Unit 6

Module 2

Self compacting concrete (SCC)

- Self compacting concrete (SCC) can be defined as fresh concrete that flows under its own weight and does not require external vibration to undergo compaction.
- It is used in the construction where it is hard to use vibrators for consolidation of concrete.
- Filling and passing ability, segregation resistance are the properties of self compacting concrete.
- SCC possess superior flow ability in its fresh state that performs self compaction and material consolidation without segregation issues.

Fig.1: Self Compacting Concrete (SCC); Image Courtesy: OpenPR

Materials Used for Self Compacting Concrete

- The main ingredients used in design of self compacting concrete are:
- **1. Cement**
- Ordinary Portland cement either 43 or 53 grade cement can be used.
- **2. Aggregates**
- The size of the aggregates used for SCC design is limited to 20mm. If the reinforcement employed for the structure is congested, the aggregate size used can be in the range 10 to 12mm. Well graded aggregates either round or cubical shape are a best choice. The fine aggregates used in SCC can be either natural aggregates or manufactured aggregates (M- Sand) with a uniform grade. The fine aggregates with particle size less than 0.125mm are generally employed
- **3. Water**
- The quality of water used is same that followed for reinforced concrete and prestressed concrete construction.

4. Mineral Admixtures

- The mineral admixtures used can vary based on the mix design and properties required.
- *Mentioned below are the different mineral admixtures that can be used and their respective properties they provide.*
- **Ground Granulated Blast Furnace Slag (GGBS):** The use of GGBS helps to improve the rheological properties of the self compacting concrete.
- **Fly ash:** The fine fly ash particles help to improve the filling of the internal concrete matrix with fewer pores. This improves the quality and durability of the SCC structures.
- **Silica Fumes:** The use of silica fumes helps to increase the mechanical properties of the self compacting concrete structure.
- **Stone Powder:** The use of stone powder in SCC is used to improve the powder content of the mix.

5. Chemical Admixtures

- New generation superplasticizers are commonly used in SCC mix design. In order to improve the freeze and thaw resistance of the concrete structure, air entraining agents are used.
- To control the setting time, retarders are employed.

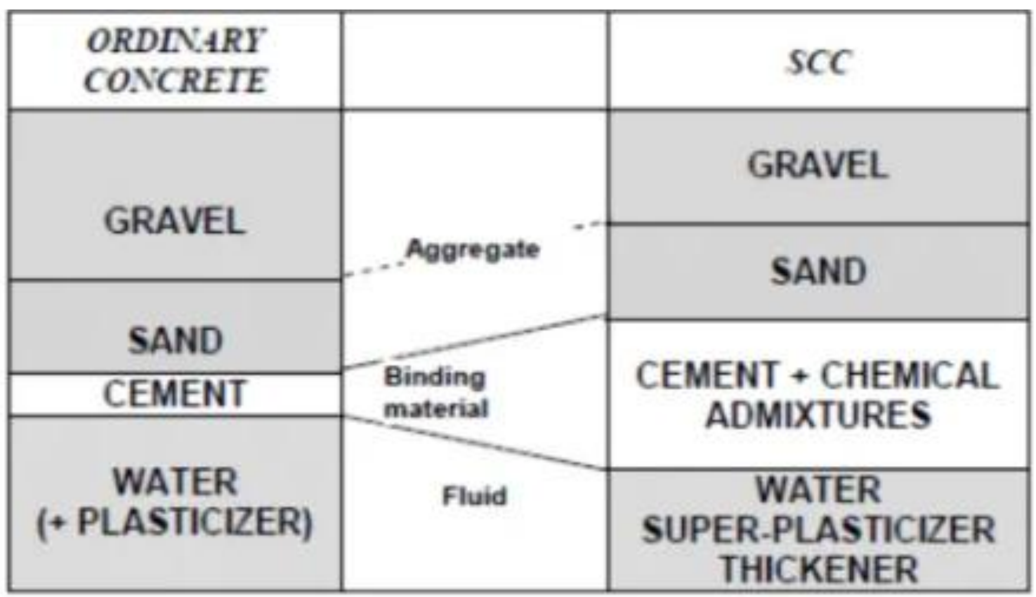


Fig.2: Material Composition of Ordinary Concrete and SCC

- The requirements of the self compacting concrete are achieved by the properties in its fresh state.
- The three main properties of SCC are:
- **Filling Ability:** This property of the concrete is the ability to flow under its own weight without any vibration provided intentionally.
- **Passing Ability:** This property is the ability of the concrete to maintain its homogeneity.
- **Segregation resistance:** This is the resistance of the concrete not to undergo segregation when it flows during the self compaction process

