The Advantages of Using Magnesium in Vibration Test Fixtures

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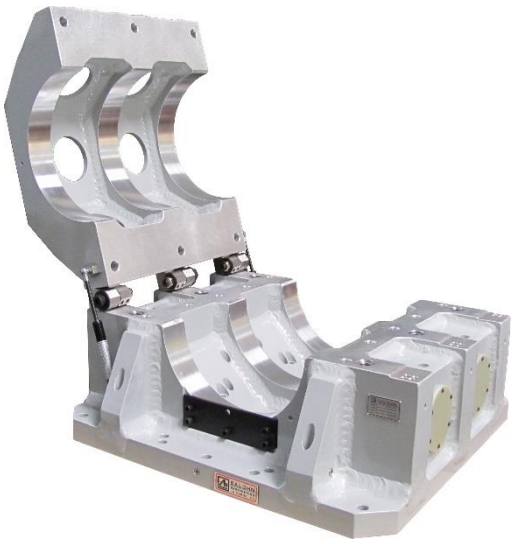
Vibration Testing

Vibration testing of components is a critical aspect of design validation in modern engineering. This type of testing ensures that components do not fail due to fatigue or fasteners do not shake loose in service. The types of testing regimes vary widely, from the simulation of shipping transportation vibrations of white goods, to launch and inflight vibrations of orbital launch systems. The vibrations can be simple single axis sinusoidal waves, or complex three axis recorded vibrations representative of real world conditions. Frequencies can range from 5Hz to 2,000Hz.



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Aside from the shaker, key aspects of a vibration testing system is the support tooling, i.e. Head Expander, Slip plate, and the fixture that supports the component. These items need to be stiff, strong, light weight and have good damping characteristics to reduce resonance amplification levels for improved controllability. Magnesium AZ31B-Tool Plate (TP) is an ideal material for these due to its combined physical and mechanical properties.

Damping capacity of Magnesium and its Alloys

Damping capacity is a measure of a material's ability to dissipate elastic strain energy during mechanical vibration or wave propagation. When ranked according to damping capacity, materials may be roughly categorized as either high- or low-damping. Low damping materials maybe utilized in musical instruments where sustained mechanical vibration and acoustic wave propagation is desired. Conversely, high damping materials are valuable in suppressing vibration for the control of unwanted noise and for the stability of sensitive systems and instruments (Zhang, 1993).

Damping capacity is the result of internal friction associated with the stretching of atomic bonds in a material that causes the conversion of elastic energy to heat during vibration such that the amplitude of vibration attenuates over time. Damping capacity is given by:

$$\psi = \frac{\Delta W}{W}$$

where ψ is the specific damping capacity, W is the energy associated with the initial displacement or strain of the material, and ΔW is the energy lost during one cycle of oscillation (Wolfenden, 1991).

The specific damping capacity for various engineering materials is given in Table 1. Magnesium and its alloys have considerably higher specific damping capacity that other conventional metals.

Table 1. Specific Damping of common engineering metals (Zhang, 1993)

Material	**Ψ at 0.1 σ_{ys}(%)**
AA6061-T6, Zn, Ti,	1.50
Cast irons, Ni alloys	2.50
Pure Al, Cu	3.50
Steel	4.00
Mg Alloy- AZ31B-F	10.00

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Properties of Magnesium Alloys AZ31B- Tool Plate

AZ31B-TP has a density of 0.064 lbs/inch^3 (1.78g/cm^3) which is over 30% lower than aluminum alloys. AZ31B-TP suitable for vibration fixtures and with good damping capacity has a tensile yield strength of 19Ksi, ultimate tensile strength of 35Ksi, elongation of 10% and a Young's Modulus of 45Gpa.

The low density and high damping capacity make AZ31B-TP the material of choice for vibration test fixtures. Fixtures fabricated from AZ31B-TP exhibit higher resonant frequencies relative to equivalent aluminium structures. This allows testing to be carried out at higher frequencies and shorter test times, reducing testing costs. The low density of the materials leads to fixtures with lower weights. This has several benefits. Firstly, vibration test machines are limited to a maximum force that they can exert. As F=ma and high acceleration enables higher frequencies with in a defined displacement, the reduced mass of a magnesium fixture increases the overall envelope of operation of any give vibration test bed. This can allow multiple parts to be run in the same test, greatly reducing the overall cost.

AZ31B-TP is free machining i.e. cutting fluids are not required. The material generates chips during machining that allow it to be machined at very high speeds. Furthermore, magnesium's free machining characteristics reduces wear of the cutting tools, greatly increasing tool life.

AZ31-B TP is weldable and is stable after subsequent stress relieving. This allows complex fixturing to be fabricated and precision machined.

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Available AZ31B-TP Dimensions

AZ31B-TP is available in a wide range of sizes. Max gage= 10 inches (250mm), Max width= 72 inches (1828mm), Max length= 240 inches (6000mm). The maximum plate weight is limited to 2860lbs (1300kg)

References

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Magnesium Elektron Data Sheet 484 AZ31B-Tool Plate

Acknowledgements

Special thanks to Jim Dumas of Vibration Fatigue Laboratory for technical input.

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