

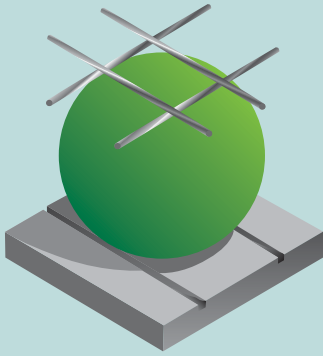
BubbleDeck Structure Solutions



Product Introduction

The Original Voids Flat Slabs
with BubbleDeck

What is the BubbleDeck® System?



Reinforcing mesh, top

Recycled plastic hollow 'Bubble' void former

Reinforcing mesh, bottom – cast into optional concrete filigree 'biscuit' permanent formwork

Advantages

Design Freedom

Reduced
Dead Weight

Longer Spans

Green and
Sustainable

Fast
Construction

Want to know more?

BubbleDeck Technical Manual

BubbleDeck Design Guide

Interactive CD ROM with
BubbleDeck slab calculator

are also available
upon request



The engineering solution that radically improves building design and performance while reducing the overall cost.

BubbleDeck is a revolutionary method of virtually eliminating concrete from the middle of a floor slab not performing any structural function, thereby dramatically reducing structural dead weight. BubbleDeck is based on a new patented technique - the direct way of linking air and steel. Void formers in the middle of a flat slab eliminates 35% of a slabs self-weight removing constraints of high dead loads and short spans.



BubbleDeck's height saving allowed 2 floors to be added during construction

Incorporation of recycled plastic bubbles as void formers permits 50% longer spans between columns. Combination of this with a flat slab construction approach spanning in two directions – the slab is connected directly to insitu concrete columns without any beams - produces a wide range of cost and construction benefits including:-

- **Design Freedom** – flexible layout easily adapts to irregular & curved plan layouts.
- **Reduced Dead Weight** – 35% removed allowing smaller foundation sizes.
- **Longer spans between columns** – up to 50% further than traditional structures.
- **Downstand Beams eliminated** – quicker & cheaper erection of walls and services.
- **Load bearing walls eliminated** – facilitating MMC with lightweight building envelopes.
- **Reduced concrete usage** – 1 kg recycled plastic replaces 100 kg of concrete.
- **Environmentally Green and Sustainable** – reduced energy & carbon emissions.

The overall floor area is divided down into a series of planned individual elements, either 3 or 2.4 metres wide dependant upon site access, which are manufactured off-site using MMC techniques. These elements comprise the top and bottom reinforcement mesh, sized to suit the specific project, joined together with vertical lattice girders with the bubble void formers trapped between the top and bottom mesh reinforcement to fix their optimum position. This is termed a 'bubble-reinforcement' sandwich which is then cast into bottom layer of pre-cast concrete, encasing the bottom mesh reinforcement, to provide permanent formwork within part of the overall finished slab depth.

On site the individual elements are then 'stitched' together with loose reinforcement simply laid centrally across the joints between elements. Splice bars are inserted loose above the pre-cast concrete layer between the bubbles and purpose made mesh sheets tied across the top reinforcement mesh to join the elements together. After the site finishing concrete is poured and cured this technique provides structural continuity across the whole floor slab – the joints between elements are then redundant without any structural effect – to create a seamless floor slab.

BubbleDeck has proved to be highly successful in Europe since its invention ten years ago. In Denmark and Holland over 1 million square metres of floors have been constructed in the last seven years using the BubbleDeck system in all types of multi-storey buildings.

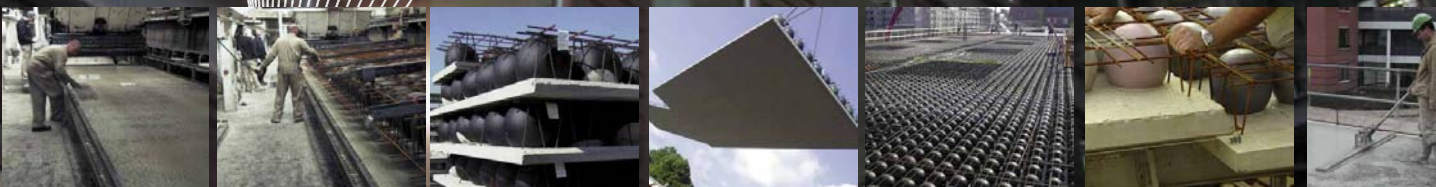
BubbleDeck® is a simple solution that eliminates non-working dead load in floors while fully retaining strength.

