

Structural health monitoring of a historic warehouse & church: theory and practice of diagnostic approaches used to control costs

Dr. Thomas Morrison, PEng, ISCARSAH*

* Heritage Standing Inc.

PO Box 66, Stn A, Fredericton, NB, E3B 4Y2, Canada

E-mail: tmorrison@heritagestanding.ca, web page: <http://www.heritagestanding.ca>

ABSTRACT

Applying research level conservation approaches can be a challenge for industry, particularly in regions where clients have limited budgets, limited timeframes and a limited political ability to support prolonged study of a structure. This paper looks at two independent projects where Condition Assessment identified concerns that led to the use of Structural Health Monitoring (SHM): a historic warehouse (1888) and church (1826). SHM was selected to benefit both assessment and intervention, by allowing the interventions to risk being too minimised. These processes were applied following the *ICOMOS Charter on the Principles for the Analysis, Conservation and Structural Restoration of Architectural Heritage*.

In both projects initial condition assessments were predominately visual inspection based due to limited project budgets. These assessments included some moisture measurements, damage mapping and borescope investigation. The warehouse is a predominately wood structure and the church predominately stone masonry. In both cases great clarity was needed in understanding building performance in order to minimise any intervention cost. Bounding analysis with structure modeling was used, but the uniqueness of the materials and systems provided insufficient data to replicate structural performance inside of costs acceptable to clients.

Due to client constraints and objectives, SHM was selected as the assessment approach to establish actual building performance. SHM was first used to confirm that the intervention was required. Then SHM was used post-intervention to ensure the intervention had successfully remediated the structural deficiency. Limited time was available for initial monitoring of the buildings before the interventions were to occur. The SHM systems were designed to look at environmental conditions and the corresponding structural responses (focused on the lateral strength of the buildings), while accounting for climate change impacts at their northern sites. The SHM program included direct results analysis, simple statistical analysis, static regression analysis, dynamic regression analysis and damage detection algorithms. Evaluation of the data depended upon different aspects of each technique.

The application of SHM techniques as a common industry tool has some challenges to overcome. Some are cultural expectation (which may be local) that the average building needs design and interventions without extended study prior to investigation. Another challenge is client aversion to spending money on investigation rather than construction, where benefits are not guaranteed. These two similar, but very different, projects demonstrate options for how SHM can be used inside these constraints to find better solutions for owners.