



## In a tunnel heading for Genoa

**The Ferriere motorway tunnel needed to be restyled to quickly cover up signs of ageing. This was done with the help of MAPEGROUT GUNITE.**

**T**he Ferriere tunnel is situated between Sestri Levante and La Spezia and is part of a network of tunnels running along the section of A12 Motorway, which have been placed in the hands of S.A.L.T., the Società Autostrada Ligure-Toscana. The tunnel in question, which is located in the borough of Carrodano in the province of La Spezia, at a height of 231 metres above sea level, is actually 334.87 metres long. Opened in 1971, it is made of a concrete structure varying in thickness from a minimum of 70 to a maximum of 100 centimetres. The concrete is only fully reinforced along a short sections (total of 20 metres) and partly reinforced at the piers near the quoins.

Problems with the tunnel began to emerge years after it opened and are mainly due to natural wear-and-tear and the systems used during the original casting and installation of the coating used during all the different construction phases right at the beginning. Working with the S.A.L.T.'s Technical Department, Mapei technicians sent to repair the tunnel coating divided up the problems detected into two categories: static-structural and resulting from inadequate finishing coating. The former were due to both macroscopic instability phenomena involving varying degrees of damage to the structure and the more or less dilapidated state of repair of the concretes; the latter were

*Photo 1.*  
The outside of the Ferriere Tunnel along the section of A12 motorway near Carrodano.

*Photo 2.*  
A Mapei technician by a tunnel wall with bags of Mapegrout Gunite, a pre-mixed cement-based grout used for repairing concrete coverings in tunnels and galleries.



apparently connected with the presence of water and problems of visibility. The planned maintenance programme, which was duly carried out, aimed at improving the waterproofing and lighting and preventing any decay already under way (but hard to pinpoint) from getting any worse. Repair works were planned in two separate phases: surveying, allowing the damage to be clearly and carefully analysed, and actual maintenance operations, during which the structure was repaired and the causes of the damage were dealt with.

#### First Stage: surveying the problem

After removing all the lighting and radio communication systems, the first thing to be



Photo 3. Technicians busy spraying on Mapegrout Gunite. You can clearly see the electrically welded steel mesh forming the frame for the plaster made from Mapegrout Gunite. The product was applied using a rotary pump directly supplied by bags of dry product hydrated when emerging from the hose.



done was to spray-clean the tunnel's coating surfaces to get rid of any dirt or dust that had formed down the years (grease, smoke marks etc.), accretions formed by dripping and running water of varying intensity, and bits of loose concrete that might break off at any moment and cause accidents. After cleaning, which perfectly exposed the intrados of the basic coating, the real state of the tunnel became clear, showing gaps in the concrete, damage and cracks where the various rings are attached and near the quoins, as well as clearly indicating where the running and dripping water was located.

### Second Stage: solving the problem

The usual repair operations carried out were adapted to the actual state of repair that came to light during the survey and involved: filling any gaps in the intrados coating by making low-pressure injections of cellular concrete at a density of 400 kg/m<sup>3</sup>; getting rid of, or at least notably reducing, the water seeping in by capturing the dripping water and conveying into special gutters at the sides of the tunnel by means of a drainage system made of small PVC channels with spiral plating; repairing and reinforcing the coating by placing electrically welded steel mesh (measuring 6 mm in diameter and 1500 along its square sides) all along the tunnel to form a protective coating over the plaster (with an average thickness of about 35 mm) made from MAPEGROUT GUNITE®. The intrados of the coating near the piers was treated with special white-coloured cement additives to improve visibility, after which the surface was finished off in a durable white resistant to micro-organisms and detergents and easy to maintain (to be washed at pressures of about 200 atm and temperatures of about 90/100°C).

### Work carried out by Mapei

Mapei's innovative solutions for underground construction are the result of years of in-depth research and on-site tests that can cope with any kind of building requirement. Constant daily on-site experience has made it possible to continually develop and perfect work methods and update products in the Mapei research laboratories. The firm offers a wide range of solutions for underground engineering and can provide full technical support with the help of its expert technicians. Mapei's repair service can analyse problems affecting firms specialising in underground engineering through a series of on-site inspections, chemical-physical tests on materials, studies into concrete mixes, product supply and, last but not least, a technical support service while work is in progress.

