Special types of concrete

Based on unit weight, concrete can be classified into three categories

- **Normal weight concrete**: concrete containing natural sand and gravel or crashed rock aggregate, weight about 2400 kg/m^3.And usually used for structural purposes.
- **Lightweight concrete**: concrete containing certain natural or pyro-processed aggregate having lower bulk density, and weighting less than 1850 kg/m^3.
- **Heavyweight concrete**: used for radiation shielding, produced from high-density aggregate, and weighting more than 3200 kg/m^3.

Concrete can be divided into three general categories based on compressive strength.

- **Low strength concrete**: less than 20 MPa compressive strength.
- **Medium- strength concrete**: 20-40 MPa compressive strength.
- **High-strength concrete**: more than 40 MPa compressive strength.

There are numerous modified concrete such as:

- Fiber reinforced concrete
- Self-compacted concrete
- Mass concrete

Light weight concrete

Light weight concrete (LWC)

- Concrete whose density (unit weight) is appreciably lower than the usual range of 2200 to 2600 Kg/m^3.
- Practical ranges of densities of LWC are between 300-1850 Kg/m^3 depending on the purpose of using concrete
- Lower density is for insulating concrete
- Higher density is for structural concrete

Advantage

1-Lowering the self -weight of the concrete ⟶ use of smaller sections
⟶ Reduction in the size of foundations

2-The formwork need withstand a lower pressure

3-The total weight of materials to be handled is reduced and that increase in productivity.

4- Gives better thermal insulation than ordinary concrete.

5- Most of lightweight concrete have better nailing and sawing properties than heavier and stronger conventional concrete

Disadvantage

Compared with ordinary concrete LWC

1-Have lower strength

2-Have lower resistance to abrasion

3-More expensive

4- More care should be given to mixing, handling and placing operations.

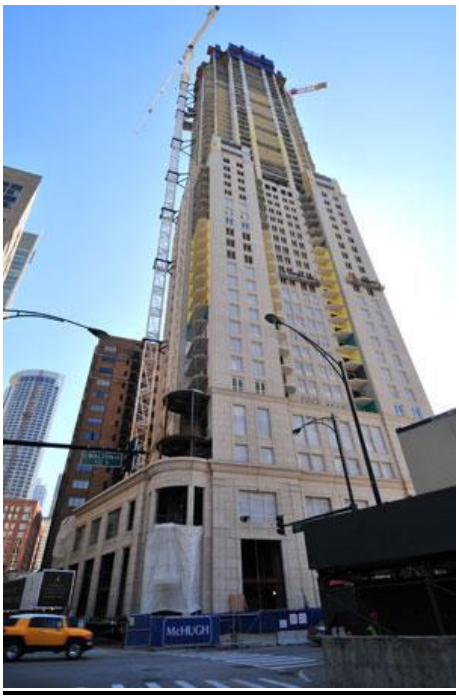

Figure (1) lightweight building

Classification of Lightweight concrete (LWC)

a)Classification of LWC according to method of production

It is convenient to classify the various types of lightweight concrete by their method of production. These are:-

1. By using porous lightweight aggregate of low apparent specific gravity, i.e. lower than 2.6. This type of concrete is known as lightweight aggregate concrete.

2. By introducing large voids within the concrete or mortar mass; these voids should be clearly distinguished from the extremely fine voids produced by air entrainment. This types of concrete is variously knows as aerated, cellular, foamed or gas concrete.

3. By omitting the fine aggregate from the mix so that a large number of interstitial voids are present; normal weight coarse aggregate is generally used. This concrete is no-fines concrete.

b) Classification of LWC according to the purpose for which it is to be used

LWC can also be classified according to the purpose for which it is to be used: it can distinguish between structural lightweight concrete, concrete used in masonry units, and insulating concrete

1. Structural LWC, which has a 28-day air dry density not exceeding 1850 kg/m^3; as its name implies, this concrete is used for structural purposes and has a minimum compressive strength of 17MPa. The thermal insulation values for structural LWC are substantially better than NWC.
2. Insulating concrete (Low-density concrete), which has a density between 300 and 800 kg/m^3; this concrete is used for non-structural purpose, mainly for thermal insulation purposes, heat insulation value are high. The compressive strength is low, ranges from 0.7 to 7 MPa.
3. Moderate strength concrete, which fall about midway between the structural and low density concrete, its compressive strength is between 7-17MPa and the thermal insulation values are intermediate.

