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FINITE ELEMENT TYPE OF STRESS ANALYSIS FOR PARTS BASED ON S235 JR STEEL WELDING

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The determination of static and/or variable stress, in case of complex shaped welded structures is hard to achieve. One solution, though, is the use of finite element method, implemented by means of various specialized software. Nowadays, this method has become very popular due to its high precision of data obtained through both research and finite element analysis. Hence, the present paper deals with the modelling of the pull-out behaviour of concave and convex welded joints through finite element method.

Key words: welded structures, stress, beads of weld, finite elements

INTRODUCTION

Researches in the field have shown that stress of welded parts is different even if welding is of high quality and does not modify the force flows within the respective parts. This is due to the fact that, during welding, the thin layer of the additional melted material dripps over the basic material, cools off quickly and, as a consequence, cannot melt the basic material. As a result, there is little connection between the basic material and the additional one[1, 2]. The melted layer solidifies quickly and gases and pollutants are not discharged entirely. Hence, stress concentrators are produced, they are highly visible within the upper layers of the material and invisible from the outside. Moreover, they are likely to diminish fatigue resistance. As far as stress within the welded joints is concerned, various assessment methods are introduced according to the type of welded structure (vehicles, marine structures etc.) [3, 4].

Likewise, an overall analysis has been developed recently on the evaluation of welded joints based on finite element method [5]. Various methods are presented and classified as follows: according to the variation of

nominal stress determined by external and internal loads and characteristics of the cross section as well as to the variation of structural stress focused on the discontinuity effect of the welded joints [6, 7].

MATERIALS AND METHODS

The current research has dealt with the finite element analysis in the case of static pull stress for two types of cross weld samples, convex and concave corner welds.

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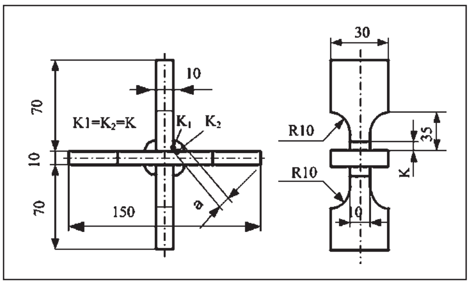

Figure 1 Shape and dimension of weld sample

The shape and dimension of the cross type of sample subject to static pull are illustrated in Figure 1.

The static pull exerts a force of 14 / kN within the sample. The sample is made of S235 JR type of steel in conformity with NF EN 10028-2. The beads of weld for both types of samples have been achieved by means of hand welding with electric arc and insulated electrode.

EXPERIMENTAL RESEARCHES

The first phase of the research process was concerned with the analysis of the pull-out behaviour of convex weld joints. The two samples were analyzed by means of finite element method. For an overall view of stress within the welded structure, the following stresses were taken into consideration: SY – stress whose direction is the same with that of the forces exerting on the system, main S1, S2, S3 type of stresses as well as Von Mises type of stress.

According to the finite element analysis, the main S1 type of stress is illustrated in Figure 2. Hence, the results show that maximum stress values are produced at the junction between the weld joint and the sample carrying the pull forces. Its maximum value is $\sigma_{max} = 0,3 \cdot 10^9$ / N/m^2. This value is below the elasticity module and this proves that once forces are eliminated, the

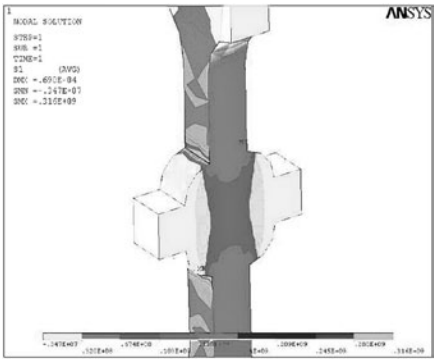

Figure 2 Main S1 type of stress when a force F_{tot} = 14 kN is exerted

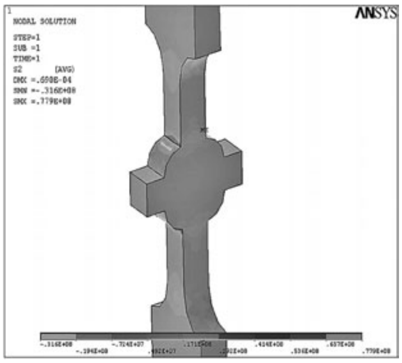

Figure 3 Main S2 type of stress when a force F_{tot} = 14 kN is exerted

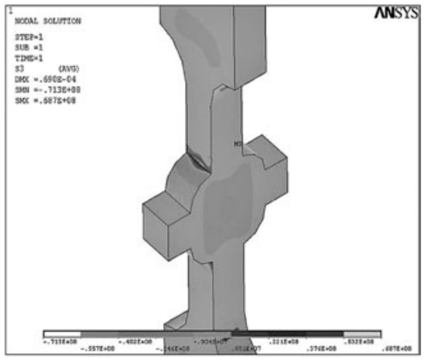

Figure 4 Main S3 type of stress when a force F_{tot} = 14 kN is exerted

structure will become flexible and bend back to the initial shape.

