

Wind Pressure Distribution on Triangular Shape Tall Buildings

Muftha Ahmed Abdusemed¹, Ashok Kumar Ahuja²Research Student, Department of Civil Engineering, Indian Institute of Technology, Roorkee, India¹Professor, Department of Civil Engineering, Indian Institute of Technology, Roorkee, India²

ABSTRACT: Present paper describes the details of experimental study carried out on the model of triangular shape tall building under stand-alone condition. Pressure measurements are made on rigid model of tall building made of Perspex sheet at many pressure points. The model is tested in an open circuit boundary layer wind tunnel. The experimental results of pressure measurements are reported in the form of contours of mean wind pressure coefficients for three wind incidence angles. Cross-sectional variation of mean pressure coefficients are also given at two sections of the model for six wind incidence angles.

KEYWORDS: Tall Buildings, Wind Incidence Angle, Wind Pressure Coefficients, Contour Plot, Cross-sectional Variation.

I. INTRODUCTION

The design of tall buildings is mainly governed by wind loads. Wind loads acting on tall buildings considered for design can be predicted referring to the relevant code of practices of various countries dealing with wind loads [ASCE:7-02 (2002), AS/NZS:1170.2 (2002), BS-EN 1991-1-4 (2005), IS:875-Part 3 (1987)]. However, these standards provide limited information about overall wind force on triangular shape buildings. Further, no information on wind pressure distribution on different surfaces of triangular shape tall buildings is available which is important for design of claddings and their connections.

Balendra and Nathan (1988) reported along-wind, across-wind and torsional fluctuating responses of tall triangular building in wind tunnel at various angle of incidence of wind. Hayashida and Iwasa (1990) presented the experimental results of aerodynamic forces and displacement response for tall triangular building. Beneke and Kwoke (1993) also reported wind induced torsion on tall triangular building. Although few such publications are available, no information is available on wind pressure distribution in recent research work. Therefore to fill the gap on data base, the authors have carried out experimental study on the models of triangular shape tall building to obtain wind pressure distribution on surfaces of building.

II. MATERIALS AND METHODS

A. Model description

The prototype tall building considered in this study is equilateral-triangular shape having floor area about 625m² (38m side) and building height about 100m (30 storeys with ground floor height as 4.3m and other storeys height as 3.3m). Pressure measurements are made on rigid model of triangular shape tall building made of Perspex sheet at a scale of 1:200. The dimensions of this model are shown in Fig. 1. Thirty-five pressure points are made on each surface of Perspex sheet model for measurement of wind pressures (Fig. 2).

B. Wind flow characteristics

In the present study, the models are tested in an open circuit boundary layer wind tunnel with a cross-section of 2m x 2m and the length of the test section of 15m. Flow roughing devices such as vortex generators, barrier wall, cubical

