PRESTRESSED HOLLOW-CORE CONCRETE SLABS

A Multi - Purpose Cost - Effective Construction Alternative

CONCRETE MANUFACTURERS ASSOCIATION

Quality cast in concrete

THE PRESTRESSED HOLLOW-CORE CONCRETE SLAB

Looking for a security wall which will withstand the impact of a truck, or a retaining wall which can hold back up to five tons/m²? Alternatively, is your requirement a fast-track warehouse which is economical to erect and provide a level of strength and durability that far exceeds conventional in-situ walling? Then look no further than the all-purpose, prestressed hollow-core concrete slab.

It was originally conceived and developed as South Africa's alternative to in-situ cast concrete floor panels for multi-storey buildings some 25 years ago. In today's world of innovation and fast-tracking, the prestressed hollow-core floor slab is a viable, and in many instances, preferable alternative to more conventional building materials.

"Besides the obvious advantages of simpler, faster construction, not to mention a more durable end product, the secret of applying the material successfully is in the pre-planning. Get one of our member companies involved at the concept stage and their advice and design input comes at no charge," says John Cairns, director of the Concrete Manufacturers Association (CMA).

Δ ***Pre-stressed hollow-core slabs being hoisted into position from the delivery vehicle.***

Set out below are several examples demonstrating the versatility and multiple-purpose functionality of the prestressed hollow-core slab. Applications covered include security walls, reservoir roofing, retaining walls, and warehouse walling. Also discussed are two important sub-contracting aspects, down-lighting and tiling, which apply when slabs are deployed in their more traditional guise as flooring.

FLOORING

Pre-stressed, hollow-core concrete slabs offer several advantages over in-situ floor casting, including speed of erection, lower building costs and consistent quality levels – attributes not often found in one convenient package.

Slabs are available in standard widths of 1 200mm, in thicknesses of 120mm, 50mm, 200mm and 250mm, and in spans of up to 11m. Non-standard widths are also available and lengths are manufactured to suit individual requirements.

Cairns noted that due to the weight saving – up to a third or more – the use of high-strength concrete, coupled with pre-stressing means that hollow-core slabs can achieve considerably larger spans than in-situ reinforced concrete slabs of similar depths.
"

The slabs can be used in the construction of virtually any type of building in which suspended floors or roofs are required. These include flats, hospitals, office blocks, hostels, factories, hotels, townhouses, schools, shopping malls, multi-storey car parks and culverts," he says.

Δ ***Pre-stressed hollow-core slabs are cast according to customer dimensions, and only 100mm bearing is required on the masonry.***

Installation is undertaken by highly-trained teams, each of which can lay slabs at a rate of up to 600m² a day. A further advantage is that at no stage during the installation process is propping a requirement, and brickwork can commence 48 hours after grouting.

Cairns adds that slab soffits are so smooth there is no need for plastering prior to painting, which is executed using dense-textured paint.

"Provision is also made for down-lighting; service holes of up to 75mm in diameter can be cut on site through the hollow sections and, when required, larger holes can be factory formed, subject to a maximum of 560mm". Larger holes can be accommodated but require alternative designs and strengthening.

"Hollow-core slabs are also well suited to ground floors in areas prone to clay heave and shrinkage," he says.

WAREHOUSES

The use of pre-stressed slabs as retaining walls was successfully applied to a fast-tracking exercise when two huge potato sheds were built for a food producer. Adapted from a system originally used in Holland. 1 100m² of wall slabs were erected in a record time of only 11 working days; the wall contractors being on site for a total of two weeks.

"Using pre-stressed concrete floors as walls is unusual in South Africa. Its method more commonly found in the US and Europe," notes Cairns.

The two buildings are steel-framed and supported on piled foundations. Precast, pre-stressed panel were slotted into the webs of 6m steel columns. As the potatoes were to be stored to the full height of the walls, very high horizontal forces had to be allowed for in the design stage.

Each building consists of two storage sheds of 40m x 20m with built-in galleries for ventilation and temperature control. Both structures were insulated with polyurethane foam.

Cairns says once the piles were in place, the total construction time was only two months.

"The alternative would have been to cast concrete on site and that would have taken twice as long. Standard panel profiles were used, allowing for normal delivery, minimal adaptation of existing lifting gear, and very shot lead-in times. As a result of the speed and success of this operation, we expect to see the system used more widely," says Cairns.

Δ ***An 800m² potato warehouse in Delmas, which took two months to build using pre-stressed hollow-core slabs.***

SECURITY WALLS

Three outstanding examples, all of them in Bloemfontein, serve to illustrate this application. Two walls were constructed to safeguard military equipment, one at an SA Airforce base, the other at an SA Defence Force equipment depot. A third wall was built for the Post Office in the industrial area of Hamilton.

Securing areas between 2 500m² and 10 000m², the walls were constructed with slabs measuring 4m x 1.2m. Each wall topped 3m, with the additional one metre section sunk into a foundation of soilcrete, a mixture of compacted gravel and cement.

