

## Session CS1.3: Structural Performance of Buildings

Session Chair: Tim Crowe, RA, SE, PE

Speakers:

1. Caroline Guay - *West Block Pendulums: Mackenzie Tower and the use of early engineering technology*
2. Daniel Cusson - *Seismic Vibration Monitoring of Centre Block on Parliament Hill*
3. Marie-José Nollet - *Experimental programme for the evaluation of mechanical parameters for seismic assessment of traditional masonry buildings in Eastern Canada*
4. Grigor Grigor Angjeliu PhD Student Politecnico di Milano - *A parametric model for ribbed masonry vaults and the development of structural simulations*

### **Session Learning objectives**

- *Historic context and examples will be explained regarding the use of pendulums in early engineering technology for masonry spires.*
- *Attendees shall gain a greater understating of the challenges and techniques available with the assessment of archaic masonry systems and their behavior.*
- *Descriptions of seismic response assessment will be presented with example data for steel structures embedded in masonry (Center Block on Parliament Hill).*
- *Explanations of the importance for identifying the mechanical properties of masonry materials for assessing the dynamic response of unreinforced masonry.*



### **West Block Pendulums: Mackenzie Tower and the use of early engineering technology**

**Presenter: Caroline Guay, Conservation Technologist, Heritage Conservation Services**

1. During the late 20th century, with the construction of taller and taller buildings, engineers developed tuned mass dampers and other advanced approaches to stabilize towers against excessive motion caused by external forces such as high winds, hurricanes/typhoons, and seismic events. The earliest use of tuned mass dampers in the U.S. began with the construction of Citicorp Center in New York City, a 59-storey tower built in 1977. But does this mark when architects and engineers began to use engineered controls to counteract external forces of nature?
2. West Block, one of the three buildings on Parliament Hill, possesses an unusual feature that up until the current rehabilitation project hung in obscurity since it's construction in 1878. Near the top of Mackenzie Tower are two pendulums, suspended inside of each of the masonry spires that project above the eaveline. They were part of the original construction of the tower to prevent excessive

movement in high winds and provide flexibility. During the course of the recent masonry conservation work, masonry team members discussed whether the pendulums were a unique feature - certainly in Ottawa, and possibly Canada. Are they unique or were they were so commonly employed that they are seldom mentioned?

3. Pendulums have been in use to manage excessive movement in spires since the latter part of the 17th century, attributed to Sir Christopher Wren. His device influenced numerous other installations throughout the UK, Europe and abroad certainly late into the 19th century. However, the desire to counter external forces on a structure was actually conceived of much earlier than that. The use of shock-absorbing shinbashira in Japanese pagodas from the 7th century onward is one example.
4. The West Block pendulums will then be discussed, describing their assembly, their installation, and how they functioned complete with diagrams and photos.
5. This presentation will demonstrate that the use of pendulums in tall slender structures to dampen excessive external forces is an old technology that has been in use for centuries.

### **Experimental programme for the evaluation of mechanical parameters for seismic assessment of traditional masonry buildings in Eastern Canada**

**Marie-José Nollet, ing., Ph.D. - Professor**

**Department of construction engineering École de technologie supérieure, Montréal**

**Co-Author: Ahmad Abo El Ezz, M.Sc., Ph.D. - Research associate**

**Department of construction engineering**

**École de technologie supérieure, Montréal**

1. Introduction
  - Earthquake damages to unreinforced masonry (URM) structures
  - Required parameters for damage prediction for seismic risk studies
2. Studied URM buildings
  - Characteristics (materials, geometry, etc..)
  - Behaviour of URM walls under seismic lateral loading
3. Experimental programme and results
  - Phase 1: Mechanical properties of masonry and its constituents
  - Phase 2 : Diagonal shear strength of masonry walls
  - Phase 3 : Cyclic behaviour - Lateral force-deformation
4. Using experimental data to estimate damage for a given earthquake scenario
5. Conclusion

A parametric model for ribbed masonry vaults and the development of structural simulations

Grigor Angjeliu

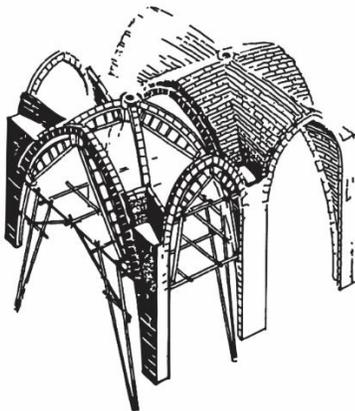
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Presentation Outline

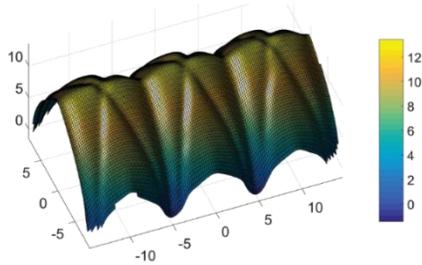
1. Introduction
2. Problem statement
  - a. Describe the complex structure of ribbed masonry vaults
  - b. How to document the complex geometry?
  - c. Ideas and solution for modelling the structure



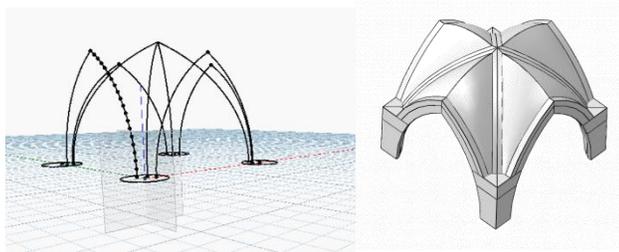
3. Investigation of the construction technique
  - a. Understanding the different typologies
  - b. Understanding the parts of a masonry ribbed vault



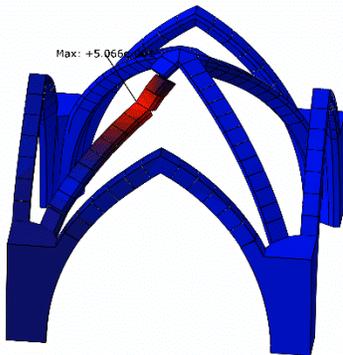
4. Geometric survey of ribbed masonry vaults
  - a. Application of photo-scanning technique
  - b. Measurement elaboration



5. Modelling of ribbed masonry
  - a. Formulation of a parametric model
  - b. Application of the parametric model



6. Development of the structural simulations for a case study
  - a. The Cathedral of Milan



7. Conclusions

**Closing with Brief question and answer with speakers.**