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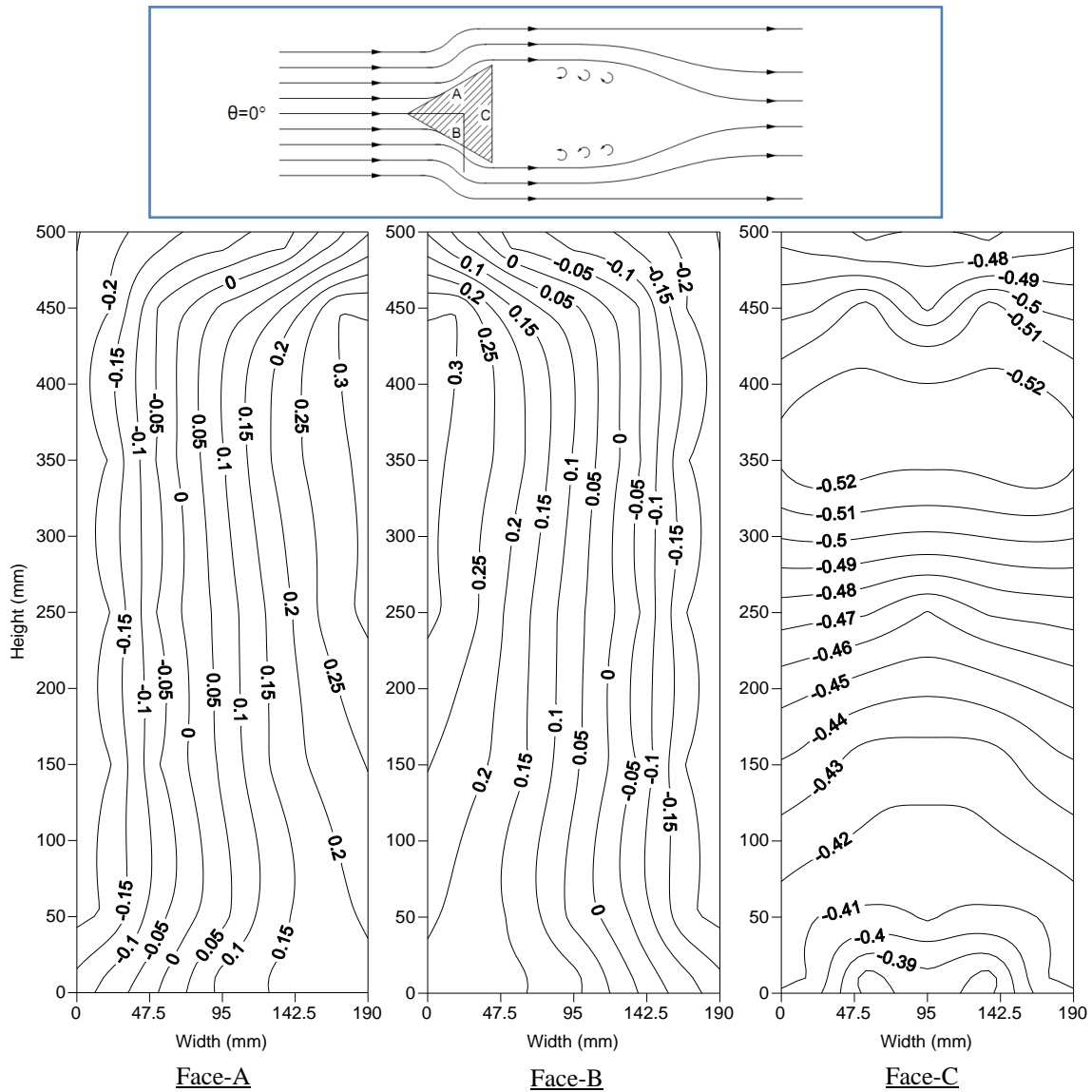


Fig. 4: Mean pressure coefficients, C_p on faces of model at 0° wind incidence angle

It is seen from Fig. 4 that when wind hits one of the edges of the model, windward surfaces (Face-A and Face-B) are subjected to pressure although of small magnitude and partly subjected to suction at furthest edge. Leeward surface (Face-C) is subjected to uniform suction over the entire surface.

