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Significance Of Welded Joints Used In Mechanical Engineering And Calculation Of Forces

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Annotation: The article provides brief information about welding joints used in machine building today. We also gave brief information about the types of welded joints, their advantages, places of use, and defects that occur in them. We calculated the tension forces in welded joints through the loadings generated at the welds of welded joints and their calculation expressions, and recommendations on the length of the weld and the methods of joining given.

Keywords: Joint, separable joint, non-separable joint, weld, butt-butt, butt-butt, contact welding, separable, weld, butt-butt, butt weld, spot, gas and electric arc.

Introduction

It is known that cars are assembled by means of assemblies consisting of parts and nodes. Compounds are divided into separable and non-separable types.

Non-separable joints are joints in which it is necessary to break the joint elements or rework the working surface in order to separate the machine units into individual parts. Joints with rivets, welds, and tightly interlocked parts are integral joints.

Grooved, keyed, slotted joints are separable joints, in which, when the nodes are separated into details, the working part of the detail is not damaged.

Poor performance of machines, premature failure, increased noise during operation are caused by the low quality of the joint (poor fastening, poor welding, improper selection of material for the joint, etc.).

Joint elements are mainly considered for strength. In this case, it is necessary to ensure that the strength of the large elements is the same as the strength of the details being attached.

Welded joints belong to the group of non-separable joints. Structures, liquid storage tanks, trusses, metal towers, casings and some details used in various industries are obtained in this way.

The advantages of welded joints include:

-saving of metal;

- in practice, it is possible to obtain details of different shapes and sizes;
- the strength of the welded joint under static and shock loads is almost close to the strength of the main part;
- high possibility of automation of the welding process;
- Gypsum density and gas and liquid impermeability of the weld.

Disadvantages of welded joints include:

- some difficulty in determining the quality of the weld;

- temperature deformation of the part being welded;
- the presence of a concentration of stresses;
- the impossibility of welding some materials.

As mentioned above, welding is based on the forces used to stick the molecules of the connecting parts. To achieve this, two methods are used: heating the metals at the junction of the parts without melting them or turning them into a liquid state, and pressing the parts together.

The first method is liquid welding, and the second is pressure welding.

This welding is divided into gas and electric arc welding types.

In the gas welding method, combustible gases (acetylene, hydrogen) are ignited between the electrodes in a certain amount and pass through the torch channel. A welding wire suitable for the composition of the metal to be welded is used. Under its influence, the welding place of the welding part and the end of the welding wire are liquidized and a joint is formed. Gas welding is used to join parts made of thin-walled steel and non-ferrous metals.

The place to be connected by electric arc welding is heated by means of an electric arc and an electrode is liquidized to it, resulting in the formation of a weld. The molten electrode between the parts acts as a bond.

Arc welding uses an electrode coated with a special compound to maintain stable arc adhesion. The thickness of details can be from 1 mm to 60 mm in the case of welding by the handle method. In this case, the current is in the range of (200÷500) A. In this method, welding is used in the quantity of single units and in serial production (if the seams are short and inconveniently placed).

Automatic welding is performed using an electrode wire. It is mechanized to transfer the wire and move it in the direction of the seam. This method is widely used for welding steels with a thickness of 2÷130 mm and their alloys. In this case, the electric arc burns stably under the layer of liquid metal flux or in environments that are protected from air gases. In this case, the current is (100÷300)A. It is used in high-volume and mass production, as well as in aircraft construction. Parts are heated with electric current (electrical contact welding) or friction welding (friction welding). Electric contact welding is used to connect parts of shafts made of different steels or cutting tools (drill, tap) (Fig. 3.1-a). When an electric current is passed through the parts to be welded, due to the presence of conductor resistance at the junction of the current, these surfaces heat up in a short time and become highly plastic.

