

1. Definition

Foamed concrete has been defined as a cementitious material, with a minimum of 20% (per volume) foam entrained into the plastic mortar. (As no coarse aggregate is used in foamed concrete, the term concrete is, strictly speaking, inappropriate). Foamed concrete is often referred to as cellular concrete. It is produced by entrapping numerous small bubbles of air in cement paste or mortar.

2. Constituents

The main constituents used to make foamed concrete are cement, foaming agent, water and fine sand. Admixtures, lightweight aggregates, fibres and fly ash are also sometimes used.

Cement

All cement sold in South Africa must meet the requirements of SANS 50197 for Common cement or SANS 50413 for Masonry cement and the National Regulator for Compulsory Standards (NRCS) requirements as detailed in NRCS VC9085. Bags should be clearly marked with the strength grade, notation indicating composition and a Letter of Authority (LOA) number issued by the NRCS. An LOA is issued for each cement type from each source. To verify valid LOA numbers contact the NRCS on 012 428 5199 or www.nrccs.org.za.

Note that Masonry cements complying with SANS 50413 are not permitted to be used in concrete and are not suitable for the use in foamed concrete.

Foaming agents

The two main types of foaming agents are:

- Hydrolysed proteins.
- Synthetic surfactants.

The foaming agents should produce bubbles that are spherical, regular in shape and size, and stable with strong walls. The air bubbles must be able to resist the physical and chemical forces imposed during mixing, placing and hardening.

Sand

If sand is used it is typically finer than 2 mm and with a high proportion smaller than 600 microns.

Admixtures

Plasticisers, viscosity modifiers, accelerators and water-proofing agents have been used in foamed concrete. Extensive testing should be performed to check for the suitability of the admixture to be used.

Fibres

Polypropylene fibres can be added to improve the compressive strength, stiffness and shear strength of foamed concrete.

3. Production

Production of foamed concrete involves the production of foam, the production of the cement paste or mortar and finally the blending of the foam with the paste or mortar.

3.1 Foam production

Foam can be manufactured in two different ways. These are:

- Wet foam. In this method a solution of foaming agent and water are sprayed over a fine mesh resulting in bubbles that are typically larger than 2 mm but smaller than 5 mm.
- Dry foam. This is produced by forcing a mixture of foaming agent and water through a special nozzle with compressed air.

3.2 Blending of foam and cement/mortar

Mechanical production of foamed concrete can take place by using an inline or pre-foam system as described below.

Inline systems

There are two types of inline systems. A *wet method*, that involves the blending of foam with the cement/mortar slurry through inline mixers, and a *dry method* in which the dry ingredients are mixed with water and then pumped into a blending chamber into which the foam is also added and then pumped to the point of placement.

Pre-foam system

In this method a given quantity of cement or mortar slurry is blended with a measured amount of foam in a conventional mixer such as a ready-mix concrete truck.

4. Properties

Foamed concrete can be produced on a small or large scale on site. It is relatively easy to place and finish without heavy or expensive equipment. Foamed concrete is self-compacting, free flowing and pumpable and, therefore, easy to place in inaccessible places. It has good thermal and acoustic properties and is also frost resistant. It is however too weak for direct exposure to traffic and hail and should be protected by a wearing layer of conventional concrete or asphalt.

Typical properties of foamed concrete are listed in Table 1. It is standard practice to classify foamed concrete according to the dry density thereof, as indicated in Table 1. This density is determined from oven-dried specimens and the actual density of foamed concrete would usually be higher than this density as there would generally be evaporable water present in foamed concrete. The presence of water in foamed concrete elements also results in an increase in thermal conductivity.

5. Applications

Since the introduction of cellular concrete systems to the construction industry over 50 years ago, the use of foamed concrete has been almost exclusively limited to non-structural void filling, thermal insulation, acoustic damping, trench filling for reinstatement of roads and for building blocks. In the Netherlands foamed concrete has been used not only for level corrections in housing developments, but also as a fill material where ground subsidence has taken place and as a founding layer for road works on very weak soils.

However the development of synthetic and protein-hydrolysis-based foaming agents and specialised foam generating equipment has allowed for the production of foam with stable and isolated bubbles that remain intact, making it possible to manufacture foamed concrete with lower permeability and suitable for structural applications.

In recent years foamed concrete has been used as a structural material in schools, apartments and housing developments.

For information on suppliers of foamed concrete, or materials for foamed concrete, contact Cement & Concrete SA Information Centre.

Historically, foamed concrete has been perceived to be weak and non-durable with high shrinkage characteristics. Unstable foams have in the past resulted in foamed concrete having properties unsuitable for reinforced, structural applications. Unprotected reinforcement in foamed concrete in which the voids are interconnected would be vulnerable to corrosion even when the external attack is not very severe.

Table 1: Typical properties of foamed concrete

Dry density, kg/m ³	Compressive strength, MPa	Elastic modulus, GPa	Thermal conductivity, W/m. K
400	1	1	0,1
600	1,5	1,5	0,11
800	2	2,5	0,2
1000	5	3	0,3
1200	10	4	0,4
1400	15	6	0,55
1600	25	12	0,65

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Published by Cement & Concrete SA, Midrand, 2021

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