

Module - 5

Special Concrete

Types of Special Concrete:

Special Concrete means the concrete used or made for special cases, such as:

Frequently, concrete may be used for some special purpose for which special properties are more important than those commonly considered. Sometimes, it may be of great importance to enhance one of the ordinary properties. These special applications often become apparent as new development using new materials or as improvements using the basic materials. Some utilize special aggregates (lightweight aggregate, steel fiber, plastic fiber, glass fiber, and special heavy aggregate).

Some special properties — increased compressive and tensile strength, water proofing, and improved chemical resistance are achieved with polymers, either as admixtures or surface treatment of hardened concrete. Admixtures for coloring concrete are available in all colors. The oldest and cheapest is perhaps carbon black. Admixtures causing expansion for use in sealing cracks or under machine bases, etc., include powdered aluminum and finely ground iron. Special admixtures are available for use where the natural aggregate is alkali reactive, to neutralize this reaction. Proprietary admixtures are available that increase the tensile strength or bond strength of concrete. They are useful for making repairs to concrete surfaces.

Why special concrete is needed?

Uses and Applications of Special Concrete

1. Special concrete is used in extreme weather.
2. HPC has been used in large structures such as the Petronas Towers and the Troll Platform. Petronas Towers was the tallest concrete building in the world built in Malaysia in the mid-1990s. In 1998, the deepest offshore platform, the Troll platform, was built in Norway — a structure taller than the Eiffel Tower.

3. Good cohesiveness or sticky in mixes with very high binder content
4. Some delay in setting times depending on the compatibility of cement, fly ash and chemical admixture
5. Slightly lower but sufficient early strength for most applications
6. Comparable flexural strength and elastic modulus
7. Better drying shrinkage and significantly lower creep
8. Good protection to steel reinforcement in high chloride environment
9. Excellent durability in aggressive sulphate environments
10. Lower heat characteristics
11. Low resistance to de-icing salt scaling
12. PC pipes with good resistance to chemical attack from both acidic and caustic effluents inside the pipe, and from chemical attack on the outside of the pipe.

1. Economy of High Performance Lightweight Concrete

Purpose of high performance lightweight concrete utilization is to reduce cost or enhance functionality of the structure or the combination thereof. The economy of high performance lightweight concrete is discussed.

One might argue that, the production of high performance lightweight concrete is greater than that of normal weight concrete. However, it should be known that the increased cost would not surpass 1%. This increased cost would be easily offset by other economical superiority that high performance lightweight concrete offers.

