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Insitu Structural Concrete Toppings For Composite Precast Floor Construction

Design

A composite section comprises different materials that act together structurally when the section is loaded or strained.

This is the case when insitu concrete is effectively bonded to the surface of a precast unit, as the two types of concrete are considered to be different structural materials.

Insitu structural concrete toppings (ISCT) can act with either precast prestressed units or reinforced lattice girder concrete floors to form a composite section.

The resulting composite section can have greater stiffness and flexural strength than a plain precast concrete section, which can be used to advantage by the Floor Designer.

The ISCT must be bonded to the precast unit upon which it is laid, taking into account all relevant Standards, Codes of Practice and other technical publications including BS EN 1992-1-1:2004 (EC2) and BS8204:Part 2.

Where the ISCT is exposed, such as in car parks, the Floor Designer must take into account the recommendations of BS 8500 Concrete (2006)–Complementary British Standard to BS EN 206-1.

Prestressed precast concrete floor units will have an upward camber. The local minimum depth of ISCT will generally be at the position of maximum camber and this *minimum depth* should be taken as the specified design thickness.

The recommended minimum design thickness is 50mm.

In most cases the top surface of the ISCT is laid horizontal and therefore the topping thickness will vary. In calculating the design loading from the ISCT, the average thickness needs to be taken into account.

The Engineer may require the ISTC to perform other design functions and these should be communicated to the Floor Designer who is responsible for the design of the composite section.

Concrete Mixes

The concrete used for the topping shall be in accordance with the requirements of BS EN 206-1:2006.

Concrete strength may be specified by the Floor Designer or Engineer, the minimum recommended concrete strength class is C25/30.

The maximum nominal size of the aggregate will depend upon several factors including thickness of the ISCT layer, mesh size and position of the mesh within the layer, method of compaction, etc. It is unusual for the maximum aggregate size to be greater than 20mm.

Construction Features

The Contractor should take into account the methods and sequences to be adopted for placing, compaction, curing and bay sizes, etc.

It is important that the Contractor takes all precautions necessary to ensure that the placing, compaction and curing are carried out with adequate protection from extremes of weather, including high wind velocities across the surface of the ISCT which can cause significant early age shrinkage cracking.

Reinforcement

The type and size of the steel reinforcement used must be designed to satisfy all of the design functions required of the composite section with regards to bending, shear and tie forces being taken by the section, as well as helping to control shrinkage cracking.

The following table provides reinforcement sufficient to control shrinkage cracking for most applications.

Depth of Insitu Structural Concrete Topping	Recommended Steel Fabric to BS4483
Up to 99mm	A98
100 – 149mm	A142
150 – 299mm	A193

Note: The Engineer may require additional reinforcement for other purposes.

Reinforcement generally used is standard mesh fabric to BS4483:2005 with additional loose bars if the design requires them. (e.g. reinforced lattice girder floors require minimum 400mm long loose bars across panel joints.)

Occasionally durability requirements may require the use of galvanised or stainless steel fabric.

The positioning of the reinforcement in the thickness of the ISCT will depend upon the design, durability and any wear requirements.

All sheets of steel fabric should be stored and handled in such a manner as to prevent any damage or deformation.

Particular care must be taken during and after the fixing of the steel fabric and during concreting to ensure that the fabric remains in position and is adequately supported by spacers, or other means, above the top surface of the precast units.

All sheets of steel fabric are to be adequately lapped, minimum 200mm, but subject to design requirements.

Fibre Reinforcement

The use of fibres in place of fabric mesh may be considered; however the designer and contractor must satisfy themselves that the method of placing and compaction of the concrete will result in an even distribution of the fibres in the finished topping.

If fibres are to be considered then specialist advice must be sought from the fibre supplier and agreement to this by the Floor Designer.

The fibre supplier may need to take on the role of Floor Designer.

Surface Preparation of Precast Units

The surface finish of the precast units should be such as to ensure that the ISCT will, after proper curing and attainment of the specified strength; bond and act compositely with the precast concrete units to form a unified structural element.

Prior to the placing of reinforcement the top surface of the precast units should be thoroughly cleaned to remove all debris, oil, mortar or any contaminants that could in any way impair the bond between the ISCT and the precast surface.

