THE LAST TEN KILOMETERS OF THE HIGHWAY RUNNING BY GENEVE FINALLY JOIN THE NORTH SEA WITH THE MEDITERRANEAN CONCLUDING AN AMBITIOUS PROJECT WHERE MATERIALS PLAYED A CHALLENGING ROLE.

ECOLOGICAL TUNNELS

by F. Stronati, A.Falco, J.P. Maillard

Thanks to perfect harmony with the landscape, to sound-deadening barriers and to safe-driving devices, the highway running by Geneve can be properly called ecological.
This attribute was also underlined by the opening, which took place last June 26. As a matter of fact the first to cross the asphalt were the runners and cyclists of the Peri-feerique contest. The project was ecological but also expensive. Each kilometer of the so called "millionaire speedway" totaled $88,000,000.
The last strips open sky tracts of the highway (8.9 km), connecting Switzerland to France, were enriched with some 155,000 trees and 140,000 shrubs planted on 300,000 square meters of surface. To easily cross the mountains two tunnels (Vernier and Confignon) were built. Particular care was devoted to the design and building of the tunnels: crossing them is actually the most interesting part of the entire project.

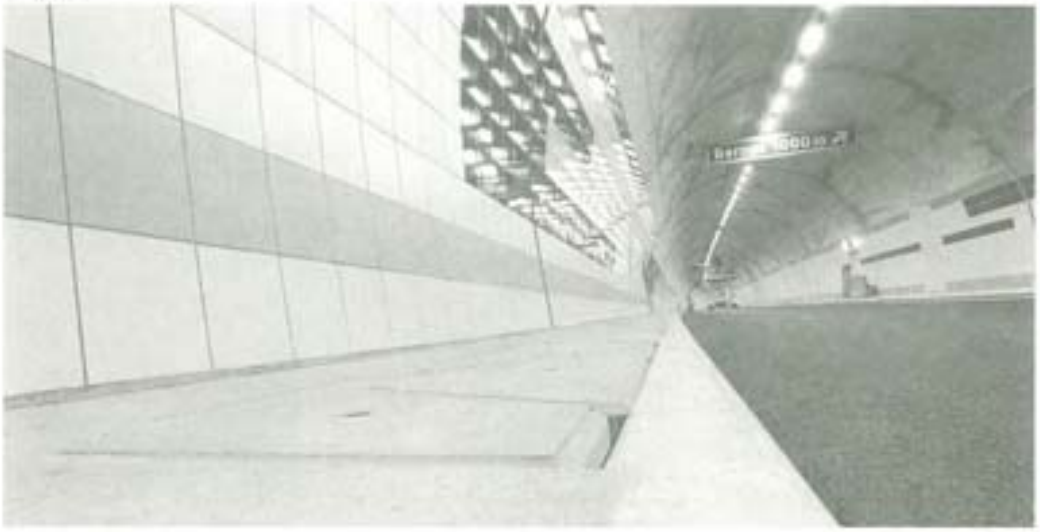
PHOTO 1

PHOTO 1
The drawing shows the Swiss, French and Italian highway network and highlights the Genevian highway stretch, recently completed

PHOTO 2
The image of a tunnel at the end of the works

PHOTO 3
The opening of the RN1A highway in Geneve

PHOTO 2



An Exceptional Vault

The millionaire speedway was covered with an exceptional vault to cope with the "tunnel effect", that is to say the drowsiness caused by the monotony of the RC walls of the tunnels. Some 3750 square meters were covered with porcelain tiles up to 3 m high, creating rich and colored mosaics. The artistic pattern of the Vernier Tunnel was designed by Claude Duprez. The color

PHOTO 5
Application of GRANIRAPID on a cast concrete support

PHOTO 6
Tile back-buttering with the adhesive

PHOTO 7
Laying the ceramic wallcovering

Technical data sheets for the products mentioned in this article are contained in Mapei binder No. 1 "Setting Materials for Ceramic Tile and Natural Stone" and No. 3 "Building Specialty Line"

PHOTO 3

PHOTO 4
One of the mosaics set inside the Vernier tunnel representing the panorama of the city of Geneve

shades from dark to light tones while driving from north to south. Midway, seven mosaics showing the most beautiful sights of Geneve were composed on a side wall. Inside the Chevres tunnel the design of the walls are by Paul Viaccoz. On one side there are drawings forming the word arc-en-ciel with the colors of the rainbow; on the other side the artist employed the Braille stud writing to form 40 patterns quoting Baudelaire: Aveugles, ils traversent ainsi le noir illimite (The blind, they may pass through the infinite black, tr.). Inside the Confignon Tunnel (1450 meters length) the drawing of the surface covering was

PHOTO 4

PHOTO 5

PHOTO 6

PHOTO 7

entrusted to Aldo Guarnera. In one sector two persons meeting, while in another sector the same people are parting.

