ISSN:2319-6890(online),2347-5013(print)
8 & 9 Jan 2016

Cellular Concrete & its facets of application in Civil Engineering

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Abstract -- Cellular Concrete is a cementitious paste of neat cement or cement & fine sand with a multitude of micro / macroscopic discrete air cells uniformly distributed throughout the mixture to create a lightweight concrete. The concrete is manufactured in two methods viz. First by mixing a pre-formed foam (surfactant) or mix-foaming agents mixture into the cement & water slurry with the hardening of concrete, the bubbles disintegrate leaving air voids of similar sizes. Second designated as Autoclaved Aerated Concrete (AAC), consisting of a mix of lime, sand, cement, water & an expansion agent. The bubble is made by adding expansion agents (aluminum powder or hydrogen peroxide) to the mix during the mixing process. This creates a chemical reaction that generates gas, either as hydrogen or as oxygen to form a gas-bubble structure within the concrete to be molded. Each mold is filled to one-half of its depth with the slurry. The gasification process begins & the mixture expands to fill the mold above the top similar to baking a cake. After the initial setting, it is cured under high-pressured-steam (180° to 210°C / 356°to 410°F) "autoclaved" for a specific amount of time to produce the final micro / macro-structure. HPCC has is an excellent insulator & significantly reduces the transfer of heat through concrete member. With a low water absorption, high tensile strength, high fire resistance & sound retention, this corrects deficiencies in the sand reducing bleeding. Besides structural forms cellular concrete finds application in as Flowable Fill or Controlled Low Strength Material (CLSM), Low Density Controlled Low Strength Material (LD-CLSM) which is a an engineered backfill material used as an alternative to compacted fill that can make backfill faster, being self-leveling, making total compaction within a few hours of placement. Compressive strengths can be adjusted according to the project requirements. Placing as a permanent material or permitting re-excavation at a later date is the paramount advantage of this material.

Keywords: Cellular Concrete, CLSM, Foam Concrete, CLC, HySSIL

1. Introduction: Foam concrete, Aerated Concrete, Lightweight Concrete, Porous Concrete

Foam concrete is a type of porous concrete. According to its features & uses it is similar to aerated concrete. Foamed concrete has been defined in several ways; indeed it has number of synonyms such as cellular concrete & there is confusion between foamed concrete & similar materials such as air-entrained concrete. A definition, cited by Jones (2005), is that foamed concrete is a cementation material having a minimum of 20 percent (by volume) of mechanically entrained foam in the plastic mortar.

1.1 The synonyms are: ***Gas or Aerated concrete, Lightweight concrete, Porous concrete.***

1.1.1 Gas or aerated concrete, where the bubbles are chemically formed through the reaction of aluminum powder with calcium hydroxide & other alkalis released by cement hydration.

1.1.2 *Lightweight Concrete*

- Light weight concrete - or foamed concrete - is a versatile material which consist primarily a cement based mortar mixed with at least 20% by volume air.
- It has high flow ability, low self-weight, minimal consumption of aggregate, controlled low strength & excellent thermal insulation properties.
- It can have a range of dry densities, typically from 400 kgm^{-3} to 1600 kgm^{-3} & a range of compressive strengths 1 MPa to 15 MPa.
- Foamed Concrete can be placed easily, by pumping, if necessary, & does not require compaction, vibrating or leveling.
- It has excellent resistance to water & frost, providing a high level of both sound & thermal insulation.