Simple site installation

(Type A - Filigree Elements)

- **Temporary Support** – Propping on parallel beams at 1.8 to 2.4 metre spacing
- **Placing Elements** – Semi pre-cast elements mechanically lifted into position
- **Joint Reinforcement** – Insert loose bottom splice bars and tie top mesh across joints between elements
- **Shear Reinforcement** – Insert loose bars across columns
- **Edge reinforcement** – Insert edge bars and hairpins around slab perimeter
- **Perimeter shuttering** – Fix shuttering to bottom pre-cast concrete layer & tie to top mesh reinforcement
- **Soffite shuttering** – Prop plywood across tolerance joints between element bays and between elements & columns
- **Preparation** – Seal joints between elements, clean and moisten bottom pre-cast concrete layer
- **Concreting** – Pour, vibrate and float 10mm max. aggregate in-situ concrete
- **Temporary works** – Remove, typically after 3 – 5 days, according to specific site advice
- **Finishing** – no further work required, the slab is complete unless requirement for exposed soffit

BubbleDeck® is a two-way spanning hollow deck in which recycled plastic bubbles serve the purpose of eliminating non-structural concrete



Bubbledeck® slab versions

The appropriate BubbleDeck slab version is bespoke engineered to suit building configuration, span length between supports, applied loadings and vertical alignment of supports. Indicative spans are given as a guide to what can be achieved. Established from full calculation FE analysis these are based on 20mm concrete cover to bottom rebar (1 hour fire resistance); live load 3+1 kN/m², dead load 1.5 kN/m² and lightweight external envelope maximum 6 kN/m line load. Completed slab mass and Site Concrete Quantity based on 3 x 9 metre pre-cast elements with 35 kg/m² total reinforcement.

Version	Slab Thickness	Bubbles	Span (Multiple bays)	Cantilever Maximum Length	Span (Single bay rows)	Completed Slab Mass	Site Concrete Quantity
	mm	mm	metres	metres	metres	kN/m ²	m ³ /m ²
BD230	230	Ø 180	5 – 8.1	≤ 2.8	5 – 6.5	4.26	0.112
BD280	280	Ø 225	7 – 10.1	≤ 3.3	6 – 7.8	5.11	0.146
BD340	340	Ø 270	9 – 12.5	≤ 4.0	7 – 9.5	6.22	0.191
BD390	390	Ø 315	11 – 14.4	≤ 4.7	9 – 10.9	6.92	0.219
BD450	450	Ø 360	13 – 16.4	≤ 5.4	10 – 12.5	7.95	0.252
BD510*	510	Ø 410	15 – 18.8	≤ 6.1	11 – 13.9	9.09	0.298
BD600*	600	Ø 500	16 – 21.0	≤ 7.2	12 – 15.0	10.30	0.348

* New 2006

BubbleDeck slab configurations: Agrément certification pending, outside scope of KOMO technical certificate.

Element types

BubbleDeck can be supplied in 3 types of manufactured elements:

Type A – Filigree Elements, where the bottom of the bubble-reinforcement sandwich includes a 70mm thick pre-cast concrete layer acting as permanent formwork within part of the finished slab depth replacing the need for soffit shuttering. The elements are placed on temporary propping, loose joint, shear & edge

reinforcement added, perimeter and tolerance joints shuttered and then the remaining slab depth concreted.

Most commonly specified being suitable for the majority of new-build projects. Requires fixed or mobile crane to lift into position due to weight of manufactured elements as delivered to site.