Types of Lightweight Concrete

1 . Lightweight Aggregate Concrete (LWAC)

In the early 1950s, the use of lightweight concrete blocks was accepted in the UK for load bearing walls. Soon thereafter the development and

production of new types of artificial LWA (Lightweight aggregate) made it possible to introduce LWC of high strength, suitable for structural work.

Light weight aggregate

The essential characteristic of lightweight aggregate is its high porosity and low apparent specific gravity .lightweight aggregate may be

a) Natural aggregate

Main aggregate in this category are (pumice, scoria, volcanic cinders, and tuff) from volcanic origin

b) Artificial aggregate

Artificial aggregate are classified on the basis of the low material used and the method of manufacture. They are (Expanded clay, shale, slate, perlite vermiculite, expanded blast furnace slag, and clinker aggregate).

Properties of LWAC

Compared with NWC, concrete made with LWA

- Aggregates absorb significant volumes of water
- Workability if LWAC is low
- Mixes tend to segregate
- Aggregates are expensive
- High cement contents increases cost per cubic meter.
- Design strength of (21-34) MPa 28 days compressive strength are common, which can be increased with partial or completed replacement of LW fine with natural sand
- Exhibit higher moisture movement , higher rate of drying shrinkage
- Resistance to abrasion is low, replacement of LW fine with natural sand improve the abrasion resistance.

Classification of light weight aggregate concrete

1) Insulating concrete (low density concrete)
2) Moderate strength concrete
3) Structural concrete

2.Aerated Concrete

Aerated concrete is a lightweight, cellular material consisting of cement and sand. It does not contain coarse aggregate, and can be regarded as an aerated mortar. Typically, aerated concrete is made by introducing air or other gas into a cement slurry and fine sand. In commercial practice, the sand is replaced by pulverized fuel ash or other siliceous material, and lime may be used instead of cement. There are two methods to prepare the aerated concrete:-

1-Gas concrete: is produced by injecting the gas into the mixing (fresh mortar) during its plastic condition by means of a chemical reaction.

Suitable materials

- Finely divided Al powder (0.2% by weight of cement) is most commonly used. Reaction of active powder with $Ca(OH)_2$ or alkalis liberates hydrogen which forms the bubbles.
- Powdered zinc or AL alloy can also be used.
- Hydrogen peroxide which generate O_2 can be used

2- Foamed concrete: produced by adding foaming agent to the mix (hydrolyzed protein or resin soap) or using an air-entraining agent which introduces and stabilizes air bubbles during mixing.

The first method is usually used in precast concrete factories where the precast units are subsequently autoclaved in order to produce concrete

with a reasonable high strength and low drying shrinkage. The second method is mainly used for in-situ concrete, suitable for insulation roof screeds. Figure 2 shows the aerated concrete.

Figure (2) :The aerated concrete

For the equal densities of concrete, the strength of high pressure steam cured concrete is about twice that of air-cured concrete. Therefore, air-cured aerated concrete is used where little strength is required e.g. roof screeds, while aerated concrete used as a structural material is usually high-pressure steam-cured. It is thus factory-made and available to the user in precast units only, for floors, walls and roofs. Larger units are reinforced with steel bars to resist damage through transport, handling and superimposed loads.

3. No Fines Concrete

The term no-fines concrete generally means concrete composed of cement water and coarse aggregate only.

No-fines concrete is thus an agglomeration of coarse aggregate particles, each surrounded by a coating of cement paste up to about 1.3 mm thick. Therefore, large pores within the body of the concrete are responsible for its low strength, and no capillary movement of water can take place.

Properties

1. No-fines concrete does not segregate; it can be dropped from a considerable height.
2. The density is about two-third or three quarters that of dense concrete made with the same aggregates (1800-2000) kg/m^3.
3. The compressive strength of no-fines concrete (6-20) MPa, is considerably lower than that of normal-weight concrete. The strength of no-fines concrete increases as the cement content is increased. However, it is sensitive to the water composition. Insufficient water can cause lack of cohesion between the particles and therefore, subsequent loss in strength of the concrete.
4. Shrinkage is lower than that of NWC because the cement paste is present as a thin coating only.

The application

No-fines concrete is almost cast in situ mainly as load bearing and non-load bearing for external and internal walls and partitions. But sometimes as filling below solids ground floors

Figure (3): No-fines concrete