JPL Tunable Beam Pyroshock Simulation System

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Overview

• **JPL Resonant Beam**
  - Similar to Sandia National Lab design
  - A projectile strikes the beam using air pressure (mass and pressure defines the speed)
  - Knee frequency in SRS specification can be adjusted by varying beam span
  - SRS amplitudes adjusted via air pressure; higher frequency attenuated using pads
    - Sensitive to other parameters such as slug configuration, pads and felt thicknesses, etc.
  - Proper felt thickness to damp out high frequency when the slug strikes the secondary block (reduces metal-to-metal contact related signatures)

• **SRS Specifications in Three Orthogonal Axes**
  - Tunable beam is being prepared for
    - 1000, 2000, 3000, and 4000 g’s with a knee frequency of ~ 1500 Hz
    - These levels will be used for MSL components pyroshock development/flight hardware qualification testing

• **Selection of accelerometer locations to obtain desired SRS specification to prevent under or over testing**
Tunable Beam Setup

- Test Area
- Strike Plate
- Projectile Tube
- Clamps
- Adjustable Resonant Beam
- Slugs
Fixture and adapter plates

First Bending Mode

\[ f_1 = \frac{1}{2\pi} \sqrt{\frac{E}{12 \rho}} \frac{t}{L^2} \]

L=14 inches \(f_1 = 4100\) Hz \(f_1 \sim 1600\) Hz (measured)
L = 16 inches \(f_1 = 3100\) Hz \(f_1 \sim 1400\) Hz (Measured)

First Longitudinal Mode

\( f_1 = \frac{c}{2L} \)

\( f_1 \sim 5300\) Hz (calculated based on measured \(c \sim 150,000\) in/sec)
Shock Signature and SRS in Z-axis (Vertical) Run 39

1000 g’s
2000 g’s
Shock Signature and SRS in Z-axis (Vertical)

3000 g’s
Shock Signature and SRS in Z-axis (Vertical)

4000 g’s
Shock Signatur Repeatability

- To achieve the desired and repeatable SRS (knee frequency and levels) and shock signature the following parameters must be controlled:
  - Correct air pressure set and stable projectile/pressure accumulator system (type of valve to release pressure is important)
  - Pads for high frequency attenuation (dorameter, thicknesses)
  - Torque on all bolts
  - Secondary block that slug strikes
  - Fixture and support plates
  - Location and mounting the control accelerometer(s); potential for over or under testing
Shock Measurement Locations w/ Wedge

Top
Top-
mid
Top-
right
Top-
left
Shock Measurement Locations, cont’d

Middle

Bottom-left

Bottom-mid

Bottom-right
Run 80

North

South

East

West
Run 86
Summary

• Current Tunable beam setup provides four shock levels in preparation for MSL components flight/none-flight hardware shock testing
  - The system is ready to be certified for flight hardware
  - Fixture plate and control accelerometer locations to achieve the desired shock levels are to be determined on a case-by-case basis
  - To achieve correct shock specification for a test hardware a stringent procedure must be followed
  - Shock levels may be extended to below 1000 and above 4000 g’s

• Current system has limited foot prints, therefore, is applied for limited test hardware
  - An adapter plate is being designed to broaden this limitation and achieve multiple axes shock with a single slug strike

• Tunable beam will be used for multi-mission shock testing