



**SNS COLLEGE OF TECHNOLOGY, COIMBATORE-35
(AN AUTONOMOUS INSTITUTION)**



UNIT IV TECHNIQUES FOR REPAIR AND DEMOLITION

16CE425 – REPAIR AND REHABILITATION OF STRUCTURES

**PRESENTED BY,
Dr.O.R.KAVITHA
ASSOC PROFESSOR
DEPT. OF CIVIL ENGINEERING
SNS COLLEGE OF TECHNOLOGY**

3/12/2020

16CE 425/ RRS/Maintenance & Repair



FOAMED CONCRETE

1) Foam concrete is a type of porous concrete. According to its features and uses it is similar to aerated concrete. The synonyms are:

1) Aerated concrete

2) Lightweight concrete

3) Porous concrete

- Light weight concrete - or foamed concrete - is a versatile material which consists primarily of a cement based mortar mixed with at least 20% of volume air.
- It possesses high flow ability, low self-weight, minimal consumption of aggregate, controlled low strength and excellent thermal insulation properties.
- It can have a range of dry densities, typically from 400 kg/m³ to 1600 kg/m³ and a range of compressive strengths, 1 MPa to 15 MPa .





- Foamed Concrete can be placed easily, by pumping if necessary, and does not require compaction, vibrating or levelling.
- It has excellent resistance to water and frost, and provides a high level of both sound and thermal insulation.

History

- Foamed concrete has a surprisingly long history and was first patented in 1923, mainly for use as an insulation material
- The first comprehensive review on foamed concrete was presented by Valore in 1954 and a detailed treatment by Rudnai and Short and Kinniburgh in 1963, summarising the composition, properties and significant improvements over the past 20 years in production equipment and better quality surfactants (foaming agents) has enabled the use of foamed concrete on a larger scale.
- Significant improvements over the past 20 years in production equipment and better quality surfactants (foaming agents) has enabled the use of foamed concrete on a larger scale.



Constituent materials

1) Constituents of base mix

2) Foam

1) Constituents of base mix

- Ordinary Portland cement, Rapid hardening Portland cement and, high alumina and Calcium Sulfoaluminate have been used for reducing the setting time and to improve the early strength of foame concrete.
- Fly ash and ground granulated blast furnace slag have been used in the range of 30–70% and 10–50%, respectively and as cement replacement to reduce the cost, enhance consistence of mix and to reduce heat of hydration while contributing towards long term strength.
- Silica fume up to 10% by mass of cement has been added to intensify the strength of cement. Alternate fine aggregates, viz., fly ash and lime, chalk and crushed concrete, recycled glass, foundry sand and were used either to reduce the density of foam concrete.



Constituent materials

1) Constituents of base mix

2) Foam

1) Constituents of base mix

- Ordinary Portland cement, Rapid hardening Portland cement and , high alumina and Calcium Sulfoaluminate have been used for reducing the setting time and to improve the early strength of foame concrete.
- Fly ash and ground granulated blast furnace slag have been used in the range of 30–70% and 10–50%, respectively and as cement replacement to reduce the cost, enhance consistence of mix and to reduce heat of hydration while contributing towards long term strength.
- Silica fume up to 10% by mass of cement has been added to intensify the strength of cement . Alternate fine aggregates, viz., fly ash and lime, chalk and crushed concrete , recycled glass, foundry sand and were used either to reduce the density of foam concrete .



- The water requirement for a mix depends upon the composition and use of admixtures and is governed by the consistency and stability of the mix .

2)Foam

Foam concrete is produced either by :-

1) pre-foaming method

2) mixed foaming method

- Pre-foaming method comprises of producing base mix and stable preformed aqueous foam separately and then thoroughly blending foam into the base mix.
- In mixed foaming, the surface active agent is mixed along with base mix ingredients and during the process of mixing, foam is produced resulting in cellular structure in concrete .

❖ MAKING OF FOAMED CONCRETE

- 1) The components of foam concrete mix should be set by their functional role in order as follows:
- 2) foaming agent
- 3) binding agent
- 4) water
- 5) aggregate

