The Original Voided Flat Slabs with the BubbleDeck® technology
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

Light with Longer Spans

Green and Sustainable

Made to Measure

Faster Construction

Economical Savings

Want to know more?

www.BubbleDeck.com

Information is available on website and upon request
The engineering solution that radically improves building design and performance while reducing the overall cost.

The revolutionary BubbleDeck® method virtually eliminates concrete from the middle of a floor slab not performing any structural function, thereby dramatically reducing structural dead weight. The patented BubbleDeck® technique is based on 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.

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, tailored up to a standard of 16 x 3 m depending on project, 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 floorslab.

The BubbleDeck® technology has proved to be highly successful around the World since invented in the 90’ies by Mr. Breuning with over 3 million square metres of slabs have been constructed using the BubbleDeck® system in all types of multi-storey buildings.

**Notice:** Descriptions and examples in this material only describes some of the technologies, production methods and execution methods available with the BubbleDeck® technology.

The BubbleDeck® system is a simple solution that eliminates non-working dead load in concrete slabs while fully retaining strength.
Simple site installation

(Type A - Filigree panels)

- **Temporary Support** – Propping on parallel beams at 1.8 to 2.4 meter 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

- **Note** - Additional Structural steel as shear-, joint- and edge-reinforcement, and installations can be integrated in elements at the factory, further reducing onsite works

BubbleDeck® technology:
Biaxial 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 (minimum 1 hour resistance); live / dead load of 3 / 1.5 kN/m² and lightweight external envelope maximum 6 kN/m line load.

Completed slab mass and Concrete Quantity based on 3 x 9 metre pre-cast panels with 35 kg/m² total reinforcement.

<table>
<thead>
<tr>
<th>Version</th>
<th>Slab height (mm)</th>
<th>Bubbles (Multiple bays)</th>
<th>Span (Single bay rows)</th>
<th>Cantilever (Maximum Length)</th>
<th>Weight of Slab (kN/m²)</th>
<th>Concrete Quantity (m³/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD230</td>
<td>230 - 250</td>
<td>Ø 180</td>
<td>5 – 8</td>
<td>£ 2.8</td>
<td>5 – 6.5</td>
<td>4.1</td>
</tr>
<tr>
<td>BD285</td>
<td>280 – 320</td>
<td>Ø 225</td>
<td>7 – 10</td>
<td>£ 3.3</td>
<td>6 – 7.8</td>
<td>5.0</td>
</tr>
<tr>
<td>BD340</td>
<td>330 – 370</td>
<td>Ø 270</td>
<td>9 – 12</td>
<td>£ 4.0</td>
<td>7 – 9.5</td>
<td>6.0</td>
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<tr>
<td>BD395</td>
<td>380 – 420</td>
<td>Ø 315</td>
<td>11 – 14</td>
<td>£ 4.7</td>
<td>8 – 11.0</td>
<td>6.9</td>
</tr>
<tr>
<td>BD450</td>
<td>430 – 500</td>
<td>Ø 360</td>
<td>13 – 16</td>
<td>£ 5.4</td>
<td>9 – 12.5</td>
<td>7.9</td>
</tr>
<tr>
<td>BD560*</td>
<td>540 – 600</td>
<td>Ø 450</td>
<td>15 – 20</td>
<td>£ 6.7</td>
<td>11 – 15.5</td>
<td>9.7</td>
</tr>
<tr>
<td>BD670*</td>
<td>630 – 700</td>
<td>Ø 540</td>
<td>17 – 24</td>
<td>£ 8.1</td>
<td>13 – 19.0</td>
<td>11.5</td>
</tr>
</tbody>
</table>

**BubbleDeck® slabs can be supplied in 3 main types of manufactured elements:**

**Type A** – Filigree Panels, where the bottom of the bubble-reinforcement sandwich includes a 60mm thick pre-cast concrete layer acting as permanent formwork within part of the finished slab depth replacing the need for soffite shuttering. Shear, edge and joint splice reinforcement can be integrated as well as installations. The panels are placed on temporary propping, and loose 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. Most structural steel can be incorporated off-site.

**Type B** – Reinforcement Modules comprising pre-fabricated ‘bubble-reinforcement’ sandwich elements.

The modules are placed on traditional site formwork; loose reinforcement added and then concreted in 2 stages to the full slab depth.

Majority of structural reinforcement including shear- and joint-splice bars can be integrated as well as installations can be manually lifted into position.

**Type C** – Finished Planks delivered to the building site as complete precast 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 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 soffit.

Chris Dunne, Project Architect, commented:- “Our original solution for Le Coie was a steel frame with Bison 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 the BubbleDeck® system for use on my future projects.”

For many others and new projects see our WEB site: www.BubbleDeck.com

These are only a few of many projects with BubbleDeck® floors.
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 allowing light to spill onto every single workplace in the building.
To achieve these wide, open, internal spaces, the BubbleDeck® system with 450mm deep voided 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 BubbleDeck® system 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 oors which was made possible within the overall height of the original building due to BubbleDeck® system reducing structural floor depth.

