BubbleDeck Structure Solutions

Site Erection & Installation Manual

Type B – Reinforcement Modules

Edition 1, Revision C: June-08

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Introduction

BubbleDeck is a structural voided flat slab system that reduces dead weight of a floor slab by 33%, allowing longer spans between column supports and a whole range of other design, cost and construction benefits. The system eliminates all other supporting structure such as beams or walls – the completed floor slab spans in two directions directly onto pre-cast or in-situ reinforced concrete columns.

BubbleDeck Type B Reinforcement Modules is a prefabricated product combining the benefits gained from off-site MMC techniques of factory manufacture in controlled conditions, ensuring quality control and consistency, with on-site concreting resulting in a seamless completed floor slab - without the issues associated with fully pre-cast methods arising from dry joints resulting in noise transfer needing additional work to seal gaps, finish with additional construction layers. When the site concrete has been cast a BubbleDeck structure is complete – providing integral overall building stability, fire resistance, weatherproofing, and sound insulation.

Site erection and installation is simple and fast, well within the capabilities of any competent concrete contractor or sub-contractor. During previous projects over 800m^2 of BubbleDeck has been erected and completed within 4 working days. The elements are manufactured 3 metres wide (upon request prior to ordering 2.4 metres wide where restricted site access) and the length is varied, to suit project floor-plate configuration and transport efficiency, up to a maximum of 10 metres long.

For more background information about the BubbleDeck system please study our separate ***Product Introduction*** Brochure prior to reading further.

Pre-Construction Planning

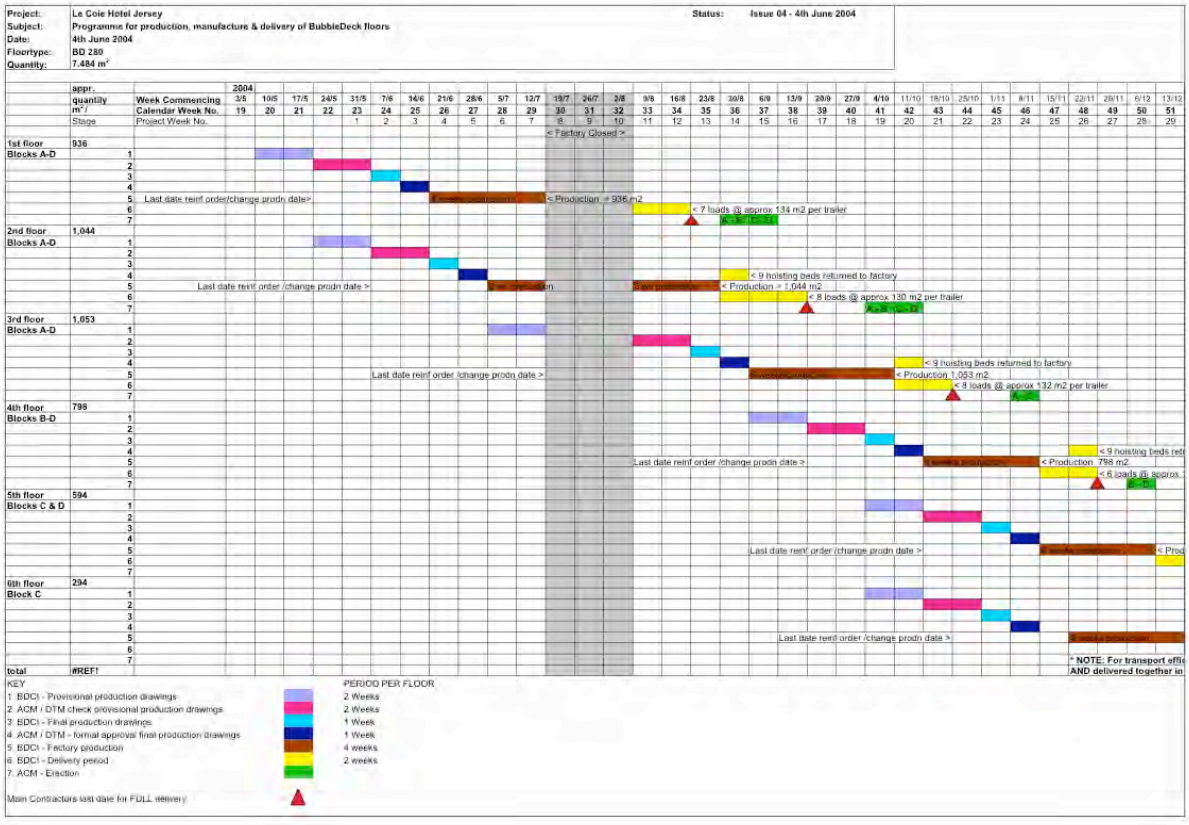
We believe the key to achieving a successful construction build is meticulous preparation and planning, with good communication. Well in advance of construction commencing on site BubbleDeck's managerial and technical team will closely work with you - advising on and defining a detailed programme for the timing and phasing of drawing preparation, drawing review, drawing sign-off approval, element manufacture and element delivery to site – to match your strategic approach and reflect your overall construction programme.