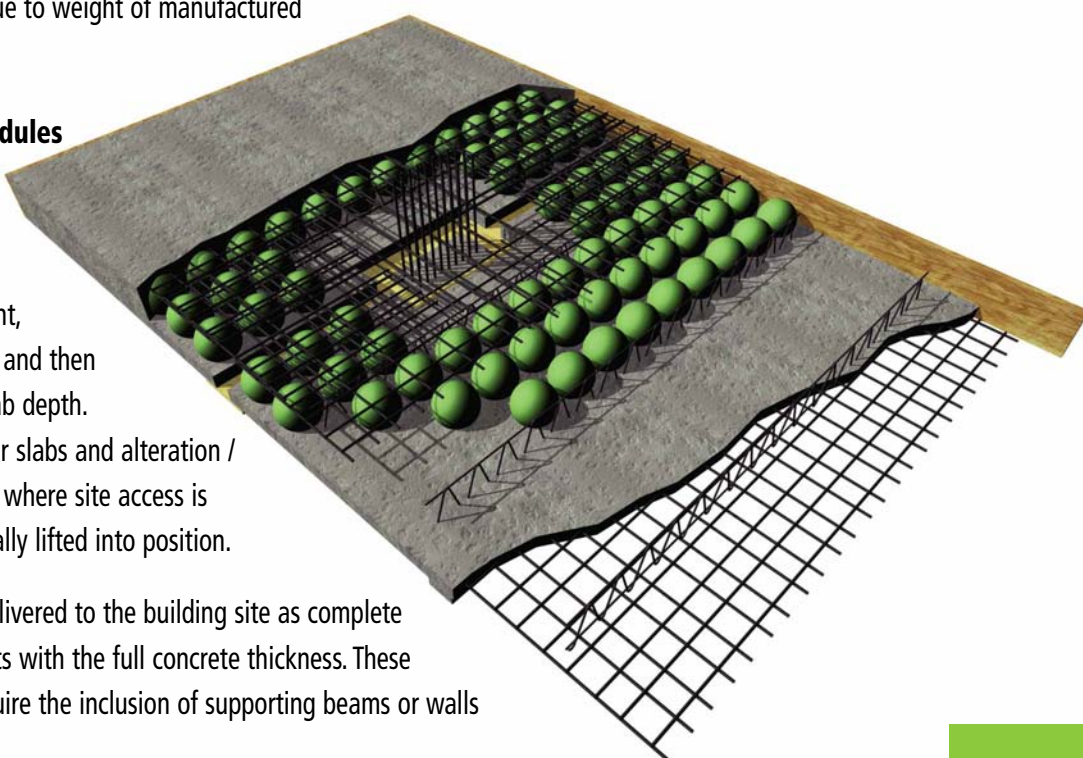
Type B – Reinforcement Modules

comprising pre-fabricated 'bubble-reinforcement' sandwich elements.

The modules are placed on traditional site formwork, loose joint, shear & edge reinforcement added and then concreted in 2 stages to the full slab depth.

Suitable for suspended ground floor slabs and alteration / refurbishment projects, particularly where site access is extremely restricted. Can be manually lifted into position.

Type C – Finished Planks, delivered to the building site as complete pre-cast factory made slab elements with the full concrete thickness. These span in one direction only and require the inclusion of supporting beams or walls within the structure.



Selected BubbleDeck® projects

Le Coie Housing

The largest BubbleDeck structure so far erected in Great Britain was completed 6 weeks ahead of programme. The structure comprises 7,800m² of BubbleDeck floor slabs between 3 and 6 stories high supported on in-situ reinforced concrete columns. Over £400,000 of savings were realised as a direct result of incorporating BubbleDeck into this project, amounting to a 3% saving off the TOTAL project cost.

The Main Contractor subsequently found the BubbleDeck system benefits continue throughout the whole construction process with faster and cheaper erection of external & internal walls plus fast and easy installation of services below the flat soffits.

Chris Dunne, Project Architect, commented:- "Our original solution for Le Coie was a steel frame with Bison floor planks & structural concrete topping in the 5 to 6 storey areas, with load bearing blockwork supporting a composite metal deck in the lower sections.