1.2 *History*

Cellular Concrete was first developed in Stockholm, Sweden in the early 1900's. The original material was known as *"gas concrete"* to be used in producing heat-insulated building materials. After the Second World War, this technology quickly spread to different parts of the world, mostly Europe & in the Soviet Union. These were used in site reconstruction & in low-rise structures. The first comprehensive review on foamed concrete was presented by Valore in 1954 & a detailed treatment by Rudnai, Short & Kinniburgh in 1963, summarizing the composition, properly. Significant improvements over the past 25 years in production equipment & better quality surfactants (foaming agents) has enabled the use of foamed concrete on a larger scale. Significant improvements over the past 25 years in production equipment & better quality surfactants (foaming agents) has enabled the use of foamed concrete on a larger scale.
The first large foamed concrete project in the UK was completed in 1980 at the Falkirk Railway Tunnel in Scotland. The first author was involved in the same from contractor's side. Around 4500 m^3 of 1100 kgm^{-3} bulk density foamed concrete was placed in the annulus space surrounding the tunnel. The largest project in the UK required around 70,000 m^3 of 500 kgm^{-3} foamed concrete encapsulating the utilities supply pipe & cable in the road foundation at Canary Wharf, London, where also the first author was involved. Significant improvements in production

methods & quality of foaming agent over the last 20 years have lead to increased production of wide range of application such as blocks, void fill & road. From there on, the use of foamed concrete has been widely spread across world-wide (Andrew & William, 1978).

In India, "FOAM CONCRETE INDIA" is a sister concern of Pavertech Constructions (P) Ltd solely catering to customers who have requirements of foam concrete (cellular lightweight concrete) in all aspects with its head office at New Delhi. Concrete design has evolved rapidly in the last 40 years. Emphasis has been placed on creating more durable concrete through jugglery in the mix constituents & proportions, including the aggregates, admixtures & the water-cement ratio. These changes have been reflected in national & hopefully will lead to global / international design, standards, performance, specifications & eventually codes. Improvements in factors as performance, durability, permeability, binder (cement) constituent ratios, & limitations on impurities. This evolution, along with improved reinforcing steel strength, has lead to modifications in design philosophy - most notably the use of thinner structural members.

1.3 *Comparison between foam concrete & conventional concrete*

Lightweight foamed concrete made with combination of cement, water, fine aggregate & foam agent have very fine pore structure, unlike that made with conventional concrete. Foam or bubbling agent is used to absorb humidity, for as long as the product is exposed to the atmosphere, allowing the hydration process of the cement to continue for its ever-continuing strength development. As in a normal concrete the greater the air content the weaker is the material, so with foamed concrete densities ranging from 300 to 1700 kgm^{-3} it is not surprising that the lower densities produce the lower strengths & at present even the densities at the upper limits do not produce strengths much above 15 MPa (Aldridge, 2005).

2. Manufacturing

Foamed concrete is produced by entrapping numerous small bubbles of air in cement paste or mortar. Mechanical foaming can take place in two principal ways:

- By pre-foaming a suitable foaming agent with water & then combining the foam with paste or mortar.
- By adding a quantity of foaming agent to the slurry & whisking the mixture into a stable mass with the required density.

To get a high performance & quality foamed concrete, the selection of the materials are very important. The various materials, equipment & procedure are discussed separately below :.

2.1 *Raw Materials*

Fly ash

- min. 20% fines
- Cement, preference Ordinary Portland Cement (OPC)
- Water for foam production : Potable
- Foaming Agent
- Fibre : Polypropylene
- Lightweight Aggregate
- Admixtures

The major raw materials of HySSIL cellular lightweight concrete are cements, pozzolanic additives, selected sand, water, extra cement additive & HySSIL activator compound (air-entrainer). One of the main differences, when compared to normal concrete, is that HySSIL concrete does not contain coarse aggregates. Protein based foaming agents like ***Greenforth*** & ***Kemilite PR*** are normally used.

2.1.1 *Portland Cement*

There are many types of Portland cement, high alumina cement, super sulphate & special cement as masonry cement. As per ASTM standard the type I, II, III is preferred to use, because of its fineness & chemical composition.

However, Ordinary Portland Cement [to BS 12:1996 (*IS: 8112:1989*) or BS EN 197: Part 1: 2000 (*IS 1489-1 (1991))*] is usually used as tile main binder for foamed concrete. However rapid-hardening Portland cement to BS 915:1983 *(IS 6452 (B) (1989))* has also been used & it is questionable why sulphate resisting cement could not be used ?

