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BLAST PERFORMANCE OF FRC COMPOSITES

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Abstract: *The paper presents ways of numerical modeling of RC and FRC slabs subjected to blast loading. The models are based on experiments which were described at the EM2011, the experiments are performed in the military training area Boletice with the cooperation with the Czech Army. The use of fracture energy as the key quantity in the modeling of FRC in comparison to RC is studied.*

Keywords: ***blast loading, fiber concrete, reinforced concrete.***

This paper presents the primary results of two sets of field tests of blast performance of reinforced concrete and reinforced concrete specimens with plastic fibers. The tests were performed in cooperation with the Czech Army corps and Police of the Czech Republic at the military training area Boletice using real scale precast slabs and 25 kg of TNT charges placed in distance from the slab for better simulation of real in-situ conditions.

Five specimens were used in total during the experiments performed in 2010 and 2011. Three of the specimens were made of C30/37 grade concrete (specimen No. 1 (2010), 2 (2010) and 5 (2011)), two of C55/67 grade concrete (No. 3 (2011) and 4 (2011)). Polypropylene 54mm long synthetic fibres were used in three of the specimens. The fibre dosage was following: specimen No. 1 - 0kg/m3, No. 2 – 4,5kg/m^3, No. 3 - 0 kg/m^3, No. 4 – 4,5 kg/m^3 and No. 5 - 9kg/m^3. The dosage of the fibres was kept low as it can be achieved on-site. The fiber tensile strength is 620-758MPa, the shape combines monofilament and fibrillated shape (slightly corrugated and blended with fibrillated PolyPropylene fibers).

A numerical model of the experiment was prepared for the purpose of further research. The model composes of several parts. The air forms boundaries of the model; the explosive transfers the energy from the blast to FE elements of the air, where the blast wave propagates. The concrete specimen is modeled by solids, reinforcement by beam elements. For example of the model, see Fig. 1.

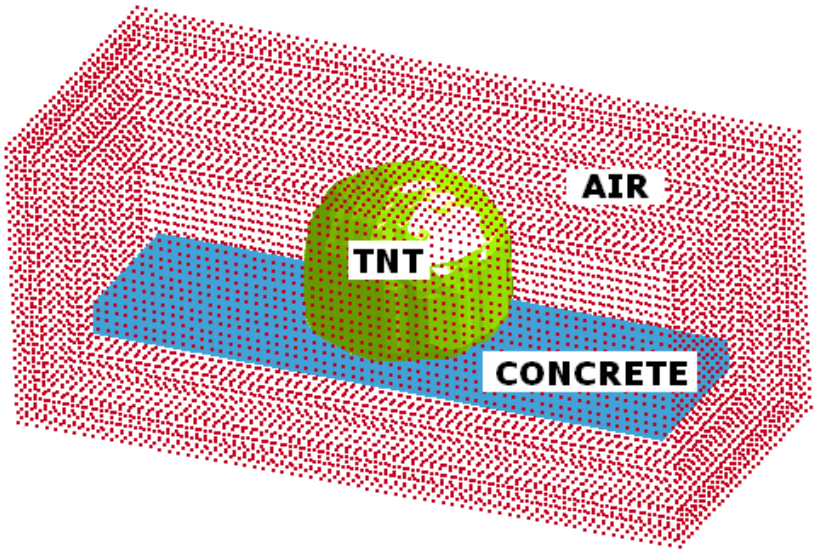

Fig. 1: Set-up of the FE model

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Fig. 2 compares the video-recorded blast overpressure wave during the experiment with the FE model; element erosion can be spotted under the hypocenter.

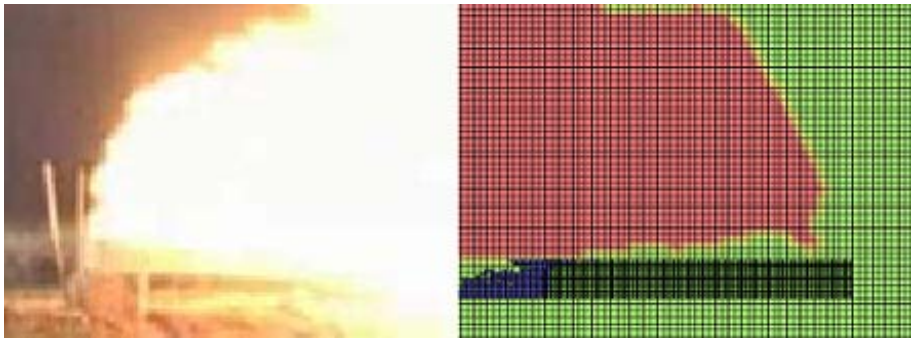

Fig. 2: Experiment vs. FE model

The FRC material model was calibrated according to experiments decribed by Drahorad, Foglar et al. (2011). The experiments studied the strain-rate effect of FRC specimens (700x150x150mm) subjected to 4 points bending. The calibration models were prepared using LS-DYNA for plain concrete and both dosages of PP fibers. The fracture energy in tension and shear of the material model of plain concrete was modified to obtain similar integral of the fracture energy both from the experiments and the numerical evaluation.

The calibrated material model was used in the 3D models. For example of the result of the modeling, see Fig. 3. The results of numerical modeling show very good agreement with the experiments for specimens with added fibers.

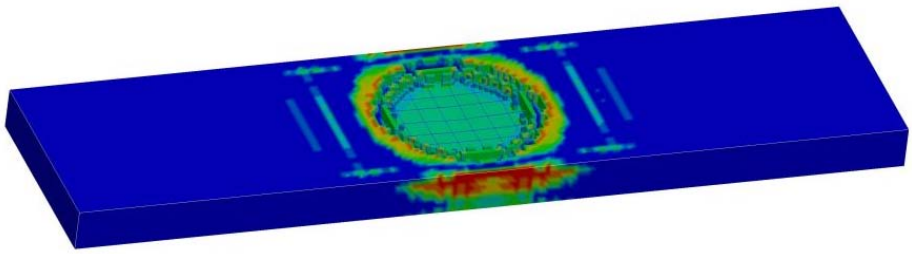

Fig. 3: Top view of the FRC specimen after the blast (t = 1 ms)

The way of modeling of fiber concrete subjected to blast loading by increasing the facture energy of plain concrete MAT159_CSCM material model was presented and evaluated. The model calibration was performed according to small scale experiments. The results of numerical modeling show very good agreement with the experiments for specimens with added fibers.

Other ways of modeling of fiber concrete subjected to blast loading lie in changing the area of plasticity of the material model or in modeling of the dispersed reinforcement. These methods require much more effort to be invested, yet the result remains questionable.

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