IABSE SYMPOSIUM
7-9 October 2020
Synergy of Culture and Civil Engineering
- History and Challenges
IABSE 2020
WROCŁAW POLAND

RESISTANCE MODELS FOR SEMI-PROBABILISTIC ASSESSMENT OF HISTORIC STEEL BRIDGES

R. Lenner[1], P. Ryjacek[2], M. Sykora[3]

[1]Stellenbosch University, Department of Civil Engineering, Stellenbosch, South Africa.
[2]Czech Technical University in Prague, Faculty of Civil Engineering, Prague, Czech Republic.
[3]Czech Technical University in Prague, Klokner Institute, Prague, Czech Republic.

e-mail: rlenner@sun.ac.za; pavel.ryjacek@fsv.cvut.cz; miroslav.sykora@cvut.cz

SUMMARY

The mechanical properties of historic metal materials exhibit a considerable scatter dependent on periods of construction and the region of a producer. Assessments of historic metal bridges then need to be based on measurements and tests. The use of non- or minor-destructive tests (NDTs) is often preferred over to destructive tests (DTs) to reduce the cost of structural survey. This contribution explores the measurement errors associated with common NDT hardness techniques and quantifies uncertainties in design (assessment) values of resistance. When deriving the partial factor, the uncertainty in geometry and model uncertainty is considered along with the variability of a material property and measurement error. Numerical studies reveal the effects of measurement error and model uncertainty (bending, buckling) on assessment values of resistance. A unity mean and coefficient of variation of 12% might be adopted for the measurement uncertainty of the hardness methods under study as a first approximation. On average, the true assessment resistance is by ~15% larger than that based on a NDT survey. Model uncertainty affects the partial factor for resistance of historic metal bridges.

Keywords: *Historic Metals, Non-Destructive Tests, Partial Factor, Uncertainty.*

1. INTRODUCTION

The mechanical properties of historic metal materials such as cast and wrought iron or old carbon steel exhibit a considerable scatter dependent on periods of construction and the region of a producer, resulting in differences in the production procedure, its quality and alloy composition [1,2]. Commonly, the design documentation for historic structures is not available and there is no clear relationship between material strengths and the year of construction of historic steel bridges [3]. This is why the information for their assessments needs to be based on measurements and tests only [4,5]. The use of various non- or minor-destructive tests (NDTs) is often preferred over to destructive tests (DTs) to reduce the cost of structural survey and damage to the structure.

However, limited attention has been paid to the investigation of uncertainties in characteristic strength estimates based on NDTs only. This contribution thus explores the measurement errors associated with common NDT hardness techniques and quantifies uncertainties in characteristic strength estimates. The measurement uncertainty is assessed considering the database of pairs of NDTs and DTs taken from historic structures from the 19th century. When deriving the partial factor, the uncertainty in geometry and model uncertainty is considered along with the variability of a material property and measurement error. Numerical studies reveal the effect of measurement error and model uncertainty on assessment values of resistance.

2. EXPERIMENTAL DATABASE

The database contains 119 pairs of NDT and DT results obtained from mostly railway bridges and some buildings from the second half of the 19th century. Most of the test results were published in previous scientific contributions [6-10]. The tests of tensile strength were conducted by the following methods:

https://doi.org/10.2749/wroclaw.2020.1061