Please take into account there is a lead in period from the date of placing your BubbleDeck order – typically 3 to 4 weeks for our design / general arrangement drawing work plus 6 to 8 weeks for preparation, producing production / installation drawings and manufacturing of the elements (on larger projects lead in period needs to be correspondingly increased and drawing / manufacturing will be undertaken in phases to match your construction programme) – before we can commence site deliveries. Between these periods you need to allow sufficient time for submitting our design / general arrangement drawings to your Approved Inspector and receiving Building control approval, although in special circumstances and smaller projects we can reduce these periods if our other commitments allow.

The pre-construction planning stages comprises:-

1. Issuing to us frozen 'For Construction' Architects / Engineers general arrangement plans, sections and relevant details in ,dwg file format together with final loading information and firm order / deposit payment.
2. Preparation by us of BubbleDeck full engineering design and general arrangement plans, showing element layout, and submission to you for review and technical approval.
3. Submission by you of our design / drawings to Approved Inspector. Referral by you to us of any queries and us providing answers / further information as may be required.

4. Confirmation from you Building Control approval receipt and issuing to us sign-off approval of BubbleDeck design / general arrangement drawings.
5. Develop together programme for production / installation drawings, manufacturing and delivery to site
6. Preparation by us of a detailed programme for production / installation drawings, manufacturing and delivery to site. Review by you and issuing to us programme approval.
7. Confirm to us your planned sequence of erecting the BubbleDeck modules on site.
8. Confirm to us your requirements for any phasing, day joints, and service riser holes above 250mm diameter you want pre-forming in the factory.
9. Planning by you of offloading systems and location – although a fixed / mobile hoisting system is most efficient the advantage of reinforcement modules is they can be manually lifted into position, suitable for where access is restricted such as existing buildings.
10. Advising us of your arrangements for site access and any access restrictions / procedures.
11. Providing our advice on technical and practical construction issues.
12. Selection by you of preferred shuttering system and arranging propping layout to be issued to us for review and comment.
13. Preparation by us of production / installation drawings (projects above 2,000 m^2 in phases as programmed) and submission to you for review and formal sign-off approval.
14. Preparation by us of Quality and Delivery Control forms showing planned loading of modules onto our transport trailers, submission to you for review and approval.



BubbleDeck Drawing / Manufacturing / Delivery Programme

Planning erection of Reinforcement Modules

Prior to us commencing preparation production / installation drawings (see Stage 7 above) you must confirm to us your planned sequence of erecting the BubbleDeck modules on site during construction. This sequence has to be incorporated on our drawing element numbering at an early stage and passed to our factory in order to plan the sequence of manufacturing / transporting elements.

We will programme the order of manufacturing modules and delivery by our transport to reflect, as closely as practically feasible, your planned erection sequence. However, for transport efficiency and safety, some modules have to be loaded on the transport trailers out of sequence to their erection order (e.g. small modules have to be stacked on top of larger modules), in which case these modules can be temporarily lifted off and stored elsewhere on site while the transport trailer is unloaded. The order of loading elements onto the transport trailers will be shown on our Delivery & Loading Control form.

