WHITE PAPER

3D LASER SCAN TUNNEL INSPECTIONS KEEP EXPRESSWAY INFRASTRUCTURE PROJECT ON SCHEDULE

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WITH SPECIAL THANKS TO PATRICK GOMÈS-LÉAL, SURVEY ENGINEER, SOCATOP.

PARIS A86 OUTER EXPRESSWAY LOOP

Traffic congestion in the metro Paris area is probably not the worst when compared with other major conurbations around the world. However, this is small consolation to French drivers when the A86 expressway's missing link problem causes significant traffic delays in and around the area.

The initial challenge of the A86 tunnel project, which was developed to solve the "missing link" problem, was to design a solution that would meet economic requirements and, at the same time, respect the natural beauty of this prime location of forest and parklands peppered with upscale residential areas. The decision to go underground was made possible by the advent of new generation TBM's (Tunnel Boring Machines) that would provide tunnel diameters compatible with the traffic flow envisaged.

Figure 1: The A86 "missing link".

The tunnel project consists of two tunnels: a regular tunnel carrying all types of traffic, and an innovative two-tier tunnel dedicated to light vehicles only. This tunnel features two superimposed, independent 2-lane expressways and a shoulder with traffic flowing in one direction only. This eliminates the risk of head-on collisions.

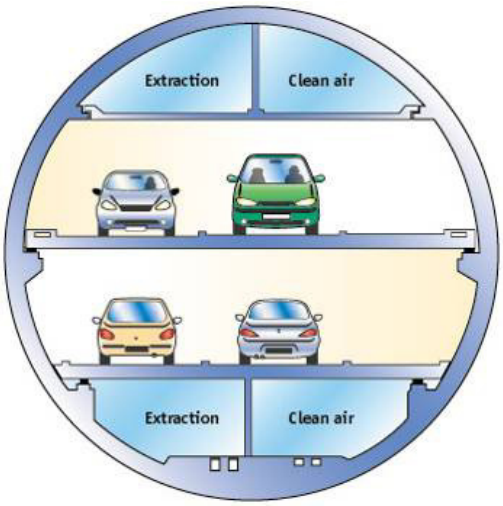

Figure 2: Innovative 2-tier tunnel design

The tunnel is 10 km long, has an internal diameter of 10.40 m and an incline of less than 4.5%.

Figure 3: Tunnel gradient

Trimble's positioning and scanning technologies were already at work on this exciting project when an unforeseen fire incident occurred during tunnel finishing that would show the extent to which Trimble's 3D scanning technology solutions can provide fast results and massive cost savings to infrastructure builders.

Figure.4: Trimble 3D scanner at work

TOP-RANKING INFRASTRUCTURE BUILDERS TRUST IN TRIMBLE

THE CLIENT ...

Cofiroute provides public agencies and the private sector with innovative transportation solutions, including toll-road operations, customer relationship management, call centers, toll-collection technology and related consulting services. The company is part of the Vinci Group, the world's largest construction and concession company.

THE BRIEF ...

Inspect and monitor fire damage effects and ensuing repair operations with a view to minimizing downtime and containing repair costs.

THE PROJECT LEADER ...

Socatop is a specially constituted group of Cofiroute shareholding companies bringing together a unique blend of human, technical and financial resources to conduct the largest underground construction project in Europe. As construction principle, it fell to Socatop to resolve the various issues related to a fire incident that occurred due to circumstances beyond the client's control.

THE EQUIPMENT ...

Given the time constraints and the level of precision that was required in terms of cost control, Socatop immediately decided to use a Trimble 3D scanner. Patrick Gomès-Léal, who was in charge of the survey, commented: "Trimble's 3D scanner was an ideal choice for this tough assignment. We felt sure that laser scanning would significantly increase the speed of operations. A key factor was also the Trimble® RealWorks Survey™ software package, which provided us with highly relevant tools to fulfill critical inspections and analysis."

Figure. 5: Trimble 3D scanner in tunnel

USING THE TRIMBLE 3D SCANNER

OPERATION 1: SCAN, CLEAN, SCAN, COMPUTE

The first operation consisted in scanning the full surface area of the tunnel where damage had occurred. Targets were set up as control points in order to conduct surface/volume comparisons after further scans.

Figure 6a, Figure 6b: damaged areas on concrete liners

After removing all survey equipment, the surfaces were cleaned with high pressure water jets.

Figure 7a: Hydro-blasting; Figure 7b: Clean surface view

The Trimble G3D scanner was set up again to scan the same surface area. At the end of this operation, other work in progress in the tunnel was able to continue.

