New Ways in Concrete Construction
Multi-storey building in the future

“To develop constructions as flexible and generally applicable that they will be able to pick up changes in a time period reaching far into the next century.”

The Danish Ministry of Housing
Basic Principle

- Reinforcing mesh, top
- Air bubble (hollow ball) made of (non toxic) plastic
- Reinforcing mesh, bottom

BubbleDeck modulo

BubbleDeck panel
Key benefits of the BD system

- Faster construction time
- Greater flexibility
- Better environment
- Better total economy
Designing with the BubbleDeck system

- Standard **Plate-Column** system
- Homogeneous Biaxial Slab
- Monolithic Behaviour like a Solid Slab
- Standard Calculations and Methods
Deviations from a solid slab – same height

- **Weight**: 33 % less weight
- **Stiffness**: Elastic state: 90 % (of EI)  
  : Yielding state: 100 % (of EI)
- **Shear**: 60 % in voided areas  
  : 100 % at column head
Codes

- Accepted like a standard solid slab
- Same regulations as for a solid slab
- Directly incorporated in Eurocodes:
    - C.3.2.2 Dimensions and positioning of ball void formers
Fire & Sound

Fire rating:

As a solid slab
Concrete cover to be adjusted for 2/3/4 hours

Sound insulation:

Airborne sound: proportional with slab height
Tripping sound: proportional with mass of slab
Helsfyr, Norway
Justice Department, Netherlands
Advantages - Design

The main structural consequences of BubbleDeck system:

- Reduced weight
- **Increased** (relative) strength
- Larger spans
- Fewer columns

No beams or ribs under the ceiling
Pillars have no capital
## Guidelines for Span / Deck height

<table>
<thead>
<tr>
<th>Type</th>
<th>Economical Span</th>
<th>Max Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner Bays</td>
<td>25-35 x h</td>
<td>40 x h</td>
</tr>
<tr>
<td>Outer Bays</td>
<td>20-25 x h</td>
<td>30 x h</td>
</tr>
<tr>
<td>Cantilever</td>
<td>7-10 x h</td>
<td>15 x h</td>
</tr>
</tbody>
</table>

Based on standard loads
SDU by Henning Larsen, Kolding, Denmark
Superior Architectural Design

- Free choice of shape
- Large corbels
- Larger spans / deck areas
- No beams and fewer columns results in flexibility
- Areas as not needed can simply be cut out
- Interior design can easily be altered
Large Cantilever at City Hall in Glostrup, Denmark
Large Cantilever at City Hall in Glostrup, Denmark
Car Parks – No Beams or Downstands
5 m Cantilever (BD450) at Villa, Denmark
Harpa (Iceland) – by Henning Larsen Architects
Winner of Mies van der Rohe Award 2013
Post-tensioning increase the effect
Piemonte Torre, Torino, Italy

209 m, 14 m outer span (BD400+PT)
Piemonte Torre, Torino, Italy

209 m, 14 m outer span (BD400+PT)
Heating/cooling through piping in slab

Emelwerda College - Emmelloord / Holland

For Cooling, Energy Savings up to 85 % is possible
Heating/cooling through piping in slab

For **Heating**, savings up to **30 %**

For **Cooling**, savings up to **85 %**

In **Total**, energy savings of **30-50 %** are realistic (European conditions).

Report from COWI
Heating/cooling

Transavia & Martinair, Schiphol Amsterdam Airport / Holland
Benefits - Environment

- **Less Material consumption** - cement, aggregates, water, steel
  1 kg of plastic replaces up to 100 kg of concrete

- **Less Energy consumption** - in production, transport and carrying out

- **Less Emission** - Savings in CO2 emission up to 40 kg / m2

- **Less Wood** - as no horizontal scaffolding is needed for semi-precast

- **Recycling** - components can be recycled – balls stays intact
  - recycling program in collaboration with Braskem
Green Roof construction - School on Iceland

