

### 3.5 SULPHUR – INFLITRATED CONCRETE

New types of composites have been produced by the recently developed techniques of impregnating porous materials like concrete with sulphur. Sulphur impregnation has shown great improvement in strength. Physical properties have been found to improve by several hundred per cent and large improvements in water impermeability and resistance to corrosion have also been achieved.

In the past, some attempts have been made to use sulphur as a binding material instead of cement. Sulphur is heated to bring it to molten condition to which coarse and fine aggregates are poured and mixed together. On cooling, this mixture gave fairly good strength, exhibited acid resistance and also other chemical resistance, but it proved to be costlier than ordinary cement concrete.

Recently, use of sulphur was made to impregnate lean porous concrete to improve its strength and other useful properties considerably. In this method, the quantity of sulphur used is also comparatively less and thereby the process is made economical. It is reported that compressive strength of about 100 MPa could be achieved in about 2 days time. The following procedures have been reported in making sulphur-infiltrated concrete.

A coarse aggregate of size 10 mm and below, natural, well graded, fine aggregate and commercial sulphur of purity 99.9 per cent are used. A large number of trial mixes are made to determine the best mix proportions. A water/cement ratio of 0.7 or over has been adopted in all the trials. A number of 5 cm cubes, 7.5 cm x 15 cm cylinders and also 10 mm x 20 cylinders are cast from each batch of concrete. These samples are stored under wet cover for 24 hours, after which they are removed from moulds and the densities determined. Control specimens are moist cured at 24°C for 26 hours.

Two procedures are adopted. In procedure “A” after 24 hours of moist curing,

the specimen is dried in heating cabinet for 24 hours at 121°C. Then the specimen are placed in a contained of molten sulphur at 121°C for 3 hours. Specimens are removed from the container, wiped clean of sulphur and cooled to room temperature for one hour and weighed to determine the weight of sulphur infiltrated concrete.

In procedure “B” the dried concrete specimen is placed in an airtight container and subjected to vacuum pressure of 2mm mercury for two hours. After removing the vacuum, the specimens are soaked in the molten sulphur at atmospheric pressure for another half an hour. The specimen is taken out, wiped clean and cooled to room temperature in about one hour. The specimen is weighed and the weight of sulphur-impregnated concrete is determined.

The specimens made adopting procedure A and B tested by compression and splitting tension tests. It is seen that the compression strength of sulphur-infiltrated cubes and cylinders are enormously greater than the strength of plain moist cured specimen. It is found that when water/cement ratio of 0.7 is adopted an achievement of about 7 fold increase in the strength of the test cube when procedure B is adopted and five-fold increase in strength when procedure A is adopted was obtained. When water/cement ratio 0.8 is adopted, procedure B gave about a tenfold increase in strength.

Similarly, the sulphur-infiltrated concrete showed more than four times increase in splitting tensile strength when procedure B was adopted.

It was also found that the elastic properties of sulphur-infiltrated concrete have been generally improved 100 per cent and also sulphur-infiltrated specimen showed a very high resistance to freezing and thawing. When the moist cured concrete was disintegrated after about 40 cycles, the sulphur impregnated concrete was found to be in fairly good condition, even after 1230 cycles, when procedure b was adopted and the sample deteriorated after 480 cycles when the sample was made by procedure A. table 12.8 and table 12.9 show the typical values of strength test conducted.

The improvement in strength test attributed to the fact that porous bodies having randomly distributed pores have regions of stress concentration when loaded externally. The impregnation of a porous body by some material would modify these stress concentrations. The extent of modification will depend on how well the impregnant has penetrated the smaller pores.

### **Application of Sulphur – Infiltrated concrete**

The sulphur-infiltration can be employed in the precast industry. This method of achieving high strength can be used in the manufacture of pre-cast roofing elements, fencing posts. Sewer pipes, and railway sleepers, sulphur-infiltrated concrete should find considerable use in industrial situations. Where high corrosion resistant concrete is required. This method cannot be conveniently applied to cast-in place concrete.

Preliminary studies have indicated that sulphur-infiltrated precast concrete units are cheaper than commercial concrete. The added cost of sulphur and process should be offset by considerable savings in concrete.

