

Materials joining methods

Two methods used to join of materials permanent and semi-permanent, Different materials can be joined in many different ways depending on the joint needs to be permanent or semi-permanent. They are (Welding, Brazing, Soldering, Riveting, Adhesives, Nuts and bolts and washers, Knock-down fittings, Screws).

- Permanent: This term refer to welding, brazing, soldering and adhesive bonding. In these processes a permanent joint between the parts is formed and cannot be separated easily, if separate these parts are damage.
- Semi-permanent: this type of joint is a method of joining that is designed to be permanent, this term refer to nuts and bolts and washers, knock-down fittings; however, it can be disassembled without damage the materials.

Welding

the process of joining two similar or dissimilar materials by application of heat, with or without the application of pressure and with or without the use of filler metal. Welding is a material joining process in which two or more parts are assembled (joined together) at their contacting surfaces by a suitable application of heat and/or pressure. Sometimes parts are united together by application of pressure only without external heat. In some welding process a *filler* material is added to facilitate united. Welding is used most commonly with metallic parts but for plastics also it is used.

The main method of permanently joining metals is by welding. Two main types of welding are *conventional and nonconventional* welding. There are many types of welding as MIG and TIG, oxyacetylene welding, electric arc and spot and seam welding, all involve permanently joining metals by the use of heat, causing the two main pieces of metal to become molten and using a joining material to mix them before they solidify, forming a permanent, strong joint.

Riveting

Rivets are used to join two sheets or plates of metal together. There are four main types of rivets: snap head, mushroom, pan head, countersunk, and the operation with join by rivets including;

1. The rivet is placed into a tool called a dolly that is held in a vice.
2. The plates are then placed over the rivet.
3. The rivet set is then placed over the rivet and pressed down to ensure that there are no gaps between the sheets/plates of metal.
4. The rivet set is tapped with a ball pein hammer. This closes any gaps and starts to form the rivet joint.

The ball pein hammer is then reversed to form the head of the rivet. The final stage is using a rivet snap to form a similar shaped dome on both sides of the joint.

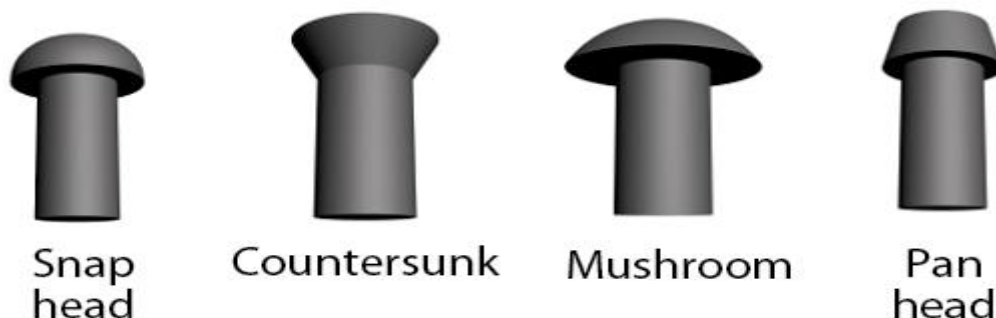


Figure 27 Rivets are used to join

Adhesives

The main advantage of using an adhesive over other methods of joining, it is generally invisible unlike other methods of joining and adhesives do not damage or change the materials being joined, but it is not used to all materials.

Types of adhesives

Synthetic resin glue; Use to joining wood, it is a powder that is mixed with water to make a thin paste, advantages of this type are; stronger than PVA, heat and water resistant, economical, permanent, And disadvantages are; takes 4-6 hours to set, hard on tools.

PVA (Polyvinyl); use to Joining wood, it is a white liquid sold in various sizes of containers, with advantages (strong and water resistant, sets quickly (2-3 hours), excess glue can be removed by a damp cloth).

Contact (impact) adhesive; Use to joining different types of materials, e.g. plastic or metallic strips to wood and other materials. Each surface is coated with the adhesive and left for 10-15 minutes until touch dry. With advantages are; Clean, quick, economical.

Epoxy resin; is the main example of this adhesive. It is used to form a rigid bond with most unlike materials with exception of silicon rubber, polythene or thermoplastic. The resin and hardener are mixed and spread over surfaces and left to set for 24 hours. Advantages are; Good water resistance, insulation and gap filling properties. Disadvantages are expensive because it needs to be spread over a larger area to be permanent, high cost prevents large-scale work.

Other adhesives are;

- Tensol 12 and tensol 70 for joining thermoplastics.
- Tensol 53 for joining PVC.
- Rigid polystyrene cements.
- Special DIY all-purpose adhesives.
- Special industrial adhesives.
- Double-sided tape.
- Latex adhesive.
- Hot-melt glue used in hot glue guns.

Nuts, bolts and washers

Nuts and bolts are used to hold two or more pieces of materials together in a semi-permanent method of joining. Bolts tend to be made from high tensile steel and are threaded (square or hexagonal threaded) for all or part of the length of the shaft. Nuts used with bolts must have matching diameter and thread form. They come in various forms, from wing nuts (made for easy removal by hand) to hexagonal nuts and special locking nuts that resist coming loose. Types of washers: Washers are used to protect the surface when nuts are tightened. They spread the load applied to the surface and prevent loosening that can be caused by vibrations.

Conventional Welding Classification

Welding processes usually divided into three main groups, solid state and liquid state welding, but there are third type namely solid/liquid state. With three types the materials are joined together with these methods cannot separate easily and achieved by pressure, pressure and heat, or heat only.

Solid-state Welding Processes; In solid state welding such as friction welding, forge welding, explosion welding, etc. The surfaces to be joined are brought into close proximity by heating the surfaces without causing melting and applying normal pressure and providing relative motion between the two surfaces, after stop the motion is applying high pressure without heating. In these processes the materials remain in solid state and welding is achieved through the application of heat and pressure, or high pressure only.

Liquid State (Fusion) Welding Processes; arc welding, resistance welding, oxy fuel gas welding, etc. There are two inherent problems with fusion welding, effect of localized heating and rapid cooling on the microstructure of the parent metals and effect of residual stresses developed in the parent metals due to restrained expansion or contraction.

Solid / Liquid State Bonding; In this state low temperature joining methods are used when the metal to be joined cannot withstand to high temperature, or complex sections are to be joined, or dissimilar metals are to be joined, or weldability of material is poor. Also in these methods, the gap between the metal pieces to be joined is filled with molten filler material after heating the base metal. Melting point of filler material is much lower than base metals. The bonding is not due to melting of parent metal.

Filler material is drawn into the gap between the metal pieces to be joined by capillary action and the bond formation is started when the molten filler metal comes to contact with the solid surface as in solid state welding. The nature of bond formed is much complex here, there is some of inter-solubility between filler and base metals to produced resulting alloy. This inter-diffusion at the base metal surface and resulting alloy has a strength which is very close to that the base metal.

Also for a good joint strength the liquid filler metal; must flow into the gap between the metal pieces to be joined and cover the entire surface area, without gaps or blow holes. Usually to good bonding are doing the following:

- Clean base metal surfaces
- Maintain optimum gap.
- Heat the joining area above melting temperature of the filler material.
- Use fluxes for welding of base metal surfaces.

Welding which is the process of joining two components for the desired purpose, can be defined as the process of joining two similar or dissimilar materials components with the application of heat, with or without the application of pressure and with or without the use of filler metal. Heat may be obtained by chemical reaction, electric arc, electrical resistance, frictional heat, sound and light energy etc.