Portland cement is essentially calcium silicate cement, which is produced by firing to partial fusion/calcination, at high temperature approximately 1500 Cº. It has different rheological & strength characteristics, especially used in combination with chemical admixtures & supplementary cementing materials/mineral admixtures. Therefore, it is necessary to look at its fitness & chemistry while choosing.

2.1.2 *Fine aggregate*

Generally the fine aggregate shall consist of natural sand, manufactured sand or combination of them. The fine aggregate for concrete that are subjected to wetting, exposed to humid atmosphere, or in contact with moist ground shall not contain any material that are deleteriously reactive in cement to cause excessive expansion of mortar concrete.

Only fine sands suitable for concrete [as per BS 882:1992 *(IS 383:1970)*] or mortar [as per BS 1200: 1976 *(IS 2116 (1980)*] having particle sizes up to about 4 mm & with an even distribution of sizes should be used for foamed concrete. This is mainly because coarser aggregate might settle in a lightweight mix & lead to collapse of the foam during mixing.

2.1.3 Water

The water used for foamed concrete should be potable. This is crucial when using a protein based foaming agent because organic contamination can have an adverse effect on the quality of the foam, & subsequently on the concrete produced.

The water/cement (or binder) (w/c) ratio of the base mix required to achieve adequate workability is dependent upon the type of binder(s), the required strength of the concrete, & whether or not a water reducing or a plasticizing admixture has been used. In most cases w/c ration will be between 0.4 & 0.8. The higher values are required with finer grained binders, such

ISSN:2319-6890(online),2347-5013(print)
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as PFA, while the lower values are necessary either when a high strength is required or a super plasticizer has been employed.

Where the water content of the mix would be inadequate to ensure full hydration of the cement, the water will be extracted from the foam & might lead to its disintegration. On the other hand whilst high w/c ratios do not significantly affect the porosity of the foamed concrete, they do promote segregation & increase drying shrinkage (Gambhir, 2004).

2.1.4 *Foamed Agent*

Synthetic or protein-based foaming agents (surfactants) can be used to produce foam. Because of the possibility of degradation by bacteria & other microbes, natural protein based agents (i.e. fatty acid soaps) are rarely used to produce foamed concrete for civil engineering works. However research is underway on the use of protein-based agents for developing high strength, i.e. the chemical composition of a surfactant must be stable in the alkaline environment of concrete. As all surfactants are susceptible to deterioration at low temperatures they should be stored accordingly. The properties of foamed concrete are critically dependent upon the quality of the foam. There are two types of foaming agent:

I. Synthetic-suitable for densities of 1000 kgm^{-3} & above.

II. Protein-suitable for densities from 400 to 1600 kgm^{-3}.

Protein-based foaming agents come from animal proteins (horn, blood, bones of cows, pigs & other remainders of animal carcasses). These surfactants might therefore be best suited to the production of foamed concrete of relatively high density & high strength. Optimum performance of foam is commonly attained at a ratio of 1:25, but the optimum value is a function of the type of surfactant & the method of production (Gambhir, 2004).

2.2 *Method of Mixing*

Batching & mixing of HySSIL is similar to that of normal strength concrete.

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 2 mm maximum size & with a grading of 60 to 90% passing through a 600 μ sieve (8).

The water-cement ratio of the slurry is usually between 0.5 & 0.6. If necessary more water can be added to increase 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.

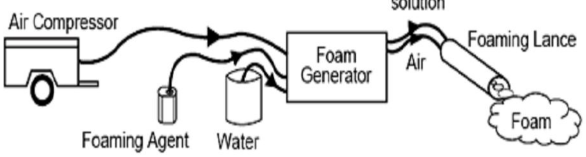

Figure 1
Schematic Details of Foam Concrete production

The process should start with the sand & cement. Dry constituents have to be mixed for a few minutes & water in stages have to be added & made sure that the mixing is thorough (mortar slurry preparation). Then preparation is pre-foamed by diluting the foam agent with water & extracted by using foam generator & air compressor. After that, foam is added to the wet slurry & it is ensured that foam has been completely mixed with the mortar. After mixing is completed the wet density of the foamed concrete is checked & matched to what is required!