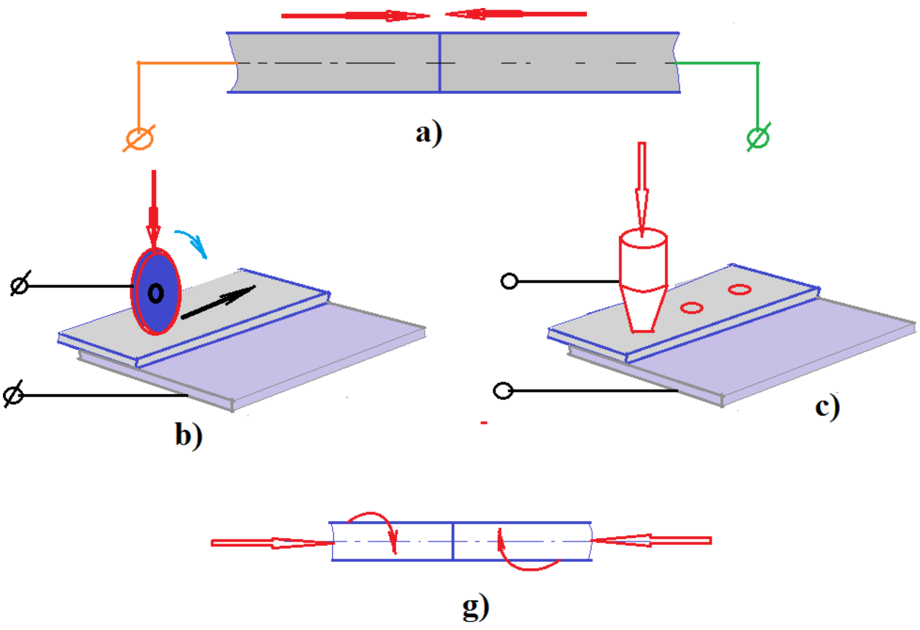

Figure 1. Types of welding

When metal parts in a plastic state are pressed together with a certain force, a welded joint is formed.

Electric contact welding is also used in sheet welding, for example, an electrode roller rotating over the parts (the roller acts as an electrode) creates a contact weld (tape) (Fig. 1-b) and a contact spot weld (Fig. 1-c). It should be said that spot welding does not create a high-viscosity (hermetic) joint, therefore, it is not used for welding parts of tanks and tanks.

In friction welding, connecting parts (shafts, tools) are rotated in opposite directions and pressed together (Fig. 1-g). The heat generated by friction heats and welds the parts to a plastic state.

Depending on the mutual location of the parts to be joined, welded joints are divided into the following:

- three by three;
- overlapping;
- angular;
- mannered.

End-to-end welds are called butt welds, and overlap, corner and diagonal welds are called fillet welds.

Triple stitches are illustrated in Figure 2a.

- mannered.

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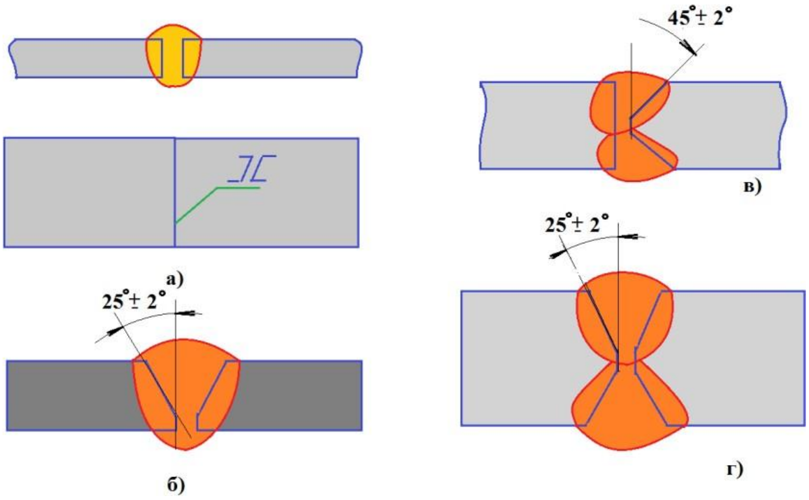


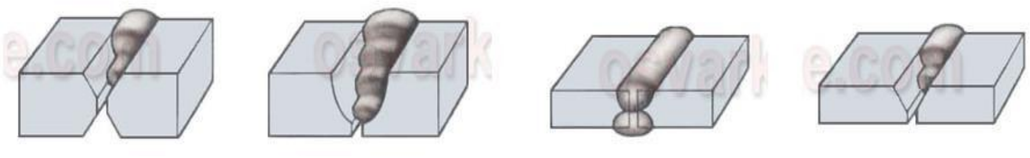


Figure 2. The thickness of the details in the joint with a triple weld: a) - up to 8 mm; b) – up to 26 mm; c) – up to 40 mm; g)- Forms of welding joints up to 60 mm.