Advantages of self compacting concrete

- The permeability of the concrete structure is decreased
- SCC enables freedom in designing concrete structures
- The SCC construction is faster
- The problems associated with vibration is eliminated
- The concrete is placed with ease, which results in large cost saving
- The quality of the construction is increase
- The durability and reliability of the concrete structure is high compared to normal concrete structures
- Noise from vibration is reduced. This also reduce the hand arm vibration syndrome issues

Disadvantages of Self Compacting Concrete

- SCC construction face the following limitations:
- There is no globally accepted test standard to undergo SCC mix design
- The cost of construction is costlier than the conventional concrete construction
- The use of designed mix will require more trial batches and lab tests
- The measurement and monitoring must be more precise.
- The material selection for SCC is more stringent

Applications of Self Compacting Concrete

- The major applications of self compacting concrete are:
- Construction of structures with complicated reinforcement
- SCC is used for repairs, restoration and renewal construction
- Highly stable and durable retaining walls are constructed with the help of SCC
- SCC is employed in the construction of raft and pile foundations

High-performance concrete (HPC)

- High-performance concrete (HPC) is produced by careful selection and proportioning of its constituents namely cement, sand, gravel, cementitious materials such as fly ash; silica fume; and slag, and chemical admixtures for instance high range water reducing admixtures.
- The strength and durability of the high-performance concrete exceed that of ordinary concrete.
- However, it has many features such as high strength, smooth fracture surface, low permeability, discontinuous pore, etc. which are different from those of ordinary concrete.
- This is due to low water to cementitious material ratio, and the presence of cementitious materials and chemical admixtures. Curing of HPC is considerably important and critical curing period runs from placement or finishing up to 2 to 3 days later

Composition of High-Performance Concrete

- The composition of high-performance concrete usually consists of the following materials:
- **Cement:**
- Chemical and physical properties of cement can help in selecting desired cement to produce high-performance concrete.
- For instance, cement with low C3A is the most desired type of cement to produce high-performance concrete because the C3A creates incompatibility of cement with a superplasticizer.
- Additionally, the rheology of cement containing low C3A can be controlled easily. Nonetheless, a certain quantity of C3A is important for cement from a strength point of view.

- **2. Water**
- Water is a crucial component in high-performance concrete which should be compatible with cement and mineral/chemical admixtures.
- **3. Fine Aggregate**
- Coarse fine aggregate is desired compared to finer sand to produce high-performance concrete since finer sand increases the water demand of concrete.
- **4. Coarse Aggregate**
- The selection of coarse aggregate is crucial since it may control the strength of high-performance concrete.
- **5. Superplasticizer**
- It is an essential component of high-performance concrete that is added into the concrete mix to reduce water to cement ratio.

- **6. Cementitious Materials**
- The cementitious component of high or any combination of cementitious material such as slag, fly ash, silica fume.
- ***TYPES OF SUPPLEMENTARY CEMENTITIOUS MATERIALS :***
- The most commonly used supplementing cementitious materials/mineral admixtures for achieving HPC are :
- 1. Silica Fume
- 2. Fly Ash
- 3. GGBFS(Ground granulated blast furnace slag)

- **1 Silica Fume:**
- Silica fume is a waste by-product of the production of silicon and silicon alloys.
- Silica fume is available in different forms, of which the most commonly used now is in a densified form. In developed countries it is already available readily blended with cement.
- It is possible to make high strength concrete without silica fume, at compressive strength of upto 98 Mpa. Beyond that strength level however, silica fume becomes essential. With silica fume it is easier to make HPC for strengths between 63-98 Mpa.

- **2 Fly Ash:**
- Fly Ash of course, been used extensively in concrete for many years.
- Fly ash is , unfortunately, much more variable than silica fumes in both their physical and chemical characteristics.
- Most fly ashes will result in strengths of not more than 70 Mpa.
- Therefore for higher strengths, silica fume must be used in conjunction with fly ash.
- For high strength concrete, fly ash is used at dosage rates of about 15 % of cement content.

- **GGBFS:**
- Slags are suitable for use in high strength concrete at dosage rates between 15-30 %.
- However, for very high strengths, in excess of 98Mpa, it is necessary to use the slag in conjunction with silica fumes.