Figure 3 illustrates the main S2 type of stress. Its value is maximum at the same place like in the case of S1. This is σ_{max} = 0,77·10 ^{8} N/m ^{2}, which is below the elasticity module.

Figure 4 presents the distribution of the main S3 type of stress, bearing the same maximum value at the junction point between the welded structures and the samples. A key observation is the distribution of bending stress that reveals a high value within the area outlined by the four welds. The maximum value of stress in this case is σ_{max} = 0,71·10^8 N/m^2.

The next type of stresses analyzed is SY , that is the stress produced in the direction of the pull force - Figure 5. The maximum is also within the fi eld of elasticity σ_{max} = 0,27·10^9 N/m^2. As a consequence, a cross section has been carried out through the welded structure, displaying maximum bending values.

Likewise, the last type of stress determined is theVon-Mises – Figure 6. These stresses show a variation in ranging from a minimum to a maximum value. The maximum value of this tye of stress is σ_{max} = 0,24·10^9 N/m^2.

The second case studied deals with the concave type of weld structures and Figure 7 illustrates the corresponding geometry.

Figure 8 shows the discretization of a welded structure into solid 187 type of element and the structure is embedded within the corresponding joints. The pull force is exerted in the opposite direction similar to the one determined in the first case, F_{tot} = 14 kN.

The first stage of the second example is concerned with the main S1 type of stress, Fugure 9. The maximum value is given by the pull forces expressed as σ_{max} = 0.19·10^9 / N/m ^{2}. In comparison with this value, the corresponding values in the fi rst case are higher , the ones in the second case represent only 63 / % of the former. Obviously, they range within the feld of elasticity, yet, a lower maximum stress value becomes significant for the change in the shape of the weld bead.

The second type is the main S2 stress. This is illustrated in Figure 10. A key observation is that its maximum is displaced from the welded joint to the upper area of the sample. Hence, this type of joint helps yield the structure due to a lack of stress concentrators at the junction between the basic material and the weld bead. The maximum values σ_{max} = 0,27·10^8 N/m^2 are shown in another area, different from the welded one.

Figure 11 reveals the main S3 type of stress with a maximum of σ_{max} = 0,2·10^8 N/m^2, a value situated within the field of elasticity, still, lower in the case of convex welding.

The stress exterted on the OY axis is presented in Figure 12. Its maximum is situated both at the joint of the welded structure and the upper part of the sample where the section is smaller The maximum stress is σ_{max} = 0,19·10^9 N/m^2.

Von Mises type of stress is illustrated in Figure 13 and the maximum is situated within the joint area be-

