



World
PORT
CONSTRUCTION
& OCEAN TECHNOLOGY

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Concrete: new mix offers advantages for marine use

A new lightweight concrete has emerged that should prove of particular interest to port developers, fully aware of concrete's problems in a hostile environment.

From the days when concrete was once a matter of mixing cement, aggregate and water, that has all changed. There are now a wide variety of admixes for the contractor to choose from, all claiming certain advantages. In some quarters, admixes have been blamed for subsequent problems, such as the much-debated 'concrete cancer' effect. Whatever is added to the mix, concrete in a marine environment is always going to be a particularly harsh test. From the "home" of concrete, Norway, one concept that has just emerged - following a long gestation period - could prove of great interest to ports. The project goes back to the late 1960s, when a Norwegian civil engineer first developed a new lightweight concrete mix. At that time, however, the product's potential was never fully established.

Subsequently, the concrete was further developed by Norway's Elkem Chemicals. Then, civil engineers Stein and Einar Knutsen worked on the concept, with the aim of advancing the technical characteristics as they could see the extensive market potential for such a product. Unfortunately, EC investment in the project ceased before the goal was reached.

Good quality

Then another cement company, based in Bergen, picks up the R&D, which took a further four years. The firm, now called Lightcem, say they are satisfied that finished result is of "good quality, practical and user-friendly". So far there have been marketing agreements finalised with the UK's Concretica Ltd, Martin Betong in Sweden and Germany Halle Bygg in Denmark. France, the Middle East and Far East is looked after by K.A. Consult.

Recently, agreement with the leading Dutch main contractor Volker Stevin has lead after some initial tests - the contractor is now planning to use Lightcem in a current construction project that calls for the structural fire

protection element in a new steel-framed building.

Lightcem lightweight concrete is described as a "versatile building material". Certainly, it would appear to have particular properties for coping with a tough offshore environment, as well as providing both new build and refurbishment possibilities. It can be pumped or sprayed on to most bases and in thick layers. The concrete also func-

tions well with several types of fibre. Contrary to most other forms of concrete, it can be worked for up to an hour or two after application. More importantly, it is claimed to "make possible the creation of buildings with a lower construction weight than similar buildings using steel or more conventional concrete".

Characteristics of the product before and after hardening gives both



A new £3.5 million wharf was recently opened for P D Wharfage Limited, as part of the £6 million Phase 6 development of the Portsmouth Continental Ferry Port for Portsmouth City Council. Main Contractors for the project are W A Dawson Ltd. Crane rails were installed by Gloucester based Gantry Railing Ltd which included grouting of 176m of track with Fosroc's Conbextra EPS epoxy resin free-flow grout.

architect and contractor, it is suggested, "the chance to erect structures that cost less". Lightcem lays claims to the fact that the material opens the way to methods which allow "unique and flexible" solutions, particularly in sandwich construction, with reinforced rendering on both sides of an insulant. The outer layers are inter-connected, creating a load-bearing construction material. Its durability - plus fire protection characteristics which Volker have gone for - are said to be major benefits.

Anyone with knowledge of off-shore projects knows the advantages of a material with great strength, low weight and incomparable fire resistance qualities. Typically, if the topsides of an off-shore platform used the Lightcem product instead of steel, the finished job would have been 40 per cent cheaper yet the same overall construction weight would have been maintained. The concrete adheres well to smooth surfaces and it can be poured in rough constructions without cooling-down. The concrete can be pre-stressed and adheres well to the reinforcement. As a dry mix, it can be used without difficulty or complication and can be supplied in different classes of strength and weight.

Lightcem's plan is to supply its "secret mix" (otherwise known as K-mix), or release details of the mix to partners holding exclusive rights. The partner then has the responsibility to produce and sell dry mixes to customers, who are "guaranteed a first-class lightweight concrete by following the simple pack directions". Anyway, say Lightcem, the concrete "is extremely user-friendly". To prove it, they point to the "considerable savings" that are possible because wastage is reduced.

