Program: RFEM 5, RWIND Simulation

Category: Fluid Mechanics

Verification Example: 0305 – Wind pressure loads on buildings in tandem arrangement

0305 – Wind pressure loads on buildings in tandem arrangement

Description

The verification example describes pressure loads on the walls of buildings in tandem arrangment located at ground level. Buildings are simplified to rectangular objects and scaled down while maintaining elevation ratios. The pressure distribution on the walls of the model of a medium-high building was conducted by experiment [1 and 2]. Experimental set-up is presented in **Figure 1** which is a configuration for simulation. The pressure was mesured along lines around the buldings, in simulation called line probes.

Fluid Properties	Kinematic Viscosity	ν	$1.5 \cdot 10^{-5}$	m^2/s
	Density	ρ	1.250	kg/m^3
Model Parameters	Width of buildings	B	40.000	mm
	Width of street	S	60.000	mm
	Hight of bulding 1	H_1	57.600	mm
	Hight of bulding 2	H_2	96.000	mm

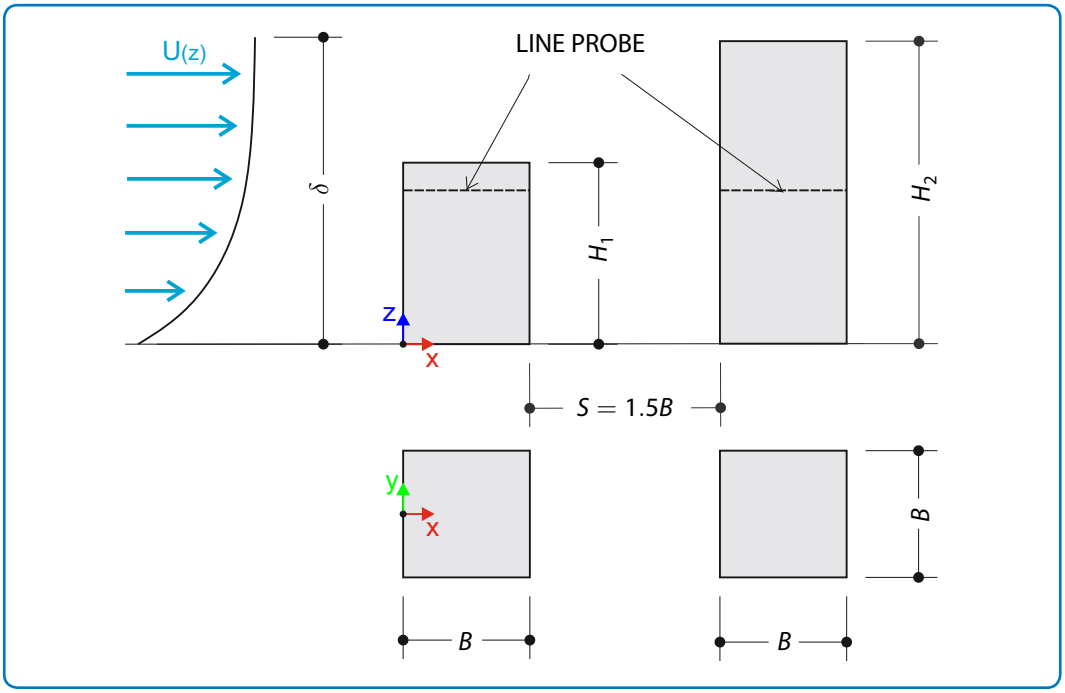

Figure 1: Problem sketch

The relationship between the geometrical parameters of both objects are $S/B = 1.5$ and the ratio of heights $H_1/H_2 = 0.6$. The line probes are placed at the height $0.925H_1$.

RWIND Simulation Settings

- Modeled in RWIND Simulation 1.25
- Model of turbulence: $k-\omega$ with intensity of turbulence $I = 6$
- Finite volume mesh with density 30% and boundary layers $NL = 10$
- Consider wall roughness: $Ks = 0.002$ m and $Cs = 0.5$

The vertical mean wind flow velocity profile is represented by an empirical power-law function with exponent $\alpha = 0.16$.

$$\frac{U}{U_0} = \left(\frac{z}{\delta}\right)^{\alpha}, \qquad (305-1)$$

where U is the mean velocity and U_0 is the free stream velocity at the height δ on the z-axis. Power-law profile is based on measured velocity profile, it represents inicident flow condition, they can be seen in **Figure 2**.

