



## **METROPOLITANO DE LISBOA - TERREIRO DO PAÇO TUNNEL: EXTENSION OF THE BLUE LINE LISBON UNDERGROUND; GEODETIC MONITORING OF AN ACCIDENT SITE**

António MESQUITA MACHADO

*SPGO- Sociedade de Projectos e Gestão de Obras, Lda.*

**Abstract:** During the construction of the Terreiro do Paço Underground Station in 2001, as part of the Blue Line expansion project, an accident occurred in the main Blue Line tunnel, at a curve executed partly in the silt bed of the Tagus river in front of the Praça do Comércio square. The consequential damages include some loss of correct longitudinal and transverse configuration of the tunnel rings in the curved part of the main tunnel. Remedial works were carried out, starting in 2005, under the engineering design and supervision of TEC – Holland.

This presentation describes the geodetic solutions implemented by SPGO, Lda, for continuously monitoring the remedial, and post-remedial works and induced displacements, in which four Leica TCA2003 robotic total stations were set up inside the tunnel, distributed from one end to the other end of the curved part of the main tunnel. For this specific purpose, the curved part of the tunnel was divided into two “cantilever” independent parts, each controlled by two total stations. The “rigid” extremes of each “cantilever” are the two outer ends of the curved and damaged parts of the main tunnel. Two special and common points in the middle of the tunnel, in the free ends of each “cantilever”, are measured by both the internal and dependent total stations, in each observation cycle.

The commercial GeoMos software, from Leica Geosystems, was applied for controlling all the parameters of the continuous, cycle after cycle, measurements. However, before implementation of the whole physical and logical geodetic system, some additional non-commercial routines were discussed previously with Leica Geosystems software developing team, concerning their approval and final agreement for the logical and physical principles described above. After this, the special routines were designed in Switzerland and, finally, tested on site by the Leica Geosystems software developers.

The presentation describes the logical functioning principles of the implemented geodetic system, the raw data transfer to the engineering designers in Holland, the general analysis of both “cantilever” object point and on site measured displacements and the often manually performed adjustments, using Epoch Suite software.

**Key words:** Monitoring, Automatic monitoring, GeoMos, Terreiro do Paço, Lisbon Underground, Epoch Suite, SPGO, Leica Geosystems.

### **Corresponding author contacts**

António MESQUITA MACHADO: [spgo@spgo.pt](mailto:spgo@spgo.pt)

SPGO - Sociedade de Projectos e Gestão de Obras, Lda, Portugal