11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

SIMULATION OF BLAST ACTION ON CIVIL STRUCTURES USING ANSYS / LS-DYNA AND ANSYS / AUTODYN

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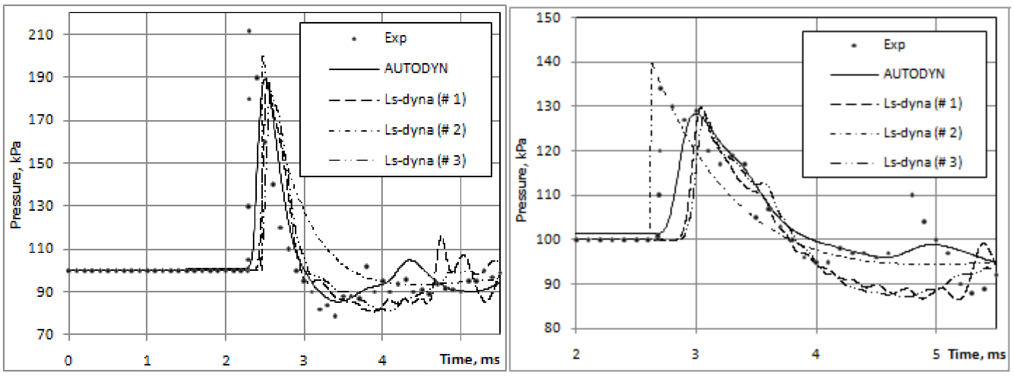
Key Words: *Instructions, Multiphysics Problems, Applications, Computing Methods.*

Nowadays, the number of industrial accidents accompanied by explosions is increasing in Russia and throughout the world. Also, increase in the number of terrorist acts committed by means of explosions is observed. For improving safety of buildings and structures it is necessary to raise their resistance to explosive effects, as well as to be able to predict degree of potential damage upon explosive loads of various intensities. One of the principal goals in designing the structure resistant to explosive effects is to determine the dynamic response of structures to the impact of the blast wave. For solving this problem one can use numerical simulations based on advanced computer aid design and engineering (CAD/CAE) software. In the paper, ANSYS modules LS-DYNA and AUTODYN [1] were tested on the problem of shock wave interaction with prismatic bodies. The calculations have been performed under the condition of the experiments [2-4] for the three test configurations. Shock action was studied on one (conf. #1) and two (conf. #2) prismatic bodies as well as on a group of prisms (conf. #3) for a various location and capacity of the explosive charge. The adaptation of ANSYS software modules (LS-DYNA, AUTODYN) was performed for the 3D problem of the blast wave impact on the building structures. Comparison of the simulation results to the experimental data have shown that LS-DYNA and AUTODYN software allows one to perform numerical modeling of explosive impact on the environment with an acceptable accuracy.

In LS-DYNA, an explosive load was modeled using hydrodynamic, empirical and mixed approaches. The first approach is based on a multi-material hydrodynamic model and arbitrary Lagrangian-Eulerian (ALE) meshes to solve the problem of the explosive detonation and the subsequent propagation of the shock wave. The second approach consists of blast wave pressure computation via the CONWEP function [1] based on experimental data. In the third approach, the CONWEP function is used to set the boundary conditions at the inlet boundary for gas dynamic calculations. As a result of computations, fields of all gas-dynamic parameters in the air domain as well as the pressure versus time distributions at the several characteristic points on the prism walls were obtained.

Figure shows the pressure versus time behavior at two points located at the center of frontal

(T1) and back (T2) faces of the conf #1. Using the semi-empirical CONWEP function (method 2) for determining the pressure field on the wall of the prism gives a good agreement to the experimental data by the pressure maximum and time of shock arrival to the



Pressure distribution versus time at points T1 (left) and T2 (right), kPa

characteristic points. However, this method does not allow one to predict accurately the secondary and reflected shock waves in the flow pattern. Therefore this method can't be applicable for the confs. #2 and #3, where complex interference effects have a significant impact on the flow wave picture.

Numerical calculations using both AUTODYN and LS-DYNA (methods 1 and 3) under-predict the first pressure peaks on the windward and leeward prism faces with an error of about 10%, as well as give some delay in the shock arrival time (error of calculation is 2÷8%). However, AUTODYN calculations provide better agreement with the experiment by the shock arrival time. LS-DINA calculation gives incorrect pressure behavior after the shock reflection from the frontal wall, which leads to a significant underestimation of pressure in the negative phase. The second pressure peak at point T2 on the leeward prism face is the result of action of the shock wave reflected from the ground. Calculations performed using both AUTODYN and LS-DINA underpredict this peak and give a delay in the shock arrival time. These effects can be due to the fact that simulation gives significantly smeared shock structure, that is caused by numerical schemes implemented in LS-DYNA and AUTODYN.

The work was supported by Ministry of Science and Education of Russia (project #8.2350.2011).

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