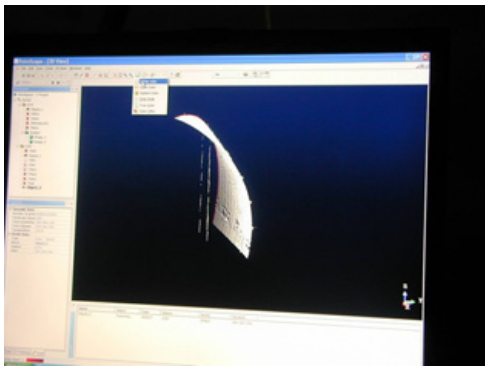

Figure 8: scanning in progress

In the meantime, the two scans were processed inside Trimble RealWorks Survey software. After tying the first scan to the second scan, the volume difference was calculated with extremely high precision. As a result, Socatop then negotiated with hydro-demolition sub-contractors based on previously agreed pricing schedules. Specifically, Socatop was able to demonstrate the real volume of the damaged concrete that had been blasted off, an amount that was in reality much less than the sub-contractors "estimate".

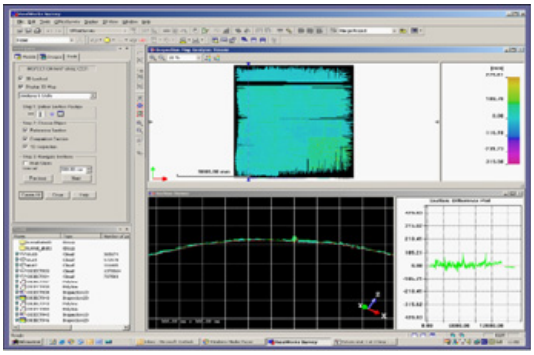

Figure 9: Volume calculation on damaged surface

OPERATION 2: NEW LINER, RE-SCAN, COMPUTE

With the surfaces now clean inside the tunnel, the concrete-liner sub-contractors were able to start relining the tunnel walls.

Figure 10: relining tunnel

Once complete, the Trimble 3D scanner was set up for its final scan. With this third data set, the client made further use of Trimble RealWorks Survey's advanced inspection tools to analyze the integrity of

the new concrete liner and to determine the total volume of concrete used.

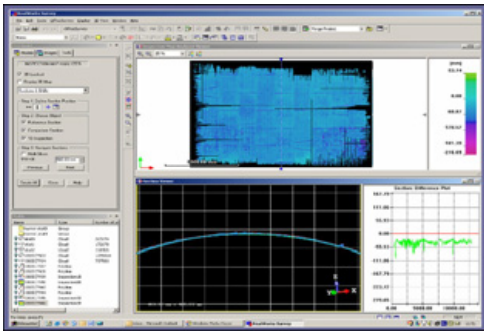

Figure 11: Inspection Map and cross-section

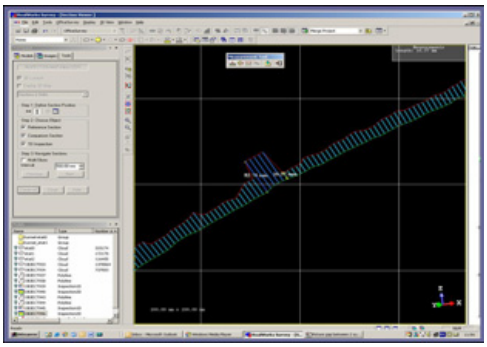

Figure 12: Image of mapped volume and surface

By providing factual information in hard-to-contest graphic deliverables, Socatop was once again able to adopt a position of strength in its relations with its sub-contractors. Patrick Gomès-Léal was enthusiastic: "Laser scanning, in addition to its now well known advantages, brings a new dimension to quantity surveying and claims management. Trimble 3D scanners and RealWorks Survey software represent a major advance in this field."

THE BENEFITS OF THE TRIMBLE 3D SCANNING SOLUTION

- Assurance of high-quality results for project management, concerning removal of degraded concrete (20 mm)
- Verification of volumes invoiced by hydro-demolition sub-contractor
- Guarantee of accurate restoration to original form
- Volume verification on new concrete

THE ECONOMIC CASE

According to calculations carried out by Socatop, the cost of the survey operation was only one tenth of the gain that was made on sub-contractor claim management. In addition, the speed of operation that was afforded by the use of laser scanning allowed general tunnel construction activities to recommence several days earlier than if traditional survey techniques had been used. The daily revenue that tollway infrastructure of this nature can generate for an operator is estimated at 15,000 vehicles/day x 2€), so completing work as soon as possible is highly desirable. On a macro-economic scale it is also worth mentioning that the total socio-economic cost to the community of a single day's delay to tunnel completion is estimated at 1 million euros.