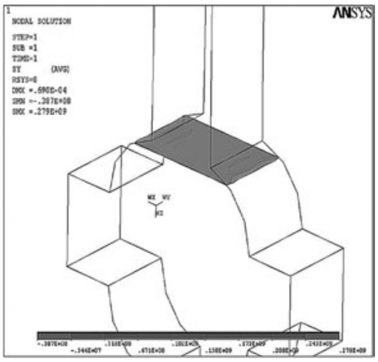

Figure 5 Main SY type of stress when a force F_{tot} = 14 kN is exerted

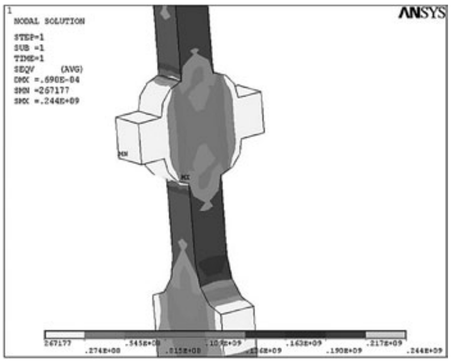

Figure 6 Von Mises type of stress when a force F_{tot} = 14 kN is exerted

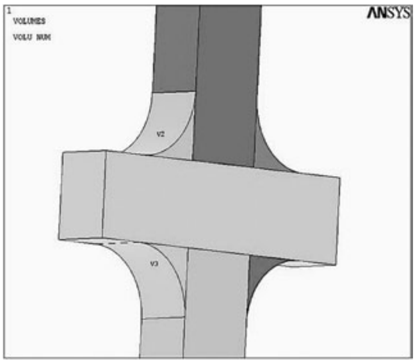

Figure 7 Joint weld geometry based on concave weld beads

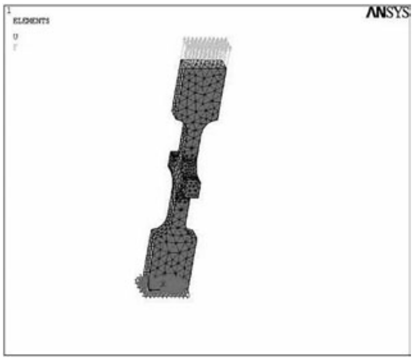

Figure 8 Work loads application onto the welded structure

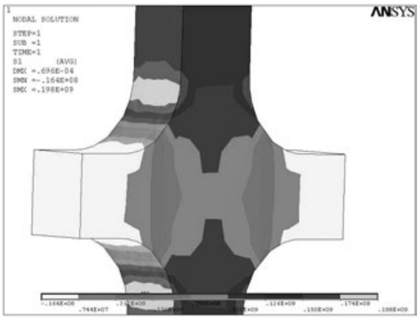

Figure 9 S1 type of stress when a force F_{tot} = 14 kN is exerted in the case of concave joints

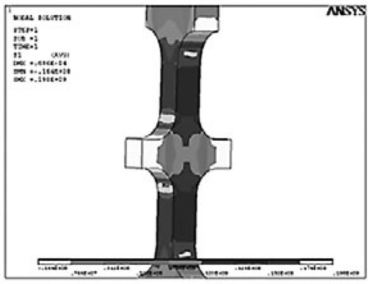

Figure 10 S2 type of stress when a force F_{tot} = 14 kN is exerted in the case of concave joints

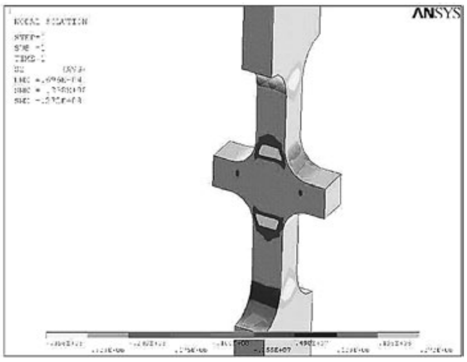

Figure 11 S3 type of stress when a force F_{tot} = 14 kN is exerted in the case of concave joints

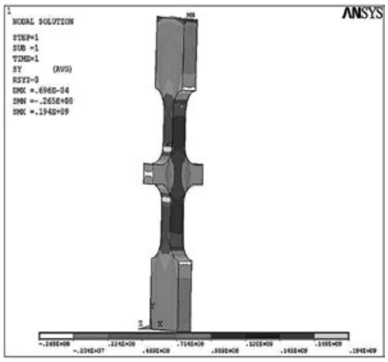

Figure 12 SY type of stress when a force F_{tot} = 14 kN is exerted in the case of concave joints

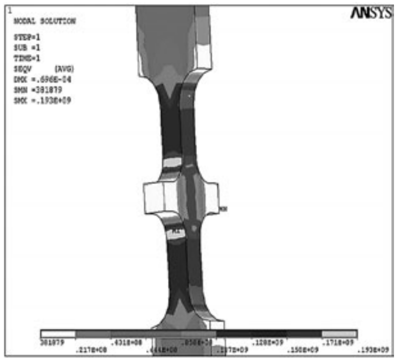

Figure 13 Von Mises type of stress when a force F_{tot} = 14 kN is exerted in the case of concave joints

tween the welded structure and the sample. The maximum stress value is $\sigma_{max} = 0,19 \cdot 10^9$ / N/m^2, higher than in the case of convex welding.

Moreover, a frequent use of concave weld beads must be carried out due to a general unfavorable stress as well as to maximum stress values in the case of a convex geometry.

CONCLUSIONS

The research data have proved that the cross section geometry of the weld bead in the case of welded joints determines the stress value. In both cases analyzed, the concave weldings trigger lower stress than in the case of convex weldings.

Taken into account the stress concentrators of the cross section convex shape like weld beads, exerting maximum of stress between the basic material and the weld bead and based on finite element method, it is advisable that welded joints be based on a concave shape rather than a convex one.

Thus, specific techniques must be developed. The finite element analysis in the case of static pull stress becomes noteworthy in view of highlighting the stress areas with maximum values. These values can be further used for the finite element analysis in the case of variable stress likely to yield fatigue.

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