Refitting strategies for Italian historical railway tunnels

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Due to its orography, Italy has a railway network which includes roughly 1460 tunnels, whose extent is more than 1480 km. Most of them, approximately 800 km, was built before 1930 so can be considered historical railway tunnels.

Mainly because of their age, many tunnels require refitting interventions for solving structural or hydraulic problems, for the adoption of new electrification standards, for gabarit adjustment or fire protection improvement. The lack of information about construction methods, material features and geotechnical conditions represents usually a challenging problem when refitting of historical tunnels is required.

Since interventions are specifically related to each single tunnel, it is generally not possible to set a unique intervention strategy in advance. However for planning interventions on existing tunnels a design flow chart, articulated in the following 6 main steps, has been proposed:

- Step 1: understand the reasons of the refitting;
- Step 2: collect information on geometry, structure, geotechnics and stress;
- Step 3: in case of structural interventions, carry out a back analysis;
- Step 4: develop design solution considering constructive aspects and site specific constraints;
- Step 5: carry out structural analysis and define a monitoring plan;
- Step 6: start of construction. Monitor the works on site and the efficiency of the solution over time

This flow chart has been followed by the engineering company Alpina S.p.A. for refitting the tunnels Bricchetto and Fey belonging to the Italian railway network.

Due to a significant increase of the convergence and the formation of cracks on the lining, RFI decided to carry out a structural rehabilitation of Bricchetto Tunnel. After defining the geological context and the conditions ante-operam through stress measures and back-analysis, specialist engineers decided to reinforce the entire section of the tunnel. In particular, the solution forecast a concrete invert slab having a "U" shape and the

strengthening of the upper portion of the lining through the installation of steel ribs within the masonry and a final shotcrete layer.

Strengthening of Bricchetto railway tunnel © www.impresaluiginotari.com

Refitting works of Fey Tunnel at first consisted only in lowering the rail level for granting enough space for the installation of the new contact line. Subsequently, considering the presence of numerous buildings along the tunnel alignment, RFI decided to apply European standards for fire protection of existing lining. After a large survey campaign and a FEM back analysis, it was decided to place a new concrete slab at the invert and to apply a fire protective sacrificial layer specifically developed for underground application.

Fire protection works in Fey tunnel © www.utt.mapei.com