The BubbleDeck technique not only saved a considerable sum but simplified the buildings structure, removing my co-ordination headache of getting services around or through beams required with a traditional solution. We were also able to eliminate all load bearing walls down the middle of each flat, required to support the short spans of composite metal decks, giving more internal space and fantastic flexibility.

I will definitely consider BubbleDeck for use on my future projects."

These are only a few of many projects with BubbleDeck floors.

For many others and new projects see our WEB site: [www. BubbleDeck-UK.com](http://www.BubbleDeck-UK.com)





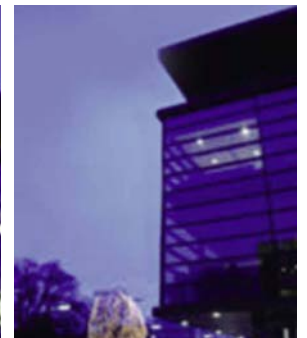
Media City

This 32.000 m² building was constructed with great transparency, revealing a huge open atrium. This atrium is the fulcrum and heart of the building. The spaces are formed in soft, organic shapes that allow light to spill onto every single workplace in the building.



BubbleDeck®
BubbleDeck is the ONLY officially certified voided flat slab system having been granted Kiwa N.V. KOMO Certificate K22722, recognised in the Building Regulations as equivalent to an Agrément Certificate.

To achieve these wide, open, internal spaces a BubbleDeck structure of post – tensioned 450mm deep floor plates, achieving 16 metre spans between columns was selected - dramatically reducing structure dead weight and enabling long spans. The flexibility of BubbleDeck also facilitated construction of the soft flowing, organic shapes forming the floors around the central atrium.



Millennium Tower

Originally designed with hollow core planks, late in the design stage it was determined that BubbleDeck would realise considerable cost and time savings. Adopting BubbleDeck also reduced the structural floor zone depth due to omission of beams, lowering the overall building's height.

Another consideration was the lack of storage space on the building site which is located close to major arterial roads and streets. The floors were on average erected, cast and completed in half the time - 4 days instead of 8 days – it would have taken to construct with hollow core planks. Half way through constructing the structure it was decided to add another 2 floors which was made possible within the overall height of the original building due to BubbleDeck reducing structural floor depth.



City Hall and Offices

BubbleDeck's superior cantilevering ability achieved 3.3 metre cantilevers from a 280mm deep slab with 7.5 metre internal spans between columns. The building provides a City Hall and financial centre for Danske Bank containing 4,000 m² floor area. The slender slab without any beams secures maximum light from the facades, which is enhanced by an internal atrium. This project won "Building of the Year 2004" award for offices and commercial buildings.

Solid deck comparisons

A BubbleDeck slab has the same applied load carrying capacity with only 50% of the concrete required for a solid concrete slab, or with the same slab thickness has twice the load carrying capacity using 65% of the concrete required by a solid concrete slab.

Schematic design basic principle

As a general guide for project scoping purposes the maximum achievable spans for each BubbleDeck slab depth is usually determined by deflection limitations. This criteria is controlled by the ratio of span / effective depth (L/d) stipulated in BS8110 and modified by applying a factor of 1.5, permitted by BS8110 to take account of BubbleDeck's dramatically lower dead weight than traditional solid flat slabs.




- $L/d \leq 30$ for simply supported floors (single spans)
- $L/d \leq 39$ for continuously supported floors (multiple spans)
- $L/d \leq 12.5$ for cantilevers.

The effective depth of a BubbleDeck slab is the overall depth less standard 20mm concrete cover (achieving 1 hour fire resistance) from the bottom mesh reinforcement to underside of the slab. Where 90 minute fire resistance is required deduct 25mm off overall slab depth, or for 120 minute fire resistance deduct 30mm off overall slab depth. In the case of spanning onto columns without beams use the longest dimensions between columns, where the slab will span onto walls or beams use the shortest span dimension.

