Methodology of Wind Tunnel Investigation of Buildings

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Introduction

The aerodynamics plays an important role in architecture and must be taken into account in design of a building geometry and its internal structure. Dynamic air flows when hitting the surface of buildings cause a number of phenomena, which are essential to the comfort of utilizing buildings and urban spaces. They also harbor potential for ventilating cities, their sections and individual buildings, as well as the use of wind energy (Zielonko-Jung, [1]).

Goals of aerodynamic investigation of buildings

In general, aerodynamic investigations may concern a single building or a complex of buildings. In the latter case, e.g. the area in an urbanistic scale (a town, a district of town etc.) can be investigated to assess the ventilating of the town. Another example is obtaining the wind comfort on the estate or around a newly created building. A common point of these investigation is that they are focused on the flow around investigated building.

In a second group of investigations, researchers are focused on the building itself, not on the flow around it. Examples of this approach are e.g.

- determination of loads acting on an elevation or a structure of investigated building;
- investigation of ways of natural ventilation of building (i.e. forming its shape to ease outflow of polluted air from proximity of the building);
- forming the building geometry to increase efficiency of wind turbines placed on it;
- analysis of dynamic phenomena of tall buildings (e.g. galloping)

Despite the investigated building is the main object of interests, it should not be separated from its surrounding. A reason is that buildings in proximity of investigated one influences on the flow both in qualitative and quantitative way.

Aerodynamic loads are also dependent on the wind velocity profile, i.e. the profile of airflow velocity in the boundary layer of Earth. Due to it, modelling of velocity profile is a crucial thing for obtaining loads acting on the elevation or aerodynamic phenomena in the flow around the building. The velocity profile is determined in Eurokod 1 norm (PN-EN 1991-1-4:2008, [2]) and in its national appendices,

as a function of i.a. geographical location, wind direction, type of surrounding terrain (like an open terrain, a city with tall buildings etc.) and its shape.

Commonly used investigation methods

The goal of investigation determines investigation methods, which may be used. For example, the smoke flow visualisation may be utilized to obtain flow pathlines and vortices in the space between buildings, it is also helpful to analyse a ventilation of building or a city. In general, methods of flow visualisation are applied more often in flow-focused investigations, while building-focused investigations requires qualitative measurements, like pressure distribution methods or HFBI (High Frequency Balance Investigation) method [3]. The latter method is utilised in investigation of elastic models of tall buildings, which are essential to analyse aeroelastic phenomena, like galloping of the building (i.e. a transverse oscillations of some structures due to the development of aerodynamic forces which are in phase with the motion [4]). However, in many cases both qualitative and quantitative methods should be applied simultaneously to better understand investigated aspect. An example of such approach is the wind comfort analysis, i.e. localizing areas of increased wind speed, which is greater then a boundary of wind discomfort (i.e. when in behaviour of pedestrians appears a tendency of protect themselves from wind [5], [6]). It obviously mean that the wind speed on the level of ground (in pedestrian area) must be obtained not only in qualitative, but also in quantitative way. Most methods, like CTA measurement or usage of Irwin probes, enable measurement in single points only. However, some techniques of measurement wind speed in wide area are developed.

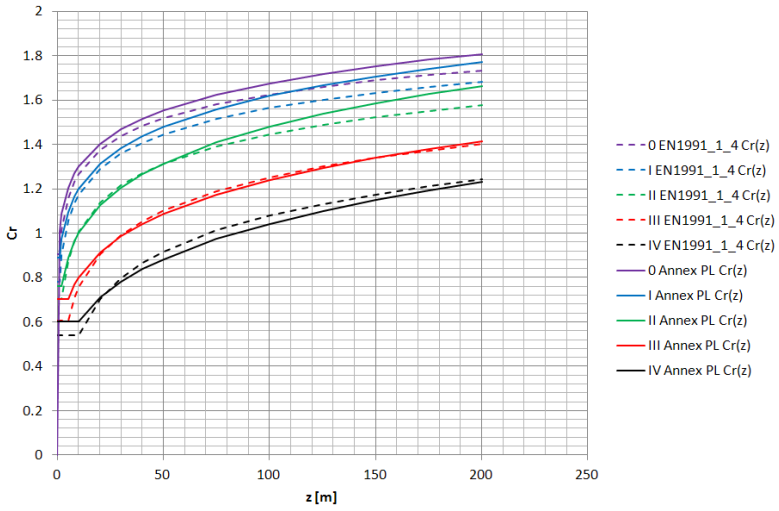

Figure 1: Wind velocity profiles according to [2]

Figure 1: Irwin probe.

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