Formal drawing approval prior to manufacture

Once we have received your production / installation drawings sign-off we can then implement manufacture of materials and the modules and be ready to commence site deliveries of modules and loose rebar within 4 weeks time.

We appreciate progress of construction on site can be affected by many external factors including exceptionally adverse weather and other events beyond your control. If you need to change the programming of BubbleDeck deliveries and/or manufacture in response to such events please immediately inform us so we can then re-programme to your requirements. Once BubbleDeck trailers have left our factory we regret we are unable to defer site delivery without passing on additional transport and storage / trailer hire costs. We have even advanced deliveries to keep up with quicker than expected progress constructing BubbleDeck slabs on site.

BubbleDeck's Construction Package

As part of our service we will supply you with the following construction information, advice, products and assistance:-

Project Stage	Service / Product
BubbleDeck Design	Engineering Design of BubbleDeck floor slabs & drawings. Submitting design to you for review and sign-off. Liaison with you about any checking engineer / Approved Inspector queries and providing further information as required.
BubbleDeck Drawing Production	Preparation of manufacturing and construction drawings comprising i) Element layout plan, ii) Loose bottom reinforcement (site installation), iii) Loose top reinforcement (site installation), iv) Bubble pattern v) Prefabricated reinforcement (incorporated into modules at factory). Submitting drawings to you & Consultants for review and sign-off.
Construction Planning	Preparing programme for manufacture and supply of products to site, agreeing with you and placing orders for materials and manufacturing. Preparation of bar bending schedules for loose reinforcement. Providing site operatives with product induction seminar.
Product Advice and Support	Providing our advice on technical and practical construction issues. BubbleDeck Site Erection and Installation Manual. BubbleDeck Health & Safety Policy. Quality and Delivery Control Forms.
Manufacturing Product	Manufacture of reinforcement modules comprising top / bottom mesh reinforcement / connecting girders / plastic bubble void formers.
Loose Reinforcement	Providing Bar Bending Schedules for others to supply loose reinforcement required to complete BubbleDeck slabs.
Site Delivery	Monitoring and arranging BubbleDeck Reinforcement Modules & loose reinforcement delivery, on time, using standard 13.6 metre long flatbed trailers.
Site Support	Technical advice and guidance to yourselves and site operatives on site installation & construction works.

Site Inspections	Site inspection of BubbleDeck installation & loose reinforcement checking prior to casting of in-situ concrete.
Insurance / Guarantees	Following completion of works on site and account settlement entering into suitable Collateral Warranty/s (subject to wording acceptable to our Insurers) as may be required and provision of our Professional Indemnity & Public Liability Insurance cover.

Concrete Column / Wall Construction

Important: In accordance with good practice and British Standards DO NOT overpour r.c. columns / walls in order to avoid reducing the slabs effective depth at support locations. Only use enough concrete to bring r.c. columns / walls up to the underside of the BubbleDeck flat slab level. In the event r.c. columns / walls are concreted above this level our inspector may require the concrete to be cut down around the perimeter of r.c. columns / walls to ensure adequate connection with the BubbleDeck slabs.

Combined Column / Wall & BubbleDeck Construction Method

While sequencing of site operations is your responsibility to decide we recommend the most efficient method, saving valuable site time and overheads, is to plan construction of supporting r.c. columns and walls together with the BubbleDeck floor slab in one combined erection operation as detailed in the following table:-

