Saved Again

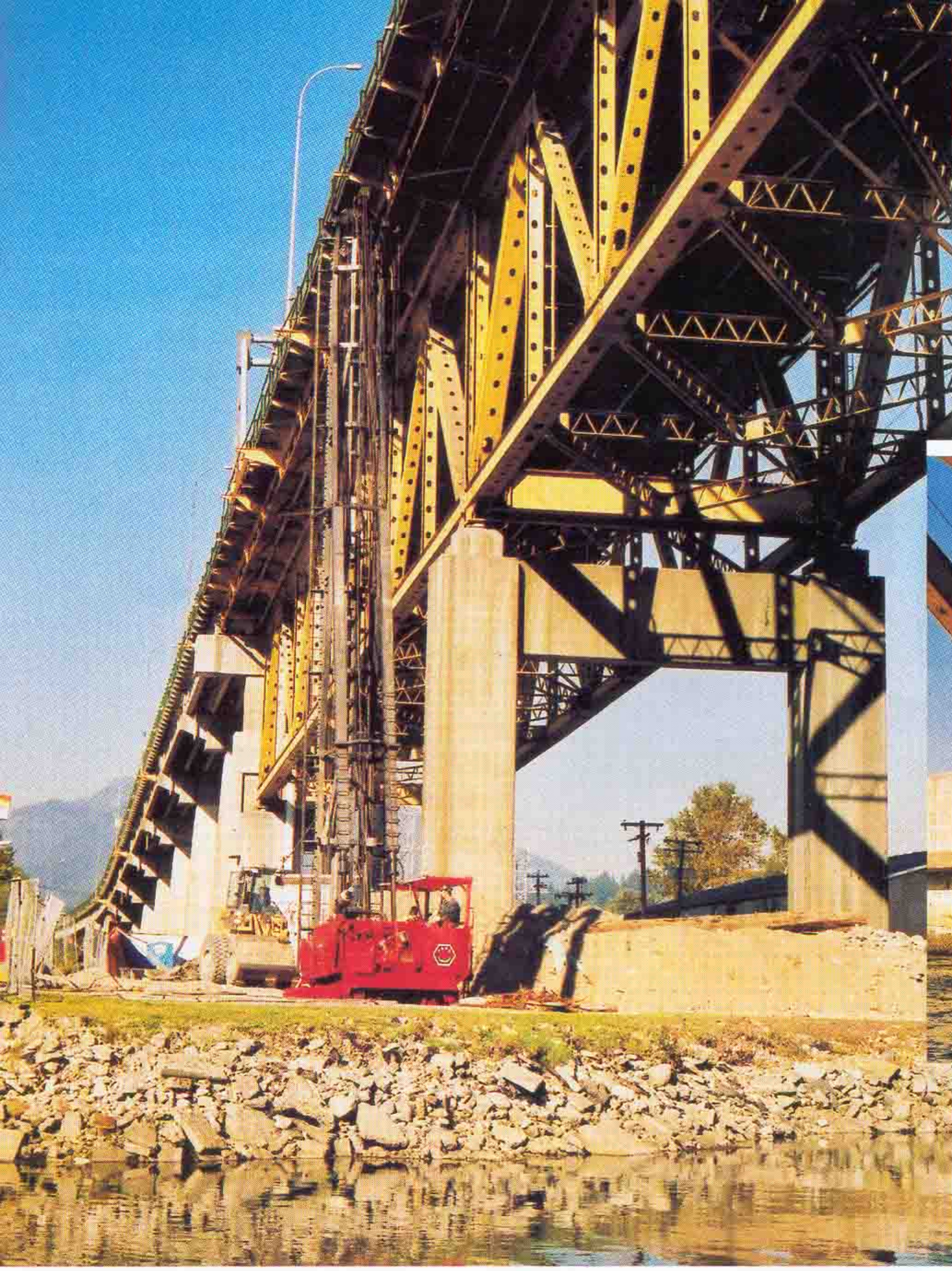
By Tonia Jurbin

Built in 1959 and part of the Trans-Canada Highway, the Iron Workers Memorial Bridge, is undergoing the fourth and last in a series of upgrades. Commonly referred to by the locals as the 2nd Narrows Bridge, it was renamed in 1994 to honor the 16 men that died during a construction accident in June of 1958. The famous Lionsgate Bridge is often referred to as the 1st Narrows, both bridges cross the Burrard Inlet and are the only two land routes to get to the Lower Mainland's affluent North Shore, and one of the largest BC Ferries terminals at Horseshoe Bay. Briefly, in 1996 there was a $4.2 million rehabilitation of the bridge deck, in 1998 seismic isolation bearings were installed at a cost of about $2.3 million and in 2000 another $2.1 million was spent on replacing bearings on the north viaduct, and major concrete work on the north approach. The current $1.4 million geotechnical upgrade to improve the performance of the loose saturated sands during an earthquake is expected to take about three months.

A crane and excavator work in tandem on pile installation.

The highlights of the job include the gravel columns being installed around two of the in-water piers, seismic drains being installed on-shore and off-shore, and a gravel compaction pile wall. Vancouver Pile Driving Ltd. out of North Vancouver was the prime contractor with Hayward Baker of Seattle the marine ground improvement sub-contractor and technical advisor.

Bottom feed vibro-replacement methods are being used to build about 360 stone columns that strengthen the soil mass through densification, and about 40 seismic drains are being installed to relieve the high pore pressures that can build up during an earthquake. If they work together as predicted, small geysers would appear during the event. The ground improvement methods in conjunction with the seismic drains will mitigate the chance of liquefaction during an earthquake. The seismic drains averaged about 13 m in length below mudline at the deepest pier, pier 15, while the land based drains were about 15 m long. The land based drains are 305 mm diameter holes with slotted PVC pipe, the annulus filled with rounded 'bird's eye' gravel, about 200 m^3 total, while the marine drains are 610 mm diameter holes filled with the 28 mm crush, the same material used in the gravel columns. The gravel columns ranged from about 12.5 to 15 m below the mudline in the marine portion of the job. About 6,000 tonnes or six barges full of 28 mm crush was used for the marine gravel columns and seismic drains. 140 gravel compaction piles round out the job forming an underground wall near the shoreline that is