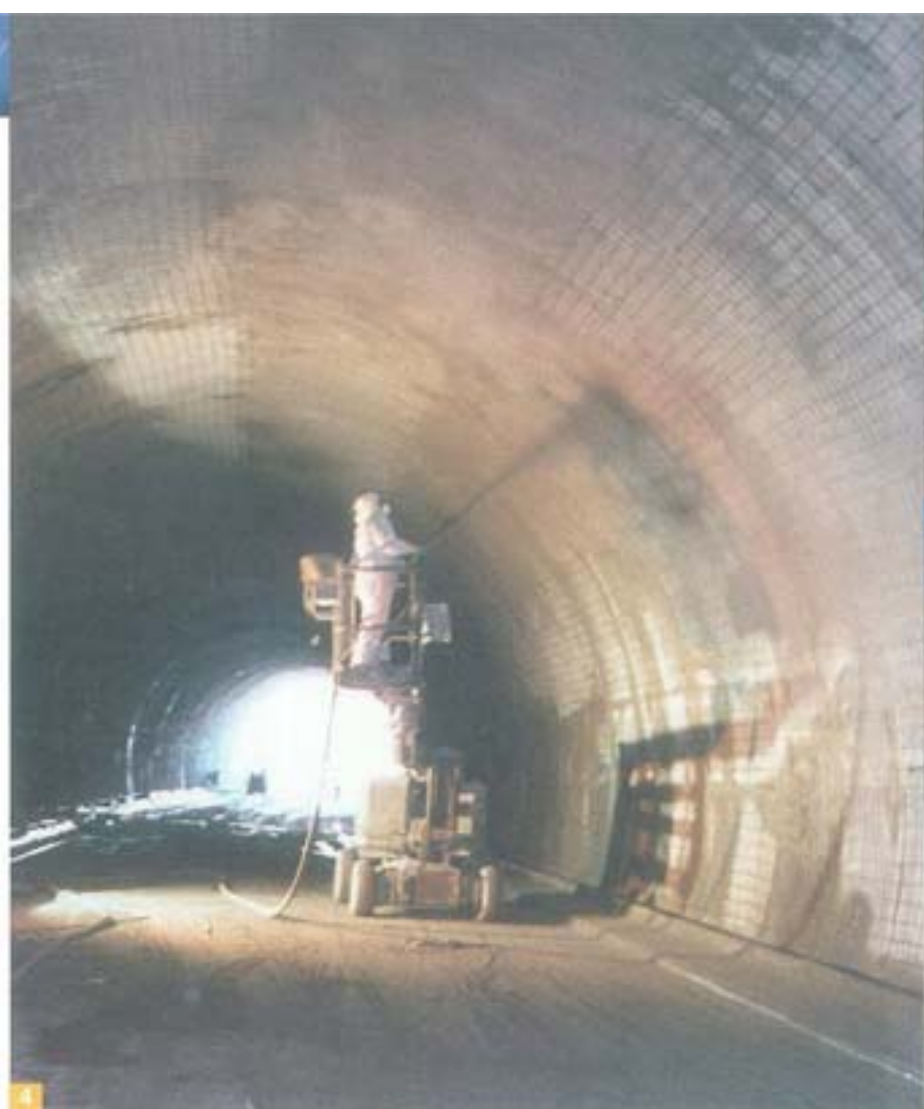


Photo 4.  
The tunnel's coating surface was carefully cleaned with water before spraying on Mapegrout Gunite.

Photo 5.  
The spray method, starting with dry product, allows the kind of fast work rates required when operating on roads. In this case, the work was carried out in almost record time; no more than 60 work days.

Mapei products for underground constructions have been used both for building new works and repairing old ones, as in the case of Ferriere Tunnel. To carry out this work – applying a covering surface with a nominal thickness of 35 mm, reinforced with an electrically welded mesh – Mapei suggested and supplied MAPEGROUT GUNITE® premixed grout, used for covering concrete tunnels, repairing damaged bridges, hydro works, reservoirs, and industrial structures. MAPEGROUT GUNITE®'s high mechanical properties make it ideal for structural repairs, that can be carried out up for thicknesses of up to 40 mm per coat without using fixed formworks. Composed of hydraulic binders, microsiliates, selected aggregates and special additives, the product is applied by means of a special dry mix spray machine on solid, dirt-free, rough surfaces that have been previously saturated with water. The product has undergone rigorous testing to assess and certify its high mechanical resistance to compression and flexion and its absolute waterproofness. For work on Ferriere Tunnel, MAPEGROUT GUNITE® was sprayed on using a special Ocmer rotor pump (mod. "0cm-030 compact"), fed directly with bags of

dry product, soaked as they came out of the pump.

This particular method, used quite often when working with large surfaces, allows high daily work rates: in the case of Ferriere Tunnel estimated at about 500 m<sup>3</sup> of coated surface-a-day, split over two daily shifts. This kind of work rate is particularly appreciated and in demand for works carried out along motorways, since it limits traffic flow problems, such as having to change lanes or long queues during rush hours. This also explains why the work on Ferriere Tunnel was carried out in almost record time, no more than 80 calendar days, equal to 60 work days. For instance, the MAPEGROUT GUNITE® was applied in less than 20 days and the approximately 600 tons of product used on-site were "worked" at a rate of 30 thousand kilograms-a-day, with peaks of 2000-2500 kg/hour. MAPEGROUT GUNITE®'s strong points are not just the way it serves its purposes, but also its easiness to use, which reduced the amount of natural "waste" product (i.e. the material bouncing off the surface onto the floor), and the improved appearance of the finished surface, which is smoother than previous applications using other products.



"The product referred to in this article is from the "Underground Technology" range, which is part of the general "Building Products" range. The appropriate technical chart is contained on the "Mapei Global Infonet" Cd and from the Internet site: [www.mapei.com](http://www.mapei.com).

**Mapegrout Gunite:** single-component premixed non-accelerated cement-based grout applied using a dry spray to repair concrete.



#### TECHNICAL DATA

**Ferriere Tunnel**, north lane, A12 motorway, Genoa - Italy  
**Opened:** 1971  
**Repaired:** 2000  
**Work:** repairs to the surface of the tunnel coating  
**Client:** S.A.L.T. Società Autostrada Ligure-Toscana  
**Project:** S.A.L.T. Technical department  
**Works Management:** S.A.L.T. Technical Department  
**Contractor:** A.B.C., Imperia  
**Installer:** M.G.A., Licciana Nardi (MS)  
**Mapei Product:** MAPEGROUT GUNITE  
**Mapei Co-ordinator:** Carlo Campinoti and Enrico Grasso