Cairns says there are several advantages to this type of walling, speed of erection being one of the major considerations.

Δ ***A 3m-high security wall with pre-stressed hollow-core slabs.***

"The current cost of building a precast security wall 3m high, is approximately half the cost of a wall offering the same properties if cast on-site. Furthermore, it would take two to three times as long with no advantage in strength or durability," says Cairns.

Also there is no requirement for shuttering or propping, on-site curing and formwork, and the installation rate is approximately 50 linear metres per eight hour day.

DOWN-LIGHTING

The fitting of down-lights into hollow-core slabs is fast becoming the preferred lighting solution thanks to the increasing use of precast hollow-core concrete floor slabs and improved lighting technology, the latter having led to smaller lights and enhanced performance.

Other factors influencing the swing to down-lighting include the recent changes to municipal requirements both for large concrete light boxes and for single transformer units.

Cairns noted that compared to fitting light boxes and conduits using the more traditional in-situ floor casting method, installing down-lighting in precast hollow-core slabs offer several advantages.

"Light points are far simpler and easier to place then in in-situ floor construction.This now requires much larger transformer boxes to be positioned between steel reinforcement, and the boxes are also difficult to position accurately.

"Costs are also lower as wiring and single light transformers can be installed the day after installation. The traditional method involves fitting larger light boxes, which are now more expensive than coring costs, and placing conduits before concrete is poured. Furthermore wiring can only begin once shuttering and scaffolding have been removed some two to three weeks later," observes Cairns.

Down-light coring is simple and accurate and far more economical than the installation of light boxes. Larger holes can be factory formed subject to a maximum diameter of 560mm and any edge chipping can be easily repaired with rhinolite or a similar material. Modern lighting equipment is a lot more compact, allowing for ancillary equipment to be stored in slab cores.

A 12-volt single light transformer requires a minimum core of 70mm. This allows for short cylindrical transformers to be easily removed and replaced during maintenance.

Longer transformers require larger cores. Smaller cores of 50mm or less can be used for 230-volt down-lights, which do not need transformers.

A scientifically monitored experiment has proved that drilling core holes through the steel reinforcement of a hollow-core slab does not adversely affect performance. During the experiment, slabs were loaded and deflections measured. A professional civil engineer assessed the results and found the slabs to be well within allowable tolerances.

Δ ***Examples of a typical down-light installation in precast***
∇ ***hollow-core concrete floor slabs.***

RETAINING WALLS

All applications are purpose-designed to bear specific loads. Time saving is the major advantage here, with installations running at 300-400m² a day and contracts generally completed up to four weeks ahead of schedule.

Another major advantage is the fact that building work can continue prior to the erection of a retaining wall which usually takes place during the installation of floor panels. Others include the possibility of window openings and no requirement for formwork or propping.

Two prominent projects which demonstrate the effectiveness of the system include the mixed office/retail/residential development at Melrose Arch in Johannesburg where a 35 linear metre wall was erected, and a new Johannesburg Hyundai dealership in the suburb of Bryanston, where the completed wall was 45 linear metres.

When used as retaining walls, the panels are generally two storeys high (6-7m) and 250mm deep. Unlike floor slabs, which are cast with prestressed steel cables at the bottom to form a positive camber, wall panels must be as straight as possible, and are therefore cast with cables at both the top and bottom of the slab, and then evenly stressed.

Δ ***Melrose Arch, Johannesburg, where this 35 linear metre retaining wall was erected using prestressed hollow-core slabs.***

Wall panels are delivered on site with ready-made holes to facilitate lifting into position. They can be simply hoisted off a truck and placed onto a concrete foundation with an in-situ kicker beam. It is then bolted to an overhead beam.

Δ ***A new Hyundai dealership in Bryanston, Johannesburg, where prestressed hollow-core slabs were used to build this 45 linear metre retaining wall.***

RESERVOIRS

Hollow-core slabs are making a contribution to the storage of clean, potable water, being used as they are for the closure and roofing of water reservoir. They present the consulting engineer and building contractor with several advantages, time saving, with an installation rate of 300-400m² per day, being the most important.

For instance, a closure contract which would normally take 8-10 weeks to complete using in-situ casting, takes only 10-14 days when prestressed slabs are deployed. The fact that no on-site curing, nor props, nor shuttering, and only minimal formwork, are required, is another distinct advantage.

One recent southern African project was a 3 500m² (30 000m³) reservoir for the supply of fresh water to industrial and residential areas in the south-western section of Maseru, Lesotho's capital.

Six metre by 1,2m precast hollow-core slabs were laid on concrete beams and columns. Service holes were drilled on site as opposed to manholes which were precast.

Δ ***A 3 500m² (30 000m³) reservoir under construction in Maseru, Lesotho. Precast hollow-core slabs measuring 6m x 1,2m were used to cover the reservoir.***

Waterproof plastic sheeting was placed on top of the completed roof which in turn was covered with a sloped layer of screed to facilitate the drainage of rainwater.

