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Calculation Of The Strength Of Welded Joints

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Abstract: The article provides information on the types, advantages, disadvantages, welding methods and calculation of welded joints, which are part of the non-separable joint type.

Keywords: joint, weld, strength, tension, torque, weld, strength, length.

Poor performance of machines produced in mechanical engineering, premature failure, and increased noise during operation are caused by the low quality of the joint in it (poor fastening, lack of 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; that 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: it is somewhat difficult to determine the quality of the weld; deformation of the part being welded due to temperature; the presence of a concentration of stresses; that some materials cannot be joined by welding.

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.

Welding in the liquid state is divided into types of welding using gas and electric arc.

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 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.

Depending on the thickness of the sheets to be welded, their ends are prepared for welding with or without special treatment.

Calculation of three-by-three welded sheets consisting of two pieces (Fig. 1) is performed as follows:

$$\sigma = F/A = F/b\delta \le [\sigma_p], \quad (1)$$

in which: F – tensile strength, N; A – sheet surface, mm^2; b – list width, mm; δ – sheet thickness, mm; $[\sigma_P]$ – permissible stress for welding, Pa.

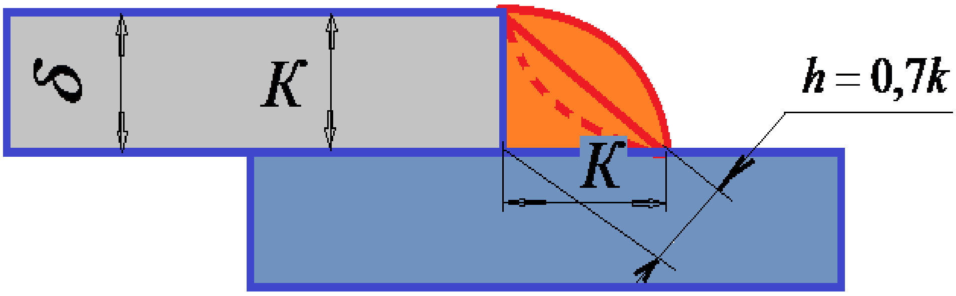

Figure 1. Overlap welding.

When taking into account the required coefficient of strength for the welded joint:

$$[\sigma_p] = 0{,}9[\sigma_{DET}] \quad (2)$$

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

If the welded part is loaded with a bending moment (Fig. 2), then the resisting moment W directed along the axis of the welded section:

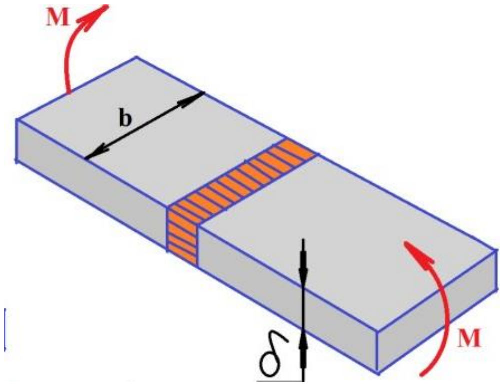

Figure 2. Effect of bending moment.

$$\sigma = M/W = 6M/(b\delta)^2 \le [\sigma_p], \quad (3)$$

In side welds, the main stress is the tensile stress in the m-m section of the weld (Fig. 3). τ - the distribution of stress along the length of the weld depends on the uniformity of the welded parts. If this uniformity is the same, the voltage is evenly distributed, and if it is different, it is unevenly distributed. Also, the longer the side seam, the more unevenly the tension is distributed, so it is recommended to make the length of the seam $l \le 50\,k$.

The value of tension in side seams under the influence of tensile force is determined as follows (Fig. 3).

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

in which: Thickness of 0,7 k seam m-m section.

When the side welds are symmetrical (Fig. 3), the length of the seam is inversely proportional to the distance from this seam to the center of gravity of the part, i.e.

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

where the stress value at the seams on both sides is the same and is determined as follows:

$$\tau = F / [0,7k(l_1 + l_2)] \leq [\tau'] \quad (6)$$

If a moment is applied to a butt-welded joint, the tension in the seam will be as follows:

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

in which: W_p – The moment of resistance to torsion of the eroding section of the W-seam, for the more common $l=b$ seams in practice

$$\tau = F / (0,7klb) \leq [\tau'] \quad (8)$$

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

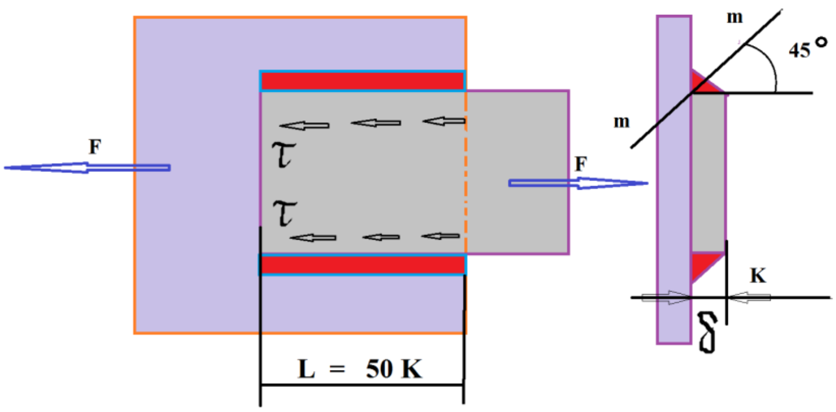

Figure 3. Butt weld joint.

τ - tension is determined by the m-m section, as in the side seam.

The value of tension generated in opposite welds (Fig. 3) under the influence of tensile force is determined as follows:

$$\tau = F / (0,7kl) \leq [\tau'] \quad (9)$$

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

$$\tau = T / W = 6T / (0,7kl^2) \leq [\tau'] \quad (10)$$

In cases where it is necessary, 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:

$$\tau = F / [0,7k(2l_{yon} + l_r)] \leq [\tau'] \quad (11)$$

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

$$\tau = T / [(0,7kl_{yon}l_r) + (0,7kl_r^2/6)] \leq [\tau'] \quad (12)$$

As a result, the value of the total tension created by the stretching force and moment.

$$\tau = \tau + \tau_v = \leq [\tau'] \quad (13)$$

According to the given information, welded joints are considered primarily for strength. Welded joints can be subjected to tensile force or bending moment. When calculating the strength of welded joints under the influence of tensile force or bending moment, the length of the welds and the thickness of the used metals are taken as their main parameters. At the same time, the allowable stress of the metal is one of the important factors in calculating the strength.

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