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Comparative Evaluation of Resistance Made Simple Shear Connection with Bolts and With Welding

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Abstract: *The objective of this work until quite investigative and experimental review, to examine the performance of simple connections using bolt SAE 1045 medium carbon steel hex head high strength according to ISO 4017 or weld metal, requested by tensile stresses, shear. It evaluates the strength of the bond fixed structures in steel sheet in the sheet direction parallel or perpendicular relative to the axis of fixation. This study raised subsidies basic and important information for future studies of criteria for choosing the best joint or bolts or welds, considering the lack of criteria and definitions in standards aimed at metal structures. According to data presented, the bolted joints showed higher shear strength than welded, noting that a smaller number of screws may be associated with fixing plates in metal structures.*
Keywords: *joining; stress shearing; high resistance screw.*

I. Introduction

The connections in steel structures can be made by common screw, high strength fasteners, welding and rivets which today only has historical value and restoration of metal structures[1].

Historically, the high strength bolt arose when studying riveted joints by placing hot rivets. When the steel after heating retract developed strong grip between the plates so that the presence friction force, the plates are not moved, generating a rigid connection, as with the welded connection.

Connections are used to transfer the forces from one member to another. Although both welded and bolted connections can be used in steel structures, bolted connections are commonly used because of the ease of fabrication and ability to accommodate minor site adjustments. The different types of bolted connections include cover plates, end plates and cleats and in each of these connections the bolts are used to mechanically fasten the steel elements.

The performance of a bolted connection is complicated and both the stress distribution in the connection and the forces in the bolts are dependent on the stiffness of the bolts, and the connecting steel elements (end plates, cleats, etc.).

The screws common and high strength are used depending on installation conditions of the metal structure. Fixing by screw can be much faster than setting made by welding. As for welding is the most efficient means of connecting elements of metal constructions.

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The joint surfaces should be prepared to provide an improved coupling according to the thickness of the sheets so that the top plate to 13 mm does not require any special finish. Welding is widely used in joining of materials, allowing you to run together with complicated geometries and ensure perfect continuity between the parties.

The relationship of forces between the fixing and the end of the screw can sometimes generate pre crack the bolt, and thread length influence on the failure mode[2]

Two primary characteristics in a bolted joint are pre-tension and interaction of the parts in contact[3]. The effect of preloading is to provide compression parts in a better resistance to external load and traction slip increase the friction between the parts so that they can better resist shear load according figure1(b).

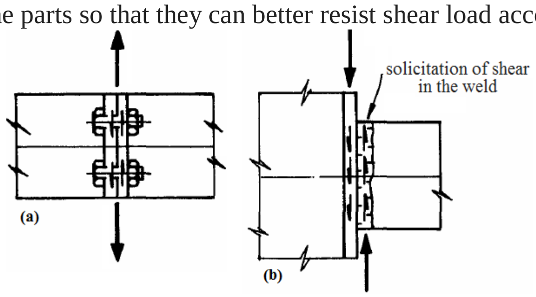

Figure 1 - Strain to shearing joints (a) screwed and (b) welded

II. Experimental procedures

To compose the data were grouped results of this and earlier experiments where the screws used in medium carbon steel SAE 1045, with entire thread high strength welded plates with nut and simple, to be portrayed only the size of the shear strength of two screws 50 mm and the weld two plates of 180 mm length, 60 mm width and 10 mm thickness each, as sketched below regarding figures 2 and 3. The tensile tests obeyed ASTM E 8M according[4] and were performed on machines Universal Tensile load capacity 10 T, adjusting the claw especially for fixing those connections.

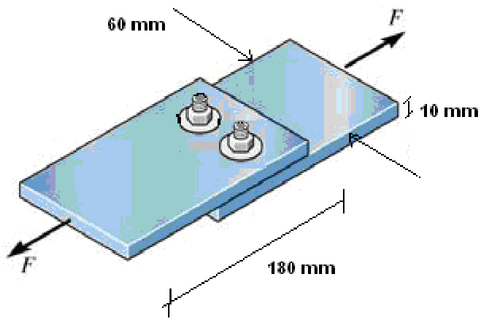

Figure 2 - Plates bolted to the shear test

The main and most common types of welds used for structural steel is the size of the fillet weld is given by the length of the cord and its resistance is determined by the thickness of the cord, which could change the values determined below.

