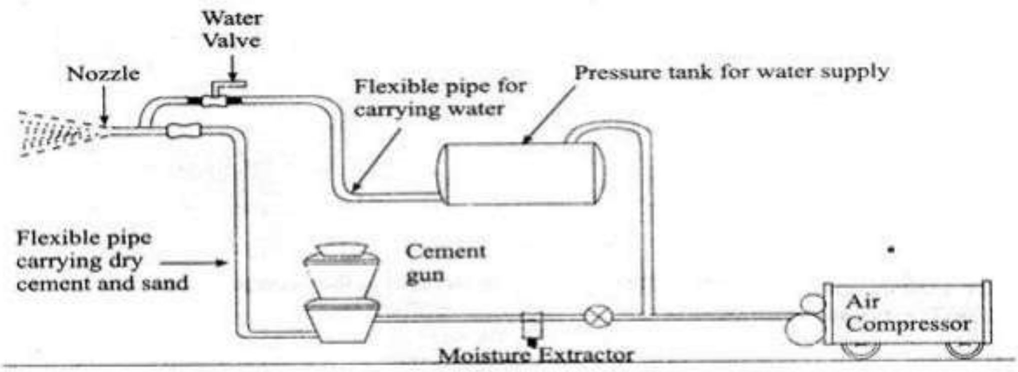
- Canal and tunnel lining
- Repair of concrete pavement
- Overlay of concrete pavements
- Refractory lining works
- Swimming ponds
- Pre-stressed tanks
- Thin overhead , vertical and horizontal surfaces

**Process of Shotcreting**

1. Mortar mixes of 1:4 or 1:4.5 and w/c ratio varies from 0.35 to 0.5 or 14 litres of water per 50kg of cement is sufficient.
2. Before putting the dry materials into the cement gun, the sand and cement should be mixed thoroughly for 12 minutes till the homogeneous mixture of one colour is obtained. Any mixed material not used within 45 minutes of mixing should be rejected.
3. In placing the mortar, the hose length should be kept as small as possible as long hose requires greater pressure for air and water. Though hose length up to 110 m has been used but preferably they should not be longer than 30 to 45 m.
4. The line diagram of a cement gun is shown in figure. After filling sand cement mix in vessel C, air at a pressure of 2.2 $kg/cm^2$ to 3.5 $kg/cm^2$ is sent from compressor A to vessel C through moisture extractor B. at B the moisture in air is absorbed and dry air reaches in the vessel C.
5. This air pushes the cement-sand mixture through pipe D and ejects it through nozzle E. as shown in Figure. Through another pipe, air is sent from compressor A at a pressure of 3.0 to 4.6 $kg/cm^2$ to water tank F. from this tank air is delivered through pipe G and ejected at E. pressures are controlled at E.

6. While guniting, the nozzle should be held normal to the surface and about 1 to 1.5 m from it. In order to obtain a uniform layer, it should be kept moving.
7. The process of guniting should be suspended when wind is blowing as it will not be possible to maintain the consistency of the mix.
8. The completed work should be protected from direct sun rays at least for 3 days and should be moist cured for at least 14 days

The material which bounces back from the working face is known as rebound. It is largely the coarser particles of sand which rebound and hence it should be avoided.




General arrangement of apparatus in gunite system.

# UNIT - V

# SPECIAL CONCRETES

***SYLLABUS***

***Light weight concretes - foam concrete- self compacting concrete – vacuum concrete - High strength concrete - Fibre reinforced concrete – Ferrocement - Ready mix concrete – SIFCON - Shotcrete – Polymer concrete - High performance concrete - Geopolymer Concrete***

## SPECIAL CONCRETES

Special concrete are the concretes, which are prepared for specific purposes. Concrete is very strong in compression, however it has the following disadvantages.

- Low tensile strength
- Heavy weight etc.
- Low durability
- High permeability
- Low corrosive resistance
- Low resistance to chemical attack



Hence special concretes are prepared to rectify these disadvantages based on its application.

Following are the special types of concrete.

