The Art
of Fabricating
a Rotational Accelerometer

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OBJECTIVE

- Briefly review the need for a device
- Discuss difficulty using commercial hardware
- Review suitable sensor technologies
- Describe successful assembly & test techniques

Rotational Accelerometer: Need for the device

- Structural testing and vehicle collision studies require rotational data

- FEA- Surface displacements and rotations are considered in the computer model where each of them represents a degree of freedom (DOF) of the system

Rotational Accelerometer: Using Commercial Hardware

- Spatially separated and sensitivity matched linear accelerometers can be used to estimate rotational acceleration

- Inherent sensor imperfections including misalignment, transverse sensitivity, etc., contaminate the computed result

Rotational Accelerometer: Using Commercial Hardware

- Prevailing levels of output signal generated by the translational components of the structure's movement tend to overshadow those due to the rotational motions

- This undesirable ratio places a high precision requirement on the sensitivity matching process

Rotational Accelerometer: Technology Tailored Designs

- Producing an accurate rotational accelerometer from commercially available hardware is a tremendous task

- Manufacturers of accelerometers have more control over the sensitivity matching process and can incorporate technologies which have the qualities required by the design constraints of an accurate rotational accelerometer

Rotational Accelerometer: Technology Tailored Designs

- Experimental Modal Analysis (EMA) is a field of study which predominately incorporates a sensor well suited for the following conditions/characteristics: low frequency range < 1000 Hz; moderate and controlled environmental conditions; excellent immunity to transverse inputs; lightweight package; and high output sensitivity

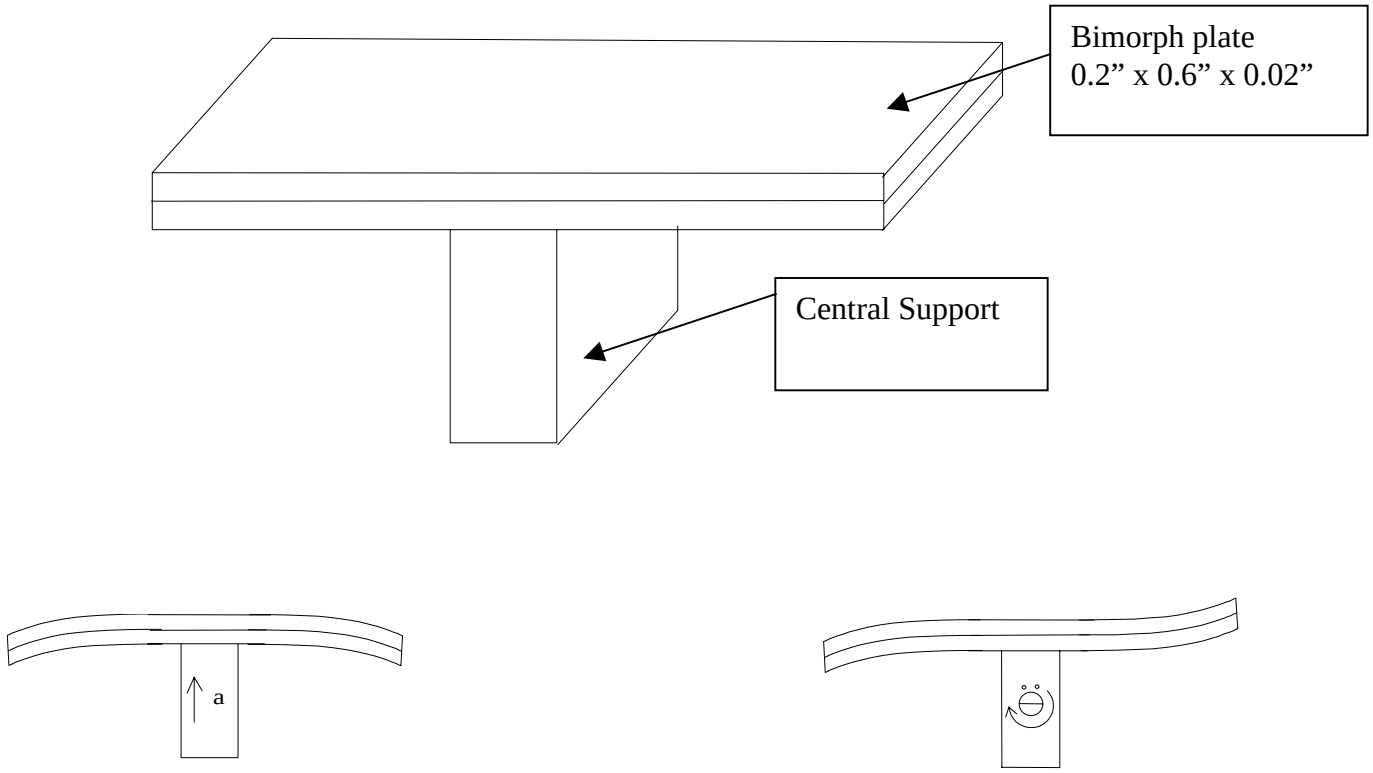
- A bimorph is an ideal piezoelectric element for this set of conditions

