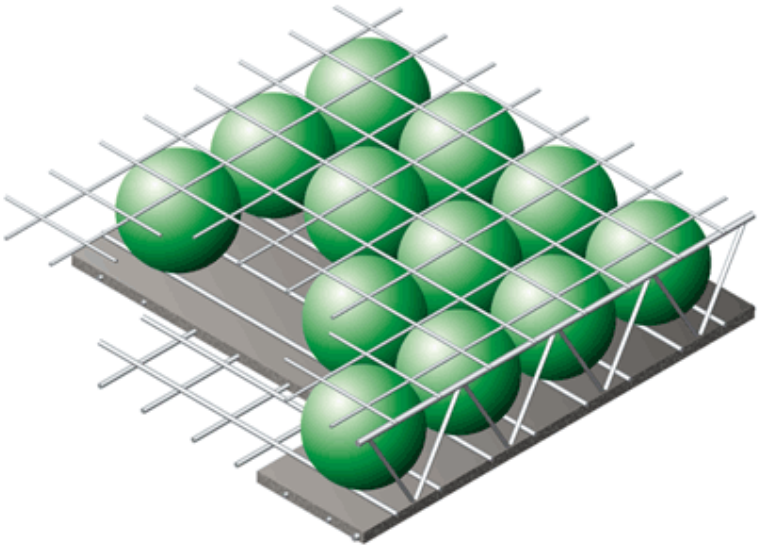

BubbleDeck

TWO-WAY HOLLOW DECK

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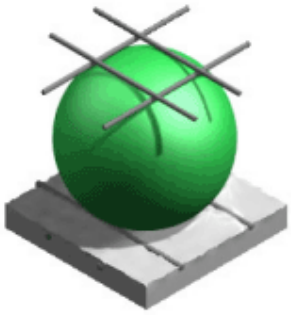
The Basic Principle

Reinforcing mesh, top

Air bubble (hollow ball) made of (recycled) plastic

Reinforcing mesh, bottom



The **BubbleDeck**® system is based upon the patented *integration technique* - the direct way of linking air and steel.

The **BubbleDeck**® is a two-way hollow deck in which plastic balls serves the purpose of eliminating concrete that has no carrying effect.

By adapting the geometry of the ball and the mesh width, an optimized concrete construction is obtained, with simultaneous maximum utility of both moment and shear zones.

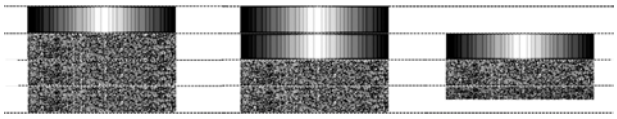
The construction literally creates itself as a result of the geometry of the two well-known components: Welded reinforcing mesh and hollow plastic balls. When the top and bottom reinforcing meshes are connected in the usual way, a geometrical and statical stable **BubbleDeck**® unit evolves.

The reinforcing mesh catches, distributes and locks the balls in exact position, while the balls shape the air volume, control the level of the reinforcing meshes, and at the same time stabilize the spatial lattice. When the steel lattice unit is concreted, a *"monolithic" two-way hollow slab* is obtained.

(For more information, see www.bubbledeck.com)

Effect

The basic effect of the bubbles is the weight reduction of the deck. The dead load of the BubbleDeck is 1/3 lesser than a solid deck with the same thickness – and that without effecting the bending strength and the deflection behavior of the deck.