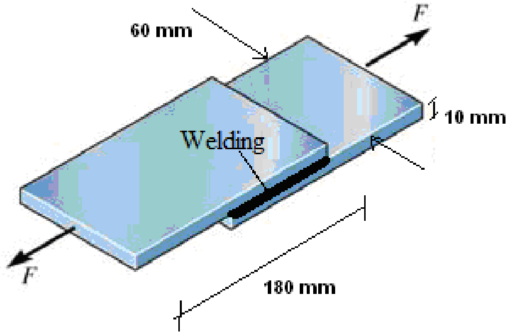

Figure 3 - Welded plates for shear test

We must consider that the plate material also is medium carbon steel SAE 1045, once the screws used have dimensions and characteristics as in figure 4 and Table 1, respectively.

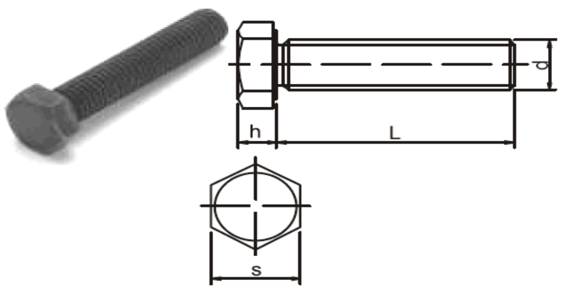

Figure 4 - Hex fixing screws

Table 1 Dimensions of the screw threaded fasteners entire

Diameter - D	20 mm
Thread/step	2.5 mm
Key - S	30 mm
Head height - h	13 mm
Length - L	32 mm

Table 2 Chemical composition of the material of screw and plate

Element	C	Mn	P_{max}	S_{max}	Si
%	0.42	0.72	0.005	0.005	0.22

We must take care that the plates and screws are not crushed by the contact stress and the plate will not rip. The bolt action according[5,6] assumes that there is a small movement between the parties to manifest and the shearing action of crushing and tearing as in figures 4 and 5 below.

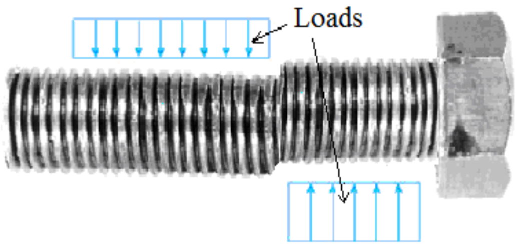

Figure 5 - Crushing shear bolt due effort

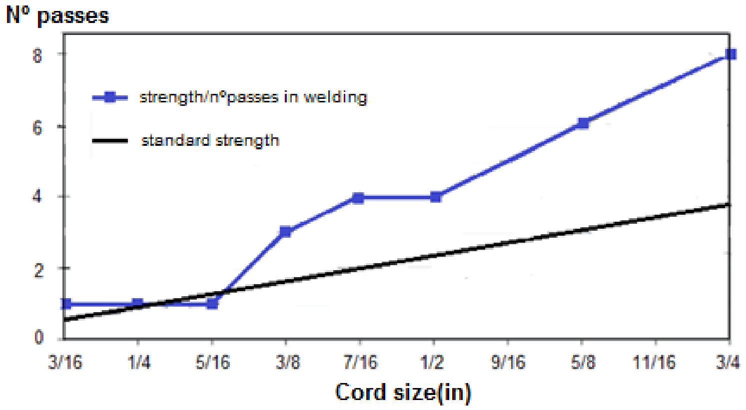

Figure 6 - Relationship of number of passes to strength

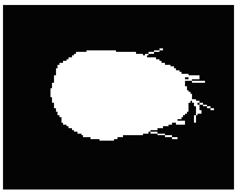

Figure 7 - Tear failure in shear of the plate due effort load

A proposed model as[7] whereby the ultimate load resistance of the joint can be computed from the following relationship:

$$R_{utl\ joint} = R_{friction} + R_{bolts} + R_{trans} + R_{long}$$

Where:

$R_{friction}$ is the frictional resistance
R_{bolts} is the bolt shear resistance
R_{trans} is the transverse weld shear resistance
R_{long} is the longitudinal weld shear resistance

$R_{friction}$ is estimated to be 0.25 times the slip resistance of the bolted joint. For connections in conjunction with welds, this factor is always present, but is accounted for differently, depending on the orientation of the weld (longitudinal versus transverse). This factor, of course, would be zero for bearing-type bolted connections.
R_{bolts} depends on the type of weld (transverse or longitudinal) and the condition of bearing, whether already in bearing (positive) or unknown (indeterminate).

