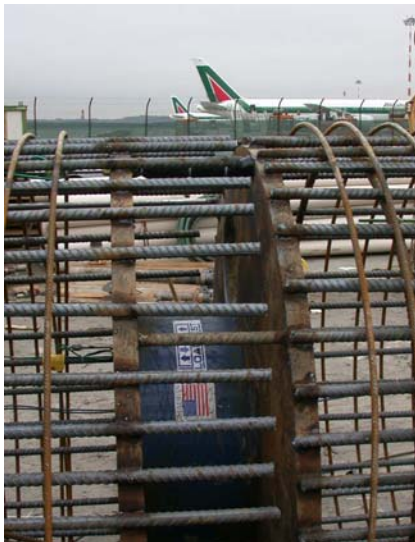


Summary:

Redevelopment and expansion of Malpensa Airport, Milan called for the installation of large diameter bored piles as part of the foundation works. Pile diameters of up to 1800mm were required with working loads of 15MN. A test load of 22.5MN on the production piles made top-down static load testing an expensive option. Soft soils would have necessitated the need for kentledge reaction, but with unstable soils consisting of sands and gravel, a deep cut-off and small test area, would have been impractical.

Bi-directional static load testing offered a cost effective alternative meeting all the difficult requirements with ease.



Project:

Malpensa is one of three intercontinental airports in the Milan region and is located approximately 50 kilometres from the centre of Milan. As with most major airports in Europe, Malpensa has seen a rapid growth of air traffic over recent years, which has necessitated a major expansion of the airport. In 2006, Malpensa saw movements of 21.7 million passengers and the separate

cargo terminal handles over 410,000 tons of freight yearly. The construction of this third satellite terminal together with a third runway will enhance the capacity of the airport for future traffic.

The construction and redevelopment contract was awarded to Codelfa Spa, the piling and foundation works forming a major part of this project.

Testing was required on one of the 1800 mm diameter auger bored piles to loads of 22.5MN. The test pile would be incorporated into the foundation structure after testing as a working pile. The O-cell[®] and annulus created around the O-cell when it expanded, together with hydraulic connections and pipe-work were grouted after testing to allow the pile to be integrated into the structure.

Bi-directional load test arrangement:

A single 670mm O-cell was used to provide the 22.5MN load required. The O-cell test assembly was welded into the instrumented steel cage at a level of 3.30m above the toe

This was then installed in to the pile shaft which had been constructed under bentonite to a depth of 19.8 m.

Three levels of strain gauges were placed within the cage to allow calculation of unit skin friction, one level located below the O-cell assembly and two levels above.

Pile Test:

A maximum sustained bi-directional load of 14.6 MN was applied to the pile. At the maximum applied load, the displacements above and below the O-cell assembly were recorded as 5.6 mm and 24.2 mm, respectively.

Using these results, a top down equivalent curve was constructed

allowing a predicted settlement from the top of the pile of approximately 6.2mm under the working load of 15MN. These values were within the load settlement criteria and the pile was successfully incorporated into the structure.



Pile head test arrangement showing reference beam

Conclusions:

Bi-directional load testing was performed on a working pile where top down static load testing would have proved to be difficult and expensive. Geotechnical information was obtained to confirm the design parameters used and to give confidence in the pile design.

With a small testing footprint and no surface loading required in soft ground conditions, bi-directional static load testing proved to be the perfect solution to the testing needs on this site.

Main Contractor:

Codelfa Spa.

Foundation contractor:

Fondamenta Spa.

April 2007