Gas defeats harsh Saudi granite

World Construction's annual look at developments in the pipeline business reports on innovative construction techniques that overcome specific difficulties, new methods of repairing decaying sewers, and a new pipe jointing system that will improve both the speed and quality of pipeline construction.

A 'non explosive' explosive, originally developed for coal mine work, recently helped an Italian contractor out of a serious jam during construction of a major oil pipeline in Saudi Arabia.

Unable to use conventional explosive due to the proximity of a working pipeline, and faced with a granite wearing out three $2000-plus hydraulic breaker points every 15 minutes, Saipem, one of the world's most experienced pipeline contractors, knew that it had a problem.

The Cardox sequence...holes are drilled in the homogenous granite and tubes inserted...

The difficulty was solved by Cardox, which produces most of the effect of a conventional explosive with little of the ground vibration.

Cardox consists of an alloy steel cartridge filled with liquid carbon dioxide and a chemical igniting agent. Placed in a borehole, detonation is initiated by an electric current controlled from a safe distance; the expanding carbon dioxide gas breaks a soft steel disc at the discharge port and pressurises the surrounding ground to heave the material.

High pressure

Classified as a high pressure gas cartridge, Cardox achieves its results with none of the time delay associated with expanding cements and other non-explosive processes.

...and the excavator comes in handy for digging out the clean broken material.

Saipem was prohibited from using conventional explosives to excavate a trench just 4 m from an existing high pressure oil pipeline. Expected to contain 50% solid rock, overblast from excavation of the original trench meant that most of the rock was broken or fissured.

Despite that, the excavator mounted hydraulic breakers found it difficult to penetrate the abrasive granite until a drill rig was brought onto the site. It stitch drilled 6-10, 3 m deep 64 mm diameter, holes across the width of the trench, with 3-4 rows for each linear metre of trench. Breaker points inserted in the holes found it easy to split the rock, with its estimated 10% solid content, by a plug and feather effect.

Although steady progress was made, Saipem expected to encounter sections of more competent rock that would be too much for the breakers, and decided to test Cardox, under the supervision of inspectors from the explosives section of the client, Aramco.

Saipem provided the air conditioned environment needed for charging the refurbished F57 high pressure Cardox tubes, but had to build a special fitting so they could be filled from the non-syphonic liquid carbon dioxide canisters available.

Two 64 mm diameter holes, 1.2 m deep, were drilled in the first test. Vibrographs were placed on the existing pipe, and on the ground above it, to measure peak particle velocity which, under the project specification, could not exceed 50 mm/sec.

Aramco officials doubted that the Cardox would achieve any yield whatsoever in the solid granite, said to be so tied in that conventional explosives would likely have little effect.

Successful shot

These reservations were overcome by firing the first tube. While producing little fly rock, it successfully broke most of the granite. As well, it used only a single hole; the hydraulic rock breakers would have required about 20 holes to produce the same result.

Vibration readings varied widely — the machine on the pipeline recorded a peak velocity of 3 mm/sec, compared with the 23 mm/sec recorded on the surface — but were well within the 50 mm/sec specified limit.

The successful test was followed the next day by another to determine the effect of simultaneously firing two tubes, as in a normal production programme. It was in the section of granite assigned for that second test that the breakers had run into severe difficulties, wearing out three points in just 15 minutes.

A series of holes were drilled along the 15 m section of granite, in anticipation of a successful result. When the two tubes were fired, the vibrographs, placed in the top soil just 2 m from the inside edge of the trench, recorded 25 and 28 mm/sec particle velocities, again well within the specification limit. Following the success of the demonstration, Cardox was used to excavate the remaining section of trench.

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The Cardox representative, Senior Project Engineer, John Hodson, stayed on site to train Saipem personnel in refurbishing and refilling the tubes so they could use the method when isolated granite sections were encountered during actual pipelaying.

Cardox is also expected to be used soon on the excavation of another pipeline adjacent to the section where the tests were performed, in ground not fragmented by overbreak from the previous blasting work. ■