Features of High-Performance Concrete

- Compressive strength > 80 MPa ,even up to 800 MPa
- High-performance concrete is quite brittle but the introduction of fibers and can improve ductility.
- High durability
- Water binder ratio (0.25-0.35), therefore very little free water
- Reduced flocculation of cement grains
- Wide range of grain sizes
- Densified cement paste
- Low bleeding and plastic shrinkage
- Less capillary porosity is achieved through the use of low water to cementitious materials that produce dense microstructure, hence migration of aggressive elements would be difficult. Hence, durability improved greatly.

- Discontinuous pores
- Stronger transition zone at the interface between cement paste and aggregate
- Low free lime content
- Endogenous shrinkage
- Powerful confinement of aggregates
- Little micro-cracking
- Smooth fracture surface
- Low heat of hydration

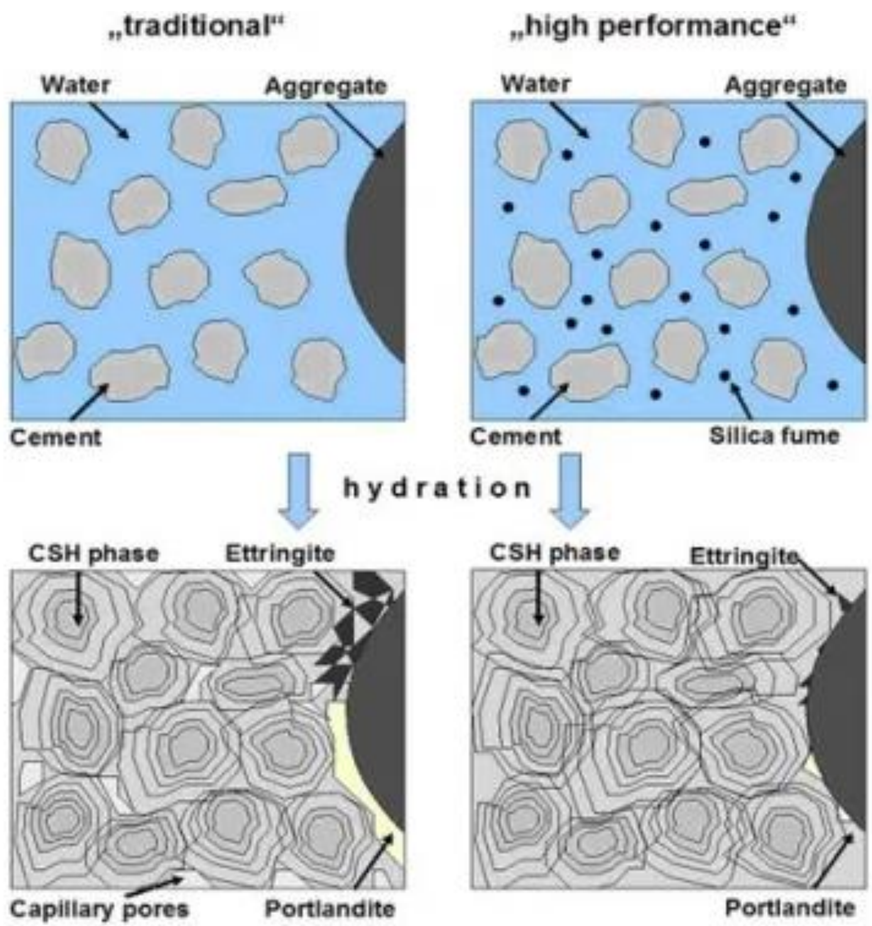


Fig. 2: Hydration of Normal Concrete Versus High Performance Concrete

What is Precast Concrete ?

- Precast concrete means a concrete member that is cast and cured at a location other than its final designated location. The use of reinforced concrete is a relatively recent invention, usually dated to 1848 when jean-Louis Lambot became the first to use it. Joseph Monier, a French gardener, patented a design for reinforced garden tubs in 1868, and later patented reinforced concrete beams and posts for railway and road guardrails.

Advantages of Precast Concrete Construction

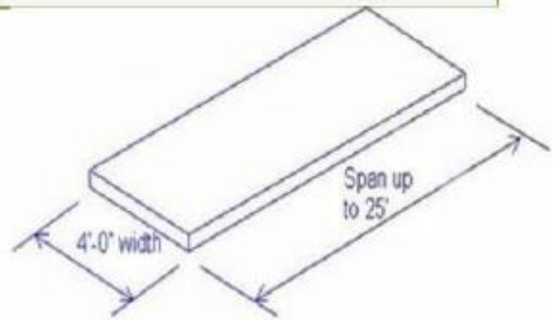
- Very rapid speed of erection
- Good quality control
- Entire building can be precast-walls, floors , beams , etc.
- Rapid construction on site
- High quality because of the controlled conditions in the factory
- Prestressing is easily done which can reduce the size and number of the structural members.

