

Advanced Resonant Plate Testing

2011 Experimental HOCWOG

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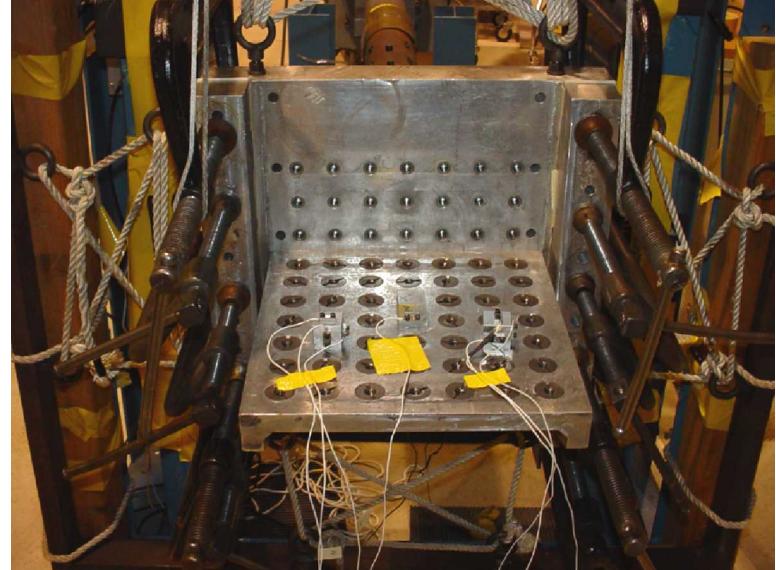
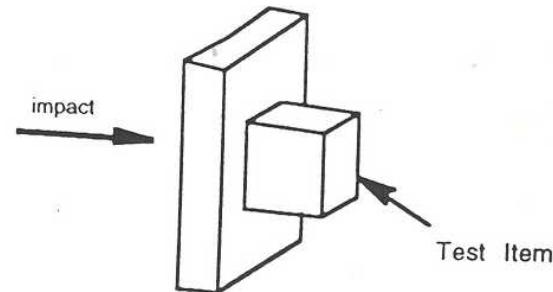
Shock Lab Overview

- **6 drop tables**
 - Carriage sizes from 6"x6" to 24"x24"
 - Maximum velocity change of 120ft/s
- **Inclined Table Shock Tester**
- **Package drop tester**
- **Hopkinson bars**
 - Aluminum, titanium, steel, and beryllium bars of various lengths
- **Pyroshock simulators**
 - 3" or ¾" diameter projectiles driven by pressurized nitrogen used to mechanically excite the fixture
 - Bars, beams, and plates and other custom fixtures available



Resonant Plate Tester

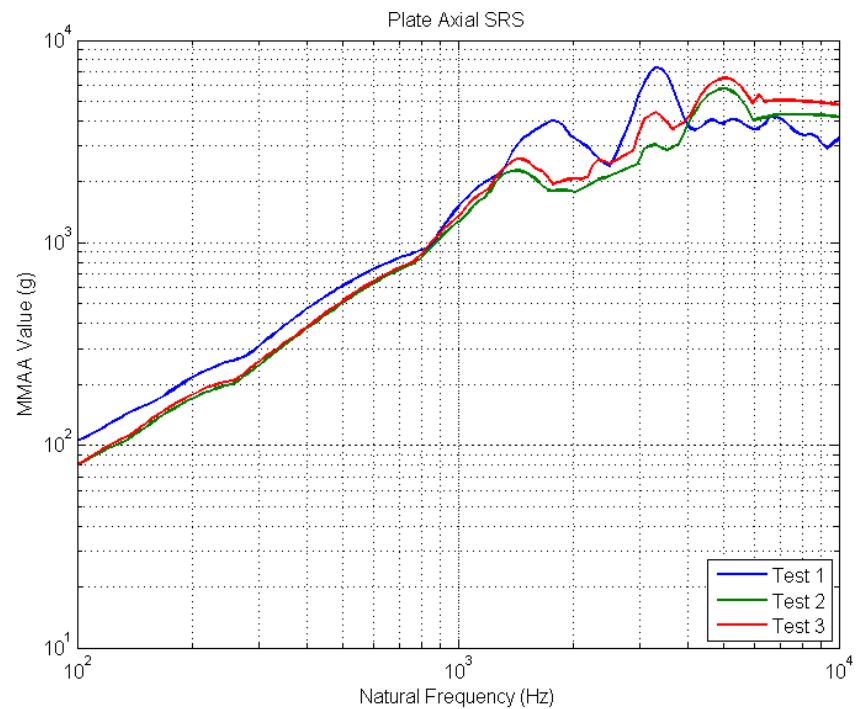
- Test item is mounted to an aluminum plate held in a support frame by ropes
 - Plates have resonance frequencies between 150 Hz and 4000 Hz
 - Plate selection depends on required knee frequency in SRS specification
- Bars and clamps added as necessary to provide damping and control shock duration