There is no chemical reaction involved when the pre-foam is added into the cement mortar. Introduction of pores is achieved through mechanical means either by pre-foaming (foaming agent mixed with part of mixing water) or mix foaming (foaming agent mixed with the mortar) (Yew, 2007). Figure 2 below shows manufacturing process of foamed concrete.

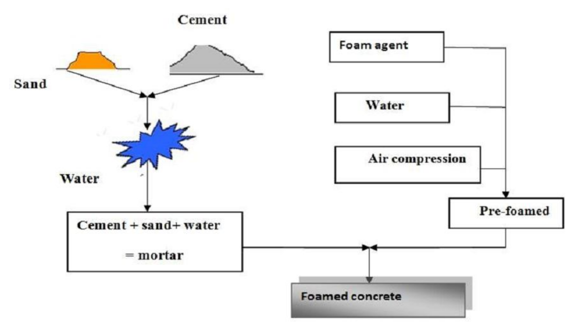

Figure 2 Manufacturing Process of Foamed Concrete

Pre-formed foaming is preferred to mix-foaming technique due to the following advantages:

(i) Lower foaming agent requirement.

(ii) A close relationship between the amount of foaming agent used & air content of a mix.

2.3 *Required Equipment*

The production of foamed concrete is a fairly easy process which does not involve any expensive or heavy machinery & in most cases uses equipment that is readily available for normal concrete/mortar production are used. That include:

- MFG / MFG-A Foam Generator
- Conventional mixers, pan-mixer, truck-mixer
- Conventional conveying system (buckets, concrete pumps, etc.)
- Conventional moulds, horizontal/vertical
- Formwork (if pre- cast components are required to be produced)

2.4 *Curing of Foam Concrete*

Curing is a process of preventing fleshly placed concrete from drying it first, during the first day of its life to minimize any tendency to cracking & allow it to develop concrete strength. Cellular concrete is generally air-cured. Curing might be accelerated by applying heat, steam or chemicals. A curing compound prevents excessive loss of water after casting & consequently increases strength.

ISSN:2319-6890(online),2347-5013(print)
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There are different methods of curing that affect the concrete properties as:

- Water curing
- Sheet curing
- Membrane curing &
- Air curing

2.5 ***Demoulding of cast elements***

Depending upon the outside temperature & upon the cement quality used, building elements of cellular concrete may be stripped 6 -10 hours after casting. As with traditional dense concrete curing on the yard or on the site, should be facilitated by keeping the demoulded elements, under moisture for a few days.

2.6 ***Ageing of Foam concrete***

Using the same basic components as for dense concrete, viz., sand, cement & water, & considering that "neopor" foam has no chemical reaction in concrete besides serving as a wrapping material for the air bubbles embedded, ageing of cellular concrete virtually carries on infinitely & as long as the cement used draws humidity from the air.

3 Properties of Foam Concrete

Concrete can be distinguished into two distinct phases; the fresh/green concrete & the hardened concrete. Three main properties should be controlled in fresh concrete; workability, consistency & cohesiveness. On the other hand, for hardened concrete, the strength is the most important property of concrete. The physical properties of foamed concrete are closely related to its density, which can be regarded therefore as the main design criterion. It is also dependent on material mix & the way of mix.

Type of foam concrete	Sort of foam concrete according to average density	Non-autoclave foam concrete	
		28 day compressive strength MPa	Thermal Conductivity W/m K
Heat-insulated	D400	1	0.1
	D500	1.4	0.12
Constructional-heat-insulated	D600	3.5	0.14
	D700	5	0.18
	D800	7	0.21
	D1000	10	0.24
Constructional	D1100	14	0.34
	D1200	17	0.38

Several studies investigated the physical & mechanical properties of foamed concrete cast in different densities & with or without fine aggregates in the mix. Because the density of cellular concrete may be varied over a wide range 320- 1920 kgm^{-3}.