Accelerometer Design - Bimorph Based

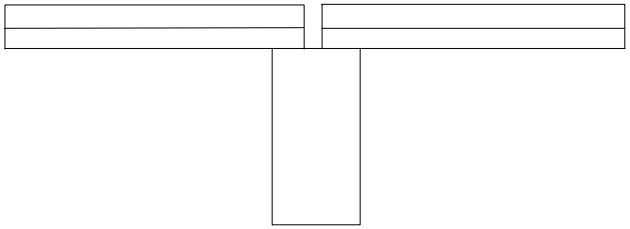
- Constructed from two inversely polarized piezoelectric plates that are sandwiched together and sliced to form a rectangle

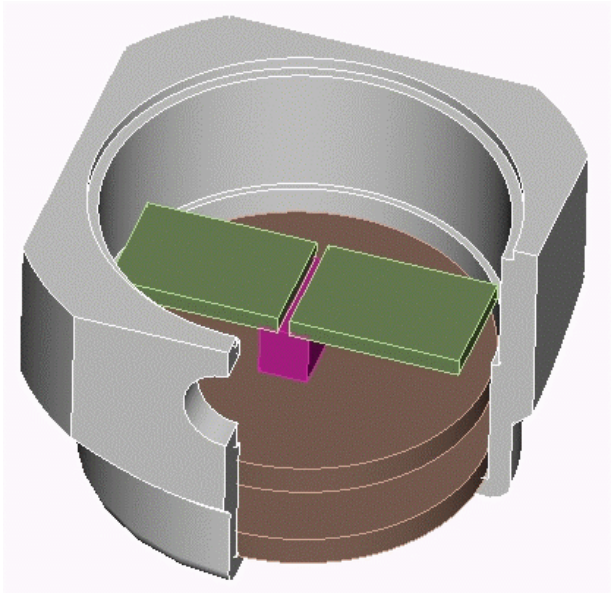
- The piezoelectric element also serves as the seismic mass since it is mounted in a manner allowing ‘beam’ flexure when exposed to acceleration

