University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

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"Impact of Extensive Green Roofs on Energy Performance of North American School Buildings"

Department of Mechanical Engineering

Friday, May 11, 2018
1:00 P.M.
Engineering and Computer Science Building
Room 467

Supervisory Committee:
Dr. Phalguni Mukhopadhyaya, Department of Civil Engineering, University of Victoria (Supervisor)
Dr. Caterina Valeo, Department of Mechanical Engineering, UVic (Member)

External Examiner:
Dr. Jennifer He, Department of Civil Engineering, University of Calgary

Chair of Oral Examination:
Dr. Gordon Fulton, Department of English, UVic

Dr. Stephen Evans, Acting Dean, Faculty of Graduate Studies

Abstract

Buildings are one of the major consumers of energy and make up a considerable portion in the generation of greenhouse gases. Green roofs are regarded as an appropriate strategy to reduce the heating and cooling loads in buildings. However, their energy performance is influenced by different design parameters which should be optimized based on the corresponding climate zone. Previous investigations mainly analyzed various design parameters in a single climate zone. However, the interaction of parameters in different climate zones was not considered. Also, the studies have been conducted mostly for commercial or residential buildings. Among different building types, schools with large roof surface are one of the major consumers of energy in North America. However, the literature review shows the lack of study on the effect of green roof on the thermal and energy performance of this type of building. This study performs a comprehensive parametric analysis to evaluate the influence of the green roof design parameters on the thermal or energy performance of a secondary school building in four climate zones in North America (i.e. Toronto, ON; Vancouver, BC; Las Vegas, NV and Miami, FL). Soil moisture content, soil thermal properties, leaf area index, plant height, leaf albedo, thermal insulation thickness and soil thickness were used as variables. Optimal parameters of green roofs were found to be closely related to meteorological conditions in each city. In terms of energy saving, the results show that the light substrate has better thermal performance for the uninsulated green roof. Also, the recommended soil thickness and leaf area index in the four cities are 0.15 m and 5, respectively. The optimal plant height for the cooling dominated climates is 0.3 m and for the heating dominated cities are 0.1 m. The plant albedo had the least impact on the energy consumption while it is effective on the mitigation effect of heat island effect. Finally, unlike the cooling load which is largely influenced by the substrate and vegetation, the heating load is considerably affected by the thermal insulation instead of green roof design parameters.