XX Fluid Mechanics Conference KKMP2012,
Gliwice, 17-20 September 2012

REDUCTION OF WIND TUNNEL TURBULENCE INTENSITY LEVEL BY INSTALLATION OF A HONEYCOMB STRAIGHTENER - CFD SIMULATION VS EXPERIMENT

Michał KULAK[1], Krzysztof OLASEK[2], Maciej KARCZEWSKI[3]
1,2,3 Institute of Turbomachinery, Technical University of Łódź, Poland;
E-mail: michal.kulak@edu.p.lodz.pl, krzysztof.olasek@edu.p.lodz.pl

Key words: Computational Fluid Dynamics (CFD), Wind Tunnel, Honeycomb, Turbulence, Flow Stabilisation

Although CFD solvers can alone be used for complex 3D flow field analysis, their integration with an experiment is necessary for results validation. This approach allows to combine the robustness and possibilities of CFD with an accuracy of wind tunnel tests.

Having a newly upgraded wind tunnel in the Institute of Turbomachinery (IMP) at the Technical University of Łódź (TUL), a series of CFD simulations has been performed in order to indicate the areas of possible flow quality improvement. One of the objectives was to minimize the turbulence intensity with the lowest possible pressure loss. The main reason of diminishing the flow velocity disturbances is the need for ensuring a good flow quality, well representing real life conditions modeled in the wind tunnel experiment. It is also required in order to perform the PIV experiment (PIV wind tunnel stand is under development at TUL). The initial measurements of turbulence intensity have indicated the level of turbulence equal to 2.2% for maximum flow velocity (Fig.1), whereas worldwide standard for this parameter measured in wind tunnel test section should be within the range of 0.1%÷0.5%.

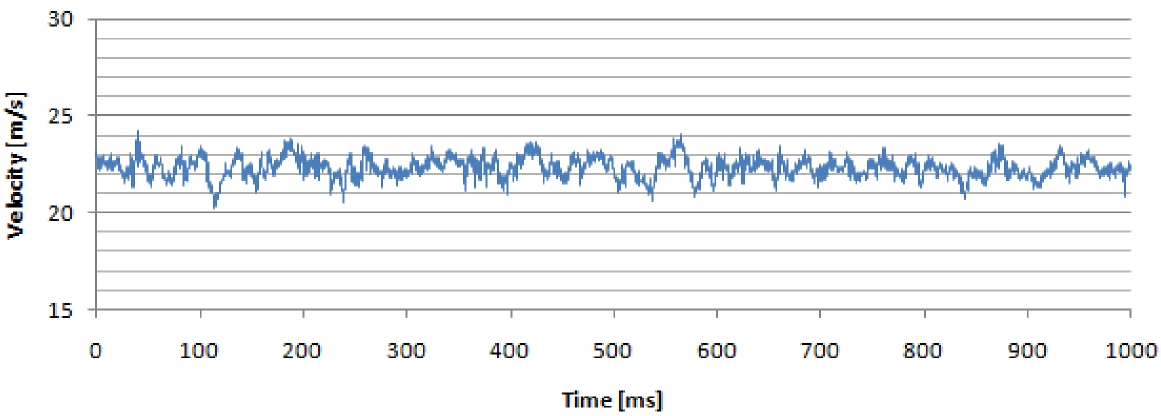

Fig.1 Velocity fluctuations measured with the hot wire probe by means of constant temperature anemometry (CTA) - example of measurement taken at the point downstream wind tunnel outlet

There are two main methods of turbulence damping: reduction grids and honeycombs (Scheiman et al., 1981). Due to the fact that the tunnel was already equipped with flow stabilization section containing two mesh-wired screens (reducing mainly axial velocity fluctuations) it was decided to introduce the honeycomb section in order to diminish the lateral turbulence intensity. Most of design aspects of honeycomb structure were based on the results of CFD simulations mentioned in the literature (Kulkarni et al., 2011). It is believed that application of the honeycomb structure (having optimum length to diameter ratio *l/d* of the cell) with a combination of existing screens should decrease the level of turbulence significantly. Honeycomb structure and schemes of various constructions are presented in Fig.2. Version presented as b) was implemented in IMP WT. Additionally, CFD simulations were performed in order to gain information about the level of turbulence reduction and the associated pressure loss.

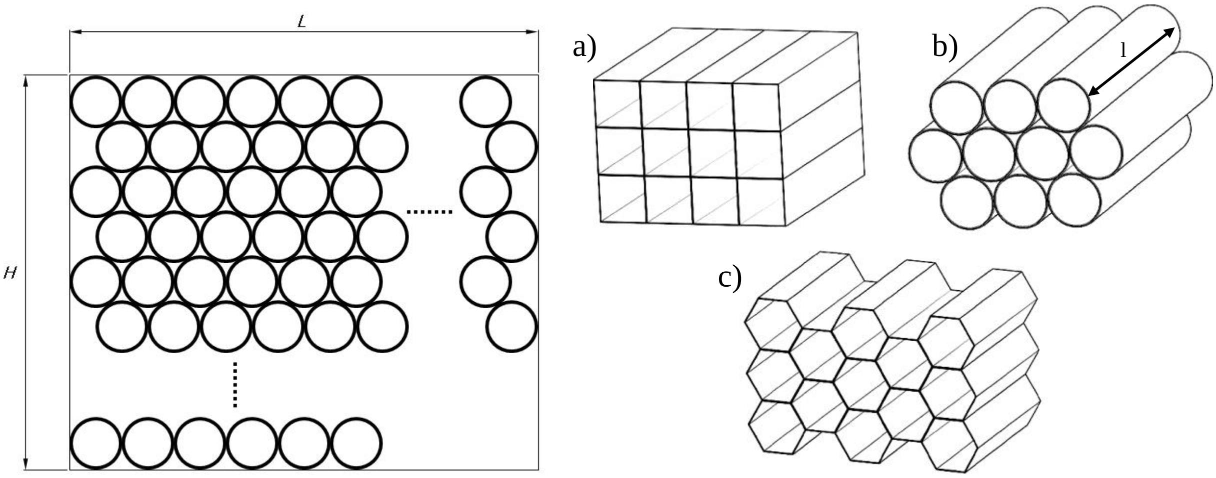

Fig.2 Honeycomb structure and different possibilities of construction

The paper presents results from both: the measurements of turbulence intensity and pressure loss before and after the installation of the honeycomb in the IMP wind tunnel, as well as the associated simulation results conducted for a WT model (virtual WT) in ANSYS CFX 13.0.

References:

Kulkarni V., Sahoo N. and Chavan S. D., (2011) *Simulation of honeycomb-screen combinations for turbulence management in a subsonic wind tunnel,* Journal of Wind Engineering and Industrial Aerodynamics, 99(1), pp. 37-45

Scheiman J. and Brooks J. D., (1981) *Comparison of Experimental and Theoretical Turbulence Reduction from Screens, Honeycomb, and Honeycomb-Screen Combinations*, Journal of Aircraft, Vol. 18, no.8