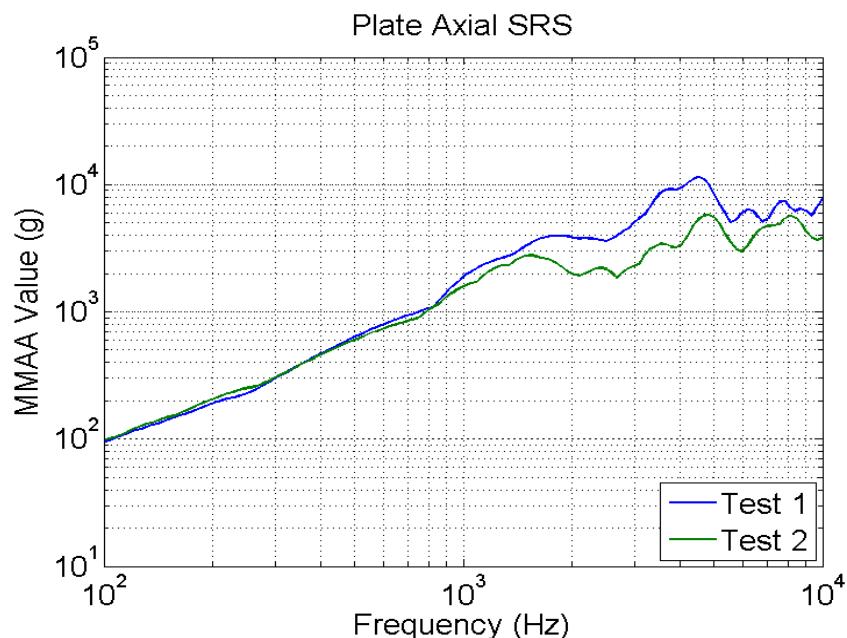
Resonant Plate Testing Challenges

- The resonant plate tester is the only system capable of achieving desired margin test levels on some components
- System has test-to-test variability issues that can be difficult to control
 - Slight setup differences can lead to significant changes in measured test levels
 - A detailed examination of the system is required between every test to spot changes
- Repeated high-g tests can lead to loosening of clamps and support ropes as well as alignment problems
- Even ordinary tasks (such as remounting a plate) can affect test results
- Characterizing and mitigating test-to-test variability can require additional dial-in work that delays testing and increases costs.

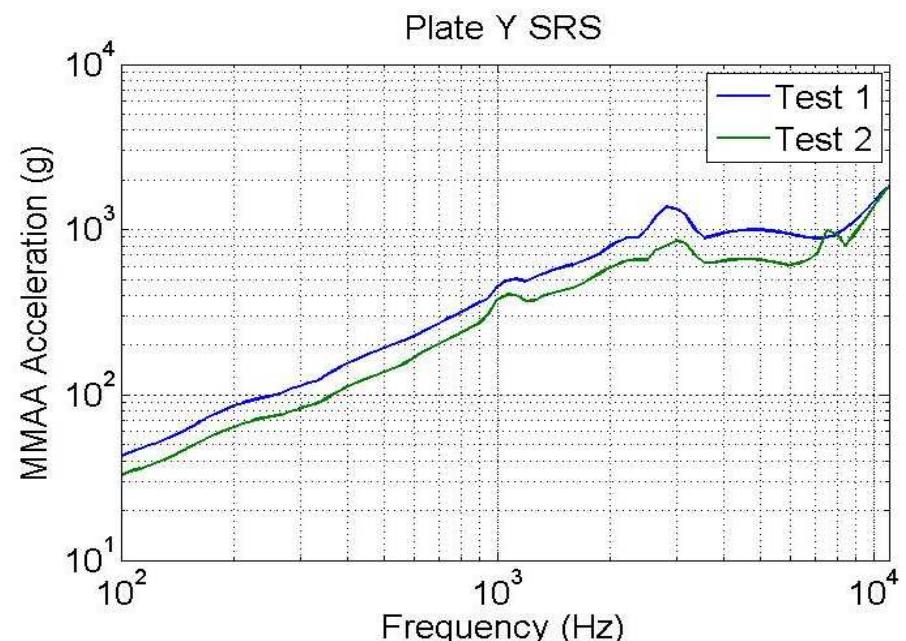


Effects of tightening support ropes on the measured SRS.

