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Non-Confidential Description - PSU No. 3475
"Energy Absorption and Load Limiting via Extension-Torsion Coupled Stitch Ripping Composite Tubes"

Keywords:

Textile load limiter, extension-twist, stitch ripping devices, composite tubes, crash landings

Links:

Inventor Website
US Patent 8,828,513

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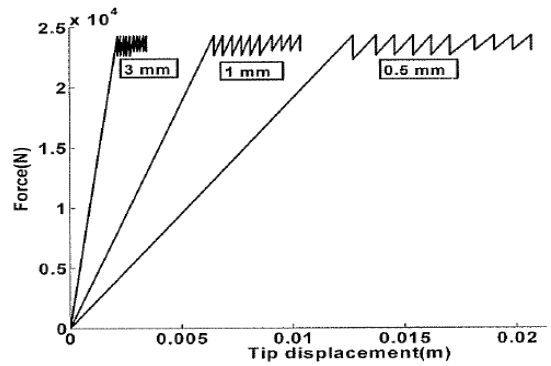

Fig 1: Sample F-d curves

Background

During crash or hard landings of vehicles, heavy payloads exert large g-forces on the mounts connecting them to the structural frame. As a result of this stress, payloads can break loose from the mounts, causing serious damage to crew, passengers, payload and surrounding structures. Additionally, during rough landings, heavy equipment (e.g. tool boxes, gear boxes, engines) mounted permanently inside the vehicle may break free from the hard mounts (e.g. struts, tie rods, etc.) and cause similar damage.

Efficient cargo restraints should have the capacity to absorb the kinetic energy of the cargo by allowing it to move a limited amount of distance (stroke) without transferring large loads on the mounting structure. Similarly, hard tie-downs should be able to absorb the kinetic energy of heavy equipment during crash sequences. Current payload-restraint systems typically lack any load-limiting capabilities. While scaling up existing restraint technology seems an intuitive solution to this problem, the potentially high-weight penalty associated with reinforcing mounting points in vehicle structure is prohibitive to this approach. As a result, energy-absorbing tie-downs must be engineered for high effectiveness-to-weight ratio.

Invention Description

The disclosed invention uses composite-based load limiters, which can provide the desired level of specific energy absorption to ensure crew and vehicular safety during rough landings. This device is designed to have two concentric composite tubes with fibers angled in opposite orientations. These tubes are stitched using a specified thread across the cross section as well as along the length of the tube, and are tailored to be extension-twist coupled. Upon the application of axial forces, the disclosed load limiters have a tendency to twist in opposite directions, but—being stitched by thread—the stiffened tubes are restrained from behaving in this manner. As the increase in axial forces continues, these threads continue to bear the loaded tension until the kinetic forces are dissipated/absorbed.

Advantages / Applications

- Higher strength-to-weight ratio than existing technologies
- Composed of high-strength carbon fibers bonded with flexible polymer matrices
- Composite tubes behave like other textile based load limiters, but F-d response is much stiffer
- Capable of meeting a wide range of design requirements due to high dimensionality of the available design space (involved parameters)

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