

Trevi / works in Lungarno Torrigiani, Florence, set to start soon

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Trevi is carrying out the first phases of the works aimed at ensuring the safety of the Torrigiani embankment which, a few months ago, underwent a structural collapse causing a 3 m displacement of the riverbank towards the Arno and creating, along a stretch of about 80m, a chasm with a maximum depth of 3.5 meters. The need to complete consolidation works, structural restoration and hydraulic protection before winter, thus avoiding any risk of possible river floods, urged the Contractor to adopt a "Top Urgent Procedure" for the allocation of works and, consequently, for the selection and Contract Award to Trevi which, besides its long-lasting experience in consolidation works, can combine a high operating capacity (staff on three shifts and equipment made available at very short notice), as well as a remarkable design capability. The presence, within the Company, of the Design, Research and Development (PRS/DRD) Department, which, since the start of the project, has been cooperating with the Client's technicians for the creation and development of design solutions, plays a substantial role in the "race against time", given that both jobsite and design activities will be carried out almost simultaneously, at least in the first phase of works.

Working operations demand great care because of the tight schedule and the peculiar location. "We are in the city centre and we want to minimize the impact of works on the citizenship – says Jobsite Director Tommaso Gondolini - but, at the same time, we must be quick, in order to ensure safety of the riverbank's protection wall by early November". Moreover, November 4 marks the 50th anniversary of Florence flood which, as shown in the old picture below, caused the Arno river to burst its banks on the Lungarno Torrigiani.

The envisaged solution allows to build a structure that is both statically and hydraulically functional and autonomous on the back side of the existing wall; said structure is capable of completely replacing the damaged riverbank wall which will be consolidated and kept in the current position.

This will ensure the safety of Galleria Poggi and of the existing buildings, reduce pressures and stresses on the existing wall thus improving its stability, ensure hydraulic protection against the Arno floods and restore the water pipeline and the road traffic on the Lungarno.

The suggested operating sequence is based on the principle of "progressively increasing structural stability and safety" of both existing and ongoing works, in order to constantly operate under acceptable safety conditions.

In fact, further to the surveys and to soil investigations, which were carried out soon after the event, the first activity - that has just been completed - involves the construction of "rigid inclusions" (see text beside) for the consolidation of the soil volume dislodged and displaced by the instability event, so as to "toughen" the soil and create a stable work surface, where also the equipment required for other activities can be used. As a matter of fact, in different and subsequent phases, a PSM-20, a SM-405/8 and a SM-30 rig will be employed; these rigs are manufactured by Soilmec, the Trevi Group company that designs and produces equipment for special foundation works.

Eventually, a "Berlin wall" will be executed adjacent to the Poggi Channel (a masonry tunnel with a diameter of about 5 meters that runs parallel to the Arno river); said wall will have a double function: on the one hand, it will protect and stabilize the tunnel itself and the buildings located close to the area affected by the instability; on the other hand, it will support the excavation up to -3.5m from ground level to create a horizontal working platform from which the actual structural works will be performed. These works consist of 2 walls made of adjacent TRELICON piles with a 600mm diameter, one opposite the other, and connected on the top with capping beams and cross beams forming a rigid frame. One more Berlin wall, supporting the frame in the cusp area, will be installed near the dislocated riverbank wall, next to the old foundation of the wall consisting of wooden piles. A vertical wall for soil support and containment, that will be installed to restore the road surface, will be finally built close to the original historical wall.

As for the consolidation of the displaced and damaged wall, the following works will be carried out: inclined foundation micropiles, suitably embedded into the wall; self-drilling rods injected with cement grout; re-compaction of the loose soil below the base of the wall and, finally, repair of the historical wall's cracks through grouting and plastering works to be carried out via the cut-and-plug technique. For these operations, a service site road -currently under construction on one side of the Arno River - will be mainly used.

Rigid Inclusion (Box)

In general, the word "inclusions" means a type of consolidation that improves the strength of a soil mass through the inclusion of elements constituted by a material having better characteristics than those of the surrounding natural ground, to improve the overall mechanical characteristics of the treated soil. Inclusions are "rigid" when the material introduced into the ground has significant and permanent cohesive properties (concrete or cement mortar) and a significantly higher stiffness (500 ÷ 5000 times) than that of the surrounding natural ground.

Typically, medium-small diameters (from 300 to 800mm) with low percentages of treatment (from 2% to 10% of the volume of soil) are employed, ensuring a high quality and consistency of the obtained product, both in terms

of diameters and elasticity modulus.

As far as the execution is concerned, "rigid inclusions" can be carried out via the displacement pile (Discrepile) or the continuous flight auger technology (CFA helix).

As for the works on Lungarno Torrigiani, the soil volume affected by the consolidation treatment is the one close to the backfill layer, dislodged and displaced by the instability event, located between the current post-event ground level at a depth of about 7-8 meters from the original street level. When activities are carried out on a reworked, poorly-structured soil, "rigid inclusion" columns are obtained by means of small diameter drilling rigs (micropiles), weighing less than 20-25 tonnes.

The columns, having a diameter of 300mm and a length of 7.5m, are made of a pre-mixed mortar with a C30 strength class. The grid, which takes into account the presence of underground structures, is almost rectangular with a 1.0 x 0.90 meters centre-to-centre distance, which corresponds to a percentage of treatment equal to about 8% of the surface.

In order to reduce any impact on nearby structures and on the existing soil, "rigid inclusions" were performed through the TRELICON technology, which allows a "dry" rotational drilling, without vibrations, thus avoiding the use of water or excavation muds that may loosen or further disturb the soil. Columns were filled with cement grout during the extraction phase of the drilling rods, in order to avoid decompression phenomena and keep the boreholes' walls always stable.

Source: Trevi Group