fischer Test Report

Fixing Tests for BubbleDeck

BubbleDeck®
UNITED KINGDOM

fischer®
FIXING SYSTEMS

Testing on BubbleDeck Pre Cast Structural Flooring System

1. Introduction

2. Fixing Products Tested

3. Test Results

4. Results Summary for 60mm Plank Thickness

5. Conclusion

1.1 Test Parameters

fischer fixings and BubbleDeck working together with the aim to offer their joint customers comprehensive and accurate information regarding the fixings compatible in to BubbleDeck Pre cast Structural Flooring System.

BubbleDeck is the only officially certified voided flat slab system having been granted Kiwa N.V. KOMO Certificate K22722, recognized in the Building Regulations as equivalent to an Agreement Certificate.

There are three types of slab:

Type A – Filigree Elements
Type B – Reinforcement Modules
Type C – Finished Planks

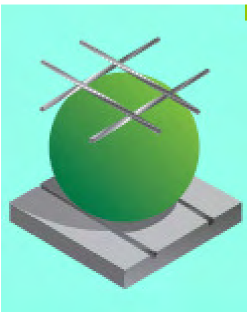
fischer initially introduced and tested the suitability and load capacity of three high performance fixings, FNA II, FBS Concrete Screw and Internally Threaded Socket FDA-R.

The tests were carried out at:

BubbleDeck
4 Firs Close
Ellesmere Road
St Martins
Nr Oswestry
Shropshire
SY11 3LT

All tests were conducted using Hydrajaws calibrated tensile tester with 0-5kN and 0-20kN gauges, in conjunction with attachments required. To conform to the CFA (Construction Fixing Association) guidelines each fixing was tested six times.

1.2 BubbleDeck Slab Information



BubbleDeck is a revolutionary method of virtually eliminating concrete from the middle of a floor slab where concrete does not perform 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.

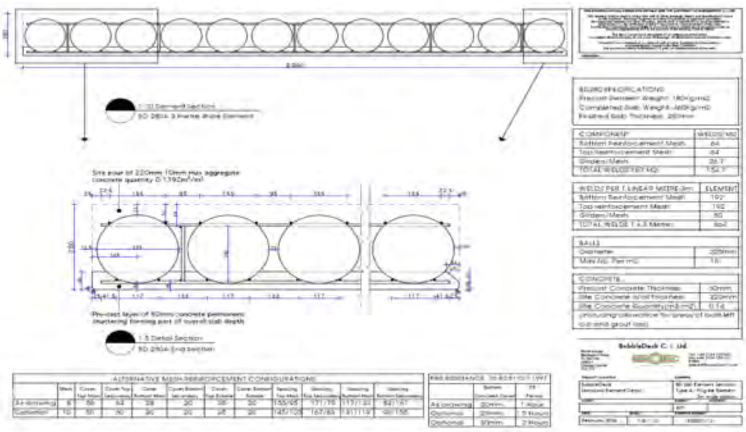
Incorporation of recycled plastics bubbles as void formers permits 50% longer spans between columns. Combination of this with a flat slab construction approach in two directions – the slab is connected directly to insitu concrete columns with out any beams – produces a wide range of cost and construction benefits including:

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

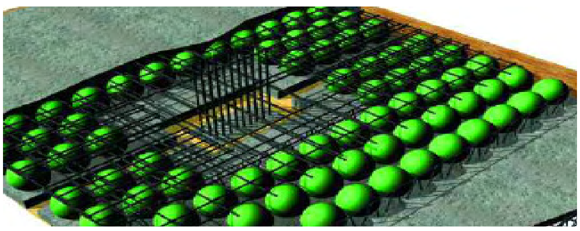
The overall floor area is divided down into a series of planned individual elements, either 3 or 2.4 meters wide dependant upon site access, which are manufactured off-site using MMC techniques. These elements comprise the top and bottom reinforcement mesh, sized to suit the specific project, jointed together with vertical lattice girders with 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 in to bottom layer of 60mm pre-cast concrete, encasing the bottom mesh reinforcement, to provide permanent formwork with in part of the overall finished slab depth.

On site the individual elements are '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 meters of floors have been constructed in the last seven years using the BubbleDeck system in all types of multi-storey buildings.