City Hall and Offices
The BubbleDeck® system achieved superior cantilevering with 3.3 metre 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.
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® slabs dramatically lower dead weight than traditional solid flat slabs.

L/d ≤ 30 for simply supported floors (single spans)
L/d ≤ 40 for continuously supported floors (multiple spans)
L/d = 15 for cantilevers.

Fire Resistance

BubbleDeck® slabs can be tailored to meet any needed fire rating by simply adjusting the concrete cover. 90 min fire resistance is standard (25 mm cover), but 120 min resistance (30 mm cover) is generally applied. The exact cover should be included in structural calculations.

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, we can provide a Post–Tensioned (PT) BubbleDeck® solution. The spans can be increased by up to 30% with post-tensioned BubbleDeck® slabs.
By virtually eliminating concrete in the middle of a BubbleDeck® slab 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 building’s structure but knock-on benefits can be realised through reduced foundation sizes. The BubbleDeck® technology can make a substantial contribution towards achieving BREEAM targets.

Every 5,000 m² of BubbleDeck® 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.

Green credentials

By virtually eliminating concrete in the middle of a BubbleDeck® slab 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 building’s structure but knock-on benefits can be realised through reduced foundation sizes. The BubbleDeck® technology can make a substantial contribution towards achieving BREEAM targets.

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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.

<table>
<thead>
<tr>
<th>Slab Depth (mm)</th>
<th>Slab Concrete Volume (m³/m²)</th>
<th>Total Slab DeadLoad (Tonnes)</th>
<th>Embodied Energy (GigaJoules)</th>
<th>CO₂ Emissions (Tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Slab</td>
<td>310</td>
<td>0.31</td>
<td>1,395</td>
<td>3,376</td>
</tr>
<tr>
<td>BubbleDeck® slab</td>
<td>230</td>
<td>0.11</td>
<td>495</td>
<td>1,758</td>
</tr>
<tr>
<td>BD SAVES</td>
<td>80</td>
<td>0.20</td>
<td>900</td>
<td>1,618</td>
</tr>
</tbody>
</table>

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 the BD slab 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 the building, and the original frame simply retted 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.
We provide two main 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 Slab Design** - by the BubbleDeck Group (BDG)

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).

   - Acceptance of Quotation and order / payment for Detail Engineering Design, Calculations and Drawing Production.
   - Detail Engineering Design and Calculations of BubbleDeck® slabs by BDG, Detail Design of all other elements (foundations, columns, external envelope & roof) by Clients Agents or others.
   - Production of Manufacturing and Site Installation drawings by BDG, including pre-cast elements ready for manufacture and all required loose reinforcement.
   - Preparation of Design & Calculation report by BDG.
   - Provision of Design Report and Manufacturing / Site Installation Drawings to Clients Agents for their Building Control submission.
   - Acceptance and sign-off by Clients Agents of BDG Design Report and Manufacturing / Site Installation Drawings.
   - Detail Engineering Design and Calculations of BubbleDeck® slabs by BDG, Detail Design of all other elements (foundations, columns, external envelope & roof) by Clients Agents or others.
   - Production of Manufacturing and Site Installation drawings by BDG, including pre-cast elements ready for manufacture and all required loose reinforcement.
   - Preparation of Design & Calculation report by BDG.
   - Provision of Design Report and Manufacturing / Site Installation Drawings to Clients Agents for their Building Control submission.
   - Acceptance and sign-off by Clients Agents of BDG Design Report and Manufacturing / Site Installation Drawings.
   - Preparation of loose site reinforcement bar bending schedules issued to Main Contractor / Site Installer for supply to site by others.
   - Adjusted Quotation, based on final amount of reinforcement per m².
   - Acceptance of Adjusted Quotation & Order for prefabricated BubbleDeck® Element manufacture, production & supply to site.
   - Advice to Clients Main Contractor & Agents on Site Installation & Construction.
   - Manufacture of prefabricated BubbleDeck® Elements & supply to Site.
   - Advice to Main Contractor during Site Installation & Construction.
   - Site Inspections of Erection, Loose Reinforcement installation and sign-off by BDG prior to final concrete pour.

**Option B – Structure BubbleDeck® Slab 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® slab and all other elements (foundations, columns, external envelope & roof) by Clients Agents or others.
5. Submission of Detail Design by Clients Agents to BDG for review & comment.
6. Production of Manufacturing drawings by BDG, production of Site Installation drawings by Clients Agents including all required loose site reinforcement.
7. Submission of Design & Calculation report and Site Installation drawings to BDG for review & comment.
8. Preparation by Clients Agents of loose site reinforcement bar bending schedules for supply to site by others.
9. Adjusted Quotation, based on final amount of reinforcement per m² in prefabricated BubbleDeck® elements.
10. Acceptance of Adjusted Quotation & Order for prefabricated BD Element manufacture, production & supply to site.
11. Advice to Clients Main Contractor & Agents on Site Installation & Construction.
12. Manufacture of prefabricated BubbleDeck® Elements & supply to Site.
13. Site Inspections of Erection, Loose Reinforcement installation and signoff by Clients Agents prior to final pour.

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

Option B under-written by BDG’s Product Liability Policy and Product Guarantee.
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