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# A scheme for the evaluation of experience of the performance of timber structures

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ABSTRACT

For the future development of a safe and efficient building infrastructure, it is of utmost importance to learn from past experience. In this paper, a scheme for the evaluation of experience gained from failures and malfunctions in timber structures is developed. It is highlighted that the main motivation to analyse structural failures is to learn from them. It is therefore stated that the description of the circumstances that led to structural failures is of highest importance. This is a somewhat different perspective compared to the structuring of information that can be found in existing studies on failed and malfunctioning structures in the literature. There, the focus is on the thorough description of the physical parameters related to the failures. The result of this paper is a proposed template for failure assessment that, in its complete extension, can be downloaded from the World Wide Web. The failure template is "ready to use"; however, it should mainly facilitate further discussions on the formulation on a broadly agreed format for how the structural engineering profession might standardise failure reporting.



## 1. Introduction

During recent decades, structural reliability methods have been further developed, refined and adapted. They are now at a stage where they are being applied in practical structural engineering problems. Typical problems in structural engineering such as design, assessment, inspection, and maintenance planning are decision problems subject to a combination of inherent, modelling, and statistical uncertainties. Structural reliability theory is concerned with the rational treatment of these uncertainties. In general, failures that result from stochastic variability in loads and resistances are addressed. The modelling of errors introduced by the use of structural mechanics models that are based on idealisations of structural and material behaviour and also the simplified representation of load variables are taken into account.

Modern load and resistance factor design (LRFD) formats are calibrated by the use of structural reliability theory; i.e. the partial safety factors are chosen in a way that failure rates for structures designed according to LRFD formats are sufficiently low. Thus, it is not surprising that structural failures due to the random occurrence of adverse combinations of high loads and low resistance rarely occur.

In contrast, a large fraction of structural failures and therefore the majority of damage costs occur as a consequence of errors in planning, design, construction, and utilisation. This has been shown by several studies in which information about collapsed and malfunctioning structures has been analysed (e.g. [1,2]; timber structures are particularly addressed in [3,4]).

These errors are not explicitly considered by structural reliability methods which are based on the assumption that customary standards of planning, design, construction, and utilisation are efficient, and which are not violated. Several attempts have been made to model the effect of errors on the structural reliability. Most of them are based on standard procedures for risk analysis of technical facilities. Possible errors and their effects are treated as scenarios that are analysed by means of event trees or fault trees. However, any reasonable estimation of the effects of errors on the structural reliability in general is lacking, due to poor information about the types of error that could occur, the probability of these errors, and their effects on the performance of the structure.

The studies of collapsed or malfunctioning structures are part of the experience of the performance of structures gained over time, and they are a valuable source for gaining insight into the corresponding causes of failures. The information about the causes of failures should be continuously used to critically reflect the structural engineering accepted practices in order to reduce failure rates and the associated expected consequences. The studies by Matousek and Schneider [5], Smith [6], and Allen [7] contain a description of the cause of failures that is mostly associated to errors. However, different definitions and classification schemes

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