Schematic design basic principle: As a general guide for project scoping purpose 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 stipulated in BS8110 or EC2 and modified by applying a factor of 1.5 permitted to take account of BubbleDeck's dramatically lower dead weight than traditional solid flat slabs. The effective depth of 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 of overall slab depth, or for 120 minute fire resistance deduct 30mm of 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.



BubbleDeck is the only light flat slab system officially certified for UK use having been granted Dutch Technical Certificate CUR 86, recognized in the Building Regulations as equivalent to an Agreement Certificate.

Environmentally Friendly – 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 or buildings to be considered. Not only is concrete usage reduced by up to 50% within a buildings structure but known on benefits can be realized through reduced foundation sizes. BubbleDeck also use recycled plastic for the hollow bubble.

1.3 Element Types

Type A – Filigree Elements, 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. 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.

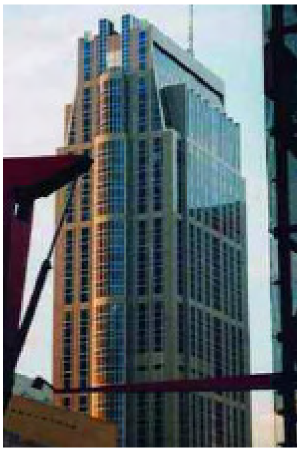
Type B – Reinforcement Modules, Comprising pre-fabricated 'bubble-reinforcement' sandwich elements. The modules are placed on traditional site form work, loose joint, shear * edge reinforcement added and then concreted in 2 stages to the full slab depth. Suitable for suspended ground floor slabs and 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 wall with in the structure.

1.4 Project Examples

Media City: This 32.000m^2 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 on to every single workplace in the building. To achieve these wide, open, internal spaces a BubbleDeck structure of post – tensioned 390mm deep floor plates, achieving 16 meter 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 realize 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 a major arterial of roads and streets. The floors were on average erected, cast and completed in half the time – 4 days instead of 8 – 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.



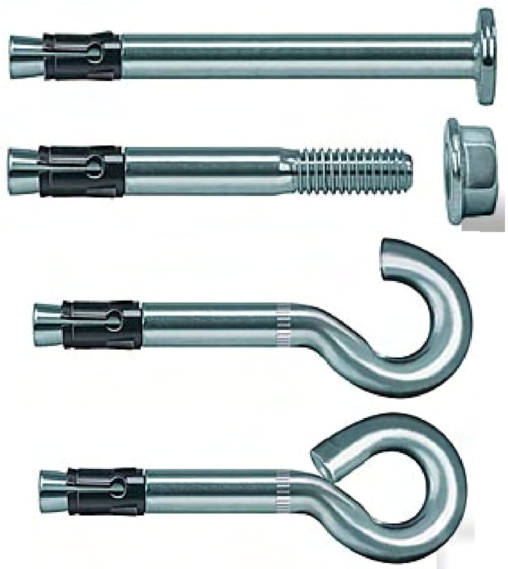
City Hall and Offices: BubbleDeck's superior cantilevering ability achieved 3.3 meter cantilevers from a 280mm deep slab with 7.5 meter internal spans between columns. The building provides a City Hall and financial centre for Danske Bake containing 4.000m^2 floor area. The slender slab with out any 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.

2. Fixing Products Tested

2.1 FNA II Nail Anchor

Material: Zinc Plated, Stainless Steel A4 and High Corrosion Resistant Steel 1.4529

Range: M6 with various head types



fischer FNA II Nail Anchor for fast and simple hammerset installation. The anchor expands automatically under load, it pulls the cone in to the expansion clip and expands against the hole.
The main feature is simple and easy setting, with only a few hammer blows and a 6mm hole. Reduced setting energy is an important benefit particularly with over head applications and it allows sensitive materials to be fixed, ie Fire Protection Boards.
The fixing is available with different head designs for various applications. Stainless Steel A4 version for outdoor use and in damp conditions. High Corrosion Resistant Steel C for applications in aggressive atmospheres.

ETA CE

For multiple fixing for non-structural applications in cracked concrete.

