Development of Hammer Blow Test to Simulate Pyrotechnic Shock

Updated Project Scope

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Project Review

- What are pyrotechnic shocks?
  - High acceleration, high frequency, short impulse, and transient behavior
- Why do they matter?
  - High damage potential for sensitive electronics
  - Need to evaluate shocks to design for component safety
- How are pyrotechnic shocks assessed?
  - Unsafe to test using pyrotechnics directly
  - Can be recreated using other means
  - Quantified using Shock Response Spectrum (SRS) curves

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Project Goals

- Project Needs Statement:
  - The current shock testing method lacks adaptability, requiring too much trial and error testing

- Goal Statement:
  - To design an adaptable shock testing apparatus and, using both experimental and analytical models, to explore the effects on SRS curve generation from varying unique test parameters

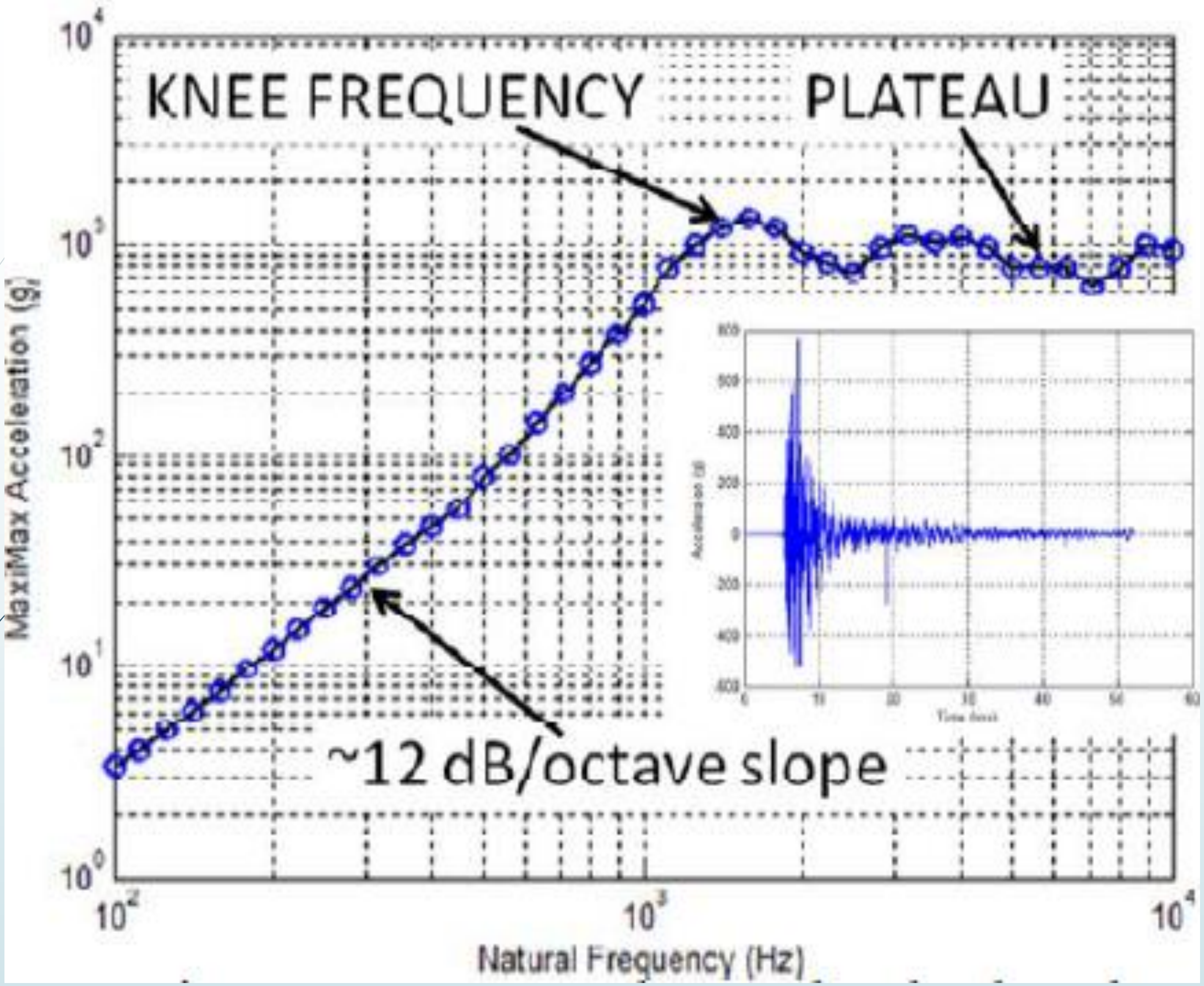


Figure 1 – Example of an SRS curve [1]

- Modeled from SDOF system
- Knee Frequency
- Frequency Domain

Revised Scope

- Smaller scale forces, emphasis on plate response
- Analytical Model to validate Experimental Methods
- Specified method: Smallwood Recursive
- Emphasis on documentation for smooth transition to second year of project

Constraints

- Test article size - up to 8 x 8 x 6 inches
- Test article weight - up to 10 lbs
- SRS response up to 500g acceleration and 10 kHz
  - Stay within tolerances set by MIL-STD-810 G, Method 517.2, Proc III
- Software allowing varied inputs to predict SRS response
- Accelerometer(s) specs must adhere to Nyquist Sampling Theorem (2.5x minimum)
- Project expenses must stay within allotted budget ($4000)
- Acceleration data acquisition that covers generated force ranges
- Software conversion for raw data to usable SRS curves

Derived Requirements

- Use of a sacrificial striking plate to preserve integrity of the more costly fixture plate
- Employing the Smallwood Recursive Method for generating SRS curves
- Documentation throughout project to be provided for year two.
- Consistent force generation to minimize margin of error
- Adjustable fixture parameters
  - Fixture plate boundary conditions
  - Test article location
  - Hammer impact location
  - Hammer tip shape

Design Modifications

- From Steel to T-slot: WHY?
- Multiple Hammer Tips (constraint)
- Sacrificial Plate

