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Assessment of existing masonry and timber structures – the ARES project

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Abstract

According to the systematic research of Statistical Yearbooks, Croatia's national building stock consists of approx. residential 800000 buildings and 125000 non-residential buildings. More than 75 % of the building stock is older than 30 years, an age which often requires renovation or modification of buildings. More than 40 % of the building stock is older than 50 years, meaning that the structure's service life is expired. In Croatia's building sector, up to 40 % of the expenses are spent for the rehabilitation, modification, and demolition of existing structures.

Key words: masonry structures, timber structures, residential buildings, non-residential buildings, existing structures, rehabilitation

1 Introduction

According to the systematic research of Statistical Yearbooks, Croatia's national building stock consists of approx. residential 800 000 buildings and 125 000 non-residential buildings. More than 75 % of the building stock is older than 30 years, an age which often requires renovation or modification of buildings. More than 40 % of the building stock is older than 50 years, meaning that the structure's service life is expired. In Croatia's building sector, up to 40 % of the expenses are spent for the rehabilitation, modification, and demolition of existing structures.

The main characteristics of buildings constructed in the period before the 1970s are traditional techniques and materials such as masonry and timber. Buildings were built as full-brick masonry structures, with 30–60 cm walls producing satisfactory static building structure. Ceilings are mostly wooden. In the 1960s, concrete in combination with timber and steel started to substitute traditional materials. However, most of the residential structures are still built as a combination of concrete, masonry and timber.

The current state-of-the-art (STAR) practice in the field of structural design and reliability analysis of existing structures neglects advantages from advanced methods such as updating and is based mainly on the simplified principles of the design of new structures. This is mostly due to a lack of adequate, practical methods and advanced techniques for the involved engineers. The surge of buildings of higher consequence class and the global goals towards sustainable development demand higher levels of reliability and a more sustainable use of the raw material.

2 ARES Project

Numerous technical documents have been published by national and international authorities that focus on the systematic and scientific methods that can be used to accurately assess the residual strength, durability and reliability of structural materials, assemblies and systems in existing buildings.

The research topic's relevance lies in the preservation of existing building stock, restoration of objects, and development of guidelines and norms. Results from NDT methods and probabilistic analyses will provide important information for a production of the new standard on a European level. The field of structural engineering strongly supports any research regarding existing structures. Not only heritage structures are of the point of interest, but also regular buildings which are near the end of their service life or which already exceeded its service life.

Despite the fundamental role of updated knowledge for the verification of the reliability of existing structures stemming from the assessment, the current STAR of structural design and reliability analysis of existing structures neglects these advantages and is based mainly on the simplified principles of the design of new structures. The aim of this research project is to study the role of assessment on the reliability analysis of

existing structures. The project focuses on existing masonry and timber structures to evaluate the benefits of assessment with regard to the economy and safety of structures. Project objectives are listed in Table 1.

Table 1. Objectives and goals of the ARES project [1]

Objective	Goal
Development of concise databases of structures and assessment techniques	...is to get the insight in Croatian building stock and STAR assessment techniques
Insight in material and structural properties obtained by assessments and structural analyses and evaluation	...is to model, analyse and predict the performance of existing structures from the inventory and prepare the data for reliability
To prepare the probabilistic database of material properties for masonry and timber structures (based on an extensive assessment)	...is to identify key material properties for the future development of norms
Quantification of material properties and time-dependent material behaviour for the structural analysis of existing structures	...is to update the knowledge and give insights of reliability methods to practical engineers
To optimize models for the prediction of structural performance	...is to develop & evaluate all necessary models and tools to predict the reliability of existing structures based on a different amount of updated information and for different future scenarios
Evaluation of proportionality and development of design guidance	...is to develop adequate and proportional techniques for the decision-maker in the assessment process.
Evaluation of reliability and development of design guidance	...is to enable the engineer to benefit from advanced methods and techniques within the assessment process.

3 Conclusion

Although there is a lot of experience regarding existing structures, no significant advancement in the quality of an assessment can actually be perceived. The interpretation of measurements and their relation to calculation parameters still represents a weak aspect of the overall process. Currently, there is a huge knowledge gap, especially in the assessment methods and design checks for existing structures, in every aspect of the assessment process. To summarize, the following issues should be defined:

- Definition of material properties
- Modelling of structural behaviour
- Ways of structural strengthening and upgrading.

The ARES project, in this context, will try to model structures with different input parameters, and try to assess them before and after the initial assessment. In order to obtain a stable system, comparison of the data provided by tests and models will be conducted. The procedure will be repeated until no further calibration is needed.

Due to recent earthquakes in Croatia, in areas with a large number of masonry structures, this topic is very important and will address basic problems and issues regarding the seismic assessment and strengthening of damaged buildings. This earthquake exposed Croatian building stock's vulnerability that should be mitigated as efficiently as possible in the coming years [2]. Novel approaches in assessment procedures should be applied together with state-of-the-art repair and reconstruction of the damaged buildings. In the process of repairing and rebuilding the city's principles of build back better should be adopted, e.g. using sustainable materials [3,4] and innovative concepts [5,6,7] or ensuring energy efficiency buildings [8]. Promoting a multidisciplinary approach with respect to all professions (structural engineers, architects, conservators, etc.) is a need to obtain good renovation of a city.

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