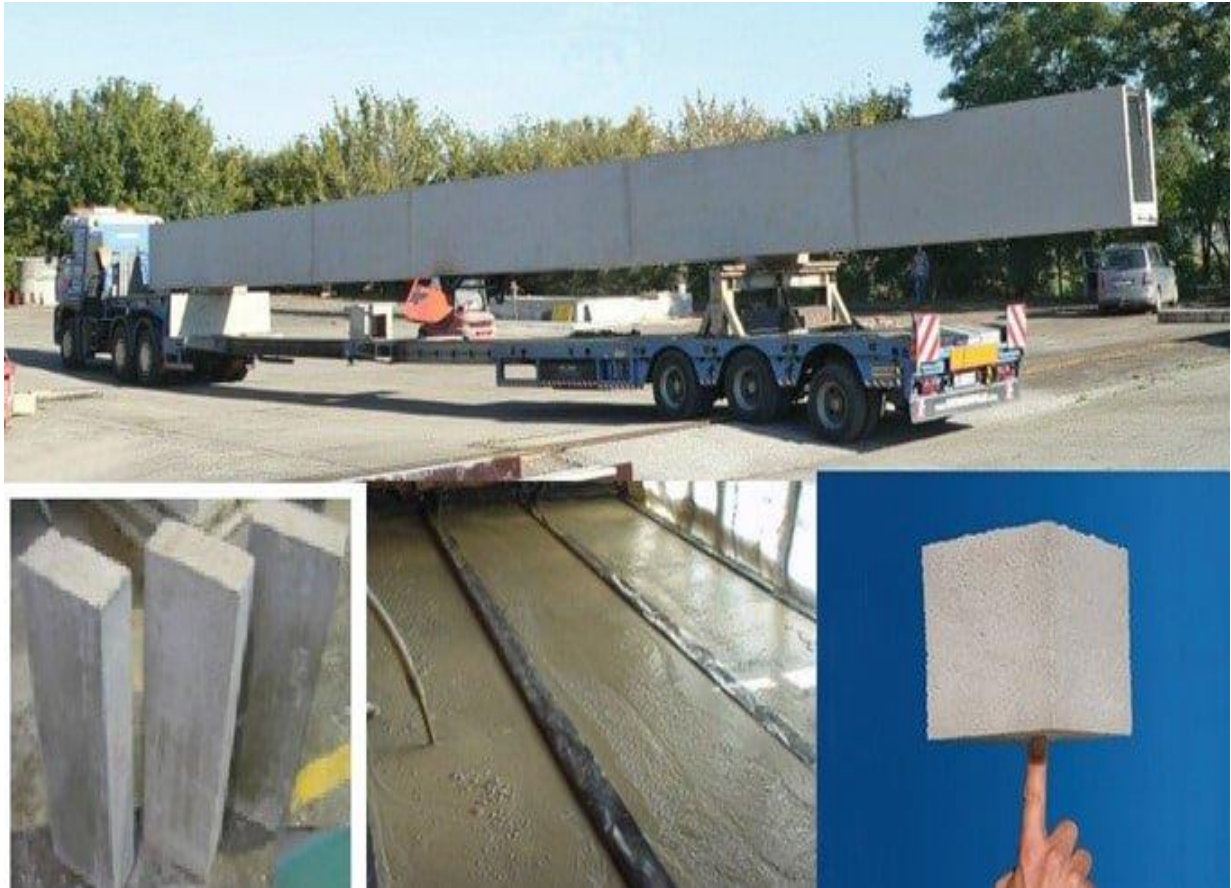


Fig.1: High Performance Lightweight Concrete

2. Economy of High Performance Light Weight Concrete

The economy of high performance lightweight concrete is explained through the following points:

1. It reduces dead load of superstructure and hence the foundation would receive smaller loads. As a result, the size of foundation would be smaller, lesser number of piles are required, smaller pile cap will be needed, and lastly, fewer reinforcement ratio will be used.
2. Because of dead load reduction, smaller sizes of superstructure members such as beams, columns, deck, girder, and piers will be needed. This will lead to decline the cost considerably.
3. Dead load reduction lead to smaller inertia forces during earthquakes. This will reduce the extent of deterioration that the structure might suffer and hence cost of rehabilitation will be smaller.

4. Comparatively, long spans can be achieved when high performance lightweight concrete is used to construct precast-prestressed members without increasing total mass. As a result, not only fewer columns or piers will be required in the structural system but also lesser joints will be needed which simplify and ease erection process.

It is reported that, the cost of precast-prestressed high performance lightweight concrete delivery is also declined which easily offset the increased cost of using high performance lightweight concrete.

5. High performance lightweight concrete allows easy movements of marine platforms when they moved out of dry docks and move through shallow water channels. This is because high performance lightweight concrete lead to increase top side loads and decline draft of the structure.

6. High performance lightweight concrete increases fire resistance of concrete members. That is why the thickness of slabs can be declined and hence considerable volume of concrete can be reduced as well.

7. In the case of bridge structure repairing, the deck of the bridge can be widened using high performance lightweight concrete instead of existed conventional concrete without increasing total loads and other elements of the structure.

This is considerably significant since the capacity of the bridge is increased which is crucial aspect of this type of concrete from economical perspective.

8. Due to that fact that high performance lightweight concrete reduces dead load of the element, then it is possible to increase concrete cover over reinforcement bars which increase the durability of the structure.

Subsequently, the structure would require less frequent maintenance which is another economical advantage of high performance lightweight concrete.

9. Thermal insulation is another important property of high performance lightweight concrete which is considerably significant especially for thermal sensitive structures such as hot water storage, petroleum storage or building insulation.

This property might make the structure adequately thermal resistant or if higher degree of insulation is needed, then the cost of insulation application would not be that much if conventional concrete were used for the construction of the building.

Lightweight concrete

Lightweight concretes can either be lightweight aggregate concrete, foamed concrete or autoclaved aerated concrete (AAC). Lightweight concrete blocks are often used in house construction.

Lightweight aggregate concrete

Lightweight aggregate concrete can be produced using a variety of lightweight aggregates.

