Comparison of Pressures on Flat Roof Buildings Using ASCE 7-05 and Numerical Simulation.

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Abstract

In this study wind pressure generated over roofs and walls of flat roof buildings during a hurricane is simulated using finite element methods and the compared with the ASCE 7-05. The results obtained through the numerical simulation were higher than the results obtained using ASCE 7-05.

1. Introduction

Hurricanes are formed when a well set of revolving winds anti clock wise in the northern hemisphere develop over tropical waters, and are categorized into five types based on Saffir Simpson scale. One of the most important natural effects that must be taken in to account for the design of low rise structures is wind forces especially in hurricane prone areas. In Gulf of Mexico region most of the structure built along costal area can be categorized as low rise buildings used for commercial, residential, industrial and other purposes. In actual wind forces on buildings may fluctuate with time but for most of the structures dynamic effect is small, therefore the wind load is treated as lateral static loads. Wind forces on the buildings are taken to be as acting perpendicular to the building walls and roofs. Both wind pressure on wind ward side and the wind suction on leeward side must be taken in to account. Especially wind suction on the roof creates a serious problem due to light weight of the structure if the roof frame members are not tied to the main building properly. The magnitude of wind pressure and suction depends upon a comprehensive relationship between wind speed, air mass density, building geometry, building dimensions, building stiffness, orientation, location, surrounding area and some other factors

2. Objective

.The objective of this study was to quantify the wind loads on buildings using ASCE 7-05 and compare these results with the numerical simulation using computational fluid dynamics (CFD) with finite element methods.

3. Analyses

Three flat roof buildings of different dimensions were considered for the analyses. These buildings belongs to type II structural category with exposure category C (According to ASCE 7 -05) of dimensions 60 ft. x 30 ft. x 15 ft. (Model--A), 60 ft.x30 ft.x20 ft. (Model--B), 60 ft.x30 ft.x30 ft.(Model--C) (L, B and H). The wind speed was taken as 130 mph and the type of the building was assumed to be totally enclosed. Three flat roof buildings with varying heights were analyzed using ASCE 7-05 and corresponding pressures on roofs and walls are determined in both directions (i.e. wind parallel and perpendicular to ridge), and same models were used for the numerical simulation using finite element methods to predict the corresponding pressures on roofs and walls.

4. Discussions

From the analysis results using ASCE 07 the pressures on the wind ward side wall and roof were maximum for Model--C and minimum for Model--A, the positive pressures indicate towards the structure and negative pressure indicates away from the structure. When wind is blowing perpendicular to the ridge for Model--A the windward side wall pressures was +34.50 psf and pressures on the roof varied with the length of roof from -29.50 psf (Cp = -0.90) to -18.89 psf (Cp = -0.50) and when wind was blowing parallel to ridge the corresponding windward wall pressure is +29.19 psf and roof pressures varies from -29.5 psf (Cp = -0.90) to -13.58 psf (Cp = -0.30). For model B the when wind is blowing perpendicular to ridge the windward side wall pressures are +36.65 psf and roof pressures varies from -32.66 psf (Cp = -0.95) to -21.95 psf (Cp= -0.57), when wind is blowing parallel to ridge the windward side wall pressures are +31.01 psf and roof pressures varies from -31.34 psf (Cp = -0.90) to -14.43 psf (Cp = -0.30). Similarly for model C when wind is blowing perpendicular to ridge the windward side wall pressures are +39.91 psf and roof pressures varies from -38.43 psf (Cp = -1.04) to -27.99 psf (Cp= -0.70), when wind is blowing parallel to ridge the windward side wall pressures are +33.77 psf and roof pressures varies from -34.14 psf (Cp = -0.90) to -15.71 psf (Cp = -0.30). While from the Numerical simulation the wall pressures and roof pressures on all the models were higher than the results obtained from ASCE 07. Plots were drawn for wall pressures and roof pressures with height of the structure for both types of analysis and compared (shown in Fig.1 and Fig.2).

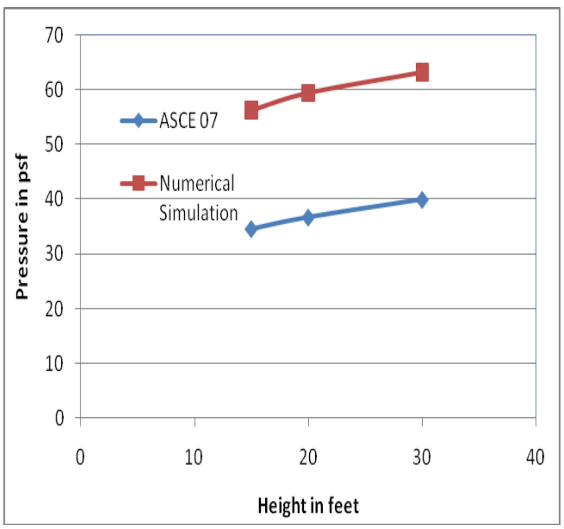

Fig.1 Comparison Wind ward wall pressure

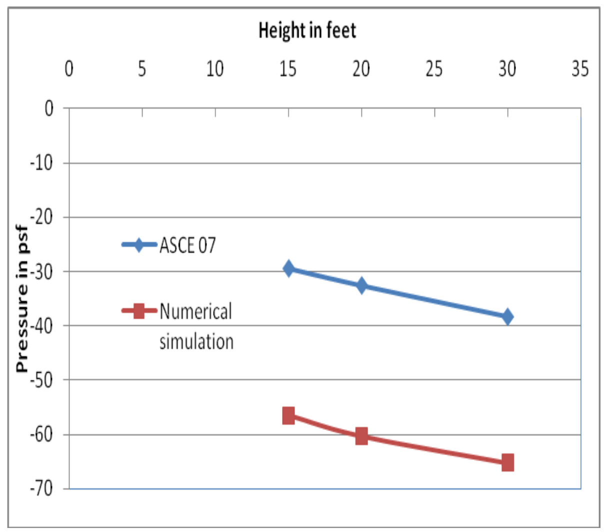

Fig.2 Comparison of Roof pressures

5. Conclusions

Based on the study it was noted that there was an increase in wall and roof pressures (flat roof structure) with increase in height in both numerical simulation and analysis through ASCE 7-05. The results obtained from numerical simulation using finite elements were higher than the results obtained from ASCE 7-05.

6. Acknowledgement

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7. References

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