

# Summary

Waterproofing of underground structures and tunnels is of overwhelming importance for the long-term durability and effectiveness of the works and for the possible impact on the surrounding environment. In conventional tunnelling, polymeric waterproofing membranes are commonly used with this aim, but some aspects of design and durability of these materials are still not well known.

In this work, a methodology based on risk analysis is proposed to choose, among the possible technologies, the best one for the boundary conditions and constraints of the project. With this aim, a specific procedure is developed, at first evaluating the risk without waterproofing and then applying different technologies assessing their effect in terms of costs and risk. This tool, based on the Monte Carlo method, gives a statistical evaluation of the initial and residual risk and evaluates the effectiveness of the different scenarios.

Furthermore, nowadays tunnel design requires about 150 years of lifespan and consequently attention has to be paid to the long-term durability of waterproofing systems. Therefore, an accelerated ageing test specifically designed for tunnel waterproofing is developed and carried out on two commercial geomembranes, in order to define their behaviour and to test their properties after degradation. Moreover, eight different formulations of plasticized PVC membrane are produced and studied, to evaluate the effect of different concentrations of plasticizer on the behaviour of the waterproofing membrane.

The loads acting on the waterproofing system during the service life of the tunnel are analysed and compared to the available properties of the membranes, in order to define the time of end-of-life of the waterproofing system from the long-term extrapolation of the degradation of the membranes.