Accelerometer Design - Bimorph Construction

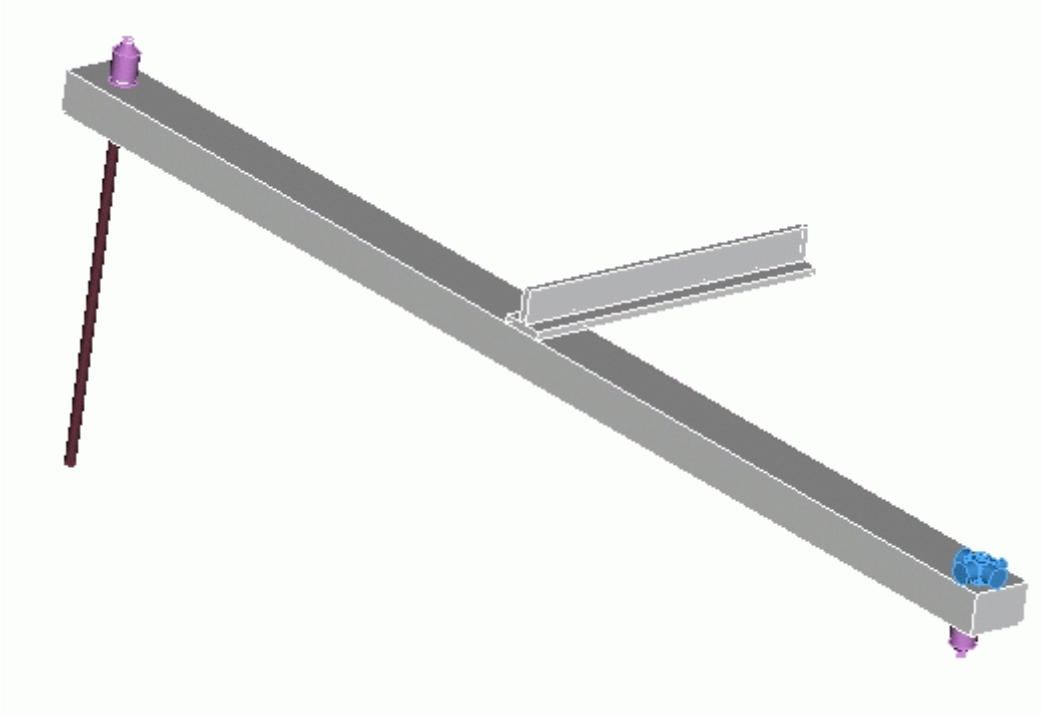


Rotational Accelerometer: Assembly Techniques





Rotational Accelerometer: Test Techniques

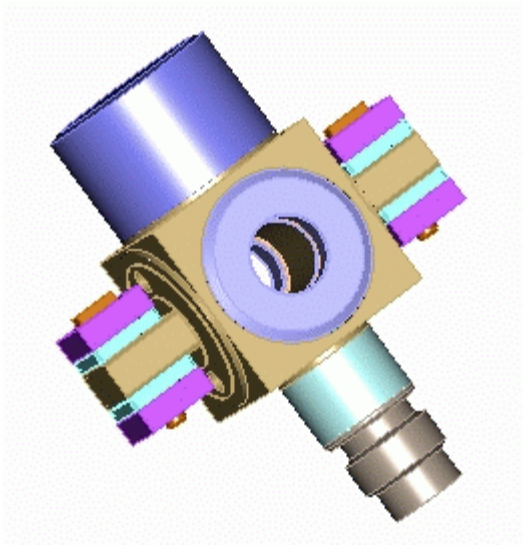


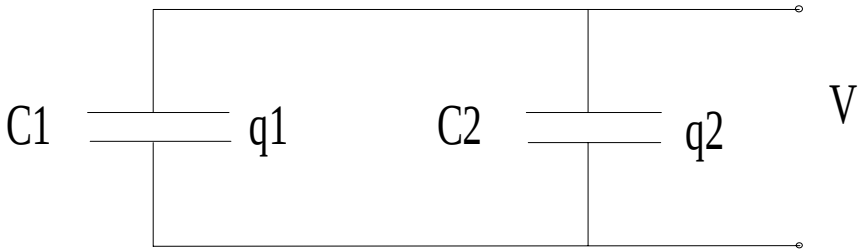
Rotational Accelerometer: Technology Tailored Designs

- Automotive crash studies have identified rotational acceleration as a tremendous influence regarding damage to humans during a vehicle collision

- A shear construction quartz based design is well adapted to this environment

Accelerometer Design - Shear Quartz Construction





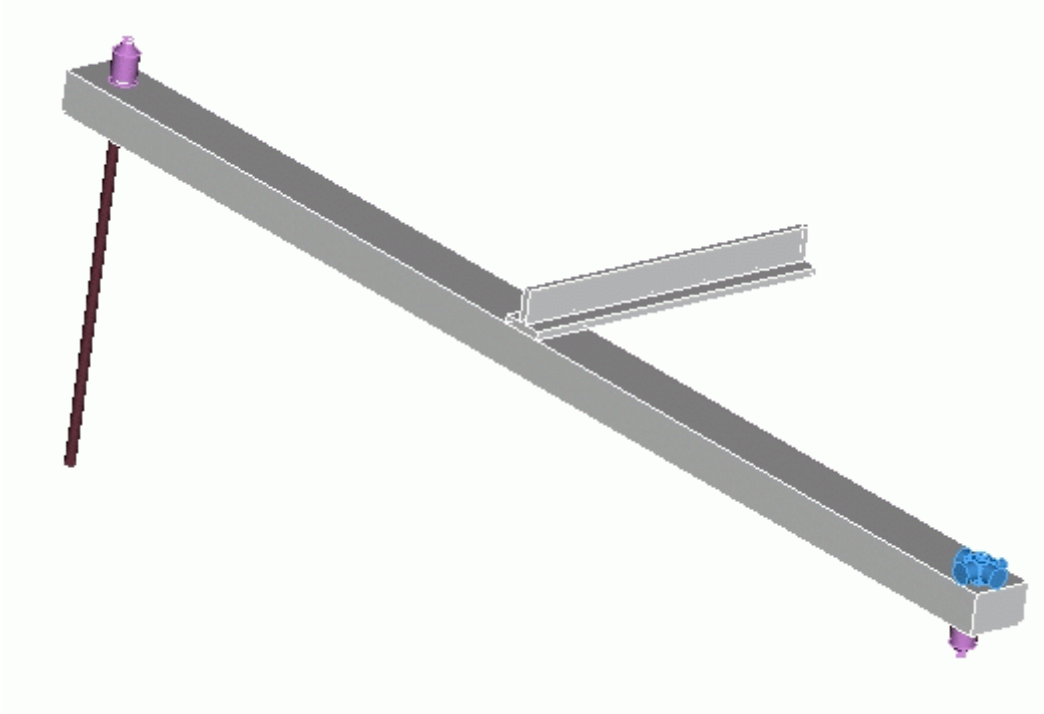
$$V = (q1+q2) / (c1+c2)$$

Rotational Accelerometer: Assembly Techniques

- The charge presented by each half of the seismic system, q1 and q2, are dependent solely on each half's total mass (sum of quartz plates, masses, & preload bolt)

- Each side can be matched for identical weight using a static weighing process - dynamic sensitivity measurement is needed only for calibration constant

Rotational Accelerometer: Test Techniques



CONCLUSION

- Reviewed the need for a rotational accelerometer
- Discussed problems associated with the use of commercial hardware
- Technologies with appropriate features were reviewed
- An overview of assembly & test techniques was presented