

Trimble ATS-3D  
Total Station in  
action

# GEOID Provides High Precision Positioning Services Using Trimble Instruments

The port of Monaco is undergoing an extensive will help Monaco to double the port's capacity eastern swells and dangerous Mediterranean include two unusual pontoon-type breakwaters of land reclaimed from the sea. The extension allows Monaco to increase the port's capacity to 700 berths and puts Monaco among the top-ranked locations for 40-100 metre super yachts and luxury cruisers. The over 243 million euro project was initiated in June 1999 and is today slightly ahead of schedule.

The existing port was built at the beginning of the century. At that time, the water was too deep to allow construction of a jetty and counter jetty using building techniques of the day to provide adequate protection within the harbour. Even today, the project faced special challenges caused by the narrow sea base, the depth of the sea and the weak seabed, which ruled against the construction of a traditional breakwater made from caissons placed on an underwater stone foundation. Another solution had to be found, a solution that would respect both the sea and the urban environment, and at a reasonable cost. The designers turned to a new, ecological "fixed seawall" concept patented by the principality of Monaco. Based on the new concept, a unique structure including two unusual pontoon-type sea walls was designed to last for one hundred years. The extension works include 6 different project parts, the three most

important elements being a semi-floating breakwater, a platform area created on reclaimed land and a counter jetty.

## GEOID in Charge of Positioning the Main Breakwater

The French company GEOID was sub-contracted for all surface



*GEOID employed a team of 9 surveyors to position the main breakwater*

and underwater positioning services, bathymetric and seabed surveys and monitoring and control of

construction in progress. For nearly twenty years, GEOID's solid experience in the field of Geosciences has consolidated its reputation among a very varied clientele, in France as well as abroad: the company's customers operate in oil industries, telecom, civil engineering, maritime and fluvial engineering, civil and military aviation and regional administration. In 2001, GEOID joined the Fugro group, the world leader in soil surveys, on land and sea and in assistance in offshore works.

One of the most important tasks for GEOID was the positioning and control of the movements of the giant main breakwater during the critical phase of clamping it to the land abutment. The operation consisted of attaching the floating breakwater into an 8 m diameter steel ball and socket joint situated 9 m beneath the water level. The two pieces – "female" for the port, "male" for the semi-

floating monster, which and protect it from heavy storms. The new port will as well as an additional hectare

floating monster – had to be adjusted with a high degree of precision: the room for manoeuvring was no greater than two centimetres in all three dimensions. "We had to work on a structure over 300 m long to an accuracy in the order of a millimetre", explained Pierre Balestrini, the technical director of GEOID.

GEOID had been contacted by Bec-Dragados at an early stage in January 2002 to study systems that could comply with the specifications. The main steps of the survey work were the definition of the system and design of the special fitting brackets, the installation and survey of the brackets on the jetty at the dry dock in Algeiras, software development and system tests, metrology surveys on the platform area and inside the receptacle, as well as the installation of equipment and tests prior to the arrival of the jetty.



**State-of-the-Art Solution at the Port of Monaco**

1) Platform area  
One hectare  
of reclaimed  
building land

2) A semi-floating breakwater  
A 352 m long concrete structure  
weighing 160,000 tonnes



5) Reorganisation of  
the whole harbour

4) Improvement of the two  
existing breakwaters

3) A 145 m long jetty



Part of the solution: Trimble GPS.

**A Delicate Combination of the Most Advanced Technologies**

The success of the operation required 2 months of very detailed planning and preparation. The demanding positioning tasks were completed with the help of two high-accuracy Trimble MS750™ GPS receivers (for position and orientation) and an IXSEA OCTANS motion reference unit (for the pitch & roll and heave), three motorised total stations, including two Trimble ATS total stations, were

used for redundancy and fine-tuning the position to a few millimetres. The French Trimble dealer, ACTHYD, supplied the Trimble equipment to GEOID. All sensors were interfaced into a Fugro Starfix Navigation Package for real-time 3D display. The 3D positions provided by these systems were controlled by a Prove

dual underwater laser system and Trittech scanning profilers. Data from all systems was compiled and sent to an offline computer for step-by-step display on AutoCAD 3D. A team of 9 surveyors was employed to operate the system on a 24-hour basis.

The main breakwater was built in one piece on dry land at the foot of the Gibraltar Rock at Algeciras in a 400 metre long basin. The fact that all of the seven caissons needed for the port extension were prefabricated outside Monaco helped to minimize the disruption to the daily life within the city and reduced the impact on the natural environment. Later on, the basin at Algeciras was opened to the sea and the breakwater was floated. It was then towed to Monaco: the 900 nautical mile sea voyage taking 12 days.

”Smit London” and ”Smit Typhoon” to bring the jetty to within 20 metres of its permanent location. From that position, the fine-tuning operation and the challenge to GEOID began. The whole process of attaching the jetty to the platform area took 32 days in total, to the satisfaction of all parties involved, the positioning systems performed as expected and no breakdowns occurred during the operation. ”The redundancy of independent techniques provided very reliable information for the personnel in charge the manoeuvre”, commented Mr. Balestrini.

**Attaching the Main Breakwater – a One Month Project**

D Day (Monday August 26) to D Day + 4: Arrival of the jetty in port and tying up to anchors 30 metres from the shore. Securing the jetty by bringing up the chains from 10 anchors which had been put into place several months ago, and attaching them to the jetty. Five anchors were located in the sea, three on land, and two on the platform. Duration of the operation: four days.

D Day + 2 to D Day + 5: The ballasting operation consisting of filling a double walled compartment in the jetty with 10,000 cubic metres of fresh water creating a draught of 16.5 metres (the draught was 15 metres during transit). Duration: three days.

D Day + 6 to D Day + 9: The delicate operation of attaching the jetty to the platform area in two phases. In the first phase the barge “Taklift IV” pulled the jetty towards the platform. When the jetty was two metres from the platform, the difficult procedure of securing the ball-and socket attachment, i.e. the male piece on the jetty to the female piece on the platform, began. The articulated attachment was joined using winches and jacks with minute precision. Duration: three days.

D Day + 9 to D Day + 32: Bolting the ball-and-socket attachment in place. Duration: 23 days.

**Operation Completed Successfully**

The floating jetty arrived in Monaco on schedule on Monday, August 26<sup>th</sup>, pulled by one of the most powerful tugs in the world, the 30,000 horse-powered ”Smit London” and guided by the ”Smit Typhoon.” At the harbour, four smaller tugs took the places of the



A question of millimetres: Attaching the breakwater into an 8 m diameter steel ball and socket joint 9 m beneath the water level.