It is unusual for the top surface of the units to require any additional surface roughening; however where it is considered necessary to increase the bond at the interface between the precast and ISCT, suitable bonding materials can be used.

The joints between prestressed units, unless previously grouted up, should be similarly cleaned.

The bottom of the joints between the precast concrete units should be sealed as necessary to prevent the loss of concrete and/or grout, and avoid contamination of surfaces and/or finished works below.

Temporary Propping

Propping may be required prior to installation of the precast units or prior to the placing of the ISCT.

This is more usual with normal reinforced lattice girder flooring than prestressed flooring units.

The propping must remain in position until the ISCT has achieved an adequate strength to be agreed with the Engineer.

The position of the propping will be specified by the Floor Designer.

The floor beneath the props must be designed to support the prop loads.

Construction Joints

The ISCT is to be placed in predetermined bays.

The size of the bays should be in accordance with good concrete practice, subject to the type of concrete mix being used, placing and finishing methods.

Dry joints at the leading edge as the work progresses are to be avoided.

Joints shall be located such that they will not impair the composite action, structural adequacy and any other required function of the ISCT.

Joints parallel to the span of the slab should be located away from the joints between the units.

In cases where the floor slab is designed as simply supported, joints transverse to the span should be placed at the supports.

Placing of the ISCT

There has been an increase in the technology and development of equipment used to control the thickness and compaction of the ISCT.

The method for placing the ISCT should be agreed with those that are to undertake the work.

In the absence of specialist equipment, properly constructed and adjustable concreting rails should be used to ensure that the ISCT can be placed and compacted, within the allowable tolerances, to the specified thickness and the correct line and level.

At the time of placing the ISCT, the surface of the precast units forming the base should be saturated, but free of standing surface water.

The concrete should be discharged onto the precast units from pump, skip, barrow, etc., as near as practicable to its final position and in such a manner as to avoid segregation of or cause any damage to the reinforcement or precast units.

Care should be taken to avoid excessive depths of fresh concrete that could cause localised overloading of the precast units.

The ISCT should be thoroughly compacted using suitable tamping rails, vibrating beam compactors or other approved means dependent upon the concrete mix used.

Particular care should be taken to ensure full compaction at edges and corners.

Reinforcement should be continuous through all joints and should project a minimum of 200mm from all joint formwork, or more if required for design purposes, for lapping with the steel fabric in adjacent bays.

The joint forms should be removed in such a manner as to avoid any damage to the ISCT and particularly to avoid spalling or breaking away of the top edge.

Care should be taken to ensure that the concrete surfaces of the joints of previous bays of ISCT are clean prior to fresh concrete being placed against them.

These concrete surfaces should be wetted to prevent excessive loss of mix water into them by absorption.

Surface Finish of ISCT

The type and class of finish of the top surface of the ISCT should be specified by the Engineer dependent upon any coverings being applied and its use.

Surface finishes can range from rough tamped, brushed, wood float, steel float and powerfloat.

If the surface is to be mechanically trafficked in its final use the use of proprietary floor hardeners may be used.

Curing and Protection

Immediately after completion of a bay, or earlier as work proceeds, the surface of the ISCT should be covered or sealed and protected as appropriate.

As the ISCT can often be relatively thin, in the case of prestressed floor units, particular care should be taken to avoid excessive rapid loss of moisture, which could lead to shrinkage, cracking, lifting of the topping, or any other defects.

This loss can be exacerbated by the effects of wind blowing across the finished areas.

Care should also be taken to project the ISCT from adverse weather conditions such as heavy rain or frost.

Areas of ISCT should not be trafficked until such time that it has reached a suitable strength, to be agreed with the Engineer.

Supervision

The Contractor should enquire that the installation of the ISCT is carried out and supervised by suitably qualified personnel.

Method Statements and Risk Analysis should be carried out and will be project specific.

Advice can be sought from the Floor Designer.

Loading of the Precast Floor Units

It is important that the precast units, prior to the ISCT being cast, or the finished floor, are not subject to loadings for which they have not been designed.

Care must be taken when positioning site plant or loading out of other materials.

Unless agreed with the Floor Designer, partition walls should only be built off the composite floor.