The CFD modeling of a wind loading on the complex geometry building

To calculate a wind loading on elements of the building, the CFD modeling of the wind environment around the complex geometry building was made.

The full Reynolds averaged Navies–Stokes equations were used to get solution.

The model geometry and the design picture are presented in figure 1.

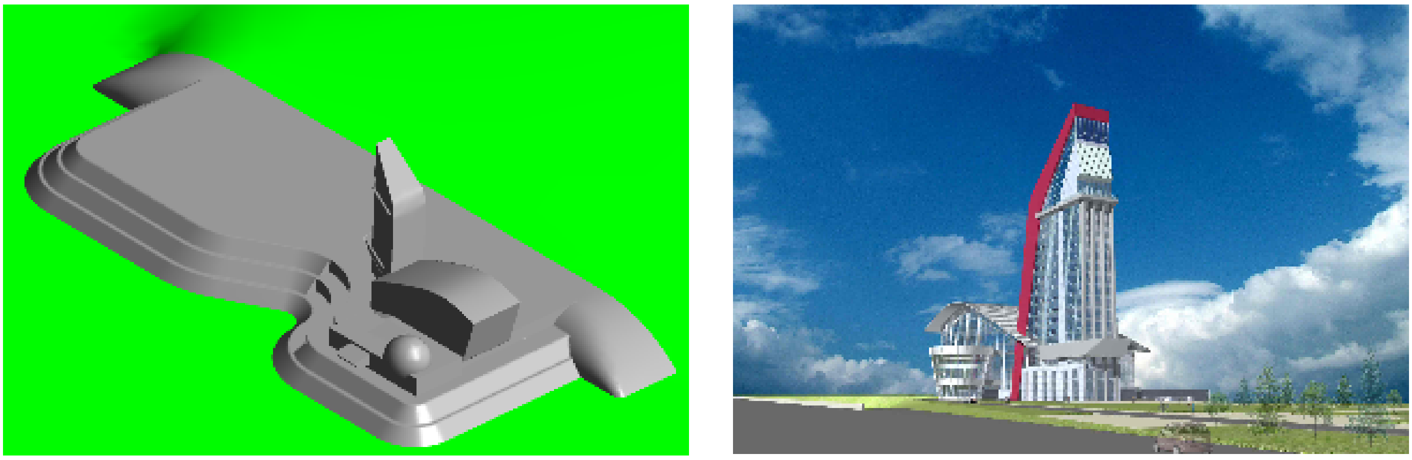

Fig. 1. The model geometry and the design picture.

The reference velocity of the wind is U_{ref} =15 m/s (for y_{ref} =10m).

To setup the wind profile, the Monin–Obuhov model for neutral atmosphere stratification was used (atmosphere temperature is constant over an altitude). It is a simple model and for this model the velocity profile definition can be written as: $U = \frac{u_*}{\kappa} \ln \frac{y}{y_0}$, where y_0 – parameter of the underlying roughness.

To setup value u_*, measurements of the velocity wind profile within atmosphere boundary layer are used: $u_* = U_{ref} \kappa / \ln(y_{ref} / y_0)$.

The atmosphere turbulence is defined by two parameters: the kinetic turbulence energy k and the kinetic turbulence energy velocity dissipation ε.

For the neutral atmosphere stratification, turbulence parameters profiles can be written as: $k = \frac{u_*^2}{\sqrt{C_\mu}}$ и $\varepsilon = \frac{u_*^3}{\kappa z}$.

For Reynolds averaged Navies–Stokes equations closure, the *RNG* $k-\varepsilon$ turbulence model was used.

The model geometry of the landscape within ~500m from model center take into account the characteristic feature of the real earth landscape (hills, embankments, etc.), then model geometry take out to ”zero level” at radius 1000m.

Walls of the building are assumed to be smooth (zero roughness), surface roughness is assumed to be: $y_0 = 1.4$ cm (grass).

The total element number $N \approx 1$ million (tetras, prisms и pyramids). Near surface there is a prism layer (three elements).

