July 20, 2018

ZERO STRESS JOINTS FOR DISSIMILAR MATERIAL STRUCTURAL ELEMENTS

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Zero Stress Joints for Dissimilar Material Structural Elements

Abstract: A technique is disclosed that firmly holds together structural members of different materials without causing additional stress due to thermal expansion, and also avoids the stress caused by the assembly and manufacturing tolerances, by placing a plastic bracket between the dissimilar metals at a joint.

This disclosure relates to the field of mechanical structures.

A technique is disclosed that firmly holds together structural members of different materials without causing additional stress due to thermal expansion, and also avoids the stress caused by the assembly and manufacturing tolerances.

Steel and aluminum are two metals widely used in the frames and components of many machines, including large format printers, for example. In a number of applications may be desirable. However, these two materials may have rather different thermal expansion coefficients, which can lead to a number of problems. If aluminum and steel elements coexist and are firmly united, thermal expansion will cause a large amount of internal stress and deformation of the joined structure. If this stress becomes large enough, it may lead to a catastrophic failure of the structure. However, if on the contrary the joints allow for longitudinal displacements between the aluminum and steel structural elements, the overall stiffness of the node will be much lower, which can cause vibration problems as the normal modes of the structure will be lower.

One prior solution attempts to avoid the thermal problem in hyperstatic structures of different materials like steel and aluminum is to include some joints working by friction to control the tension caused by thermal effects. The controlled friction force will allow the joints some longitudinal movement. The problem is that the tension in the structure does not disappear but is only controlled, and the resultant joint is weak.

According to the present disclosure, a plastic bracket is placed between the dissimilar metals at a joint. This plastic bracket is made of a resin having a very high thermal expansion coefficient, and that compensates for the extra elongation that, for example, aluminum suffers in comparison with steel.

Consider an example mechanical structure that carries modules of a device. Two sideplates at each side of a steel beam are firmly attached to an aluminum structural frame. However, the beam is made of steel. Since the thermal expansion coefficient of aluminum is larger than that of steel, when the temperature rises, the sideplate will tend to move further than the steel allows. This causes stress at the joint, and if the temperature is high enough the attaching screws will fail.

As a result, a plastic bracket made of a resin having a very high thermal expansion coefficient is placed between the steel beam and one of the sideplates.

The length of the plastic bracket is determined according to the following equation:

$$L_{Al} \cdot \alpha_{Al} = L_{steel} \cdot \alpha_{Steel} + L_{Bracket} \cdot \alpha_{Polymer}$$

Where:

L_{Al} is the distance between sideplates

L_{steel} is the length of the service Beam

$L_{Bracket}$ is the length of the plastic bracket
α_x is the thermal expansion coefficient of the different materials

The plastic bracket carries forces only in the X direction, while the forces are transmitted directly from the steel beam to the sideplate. This configuration negates any adverse effects of the lower stiffness of the plastic bracket. Due to its geometry, the bracket is very stiff to traction/compression loads (x direction). If the steel beam is hollow on the inside, the plastic bracket can be accommodated within the beam without adversely affecting the overall length of the mechanical structure.

The plastic bracket may have slots in the X direction in its interface with the steel beam, which allows it to have compliance to any deviations of the sideplates from their nominal position.

The disclosed technique advantageously allows the manufacturing of structures made of dissimilar materials, assuring good load transmission between its different members and high stiffness. It eliminates the stress caused by the thermal expansion of the structure.

In addition to this, the plastic bracket acts as an adjustment for any deviation from nominal of the distance or angle between the sideplates. As a result, the technique advantageously makes the design isostatic, avoiding unwanted stress during the assembly process.

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