

Assessment of Moisture Response and Expected Durability of a Heritage Masonry Building Subjected to Projected Future Climate Loads of Ottawa, Canada

John Wells¹, Michael A. Lacasse² and Gary Sturgeon³

¹Crosier Kilgour & Partners Ltd., Consulting Structural Engineers, Winnipeg, Manitoba, Canada

²Facade Systems and Products Group, Construction Research Centre, National Research Council of Canada, Ottawa, Ontario, Canada

³BBSTEK Ltd., Consultant & Structural Engineer, Millarville, Alberta, Canada

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1 Introduction

As part of the Canadian government's recent drive to the "Greening Government" initiative, heritage buildings forming part of the parliamentary precinct district in Ottawa are to be retrofitted in the coming years to help reduced energy use for heating and cooling loads and ultimately decrease greenhouse gas emissions. There is overwhelming evidence that continued increases in world greenhouse gas (GHG) generation is impacting climate change on a global scale. Although Canada's contribution to world GHG's has been trending downward from 1.8% to 1.6% over the last 10 years, it remains 9th overall in contribution to world GHG generation. Buildings in Canada contribute 12% of its overall GHG annual total and this number has remained relatively unchanged between 1990 and 2017². Thus, significant room for improvement exists in Canada to decrease GHG's for both new and existing building stock.

The purpose of this paper is to present the results of the predicted durability analysis of one of the several Parliamentary precinct buildings, specifically, the Wellington Building located at 180 Wellington Street in downtown Ottawa, Canada. The Wellington Building was designed and substantially complete in 1927. The existing building cross-section consists of interior painted plaster, air space, cork insulation, parging over two wythes of red clay brick, faced by exterior Indiana Limestone veneer.

2 Methodology

A comparative study was completed on the hygrothermal analysis for the typical masonry wall system of the building using both the present climatic data and a revised climatic data base that incorporates changes to climate based on a mean global temperature increase of 3.5°C associated with increasing levels of GHG's. The impact of various insulation strategies on cumulative moisture within wall materials and assemblies is also presented for discussion for both the existing and predicted changes in climatic load files.

The commercial hygrothermal modeling program, WUFI6.3Pro was utilized for the analysis. Hygrothermal modeling was utilized to establish if projected changes in temperature and precipitation loads predicted by climate change models from a warming climate will impact the durability of a masonry heritage building, located in Ottawa, Canada having insulation introduced on its interior wall face.

3 Results

The significant findings are summarized below.

- Increasing levels of GHG concentrations has the potential to raise the mean global temperature by +3.5°C degrees. The predicted impact on Ottawa's climate will be

significant, increasing precipitation annually by 14.4% and decreasing the January winter design temperature from -25.0°C to -11.7°C or by 53%.

- Results show that although the climate change model produces higher volumes of annual precipitation, no deleterious levels of moisture build-up were observed in the masonry wall systems studied. In fact, moisture levels remained relatively consistent, irrespective of the insulation type applied to the interior face of the walls. Accumulated moisture content for all scenarios is well below critical saturation of the masonry materials.
- Total predicted moisture content in the wall system quickly reaches a semi-asymptotic value for the climate change model whereas the historical data file creates a continuing increase in moisture within the wall system. The increasing temperatures appear to facilitate drying of the walls.
- The warming climate has a dramatic effect by reducing the number of hours below freezing experienced by the interior paring and wythe of brick. The existing wall section, without insulation was predicted to have no hours below freezing along the interior wythe under future climate change loads versus 718 hours under historic loads. With the inclusion of insulation, the reduction in hours below freezing varies from 60%, 55%, and 52% for mineral wool, open-cell foam, and closed-cell foam, respectively, under exposure to future climate loads versus historic climate loads.

4 Summary and Conclusion

The placement of insulation on the interior face of masonry walls in heritage buildings is a proposed solution to reducing heating and cooling loads, and thus, to reducing GHG generation. Using hygrothermal analysis, the study shows that the warming temperatures resulting from climate change potentially will substantially reduce the number hours of freezing temperatures experienced by the interior wythe of masonry, maintain the moisture content of the masonry below a damage threshold, and therefore will reduce the potential for freeze-thaw damage to the masonry. The interior application of moderate levels of insulation should therefore be considered for retrofit measures for this heritage building, located in Ottawa, Canada, without increasing the risk of damage to the wall. Future studies are proposed which will include a comparative analysis of the hygrothermal results based on testing the actual masonry materials in the Wellington Building in order to validate the material assumptions made in the present study.

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