CAD model

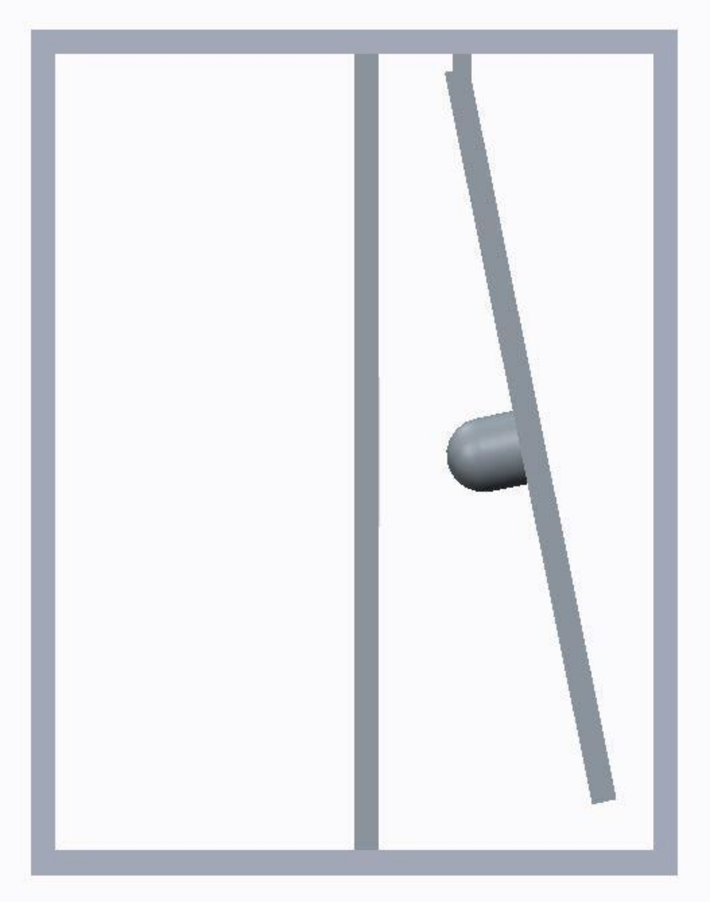


Figure 2 – Side View

