# A Probabilistic Assessment Methodology for Life Cycle Analysis of Structures

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## Summary

The life cycle analysis (LCA) of structures is a framework that evaluates its condition and safety within the whole life through specific performance indicators. Management decisions are then taken considering this state and in a way that cost is optimized. Used indicators are strictly correlated and they are usually determined through a structural assessment procedure. However, this procedure is carried of different sources of uncertainty. This paper presents one methodology for a probabilistic assessment which considers and mitigates some of these uncertainties. This algorithm is based in both optimization and Bayesian inference techniques. It will be applied with two structures, respectively, a reinforced concrete and one composite beam. Two performance indicators will be computed considering traditional probabilistic assessment techniques and this methodology Obtained results pointed out the economic advantages of considering this methodology.

**Keywords:** Probabilistic Assessment Methodology; Uncertainty Sources; Optimization Algorithms; Bayesian Inference; Reinforced Concrete Beams; Composite Beams.

## 1. Introduction

Structural assessment is usually performed by engineers to evaluate the real condition and safety of an existing structure. This state is reproduced by one indicator that is used for life cycle analysis (LCA). LCA is one framework that helps operators taking the best decision regarding the duality maintenance vs. cost in each time instant. Thus, the accuracy of used indicators becomes one important issue for this matter.

There exist different levels of structural assessment, and, accordingly different performance indicators. Both condition and safety indexes are visual-inspection based, being the former used to measure the structure remaining load-carrying capacity while the latter relates available and required live load capacity. The reliability index is one other performance indicator used to quantify safety level [1].

Despite the correlation between these indicators, its subjectivity degree is completely different. The reliability index is more objective than the others as is computed through probabilistic based techniques. First it is developed one model that tries to reproduce the assessed structure with maximum accuracy and then this model is leaded up to failure. The reliability index will relate resistance and loading distribution curves through one pre-established failure criterion [2].

Several sources of uncertainty are present in the structural assessment procedure [2]: (1) human errors (e.g. during concreting, fabrication and curing processes); (2) modelling and measurement errors; (3) physics (e.g. randomness in structure materials); (4) statistics (e.g. errors in statistic parameters). One other point to take into account is deterioration. Structures tend to deteriorate and structural assessment should consider this phenomena.

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