Long term stability of deep tunnels - Analysis of Swiss underground constructions (FGU2003/002)

Tenue à long terme des tunnels profonds. - Analyse d’ouvrages suisses. (FGU2003/002)

Funding: National (Switzerland)
Duration: Mar 2004 - Dec 2012
Status: Complete with results

Background & policy context:

The first part of the project will compile a database of Swiss tunnels experiencing delays and maintenance problems. Based on these documented case studies, an analysis will be carried out to determine the conditions potentially inducing this time-dependent behaviour. It is intended to identify tunnels with potential problems of large deformations and/or long term build-up of support pressure. The second part will be devoted to the thorough investigation of some tunnels where significant time-dependent phenomena are observed. A close interpretation of the monitoring data and observations will be carried out by means of simple models established in the framework of the "convergence-confinement" method. The objective is to provide a methodology and a tool to reliably estimate the consequences of delayed processes (primary and secondary consolidation) on the long term stability of tunnel walls. Finally, the experience learned from these case studies will provide guidance for the design of future tunnels as well as for the definition of control procedures and monitoring frequency.

Objectives:

A frequent and adequate monitoring of tunnels during construction and during their intended design, life enables to obtain sufficient information on the time-dependent changes in both the structure and the underground, and consequently to improve the prediction of the long term pressure acting on the lining. By interpreting these measurements and observations by means of analytical solutions based on the "convergence-confinement" methodology, the project aims at providing a tool to reliably estimate the long term stability of deep tunnels. The method, developed according to the observational method concepts, will contribute towards the maintenance of tunnels with concerns about reducing costs and ensuring safety.

Methodology:

The following steps will take place during the project:

1. Inventory of books with a delayed behavior.
   - Inventory of Swiss tunnels asking delayed behavior and maintenance problems.
   - Deduction criteria for the conditions under which such problems develop.
   - Confrontation - criteria with those reported in the literature.
   - Choice of several road tunnels showing clear signs of deferred phenomena.

2. Analysis Tool based on the convergence-confinement method.
   - Development of a tool for analysis of observed convergences and deferred loads. Consideration initially deferred phenomena due to creep.
   - Integration from deferred phenomena associated with water movements of the massif.
   - Implementation of the method in a spreadsheet.
   - Improved tool as the experiences on the studied works.
3. In-depth study of certain road works selected through the inventory (item 1):
   - Collection of information (mostly action) necessary to value the deferred behavior.
   - Interpretation of various measures by simple models of the developed analytical tool.
   - Evaluation of the long-term performance.
   - If necessary, realization of finite element (Z_SOIL) for interpretation.

4. Production of results
   - Providing the analysis tool of deferred phenomena.
   - Writing recommendations for those responsible for maintenance and security.
   - Writing the final report.

**Parent Programmes:**
ARAMIS - ARAMIS information system

**Institute type:** Public institution
**Institute name:** Swiss Government: State Secretariat for Education and Research
**Funding type:** Public (national/regional/local)

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**Key Results:**
The practical implications of the work are:

1. The inventory of books with a delayed behavior and analysis that will be made to identify the conditions under which such phenomena occur, will point tunnels to be the subject of more attention.

2. The analysis tool deferred phenomena in underground structures will be an aid in the assessment of long-term performance of road tunnels.

3. The various observations made on the relevant works will help define recommendations for the
design of structures as well as their control program and measures in time. The work will also contribute to greater disclosure of deferred phenomena in underground structures and the implications they can have on their safety and serviceability. As such, it is therefore aimed as much to engineers responsible for the design and execution of works to persons responsible for the maintenance and security.

Documents:
- [TUST_Sandrone_Labiouse_author_version_Identification and analysis of Swiss National Road.pdf](TUST_Sandrone_Labiouse_author_version_Identification and analysis of Swiss National Road.pdf)

**STRIA Roadmaps:** Vehicle design and manufacturing, Infrastructure

**Transport mode:** Road transport

**Transport sectors:** Passenger transport, Freight transport

**Geo-spatial type:** Network corridors