1. Light Weight Concrete
2. Aerated Concrete
3. High Density Concrete
4. Ready Mixed Concrete (RMC)
5. Recycled Aggregate Concrete (RAC)
6. Fibre Reinforced Concrete (FRC)
7. Fibre Reinforced Polymer Concrete (FRP)
8. Polymer Concrete

9. Shotcrete (or) Gunite
10. Ferro-Cement
11. Self-Compacting Concrete (SCC)
12. High Performance Concrete (HPC) etc.

## 5.1 LIGHT WEIGHT CONCRETE

The concrete having the density value of about 300 kg/cum – 2100 kg/cum is called light weight concrete or low density concrete.

The density of ordinary concrete is about 2100 kg/cum – 2650 kg/cum.

### Light Weight Aggregates

Light weight aggregates are used to reduce the density of the concrete.


Fig. 5.1. Light-Weight Aggregates

### Properties of LWC

- ✓ Due to the low density and rough texture of porous aggregate, the workability of concrete needs special attention.
- ✓ The density of LWC is 300 kg/cum -2100 kg/Cum.
- ✓ It provides the compressive strength as Normal concrete.
- ✓ The modulus of elasticity differs from Normal concrete.
- ✓ Creep is approximately same to the normal weight concrete.

- ✓ Shrinkage of LWC, is higher than the normal weight concrete.
- ✓ It have high fire resistant and insulator.
- ✓ It is typically dark grey, brown, reddish brown, rust colored or even orange.

**Classification of LWC**

***i. Based on Method of Production***

1. **Light weight aggregate concrete**

Concrete manufactured by using porous light weight aggregate of low specific gravity.

2. **Aerated, Cellular, Foamed or Gas Concrete**

Special type of concrete is prepared by introducing air bubbles into the plastic cement mortar mix, the make the cellular structured material.

3. **No fines concrete**

Produced by omitting the fine aggregate – large number of voids are present.



***ii Based on purpose of use***

1. Structural light weight concrete
2. Insulating concrete
3. Masonry units

***iii Based on Density***

1. **Low density concrete**
   - ✓ Used for insulation purpose
   - ✓ Unit weight exceeds 800 kg/cum.
   - ✓ Insulation value are high
   - ✓ Compressive strength ranges from 0.69 to 06.89 Mpa.

2. **Moderate density/strength concrete**

   - ✓ Compressive strength are approximately 6.89 to 17.24 Mpa
   - ✓ Insulation value are medium.

3. **Structural concrete**

   - ✓ Minimum compressive strength is 17.24 Mpa
   - ✓ Maximum compressive strength is 34.47 Mpa
   - ✓ Insulation efficiency is low
   - ✓ Thermal insulation values for structural LWC are substantially better than NWC.

**Advantages of LWC**

- ✓ Light in weight.
- ✓ Lower cost for handling.
- ✓ High fire resistance.
- ✓ Can be prepared with industrial waste materials such as fly ash, clinker, slag, etc.
- ✓ Can be applied for seismic design of structures.
- ✓ Low thermal conductivity etc.



**Application of LWC**

- ➢ Decks of long span bridges
- ➢ Fire and corrosion protection
- ➢ Covering for architectural purposes
- ➢ Heat insulation on roofs
- ➢ Insulation of water pipes
- ➢ Filling for floor and roof slab

- Construction of partition walls and panel walls in framed structures
- Production precast building blocks and low cost housing.

**Uses of LWC**

- Good fire and corrosion resistant
- Heat insulation in roofs
- Insulating water pipes
- Construction of partition walls and panel walls in framed structures.
- General insulation of walls
- Surface rendered for external walls of small houses.

### 5.1.1 Foam concrete

This is a kind of LWC, which is prepared by adding air bubbles into the plastic cement mortar mix, to make the cellular structured material. It is also termed as Gas concrete or Cellular concrete or Aerated concrete.



#### 5.1.1.1 Methods of preparing foam concrete

1. Forming gas by chemical reaction during plastic-stage.
2. Adding pre-foamed stable foam with slurry.
3. Adding finely powdered expansive solid matter.