As an example for BD280 slab version, with 1 hour fire resistance, d is 260mm so $39xd$ indicates a maximum 10.14 metre continuously supported (multiple bay) span; $30xd$ indicates a maximum 7.8 metre simply supported (single bay) span, and $12.5xd$ indicates a maximum 3.25 metre cantilever is potentially feasible. This basic principle has been verified for dead loadings up to 4.5 Kn/m^2 following full calculations on many projects as a generally reliable indication. We can refine this approximate indication by full calculation and we would be pleased to give you advice on a specific project.

Post tensioning

When mega spans are required (above 15 metres) we can provide a Post-Tensioned (PT) BubbleDeck solution. The above deflection limits can be increased by up to 30% with post-tensioned BubbleDeck slabs.

	Solid slab	BubbleDeck® same thickness	BubbleDeck® same capacity
Carrying capacity			
Slab Dead load			

Relative values in % of solid slab

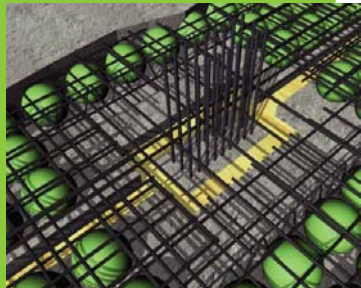
Carrying capacity	25	50	25
Dead load	75	50	40
Dead load / Carrying capacity	3:1	1:1	1.5:1

Absolute values in % of solid slab

Carrying capacity	100	200	100
Slab 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 to a solid slab.

BubbleDeck® floors make a substantial contribution to reducing carbon emissions arising from construction.



Green credentials

By virtually eliminating concrete in the middle of a slab BubbleDeck makes a significant contribution to reducing environmental impact. Guidance from the ODPM requires the direct environmental effects of buildings to be considered, including usage of natural resources and emissions resulting from construction. Not only is concrete usage reduced by up to 50% within a buildings structure but knock-on benefits can be realised through reduced foundation sizes. BubbleDeck can make a big contribution towards achieving BREEAM targets.

Every 5,000 m² of BubbleDeck floor slab can save:-

- 1,000 m³ site concrete.
- 166 ready mix lorry trips.
- 1,798 Tonnes of foundation loads – or 19 less piles.
- 1,745 GJ energy used in concrete production & haulage.
- 278 Tonnes of CO₂ – green house gases – emissions.

Consider the benefits

Data based on typical 4,500 m² Office Building with 7.5 x 7.5 metre multiple spans between in-situ or precast concrete columns.

	Slab Depth (mm)	Site Concrete Volume m ³ / m ²	Site Concrete Quantity m ³	Total Slab Dead Load (Tonnes)	Embodied Energy (Giga Joules)	CO ₂ Emissions (Tonnes)
Solid Slab	310	0.31	1,395	3,376	3,278	522
BubbleDeck	230	0.11	495	1,758	1,707	272
BD SAVES	80	0.20	900	1,618	1,571	250

Assumptions:

- 1) Lightweight external envelope (curtain walling or equal).
- 2) Typical office live load 2.5 kN/m² + 1.5 kN/m² for lightweight partitions, computer floor, finishes & services.
- 3) Overall stability braced by stair / lift core shear walls in both cases BubbleDeck transfers lateral loads to cores.
- 4) Energy from materials transport – cement 50 miles, aggregate 10 miles (to ready mix plant) and concrete 5 miles (to site).

BubbleDeck structures are also Sustainable with the system allowing frame re-use for future purposes. The envelope and all internal work can be removed from a BubbleDeck building and the original frame simply refitted for a new purpose. The two way spanning nature of BubbleDeck slabs allows any internal layout to be reconfigured to new uses within the original design load parameters.