III. Results and discussion

We observed that the greater the number of cutting surface, the greater the resistance of the screw, where the number of cutting surfaces is determined by the number of interfaces for connecting the plates, multiplied by the number of connecting bolts employed.

As the shear stress σ, we are able to determine the maximum strain F (resistance to shear surface) that the joint can suffer.

$$F = \frac{\sigma \pi d^2}{4}, \text{ or } \sigma = \frac{4F}{\pi d^2} \text{ (for an interface and a screw)}$$

In this case we work as an interface and 2 screws, the effort will be active:

$$F = 2\frac{\sigma \pi d^2}{4}, \text{ or } \sigma = \frac{2F}{\pi d^2}$$

As shear tensile test[9] conducted in the bolted joints (two bolts) and the welded joints obtained the results shown in Table 3.

Table 3 Results of tensile strength and shear of the connections.

Sample	Yield strength (MPa)	Tensile strength (MPa)	Shear stress (MPa)
Bolts joint	1301	4008	15.3
Welded joint	1245	3948	9.8

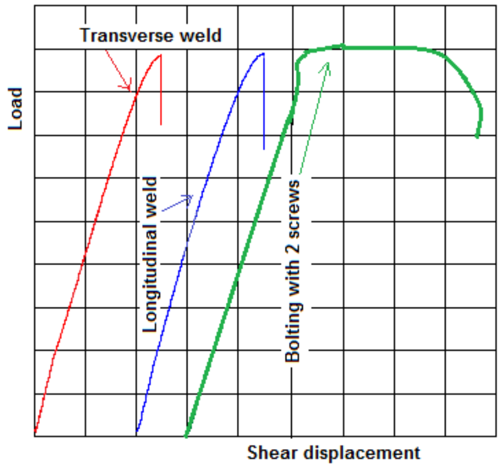

Figure 8 - Load curve as a function of displacement for welded joints and bolts joints

IV. Conclusion

Therefore we can conclude that the tensile properties of the welded joints of the links have greater stiffness and shear strength lower than that for the screw connection which in turn has a lower rigidity.

Also, we should note that the welded joints to effect efficiency of the work, have a greater reduction in manufacturing costs (eliminating holes), reducing the amount of steel because of its connections (more compressed), better finishing and ease of cleaning and painting.

However, we have observed bolted joints higher tensile strength associated with the lowest number of screws used, considering that the friction between the plates to be screwed less, prevents movement of the connected parts and a more acceptable rigidity of the connection.

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REFERENCES

[1] Manuel, Thomas J. and Kulak, Geoffrey L., Strength of Joints That Combine Bolts and Welds. Journal of Structural Engineering; 2000, 126(3):279-287
[2] Fransplass, H., Langseth, M. and Hopperstad, O.S., Tensile behaviour of threaded steel fasteners at elevated rates of strain. International Journal of Mechanical Science; 2011 53(11):946-957
[3] Jarosch, K.H. and Bowman, M.D., Behavior of Tension Butt Joints Using Bolts and Welds in Combination. Structural Engineering Rep.1985, CE-STR-85 20, Purdue University, Lafayette, Indiana
[4] ASTM E 8M Standard Test Methods for Tension Testing of Metallic Materials. American Society for Testing and Materials, 2001
[5] Swanson, J. A. and Leon, R. T. Bolted steel connections: Tests on T-stub components, Journal of Structural Engineering ; 2000, 126(1):50-56
[6] Shakir-Khalil, H. and Ho, C. M., Black Bolts under Combined Tension and Shear. The Structural Engineer,1979; 57B(4)
[7] Kulak, G.L. High Strength Bolting for Canadian Engineers. 5ndEdition, September 2005
[8] ISO-898-1:(E).Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel. 1999; Part 1: Bolts, Screws, and Studs
[9] Astaneh, A., Liu, J., and McMullin, K.M., Behaviour and Design of Single Plate Shear Connections, Journal of Constructional Steel Research; 2002, 58:1121-1141
[10] Renner, A. and Lange, J., Load-bearing behaviour of high-strength bolts in combined tension and shear. Steel Construction; 2012, 5(3):151-157.