

Thermoplastic Composite Lunar Tower Truss Structure: Design

Development and Verification Plans

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The National Aeronautics and Space Administration (NASA) Space Technology and Mission Directorate (STMD) is advancing thermoplastic composite (TPC) technologies for exploration missions. The Technology Development for Exploration Applications (TDEA) project goals are to develop and mature TPC materials, designs, analyses tools and techniques, and mature manufacturing processes. This includes development of manufacturing and joining approaches relevant to space environments. To these ends TDEA endeavors toward demonstrating a TPC truss structure for a lunar tower configuration. The design, predicated on robotic assembly, uses open section truss elements fused to a joint splice plate, without a structural adhesive.

This presentation details the TDEA lunar truss structure design development approach including design heritage, the requirements established, the mechanical design and analyses, and thermal analyses demonstrating structural requirements conformance, as well as planned building block verification efforts either underway or planned. The mechanical analyses show the most severe environment is a moonquake the truss dynamic responses. The thermal analyses shows the extreme cold for on orbit welding, the window for less severe on orbit welding, as well as the large thermal gradients on the truss. The building block approach shown includes ultrasonic welding and lap shear coupon testing on various truss element thicknesses and layups. Knockdown factor determinations due to lunar dust contamination (simulated) and effects of welding in a vacuum are presented. The most highly loaded truss joint configuration sub-element verification test matrix is outlined. Lastly, plans to build, inspect, and test a 2 bay truss representative unit cell that is 1.5 meter by 1.5 meter by 3.0 meters tall are detailed.