Research on Energy-Absorption and Failure of Carbon Fiber Reinforced Epoxy Resin Double Cone Structure (CFREPDCS) [DOI: 10.1088/1742-6596/1507/6/062006]

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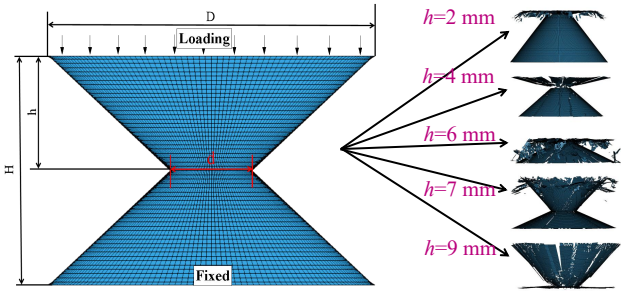
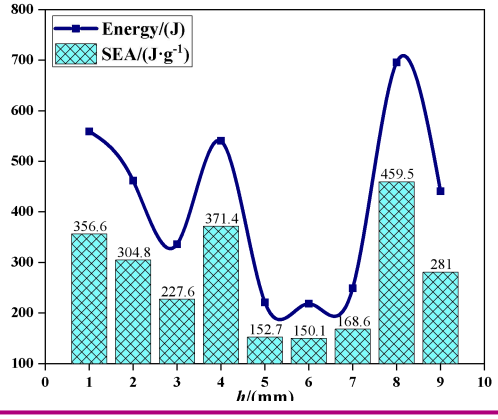
1 Abstract. One of the research hotspot in strategic missile is to develop a multifunctional and lightweight composite launcher, which has a certain bearing capacity and anti-fragment penetration capability. On this basis, this paper designs the launcher's wall by using carbon fiber reinforced epoxy resin composite double cone structure (CFREPDCS) as sandwich core layer. Due to obtain the high-speed impact energy-absorption and failure characteristic of the CFREPDCS, the quasi-static collapse experiment and the LS-DYNA finite element simulation were used. The experimental results and the scanning electron microscope show that the failure mode of the carbon fiber reinforced epoxy resin composite (CFREP) circular tube is progressive failure, which includes matrix fragmentation and fiber fracture. The CFREP circular tube with larger wall thickness has higher specific energy-absorption (SEA), approximately 58.6 J/g. The coupled relationship between SEA and mid-diameter height shows that the maximum SEA occurs while mid-diameter height reaches 8 mm. On the other hand, the change of the mid-diameter height also reflects the influence of loading direction on SEA. This study provides the significant guide to design and manufacture of sandwich carbon fiber composite launcher.

3 Simulations. The element type of SHELL and material model *MAT 54 were used in the simulation. As shown in Figure 4, the initial velocity was set as 100 m/ s, and the value of h is 1-9 mm. Total energy-absorption and Specific energy-absorption (SEA) were obtained below.





2 Materials and Experiments. The composite tubes used in this experiment were T700/3K CFREP, which was wound with T700 carbon fiber orthogonal $[0°/90°]_s$ and adhered by epoxy resin matrix. The wall thickness of CFREP thin-wall circular pipe is 1 mm (laying 7 layers) and 2 mm (laying 14 layers). The height of the tube is 30 mm, and the outer diameter is 15 mm. The MTS universal electronic testing machine was used to carry out the quasi-static experiments, and the loading speed was set as 1.8 mm/min. The maximum collapse stroke is 25 mm, and the precompression force is 0.1 kN. The failure modes were obtained by different compression displacement.

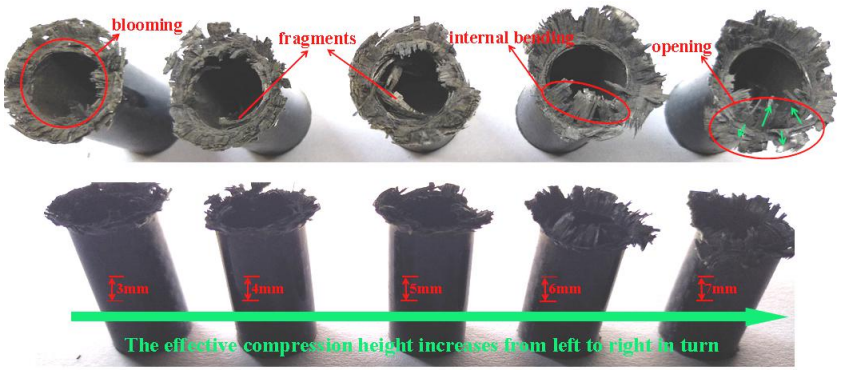


Figure 1. Failure condition with different compression displacement

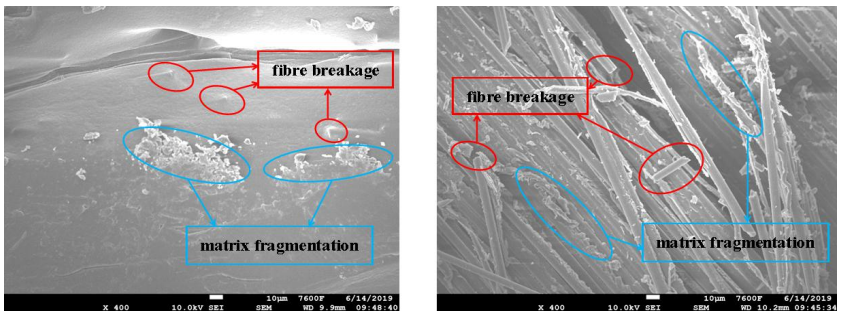


Figure 2. Scanning electron microscopic diagrams of failure fragments of CFREP

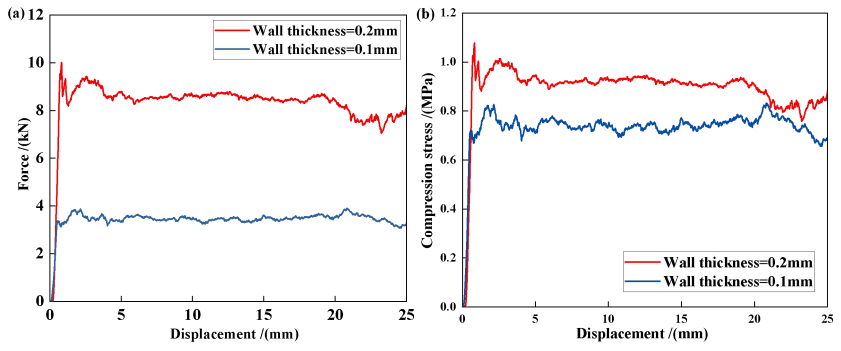


Figure 3. (a) Force-displacement curves, (b) Stress-displacement curves

4 Conclusions. The failure mode of CFREP thin-wall circular tube belongs to progressive failure, and the failure conditions includes fiber fracture and matrix breakage. Namely, FMH (Farley-Mamalis-Hull) failure mode. The simulations of CFREPDCS show that the significant influence of medium-diameter height h on SEA, but it can be found that the optimum h value of SEA is 8 mm. These results will provide a guidance for the fabrication of sandwich core layer so that design a composite launcher with better energy-absorption characteristics.