Major customers such as producers of concrete products and ready-made concrete will, with proper equipment, be able to purchase the chemicals as wet mixes in drums. This will at first be supplied by Lightcem, but when the proper chemicals are available locally, it will be possible for the partners to produce wet mixes. Meanwhile, the task of further developing lightweight concrete has high priority. Great emphasis is being placed on the search for new or improvement projects where the light concrete presents the buyer with significantly improved benefits.

Lightcem's income will be from the sale of exclusive rights to produce and sell, consultancy fees, and the sale of the K-mix. Its dry mix range includes the product types LC5, LC10, LC25, LC35 and LC50 (these indicate the pressure resistance in MPa).

These lightweight concretes are

based on cement, micro-silica, aggregates (various types), K-mix (dry or wet) and water. The additive K-mix itself, say the makers, "based on a combination of ordinary concrete additives". The v/p of lightweight concrete varies from 0.30 to 0.55, depending on the quality and use of the concrete (p represents the sum of cement and micro-silica).

When the lightweight product is supplied as a dry mix, the only additive required is water. If the concrete is given good, moist conditions during hardening, higher values for E-module and flexural strength can be achieved. At the same time, drying shrinkage is reduced.

It is also possible to spray the LC series without the addition of an accelerator which means that it can be plastered/rendered after having been sprayed on. Recently, polypropylene fibres have been used in the LC series with good results. This has improved some of the strengths and prevented the development of plastic shrinkage and cracks.

Concrete fish farm

Among the applications so far has been the building of a Mediterranean 2000m² combination steel/lightweight concrete fish farm, built at Barcelona's Vulcan Shipyards. Today, the structure is in busy use offshore from Formentera, with the client reported to be "extremely pleased". In addition, several Norwegian floating quays and jetties ranging in length between 30-500m² have been constructed, all with no problems.

Lightcem say they are keen to develop the type of structure where they feel "there is particular room for improvement on what present methods". But they are keen to stress that 'improvements' in this case would also mean cost savings. Salt water claims

The company has also been involved in a new low-cost construction method for reducing earthquake damage. Floating structures can be built on the same basic idea, with a much higher degree of certainty of achieving dense concrete. This particular mix is claimed to be much more resilient - and performs better - in salt water or other aggressive environments than traditional concrete.

Quoting the fact that "Archimedes Law is irrevocable", Lightcem point to the fact that floating structures built with the mix require little buoyancy volume. As a result, savings in cost are realised without detriment to strength. To end with a topical reference: war in the Persian Gulf has created a great need of floating docks and workshops

to serve the allied fleet. Lightcem say they have already produced "an outline scheme" to assist in this regard, and which apparently has been well received.

Away from war zones, the Third World also has an enormous need for deepwater quays of this type. Industries built on concrete barges and transported by large vessel to user-countries could also result in considerable savings. The company also notes that it has received enquiries regarding floating quays with storage facilities built into the quay structure, confirming concern that "many areas around the globe have problems with deep water quays".

In Nigeria, for instance, Lightcem has designed a floating quay 1km out in the sea, with a floating pier construction to the mainland. As it is today, several mud lights suck up sand from the ships' channel. The costs every year are several times that of their proposal, say the company.

A cylinder placed on the sea bottom and built of lightweight concrete produces a lagoon in which can be floating buildings can be erected. Everywhere, stress the firm, there are long, shallow-bottomed harbours exist: great advantages exist in building in the natural basin provided especially where the sub-soil is suitable and a large diameter cylinder can be adapted to form a dry island. This may also be the solution if it is necessary to penetrate the sea bottom with a shaft for mining or construction work.

The advantages of lightweight concrete for floating constructions is that the floating ability can be regulated by the use of the right specific gravity to produce concrete lighter than water. "There is no need," stress the company, "to produce cavities to give buoyancy" as these would have to be watertight and the construction sufficiently strong when great depths are involved.

All in all, a fascinating concept. Lightcem's only immediate problem would seem to be how to list an order of priority for its prototype applications. Considering concrete's past record of problems when faced with a harsh marine environment, ports and harbours should be near the top of the list. •

Companies mentioned in this article include

| name | quote box |
|------------------|-----------|
| Lightcem, Norway | HA12 |
| Foscroc, UK | HA13 |

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