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The Damping of Vibration in Engineering Structures

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In many structures, particularly in transport, vibration can be excited by a wide range of sources. In cars, such sources will be the engine and transmission, the suspension, and tyre and wind excitation. Similar sources exist in aircraft and boats [large and small]. If the oscillatory energy is not dissipated, it can build up and cause large amplitudes of vibration, especially if resonance can occur. This can cause fatigue and human discomfort.

The vibrational energy can be dissipated, transformed into heat, within the structure by damping or transmitted to the surroundings such as by acoustic radiation. Each situation is different. Here, I will look at the inherent damping of the structure. It is, of course, possible to increase the damping by using add-on damping in the form of a polymer layer contained by a thin metal sheet. However, since there is constant pressure to reduce the weight and cost of all forms of transport, add-on damping solutions are used sparingly. It is therefore important that all passive forms of damping are harnessed first.

Most structural materials, even carbon and glass fibre reinforced plastics, have little damping. In steels and other ferromagnetic alloys, the main damping source is magnetomechanical. Cast iron can provide good damping, but there is an inverse relationship between damping and strength. Some special alloys using manganese and copper rely on an unstable stress-induced martensite-austenite transformation. When panels are joined using bolts and rivets, there is always some slipping [relative movement] in the joints and this is an excellent, but unreliable, source of damping. Continuously welded joints effectively stop slipping and even spot welding allowed little slip.

With the increasing use of multimaterial structures, welding is impractical and joining has to be by bolts and rivets or by adhesive bonding, especially where composite materials are used. Point loads in composites are unattractive owing to their poor shear and transverse mechanical properties.

It is the purpose of this presentation to indicate what level of damping might be expected in practice