THE HIGH STRENGTH STEEL AND ITS WELD UNDER IMPACT

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1. Introduction

High strength steels of the MC type (M- hot rolled, C – for cold forming) belong to a very attractive category of structural materials with respect to theirs' mechanical properties, such as the yield point (min. 650 MPa), ultimate tensile strength (even 1250 MPa) and elongation (min. 7%) [1]. Nevertheless, an application of this kind of steel in real engineering structures requires many prior experiments. It is related directly to the restricted requirements concerning mechanical properties of welding joints made of such steel on one hand, and their destination to operate under dynamic loading on the other, [2]. Therefore, the paper aims to investigate the S700MC behaviour and its weld at a range of the impact energy values, thus supplementing existing data base on this material.

2. Material, specimens, testing

The S700MC steel and its weld were subjected to the Charpy impact tests. The V-notched specimens were used. All tests were conducted using the HV 9529 Instron Drop Tower at room temperature. The specimens were mounted in the column-roller gripping system. Four values of impact energy equal to 50 J, 100 J, 200 J, and 300 J were applied. The following physical quantities were recorded during experiments: accumulated energy; force; projectile velocity and deflection. After tests, each specimen was subjected to macro-photographic observations to capture characteristic features of the fracture zones.

3. Results

The S700MC steel and its weld exhibited different behaviour under the impact, Figs. 1-4. It can be easily noticed looking at diagrams of the recorded physical quantities, Figs. 1, 3. In all cases taken into account, lower values of the accumulated energy and force were obtained for the weld, Figs. 1, 3a, while the projectile velocity reached higher values, Fig. 3c. Such results identify a significant influence of the weld quality on the material properties.

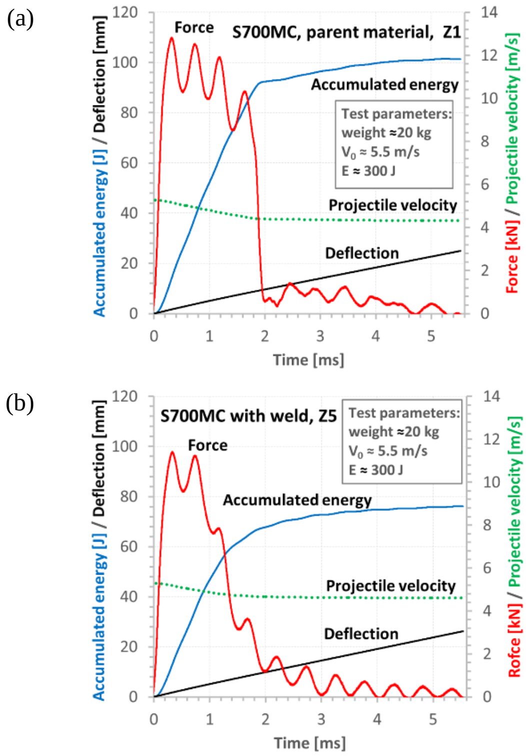


Fig. 1. Parameters captured from Charpy test on the S700MC steel for: (a) parent material; (b) weld.

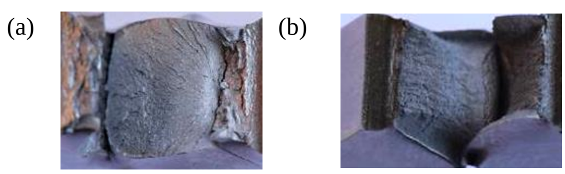


Fig. 2. Fracture zones after impact tests for: (a) parent material; and (b) weld under impact energy of 300J.

It can be observed not only for parameters determined, but also by differences in courses of the accumulated energy, Figs. 1a, b, 3a.