Variability Examples



Effect of plate alignment on the measured SRS. The plate and gun were slightly misaligned in test 1, and the alignment was corrected in test 2.



Effect of removing and reinstalling the plate support frame between two tests.



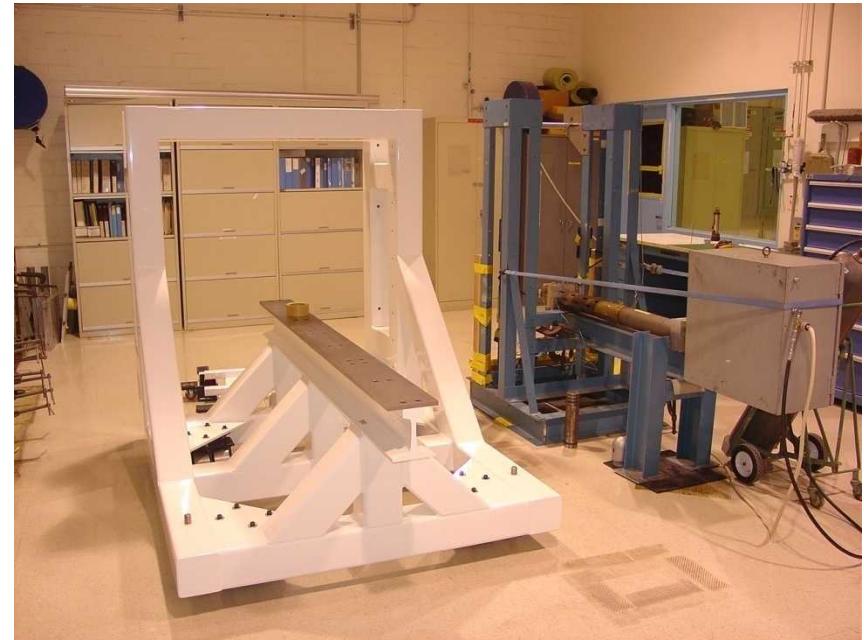
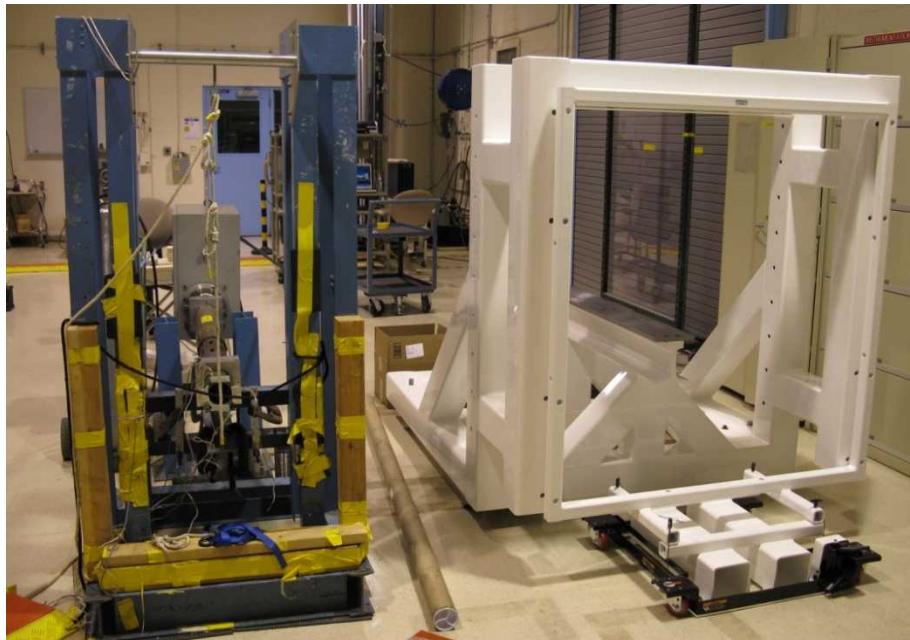
New Resonant Plate Tester