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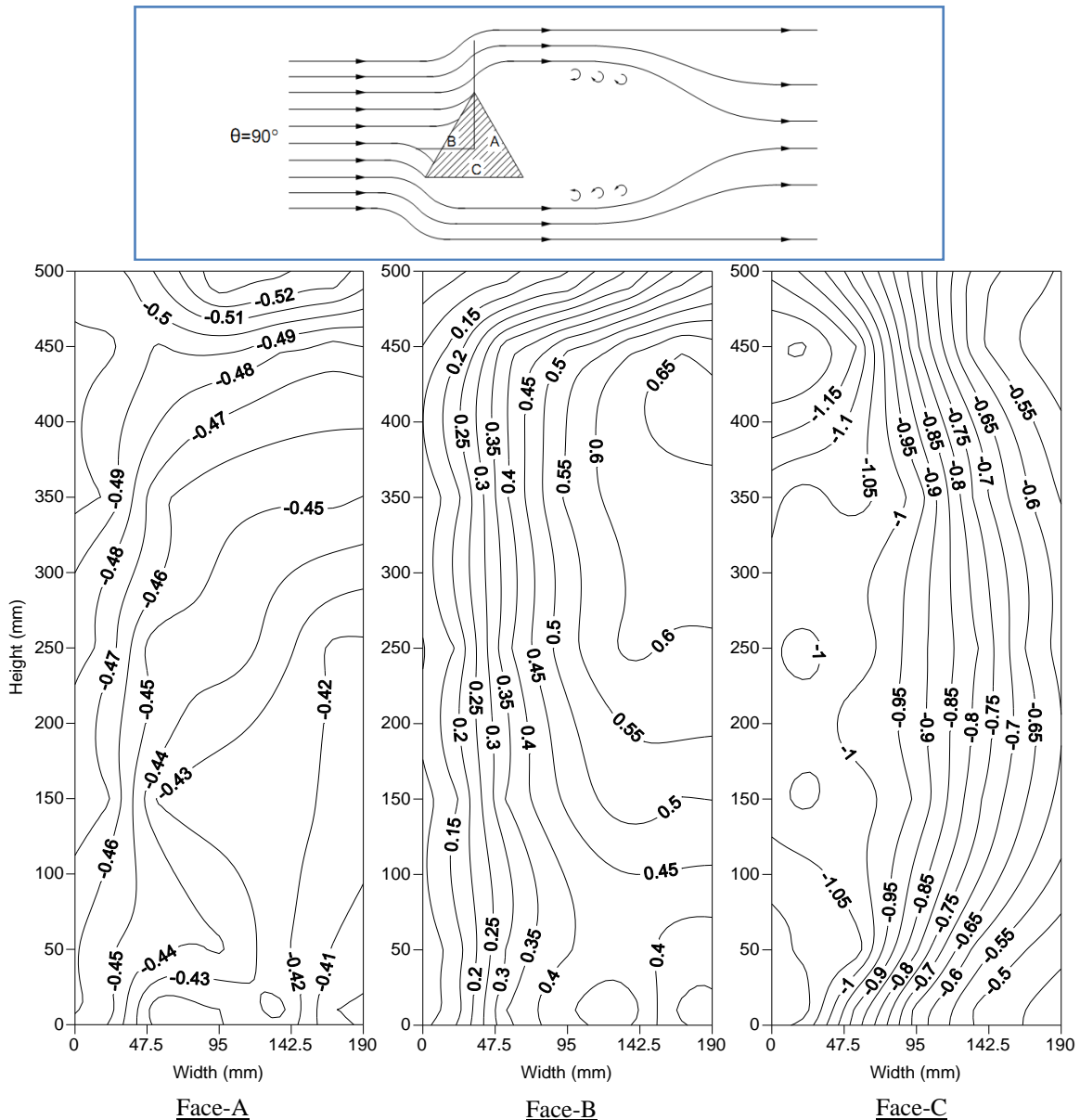


Fig. 5: Mean pressure coefficients, C_p on faces of model at 90° wind incidence angle

At 90° wind incidence angle (Fig. 5), front surface (Face-B) is subjected to varying pressure with maximum C_p of 0.65; leeward surface (Face-A) is subjected to varying suction with minimum C_p of -0.53; and the side face (Face-C) is subjected to varying suction with minimum C_p of -1.25.

