
BUBBLE DECK SLAB - EDGE OVER CONVENTIONAL SLAB

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Abstract

Bubble Deck slab is a method of virtually eliminating all concrete from the middle of a floor slab, which is not performing any structural function, thereby dramatically reducing structural dead weight. The BubbleDeck is a two-way hollow deck in which High density polyethylene hollow spheres eliminating concrete that has no carrying effect. BubbleDeck slab is an in-situ slab which is created by inserting voids in the form of bubbles which reduces dead weight and is an eco-friendly practice. Plastic waste is non – degradable and its disposal has become a matter of great concern to the environment. Bubbles can be created in various forms using recycled plastic. Recycling of plastic waste is of utmost importance to create an eco-friendly atmosphere.

The aim of this paper is to discuss about various properties of BubbleDeck slab based on the various studies done abroad. Currently, this innovative technology has only been applied to a few hundred of multi-story and residential floor slabs. The paper also gives a brief idea about the different BubbleDeck slabs, their production and procedure for laying out the BubbleDeck concrete slab and advantages over conventional concrete slabs.

Materials & Types:

BubbleDeck slab is composed of three main materials; they are steel, plastic spheres and concrete.

Concrete: The concrete is made of standard Portland cement with max aggregate size of 20 mm. No plasticizers are necessary for concrete mixture. Tests have proved that the characteristic compressive strength of concrete is achieved by BubbleDeck slabs in the same manner as that of solid slabs. In certain type of BubbleDeck slab a thin layer of concrete at the bottom is precast at the manufacturing plant. These are achieved by placing concrete in platforms and lowering the bubbles into concrete.

Steel: The steel reinforcement is of grade F_y60 ($F_y=60\text{ksi}$) strength or higher. The steel is fabricated in two forms -meshed layers for lateral support and diagonal girders for vertical support of the bubbles. Steel reinforcement is mainly arranged as soon as the bubbles are prepared. The top and bottom reinforcements are then held together by welding with the help of diagonal short length bars. The steel reinforcement is designed as per the design procedure.

Plastic Spheres: The hollow spheres are made from recycled high-density polyethylene or HDPE. Plastic bubbles are available in different sizes based on the size of structure. The main dis-advantage of bubbles is that it is not stackable. These HDPE bubbles can be salvaged and reused again or recycled.



BubbleDeck Types:

Filigree Elements: Type-A is a combination of constructed and unconstructed elements. A 60mm thick concrete layer that acts as both the formwork and part of the finished depth is precast and brought on site with the bubbles and steel reinforcement unattached. The bubbles are then supported by temporary stands on top of the precast Layer.

Reinforcement Modules: This Type-B is a reinforcement module that consists of a pre-assembled sandwich of steel mesh and plastic bubbles, or "bubble lattice". These components

are brought to the site, laid on traditional formwork, connected with any additional reinforcement, and then concreted in place by traditional methods.

Finished Planks: This Type-C is a shop-fabricated module that includes the plastic spheres, reinforcement mesh and concrete in its finished form the module is manufactured to the final depth in the form of a plank and is delivered on site. Unlike Type A and B, it is a one-way spanning design that requires the use of support beams or load beams.

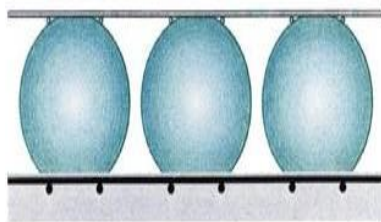


FIG: TYPE-A

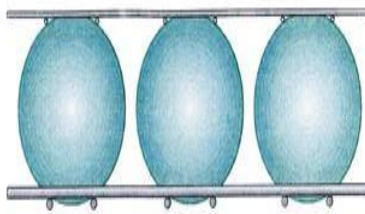


FIG: TYPE-B

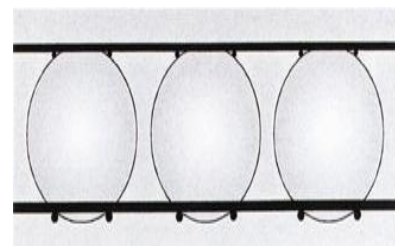


FIG: TYPE-C

Production and procedure for laying out the BubbleDeck concrete slab

Pre-fabricated plastic bubbles are made of recycled plastic in certain moulds. Plastic bubbles are available in different diameters and are ready to be placed. Production of the bubble-lattice by welding the top and bottom reinforcement together. The bubbles are kept in

place by locking them in-between the top and bottom reinforcements.

To prevent movement of bubbles the top and bottom reinforcements are suitably welded together and short length diagonal bars are used to connect the top and bottom reinforcements. A

thin layer of concrete is prepared on the tables and the bubble deck-lattice is fixed to the concrete slab which includes top and bottom reinforcement and bubbles.

These elements are placed correctly by skilled labor, needle vibrators are used for compaction of concreting and other suitable vibrators for finishing the surface.

Acceptance & Utilization in Constructions

Field

BubbleDeck slabs with gaps reinforced on two directions, assure mechanical strength and stability of the construction by designing of the slab by calculating it for stresses given by dead and live loads according to Romanian Standards and fulfilled the requirement of 10/2005 Romanian Law regarding the quality in constructions.