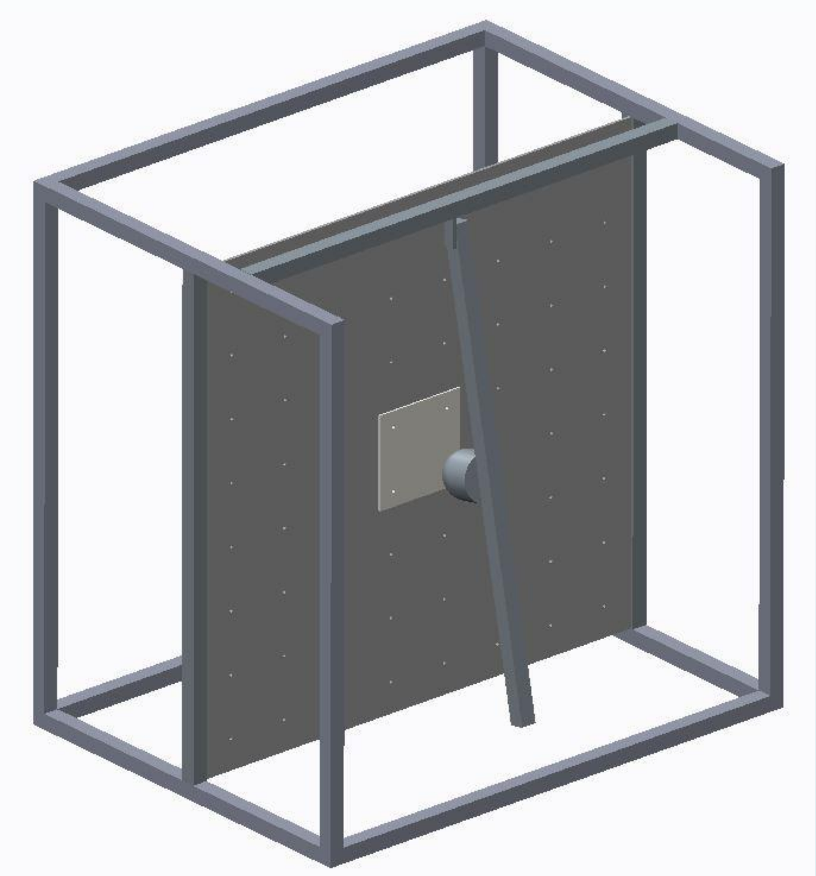
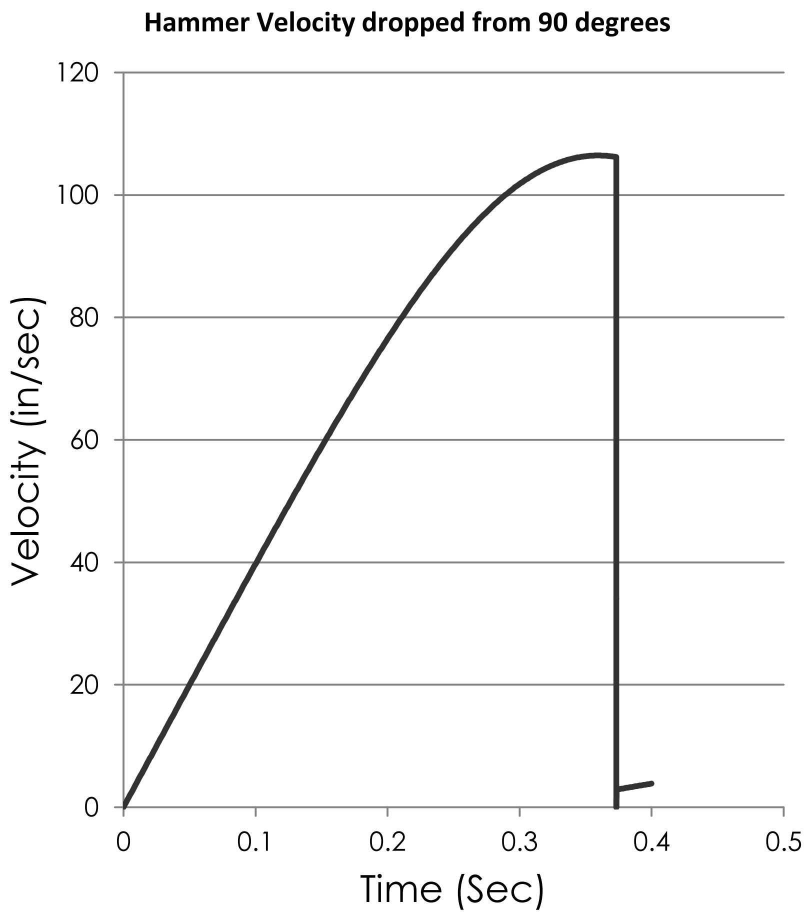


