CRASHWORTHINESS PREDICTION OF COMPOSITE VEHICLE TRUCTURES

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KEYWORDS

Fiber reinforced composites, damage models, post-peak, irreversible deformation.

ABSTRACT

Composite structures exhibit superior specific energy absorption (SEA) than metallic structures. Composites have been used extensively in racing cars for lightweighting and performance enhancement including crashworthiness. The application of composites in vehicle structures is still limited. The lack of reliable crashworthiness predictions for composite structures is considered to be one of the key factors.

This talk assesses the current crashworthiness prediction capability for composite vehicle structures and presents recent developments.

The vehicle structures can be divided into two broad categories: body panels and primary structures. Body panels include all closures such as doors, hood, roof panel, fender, etc. The primary structures include chassis, pillars, door beam, pumper beam, underbody, and etc.

Composite body panels have been used in vehicles. Commercially available finite element (FE) packages are sufficient in crashworthiness design of such structures.

For primary structures, we further divide them according to the direction of crash load to the structures as whether it is dominated by lateral or axial loading. In a crash event, some structures will be subjected to lateral impact. Examples are bumper beams in frontal impact, rockers and B-pillars in side impact. Although more challenging than body panels, predictions for laterally loaded structures are attainable. The structures related to energy management such as the crash box and front rail are often subjected to axial load. Axial crash is also of interest of aerospace industry in the design of steering column and landing gears of helicopters, and fuselage sub-floors of aircrafts.

The simulation methodology for axial crash of composite structures is still under development.

In axial crash, composite structures absorb energy by sustaining extensive damage. The inserts in Fig.1 show braided composite tubes after axial crash. To predict the crashworthiness performance of the structure, the material models have to describe the material response over the entire range from the elastic region, initial failure, to the post-peak severely damaged composite. Furthermore, correct representing the irreversible deformation and unloading path of damaged composites is critical to crashworthiness predictions [1-3]. The existing composite material models are often inadequate in this regard. Material models with these features have resulted in significant improvement in axial crash prediction of composite structures [1-5].

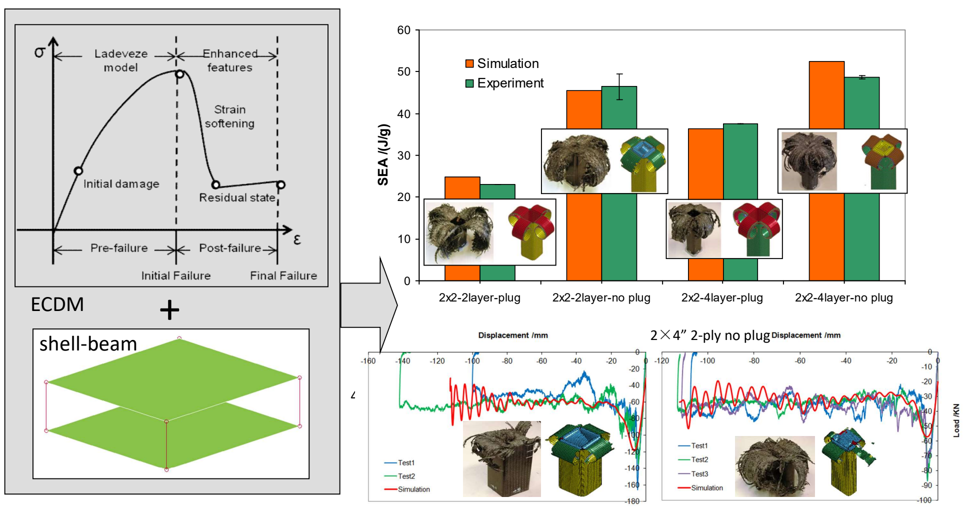

Fig. 1 An enhanced continuous damage mechanics model [4] with a shell-beam method [5] has significantly improved the prediction of braided carbon composite tubes under axial crush loading.

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