- **Stiffness of the support frame has been increased substantially**
 - Air gun support structure and plate support structure are now solidly joined
 - Support frame is also significantly heavier (6"x6" steel tubing, $\frac{1}{4}$ " thick)
- **Space around the resonant plate has been increased to allow the plate additional room to swing freely**
- **Plate frames mount directly to the support frame on $\frac{3}{4}$ " hardware**
- **System can be easily reconfigured to test new mounting and damping concepts**



Original & New Frames





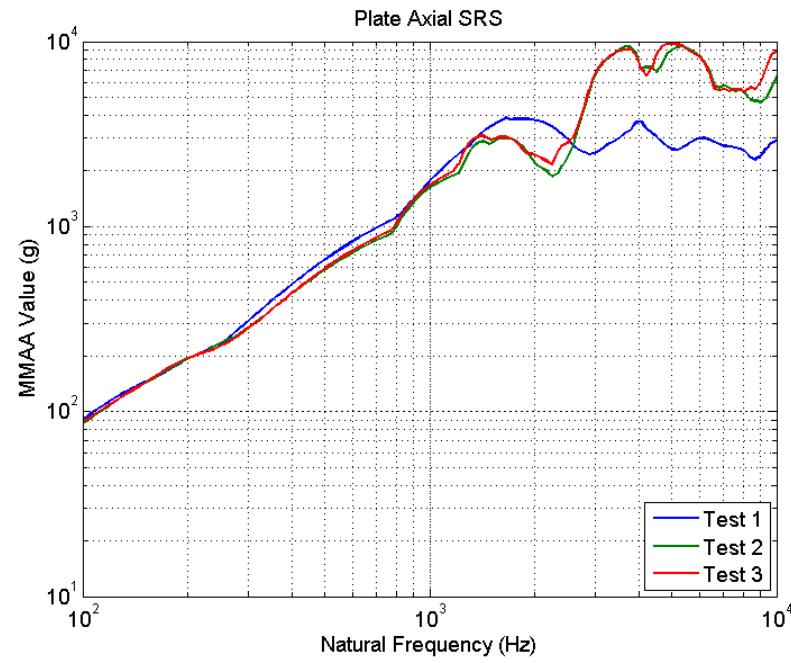
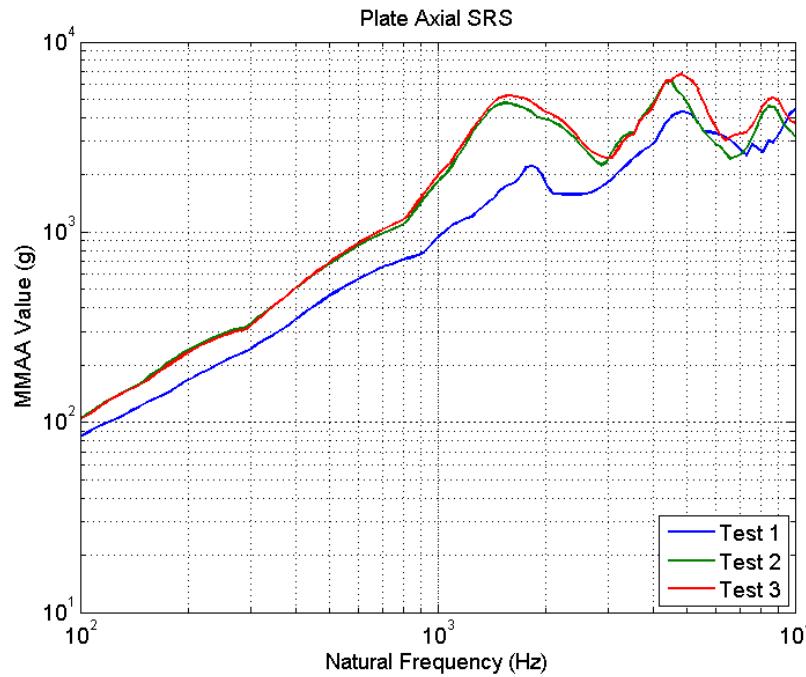
Summary & Future Work

- The redesigned resonant plate tester builds on the capabilities of the current system and addresses many of the setup issues
 - Plate mounting consistency has been improved
 - Rigidity of the new support frame will improve alignment between the gun and plate
 - Additional space around the plates will allow looser mounting while preventing secondary impacts
- Additional development work is needed to expand the range of available tuning/damping options
 - Plate mounting schemes will also be considered

