A R C H I V E S O F M E T A L L U R G Y A N D M A T E R I A L S
Volume 60 2015 Issue 1
DOI: 10.1515/amm-2015-0076

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WELDABILITY OF THERMOMECHANICALLY TREATED STEELS HAVING A HIGH YIELD POINT

SPAWALNOŚĆ STALI OBRABIANEJ TERMOMECHANICZNIE O WYSOKIEJ GRANICY PLASTYCZNOŚCI

The article concerns the issue of weldability of S700MC steel, treated thermo-mechanically, with high yield point. The weakest area of welded joints of this steel is a high - temperature coarse heat affected zone (HAZ) in which due to the nucleation effect of the dissolved phases, strengthening the matrix and their subsequent uncontrolled separation precipitation in the form of finely disperse and rapid decrease impact strength is observed. Performed arc welding tests here have shown that in order to ensure high quality of welded joints, it is necessary to limit the welding linear heat input. During the welding process of S700MC steel, it is not recommended to use pre heating before the welding process and heat treatment after welding, and the number of repairs should be kept to a minimum, because it leads to a reduction of strength and plastic properties in the HAZ area, as a result of aging processes, dissolution of strengthening phases in the matrix and their subsequent uncontrolled precipitation during cooling.

Keywords: Weldability, TMCP steel, HAZ

W pracy przedstawiono problematykę spawalności stali obrabianej termomechanicznie S700MC o wysokiej granicy plastyczności. Najsłabsze miejsce złącza spawanego tej stali stanowi wysokotemperaturowy, gruboziarnisty obszar strefy wpływu ciepła (SWC), w którym na skutek zarodkowania rozpuszczonych faz umacniających w osnowie i ich ponownego, niekontrolowanego wydzielenia w postaci drobnodyspersyjnej, następuje gwałtowny spadek udarności. Przeprowadzone próby spawania łukowego wykazały, że w celu zapewnienia wysokiej jakości złączy spawanych należy ograniczyć energię liniową spawania. Podczas spawania stali S700MC nie zaleca się stosowania podgrzewania wstępnego przed spawaniem oraz obróbki cieplnej po spawaniu, a liczbę napraw należy ograniczyć do minimum, gdyż prowadzi to do obniżenia własności wytrzymałościowych i plastycznych w obszarze SWC, na skutek procesów o charakterze starzeniowym, rozpuszczania faz umacniających w osnowie i ich ponownego, niekontrolowanego wydzielania w czasie chłodzenia.

1. Introduction

Recent years have seen a continuous increase in the global share of welded structures made of steels with an increased and overall high yield point. Quality requirements in many industries such as shipbuilding, civil engineering, hydro and nuclear power, the construction of oil rigs and pipelines dictate that new technologies applied in steel metallurgy and metal forming should be developed and implemented in a manner enabling the obtainment of end products, such as plates and tubes, characterised by a high strength, yet without compromising their plastic properties. The development of new steel grades and higher requirements set for welded structures have inspired detailed studies dedicated to factors affecting the behaviour of such materials in structures during welding and in post-weld operation. Newly developed materials include thermomechanically rolled steels, particularly those with a yield point of 700 MPa. The implementation of thermomechanically processed steels with a high yield point and a relatively low carbon equivalent significantly reduces the duration of welding works by decreasing the temperature of a preheating process or even by completely removing this processing stage. Furthermore, the reduction of the cross-sectional areas of structural elements makes welded structures more slender and lightweight. The use of the aforesaid steels reduces welding costs by decreasing the cross-sectional areas of joints, thus leading to the reduced consumption of welding consumables as well as to the reduction of welding process duration and to the reduction of time necessary for carrying out construction-related preparatory works or testing welded joints [1,4]. The technical and economic aspects arising from the possibility of making products of these steels and applying them in energy-efficient integrated production lines as well as their suitability for the construction of various structures, including those operating in extreme climatic conditions, are of great importance for the materials science related to this group of steels and for the improvement of technologies used for manufacturing and joining such steels by means welding methods. The usefulness of these materials for the manufacture of welded structures often depends on factors which until recently have not been fully considered while assessing the weldability of the materials

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