Depending on the thickness of the sheets to be welded, their ends are prepared for welding with or without special processing. If the thickness of the sheets does not exceed 8 mm, then the initial processing is not performed (Fig. 2a).

If the thickness of the sheets is from 8 mm to 25 mm, the joining edges of the sheets are pretreated on one side. (Fig. 2b) - chamfers (kertish) with an angle of 25□ are formed on the edges. When the thickness of the sheets is from 26 to 40 mm, the edges are inserted as shown in Fig. 2. When the thickness of the sheets is from 40 to 60 mm, the edges are inserted on both sides, as shown in Fig. 2-g.

Calculation of three-by-three welded sheets consisting of the second piece (Fig. 6) is performed as follows:

□ □ F □ F

□ □□ P □ , (1)

$A = b\delta$

in this: F – tensile strength, N

A – sheet surface, mm2 ;

V – list width, mm ;

δ – sheet thickness, mm;

$[\sigma_P]$ – permissible stress for welding;

Safety coefficient of strength for the weld joint considering

$$[\sigma_P] = 0{,}9[\sigma_{DET}], \qquad (2)$$

in this: $[\sigma_{DET}]$ – allowable stress for the detail material, that is, the welded part of the sheet.

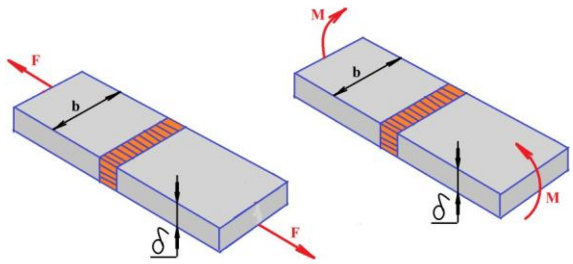
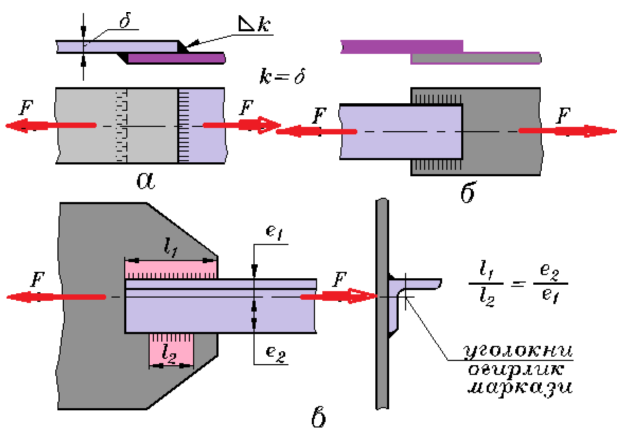


Figure 3. Effect of tensile force and bending moment.

If the welded part is loaded with a bending moment (Fig. 3b), then the resisting moment directed along the axis of the welded section W:

$$\sigma = \frac{M}{W} = \frac{6M}{\delta b^2} \le [\sigma_P]. \qquad (3)$$

When the sheets are attached, they are divided into front and side seams. Figure 3.4-a shows two sheets joined by a two-sided opposite seam. This is where the sign of the corner seam is reflected, as shown in the drawing, it is called a corner seam with k legs. Usually, the value of the chain link is connecting lists δ to the thickness



4 pictures. Butt and butt weld joints.

will be equal. It should be taken into account that the tensile load F acts along the axis of symmetry of the joint. The joint shown in Fig. 4-b is formed from the same angular side seams as the previous one.

It is assumed that the stretching force acting on the welds formed when connecting the sheet and the ugolok is placed on the longitudinal line passing through the center of gravity of the ugolok cross-section, Fig. 4v. In this case, the length of the side seam is determined inversely proportionally as shown in the picture.