Beneficial properties associated with cellular concrete include:

• Workability
• Stability
• Durability
• Flow-ability
• Self-leveling
• Self-compaction
• Thermal insulation
• Fire resistance
• Mold resistance
• Sound absorption
• Seismic resistance
• Permeability
• Energy absorption
• Density
• Strength
• Walk-ability (in roof deck & flooring applications)
• Nail-ability & saw-ability (in pre-cast manufacturing)

Range of densities : 400-1800 kgm^{-3}
Achievable strength : 1.0-25.0 MPa
Shrinkage behavior : 1200 kgm^{-3} – 0.215 mm m^{-1}
Dense concrete – 0.145 mm m^{-1}
Thermal conductivity : 0.082-0.555 (W/m K)
Dense concrete – 2.1 (W/m K)
Fire rating : non-combustible DIN 4164
Water absorption : approx. 5 % at a density of 1200 kgm^{-3} no condensation closed cellular structure.

Recommended usage of CLC based on density:

- 300-600 kgm^{-3}: This density is primarily applied for thermal insulation or fire protection. It uses only cement (or little fly ash), water & foam & can easily be pumped. Foam generators allow the production of stiff foam for slopes to be applied on roof-tops.
- 700-800 kgm^{-3}: Is also used for void-filling, such as a landscaping (above underground construction), to fill voids behind archways & refurbishing of damaged sewerage systems. It is also been used to produce building blocks.
- 900-1100 kgm^{-3}: Serves produce blocks & other non-load bearing building elements mostly, such as balcony railings, partitions, parapets & fence walls etc.
- 1200-1400 kgm^{-3}: These are the most commonly used densities for prefab & cast in situ walls, load-bearing & non-load-bearing. It is also successfully used for floor screeds (sound & insulation, plus weight reduction).
- 1600-1800 kgm^{-3}: Recommended for slabs & other load-bearing building elements, where higher strength is obligatory.

4 Advantages of Foam Concrete

Foam contributes to the reduction of building dead weight thus resulting in more economic structural design. Production of more economic structural design will reduce the amount of material used & eventually cutting down the cost of construction project itself resulting in profit increase to the contractor. Besides that, other researchers add that the lightness of structure makes it easier to be transported & handled. In addition, it also has a very low thermal conductivity that makes it an excellent fire protection material for use in property (John& Ban Choo, 2003). Some of advantages are explained below:

4.1 ***Reduction of dead load***

The reduction in foundation loads may result in smaller footing, fewer piles, smaller pile caps, & less reinforcing. Reduced dead loads may result in smaller supporting members (decks, beams, girder, & piers) resulting in major reduction in cost & result in larger space availability. Reduced dead load would mean reduced inertial seismic forces. Lighter & smaller pre-cast elements need smaller & less expensive handling & transporting equipment.

4.2 ***Savings in Raw Material***

The tremendous savings described when using CLC are manifold, continuing with substantial savings in raw material as here no gravel is required, depleting the dead load of high-rise structure, reducing it by almost half. Considering that a substantial amount of steel is necessary only to carry the weight of the structure, steel requirement might reduce by hundreds of ton in a high rise, resulting in economy & wastage of tax-payers fund.

4.3 ***Considerably Lower Weight***

Weight reduction is obviously beneficial in transport, where almost half of the mass of building material being used transportation cost is also reduced considerably, impacting crane usage, where either larger panels can be erected, or the full capacity in span. Alternatively less relocation of the crane is necessary.

