INFLUENCE OF SURROUNDING BOUNDARY WALLS ON THE EXTERNAL WIND PRESSURE OF A LOW-RISE GABLE-ROOFED BUILDING

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Department of Civil Engineering

University of Moratuwa

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DECLARATION

I hereby witness that this thesis represents my original research work conducted after registration for the degree of M.Sc. at the Department of Civil Engineering, University of Moratuwa. It has not been submitted elsewhere or for any degree or diploma and the collaborative contributions and previous work related to the current study have been stated and properly acknowledged.

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The above candidate has carried out research for the Masters under my supervision

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ABSTRACT

Low-rise structures are not often subjected to rigorous structural analysis, despite their omnipresence. Estimating wind loads on low buildings is moderately complicated compared to high-rise structures due to the effect of the roughness layer. Therefore, an accurate modelling sequence is required to obtain reliable results. Recent wind tunnel experiments revealed that the interference of surroundings affects the wind pressure characteristics in contrast to the isolated environment. Compared to large-scale objects, smaller objects have been given relatively less attention. One such example is a boundary wall that obstructs the wind flow, forming a wake behind. This research presents a detailed analysis of the effect of boundary walls on external pressure coefficients of low-rise gable-roofed buildings. Wind tunnel experiments were conducted on 1/50 scaled-down gable-roofed low-rise buildings. It was observed, the mean and peak pressure tend to decrease particularly near the perimeter zones at eaves' height in the presence of boundary walls. Moreover, a reduction was observed in the intensity of diagonal vortices formed along with oblique wind attacks. Interestingly, the boundary walls not only altered the magnitude of external pressure but also its variation, notably. The wind tunnel results were in good agreement with the performed CFD modelling. There it directs to revise current wind loading standards related to low-rise buildings, considering provisions on shielding effect in the presence of boundary walls.

Keywords: Low-rise gable-roofed building, Boundary wall, Wind tunnel test, External pressure coefficient

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LIST OF ABBREVIATIONS

$\overline{C_P}$ – Mean pressure coefficient

$\overset{\frown}{C_P}$ – Maximum pressure coefficient

$\overset{\smile}{C_P}$ – Minimum pressure coefficient

$C_{\sigma P}$– RMS pressure coefficient

ABL – Atmospheric Boundary Layer

CFD – Computational Fluid Dynamics

GEV – Generalized Extreme Value

EV – Extreme Value

ACC – Auto Correlation Coefficient

LES – Large Eddy Simulation

RANS – Reynolds Averaged Navier Stokes

FS – Full Scale

DAD – Database Assist Design

WOW – Wall of Wind

ASCE- American Society of Civil Engineers

TTU- Texas Tech University

TPU- Tokyo Polytechnic University

ASHRAE-American Society of Heating, Refrigeration and Air-conditioning Engineers

NIST- National Institute of Standards and Technology

BM- Base Model (Without Boundary walls)

BW1- Boundary Wall 01

BW2- Boundary Wall 02

BW3- Boundary Wall 03

Re – Reynolds Number

Gu- Gust Effect Factor

I_{uu} – Longitudinal Turbulence Intensity

I_{vv} – Lateral Turbulence Intensity

I_{ww} – Vertical Turbulence Intensity

Z_G – Gradient Height

ME – Mean Error

MAE – Mean Absolute Error

RMSE – Root Mean Square Error

R^2 – Coefficient of Determination

R – Coefficient of Correlation (Pearson Correlation Coefficient)

SI – Scatter Index

AIC –Akaike Information Criteria

C_s – Sand grain roughness

UDF – User Defined Function

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