

Numerical simulation of breakup of concrete magazine due to accidental internal explosion and determination of its debris hazard zone

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Abstract

This presentation will give an overview and a summary of the research project for the study of explosion hazards from Earth Covered Magazine (the ECM project in short). The ECM project is one of the major research projects conducting under the Protective Technology Research Centre of Nanyang Technological University (NTU), Singapore. The main objective of the ECM project is to formulate practical guidelines to predict the hazards from the breakup and the debris generated from above-ground, earth covered magazines due to internal explosion. The ECM project also aimed to develop practical engineering tools (in form of a computer program with user-friendly GUI) for the prediction of Inhabited Building Distance of the ECM. In order to predict and quantify the hazards from internal explosion of ECM, the main research works of this project involves theoretical, numerical and experimental investigations of (1) high strain rate break up behaviors of reinforced concrete structures and earth cover subjected to internal explosion, (2) intersections of high-speed flying debris with surrounding air and (3) the effect of bounce and ricochet of debris on the final debris dispersion range. Numerical simulation uses advanced modelling techniques as a valuable alternative approach. Basic modeling approaches are

- ☒ Main computing platform: LS-DYNA
- ☒ Multi-material Arbitrary Lagrangian-Eulerian (MM-ALE) formulation: air, TNT, concrete, steel, soil
- ☒ Eulerian grid for air and TNT, with equation of state (EOS)
- ☒ Lagrangian grid for RC Structure (concrete + steel with cohesive elements)
- ☒ Lagrangian grid (preferred) or Eulerian grid for soil
- ☒ Coupling and interactions among different grids and materials
- ☒ Strain rate effect (100s^{-1} to $>1000\text{s}^{-1}$) and stochastic distribution of material properties are employed

Fig. 1 shows schematically the configuration. Fig. 2 illustrates a snapshot during the breakup of the earth-covered magazine (ECM).

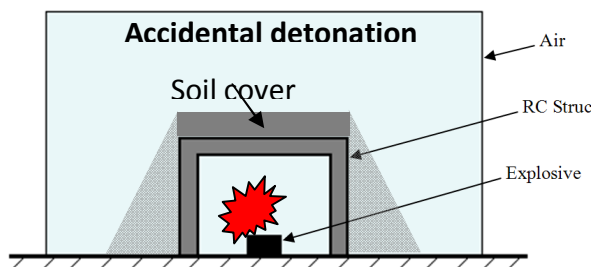


Figure 1

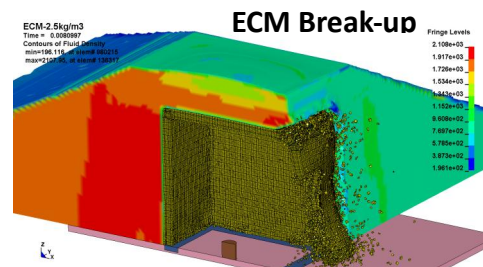


Figure 2

References

- Fan, S. C., Yu, Q. J. and Lee, C. K. (2014) Simulation of Fracture/breakup of Concrete Magazine using Cohesive Element, *Materialwissenschaft und Werkstofftechnik (Materials Science and Engineering Technology)* **45**, No.5, 386-396.