ENGINEERED COMPOSITES FOR YOUR WORLD

POLYGON® COMPANY

Q: "What can be expected as a resultant failure mode of the PolySlide™ composite cylinder if an internal return spring fails (fractures) during operation?"

A: The most popular projectile related failure theories for composite cylinders are those that are simplest to use and applicable to general composite failures such as matrix cracking, laminate ply failure, and transverse fiber pullout failure. There are reasonable predictions that can be made concerning composite materials and their failures. The following is a summary of these known circumstances:

- The PolySlide filament wound cylinder is not prone to be brittle. It offers high structural integrity and not expected to shatter or break apart catastrophically upon reasonable impact.
- The PolySlide cylinder offers highly elastic morphology as compared to metal tubing. This favors the spring potentially being contained by the composite matrix if failure occurs. The modulus of elasticity in the hoop direction is 3 to 4 Msi as compared to 28 to 30 Msi for metal cylinders.
- The stress / strain curve is a straight line from zero load to failure and does not exhibit a plastic range similar to metals.
- The hoop strength is approximately 70 ksi depending on the specific tube diameter, wall thickness, cylinder design and manufacturing of the PolySlide cylinder. This exceeds the yield strength of a 1018 cylinders and is comparable in tensile strength.
- The construction of a filament composite tube is formulated from a laminated material consisting of composition of heterogeneous orthotropic lamina as compared to metals, which are homogeneous and isotropic materials. In the case of impact resistance, a sudden impact force generated upon the composite structure would need to progressively fail each lamina in the composite wall before the total structure would submit to ultimate failure. Whereas in the case of isotropic metal cylinders, once a fracture is initiated it has less resistance to further expand through the entire material.
- Each lamina of the composite cylinders primarily consists of two distinct material phases that includes continuous wound fiberglass reinforcements and cured cross-linked high strength epoxy resin. The glass fiber provides the tube its high tensile, high stiffness, modulus and stability properties. The epoxy adds toughness, durability and elasticity to the composite cylinder structure. In order for catastrophic or ultimate failure to occur at a micro mechanics level, the tensile and /or shear strength of each glass filament would need to be exceeded beyond its mechanical limits. It is reasonable to assume and understood this process would take place in a progressive mode of lamina failures as consecutive laminar tears of the epoxy and glass fiber structure. This would result in impact inertia dissipating through the lamina layers and fibers as the spring penetrates the composite wall.

Based on these fundamental composite characteristics and of the PolySlide cylinder construction, ***it is reasonable to predict that the PolySlide cylinder is likely to withstand an impact by spring failure***, which would result in progressive lamina failure and containment of the spring element within the cylinder tube.

PolySlide cylinder tubing is likely to contain any metallic debris resulting from a spring fracture or failure. However, if this is a real liability concern and not just limited to a design-oriented question, then we would recommend that an independent lab test the PolySlide cylinder under prescribed failure conditions.

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