



## CRIAM: Structural Risk Index Weighing Model

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## Summary

In the Netherlands, the partnership between the Ministry of Infrastructure and the Environment and the market has led to the new method CRIAM, which stands for 'Structural Risk Index Weighing Model'. With this model, an inspector and engineer can objectively determine whether a Unity Check, further material research or a complete re-examination is necessary. Many hours of research and calculations of infrastructural objects were saved with this objective weighing model. This process has led to considerable savings in both time and social costs. In addition, this method objectively determines a score which provides the urgency in which further research or re-examination is required. Meanwhile over 800 objects have been classified by urgency in The Netherlands. The uniform objective CRIAM score was successfully validated by the Ministry of Infrastructure and the Environment using historical figures and refined re-examination of objects, which took already place in the past.

**Keywords:** risk based maintenance, saving costs, objective, urgency, structural safety, existing structures, uniform score.

## 1. Introduction

One of the most internationally discussed topics is the safety of old existing structural objects in our infrastructure with a direct link to damage effects and available design documents. For the owner of these objects, it is vital to have a risk list of the different types of structures in the network. Coupling the availability of design, the inspection documents from the past and the actual one with the possibility of damages to the structure and the level of structural risk taken while scheduling an optimal maintenance or repair plan. To avoid expensive and time-consuming re-examinations of the structure, the method CRIAM is developed to give quickly and easily an objective uniform opinion for the urgency and depth of further analysis, investigation and calculations over several objects in the infrastructure network. The main criterion, in addition to the visible damage, is the history of an object and the exploitation versus design conditions. In this way the owner is provided with an evaluation of the current situation, status, urgency and recommended steps required to minimize safety risks and execute the correct and most efficient maintenance or repairs. Finally we would like to indicate that CRIAM is only a small part of the risk based approach to the damage in relation to operations, maintenance, repair and life extension of infrastructural objects.

## 2. How it started

The emergence of CRIAM method comes from the Inspection Program IP2012 which the market executes commissioned by the Ministry of Infrastructure and the Environment. Within 3 years, approximately 1550 objects divided into two clusters, North(946) and South(608), had to be provided with a conservation plan based on risk-based inspection and analysis. In the preliminary phase and during the pre-study, risk based analysis of objects are created using existing records, old inspection reports and changes in use, standards and regulations. During this pre-study one of the things advisors ran into, was the increase in traffic intensity since 1960 and the increase of traffic loads since 1960 too versus the design loads. The requirements used during construction were not consistent with the current use and current requirements for the traffic classes. Questions like "Is the structural safety of the structure at stake?" and "Can we estimate the risk in loss of structural safety without making detailed and time-consuming calculations?" came up. These questions were reinforced by the knowledge that the Ministry of Infrastructure and the Environment was busy testing structures on shear capacity in a project called "Renovation Bridges". One of the results of this project, research showed that the hardening behaviour of concrete structures build before 1975 sometimes resulted in concrete with twice the strength of the design circumstances. Note that this increase of strength is often true for constructions designed before 1975 by the Civil Engineering Division of the Ministry of Infrastructure and the Environment and are not directly applicable to objects of other owners such as counties, municipalities and railroad companies. This has partly to do with the way of handling the concrete and the specification of the concrete required by the Ministry of Infrastructure and the Environment. It therefor is a positive parameter when questions about the structural safety has to be answered. The answers to this questions also require more technical and structural knowledge from advisor and inspector. They are not always adept with this requirements.

It was therefore clear to answer these questions so that an advisor and an inspector, together with the structural engineer, could objectively determine the risks of structural safety based on existing records and their field experience. The Ministry of Infrastructure and the Environment also gave input from her experiences with the project "Renovation Bridges" and wanted a first filter configuration for the urgency and depth of any further analysis, investigation and calculations. Easier said than done, but still an advantage for the inspection regime and the engineering regime together.

CRIAM method is a quick way to determine the urgency and depth of analysis and calculations based on studies, history and use versus design of objects in the infrastructure. It is not said that



calculations are not necessary. It just gives a more objective assessment of how and when (now or later), an owner must take into account any in-depth analysis or even strength calculations. The urgency is thereby determined by findings resulting from an inspection. Think about cracks but also about damage affecting the structural strength and structural reserves such as Alkali Silica Reactions (ASR), degradation of reinforcement, deferred maintenance and so on (Fig. 1).

*Fig. 1: Effect of damage on the bearing capacity*