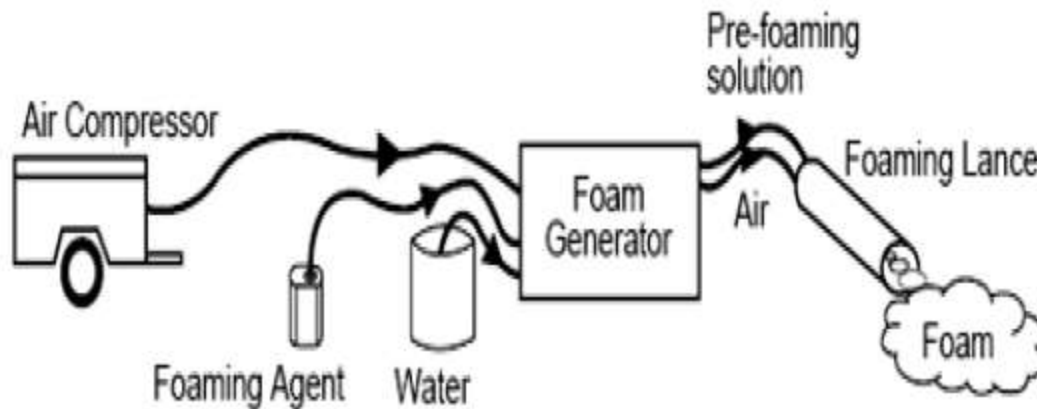


❖ Making the Slurry

- The cement used for the slurry is usually Type 1 Portland Cement although other cements can be used. If sand is specified in the mix design ideally it should be fine with 2mm maximum size and 60 to 90% passing through a 600 micron sieve(8).
- The water:cement ratio of the slurry is usually between 0.5 and 0.6. If necessary more water can be added to increased the workability.
- The slurry can be made using a ready mix truck mixer. Firstly, the cement mortar slurry is made at the batching



plant, according to the mix design, by either the DRY or WET method.

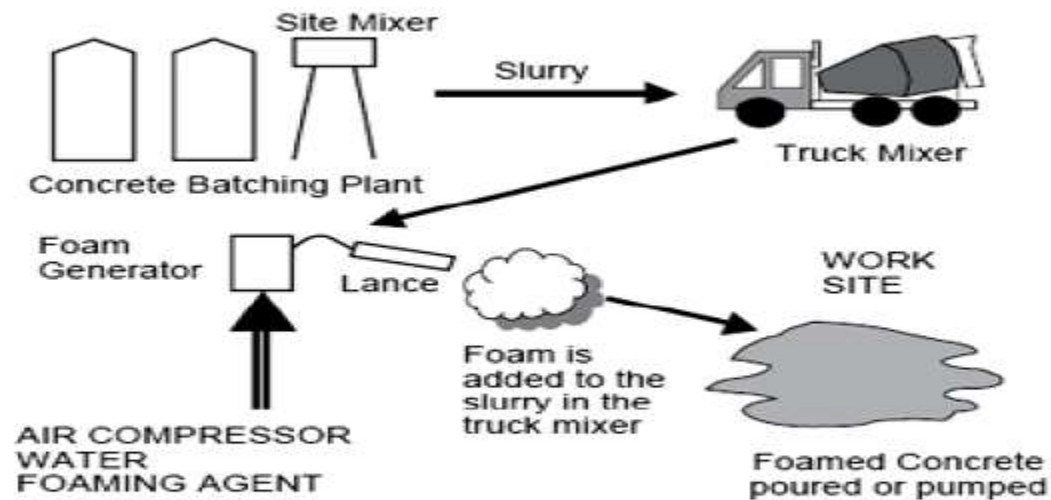


Making foam from foaming agent, water and compressed air.

- Foam for foamed concrete is made from a concentrated Foaming Agent. The foam is made using a foam generator. In the foam generator the foaming agent is diluted in water to make a prefoaming solution and then the pre-foaming solution is expanded with air into foam. The bubbles are stable and able to resist the physical and



❖ Making Foamed Concrete



A Schematic diagram showing the stages involved when making foamed concrete.



❖ **Fresh state properties**

- As foam concrete cannot be subjected to compaction or vibration the foam concrete should have flow ability and self-compact ability. These two properties are evaluated in terms of consistency and stability of foam concrete.

❖ **Consistency**

- Flow time using marsh cone and flow cone spread tests are adopted to assess the consistency of foam concrete.
- The consistency reduces with an increase in volume of foam in the mix, which may be attributed to the (i) reduced self-weight and greater cohesion resulting from higher air content .
- adhesion between the bubbles and solid particles in the mix increases the stiffness of the mix.

❖ **Stability**

- The stability of foam concrete is the consistency at which the density ratio is nearly one (the measured fresh density/design density), without any segregation and bleeding .



❖ **Physical properties**

□ **Drying shrinkage**

- Foam concrete possesses high drying shrinkage due to the absence of aggregates, i.e., up to 10 times greater than those observed on normal weight concrete.
- Autoclaving is reported to reduce the drying shrinkage significantly by 12–50% of that of moist-cured concrete due to a change in mineralogical compositions.
- The shrinkage of foam concrete reduces with density which is attributed to the lower paste content affecting the shrinkage in low-density mixes.