Disadvantages of Precast Concrete Construction

- Very heavy members
- Camber in beams and slabs
- Very small margin for error
- Connections may be difficult
- Somewhat limited building design flexibility
- Because panel size is limited, precast concrete can not be used for two-way structural systems.
- Economics of scale demand regularly shaped buildings.
- Need for repetition of forms will affect building design.
- Joints between panels are often expensive and complicated.
- Skilled workmanship is required in the application of the panel on site.
- Cranes are required to lift panels.

Slabs:

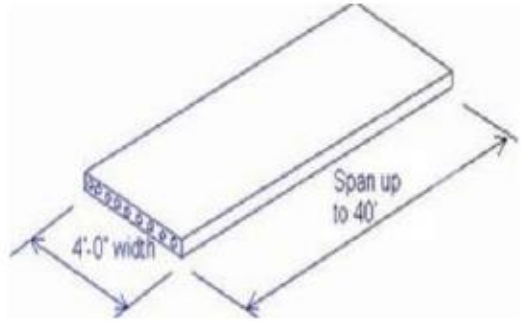
- a) Flat slab -



- Thickness of 4", 6" and 8"
- Spans up to 25'-0"
- Standard panel width = 4'-0"
- Typical designations = FS4 (FS = Flat Slab, 4 = thickness of slab in inches)

- precast concrete

- b) Hollow Core slab -



- Thicknesses of 4", 6", 8", 10" and 12"
- Spans up to 40'-0"
- Standard panel width = 4'-0"
- Typical designations = 4HC6 (4 = panel width in feet, HC = Hollow Core, 6 = slab thickness in inches)

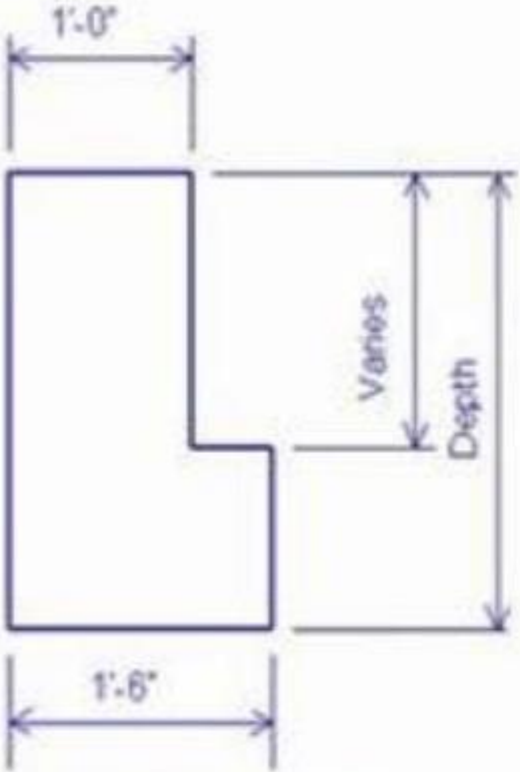
Beams:

- a) Rectangular Beam (RB) -

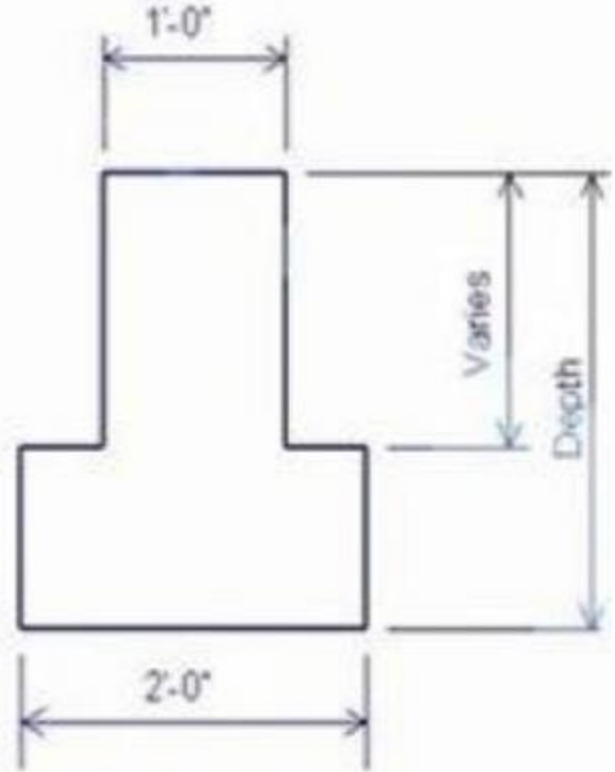
- Typical beam width = 12" or 16"
- Spans up to 50'-0"
- Typical designation = 16RB24 (16 = width in inches, 24 = depth in inches)

