FIU | Wall of Wind
NHERI Experimental Facility

Scope of Work

Wind-induced loads on roof overhangs – Phase II

Florida Department of Business and Professional Regulation

Florida Building Commission

And

Laboratory for Wind Engineering Research (LWER), Extreme Events Institute (EEI)

Florida International University (FIU)

Project Lead: Ioannis Zisis

1. Introduction

An overhang is an unenclosed continuation of the roof surface. Particularly on low-rise residential applications, overhangs may be open or covered by a soffit and may be cantilevered or supported. Most of the foundational belief about overhangs seems to suggest that overhangs extend no more than 2 feet, whereas, in Florida, overhangs are often much longer and are necessary for energy efficiency and livability in this semi-tropical climate. Overhangs in Florida can be cantilevered 6-ft or more, or supported, as on a terrace or porch, for 10 to 12 feet or more.

The American Society of Civil Engineers (ASCE) 7-16 Minimum Design Loads and Associated Criteria for Buildings and other Structures, as adopted by the Florida Building Code, provides methods for analysis of the loads on overhangs, both for main wind force resisting systems (MWFRS) and component and cladding (C&C) loads However, it has failed to provide any information as to the maximum length of overhang for which this analysis is valid.

In this research project, the Florida International University (FIU), Laboratory for Wind Engineering Research (LWER), Extreme Events Institute (EEI) (henceforth FIU LWER/EEI) shall conduct large scale wind tunnel testing at the Wall of Wind Experimental Facility (henceforth WOW-EF), necessary to clarify how the pressures on the wall relate to the overhang and for what distance, and at what point does the wall pressure cease to affect the overhang and the more direct wind loads on the overhang control, as though for an open building.

2. Scope of Work

Task 1 – Physical Testing Campaign

The objective of this task is to continue the work done under Phase I (funded by FBCC - Order B83FC1) which considered only a limited number of configurations for physical testing. An informal advisory board (IAB) was formed that included building code officials form Miami Dade, Coral Gables and Broward County, as well as representatives from two major truss manufacturing companies. The feedback that was received by IAB was very valuable in prioritizing overhang geometries that are most common in current construction industry. Moreover, current issues were identified and discussed, such as the wind-induced damage occurred on extended overhangs in Bahamas after Hurricane Dorian's passage (see Figure 1). The seed funding provided by FBC in Phase I was sufficient to carry out a thorough literature survey, test 2 large-scale model configurations at WOW-EF and analyze the acquired data for better understanding of the implication of the recent code changes. Nevertheless, the limited amount of testing cases will not allow us to proceed with a detailed codification process that can lead to potentially valuable design recommendation for enhancement of future wind standards and building codes of practice.

Figure 1. Aerial Footage of Great Guana Cay (Baker's Bay), Abaco after Dorian (retrieved on 2/26/2021 - https://www.youtube.com/watch?v=92PutXku0xU&feature=youtu.be)

Therefore, in Phase II we propose to expand the physical test model database and carry out a more detailed parametric study that will consider different construction methods and geometries used in low-rise building stock. Such parameters may include the roof type (e.g. overhang on a gable end

roof), overhang extension (e.g. cantilevered truss for areas that extend more than the 2 ft truss overhang such as a porch or terrace covering), soffit presence (see Figure 2) etc.

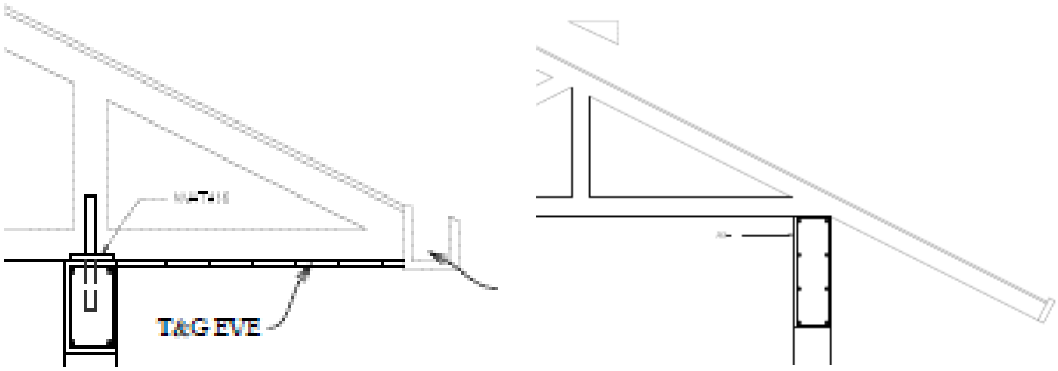

Figure 1. Structural detail of overhang with and without a soffit.