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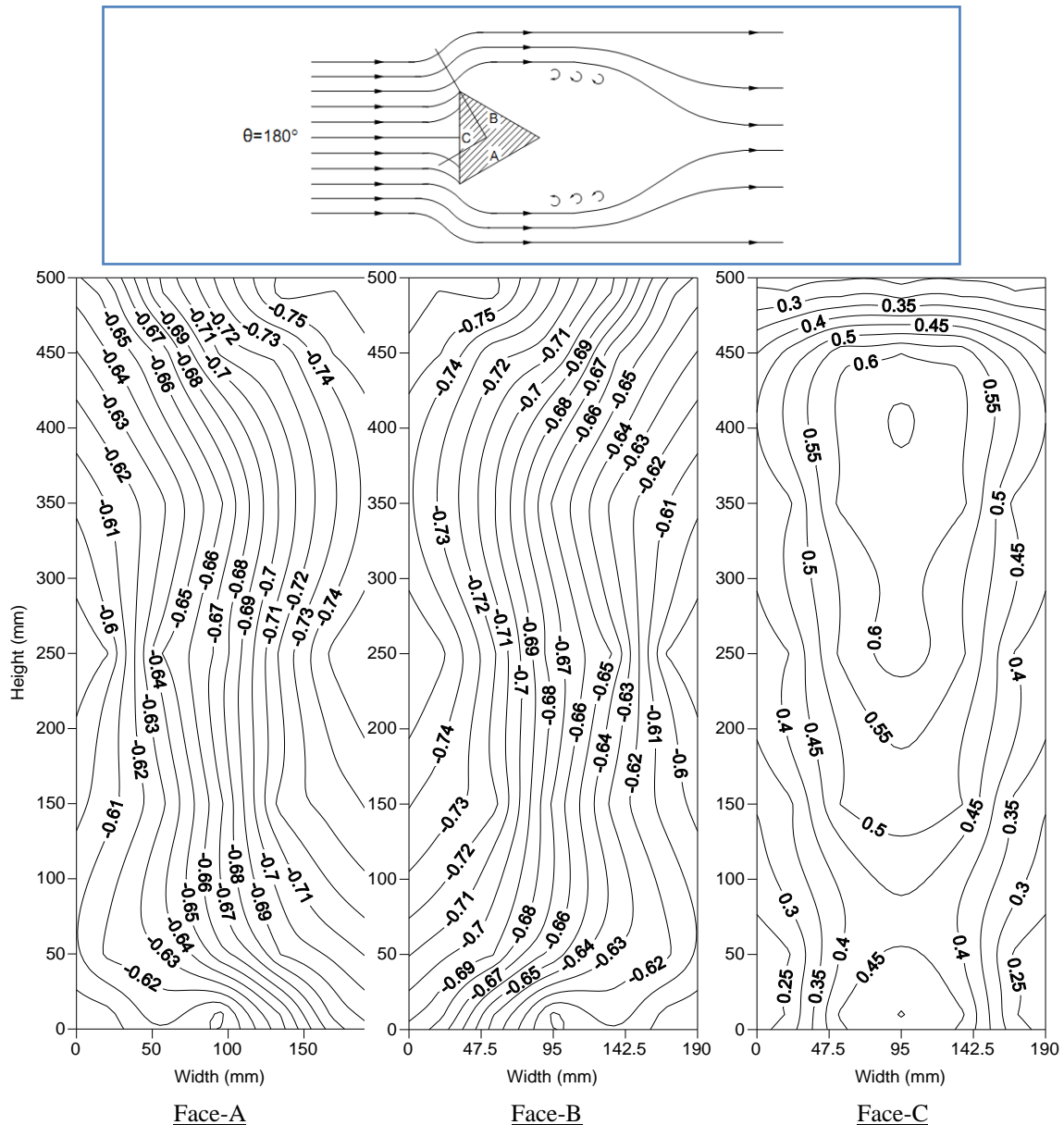


Fig. 6: Mean pressure coefficients, C_p on faces of model at 180° wind incidence angle

At 180° wind incidence angle (Fig. 6), leeward surfaces (Face-A and Face-B) are subjected to varying suction with minimum C_p of -0.76; and windward surface (Face-C) is subjected to pressure with maximum C_p of 0.65.

Higher suction and pressure are generally found near the top windward edge of surfaces of model when wind blows parallel to one of the faces. In this study, the minimum suction found near the top windward edge of side face is about -1.25 and the maximum pressure found near the top windward edge of front face is about 0.65.

Cross-sectional variation of mean wind pressure coefficients (C_p) at horizontal sections 50mm and 250mm from top of the model for 6 different wind incidence angles are shown in Figs. 7-8.