The Importance of the Surface Covering

In the past the protection of concrete was obtained by using a special light colored paint. On this project the director, architect Jean-Bernard Varone, ruler of the Atelier d'architecture et d'urbanisme AVV of Geneve, chose ceramic in place of paint, by saying: "It is an innovation for French Switzerland, but not for the whole country since it was already successfully adopted, for example in the Uri Gallery. We mostly used this technique because of its durability and strength compared to paint, which usually needs an application every ten years. On the contrary, ceramic grants protection for at least 50 years". "We laid Timaker unglazed porcelain tile by Mirage," explained Jean Pierre Maillard, director of Getaz-Romangs ceramic division, "but treated as they were set on a facade." The tests confirmed, for example, low water absorbent-capacity (0.01%). The role played by installation materials and by the supervision of construction, overseen by the Science of Materials faculty of Lausanne, was very important. They chose Mapei's materials because of the physical-chemical performances required in the

PHOTO 8

PHOTO 9

PHOTO 8
A stage of the porcelain tile installation inside the Vernier tunnel: one of the mosaics is being set

PHOTO 9
*Grouting tiles with KERACOLOR + FUGOLASTIC**

**(FUGOLASTIC is named PLASTIJOINTS in the North American market)*

project and its capacity to guarantee, over time, the adhesion of the covering. Porcelain tiles in conjunction with the setting materials form a covering with the following performances:

- resistance to petrol pollution
- polish from dust and dirt through abrasive brushes and water steam
- unalterable colors over time
- well-sheltered concrete
- lack of dangerous fumes in case of fire
- resistance to thaw-freeze cycles and to crazed concrete.

Setting Method

Let's sum up the course of the work:
1) The concrete surface of the tunnel was scarified through hydro-jet to remove possible traces of form release agents and make it rough to strengthen the adhesives bonding capacity.
2) Only where it was necessary the surfaces were leveled using NIVORAPID, shrinkage-compensated ultra-fast setting thixotropic cement leveling mortar.
3) Waterproof cement mortar resistant to attack by chlorides and sulphates. Such procedures also protected concrete from possible de-icing salt penetrations piercing through tile joints at the entrance of the tunnels. At the base of the vault the reinforced cement sections were covered up to 60 cm high, whereas the rest was protected to 10 cm. MAPELASTIC was then used for sheltering the expansion joints and the new-on-old concrete vaults.
4) Tiles were set using GRANIRAPID, a two-component fast-setting cementitious adhesive with rapid hydration.
The supervision of construction approved of this product only after verifying, through tear resistance tests, a bonding strength of 29kg/cm² and a flexibility fit for supporting the vibrations caused by heavy traffic.
During the tests the adhesive was applied with the double-coat technique, in

PHOTO 10

PHOTO 11

PHOTO 10
A detail of the wallcovering in the Chevres trench

PHOTO 11
Detail of the expansion joint filled with MAPELASTIC

PHOTO 12

PHOTO 13

PHOTO 12 and 13
The entrance of the two tunnels at an initial stage and once finished

compliance with the regulations in force. The notched trowels were shaped in order to ensure the complete wetting of the back of the tiles, otherwise impossible to obtain, considering the arch of the vault. GRANIRAPID proved to be a profitable choice since during the work the temperatures inside the tunnels were comparatively low. Its fast-setting characteristics allowed installation within the required time period.
5) Tiles were set with large joints to match the expansion joints treated with MAPELASTIC.
6) Grouting was executed using KERACOLOR large grain mixed with FUGOLASTIC (named PLASTIJOINTS in North America). This is a cementitious grout modified with a latex able to make the joints waterproof, flexible and mechanically sound. Choosing such products was necessary to obtain a grouting particularly resistant to future maintenance operations, such as frequent water jet cleanings.

Perfect Bonding

More than 80 installers (gathered in a society and coordinated by Bauur C+G from Geneve), were divided into groups of four people, and worked for two months setting 440,000 tiles, at a rate of 1000 square meter surface a day. The work inside the tunnels started in February 1995, and has been periodically overseen by Mapei Technical Assistance. The Mapei team proceeded with a systematic and probing check on the setting quality, providing an authoritative support during the application stage of the project. At the conclusion of the project, in June 1995, technicians verified the bonding capacity of GRANIRAPID to concrete. Bond tests, directly performed on tiled surfaces, recorded rates higher than 30 kg/cm^2. Undeniable results were obtained thanks to the faultless union between planners, technicians, installers and material manufacturers. Always in search of solutions to insure ceramic and natural stone projects last for many decades.

TECHNICAL DATA

Project: RN1A highway tunnel by Geneve, Switzerland

Contractor: Ministry of Works, Engineering Department of Geneve

Wallcovering designers: Jean-Bernard Varone of the Architecture and Town-planning Office AVV in Geneve

Material supplier: Jean-Pierre Maillard, Director of Getaz-Romang ceramic, stone and marble sector

Tile Installers: A union coordinated by Baur C+G of Geneve

Year of construction: 1981/1993

Year of wallcovering installation: 1993

Ceramic wallcovering: 30x30 unglazed porcelain tile "Timaker" by Mirage