Abstract for general public in English

In the last decades, civil engineering sector in Central Europe has been experiencing an increase in utilizing natural materials for construction, also for tall timber buildings. Among these materials, wood plays the most significant role due to its advantageous mechanical and environmental-impact properties. However, to utilize wood in a structure, one is obliged to use connections to provide needed structural dimensions and spans. Adhesive bond is the most frequent connection to form wood-based composites (WBC's), such as Cross-laminated Timber (CLT) or glued laminated timber (GLT) and it also plays significant role in performance of the material, especially from a long-term perspective. WBC's undergo cyclic hygro-thermo-mechanical loads and, at the same time, weathering or aging of the material and adhesive bond in their service life, influencing structural resistance to wind, earthquake and dead loads. These mechanical deterioration, weathering and aging effects have not yet been fully described in the literature, although they strongly influence the performance of the adhesive bond and, eventually, the integrity of the whole structure.

The project will focus on diagnostics and assessment of mechanical performance of aged beech and adhesive bond made of rigid (RPU) and flexible polyurethane adhesives (FPU). The aim of the project is to answer the question to what degree the ageing of the adhesive bondline can be predicted and diagnosed prior to its functional failure. Furthermore, the main goals are: 1) To evaluate properties of adhesive bond with RPU and FPU prior and after accelerated and natural weathering (ANW); 2) To investigate the effect of spatial distribution of adhesive and its microstructure incorporation on the behavior of adhesive bondline prior and after ANW; 3) To evaluate quasi-static, cyclic, fracture and dynamic mechanical properties and the behavior of adhesive RPU and FPU bondlines prior and after ANW; 4) To find whether the acoustic signals may be utilized to diagnose the effect of ageing on an adhesive bondline; 5) To assess the behavior of RPU and FPU bondlines at elevated temperatures simulating fire damage; 6) To conceptualize use of RPU and FPU for modern and tall-timber buildings including its life-cycle assessment; 7) To comprehend fundamental findings for a development of prediction models of adhesive bond made with RPU and FPU with respect to its damage and diagnostics.

Within the project, all the adhesive bonds will be examined from many various perspectives (weathering regime, short term, long term, static, dynamic, fracture, fatigue, acoustic, thermal, visual) and at three scales (macro, micro and nano). Examining the adhesive bond from such wide range of perspectives will provide significant fundamental answers on anticipated researched goals.

To achieve these goals, project will utilize a synergic cooperation of two Polish universities (Tadeusz Kościuszko Cracow University of Technology & AGH University of Science and Technology) with two Slovenian institutes (InnoRenew CoE & Slovenian National Building and Civil Engineering Institute). The synergy of cooperation will lie in competencies of researchers and complementary research equipment and devices. The output of the project can be foreseen mainly in strengthening cooperation with foreign partners and in providing new fundamental knowledge that is currently missing and highly needed by a sustainable civil engineering sector focusing on application of green but also safe technologies.