Lightweight aggregates originate from either:

- Natural materials, like volcanic pumice.
- The thermal treatment of natural raw materials like clay, slate or shale i.e. Leca.
- Manufacture from industrial by-products such as fly ash, i.e. Lytag.
- Processing of industrial by-products such as pelletised expanded slab, i.e. Pellite.

The required properties of the lightweight concrete will have a bearing on the best type of lightweight aggregate to use. If little structural requirement, but high thermal insulation properties, are needed then a light, weak aggregate can be used. This will result in relatively low strength concrete.

Foamed concrete

Foamed concrete is a highly workable, low-density material which can incorporate up to 50 per cent entrained air. It is generally self-levelling, self-compacting and may be pumped. Foamed concrete is ideal for filling redundant voids such as disused fuel tanks, sewer systems, pipelines, and culverts - particularly where access is difficult. It is a recognised medium for the reinstatement of temporary road trenches. Good thermal insulation properties make foamed concrete also suitable for sub-screeds and filling under-floor voids.

Lightweight structural concrete

Lightweight aggregate concretes can be used for structural applications, with strengths equivalent to normal weight concrete.

The benefits of using lightweight aggregate concrete include:

- Reduction in dead loads making savings in foundations and reinforcement.
- Improved thermal properties.
- Improved fire resistance.
- Savings in transporting and handling precast units on site.
- Reduction in formwork and propping.

The elastic modulus of lightweight concretes is lower than the equivalent strength normal weight concrete, but when considering the deflection of a slab or beam, this is counteracted by the reduced self-weight.

The basic design for lightweight concrete is covered in Eurocode 2 Part 1-1, with section 11 having particular rules required for lightweight aggregate concretes. Concrete is considered to be lightweight if the density is not more than 2200kg/m^3 (the density of normal weight concrete is assumed to be between 2300kg/m^3 and 2400kg/m^3) and a proportion of the aggregate should have a density of less than 2000kg/m^3 . Lightweight concrete can be specified using the notation LC for the strength class, e.g LC30/33, which denotes a lightweight concrete with a cylinder strength of 30MPa and a cube strength of 33MPa.

The lighter the concrete, the greater are the differences to be accounted for in the properties of the concrete. The tensile strength, ultimate strains and shear strengths are all lower than a normal weight concrete with the same cylinder strength. Lightweight concretes are also less stiff than the equivalent normal strength concrete. However, this is mitigated by the reduction in self-weight to be carried, so the overall effect tends to be a slight reduction in the depth of a beam or slab.

Creep and shrinkage for lightweight concretes are higher than that for the equivalent normal weight concrete, and this should be taken into account when designing the structure.

Batching of lightweight concretes is normally done from ready-mixed concrete producers. At low workabilities, the concrete can easily be placed by skip or chute. Pumping lightweight concrete can be achieved, but care needs to be taken so that the concrete mix doesn't separate. For pumpable mixes it is usual to use a natural sand, i.e. not to have a lightweight aggregate for the fine portion of the mix and to have a high workability so that increased pump friction and blockage is avoided. This is achieved with the use of admixtures. Over vibration of a lightweight concrete tends to cause segregation so a flowing concrete is best used when it is to

be pumped as it requires only minimum vibration. More information can be found in Concrete Quarterly Winter 2015.

Autoclaved aerated concrete (AAC)

AAC was first commercially produced in 1923 in Sweden. Since then, AAC construction systems such as masonry units, reinforced floor/roof and wall panels and lintels have been used on all continents and every climatic condition. AAC can also be sawn by hand, sculpted and penetrated by nails, screws and fixings.

Self-compacting concrete (SCC)

Self-compacting concrete (SCC) is a flowing concrete that does not require vibration and, indeed, should not be vibrated. It uses superplasticisers and stabilisers to significantly increase the ease and rate of flow. It achieves compaction into every part of the mould or formwork simply by means of its own weight without any segregation of the coarse aggregate.

The consistence of the concrete is specified and measured as a flow rate rather than the normal slump.test.

SCC offers:

- Health and safety benefits (as no vibration is required).
- Faster construction times.
- Increased workability and ease of flow around heavy reinforcement.
- Excellent durability.

Having no need for vibrating equipment spares workers from exposure to vibration. No vibration equipment also means quieter construction sites.