The anticipated actions within this task are the following:

- FIU LWER/EEI shall analyze the findings from Phase I and the feedback provided by IAB to develop the Phase II test campaign at the WOW-EF. A detailed description of the testing protocols and model parameters adopted in the WOW-EF tests shall be developed. The geometric parameters for the large-scale models that will need to be tested will include geometries that were not considered but reflect realistic configurations in practice and particularly in Florida. FIU LWER/EEI shall define all important flow field simulation parameters, including the upstream terrain characteristics, the wind speed and turbulence intensity profiles, the power spectrum and the WOW developed Partial Turbulence Simulation approach that is used in large-scale model studies. Last but not least, the necessary number of wind directions to be tested shall be defined for each model configuration.
- FIU LWER/EEI shall perform WOW tests to acquire wind-induced pressure data. A large enough number of pressure taps shall be included on each model to be tested, in order to provide a detailed depiction of the wind load applied on both upper and lower surfaces of the roof overhang. The pressure scanning equipment shall record wind pressure time histories at high sampling rate so as to identify the important, for codification purposes, peak pressure coefficients.

Task 2 – Data Interpretation and Codification

The objective of this task is to analyze the data collected during the Phase II experimental campaign at WOW and proceed with their interpretation is such format that can be utilized by the Florida Building Code as well as the ASCE 7 wind load committees.

- FIU LWER/EEI shall analyze the pressure data and present findings in a user-friendly format. This shall include upper/lower and net mean and peak pressure coefficient variation as a function of the wind direction, contour plots and area averaged pressure integration analysis.
- FIU LWER/EEI shall utilize the data from the experimental task towards the development of code-ready output by applying codification approaches worked successfully in the past. These consist of comparison, generalization and simplification of large quantities of data in order to produce simplified diagrams suitable for incorporation in building codes and wind standards. The area-averaging effect shall be assessed for the net pressures acting on the roof overhang by averaging the peak pressures experienced at increasing numbers of adjacent tap pairs and assigning them to their corresponding tributary area.
- FIU LWER/EEI shall compare the findings of the current research project to the ASCE 7-16 Wind Standard (also adopted by the Florida Building Code). Agreement and/or deviations from current design recommendations shall be identified and cases that are currently not considered shall be considered for future recommendation and code enhancement. FIU LWER/EEI shall evaluate the 2020 Florida Building Code (FBC) requirements to recommend what additional steps will be necessary to incorporate results of the proposed study into the appropriate sections of the FBC.

Task 4 – Publication of Database

- FIU LWER/EEI shall publish the obtained databases on DesignSafe-CI (https://www.designsafe-ci.org/). DesignSafe is the web-based research platform of the NSF-funded Natural Hazards Engineering Research Infrastructure (NHERI) Network that provides the computational tools needed to manage, analyze, and understand critical data for natural hazards research. A virtual session shall be organized through the DesignSafe platform to inform the natural hazards engineering community regarding the study's outcomes.

3. Staffing

Personnel

PI: Ioannis Zisis, Associate Professor, CEE, Florida International University, USA

Co-PI: Ted Stathopoulos, Professor, BCEE, Concordia University, Canada

Graduate Student: TBD, Florida International University, USA

4. Method of Payment

A purchase order will be issued to the Florida International University. This project shall start on date of execution of the purchase order and end at the midnight on July 31, 2022. This purchase order shall not exceed $85,000 and shall cover all costs for labor, materials and overhead. Payment will be made for the study after the Program Manager and the Florida Building Commission's Hurricane Research Advisory Committee have approved the final report. Additionally, the Contractor agrees to provide additional documentation requested by the Program Manager to satisfy all payment and audit requirements.

5. Deliverables

a. An interim report shall be prepared and delivered no later than February 28, 2022. The interim report shall contain the deliverables of Task 1 and any preliminary findings from Task 2; i.e. a detailed description of the testing protocols and model parameters adopted in the WOW-EF tests. In addition, the interim report shall be formally presented to the Florida Building Commission's Hurricane Research Advisory Committee at a time agreed to by the Contractor and Department's Program Manager. The due date may be extended with the approval of the Department of Business and Professional Regulation's ("Department") Program Manager.

b. A final report shall be prepared and delivered no later than July 31, 2022. The final report shall contain deliverables of the first three Tasks as discussed in Section 2. This shall include upper/lower and net mean and peak pressure coefficient results in different formats (e.g. function of wind direction, contour plots and area averaged), simplified diagrams suitable for incorporation in building codes and wind standards and recommendations that are necessary to incorporate results of the proposed study into the appropriate sections of the FBC. In addition, the final report shall be formally presented to the Commission's Hurricane Research Advisory Committee at a time agreed to by the Contractor and Department's Program Manager. The due date may be extended with the approval of the Department of Business and Professional Regulation's ("Department") Program Manager.

6. Financial Consequences

FIU LWER/EEI is solely responsible for the satisfactory performance of the tasks and completion of the deliverables as described in this Scope of Work. Failure to complete the tasks and deliverables in the time and manner specified in Sections 2 and 5, shall result in a non-payment of invoice until corrective action is completed as prescribed by the program or contract manager.

7. Program Manager

The Program Manager for this project is Mo Madani. Mo Madani's email address is Mo.Madani@myfloridalicense.com and his phone number is 850-717-1825.