Fire resistance classification F 120

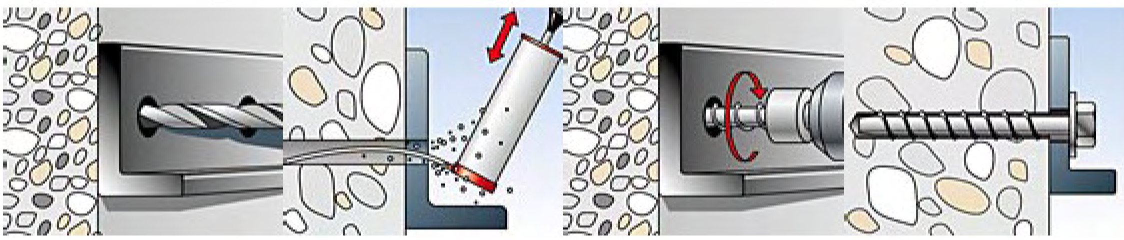
2. Fixings Protect Tested

2.2 FBS Concrete Screws

Material: Zinc Plated grade 5.8 and Stainless Steel A4

Range: M8/M10 only for I version, M6-M12 with various head types

The fischer Concrete Screw FBS have a specially hardened thread. The serration on the thread makes the screw easy to install, reducing the amount of energy required to insert the screw in to concrete. Concrete screws are completely removable anchors, therefore particularly suitable for temporary fixings. Virtually expansion free operation allows cost-efficient fixing with small axial spacing and edge distances. The threads turn creating a fine undercut, thereby ensuring that a perfect form fit safely supports the load. Fixing with different head designs allows solutions for various applications.



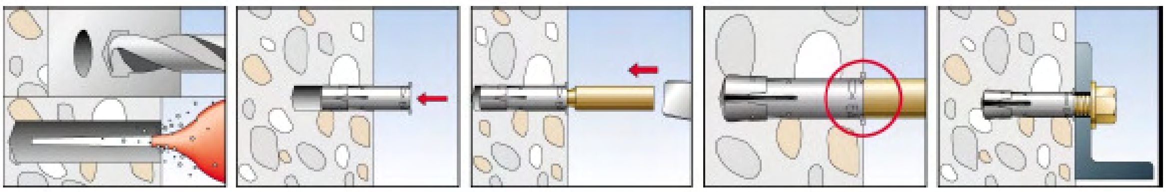
2. Fixing Products Tested

2.3 FDA-R Rimmed Drop In Anchor

Material: Zinc plated and Passivated to 5 Microns

Range: M6-M10

The FDA-R is similar to the conventional Drop In anchor. Its rimmed collar on the fixing ensures the anchor remains flush with the surface at all times even if the hole is drilled slightly deeper then required. To ensure correct installation a setting tool should be used with this anchor. The setting tool required is the EAW H Plus.



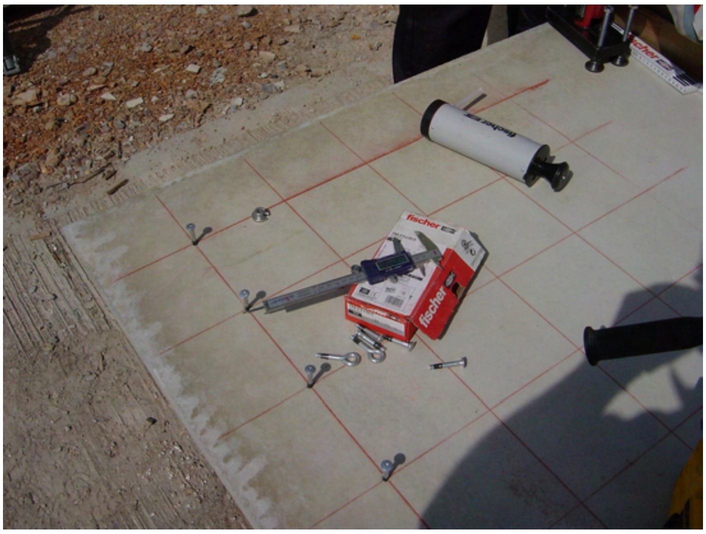
3. Test Results

3.1 FNA II 6x25/5

Test No	Embedment Depth mm	Axial Spacing mm	Hit Rebar	Hit Bubble	Full Depth Achieved	Load Achieved kN	Type of Failure
1	25mm	150mm	×	✓	×	7kN	Displacement
2	25mm	150mm	×	✓	×	8kN	Steel Failure
3	25mm	150mm	✓	×	×	7.4kN	Steel Failure
4	25mm	150mm	×	×	×	7.8kN	Steel Failure
5	25mm	150mm	×	✓	×	7.8kN	Steel Failure
6	25mm	150mm	×	×	✓	8kN	Steel Failure

