A Micromechanic-based approach towards the Response of Fiber-reinforced Composite Laminates under ballistic impact and blast loading

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Composites material are a significant part of a wide variety of applications such as bulletproof vests of soldiers on a battlefield to the passenger jet airliners. The dynamic and multitudinous forces of nature acting on these composites push the materials towards complex deformations, answers to which involves extensive work using numerical techniques, in order to save the expenditure involved in testing and experimentation. In the present study, an attempt has been made to solve this challenging problem to predict the response of composite laminates under ballistic impact and blast loading conditions by implementing a progressive damage based micromechanical model for unidirectional composite laminates and fiber metal laminates.

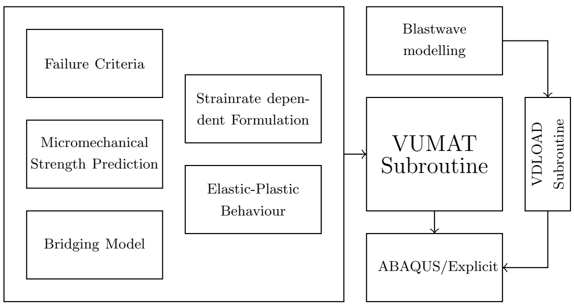

Figure 1: Simulation Schematic

The material response is studied by integrating the concepts of continuum damage mechanics (CDM), bridging model[1] , elasticity and plasticity[2], micromechanics based strength prediction[3], strain-rate dependent formulation[4] and a string of failure criteria into the user coded VUMAT subroutine which is used in ABAQUS/Explicit for simulation. In addition to this, the layers of laminates are bonded using surface-based cohesive behavior whereas the interaction between the projectile and the plate is defined using the general contact algorithm. The model consisting of a target plate is having C3D8R elements and the projectile has meshed with R3D4 elements. The mesh is checked for the quality and errors using the metrics such as geometric deviation factor and aspect ratio.

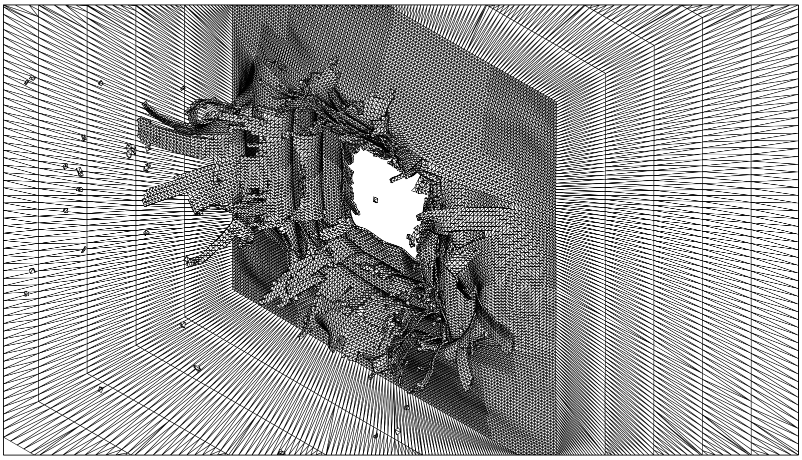

Figure 2: Back face deformation of 8 layered cross ply laminate under blast loading ($I = 642MPa$)

The blast wave is modeled using the VDLOAD subroutine which contains modified Friedlander equation while considering a near-field blast approach to model time decay and a decoupled approach in modeling spatial decay. The results are obtained using materials Carbon/Epoxy and Glass/Epoxy for simulation. The results of the simulation are validated by the work of performed by previous researchers[5][6] and was found in good agreement.

References

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