Stage	Operation	Activities
1	Erect temporary formwork (Prior to BubbleDeck element delivery)	a) Fabricate & erect column / wall formwork. b) Fabricate & install r.c. column & wall reinforcement. c) Erect suitable soffite shuttering system – table form or equal – on temporary propping system
2	BubbleDeck Module Erection	a) Receive, lift and place BubbleDeck modules onto formwork (Refer to Stage 2 below)
3	Loose Reinforcement	a) Install BubbleDeck loose reinforcement (Refer to Stage 3 below)
4	Perimeter shuttering	a) Fabricate and erect perimeter shuttering (Refer to Stage 4 below)
5	Slab Preparation	a) Prepare columns, walls and BubbleDeck slabs for concreting (Refer to Stage 5 below)
6	BubbleDeck Site Inspection	a) Notify us of the date set for concreting (Refer to Stage 6 below)
7	Pouring Site Concrete	a) Pour concrete firstly into columns and walls, vibrate and compact. Then in a two stage process pour concrete to complete BubbleDeck slabs (Refer to Stage 7 below)
This combined erection method has the advantages of a) Condensing a two stage sequence (erecting & casting columns / walls first and then BubbleDeck slabs second) into a one stage sequence; b) Providing s stable & firm platform for casting columns / walls; c) Eliminating separate concrete deliveries for columns / walls and slabs; and d) ensuring a good bond between column / wall and BubbleDeck slab site concrete.		

Stage 1 – Erect Temporary Formwork

During erection modules must be placed, with reinforcement spacers (supplied by you) onto suitable traditional temporary shuttering designed to adequately support the weight of the prefabricated reinforcement modules plus concrete poured on site to complete the BubbleDeck slabs and all other site construction loads applied during concrete pouring and curing of the slab.

Important: Removal of the temporary formwork is NOT allowed before each slab is cured sufficient to support its own weight and temporary construction loads.

Back-Propping

When consecutive floor slabs within one block are to be constructed above each other either:- a) the slab below the one being constructed must be back-propped, or alternatively b) each completed slab must be self-supporting within the maximum allowed deflection.

Option a) Prior to erecting formwork for constructing the next, subsequent, slab above the completed slab remove formwork from below the completed slab and erect back-props at 1.8m intervals (without parallel beams) at either mid-span or third-span, dependant upon length of spans involved.

Option b) Prior to erecting formwork for constructing the next, subsequent, slab above loosen the props supporting formwork below the completed slab, to allow the floor to reach it's maximum deflection, and then tighten the props again. This is to ensure additional loads from the slab being erected above is taken on its own props rather than adding to loads onto the floor directly below, avoiding weight accumulation from consecutive floors placing unnecessary strain on props and other construction elements.

Stage 2 – Delivery, Offloading and Lifting Reinforcement Modules

Site Delivery: We deliver the modules on flatbed trailers typically between 12m to 13.6m long, excluding drivers cab. The reinforcement modules will be stacked on top of each other up to a maximum 2.5 metres overall height. For example, with BD280 slabs there will be maximum 8 layers of modules, with a transport height of 250mm each plus wooden packers typically 50mm deep separating each element, making an overall height of 2.4 metres above the trailers bed. You must provide suitably hard and level access for our delivery transport to reach the offloading position you have determined.

Important: Upon arrival of the delivery trailers on site it is your responsibility to carefully inspect the reinforcement modules for quality and to ascertain any damage that has been incurred during transport. You must report any damage to the reinforcement modules, or other unacceptable characteristics to us by entering the details on our Delivery & Loading Control Form and faxing this back to our Head Office within 2 hours of trailer arriving on site. Once the modules have been lifted off the trailer we may be unable to determine when any damage occurred and in this event we cannot accept responsibility.

Following your inspection the delivery driver will require you to sign the Delivery & Loading Control Form to confirm you have received the modules, which will be retained by him / her for our records. After removing all the reinforcement modules from the flatbed trailer the wooden transport packing beams / blocks must be replaced back onto the trailer before it leaves site, for return to our factory and re-use. Any transport materials that are not returned to our transport operator will be contra-charged by us to your account.