Cairns says that in some instances a layer of aggregate is then thrown over the screed for additional weather-related protection.

Δ ***Precast hollow-core slab can be cut to fit as was the case with this 530m² circular reservoir in Upington which was completed in 2002.***

TILING ON SUSPENDED FLOOR – AVOIDING THE CRACKS

Fixing of ceramic tiles onto precast hollow-core suspended floor slab systems, or onto any concrete suspended floor slab, requires special attention if cracking is to be avoided. Flexible adhesive is the answer, nevertheless several basic rules must be followed to ensure success.

These include:

- All new concrete work or screeds must cure fully before any tiling proceeds. Surfaces must be clean and free of all traces of curing agents, laitance, loose particles and sand, or any other surfaces contaminants.

- Power-floated or steel-trowelled surfaces must either be scarified or keyed with slurry consisting of a cement and a "Keycoat" type product. Specifications are obtainable from various adhesive manufacturers. The adhesive must be applied while the slurry is still "tacky".

- The adhesive itself should always remain flexible to counter the possibility of cracking, whereas rigid adhesives – as most are – will transfer any minor racking through to the tile. To obtain this type of flexible adhesive, manufacturers have developed liquid bonding additives which replace water when mixed with the cement-based power adhesive. Alternatively, high-polymer cement-based adhesives are suitable for use where extra flexibility, high strength or water resistance is required. These adhesives require no additives; they are simply mixed with water and will maintain the necessary flexibility to avoid cracks.

Δ ***Placing steel mesh in floor topping prior to tiling eliminates shrinkage cracking.***

- Adhesives should be at least 5mm thick and spread in 1m^2 batches. This prevents the adhesive drying. Only DRY tiles – not soaked – must be bedded into the wet adhesive, by twisting slightly and lightly tapping home with a mallet.

- Grouting must not be carried out until a sufficient strong bond has developed between the bedding mix and the tiles to prevent disturbance of the tiles during the grouting operation. Grouting should therefore not commence until one to three days after tiles have been laid. Joints exceeding 8mm require a different grout mix – consult with the manufacturer on specifications.

Δ ***A precast hollow-core suspended floor slab, which has been tiled using flexible adhesive to avoid cracking.***

- To further ensure tiles on suspended floors do not crack, movement joints must be left across door openings and at interfaces of concrete and brickwork, and directly above any structural ground floor walls.

- Movement joints must be located around any fixtures protruding through the tiled surface, such as columns or stairs.

- Joints should be a least 5mm wide and extend through the tile and adhesive layers to the surface. The bulk of the joint depth can be fitted with an inexpensive compressible material such as polyethylene foam strips. Seal the joint using a suitable resilient sealant according to the manufacturer's instructions. It is important that the joint sealant is only bonded to the sides of the movement joint.

Cairns says that these tiling procedures have proven successful when effectively implemented. "Ensure that the specification is given to the tiling contractor and indicate to the contractor where joints are required to enable the planning of the tile layouts," concludes Cairns.

FLOOR SLAB MEMBERS
FEBRUARY-2002

Deranco Precast
P O Box 98 Port
Elizabeth 6210
Tel: 041 463-3338 Fax: 041 463-2608
Cell: 082 468 0781
Email: deranco@iafrica.com
Contact: Herman Strydom

Echo Floors
P O Box 706
Muldersdrift 1747
Tel: 011 957-2033 Fax: 011 957-92037
Cell: 083 605-0077
Email: echo@echo.co.za
Contact: Melinda Louw

Echo Prestress
Private Bag 1
Edleen 1625
Tel: 011 393-4655 Fax:011 393-4651
Cell: 083 601-5173
Email: Monique@fastfloor.co.za
Contact: Monique Eggebeen

Echo Prestress Durban
P O Box 40726
Red Hill 4071
Tel: 031 569-6950 Fax:031 569-6974
Email: legweak@mweb.co.za
Contact: Wally Armstrong

Neat Contech
P O Box 275
Kenton-on-Sea 6190
Tel:046 624-3377 Fax: 046 624-3147
Cell: 084 360 3114
Email: spladewig@neatcontech.co.za
Contact: Sven Ladewig

Stabilan
P O Box 28690
Bloemfontein 9310
Tel: 051 434-2218 Fax:051 435-3925
Cell: 082 568 0204
Email: stabilan@cybertrade.co.za
Contact: Stoffel Botha

Topfloor
P O Box 41
Maitland 7405
Tel: 021 552-3147 Fax:021 552-6892
Email: info@topfloor.co.za
Contact: Dave Watson

CONCRETE MANUFACTURERS ASSOCIATION
Quality cast in concrete

Block D, Lone Creek, Waterfall Office Park, Bekker Road, Midrand.
PO Box 168 Halfway House 1685
Tel +27 11 805 6742, Fax +27 11 315 4683
e-mail: main.cma@gmail.com website: www.cma.org.za