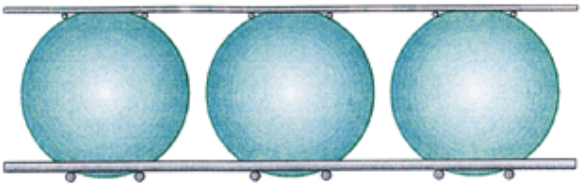


	Solid deck	BubbleDeck® same thickness	BubbleDeck® same capacity
Relative values in % of solid deck			
Carrying capacity	**25**	**50**	**25**
Dead load	**75**	**50**	**40**
Dead load / Carrying capacity	**3:1**	**1:1**	**1.5:1**
Absolute values in % of solid deck			
Carrying capacity	**100**	**200**	**100**
Dead load	**100**	**65**	**50**
Utility value of concrete increased		**300**	**200**

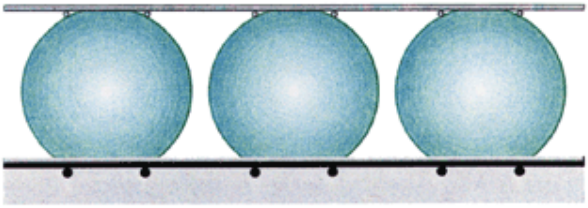
A* BubbleDeck® *has twice the capacity with 65% concrete and the same capacity with 50% concrete* compared with a solid *deck.

Deck Types

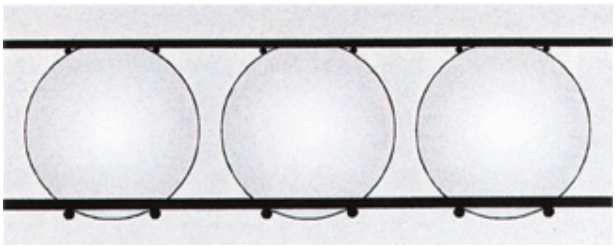
The *simple* **BubbleDeck**® is cast over the pre-fabricated 'bubble-lattice' on traditional formwork



In the *filigree-slab* **BubbleDeck**® the bottom side of the 'bubble-lattice' unit is furnished with a pre-cast concrete layer which on the building site replaces the horizontal part of the formwork.



The *simple* **BubbleDeck**® may also be delivered to the building site as pre-cast factory-made slabs.



For transportation reasons, all compositions must normally have a width of less than 3 metres, but connecting the **BubbleDeck**® units on the building site poses no problem at all. The entire carrying capacity of such combined slabs is thereby fully maintained.

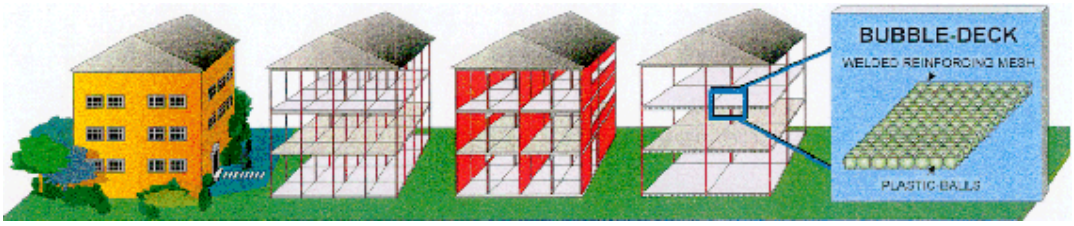
Standard Deck Types

BubbleDeck is produced in 6 standard deck types (the marked standards are recommended):

Deck thickness (mm): 170 **230** 280 **340** 390 **430**

Present & Future

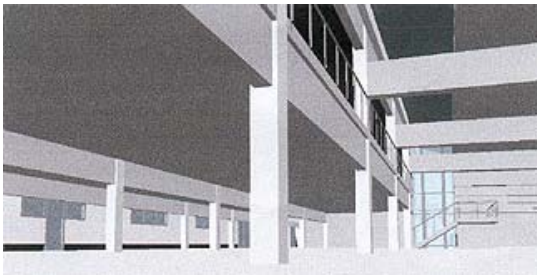
The difference between traditional buildings and buildings with BubbleDeck:



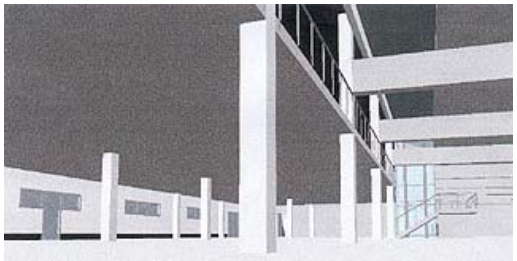
FROM THE OUTSIDE THE BUIIDINGS LOOK SIMILAR BUT THE CONSTRUCTIONS ARE DIFFERENT	**80 % OF THE WORLD CARRY OUT THE DECK IN SITU CASTED** CHOICE OF SUPPORT IS ARBITRARY - BUT SPAN IS SHORT	**20 % OF THE WORLD USE PRECAST SLABS** CHOICE OF SUPPORT IS TIED TO WALLS OR BEAMS CAUSING AN UNCHANGEABLE AND UNFLEXIBLE BUILDING	**NEW METHOD BY JORGEN BREUNING:** **THE BubbleDeck** SUPERIOR IN EVERY WAY CHOICE OF SUPPORT IS ARBITRARY - AND SPAN IS LARGE

BubbleDeck gives an exceptional degree of freedom in architectural design – choice of shape, large overhang, larger spans / deck areas with fewer supporting points – no beams, no carrying walls and fewer columns results in flexible and easy changeable buildings. Interior design can easily be altered throughout the buildings lifetime.

The cross section of BubbleDeck is similar to ordinary prefabricated one-way hollow decks that have been used during the last 40 years. Unfortunately, such deck structure has the disadwantage of transmissing forces in one direction only, why such slabs need support at the full length of both ends by beams or walls, which result in rigid, inflexible and unalterable buildings.



Deck made of one-way prefabricated hollow deck, supported by beams on both ends.



The same deck made of BubbleDeck, i.e. two-way hollow deck, without beams.

Advantages

Superior Statics

- Reduced weight
- Increased strength
- Larger span
- Fewer columns
- No beams or ribs under the ceiling; pillars have no capital

Production & Carrying out

- Higher quality through automated production of prefabricated units
- Less work in situ ; employment of unskilled labour
- Easier and more simpel erection
- Less storage space
- Light and cheap lifting equipment

Transportation

- Transportation of materials is reduced considerably - lower costs and environmental improvement

Safety

- Fire – Fireproof construction
- Earthquake - Safety will benefit significantly alone from the weight reduction
- Moisture - Condensation-safe construction

Economic Savings

- Savings in materials (slabs, pillars, fundaments) are substantial (up to 50 %)
- Manual mounting of reinforcement meshes on the building site is avoided
- Transportation costs are heavily reduced
- Subsequent work (installations) are simplified
- Buildings are more flexible
- Changes are much less costly
- Life span of buildings is longer

All saving effects combined may offer a savings potential of 5 - 15 % of the carcase

Environmental Improvement

- Savings in materials - up to 50 % - 1 kg of plastic replaces more than 100 kg of concrete
- Less energy consumption - both in production, transport and carrying out
- Less emission - exhaust gases from production and transport, especially CO_2
- No waste generation - 100 % recycling
- Better social environment:
  Improvement of working conditions
  Reduced building time means less disturbance of surroundings
  Less emission of noise - in production, transport and assembly

The reduction in energy consumption and emission is in the same order as the savings in materials - up to 50 %

Tests

Tests on BubbleDeck have been carried out in:

- **Denmark** — **Technical University of Denmark**
- **Netherlands** — **Technical University in Delft**
  Technical University in Eindhoven
  TNO
  Dycore Verwo
- **Germany** — **Technical University of Darmstadt**

Bending strength and deflection behaviour: BubbleDeck where compared to a solid deck both practically and theoretically. The results in the table below show that for the same deck thickness the bending strength is the same for BubbleDeck and for a solid deck and that the stiffness of the Bubbledeck is slightly lower.

In % of a solid deck	**BubbleDeck**		
	Same strength	Same bending stiffness	Same concrete volume
Strength	100	105	150 *)
Bending stiffness	87	100	300
Volume of concrete	66	69	100

*) On the condition of the same amount of steel.

