Towards a digital twin for monitoring in-service performance of post-tensioned self-centering cross-laminated timber shear walls

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ABSTRACT

A digital twin (DT) can be defined as a multi-physics, multiscale model in which a digital model, such as a building information model (BIM), is updated based on data obtained from a physical system as well as results from probabilistic simulations and models. This study describes the critical steps towards the implementation of DTs to support structural health monitoring (SHM) of mass timber buildings. In particular, the study defines a methodological approach used to integrate as-built geometry of existing buildings, as well as their material properties and sensors, to link SHM parameters into a digital model to assist in assessing a building's structural performance. A coupled pair of post-tensioned cross-laminated timber (CLT) self-centering shear walls at the George W. Peavy Forest Science Center ("Peavy Hall") at Oregon State University were used as a case study to test the proposed approach. The BIM of the shear walls was developed using a Scan-to-BIM approach by converting LiDAR point clouds into a BIM. Sensors in the building recorded environmental and structural parameters influencing the long-term performance of the shear walls. Measurands included relative humidity, air and wood temperature, wood moisture content, displacements and deformations of shear walls, and tensile force of post-tensioned rods. The precise placement of these sensors and the possibility to associate the measured parameters of these entities within a BIM is hypothesized to assist with data management by adding a spatial element to data and analysis results, which could lead to the prolonged service life of a building.