

## ABSTRACT

Terrain is one of the most important parameters affecting wind loads on buildings. Current building codes such as ASCE 7-16 consider uniform upwind exposure to estimate the wind loads and recommend wind tunnel testing for complex upwind terrain. There is a need to understand the distribution of pressure on the buildings facing a nonuniform upwind terrain. This study aims to investigate the effect of heterogeneous simulation of terrain on wind characteristics and pressure in wind tunnel testing. The knowledge gap in our research, includes a) a limited number of tests of heterogeneous terrain, b) a limited number of tests on mid-rise models, c) dealing with the simulation of heterogeneous terrain in the wind tunnel tests, and also d) difficulties in producing the dataset for heterogeneous terrain will be addressed. In the first task we validated the wind tunnel testing. We also prepared a dataset of heterogeneous terrain using a deep neural network (task 2). In task 3, first, we investigated terrains with simple transitions and small openings. Then, using the results of the previous step and the heterogeneous terrain database, we performed a series of wind tunnel testing on the generic heterogeneous terrain. Analytical and computational models will also be developed to explain the observed terrain effects in task 4. In order to simulate the heterogeneous terrain, a staggered array of 1116 individually controlled roughness elements called Terraformer in the Boundary Layer Wind Tunnel Experimental Facility at the University of Florida was used. In this study, we proposed a Convolutional Neural Network that can classify images in a way it can be used in wind tunnel testing. Landsat-8 images and National Land Cover Database were introduced to the neural network as an unlabeled and labeled dataset, respectively. Unsupervised machine learning algorithms will be used to find representative images among all images in the dataset. Before testing the generic heterogeneous terrain configurations modeled after real terrain, we tested simple heterogeneous terrains. A series of testing has been performed in the wind tunnel to investigate the effect of simple nonuniform terrains such as smooth to rough change, rough to smooth change, and small opening fetch. In this testing, two different building models (low-rise and mid-rise) were located at the center of the turntable. The wind pressure was measured on the walls and the roof of the models using pressure taps connected to the Scanivalve ZOC33 pressure scanning system mounted under the turntable. The three wind speed components were also collected using Turbulent Flow Instrumentation Cobra Probes. The wind speed profile over simple nonuniform terrains was compared with known theories. Then, using the results of the

previous testing, and the heterogeneous terrain database in task 2, we performed a series of wind tunnel testing on the generic heterogeneous terrain. The results of wind speed profiles and pressure coefficient distribution in the wind tunnel tests were analyzed and compared for the nonuniform and uniform upwind terrain cases.