Reducing the weight of the construction leads to reducing of the calculus seismic force. The product is close to class A1(C0) as reaction to fire. The degree of fireproofing of BubbleDeck composites slabs with gaps can be calculated according to SR EN 1992 1-2:2004.

BubbleDeck slabs with gaps are not toxic and environmental friendly, doesn't diffuse noxious substances and they are not radioactive. The materials used are not on the list of cancer producing list nor on the potentially cancer producing list. Slabs don't influence significantly the thermal insulation requirement of the building.

The quantity of concrete and cement is reduced by 30 to 50% for the same built surface compared with the classical slabs, fact that gives an important reduced quantity of carbon emitted. Designer / Architect will design the slabs corresponding to the efforts given by the dead and live loads and the recommendations of the producer.

ADVANTAGES

STRUCTURAL PROPERTIES: Due to the lower dead weight of the slab and its two-way spanning action, load-bearing walls become unnecessary. BubbleDeck is also designed as a flat slab, which eliminates the need for support beams and girder members. As a result, these

features decrease some of the structural requirements for the columns and foundations. Additionally, BubbleDeck slabs can be designed and analyzed as a standard concrete flat slab according to research performed on its strength and ductility.

MATERIAL AND WEIGHT REDUCTION:

The dominant advantage of a BubbleDeck slab is that it uses 30-50% less concrete than normal solid slabs. The HDPE bubbles replace the non-effective concrete in the center of the section, thus reducing the dead load of the structure by removing unused, heavy material. Decreased concrete material and weight also leads to less structural steel since the need for reinforcement diminishes. The building foundations can be designed for smaller dead loads as well. Overall, due to the lighter floor slabs, the several downstream components can be engineered for lower loads and thus save additional material (Wrap).

CONSTRUCTION AND TIME SAVINGS:

On site construction time can be shortened since BubbleDeck slabs can be precast. Type A includes a 60 mm precast concrete plate as the base and formwork for the slab. This type of slab would eliminate the need for onsite erection of formwork, thus significantly cutting down construction time.

Inline to modern precast concrete flooring modules, BubbleDeck can be fully shop fabricated and transported on site for installation as well. Time savings can also be achieved through the faster erection of walls, columns and MEPs due to the lack of support beams and load bearing walls for this innovative flat slab. Addition time may be saved from the quicker curing time since there is less concrete in the slab

COST SAVINGS: In relation to the savings in material and time, cost reductions are also typical with the BubbleDeck system. The decreased weight and materials mean lower transportation costs, and would be more economical to lift the components. With less on-site construction from the full and semi-precast modules, labor costs will decrease as well. In addition, money can be saved downstream in the design and construction of the building frame elements (columns and walls) for lower loads.

There is a slight rise in production costs for the BubbleDeck slab due to the manufacturing and assembly of the HDPE spheres. However, the other savings in material, time, transportation and labor will offset this manufacturing price increase (Stubbs).

GREEN DESIGN: The number of owners, designers and engineers who desire green alternatives is growing exponentially. BubbleDeck is a fitting solution for lowering the embodied carbon in new buildings. According to the BubbleDeck Company, 1 kg of recycled plastic replaces 100 kg of concrete. By using less concrete, designers can save up to 40% on embodied carbon in the slab, resulting in significant savings downstream in the design of other structural members. Carbon emissions from transportation and equipment usage will also decrease with the use of fewer materials. Additionally, the HDPE bubbles can be salvaged and reused for other projects, or can be recycled.

CONCLUSIONS

Due to the fact, that the structural behavior of this new kind of monolithic flat slab is the same as for solid slab, excluding slab-edge column connection, we surely can talk about appropriateness of use and advantages of the new technology.

1. Concrete usage is reduced – 1 kg of recycled plastic replaces 100 kg of concrete. Reducing material consumption made it possible to make the construction time faster, reduces costs, reduce dead weight up to 50%, thus allowing smaller foundation sizes.
2. The technology is environmentally green and sustainable as over a period of time cement production might reduce leading to lower CO₂ emissions.
3. Most cost-effective application of the technology is with semi-precast panels, this approach eliminates over 95% of expensive formwork compared with traditional concrete structures.
4. Virtually no formwork, no downturn beams or drop heads, and fast coverage of typically 350ft² per panel,

BubbleDeck reduces this up to 20% faster

5. There are many green attributes including:
 1. Reduction in total construction materials
 2. Use of recycled materials
 3. Lower energy consumption and reduced CO₂ emissions
 4. Less transportation
 5. Crane lifts that make BubbleDeck more environment friendly
6. Mechanical, electrical and plumbing (MEP) lines and fixtures are easily installed within the floor. Individual through-hole areas can be coordinated and installed within the precast panels
7. Off-site manufacturing, fewer vehicle trips and crane lifts as well as simple installation all combine to minimize operating risks, thus lowers health & safety risks.
8. BubbleDeck panels are suitable for use in all building types especially open floor designs such as commercial, educational, hospitals and other institutional buildings.

References

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