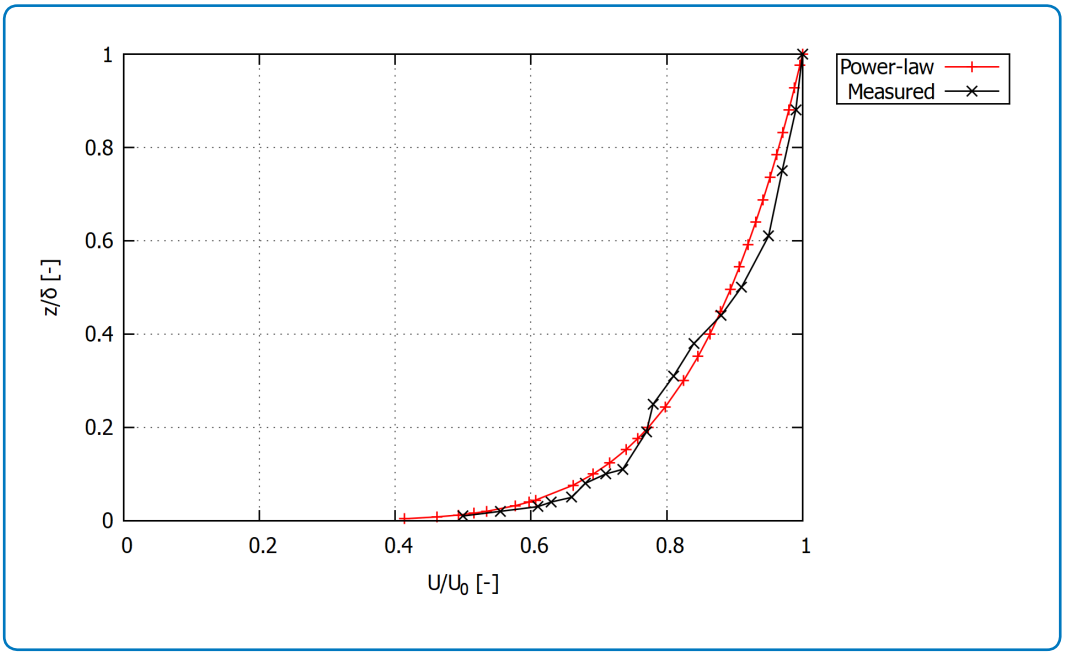

Figure 2: Velocity profile

Results

Structure Files	Program
0305.01	RWIND Simulation

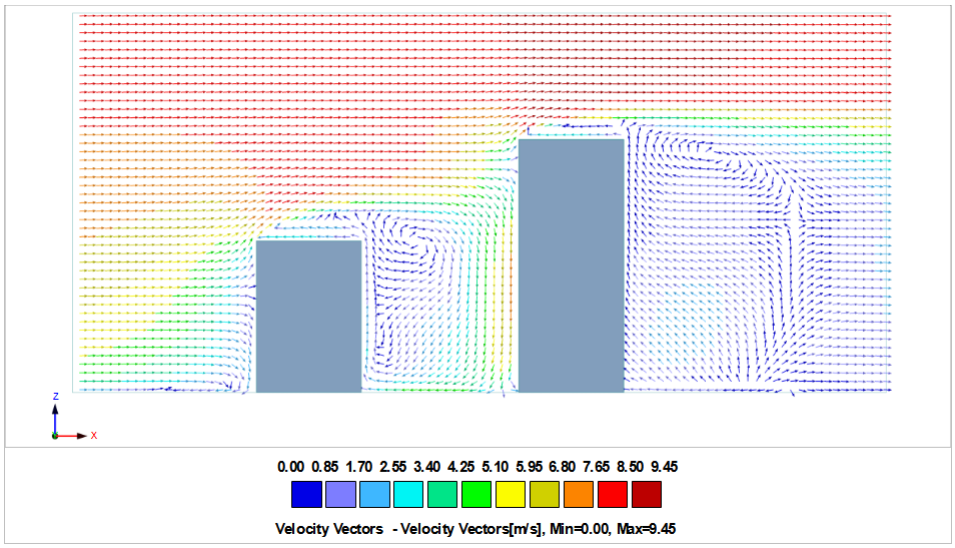

Figure 3: Velocity field

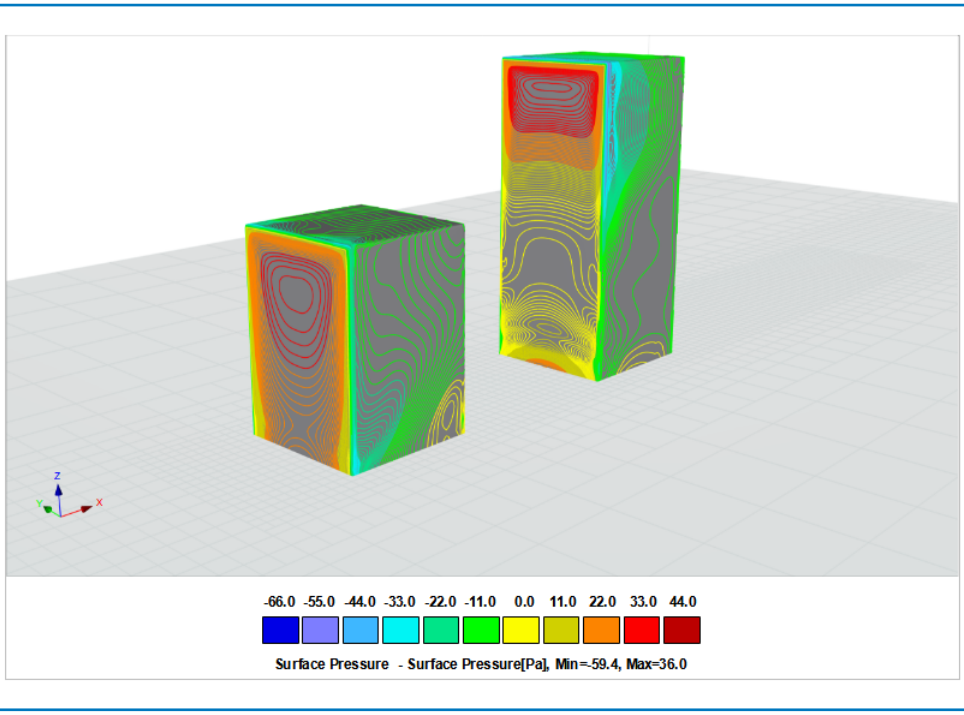

Figure 4: Pressure distribution

In **Figure 3** can be seen results of velocity field around the buldings and in **Figure 4** results of pressure distribution on the building walls.

The following figures show comparison of pressure coefficient C_p obtained by RWIND simulation result and wind-tunnel experiments along measuring lines on windward and leeward walls and side walls of both buldings, experimental data presented in the literature [1 and 2].

