



Assessment of bridges on the Swiss national roads

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Summary

A main strategic goal in the assessment of the existing Swiss national road net is to provide a high level of availability and to reduce the traffic interference originated by constructions or repairs. Therefore, renovation works tend to be executed in larger maintenance sections, for which the complete infrastructure is repaired in order to ensure a period of 15 years without additional construction work.

Before 2008, the existing bridges were maintained individually under the responsibility of local cantonal administrations. Entering into the new maintenance cycle requires a careful assessment of the structural conditions. Visual inspections and laboratory testing programs are required in order to reach a homogeneous level of the structural condition and fulfilling all standards as far as costs are not disproportional to the benefits.

The structural safety is evaluated according to the new Swiss code for existing structures, SIA 269, which was published in 2011. For typical short span bridges and overpasses from the early 1970's, which represent the largest number of existing objects, focus has to be set on the shear verifications of slabs without stirrups as well as on bending capacity of cantilever slabs.

Keywords: existing bridges; maintenance; inspections; condition assessment; structural verification.

1. Maintenance planning

The maintenance planning for the national roads projects (UPlaNS) is scheduled in three planning phases: First, the basis for strategic decisions is prepared including condition assessment, the identification of major technical issues and boundary conditions as well as cost and construction time estimates. In a second phase, the basis for selecting the appropriate measures is elaborated and recommendations are given. In the third phase, the proposed measures are elaborated.

A large advantage of the UPlaNS is to bring all different structures onto a similar level of norm conformity and to increase the degree of standardization by considering the FEDRO's guidelines for all new elements. By cross comparisons it can be achieved that investments are carried out, where most value is generated, e.g. where condition is worst or where increase in safety is most efficient. Significant synergy is gained by the simultaneous treatment of a larger number of structures.

2. Condition Assessment

The condition assessment is essential for identifying current and potential deficits. Based on the condition, the measures are planned to improve durability, which can either be achieved by repair works or by deceleration of the deterioration process. Therefore, a deep understanding of the deterioration processes is a requirement for the bridge inspectors.

Since main deterioration of bridges is caused by water and chlorides, the condition of the waterproofing and the level of chloride penetration are the most relevant issues to be examined.

Every bridge on the national road net is inspected every five years, by the owner or by an assigned engineer.

Prior to visual inspections, the structure's documents need to be studied in order to capture all relevant parts. The availability of the archive documentation is fundamental. For the inspections, the particularities of each structure have to be evaluated first, in order to increase the awareness of the inspector regarding weak points of the structure.

For the structural evaluation, also the material properties are of importance. Therefore, apart from visual inspections also laboratory testing programs provide the basis for the condition assessment. The amount of tests is defined after the visual inspections and under consideration of findings as run-down signs or wet surfaces. Tests shall be carried out in two phases, adjusting the amount and location of samples based on the results of the first phase. This two steps approach requires more time, but it can avoid expensive testing without obtaining the desired information.

In the approximately 40 year old bridges, the following damages are the most frequently found: Water proofing is not tight at the edge and around sumps; damages within box girders due to leaking drain pipes; damages at supports and walls exposed to de-icing salt; local concrete damages due to insufficient concrete cover or cracks; damages around leaking expansion joints or pavement drainages; deficiencies in the corrosion protection of the cables; defective vehicle restraint systems and utility installations.

3. Structural Assessment

An essential part of the structural assessment is the identification of critical components and verification sections, such as girders with slight or missing shear reinforcement, indirect force transfers, cantilever extensions or highly demanded components.

In addition to standard structural analysis according to the relevant standards, the detailing of the essential parts and potential deficiencies from the construction process have to be checked.

In the FEDRO's guidelines, the standard procedure for the structural verification is defined. The most significant update of the structural verifications is usually due to the changes in the regulations and the changes of material properties with time.

4. Conclusion

From the assessment of bridges on the national roadway, the following conclusions can be drawn:

- 1) A proper archive of construction drawings, design basis, inspection reports, condition assessments and structural calculations reduce significantly the planning costs and are an important investment for the maintenance of the structures.
- 2) During structural evaluations, focus should not only be set on the structural calculations but also on the assessment of detailing.
- 3) Exploitation of the remaining service life prior to repair and entering into a new repair cycle due to changes in maintenance strategy require a careful evaluation of conditions and an estimate of the deterioration process.
- 4) The extent of damage from chloride infiltration can significantly be reduced by reacting early (prior to reaching the level of reinforcement).
- 5) Laboratory tests shall be carried out in two phases, resulting in a more precise definition of the second testing campaign, according to the information required for defining the appropriate extent of repair measures.
- 6) A strong structural understanding and analysis capabilities can often elongate the service life of an existing structure, while being aware of structural deficiencies.
- 7) The experience of assessing existing bridges is worth value for the design of new durable bridges, aiming at reducing future traffic disturbances to a minimum.