Shear strength and punching shear: The results of a number of practical tests confirm that the shear strength depends on the effective mass of the concrete. The shear capacity is measured to be in the range of 72-91% of the shear capacity of a solid deck. In calculations, a factor of 0,6 is used on the shear capacity for a solid deck of identical height. This guarantees a large safety margin. Areas with high shear loads need therefore a special attention, e.g. around columns. That is solved by omitting a few balls in the critical area around the columns, therefore giving full shear capacity.

Sound: A comparison was made between BubbleDeck and one-way prefabricated hollow deck of similar height. The noice reduction with BubbleDeck was 1 db higher than the one-way prefabricated hollow deck. The main criteria for reducing noice is the weight of the deck and therefore BubbleDeck will not act otherwice than other deck types with equal weigth.

The BubbleDeck construction is following every usual criteria, and can be calculated according to usual principles. The construction is not deviating, in any way, from what is already known and used. The construction is analogous to an equivalent solid deck.

The results are unambiguous -

The BubbleDeck behaves as a solid deck and can be calculated as such !

Production and Carrying out

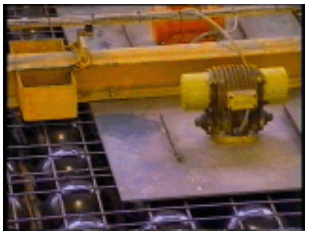
Pre-fabricated plastic bubbles (hollow balls) made of (recycled) plastic.

Production of the bubble-lattice by welding the top and bottom reinforcemnt together.

The diagonal girders keep the bubbles fixed between the top and bottom reinforcement

Preparation of concrete for filigree-bottom at the assembly line.

The bubble-lattice is loweret into the concrete.



Vibration of the concrete.

Finishing of a filigree-element.

Finished BubbleDeck filigree-element.

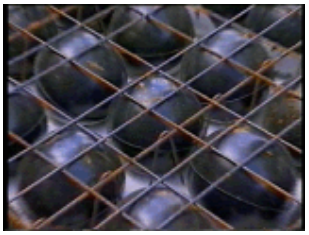
BubbleDeck filigree-element at stock.

Transportation of BubbleDeck filigree-elements.

Transport on trucks.

Transport in the air.

Fitting the elements.



Placing reinforcement between the BubbleDeck filigree-elements.

Concreting.

Vibrating.

Surface finishing.

Examples of Projects

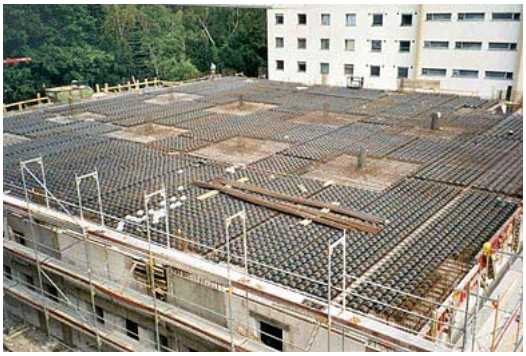
BubbleDeck has been used in buildings in Netherlands, Belgium, Germany and Denmark.

Millenium Tower Rotterdam

The first high rise building erected with BubbleDeck filigree-elements and the second highest building in Netherlands, 34 stories and 131 meter high. BubbleDeck was chosen, in spite of being a completely new product, because of its advantages in cost, construction time and flexibility and because of environmental issues. Beams could be excluded resulting in two more stories than planned in the beginning for the same building height. Built in 1998-2000.

Car park

Car park built with BubbleDeck in Frankfurt Germany in 2001. BubbleDeck was chosen to reduce the weight of the decks and to get wider spans.



Fitness center

Bamberg Physical Fitness center in Germany is the first project where the BubbleDeck is combined with prestressing. The span of the slabs varies between 12 m and 17 m. The slab thickness between 40 cm and 55 cm.