Cement bags bring solutions to pipe-laying problems

by Dr AD Bruce and LA Bell

With all the fanfare about installing offshore production facilities in deeper and deeper waters, and the technical achievements required to accomplish the task, it comes as a surprise to see an offshore construction problem handled in a very simple and low-cost way. A company which originally made its mark in the North Sea—that spawning ground of high-tech solutions—has come up with a straightforward approach to the problem of stabilizing and underpinning underwater pipelines.

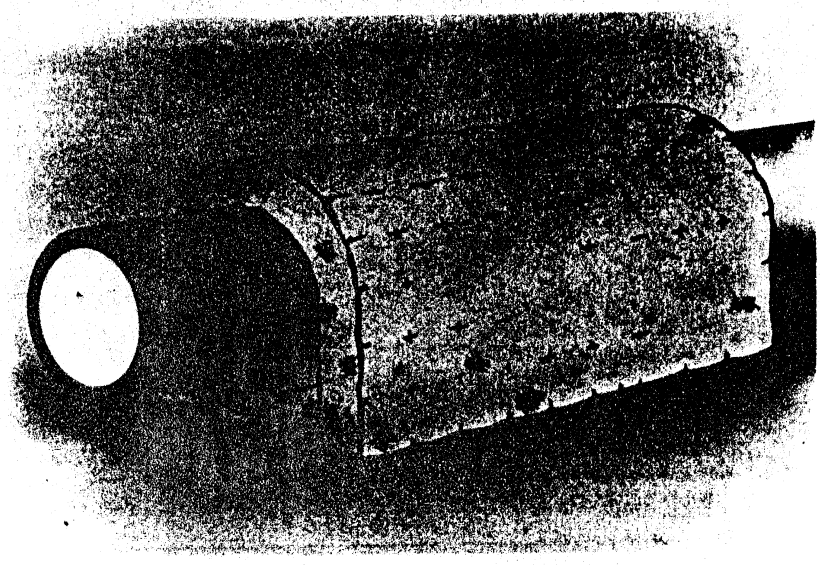
For protection of offshore pipelines, most operators rely on an application of concrete coating. These coatings are sprayed or cast around the pipe prior to laying offshore, and the thickness of the coating depends on such factors as seabed currents, pipe size, buoyancy, concrete density, corrosion protection and resistance to mechanical damage and spalling.

Natural irregularities in the seabed topography or scour under the pipe during service can result in substantial free lengths of unsupported pipe. This cannot be tolerated, since the concrete coating becomes overstressed and spalls, leading to loss of protection and instability. Less frequently, the concrete coating is damaged during the pipe-laying operation, or after installation by ship anchors and trawl boards.

Over irregular ground, freespan sections are usually installed by providing intermediate supports, augmented where necessary by additional weight coating or perimeter protection. In this regard, purpose-made engineering solutions have been introduced recently by the company Colos, a joint venture between Colcrete Ltd of the UK and the Swiss civil engineering company Losinger Ltd. Both companies have previous experience in the offshore market in the North Sea, including post-tensioning of Condeep platforms and underbase grouting of the Ninian central platform.

The Colos system, which was introduced in April 1979, is designed around well-proven VSL flexible fabric, which is formed into bags or mattresses. These are then filled with grouting, using the company's colloidal grouting plant.

The system is specifically designed to simplify the role of the diver and minimize diving time.



The Colos saddlebag is a cinch

The grouts are cement-based and are formed primarily from OPC (Type I) or API Class B cement and seawater (w/c = 0.35-0.45). Filler materials such as sand or flyash may also be added for economy, or to obtain special grout characteristics. However, the grout must combine high fluidity and strength. It must be able to be placed easily through significant lengths (300-400 m) of small diameter flexible lines (25-50 mm), and yet retain sufficient continuity and strength after injection to act as a well bonded impermeable or strengthening medium.

Close control of the water:cement ratio by flow and density tests ensures that the grout pumped into the fabric formwork is of high quality, with no shrinkage and minimal bleed as the material sets and hardens.

The formwork is made from a purpose-woven polyprophylene fabric having several interconnected compartments (Colobags) with vent pipes to ensure that the bags are correctly filled and that contact with the underside of the pipe for a standard distance of 1.5 m will be maintained. The system is tailored to inflate with grout into a pyramid shape beneath the pipe, and the bags can be supplied to accommodate varying heights of undercut beneath the pipeline.

The fabric is also supplied in the form of a saddlebag, to provide additional weight coating or protection over the pipe *(fig 1)*. Another important application is the repair of isolated areas of damaged coating, using the fabric as a sleeve which is zipped up around the pipe.

Cement for filling the fabric bags can be supplied from pressurized bulk silos, gravity feed silos or in bags, depending on the requirements and scope of the work. Pressurized silos of 40-50 tons capacity are commonly used on dynamic-positioning diving vessels. Colloidal mixers (single or double drum, depending on whether fillers are required) are used with individual outputs in the range of two to 15 m^3/hr. A wide range of rotary screw, piston and ram pumps are available, capable of individual outputs up to 10 m^3/hr and pressures up to 10,000 kN/m^2.

Bearing in mind the space restrictions on small diving vessels, experience indicates that small, compact plants built into modules are invariably more attractive than large, high-capacity plants, since silo storage can be maximized to permit longer work at sea.

For mechanical handling of the double grout line, a stowinch is required to give the necessary safe handling and control when lowering and lifting.

After weight batching and mixing, the grout is pumped through a grout umbilical consisting of two 40-mm pressure hoses. The double hose provides a return line to the surface in order that the grout can be recirculated when necessary. A special valve at the bottom of the hose gives the diver closer control of the grout supply and less dependence on communiction and action from the surface grout station.

The grout is pumped into the fabric through self-sealing injection sleeves, which eliminate grout spillage from the fabric formwork and ensure that the diver's work in making connections and disconnections is minimized. Dilution effects during placing of the grout through water are negligible, due to the efficient hydration of the cement in the colloidal mixer, combined with the gravity displacement technique.

During the past four years, this grouting system has been used successfully for a range of applications at various depths. An early example was Shell Expro's Flags gasline. This is a 914-mm diameter, 450-km long gas pipeline running from the Brent field to St Fergus on the northeast coast of Scotland.

More recently, Colos have established a permanent operation in Singapore to cover Southeast Asia. Since the office opened in April 1982, contracts involving the use of pipeline and riser supports and scour mattresses have been successfully completed on behalf of Pertamina, Esso Production Malaysia Inc (EPMI) and Atlantic Richfield.

The contract for Pertamina involved the stabilization of five km of 410-mm pipeline near Balikpapan, Kalimantan. The work was carried out in conjunction with P T Calmarine, and involved placing and injecting 16 Colobags and 26 scour matresses. The Colobags ranged from 0.5 m to 1.32 m in height and a total of 130 tons of cement was injected in 10 days.

A separate operation for EPMI consisted of placing eight pyramid supports to underpin the new 600-mm pipeline running from the Tapis field offshore Peninsular Malaysia to the Kuala Trengganu terminal. This contract was of particular interest, as the placing and supervision of filling of the Colobags was carried out using the "Wasp" ADS system in 73 m of water. The diving contract was completed by Oceaneering Intl working from the *Knut Inspector*, and the total operation was completed in 23 days round trip from Singapore.

New developments include the protection of pipeline connections, which invariably have valve assemblies and other exposed fittings. Preformed protective covers can be difficult to position without putting the pipeline equipment at risk due to movement of the vessel controlling the lowering operation.

Fabrics can be tailored to suit the subsea topography and the pipeline sizes, and be placed subsequently by divers and injected with structural sand or cement grouts.

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