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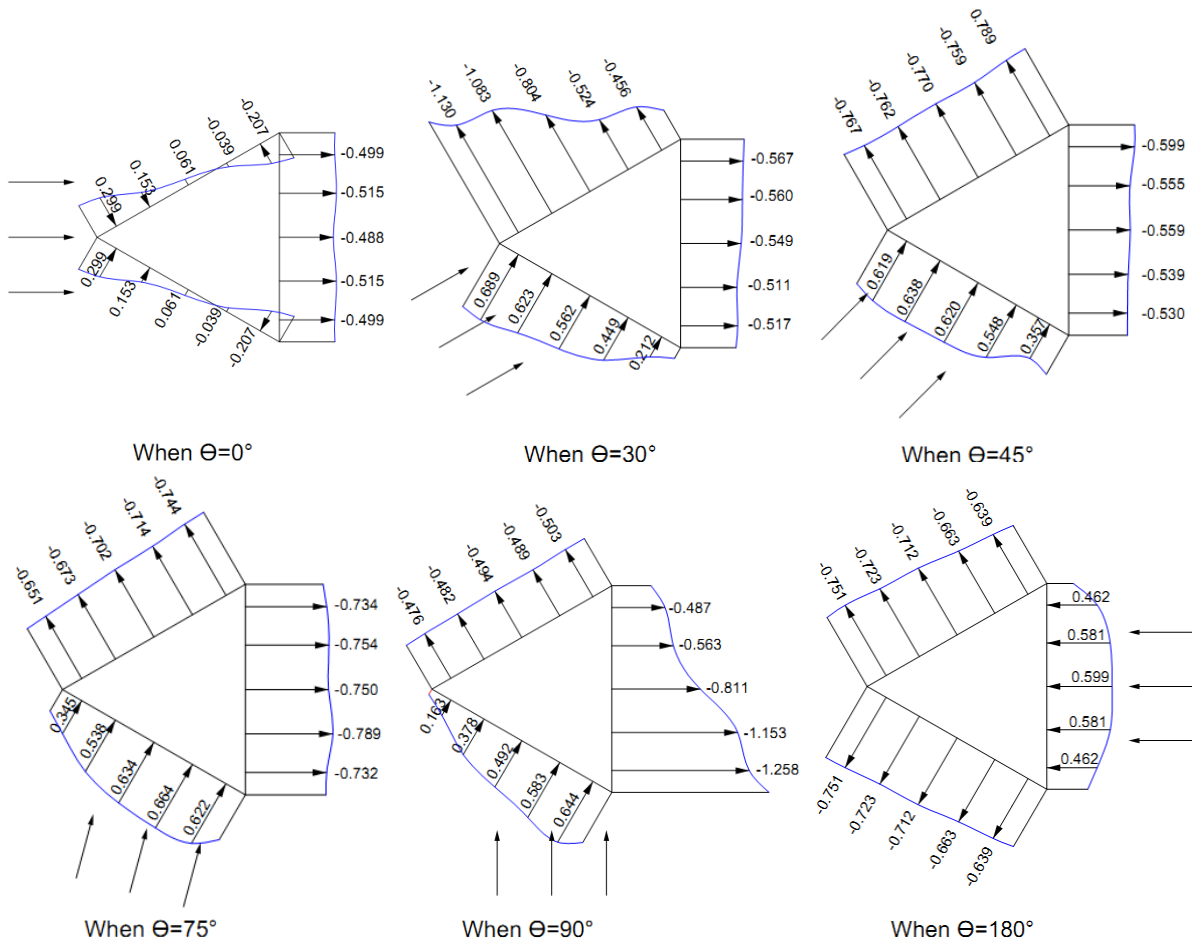
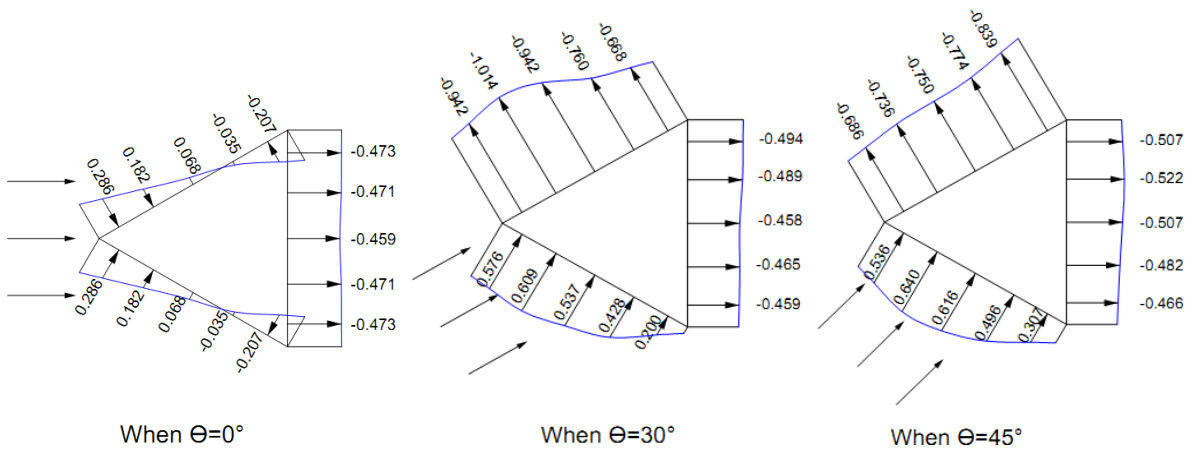


Fig. 7: Variation of mean pressure coefficient, C_p at section 50mm from top of model