Average ultimate load is: 7.6kN

Using a global safety factor of 4 the safe working load is: 1.91kN



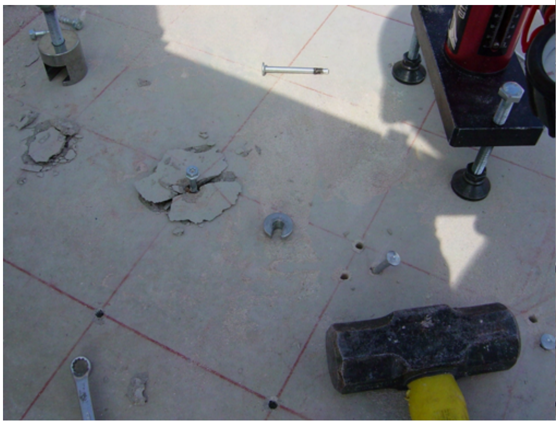
3. Test Results

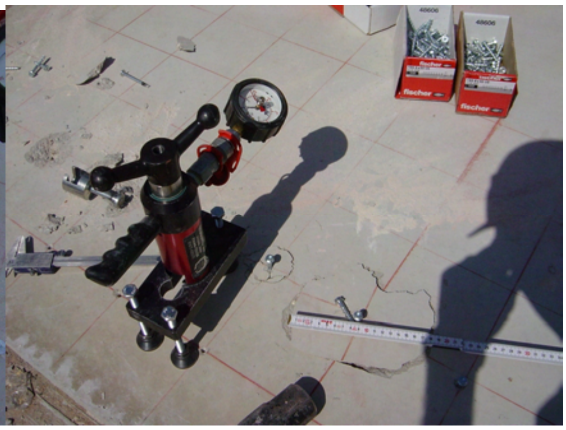
3.2 FBS 6x40 US Concrete Screws

Test No	Embedment Depth mm	Axial Spacing mm	Hit Rebar	Hit Bubble	Full depth achieved	Load Achieved kN	Type of Failure
1	30mm	150mm	×	×	✓	11kN	Cone Failure
2	30mm	150mm	×	×	✓	9kN	Cone Failure
3	30mm	150mm	×	×	✓	11kN	Cone Failure
4	30mm	150mm	×	×	✓	8kN	Cone Failure
5	30mm	150mm	×	×	✓	10kN	Cone Failure
6	30mm	150mm	×	×	✓	11kN	Cone Failure

Average ultimate load is: 10kN

Using a global safety factor of 4 the safe working load is: 2.5kN





3. Test Results

3.3 FBS 6 M8/M10I Concrete Screw

Test no	Embedment Depth mm	Axial Spacing mm	Hit Rebar	Hit Bubble	Full Depth Achieved	Load Achieved kN	Type of Failure
1	55mm	150mm	×	✓	×	13kN	Displacement
2	55mm	150mm	×	✓	×	20kN	Displacement
3	55mm	150mm	×	✓	×	20kN	Displacement
4	55mm	150mm	×	×	✓	23kN	Displacement
5	55mm	150mm	×	×	✓	20kN	Displacement
6	55mm	150mm	×	×	✓	17kN	Displacement

Average ultimate load is: 18.83kN

Using a global safety factor of 4 the safe working load is: 4.70kN

3. Test Results

3.4 FDA-R 6x25 Rimmed Drop In Anchor

Test No	Embedment Depth mm	Axial Spacing mm	Hit Rebar	Hit Bubble	Full Depth Achieved	Load Achieved kN	Type of Failure
1	25mm	150mm	×	×	✓	8kN	Displacement
2	25mm	150mm	×	×	✓	7kN	Displacement
3	25mm	150mm	×	×	✓	8kN	Displacement
4	25mm	150mm	×	×	✓	9kN	Displacement
5	25mm	150mm	×	×	✓	9kN	Displacement
6	25mm	150mm	×	×	✓	9kN	Displacement

