II. Abstract

This thesis research investigates the insulating performance of screen systems, specifically, the combined effects of thermally bridging elements and wind sheltering, provided by external screens. In order to quantify these effects, U-factors of simple glazed wall assemblies with and without external screens were calculated and compared. To calculate the U-factors, this research proposes a multi-step modeling approach to minimize the computational costs of explicit modeling of screen systems. At various length scales, Computational Fluid Dynamics (CFD) modeling as well as thermal Finite Element Analysis (FEA) were used to analyze various components of screen systems and their thermal performances. From the analyses, it was concluded that the insulating benefits gained from the wind sheltering were marginal under the boundary conditions specified by the National Fenestration Rating Council (NFRC). The overall U-factors of façades with screen systems degraded due to the increased surface exposure and thermal bridging when compared to a baseline façade without any screen.

This research also investigates the solar shading performance of screen systems. In order to quantify the impacts of varying screen properties on overall building energy consumption, a commercial office space in New York, NY was simulated in COMFEN, an energy modeling software, and analyzed. For orientations where high solar irradiation is expected, solar shading from external screens resulted in overall energy savings by reducing the cooling loads. For orientations with marginal solar exposure, however, screen systems resulted in higher annual energy consumption due to increased lighting demand caused by blockage of visible light. Based on the analyses performed in this paper, it was concluded that a screen system should be considered for a project after analyzing it for a specific site and quantifying the benefits it may provide throughout the life-cycle of the building.