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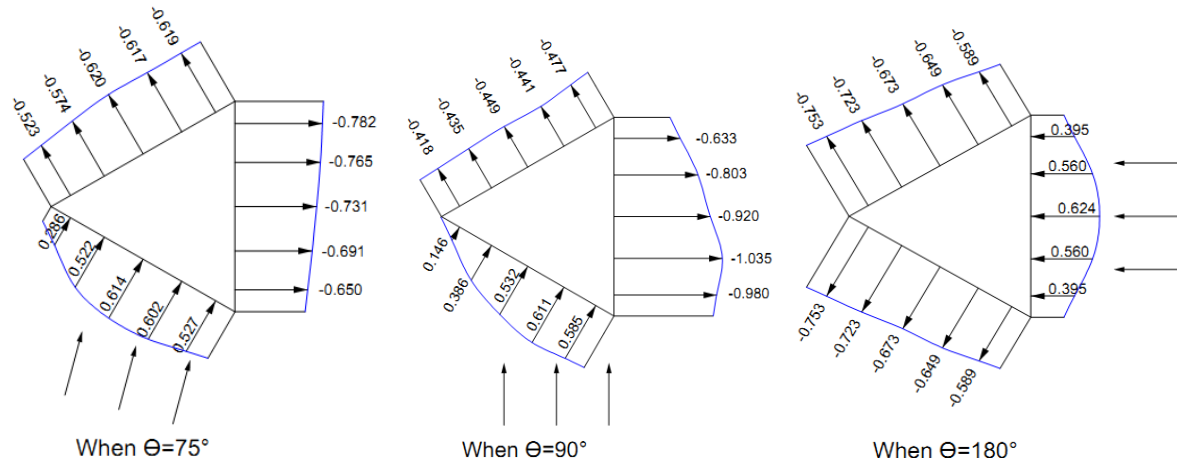


Fig. 8: Variation of mean pressure coefficient, C_p at section 250mm from top of model

It is seen that depending upon the direction of wind, surfaces may be subjected to very high suction at times. These values are important to be used by the designers while designing glass cladding and its fixtures. Minimum pressure coefficient (C_p) less than -1.0 is obtained at 90° and 30° wind incidence angles when wind blows parallel to one of the faces.

IV. CONCLUSIONS

The following conclusions are drawn from the study presented in this paper.

1. Absolute maximum and minimum pressures occur on triangular shape model when wind blows parallel to one of the faces. Maximum pressure coefficient of +0.65 is observed at a point on windward face and minimum pressure coefficient of -1.25 is observed at a point on the face parallel to wind near windward edge.
2. Minimum pressure coefficient (C_p) less than -1.0 is obtained at 90° and 30° wind incidence angles when wind blows parallel to one of the faces.
3. The wind pressure distribution on the surface of triangular shape model is found to depend on the direction of wind.

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REFERENCES

- [1] ASCE: 7-02, "Minimum Design Loads for Buildings and Other Structures", 2002.
- [2] AS/NZS: 1170.2, "Structural Design Actions, Part 2 - Wind Actions", 2002.
- [3] Balendra, T. and Nathan, G.K., "Dynamic Response of a Triangular Building Model in an Atmospheric Boundary Layer", Journal of Wind Engineering and Industrial Aerodynamics, Vol. 31, pp. 29-39, 1988.
- [4] Beneke, D.L. and Kwoke, K.C.S., "Aero-dynamic Effect of Wind Induced Torsion on Tall Buildings", Journal of Wind Engineering and Industrial Aerodynamics, Vol. 50, pp. 271-280, 1993.
- [5] BS-EN 1991-1-4, "Euro code 1: Actions on Structures – Wind Actions", 2005.
- [6] Hayashida, H. and Iwasa, Y., "Aerodynamic Shape Effects of Tall Building for Vortex Induced Vibration", Journal of Wind Engineering and Industrial Aerodynamics, Vol. 33, pp. 237-242, 1990.
- [7] IS: 875-Part 3, "Code of practice for the design loads (other than earthquake) for buildings and structures (Part 3, wind loads)", New Delhi, India, 1987.

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BIOGRAPHY



Muftha A. Abdusemed, B.Sc. (Civil) 1990, M.Tech. (Structural Engg) 1996, currently Ph.D. Research Student in the Dept. of Civil Engg., IIT-Roorkee;



Ashok K. Ahuja, B.E. (Civil) 1976, M.E. (1979), Ph.D. (1990), Professor of Civil Engg at IIT-Roorkee;