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PRACTICAL APPLICATION OF PROBABILITY BASED ASSESSMENT TO BRIDGES

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ABSTRACT
A common problem among bridge owners/managers is the need to reduce spending whilst attempting to operate and maintain an increasingly ageing bridge stock which is subject to a loading intensity for which, in many cases, it was not designed. The problem is compounded by the ever increasing trend in motorway traffic frequency. As a result the past decade has seen increased interest by bridge owners and managers in the use of probabilistic methods for the assessment of their bridges specifically within the context of documentation of higher load carrying capacities such that unnecessary repairs/rehabilitations can be avoided. Employed once a deterministic assessment has rendered a repair/rehabilitate/replace now scenario, the methods have been demonstrated to provide significant cost savings where the required safety of the structure at higher load levels can be demonstrated by probabilistic methods. This paper presents the practical implementation of probability based assessment methods to a selection of road and rail bridge structures. For the structures analysed, modelling of the critical limit states is described as are the statistical techniques employed in modelling the loads and resistances. Ultimately the benefits to bridge owners/managers of performing probabilistic assessments are apparent from the results, which consistently provided (a) higher load ratings for the bridges considered and (b) considerable financial savings (both direct and indirect) through the avoidance of unnecessary repair/replacement of serviceable highway structures. Examples presented in the paper demonstrate direct monetary savings in excess of $30ml (USD).

INTRODUCTION
Probabilistic assessment of a bridge involves the derivation of a bridge specific code and consequently a bridge specific safety rating. The procedure involves statistical modelling of load and resistance parameters obtained through on-site measurements and from as-built drawings. Updating of these models may be performed where additional information is available. The first stage of the process involves deterministic assessment to identify the critical limit state for the structure. Next probabilistic assessment results in a formal probability of failure, p_f, for the structure at the critical limit state. Comparison of the calculated p_f, or of the reliability index $\beta = -\Phi^{-1}(p_f)$, with acceptable values specified by legal requirements, e.g. Table 1, and demonstration that it exceeds these requirements is deemed sufficient to validate the safety of the structure.

This focus of this paper is on presentation of case studies where probabilistic methods have been employed to validate the safety of structures, which had received a repair/rehabilitate/replace now result following deterministic assessment as such the theory is not discussed further here, the interested reader is referred to the literature (O'Connor and Enevoldsen 2007). The majority of cases presented are selected from Danish experience, as it

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