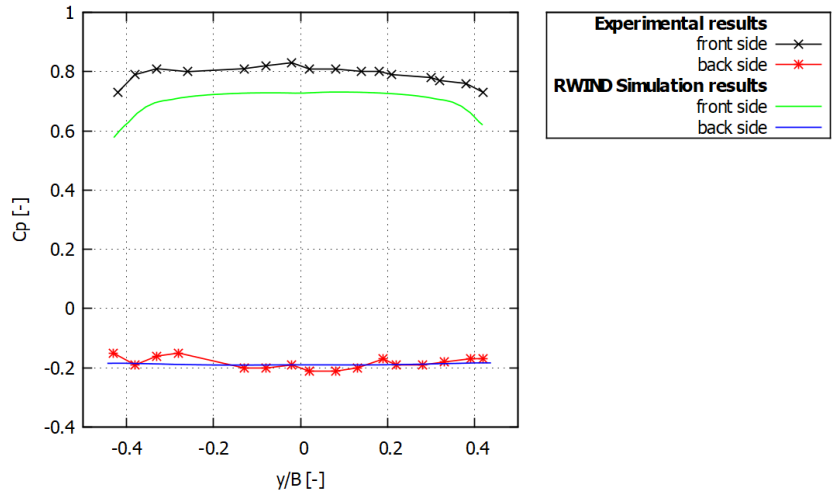

Figure 5: Front and back side of building 1

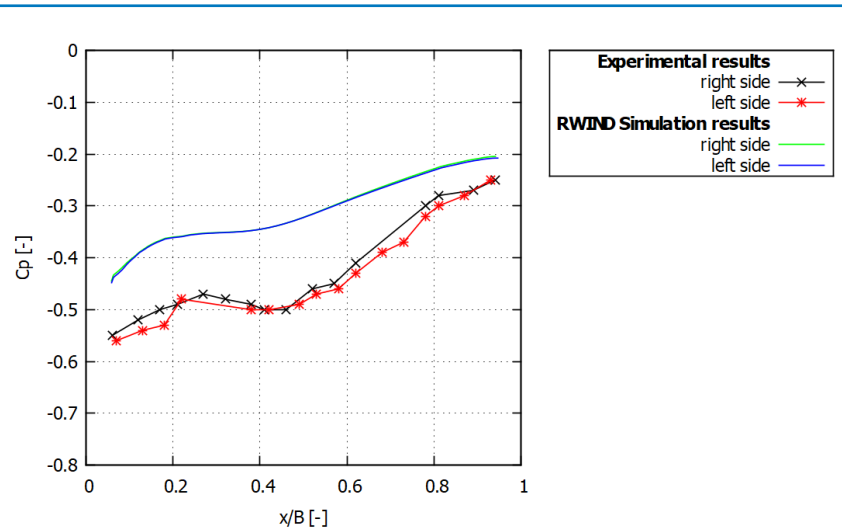

Figure 6: Right and left side of building 1

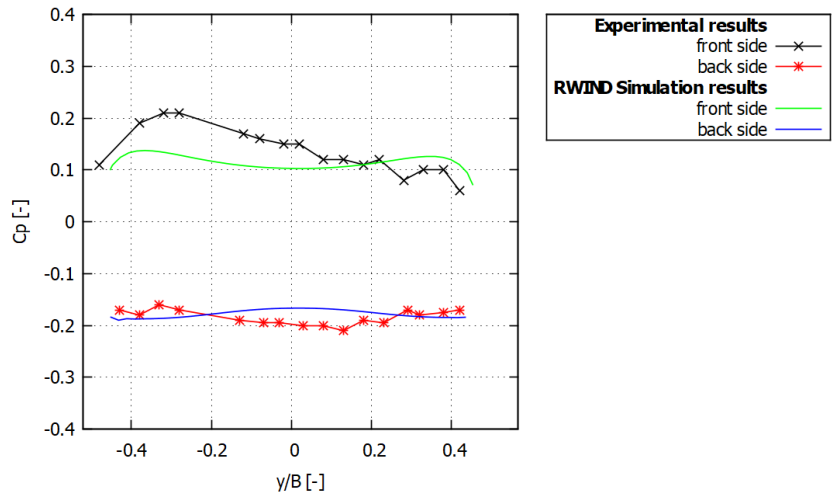

Figure 7: Front and back side of building 2

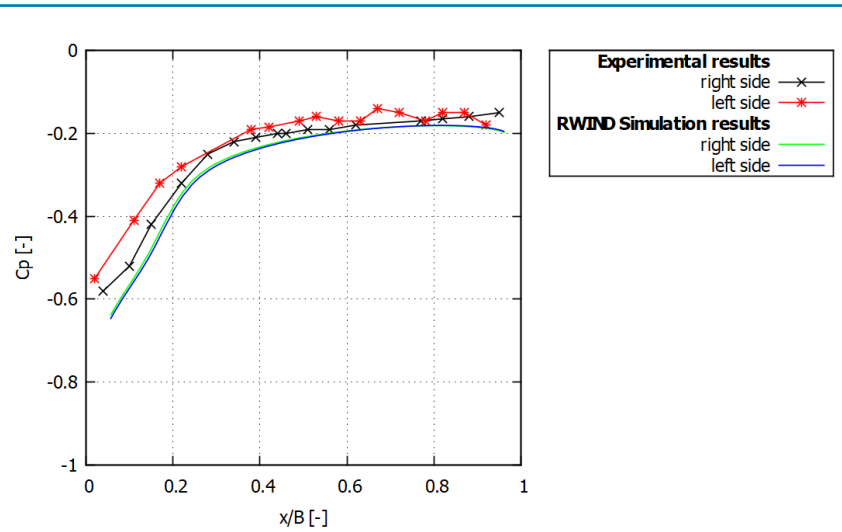

Figure 8: Right and left side of building 2

Conclusion

To properly understand the results, should be considered that we compare the experimental results with the numerical results, where, on the one hand, there are inaccuracies of the experimental measurement and, on the other hand, the simplification of the numerical model. One of the important factors in the calculation is the choice of the turbulent model and it's parameters, where we try to approach the set-up of the experiment and to achieve the most accurate results.

References

[1] GNATOWSKA, R.. Aerodynamic characteristics of three-dimensional surface-mounted objects in tandem arrangement. *International Journal of Turbo Jet Engines*, 28:21-29, 2011.

[2] GNATOWSKA, R.. A study of downwash effects on flow and dispersion processes around buildings in tandem arrangement. *Polish Journal of Environmental Studies*, 24(4):1571–1577, 2015.