Service options

We provide two alternative Service Options covering provision of design, detailing, drawing production, element manufacture and supply of all components to site completely ready for construction:-

Option A – Full Floor Design by BubbleDeck (BD)

1. Initial Enquiry & consultation / advice / meetings (FOC).
2. Schematic design of Deck Type and advice on appropriate solution (FOC).
3. Quotation for Detail Design, Drawing Production, Element Manufacture & Supply, based on estimated amount of reinforcement required per m² (FOC).
4. Acceptance of Quotation and order / payment for Detail Engineering Design, Calculations and Drawing Production.
5. Detail Engineering Design and Calculations of BubbleDeck floors by BubbleDeck, Detail Design of all other elements (foundations, columns, external envelope & roof) by Clients Agents or others.
6. Production of Manufacturing and Site Installation drawings by BubbleDeck, including pre-cast elements ready for manufacture and all required loose reinforcement.
7. Preparation of Design & Calculation report by BubbleDeck. Provision of Design Report and Manufacturing / Site Installation Drawings to Clients Agents for their Building Control submission.
8. Acceptance and sign-off by Clients Agents of BubbleDeck Design Report and Manufacturing / Site Installation Drawings.
9. Preparation of loose site reinforcement bar bending schedules issued to Main Contractor / Site Installer for supply to site by others.
10. Adjusted Quotation, based on final amount of reinforcement per m².
11. Acceptance of Adjusted Quotation & Order for prefabricated BubbleDeck Element manufacture, production & supply to site.
12. Advice to Clients Main Contractor & Agents on Site Installation & Construction.
13. Manufacture of prefabricated BubbleDeck Elements & supply to Site.
14. Advice to Main Contractor during Site Installation & Construction.
15. Site Inspections of Erection, Loose Reinforcement installation and sign off by BubbleDeck prior to final concrete pour.

Option A under-written by BubbleDeck's Professional Indemnity / Product Liability Insurance Policies and Collateral Warranty issued following settlement of BubbleDeck Account.

Option B – Structure & BubbleDeck Floor Design by Clients Agents

1. Initial Enquiry & consultation / advice / meetings (FOC).
2. Advice on Deck Type, appropriate solution, element layout and design (FOC).
3. Quotation for Element Production & Supply, based on Clients Agents estimated reinforcement per m² (FOC).
4. Detail Design of BubbleDeck floors and all other elements (foundations, columns, external envelope & roof) by Clients Agents or others.
5. Submission of Detail Design by Clients Agents to BubbleDeck for review & comment.
6. Production of Manufacturing drawings by BubbleDeck, production of Site Installation drawings by Clients Agents including all required loose site reinforcement.
7. Preparation by Clients Agents of Design & Calculation report and submission with Manufacturing / Site Installation Drawings by Clients Agents to Building Control for approval.
8. Submission of Design & Calculation report and Site Installation drawings to BubbleDeck for review & comment.
9. Preparation by Clients Agents of loose site reinforcement bar bending schedules for supply to site by others.
10. Adjusted Quotation, based on final amount of reinforcement per m² in prefabricated BubbleDeck elements.
11. Acceptance of Adjusted Quotation & Order for prefabricated BubbleDeck Element manufacture, production & supply to site.
12. Advice to Clients Main Contractor & Agents on Site Installation & Construction.
13. Manufacture of prefabricated BubbleDeck Elements & supply to Site.
14. Site Inspections of Erection, Loose Reinforcement installation and signoff by Clients Agents prior to final concrete pour.

Option B under-written by BD's Product Liability Policy and Product Guarantee.

The
BubbleDeck®
system is based
upon the patented
integration
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UNITED KINGDOM

WEB: www.BubbleDeck-UK.com

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Please complete the form below, thank you:

Contact Name: _____

Company: _____

Address: _____

Town: _____ Post Code: _____

Tel No: _____

Fax No: _____

Email: _____ Web Site: www.bubbledeck.co.uk

Project Name: _____ Project Town: _____

- | | |
|---|-----|
| Please Contact Me/Us | [] |
| I would like advice on a specific project | [] |
| Please send me your full Data Pack | [] |
| Please call to arrange a CPD Presentation | [] |
| Please send me your Technical Manual | [] |
| Please send me your Design Manual | [] |
| Please send me your BubbleDeck Interactice
CD-Rom. Includes: Slab Calculator, Technical
Manual, Design Manual and Video | [] |

Other: (Please write your requirements below)

BubbleDeck Product Introduction
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