Encyclopedia of Aluminum and Its Alloys

Aerospace Fasteners: Use in Structural Applications

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Abstract:	Aircraft materials need to be selected and manufactured to adequately combat the environment, temperature, loading, compatibility, et cetera. When structural materials such as aluminium alloys or fibre-reinforced polymer composites need to be joined in aircraft, the selection of fasteners, bolts, rivets, adhesives and other methods need to be quantitatively assessed in order to identify the correct design for the component and joining method. Aluminium rivets are often used to join aluminium components in an aircraft. Bolts are designed to clamp material together, and even though the bolt may be adequate to support a particular structure and load requirement, consideration must also be given to the Modulus of Elasticity and stiffness of the components that are being clamped together. An understanding of each of the materials being clamped or joined together is necessary. Bolts manufactured from steel for instance have coatings applied in order to help protect them from corrosion. The use of composites translates to a reduced number of rivets and fasteners to be used. Drilling of holes into composites to insert fasteners poses many challenges because the fibres are damaged, a region of high stress concentration may be formed, and the hole is a site for the ingress of water or moisture. The insertion of aluminium fasteners or contact with aluminium components with carbon fibres creates galvanic corrosion due to differences in electrical potential. Titanium alloy Ti-6Al-4V is a typical fastener where there is composite joining due to its better compatibility (elimination of galvanic corrosion) and increased strength properties.

Aerospace Fasteners:

Use in Structural Applications

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Abstract

Aircraft materials need to be selected and manufactured to adequately combat the environment, temperature, loading, compatibility, et cetera. When structural materials such as aluminium alloys or fibre-reinforced polymer composites need to be joined in aircraft, the selection of fasteners, bolts, rivets, adhesives and other methods need to be quantitatively assessed in order that the correct design for the component and joining method is identified. There is a variety of fasteners, bolts and rivets, made using a variety of materials. Aluminium rivets are often used to join aluminium components in an aircraft. Rivets do not perform well under tension loading, but perform better in shear thus limiting the application specifically for these purposes. Bolts are designed to clamp material together, and even though the bolt may be adequate to support a particular structure and load requirement, consideration must also be given to the Modulus of Elasticity and stiffness of the components that are being clamped together. Therefore, an understanding of each of the materials being clamped or joined together is necessary. Bolts manufactured from steel for instance have coatings applied in order to help protect them from corrosion.

The use of composites translates to a reduced number of rivets and fasteners to be used. Drilling of holes into composites to insert fasteners poses many challenges because the fibres are damaged, a region of high stress concentration may be formed, and the hole is a site for the ingress of water or moisture. The insertion of aluminium fasteners or contact with aluminium components with carbon fibres creates galvanic corrosion due to the large difference in electrical potential. Titanium alloy Ti6Al4V is a typical fastener where there is composite joining due to its better compatibility (elimination of galvanic corrosion) and increased strength properties.

Substitution of rivets and fasteners for welding is also on the increase in aircraft since Laser Beam Welding (LBW) and Friction Stir Welding (FSW) both reduce cracking, porosity, better properties achieved due to deeper penetration and reduces the Heat Affected Zone (HAZ) which would typically be undesirable with conventional arc welding such as Metal Inert Gas (MIG) and Tungsten Inert Gas (TIG) welding. The shear and compressive stresses are increased, fatigue cracking, weight and cost is also reduced as a result of LBW, including the elimination of stresses and corrosion associated with rivets, and the elimination of adhesives. Dissimilar metals such as the 7000 series and 2000 series can be joined with a filler metal compatible to both metals to mitigate galvanic corrosion.