Average ultimate load is: 8.3kN

Using a global safety factor of 4 the safe working load is: 2.08kN

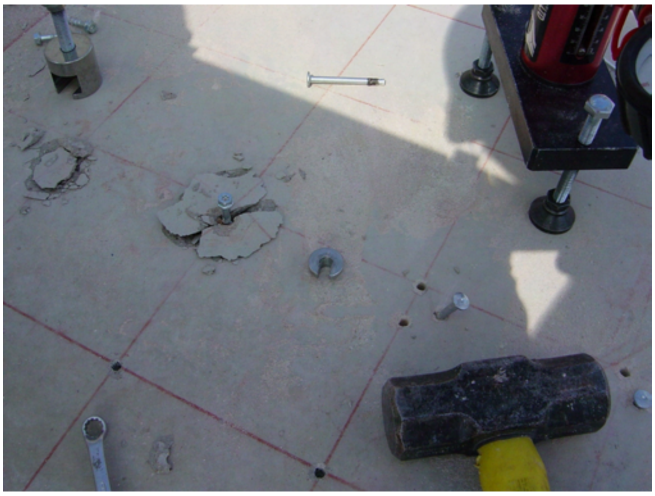
3. Test Results

3.5 FDA-R 8x30 Rimmed Drop In Anchor

Test No	Embedment Depth mm	Axial Spacing mm	Hit Rebar	Hit Bubble	Full Depth Achieved	Load Achieved kN	Type of Failure
1	30mm	150mm	×	×	✓	13kN	Displacement
2	30mm	150mm	×	×	✓	13.6kN	Displacement
3	30mm	150mm	×	×	✓	12kN	Displacement
4	30mm	150mm	×	×	✓	7kN	Displacement
5	30mm	150mm	×	×	✓	12kN	Displacement
6	30mm	150mm	×	×	✓	10kN	Displacement

Average ultimate load is: 11.26kN

Using a global safety factor of 4 the safe working load is: 2.81kN



3. Test Results

3.6 FDA-R 10x30 Rimmed Drop In Anchor

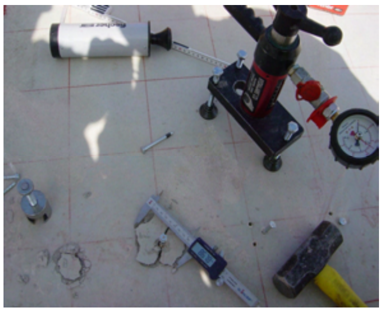
Test No	Embedment Depth mm	Axial Spacing mm	Hit Rebar	Hit Bubble	Full Depth Achieved	Load Achieved kN	Type of Failure
1	30mm	150mm	✓	×	×	18kN	Displacement
2	30mm	150mm	×	×	✓	14kN	Displacement
3	30mm	150mm	✓	×	×	9kN	Displacement
4	30mm	150mm	×	×	✓	15kN	Displacement
5	30mm	150mm	✓	×	×	13kN	Displacement
6	30mm	150mm	×	×	✓	16kN	Displacement

Average ultimate load is: 14.16kN

Using a global safety factor of 4 the safe working load is: 3.54kN

4. Results Summary

Product	Average Load kN	Safe Working Load kN
FNA II 6x25/5	7.6kN	1.91kN
FBS 6x40 US	10kN	2.5kN
FBS 6 M8/M10I	18.83kN	4.70kN
FDA-R 6x25	8.3kN	2.08kN
FDA-R 8x30	11.26kN	2.81kN
FDA-R 10x30	14.16kN	3.54kN



5. Conclusion

It is in our opinion that all fixings tested are suitable for installation in conjunction with BubbleDeck B0280, 60 Thickness (Primary Plank). Only three anchor types are approved for this substrate at the moment.

The tests were carried out on the primary plank only, without the positive influence of the supporting mass concrete above. If the tests were conducted in to the finalized floor slab with poured concrete above the plank, the loads in some cases might be even higher; however we feel where possible the recommended loads of our fixings should not exceed that of our original test.

The slabs were in an inverted position for the ease of access and testing. In practice the slabs would be laid in-situ with the reinforcement in the bottom face (i.e. the tensile zone).

At the moment we assume anchors are installed in non-cracked concrete. Evaluation of possible cracks in the slab shall be made by BubbleDeck so that we would be able to comment on load reduction for anchors being installed in the tensile zone.