Offloading Reinforcement Modules: It is your responsibility to provide attendance and adequate mechanical lifting equipment or manual labour for offloading modules from the trailers upon their arrival at site. **For optimum working efficiency we recommend you plan site operations to allow the modules to be lifted off the trailers and moved straight into their final position onto temporary formwork.**

However, for transport efficiency some modules may be loaded onto the trailer out of sequence to their erection order, in which case or in the event of site circumstances preventing final placing the modules can be temporarily stored elsewhere on site. The modules must be transversely supported on timber packers laid between the bubble rows (sat on the top reinforcement mesh) at maximum 2.4 metres centres resting on flat, level, ground and protected from soiling by mud, dirt, or other materials. Modules can be stacked on top of each other to a maximum 10 layers high.

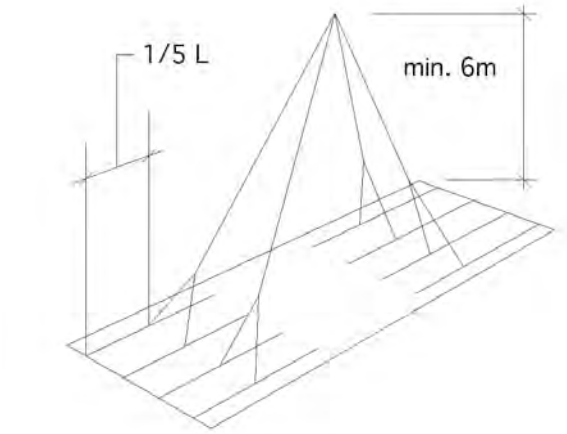
While we will organise and plan deliveries in accordance with your programme as earlier agreed with us (refer to Pre-construction Planning above) we are unable to accept any responsibility for

any delays with deliveries or construction progress arising from events outside our control such as unexpected access restrictions or force majeure.

Lifting and Placing Reinforcement Modules: The modules can be lifted either by slings passed around and underneath the cages, or with lifting hooks clipped around the lattice beam girder reinforcement. Lifting hooks must be attached under the upper angles of the girder reinforcement diagonals. Lifting hooks must NEVER be attached to the upper reinforcement mesh as this would be unsafe.

It is your responsibility to organise and provide suitable lifting equipment All lifting equipment must be tested and certified capable of lifting a minimum of 2 Tonnes, appropriate for the purpose as described below, and must meet all legal health and safety requirements.

Each individual element requires the use of EIGHT lifting hooks, in 2 parallel rows of 4 hooks each attached around the lattice girders positioned approx. 1/5 of the total element length in from each end. The upper part of the hoisting system (4 suited chains) must be at least 6 metres minimum in length. Chain branches to the eight lifting hooks must be equal lengths. When in use, care should be taken that lifting forces are equal at each lifting hook point and the element remains horizontal during lifting. Before lifting attach suitable ropes at two opposite corners of the element for guiding element into position on the propping beams



Typical lifting chain configuration

Positioning of Placing Reinforcement Modules on formwork: It is important the modules are lifted into position in the planned erection system, and care is taken with correct positioning of the elements. Each module must be positioned the correct way round - often obvious from position of column cut outs and building shape, but please refer to element installation drawings.

Important: During final positioning of the modules ensure the bubble pattern between adjacent elements are aligned as shown on the installation drawings, so the spaces between bubble rows on adjacent elements align to facilitate inserting splice reinforcement across the joints between modules.

For quick installation of the bottom splice reinforcement we recommend when the first module is in final position the bottom splice bars are temporarily slid fully in between the bubble rows on top of the bottom reinforcement mesh before the adjacent module is placed. At a later stage please remember to slide the bottom splice bars back across the element joint between the bubble rows in the adjacent element, so the bars are finally positioned and wired into place half in one element and half in the adjacent element prior to concreting.

Site Adjustment of Reinforcement Modules: The modules are designed and manufactured to suit the buildings configuration and column / wall layout. They arrive on site with cut-outs / recesses / steps for column or wall positions and larger service holes already formed, therefore they should not require any site adjustment. However it has been known for columns to be erected out of position on site and in this unusual event it is possible to carefully alter the module with a disc cutter.

Important: The upper and diagonal bars in the lattice beam girder reinforcement must NOT be cut on site as they have an important structural function both during lifting and once in place.

