

Numerical modeling of ship collision with coupled DE-FE approach

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ABSTRACT

With growth in traffic of ships, the risk of collision is increasing. Efforts are being made to improve the crashworthiness of ships and one promising design approach is to use granular materials in the cavity of double hull ships [1]. In context of numerical simulation of such a problem, different modeling aspects have to be considered. For instance, during the collision process, degradation/damage of interacting bodies can occur. In this contribution, such a phenomenon is accounted for by a gradient enhanced ductile damage model, where growth of damage is based on a combination of stress triaxiality and total accumulated plastic strain. Since standard lower order formulations based on three-dimensional elements do not perform very well for bending dominated thin structures, enhanced strain formulation based elements will be used instead [2]. In order to demonstrate the effectiveness of such an element for ductile damage, several examples will be presented where comparison with standard element formulations will be carried out. Furthermore, examples with contact force (based on mortar method) driven impact, coupled with gradient enhanced based damage, will also be presented.

For the current problem, numerical modeling of granular materials is based on discrete elements. Since for large scale problems, numerical modeling of granular materials can be computationally expensive, an Arlequin method based coupling of discrete element and finite element method will be employed [3]. For such a coupling, the region with small deformation will be modeled with continuum based Mohr-Coloumb material model, while the region with large deformation/localization will be modeled with the discrete element method. Finally, for such a coupling, a representative example of ship collision will be presented. For validation of numerical results comparison with experimental results will be done, where realistic material properties of granules [4] and ship structure will be used.

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