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Investigation of the External Pressure Coefficients on the Facade of the Triangular High-Rise Structure with Curved Corners

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Abstract

The paper deals with the analysis of external pressure coefficients on the facade of high-rise building structure. The structure has shape of a triangle with curved corners. Analysis was performed mainly as an experimental study carried out in boundary layer wind tunnel. Second approach was performed by numerical simulation of wind flow using computational fluid dynamics (CFD) software module ANSYS CFX based on the Finite Volume Method. One of these experimental results was compared with numerical simulation to prove precision and verification of computational analysis. Both methods used scaled model of the structure. For the wind tunnel experiment, 31 points of interests around an object were monitored in steady wind flow and from those points, results of external pressure coefficients from 6 directions of wind flow were obtained.

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Keywords: Wind Tunnel; CFD Simulation; Pressure Coefficient; High-rise Building; Wind Load.

1. Introduction

The principal idea of this article is to present methods of analysis of structures loaded by wind. An irregular cross-section of the building is a matter of interest here. The standard Eurocode 1 [1] does not mention recommendations for calculation of wind pressure and wind forces coefficients for the cases of buildings having an irregular cross-section – irregular triangle with rounded corners. Only the solutions for buildings having rectangular and circular cross sections have been presented in the mentioned standard. Simplistically, it is possible to divide such a structure to combination of circles and a rectangle [2], however, results would be distorted. This article presents the design calculations for the specific building. There are several possibilities, how to calculate or obtain necessary variables for structural engineering purposes. Experimental measurements obtained in boundary layer wind tunnel are ideal,

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when precise result of some basic variable in a particular point is needed. However experiments are mostly limited with number of sampling points where variables are measured on an object. When scaled model is created without any computational wind flow simulation (CFD), it is hard to tell where the sampling points should be and where we expect some local peak values. Another problem is that pressure distribution around an object can be slightly different between scaled model and real size structure because of Reynolds number [3] and other aerodynamics characteristics of an air flow. In this paper, pressure distribution (pressure coefficient) around a mentioned object will be shown, where six main directions of wind flow will be analyzed. For comparison of experimentally measured pressures with those, calculated by CFD software, one wind flow direction will be simulated and results of both methods will be shown below.

1.1. Analyzed structure

Let us present an example of the analysis: a high-rise structure was considered (see Fig. 1) having a shape of an irregular triangle with rounded corners. The building's width is 40.08 m, the perpendicular dimension is 29.15 m. In the center of building there is a reinforcing core containing elevator shafts and stairways. From the central core, walls diverge towards the building facade. Thickness of wall is from 200 to 300 mm, varying along the height of the building, ceilings are 200 mm thick. The building has 27 floors (25 above ground, 2 underground floors).

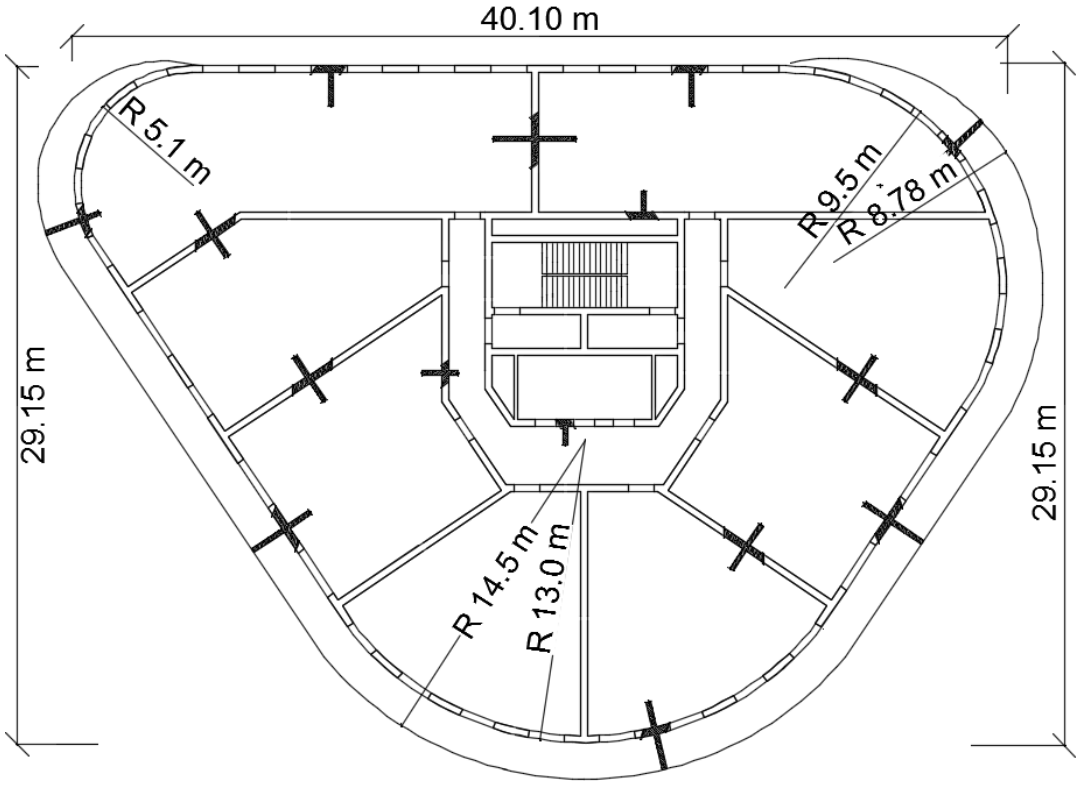

Fig. 1. Floor plan of an analyzed high–rise building.