Stage 3 - Fixing Loose Reinforcement.

We provide site installation drawings for reinforcement fixed at the bottom of the slab (directly on top of the bottom mesh reinforcement) and reinforcement fixed at the top of the slab (directly on top of the top mesh reinforcement), together with accompanying bar bending schedules. These must be studied and closely followed at all times, if you have any question please call our site support officer or Head Office for assistance. The sequence for fixing loose reinforcement is at your discretion, however we recommend the following procedure is adopted:-

Typical Reinforcement Type	Installation / Fixing Procedure
1. Bottom Joint Splice bars	Inserted between every bubble directly on top of bottom reinforcement mesh and fix. If they have been inserted into one module during lifting into position, as we recommend, then simply slide the bars across the joint between adjacent modules and wire in place to sit with equal lengths both sides of the joint between elements.
2. Bottom Shear bars	Inserted between bubbles in positions shown on drawings across holes, openings and returns in slabs where applicable supported on spacers and wire in place.
3. "Beam Strips" within slab depth	Where applicable assemble bars into cages and fix between and / or around columns (if shown on drawings)
4. Perimeter Hairpins / Bars	Slide hairpins in between bubble rows and slide in top / middle / bottom edge bars around slabs perimeter, tying to hairpins as shown on drawings
5. Column Shear Reinforcement	Insert bottom bars across columns directly on top of the bottom reinforcement mesh. Fix bars over top mesh reinforcement (between the bubbles) across and around column heads as shown on drawings, tying in place to mesh. Note: where shear studs or shear rails have been pre-cast into element at factory there may not be any bars to be fixed on site.
6. Top Joint mesh / bar reinforcement	Purpose made mesh sheets are placed with the bars between bubble rows and tied in place equally across the joint between adjacent elements. In certain locations, for engineering reasons, splice bars will be placed equally across the element joints between bubble rows and tied to the top mesh reinforcement, as shown on the drawings.
Other loose Reinforcement	As building configurations vary it is not possible to describe all possible non-typical loose reinforcement configurations (such as cages for steps between main slab and balcony / cantilever slab) requiring site fixing. This non-typical reinforcement will be shown and detailed on the site installation drawings.
Important: Top joint mesh reinforcement must fit between the bars above columns to avoid excessive layers of steel and difficulty with achieving required concrete cover.	

Stage 4 – Constructing Perimeter Shuttering

Once the perimeter loose reinforcement has been installed work on erecting perimeter shuttering can commence. Temporary works are your responsibility to determine, but our recommendations are:-

Location	Shuttering Erection Procedure
Perimeter Shuttering	Cut sheet of 18mm ply into strips with width of finished slab depth. Fix 100x50mm battens along back edge at top and bottom. Fix bottom batten to formworks system. Fix top of ply shuttering by wire tying back to top mesh reinforcement from screws fixed into top batten.

Stage 5 – Preparation for Concreting

Prior to pouring site concrete remove element labels, unused tying wire, unused reinforcement, loose concrete and all other debris or foreign matter. Then immediately before placing in-situ concrete power-wash top of the pre-cast concrete permanent formwork to clean off residual dirt and moisten the pre-cast concrete surface.

Stage 6 – BubbleDeck Site Inspection

Once you are able to predict when all loose reinforcement will be fixed please contact our Site Support Adviser to notify the date you intend to pour concrete and arrange our site inspection. He will then arrange for our technical representative to visit site and undertake a full inspection of the BubbleDeck element and loose reinforcement installation. Following inspection our technical representative will issue you with an inspection record listing any work that needs to be undertaken prior to site concreting, or confirming the installation is ready for concreting and the work is to our approval.

Important - While we always seek to provide a quick and efficient service we do need at least 2 working days notice of any site concrete pour to be able to ensure our inspection team are available to attend site. It is essential we are able to inspect prior to site concreting in order to be able to covert your project with our Professional Indemnity and Product Liability Insurance cover.