Details can be attached at an angle: external corner seam (Fig. 3.5-a); with the help of external and internal corner seams (Fig. 5-b) and with the help of a seam with the edges joined (Fig. 5-v). Shaped details can be attached: corner seam with no edges (Fig. 5-g); using one (Fig. 5-d) or two (Fig. 5-ye) corner stitches with inserted edges.

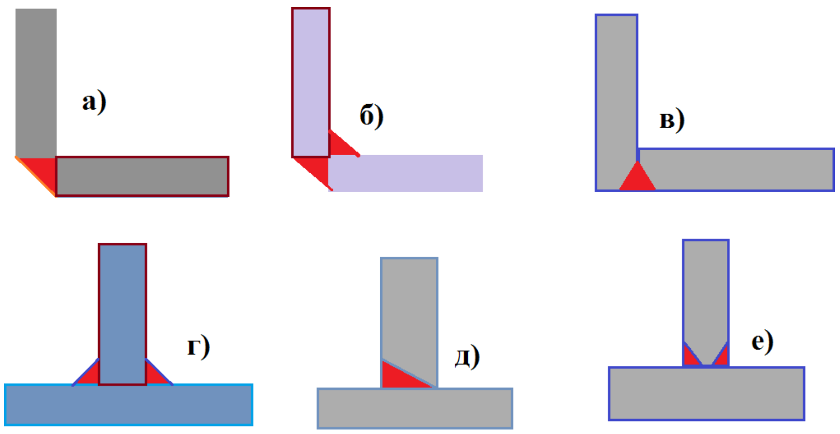


Figure 5. Types of vertical welding of details.

If two parts that need to be connected, for example, a sheet, are welded on top of the other, an overlapping seam is formed. In such cases, the cross section of the welded seam is triangular and is called an angular or roller seam.

The shape of the seam can be normal, concave and convex (Fig. 6).

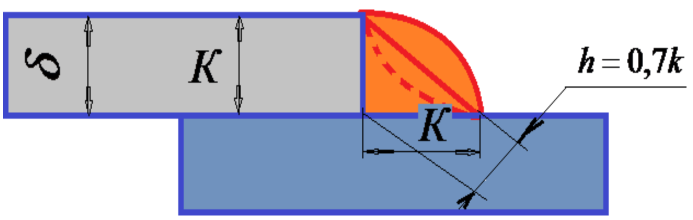
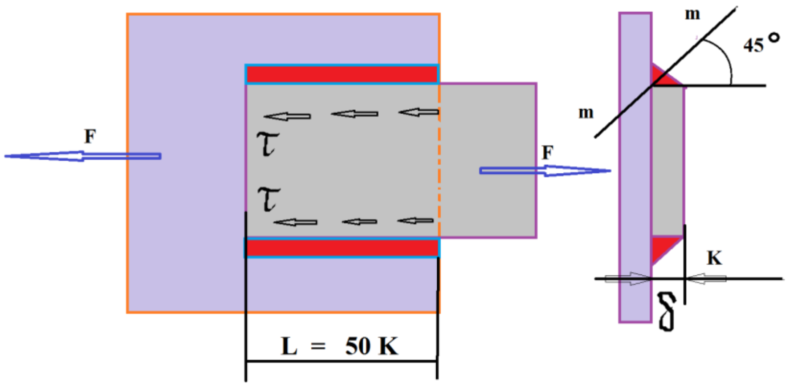


Figure 6. Corner seam

A convex seam significantly changes the section of the part at the joint, which, in turn, causes additional accumulation of stresses there. Therefore, it is appropriate that the seams are concave. But it takes extra work to make the seams concave. Therefore, most stitches are made in the normal form. But it is recommended to make the seam concave in cases of variable force.

The main characteristic dimensions of angular seams are its side k and height h (Fig. 5). The height of the seam depends on its length and can be determined as h=k sin 450=0.7k.



7-rasm. Yonbosh chokli payvand birikma.

The value of the tension in the side seams under the influence of tensile force is determined as follows (Fig. 7).

$$\tau = F/(2 \cdot l \cdot 0{,}7 \cdot k) \le [\tau]' \qquad (4)$$

where: 0.7 k is the thickness of the seam on the m-m section.