- b) "L" and "IT" (inverted "Tee") beams (LB and IT) -

- Typically used to support slabs, walls, masonry, and beams
- Typical beam width = 12"
- Depths of 20", 28", 36", 44", 52" and 60"



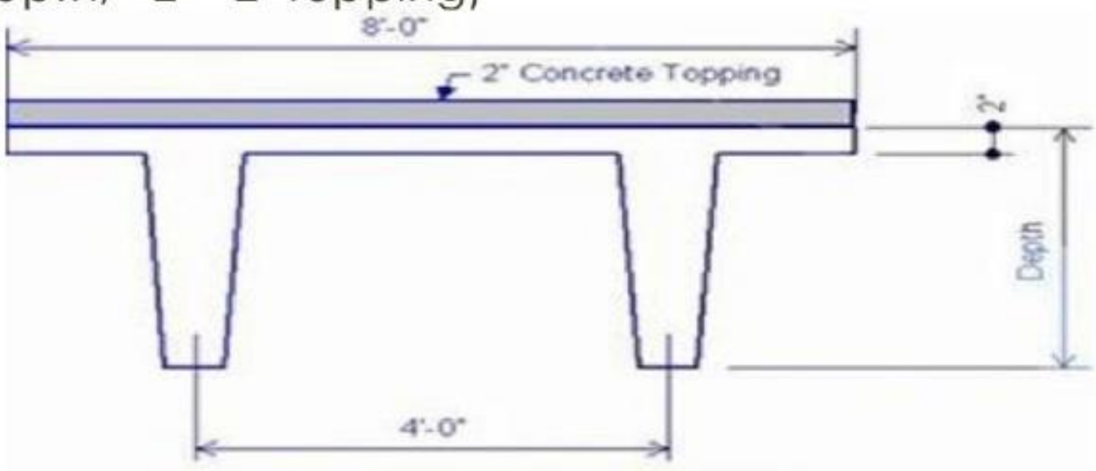
Typical Precast "L" Beam



Typical Precast "IT" Beam

c) Double Tee Beam (DT) -

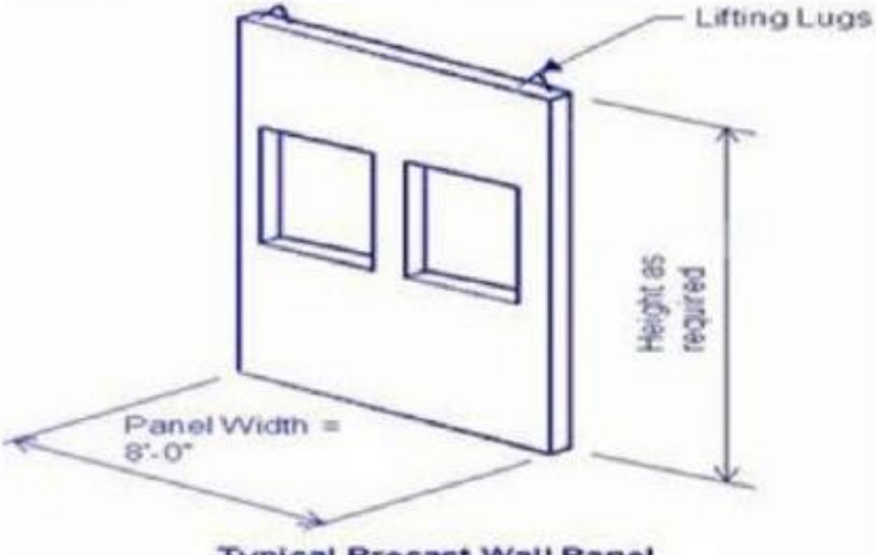
- Combination beam and slab
- Spans up to 100'-0"
- Typical width = 8'-0"
- Depths of 12", 18", 24" and 32"
- Designation = 8DT24+2 (8 = width in feet, 24 = depth, +2 = 2" topping)



Typical Precast Double Tee Beam

Walls:

Wall panels available in standard 8'-0" widths.
Can be flat, or have architectural features such as window and door openings, ribs, reveals, textures, sandwich (insulation built-in), sculptured, etc.



Typical Precast Wall Panel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