

# Vulnerability assessment of a concrete bridge through fuzzy logic analysis of visual inspection compared to chemical inspection.

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## Summary

In this paper we compare the results of different methodologies of inspections, made on the deck of a concrete bridge located near Cagliari, along the SS 195 road to Capoterra. From a strategic point of view this structure plays a key role ensuring direct connections from Cagliari to different structures related to industrial and local productions and to an important touristic district. Aim of our work is to obtain a real measure of the vulnerability through two procedures and compare them. The first one is based only on visual inspection while the second one realizes a measure in time of the vulnerability through chemical and physical processes focusing on the carbonation depth.

With the first procedure we manipulated the data obtained by visual inspection with fuzzy logic, thus using mathematical and logic functions to transform linguistic assessments, inherently subjective, into a numerical result, thus objective, representing the failure probability. This is derived from visual inspection and it's then compared to the results obtained through the evaluation of the carbonation process in the concrete beams of the bridge. The goal is to verify the reliability of visual inspection through the comparison of the data obtained with the two different approaches and trace a methodology in order to reduce the number of invasive actions and their cost.

**Keywords:** visual inspection, fuzzy logic, security assessment, carbonation depth.

## 1. Introduction

### 1.1 Problem overview

In the last years the request for a reliable evaluation of safety of existing structures has become ever more strict and demanding. This request derives both from traumatic events that caused great impact on the population and also from a greater attention paid by the Administrations in relation to the recovery of buildings and the need to keep functioning those constructions holding a strategic and functional importance. In order to formulate an objective judgment [1] on the safety level of existing structures we can identify four operation (not all of them strictly necessary):

- visual inspection;
- historical data collection;
- in situ (non-destructive) tests;
- lab test (on properly chosen samples).

Subsequently, through a comparative critical exam of all information collected, we can produce a diagnosis on the degradation level of the structure under exam.

Nevertheless, often the only available diagnosis instrument in order to evaluate the vulnerability of a construction is represented by visual inspections, mainly because of the urge of the restoration operations, and they hardly are associated to the realization of an experimental program.