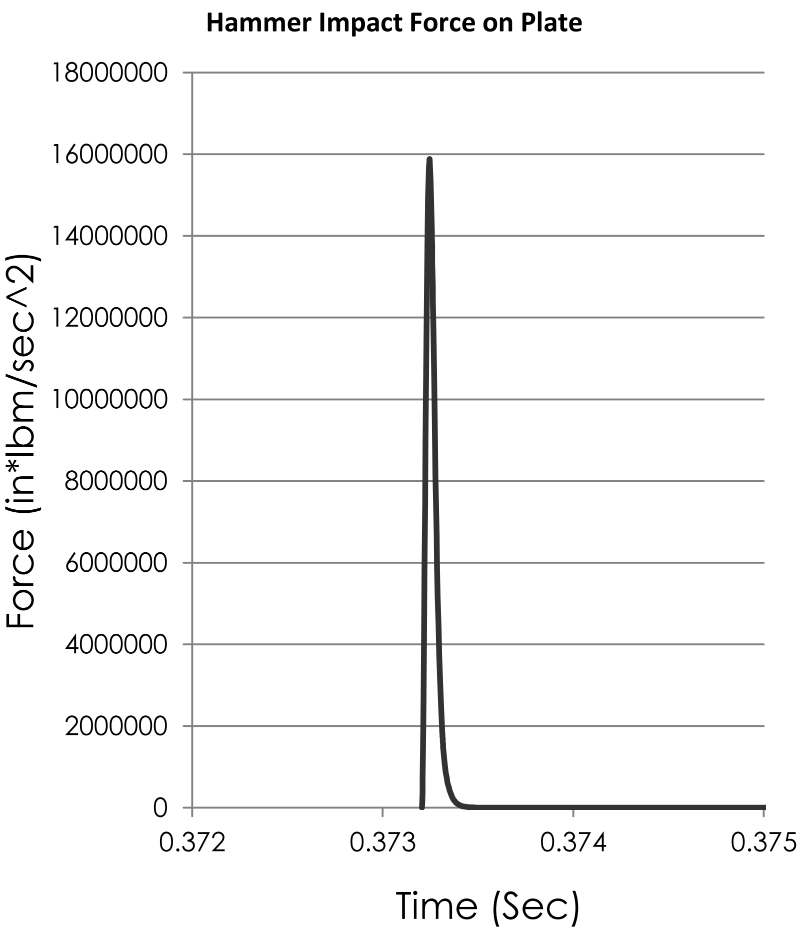
Figure 3 – Isometric View

Detailed Drawings

- Part description and drawings

ProE graphs





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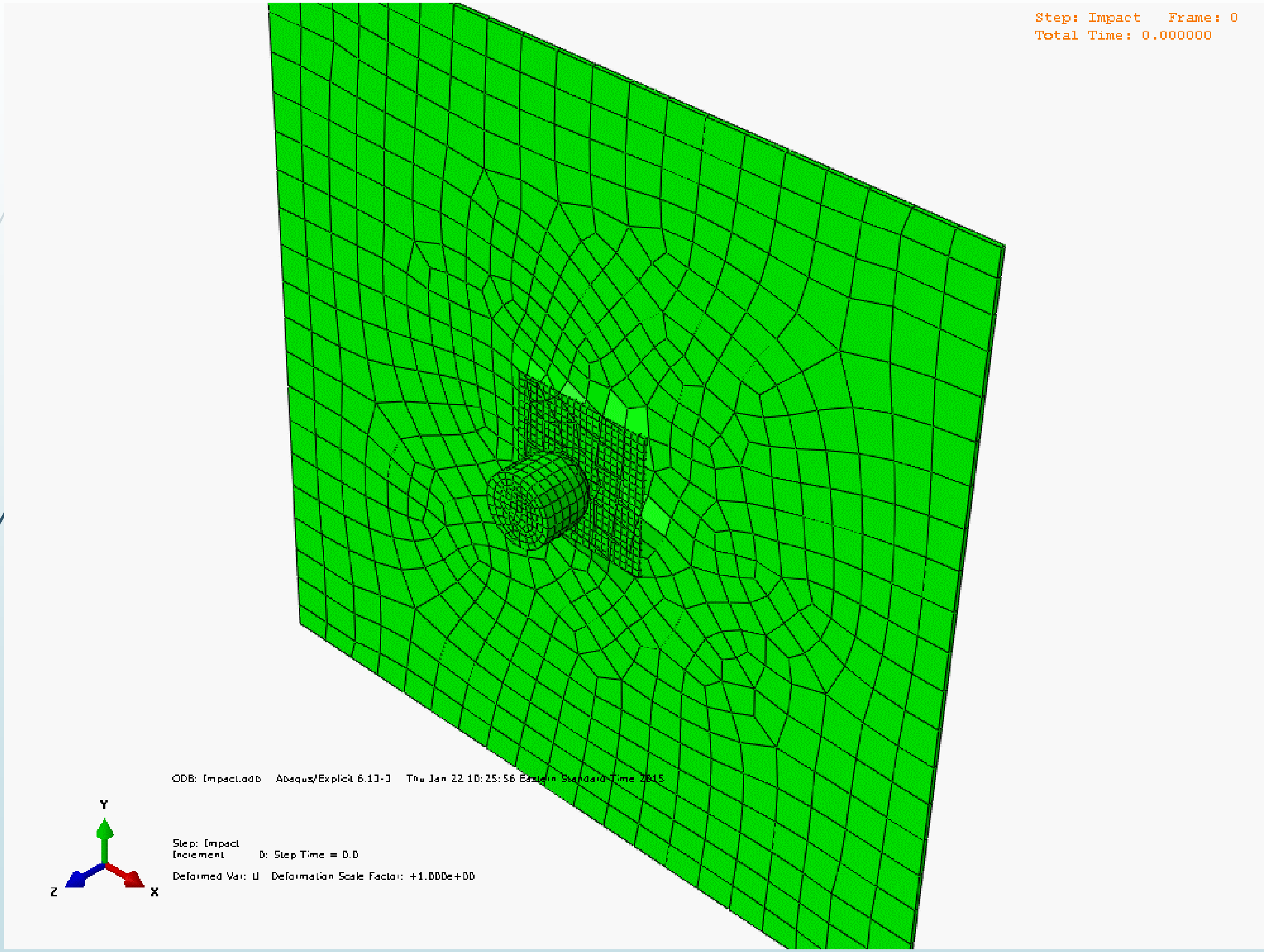
Abaqus animation



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Current Status

- Describe current state of project
  - Awaiting test fixture plate for machining
  - Refining CAD drawings for machine shop
  - Analytical Modeling with Creo, COMSOL, etc.
    - Preliminary analytical model refinement
    - Generate “target” data

Future Work

- Part 1 – Physical manufacturing
  - Machine hammer heads
  - Size & drill fixture plate and sacrificial plate
  - Manufacture plate fixture holders
- Part 2 – Assembly
  - Assemble chassis & fixture
  - Assemble hammer
  - Mate hammer to chassis, ensure proper tolerances
- Part 3 – Experimental Testing
  - Run iterative testing to compare with analytical models
  - Tabulate results
  - Modify test setup as necessary

References

- [1] Robert, Wells. "University Capstone Development of Hammer Blow Test Device to Simulate Pyrotechnic Shock 2 Year Project." 6 Jan. 2015. Web. 7 Jan. 2015.