Extra Slides



Additional Test Variability Plots





Pyroshock Simulators

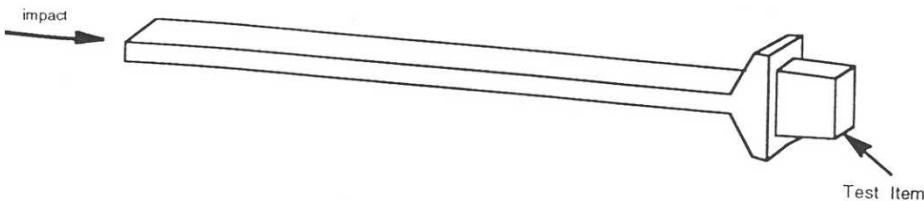
- **Resonant plate**
- **Resonant beam**
- **Tunable beam**
- **Portable resonant plate/beam system**
- **Custom fixtures**

- **3" or 3/4" diameter projectiles driven by pressurized nitrogen guns used to mechanically excite the test fixtures**
- **Nitrogen guns and test fixtures can be rearranged/reconfigured to suit testing needs**



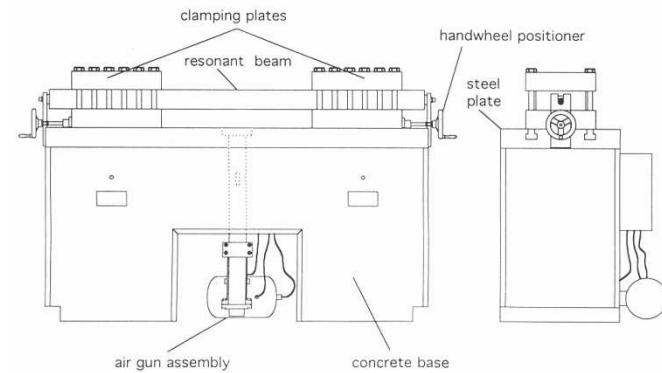
Resonant Beam

- Longitudinal response excited by projectile impact
- 2 inch and 4 inch beam thicknesses
- Clamped elastomer pads provide damping and allow some control over knee frequency
- Capable of testing larger items
- Good repeatability



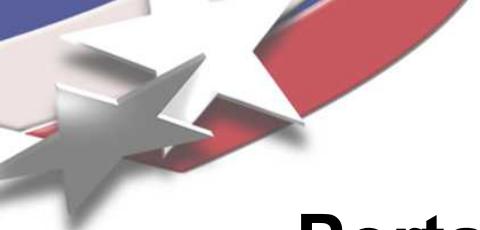
Tunable Beam

- 3 inch, 4 inch and 6 inch thick beams
- Moveable clamping plates
- Beam resonance adjustable from 500-5000 Hz
- Damping materials can be placed between the beam and clamping plates
- Excellent repeatability



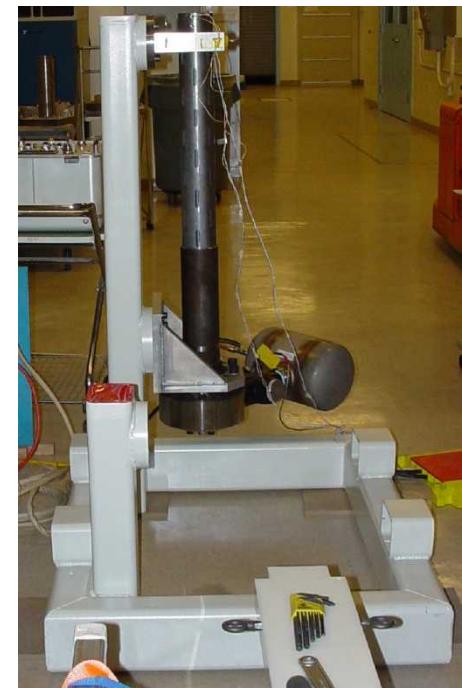
front view

side view



Portable Resonant Beam/Plate Tester

- Allows pyroshock testing outside the Shock Lab
- Nitrogen gun can be oriented in either horizontal or vertical direction
- Capable of testing large systems when paired with appropriate plate or beam fixtures





Additional Photos