Working in close proximity to the bridge kept equipment operators on the alert.

A close look at one of the bridge's rebuilt piers.

meant to contain the soils from flowing into the inlet during a seismic event.

The contract dictated a performance specification rather than an installation method so Hayward Baker determined the layout and spacing of the stone columns. Based on their equipment and experience, they went with 3 m centres on a square grid. The 0.6 m dia vibrofloat (complete with fins) build stone columns that range in size from 1.0 to 1.2 m. The density was tested using becker hammer drilling techniques.

The land-based soil densification work, that is the gravel compaction wall, was installed by Agra Foundation Limited of Richmond, BC. First a 0.75 m excavation was required because of restricted headroom under the bridge. The compaction piles were built using methods similar to building Franki Piles. A 20 m-long open-ended steel pile was positioned on a 2 m grid. Once in place, gravel was dropped into the pile and compacted with a very heavy hammer dropped from an average of 4.6 m. That caused the gravel to bridge in the bottom of the pile. The pile was advanced down to competent soils by hammering on the gravel plug, and the stone columns were built to the surface by continually dumping gravel into the top of the pile, while at the same time raising the pile, pounding the gravel into the weak surrounding soils. This doesn't require the expensive vibro equipment which is subject to wear from working the aggregates, but it is labour intensive. Each bucket of gravel has to be handled several times by a loader, and a worker has to climb the leads to dump every bucket. About 400 m^3 of 32 mm crush went into the containment wall at the north approach.

For the off-shore work, the vibrofloat probe was advanced using mostly air. A Cat EL300 long reach works off of the stone scow, feeding the material into a skip near water level, which is raised up to the hopper and fed to the bottom of the probe