When the side welds are symmetrical (Fig. 7), the length of the seam is inversely proportional to the distance from this seam to the center of gravity of the part, i.e.

$$l_1 / l_2 = ye_1 / ye_2 , \qquad (5)$$

in this case, the voltage value at the seams on both sides is the same and is determined as follows:

$$\tau = F / 0{,}7k(l_1 + l_2) \le [\tau]' \qquad (6)$$

If a moment is applied to a joint with a side weld, the tension in the seam will be as follows:

$$\tau = T / W_p \qquad (7)$$

here: W_p – due to the twisting of the eroding section of the seam resistance torque, which is more common in practice $l \ge b$ for stitches

$$\tau = F/(0{,}7 \cdot k \cdot l \cdot b) \le [\tau]' \qquad (8)$$

The resistance of the butt welds to external forces is determined only by the value of the experimental stresses.

τ - tension is determined by the m-m cross-section, as in the side seam (8-picture)

Under the influence of tensile force, the value of stress generated in opposite welds (Fig. 8) is determined as follows:

$$\tau = F/(0{,}7 \cdot k \cdot l) \le [\tau]' \qquad (9)$$

If the torque is acting, the tension is defined as:.

$$\tau = T / W_p = 6T/(0{,}7 \cdot k \cdot l^2) \le [\tau]' \qquad (10)$$

in necessary cases, both the opposite seam and the side seam are used at the same time, if tensile force is applied, the tension in the seam is determined as follows:

If both the moment and the force are acting, the tension is determined as follows.

$$\tau_m = \frac{T}{0{,}7kl_{yon}l_p + (1/6)0{,}7kl_p^2} \qquad (11)$$

as a result, the total resulting from the stretching force and moment voltage value.

$$\tau = \tau_v + \tau_m \le [\tau]' \qquad (12)$$

If the sheets are welded with three-to-three contacts, the strength of the seam is equal to the strength of the sheet. Therefore, in such cases, there is no need to calculate the seam separately.

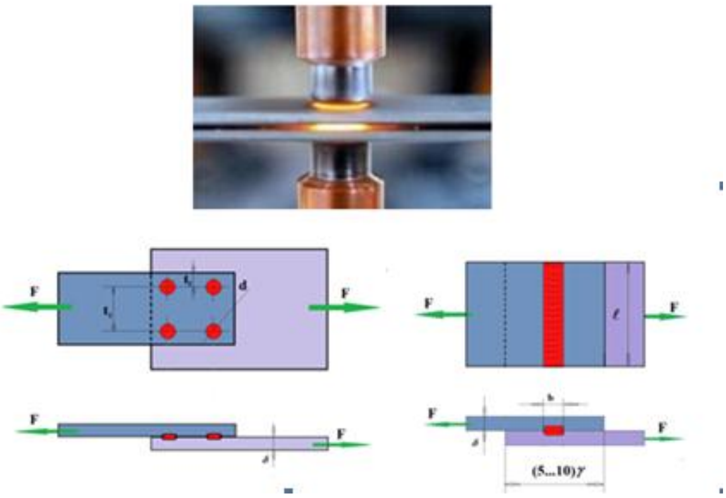


Figure 8. Point and tape contact welding.

The spot weld joint is checked for shear stress, i.e:

$$\tau = \frac{4F}{z \cdot i \cdot \pi \cdot d^2} \le [\tau'] \qquad (13)$$

where: z is the number of welding points; i is the number of planes that can be clipped at each point.

The tape type of contact welding consists in forming a tape-shaped seam in the attached parts of the sheets (Fig. 3.8, b). where the tension in the seam is determined as follows:

$$\tau = \frac{F}{b \cdot l} \le [\tau'] \qquad (14)$$

where: b is the width of the weld seam: l is the length of the seam.

Summary. The strength of welded joints is structural (convenient placement of the weld in relation to the forces acting on the weld, their specific shape, etc.) and technological (protection of the weld formed during the welding process from various harmful effects, thermal treatment, polishing and b.) can be increased by using methods.

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