Summary of:
Safety in tunnels: the Suspended Emergency Escape Route

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This enclosed walkway, suspended from the crown of a tunnel, is a particularly effective and innovative means of providing emergency escape routes.
The suspended emergency escape route is an enclosed walkway that is large enough to provide an easy escape route. Access to it is along connecting stairways sited inside side chambers or at parking areas.
The walkway is trapezoid or rectangular in shape and it is fixed to threaded bars or bolted plates.
The structure is in concrete or steel and it is protected with materials designed to resist high temperatures such as mortars, plasterboard or similar materials. The exit to the walkway may be near the tunnel portal, where special areas are set aside and equipped for emergency rescue operations.
The walkway is therefore designed to fully meet requirements for the emergency evacuation of tunnel users, because it is fully enclosed (prevents the passage of flames, gas and smoke), thermally insulated (it limits the transfer of heat) and conserves its structural integrity (it will maintain its structural integrity for at lease 120 minutes in a fire). In other words it constitutes an REI 120 structure to all effects and purposes.
This structure provides the following advantages over conventional solutions:

- industrialised construction: the prefabricated components are produced under controlled conditions in a workshop and are subsequently assembled and fitted on site;
- low production costs: the suspended enclosed walkway is an alternative to the costly excavation operations required for other solutions. Excavation is only required for the side chambers which give access to the walkways;
- rapid installation: anchor bolts are fitted in advance in the crown of the tunnel, while the structure is already preassembled on the ground with threaded bars and the steel reinforcement grid for the Fireshield mortar. The next stage consists of raising the structure and temporarily fixing the units together and to the crown of the tunnel. The last stage consists of placing the layer of Fireshield mortar which provides protection against fire.

It is therefore an innovative solution designed to save the lives of tunnel users in the event of a serious fire. It requires certification by a highly qualified independent third party which tests both the statics characteristics and the REI 120 functions specified by the relevant standards.
A full scale test was therefore performed inside the S. Croce Tunnel on the "*Strada dei Marmi*" at Carrara. The testing for certification was performed by the Energy Department of the Polytechnic of Turin, which designed and supervised all the tests on site.
The results of the structural strength, the hermetic sealing and the thermal insulation tests over a period of 120 minutes were as follows:

- the temperature inside the suspended emergency escape route did not exceed 35 °C. with a fire load equivalent to 70 MW;
- the temperature of the threaded bars did not exceed 45 °C.
- the temperature at the interface between the insulating material and the concrete did not exceed 100 °C.
- expansion between joints was less than 0.3 mm
- the increase in the length of the threaded bars was less than 0.5 mm
- no smoke escaped outside the heat resistant structure;
- there was no increase in opacity or the concentration of carbon monoxide inside the structure following heat testing;
- the internal temperature of the walls did not exceed 40 °C.

The prototype of the suspended emergency escape route passed the statics and fire resistance tests conducted on site in the S. Croce Tunnel on the "Strada dei Marmi located in the municipality of Carrara in the province of Massa Carrara.
The tests conducted provided a measure of the extent to which the design criteria adopted were satisfied in accordance with the principles of safety engineering.
A new frontier has been opened in the world of tunnelling which will help to solve evacuation problems in many road tunnels, especially those with two way traffic and no emergency exits to save the lives of tunnel users in compliance with recently introduced regulations.

Acknowledgements

The author wishes to thank the following: Progetto Carrara SpA, the Industriale Maccaferri SpA Group, Adanti SpA, because they believed in the design idea from the beginning and have supported it with conviction.