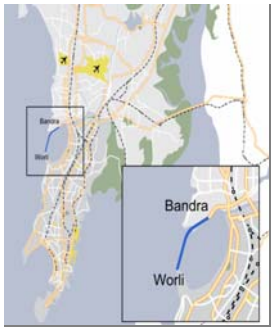
LOADTEST
The Rajiv Gandhi (Bandra-Worli) Sea Link Project, Mumbai

Project: **Rajiv Gandhi** (formerly known as Bandra-Worli) **Sea Link**

Location: Mumbai, India

Client: Hindustan Construction Company

Project Description: The Rajiv Gandhi (Bandra-Worli) Sea Link will become an eight-lane, 4.7km bridge connecting the province of Bandra and the western suburbs of Mumbai with Worli and the rest of Mumbai, India. The sea link consists of approach viaducts and two aesthetically pleasing cable-stayed bridges supported by a single tower. The project's salient features are numerous:



- An 8-lane bridge with 2 lanes dedicated for buses.
- Single tower supported 500 meters long Cable Stayed Bridge at Bandra Channel and Twin tower supported 350 m Cable Stayed Bridge at Worli Channel for each carriageway.
- An intelligent bridge with state-of-the-art systems for traffic monitoring, surveillance, information and guidance, instrumentation, emergency support etc.
- Unique bridge design for the Link Bridge to emerge as a landmark structure in the city.
- Modern toll plaza of 16 lanes with automated toll collection system.
- Development of promenade and landscaping to enhance the environment.

Under construction, May 2008

The main developer of the project, the Maharashtra State Road Development Corporation Ltd. (MSRDC), awarded the construction contract to the HCC (Hindustan Construction Company) and its foreign partner, the China Harbour Engineering Corporation.

The load tests were the first O-cell bi-directional load tests performed in India. Three multilevel and one single level O-cell bi-directional load tests served to validate the design assumptions and provided key data in selection the final toe elevations for the working piles. Due to the highly variable subsurface geology, final design was performed on a pier by pier basis. At the main Pylon, the results of the load tests allowed the pile lengths to be shortened to approximately one-half the lengths estimated during the preliminary design, resulting in a saving in excess of 500 m in total pile length.

Lower level O-cell arrangement

Upper level O-cell arrangement

Tremmie guide

The bridge opened July 1, 2009.

Source: bandraworlisealink.com

LOADTEST
O-cell Technology at Lodha Place, India

Project:	**World One, World Crest Towers at Lodha Place**
Location:	Upper Worli, Mumbai, India
Client:	Lodha Group
Consultant:	Langan Engineering and Environmental Services
Project Description:	Cities have typically been marked by iconic structures to symbolize economic progress and Mumbai, the commercial capital of India is no different. World One is the iconic masterpiece of a three residential tower, shopping mall and office building development at the site of the old Srinivas Cotton Mills factory located in Upper Worli, Mumbai. At 442 m and 117 storeys, World One is destined to become the second tallest residential building in the world, a mere 70 m short of Pentominium Tower in Dubai, slated to be completed in 2013, one year ahead of World One. However, the final height and number of floors will not be made public until closer to the completion of the tower. One of the landmark features of the tower will be the open-to-air observatory '1000' located, at 1000 feet above sea level.

Artists Rendering of World One
source: Wikipedia.org

Artists Rendering of World Crest
source: skyscrapercity.com

The tower has been designed by the world famous architectural practice Pei Cobb Freed & Partners and the consulting engineering firm Leslie E. Robertson was responsible for providing structural engineering design services. Due to its "green" environmental credentials, it will be rated as a Gold LEED Certified building by the Green Building Council.

Some interesting facts about living at 450 m above sea level:

- Air temperature at the top of World One will be 4.5^{o}C lower than at the ground.
- Street noise levels can be reduced by nearly 100%.
- The outside air will be cleaner, fresher and with better visibility due to a decrease in airborne pollutants usually associated with automotive sources.

World Crest tower, at 57 storeys is the smallest of the three iconic residential towers at Lodha Place. It may be dwarfed by World One but is itself a contemporary structure that stands in a league of its own. The finest names in design and architecture have come together to lend their expertise to the creation of this tower. Though the expertise of Fugro Loadtest in pile foundation testing is seldom acknowledged by the public, our input provides confidence to those that build upon them. See over page for the critical involvement of Fugro Loadtest.

LOADTEST
O-cell Technology at Lodha Place, India

O-cell Assembly Fabrication

Instrumented Cages Ready For Installation

Hoisting and Installation of Cages

The involvement of Fugro Loadtest was initially on the World One Tower where two preliminary 1200 mm diameter piles were tested in advance of the construction of the production piles. Both test piles at near 27 m in length were relatively short for the foundations of such a tall building. However, the geological formation at the site was weathered but very competent Tuff bedrock.

The trial piles were instrumented with 7 no. levels of strain gauges over the lowest 10 m of pile to follow the design length of the rock socket. Two 405 mm O-cells with a combined rated test mobilization capacity of 25.2 MN were adopted. The Tuff was much stronger than the design team expected and even over-pressurizing the O-cells beyond their rated capacity to provide a bi-directional test load of 38 MN, O-cell expansion of less than 10 mm was recorded.

The strain gauge instrumentation indicated that the O-cell applied load was resisted by shaft friction forces only with no load transferred to end bearing. Strain gauge recorded data suggested the mobilized unit skin friction reached as high as 1500 kPa.

For the World Crest Tower, the design of the foundation piles followed that of the World One Tower in close proximity as the geological ground condition was similar. Fugro Loadtest was engaged to carry out two verification tests on piles also to be included as production piles in the structure foundation. Since both the test piles were intended to carry structural loading, the O-cells and annular void created as a result of the expansion of the O-cell were grouted to reinstate the structural integrity.