"Vibro-replacement" for earthquake resistance

An extension program is under way at the National City Marine Terminal in San Diego, California. The new complex under construction is located in an seismic area, and benefits from the know how of Ménard Soltraitement.

MÉNARD SOLTRAITEMENT WAS CALLED IN TO participate in the work to prolong the Southern end of quay 24-4, which is part of the extension work on the National City Marine Terminal in San Diego. This extension work includes widening of the shoreline by driving sheet pile caissons and backfilling behind the newly constructed curtain. It will bear a pontoon extending outside the line of the sheet piles. The new pontoon will be built on driven piles and will be 340 m long by 25 m wide so that ships, each carrying more than 4 000 European vehicles, can be unloaded.

Seismic considerations

The work is done in the "San Diego Embayment", which is a sedimentary basin limited by a fault. Seismically, the site is located on the area of the Rose Canyon fault, the most active main ramification of this area being the Silver Strand fault which is approximately 4 km to the east. Seismic analyses carried out based on initial geological records indicate that most fill and deposits existing in the bay have a strong potential for liquefaction at depths of up to 18 m. The effects of soil liquefaction include loss of foundation bearing capacity and side friction capacity, surface settlements and risks of circular slips in submarine slopes adjacent to the sheet pile curtain.

Consolidation work

It was considered of utmost importance to improve the characteristics of the materials used for filling the box girders and sloping material under the pontoon using the vibro-replacement method, to stabilize the system and ensure that the new pontoon would behave satisfactorily. This is a variant of vibro-compaction in which ballast is used to fill the hole bored by vibrating drill. This method is used with low size grade materials, since it reinforces the soil and drains water overpressures through the stone columns network.

The soil densification work currently being carried out is done after driving caissons and dredging the sloping material. They make use of the *bottom feed* system (ballast filled through the end of the vibrating probe) designed to operate under offshore conditions (slope densification). The installation of columns is closely controlled during execution of the work using the Emparex System (record of construction parameters) and offshore columns are positioned using a differential GPS.