Stage 7 – Pouring Site Concrete

Important – When ordering concrete please take into account the volume taken up by the bubble void formers mean the concrete volume is NOT arrived at by taking the pour area x finished slab depth. The concrete volume to order can be estimated, dependant upon BubbleDeck slab depth type, from the following table:-

BubbleDeck Slab Type	Finished Slab Depth	First 90mm Concrete Pour Volume m^3 / m^2 plan area	Final Concrete Pour Volume m^3 / m^2 plan area	Max aggregate size
BD230 -B	230 mm	0.070	0.100	10mm
BD280 -B	280 mm	0.072	0.130	10mm
BD340 -B	340 mm	0.075	0.170	15mm
BD390 -B	390 mm	0.078	0.200	15mm
BD450 -B	450 mm	0.081	0.242	15mm
BD510 -B	510 mm	0.085	0.290	15mm
BD600 -B	600 mm	0.087	0.338	15mm

Important – The concrete must be laid in two stages. Undertake the first concrete pour using self-levelling concrete to approximately 70 – 100mm depth. Following initial set of first pour the temporary loading weights / boards can be removed. Then proceed to undertake final concrete pour to overall finished slab depth.

Pouring, Vibrating & Floating Site Concrete

When pouring concrete evenly distribute across the area and avoid placing in heaps. Due to the limited space between the bubbles a thin vibrating poker MUST be used to compact the concrete, remove any entrained air and to ensure a good flow around the bubbles. Avoid separation occurring due to the vibrating of shuttering, reinforcement and/or bubbles that can result in segregation of the concrete mix. Once the concrete has been poured a steel beam or power float is then used to level the top and finish to an even and level surface.

Stage 8 – Removing Temporary Formwork

During construction planning we will confirm to you the minimum period for removal of formwork before back-propping. This is usually between 3 to 5 days from pouring of the site concrete as long as early concrete test results have confirmed the site concrete has reached at least 60% of its final design strength, but can vary dependant upon our floor slab design, strength of site concrete, and ambient temperatures.

Once you have received the first concrete test results please forward them to our Head Office, our technical team will then confirm to you it is acceptable to remove temporary formwork. If you are then proceeding to construct another floor immediately above the one just completed please refer to the section about Back Propping on Page 6 of this Manual.

Subsequent Site Operations

Lightweight Fixings

There is a minimum of 20mm concrete below the centre of each bubble, but just a short distance away from the bubble centre the concrete depth quickly increases to 70mm plus up the side of each bubble. Therefore fixings for attaching light and medium weight articles can be made using normal methods (plug & screw / expanding anchors, etc.) to provide adequate fixings for wiring conduits, small cable trays, small ventilation ducts and the like.

Heavy Weight Fixings

Where stronger fixings are required to resist higher pull out (downward) forces from heavy loads to be suspended from the soffite we recommend our Bubble layout drawings are inspected to determine where fixings will occur directly below or close to the edge of a bubble. Where fixing locations and lengths are likely to project into a bubble void we recommend Hilti HIT HY20 Injection Resin Anchor

with HIT sieve, item no. 00068613, are used. Hilti also produce a range of other fixing systems designed for fixing through into voids.

Holes through slabs
Holes can easily be diamond core drilled through the completed BubbleDeck slab. Due to the two way spanning attributes of BubbleDeck slabs there are few limitations on the positioning of holes, except near columns where loads are transferred from the slab into the columns and shear forces are highest.

Service risers larger than 250mm square should be designed into the slab for forming in the factory & boxing out on site prior to pouring insitu concrete. Pipe holes up to around 250mm diameter are best diamond core drilled after casting of slabs to ensure optimum vertical alignment. There is great flexibility where these can be placed because the slab will span around such holes. The only limitations are to avoid cutting off too much support when holes are formed near supporting columns / walls, or a series of holes in a row in certain situations, but these can be allowed for during design stage.

Prior to forming holes in completed slabs larger than 250mm diameter, within 500mm of a supporting column / wall, or multiple holes in close proximity please refer to our Technical Department for advice before undertaking such works.

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