LOADTEST
O-Cell® Technology San Sebastian, Northern Spain

Project:	**New Bridge over the River Urumea**
Location:	San Sebastian – Donostía, Northern Spain
Foundation Contractor:	Rodeo-Kronsa Group
Geotechnical Co.:	University of Madrid

Project Description:

In the North of Spain, overlooking the Bay of Biscay, lies the beautiful Basque city of San Sebastian-Donostía. This city was the location of a research project undertaken by the University of Madrid with the help of O-cell Technology. The project was situated on the site of the construction of a new bridge over the River Urumea. The underlying Flysch rock made this location ideal for a research project undertaken by the University of Madrid assisted by Rodeo Kronsa Group.

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Playa De La Concha, San Sebastian

In order to further research on pile design in rock, Professors Olalla and Serrano have been investigating the behaviour of the shaft friction of piles in rock. The research was planned to check a new empirical design theory with a secondary objective to determine the pile end bearing resistance. To obtain useable data for this research, controlled loading of a fixed shaft length in the rock was required. Two levels of O-cell were placed so that the mid-section was a know length and therefore the skin friction area was readily quantifiable.

The pile bore was constructed 17m long and one O-cell level was set very close to the toe to measure the end bearing properties. The second upper level was placed exactly 2.5 metres above this level. A zero shear sleeve section was inserted into the top section of the pile to give a second 2.5 metre section between the upper O-cell level and the zero shear zone. An arrangement of two 330 mm diameter O-cells at each level was chosen. These provided a 7.8 MN loading to the base and to the rock sections below and above the upper O-cell levels. It was considered that this loading should provide sufficient capacity to obtain ultimate values of both the end bearing resistance and skin friction in the rock.

Multi-level cage layout before installation

The pile was loaded in two stages, the initial stage loading the toe of the pile using the upper section of the pile as resistance. Once the toe of the pile moved downwards, the bottom O-cell level provided zero resistance to downward movement when the upper level of O-cell was loaded in the second stage. Stage one loading provided a total maximum of 8.5 MN to the base, but the ultimate end bearing had not been mobilised sufficiently to fully characterise the base behaviour. Loading of the upper O-cell level was then performed, loading an independent section of pile above and below the O-cell arrangement of 2.5 metres. At the maximum rated O-cell capacity, the rock still held steady and even with increasing the pressure by an additional 50%, the friction could not be fully mobilised in the rock; achieving less than 1.5 mm movement above and below the upper O-cell level.

The maximum mobilised reaction from the bi-directional test was 32.5 MN, far in excess of the value predicted before testing commenced. Values of skin friction obtained for the rock, were significantly higher than predicted by nearly an order of magnitude. As such, it was not possible to provide ultimate values of either the end bearing or for each of the 2.5 m sections of the shaft friction during this test. Post test analysis of the behaviour using Cemsolve predicted the ultimate end bearing to be in excess of 20 MN (twice the scheduled test capacity). The predicted ultimate values of the combined rock socket above and below the upper O-cell would be of the order of 40 MN.

University of Madrid, Rodeo Kronsa and Fugro Loadtest personnel.

The testing has proved that sometimes even the most pessimistic of design parameters taken still results in very conservative values for pile design in rock.