Abstract

The execution of complex infrastructure projects often demands the development of innovative materials and methods to solve project-specific issues. This is also the case of pavements in road tunnels, which face several challenges during design and construction due to their location and complex geometry. Factors like the volume of traffic, fire safety regulations and local environment influence the design choice of pavement in road tunnels. In any case, a good pavement foundation has to be designed by considering all the necessary site-specific requirements. The foundation of pavements in road tunnels is different from conventional pavement foundations due to several reasons. The presence of buried utility lines at the tunnel invert creates inconveniences for the laying and compaction of the conventional cement-stabilized materials. In particular, high-voltage cables among the utility lines, have to be backfilled with a material of higher thermal conductivity to promote heat dissipation and effective power transfer. Such specific requirements prevent the use of conventional unbound granular layers and cement-stabilized layers in the pavement foundation of road tunnels. Considering these factors, a self-compacting cement-bound mixture containing a significant quantity of recycled materials is introduced in this thesis for the construction of pavement foundations in road tunnels.

The development of a mix design procedure for self-compacting cement-bound mixtures was the first step in this direction. A generic mix design procedure would help in designing mixtures with an adequate performance from a lesser number of trial mixes. A rational mix design methodology would also help to promote the systematic inclusion of various secondary raw materials in the composition of these mixtures. Following mix design, several mixtures were prepared and subjected to performance assessment. Thermal properties of these mixtures were also evaluated to understand its feasibility for backfilling high-voltage cables that need to be buried in the pavement foundation of road tunnels.

Laboratory research needs to be transferred to the construction industry for its practical implementation. A series of field trials were conducted in the next stage of research with this purpose. Moreover, the composition of the mixtures was further optimized based on the performance assessment in these field trials. This approach led to a more fine-tuned composition of the self-compacting cement-bound mixture and development of performance-based acceptance criteria for quality assurance during construction.

Incorporation of self-compacting cement-bound mixtures in the pavement design requires knowledge of their relevant material properties and performance. The selection of a suitable

pavement solution needs to be performed following a holistic approach, which considers the all-round performances of all the competing options. A comparison was made in this direction between a conventional pavement section and the innovative pavement section with self-compacting cement-bound mixtures in the foundation layers. Such an assessment revealed the relative ranking of cross sections in terms of their design life. The importance of adopting an overall analysis to make a better-informed decision about the selection of pavements and the advantages of using alternate construction materials with recycled components were demonstrated in this part of the research.

This thesis demonstrated the suitability of self-compacting cement-bound mixtures in pavement foundations of road tunnels. In the future, the proposed mix design approach can be used for the development of self-compacting cement-bound mixtures with other recycled components, whereas the experimental investigation conducted for the field trial activities can be adopted for preparing the relevant performance-related specifications and pavement design.