4.4 ***Thermal Insulation***

Thermal Insulation increasingly turns to be the most important issue in the planning & construction of buildings. There are many costly ways of insulation on sandwich structure of a wall, adding the one or another rigid insulation material, with a satisfactory result by computation, but not always a sound solution in safety, health or environment is achieved. Incorporation of thermal insulation in the concrete mix is the best solution, as offered in air-cured CLC.

4.5 ***Fire Protection***

The air-embedded in the CLC is also instrumental for the high fire rating. In 1200 kgm^{-3} density a 13-14 cm thick wall has a fire endurance of 5 hours. The same delay occurs with a 400 kgm^{-3} layer of CLC in only 10 cm thickness. CLC is otherwise non-combustible.

4.6 ***Sound Insulation***

As the thermal capacity of building members is better the other aspects such as sound insulation is also good. Sound is experienced as air-borne or foot-fall sound (impact). Being air-borne it is the rule of density & therefore CLC offers superior protection than very light concrete (ACC). In impact sound it is superior to conventional concrete. Hitting a wall with a hammer, will let you feel the full force on the other side, whilst the air embedded in CLC dampens /prevents the blow to pass through. It will suffer a small dent & thereby prevent any larger damage.

4.7 ***Economical Production***

Using only fly ash, cement, water & foam, the cost for one m^3 of CLC in most cases is less, even than for the equivalent volume of conventional concrete. Adding all the described highly appreciated benefits (comprising CLC) to regular concrete, if at all possible, the cost for such regular concrete would probably double, but still the overall quality of CLC is unreachable.

4.8 ***Self leveling / Self compacting***

Foam concrete is naturally self-leveling & self-compacting, filling the smallest voids, cavities & seams within the pouring area. In excavations in 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 the adjacent structure. In these situations, foam concrete with its reduced lateral loading is a safe solution.

4.9 ***Speedier Constructions***

The absence of gravel coupled with the ball-bearing effect of the foam, lends cellular concrete much higher consistency. No vibration is necessary when pouring cellular concrete into moulds/forms. It distributes evenly & fills all voids completely ensuring uniform density all over the material. In this way full-height walls of a complete building (all internal & external walls) can be poured in-situ in one step/cast, thus speeding-up the construction considerably.

4.10 ***Saving time & cost***

Foam concrete is an economically viable solution, particularly in large volume applications, where its use can also have an effect on other aspects of construction.

- From the above advantages is clear that all lead to save money & time.
- Durability of foam concrete means, lower maintenance costs.
- High volume equipment with rapid installation reduces installed unit costs
- Savings in manpower cost. Only a few workers are needed to produce foamed concrete for casting / pouring of panels, blocks or even complete walls for houses.
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5 Applications of Foam Concrete

Listings of typical cellular concrete applications follow as below:

5.1 ***Construction, Renovation, & Rehabilitation***

- Insulating cellular concrete roof decks with 2-hour fire ratings (UL-listed)
- Insulating roof deck fills
- Composite insulated roof decks
- Floor/ceiling fill systems
- Cast-in-situ affordable housing
- Cast-in-place walls, floors & roofs
- Pre-cast, reinforced-concrete wall, floor & roof panels
- Air-cured, cast-in-situ lightweight concrete blocks & pre-fabricated elements
- Permeable pavement underlayment & recharge beds
- Firewalls

- Slab-on-grade insulation & sub-base fill
- Underground thermal conduit linings
- Pipeline & culvert installation (bedding & backfill)
- Roadway rehabilitation
- Retaining wall backfill
-