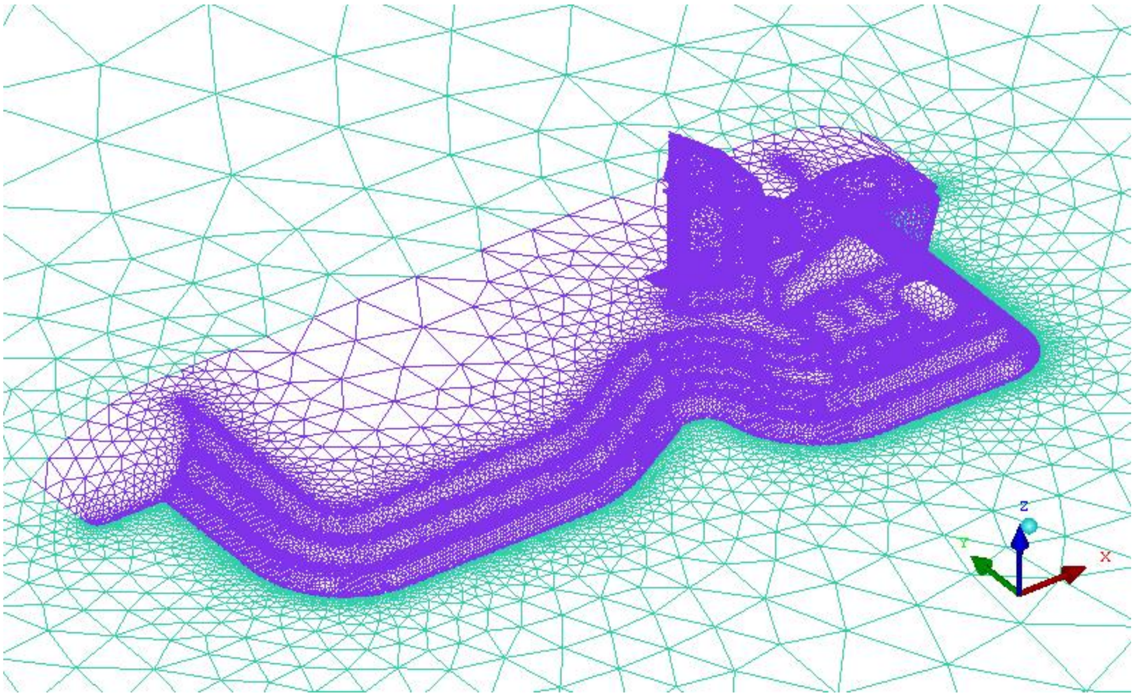

Fig. 2. Surface mesh.

The problem is unsteady and main results of the work are a pressure distributions on the model surface. The pressure was statistically averaged over solution time interval.

The time interval T ~ 40-60s, during this time air masses are moved for a distance about two-three characteristic length of the building and, so, the result pressure is averaged over time that is more than characteristic life time of biggest vortices around model.

On the figure 3 there is an averaged pressure distribution on the building surface.

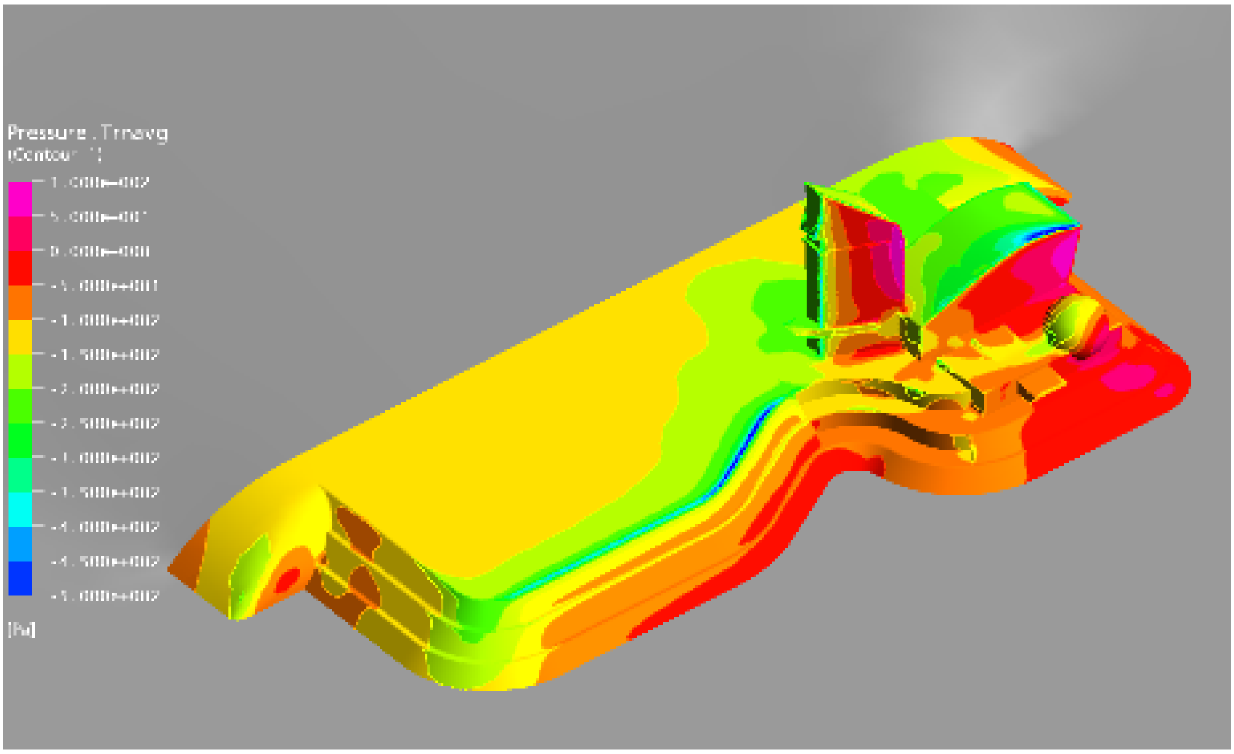

Fig. 3. The pressure distribution on the building surface.