Low Density and High Strength

- Due to its low density, foam concrete imposes little vertical stress on the substructure - a particularly important attribute in areas sensitive to settlement .
- Heavier density (1000 kg/m^3+) foam concrete is mainly used for applications where water ingress would be an issue - infilling cellars, or in the construction of roof slabs for example.



❖ **Well-Bonded Body**

- Foam concrete forms a rigid, well-bonded body after hydrating. It is effectively a free-standing (monolithic) structure and once hardened, does not impose lateral loads on adjacent structures.

❖ **Self Levelling**

- ✓ Foam concrete is naturally self-levelling and self-compacting, filling the smallest voids, cavities and seams within the pouring area.
- ✓ In excavations with poor soils that cannot be easily compacted, foam concrete forms a 100% compacted foundation over the soft sub-soil. Compaction of conventional, granular backfill against retaining structures or deep foundations can cause damage or movement to



❖ **Compressive strength**

- The compressive strength decreases exponentially with a reduction in density of foam concrete .
- The parameters affecting the strength of foam concrete are cement–sand and water–cement ratios, curing regime, type and particle size distribution of sand and type of foaming agent used.



- For dry density of foam concrete between 500 and 1000 kg/m³, the compressive strength decreases with an increase in void diameter.
- For densities higher than 1000 kg/m³, as the air-voids are far apart to have an influence on the compressive strength, the composition of the paste determines the compressive strength .

Flexural and tensile strengths

- Splitting tensile strengths of foam concrete are lower than those of equivalent normal weight and lightweight aggregate concrete with higher values observed for mixes with sand than those with fly ash.
- Use of Polypropylene fibers has been reported to enhance the performance with respect to tensile and flexural strength of foam concrete.

❖ Durability of foam concrete

- Permeation characteristics
- Resistance to aggressive environment

❖ Permeation characteristics

- *Water absorption:* Water absorption of foam concrete decreases with a reduction in density, which is attributed to lower paste volume phase and thus to the lower capillary pore volume.



- The oxygen and water vapour permeability of foam concrete have been observed to increase with increasing porosity and fly ash content.
- ❖ *Sorptivity* : The moisture transport phenomenon in porous materials has been defined by an easily measurable property called sorptivity (absorbing and transmitting water by capillarity), which is based on unsaturated flow theory .
- Sorptivity of foam concrete is reported to be lower than the corresponding base mix and the values reduce with an increase in foam volume.

Resistance to aggressive environment

- Foam concrete mixture designed at low density taking into consideration of depth of initial penetration, absorption and absorption rate, provided good freeze-thaw resistance
- Sulphate resistance of foam concrete, reveals that foam concrete has good resistance to aggressive chemical attack.



❖ **Functional characteristics**

- **Fire resistance**
- **Thermal insulation**
- ❖ **Thermal insulation**
 - Foam concrete has excellent thermal insulating properties due to its cellular microstructure.
 - The thermal conductivity of foam concrete of density 1000 kg/m^3 is reported to be one-sixth the value of typical cement–sand mortar.

❖ **Fire resistance**

- Foam concrete is extremely fire resistant and well suited to applications where fire is a risk.
- Test have shown that in addition to prolonged fire protection, the application of intense heat, such as a high energy flame held close to the surface, does not cause the concrete to spall or explode as is the case with normal dense weight concrete.



Advantages of Foamed Concrete

- 1) Does not settle, hence requires no compaction.
 - 2) Lightweight - does not impose large loadings.
 - 3) Free flowing - spreads to fill all voids.
 - 4) Excellent load spreading characteristics.
 - 5) Once placed requires no maintenance.
 - Does not impose significant lateral loads.
 - Reliable quality control - batches are easy to reproduce .
 - Resistant to freeze-thaw cycle (1000 cycles of -180c to+200C).
 - Low water absorption over time.
- Non-hazardous either during application or in service.
 - Highly cost effective compared with other methods.
 - Enables fast work.
 - Sufficiently strong and durable for most applications.

Applications of Foamed Concrete

- **Building Blocks** : Blocks and panels can be made for partition and load bearing walls. They can be made with almost any dimensions.
- **Floor Screed**: Foamed concrete can be used for floor screeds, creating a flat surface on uneven ground and raising floor levels.



❖ ROOFING

- **Roof Insulation:** Foamed Concrete is used extensively for roof insulation and for making a slope on flat roofs. It has good thermal insulation properties and because it is lightweight foamed concrete does not impose a large loading on the building.

**ANY QUESTIONS
???????**