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EXTENDED VALIDATION FOR USING NONLINEAR FINITE ELEMENT ANALYSIS FOR ASSESSING EXISTING CONCRETE STRUCTURES

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SUMMARY

The Dutch Ministry of Infrastructure and the Environment is concerned with the safety of existing infrastructure and expected re-analysis of a large number of bridges and viaducts. Nonlinear finite element analysis (NLFEA) can provide a tool to assess safety to obtain a more realistic estimation of the existing safety. Guidelines, based on scientific research, general consensus among peers, and a long-term experience with nonlinear analysis, allow for a reduction of model and user factors. The guidelines have been developed with a two-fold purpose. First, to advice analysts on NLFEA of (P)RC structures. Second, to explain the choices made and to educate analysts, related to the responsibility of limiting model uncertainty. The updated 2017 NLFEA Guidelines can be used for the FE analysis of basic concrete structural elements. Existing concrete structures, like box-girder structures, culverts, cable-stayed bridges and bridge with composite bridge decks can be analysed. The paper contains an overview of the impact of extended validation simulations of tested RC girders with variations in dimensions of cross-sections, amount of reinforcement, strength of concrete. In this way NLFEA can be a reliable tool for re-analysis of existing RC structures.

Keywords: *Nonlinear analysis, guideline, re-examination, existing structures, concrete.*

1. INTRODUCTION

The fib ModelCode2010 (MC2010) [1], the final version was published in 2012, provides four levels of approximation, where level IV refers to nonlinear analyses. Within this level IV, three alternative so-called safety format methods are defined, where the Eurocode 2 only describes one safety format method. The three different safety format methods are:

- the Partial Safety Factor method(PF),
- the Global Resistance Factor (GRF) and
- the Estimation of Coefficient Of Variation of resistance (ECOV).

The main difference between the safety format methods is the use of either mean material values, characteristic material values or design material values as input in the nonlinear analysis. Only the ECOV safety method involves two analyses, the other two safety format methods require only one nonlinear analysis. Details of the safety formats can be found in the ModelCode2010 or in the Eurocode[2] as well. To facilitate the analyst and the checking authorities in the process of a nonlinear analysis a NLFEA guideline was needed. Handbooks on the use of nonlinear analysis were already available, but it was envisioned that more guidance on the selection and use of material models was needed. Also, more validation studies of nonlinear analysis results was required. The objectives are threefold:

- Limit the scatter of finite element results, attributed to relatively arbitrary finite element modelling choices made by finite element users, by standardizing safe guidelines.
- Limit the work for finite element users for justifying the finite element modelling choices made.

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