5.2 *Geotechnical & Mining*

- Thermal Fills [CLSM-CTF]
- Pavement Base [CLSM-CPB]
- Controlled Structural Fill [CLSM-CSF]
- Anti-corrosion Fill [CLSM-ACF]
- Self-Compacting Concrete [SCC]
- Sub-base
- Erosion Control / Soil Stabilization
- Conduit / Pipe Bedding
- Bridge Approach / Abutment
- Insulating / Isolation Fills
- Site Reconstruction
- Shock & Blast Mitigation
- Shock Absorbing Concrete [SACON]
- Seismic Energy Absorption
- Soft Ground Arresting Systems [EMAS]
- Load reducing Engineered Fill over underground structures.
- Void filling for abandoned underground & mining facilities, wells, tunnel shafts, or additional cavity fill.
- Culvert Fill for Sub-standard Bridge Conversions
- Backfill in or around engineering structures when this is more practical than using soils.
- Fill to reduce hydrostatic pressure on retaining walls
- Canal Distribution Systems [CDS] Flood Control Reconstruction & Land Reclamation
- Slurry Walls

6 Cellular concrete, the environment, Green building & Sustainable development

Sustainable development is a holistic endeavor, making it difficult to define the independent role any of the thousands of materials, products, or technologies used on a given construction site bring to supporting project-specific green-building objectives. But cellular concretes do play constructive roles in enhancing the environment, meeting green-building objectives & attaining sustainable development.

Cellular concretes help achieve sustainable building solutions in many areas, including:

Building reuse – Cellular concrete is an excellent material for re-roofing applications & for floor restoration applications.

Disaster resistance – When used in roof deck, flooring, in-situ affordable housing, cast-in-place walls, floors, or roofs, or block or pre-fabricated element applications, cellular concrete provides proven deformation resistance properties & an ability to absorb loads & crush in a controlled manner. Cellular concrete is also fire resistant.

Durability – Cellular concrete provides excellent durability, compared to other low-density materials.

Indoor air quality – Negligible VOC emissions from cellular concrete support indoor air quality in structure applications.

Locally produced – The raw materials used to make the cement slurry or grout for cellular concrete production are abundant in most areas of the world & are usually obtained or extracted from sources within 250 miles of the project site or pre-cast or manufacturing facility.

Cellular concrete is produced on-site in most construction & manufacturing applications or at a pre-cast facility within 200 miles of the construction site. Local production reduces shipping distances for building materials, minimizing fuel requirements for transportation & handling, & associated lesser energy consumption & carbon dioxide emissions.

Minimal site disruption – When used as pavement underlayment & recharge bed in permeable pavement applications, pervious cellular lightweight concrete can reduce the amount of excavation required by as much as 50% minimizing site disruption, saving time & money & reducing the project's carbon footprint.

Recyclable – Cellular concrete is inert & can be safely reused & removed. One green use of recycled cellular concrete is as aggregate in vegetated roof construction (green rooftops).

Recycled content – Cellular concrete can incorporate ground granulated blast-furnace slag (ggbs) or fly ash (pfa) in the slurry or grout mix design without adversely affecting cellular concrete performance.

Reduced sound transmission – When used in roof deck, flooring, in-situ affordable housing, cast-in-place walls, floors, or roofs, block or pre-fabricated elements, fire or partition wall applications, or as cavity fill for vehicles, the void structure of cellular concrete reduces the passage of sound reducing noise pollution.

Thermal performance – Cellular concrete supports thermal performance optimization in many construction & manufacturing applications.

7 Innovations in Foam Concrete Technology

Recent innovations in cellular concrete technologies include:

- The smart foam liquid concentrates
- Advances in foam generation equipment,
- The development of pervious versions of geotechnical cellular concrete fills, permeable, open-cell, lightweight concrete. These are suitable to stabilize soil without disturbing or redirecting natural water flow.

In instances where projects are sited on marginal lands with areas of soft or loose soils incapable of supporting typical aggregate loads, the use of pervious cellular lightweight concrete (PCLWC) technology permits designers & geotechnical engineers to control both site bearing capacity & drainage characteristics, without disturbing the natural water flow.

8 Foam concrete an innovative product

Foam concrete, Cellular Concrete, CLSM , pervious cellular lightweight concrete, CLC & HySSIL are innovative products for the human civilization, for the days to come & is expected to show its multi-various facets in all the spheres of construction yet to be explored in the hands of future researchers & technocrats.

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