The techniques are simple, effective and inexpensive. The tremendous strength gained in pressure application, where in immersion accompanied by evacuation may also offset the extra cost. The attainment of strength in about two days time makes this process all the more attractive.

## **FERROCEMENT**

Ferrocement is a type of thin wall reinforced concrete commonly constructed of hydraulic cement mortar reinforced with closely spaced layer of continuous and relatively small size wire mesh.

Ferro-cement is a relatively new material consisting of wire meshes and cement mortar. It consists of closely spaced wire meshes which are impregnated with rich cement mortar mix.

The ferro-cement members are usually of 20 mm to 30 mm thickness with 2 mm to 3 mm external covers to the reinforcement. The reinforcement or wire mesh is usually of 0.5 mm to 1 mm in diameter at 5 mm to 10 mm spacing and cement mortar is of cement sand of 1 : 2 or 1 : 3 with water-cement ratio

0.4 to 0.5. The steel quantities vary between 300 to 500 kg per m<sup>3</sup> of mortar. The basic idea behind this material is that concrete can undergo large strains without cracks in the neighborhood of the reinforcement throughout the mass of the concrete.

### **Application of ferrocement**

#### **1. Marine application**

Used for constructing boats, fishing vessels, barrages, docks etc Water tightness, impact resistance, small thickness and light weight

#### **2. Water supply and sanitation applications**

Water supply tanks, sedimentation tanks, well casings, septic tanks, sanitary tanks

#### **3. Agricultural application**

Grain storage bins, silos, water tanks, pipes linings for underground pits and irrigation channels

4. Housing applications : Mosque domes, shelters, sheds, domed structure, precast housing elements, wall panels, sandwich panels, corrugated roofing sheets.

5. Rural energy application : Biogas digesters, biogas holders, incinerators and panels for solar energy collectors

6. Permanent formwork ; For reinforced or prestressed concrete column beams, slabs

### **Materials used in ferrocement**

Cement mortar mix Skeleton steel

Steel mesh reinforcement or Fibre-reinforced polymeric meshes

### **Cement mortar mix**

OPC and fine aggregate matrix is used

The matrix constitutes 95% of the composite and governs its behavior FA (sand), occupies 60 to 75% of the volume of the mortar

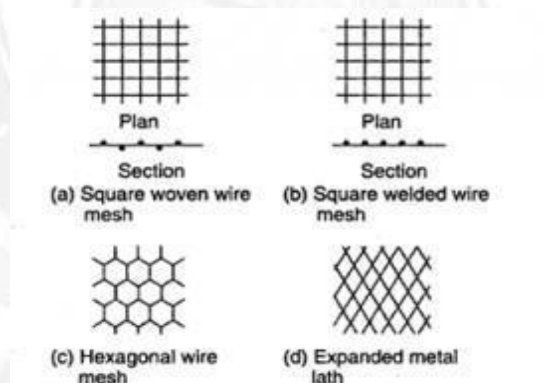
Plasticizers and other admixtures are used

### 3.7.1 SKELETON 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 .

#### Steel Mesh Reinforcement

Consists of galvanized steel wires of diameter 0.5 to 1.5 mm, spaced at 6 to 20mm centre to centre. Available as woven/interlocking mesh and welded mesh Welded wire mesh has hexagonal or rectangular openings .Expanded- metal lath is also used .



#### Advantages of Ferrocement:

Greater Tensile strength

It's simple techniques require a minimum of skilled labor

The materials are relatively inexpensive, and can usually be obtained locally Only a few simple hand tools are needed to build uncomplicated structures Repairs are usually easy and inexpensive

No upkeep is necessary

Structures are rot-proof, insect-proof, and rat-proof, and non-flammable

Structures are highly waterproof, and give off no odors in a moist environment; Structures have unobstructed interior room

Structures are strong and have good impact resistance

Structures can be shaped in any form.

**Disadvantages of Ferro cement:**

Its heavy in weight and its poor impact resistance

Structures made of ican be punctured by forceful collision with pointed objects. The large amount of labor is required

It is not possible to nail, screw, or weld to Ferro cement.