(a)
(b)
(c)

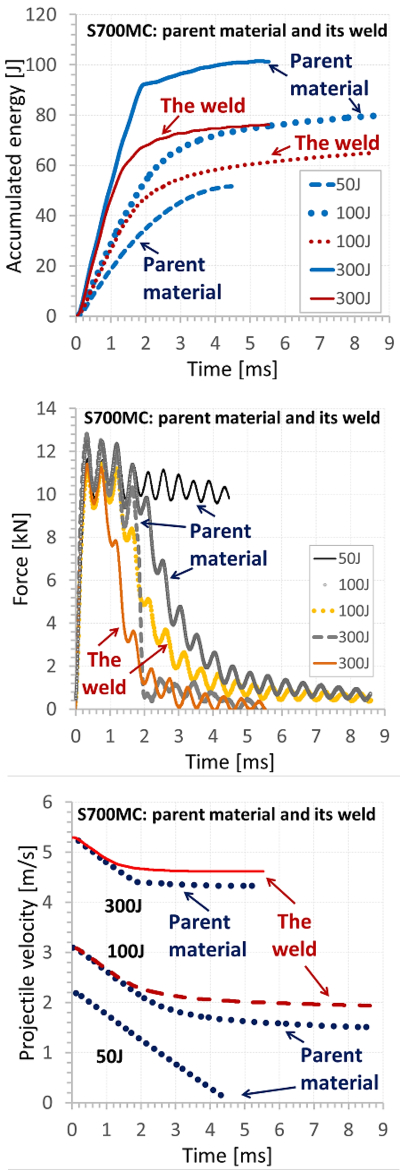
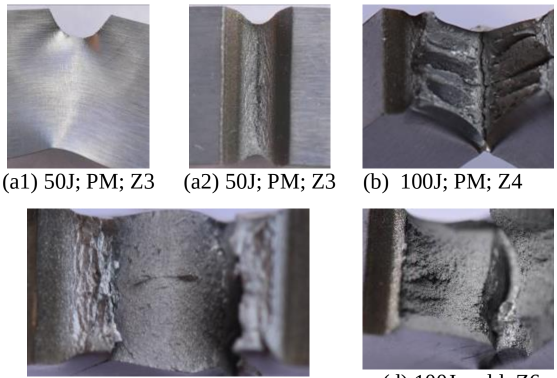


Fig. 3. Accumulated energy (a), force (b) and (c) projectile velocity versus time at different impact energy for parent material and weld of the S700MC steel.

In the case of force, its reduction appeared after a local maximum was attained, Fig. 3b. One can indicate, that the force courses are very similar either for parent material or weld, reflecting almost the same response on the impact in the initial stage of tests. In further stages the curves are significantly different, reflecting the weld quality of the material examined. Similar features represent the projectile velocity characteristics, Fig. 3c. The weld caused a lower decrease of the projectile velocity than the parent material, thus demonstrating a lower resistance to impact.

Fracture zones enabled to distinguish characteristic features of the steel tested, Fig. 4. They were represented by the longitudinal cracks (Fig. 4b), vanishing of these effects (Figs. 2a, 4c) with an increase of the impact energy. This effect was not visible in the case of weld, Figs. 4d. Moreover, the steel cracking occurred at a higher plastic deformation than that for the weld obtained, Figs. 2a; 4b, d.



(a1) 50J; PM; Z3 (a2) 50J; PM; Z3 (b) 100J; PM; Z4

(c) 200J; PM; Z2 (d) 100J weld, Z6

Fig. 4. Fracture zones of the S700MC: (a), (b), (c) parent material (PM), (d) weld.

4. Summary

The S700MC behaviour under impact is strongly dependent on the energy. The weld can reduce the accumulated energy significantly. Such effect was discovered for a wide range of the impact energy values considered (i.e. from 100 J to 300 J). The weld in the S700MC steel affected the fracture region leading to its smoothness improvement in comparison to the base metal.

Acknowledgements

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References

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[2] T. Szymczak, A. Brodecki, K. Makowska, Z.L. Kowalewski (2019). Tow truck frame made of high strength steel under cyclic loading. *Materials Today: Proceedings*, 2019, 12, 207–2012.