Lightweight homogeneous slab ideal for Green roofs
Fast implementation

- Prefabricated BD reinforcement modules/panels
  - High uniform quality
  - Made to measure
  - Shear reinforcement incorporated
  - Installations can be incorporated
  - Suitable for easy installation of PT
BD Modules on traditional formwork (Product Type 1)
BD Semi Precast Panels (Product Type 2)
Steel above columns for hogging moment
Concreting  (no need for adjustment layer)
Simplified finishes, as beamless ceiling is of high quality
Fast implementation

- Prefabricated BD reinforcement modules/panels
  - High uniform quality
  - Made to measure
  - Shear reinforcement etc incorporated

- Fast placement of modules/panels onsite
  - For BD reinforcement modules, one crane can place 10 - 15 modules p/h
  - For BD semi precast panels, one crane can place 8 - 12 panels per hour

- Limited and simple onsite reinforcement
  - Joint splice bars placed simultaneous with modules
  - Easy walking and working platform
  - Normal erection cycles of 4-5 days. Speedy cyclus 3 days

- Practical & Safe setup
  - Labour transferred from building site to factory
  - Better and safer working conditions
  - Limited & practical onsite works results in fewer accidents
Implementation of the BD system

Fast cycle of 3 days  (temporary supports not included)
In Australia, the installation speed often determines the choice of building system.

Building height 20-30 levels

Shear walls, no beams
Benefits - Economy

- **Savings in materials** can be substantial [LEED]
- **Transportation** costs are substantially reduced
- **Faster construction time** (reduction in erection cycles with 20-40 %)
- **Subsequent work** (installations), is simplified
- High Quality prefab finish – no coatings are needed [LEED]
- Buildings can be made more **flexible**; changes are less costly
- **Lifespan** of buildings are longer / Easier change of use [LEED]
Millennium Tower, Holland

- Erection cycle reduced to 4 days
- Number of crane lifts reduced by 50%
- Number of trucks into Rotterdam was reduced by 500
- Extra two levels within the same building height
- Finished ahead of program
Le Coie, UK

• Start delayed due to change to the BD system
  But finished 6 weeks ahead of program

• Savings: 3 % of total project costs (£50 / m2)

• Award: Best use of Innovation 2005
Administrative Center, Brasilia, Brazil

- 170,000 m² of constructed area
- Daily production of 1000 m² of semi precast BD panels
  - 35% less concrete used. 2500 truck trips saved;
  - 60% reduction in the amount of temporary supports
  - Semi precast saves app 2800 trees (scaffolding)
- 13 % savings in construction costs
Recognitions

“Mies van der Rohe Award 2013" for Harpa project, 2013
“Eco Product Award", Malaysia 2013
"Best New Product" at Green Build Asia, Malaysia 2012
“NOVA Award Winner", Canada 2012
Windesheim Building X awarded "BNA Building of the Year", Holland 2011
Vexpan Parkeergarage Award, Holland 2009
"Best New Product" at Designex/Form & Function, Australia 2009
Jersey Construction Awards: “Best Use of Innovation”, Jersey 2005
“Building of the Year” for Office buildings, Denmark 2004
RIO Award, Germany 2003
Innovation Award, Holland 2000
The Stubeco Building Prize for Execution, Holland 2000
The Industrial Environmental Prize, Holland 1999
The Dutch Building Prize, Holland 1999

The BubbleDeck system was also nominated for the European Environmental Prize for Sustainable Development
BubbleDeck International A/S

- Headquarters in Denmark
- Joint ventures in 20 countries / regions
- BDI exploring / optimizes the BD technology
- Certified Production – identical Worldwide
- Consultant for Partners
- In charge of the BubbleDeck Group
- www.BubbleDeck.com

**Local Partners:**
- General marketing, Production, Selling, Logistics
- General Consulting, Project Optimization
- Site supervision
BubbleDeck – Build More with Less

BubbleDeck – Reaching Higher