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ISSN 0543-5846
METABK 55(2) 213-216 (2016)
UDC – UDK 669.14.018:612.791.052:539.377:620.17=111

THE INFLUENCE OF TEMPERATURE ON MECHANICAL PROPERTIES OF THE BASE MATERIAL (BM) AND WELDED JOINT (WJ) MADE OF STEEL S690QL

Received – Prispjelo: 2015-04-11
Accepted – Prihvaćeno: 2015-10-10
Preliminary Note – Prethodno priopćenje

This paper presents the analysis of the influence of temperature on mechanic properties of the base material and welded joints made of high strength steel. The joints were welded on S690QL high strength steel plates using the Metal Active Gas (MAG) Welding and two filler materials of different properties. Since the steel S690QL belongs to a group of steels with high strength, the aim of this paper is to determine the temperature at which strength starts to decrease. Experimental tensile testings of the welded joints were performed at five different temperatures in the range from 20 to 550 °C.

Key words: S690QL steel, welded joint, base material, temperature, mechanical properties

INTRODUCTION

With constant advancements in the field of welding technology, there is a growing need for high strength construction steels such as the steel grade S690QL. In order to maintain good weldability, the carbon content in high strength steels has to be as low as possible (max. 0,22 %) and the steel should have good mechanical properties which would make the welded construction reliable and light. When complex welded constructions are made, the steel is often heated (preheated, additionally heated and tempered), leading engineers to a dilemma concerning the maximum temperatures allowed for this process. In the literature, wide ranges of these temperatures can be found, depending on the thickness of the welded plates i.e., their thickness equivalents. The aim of this paper is to determine the maximal temperatures at which both base materials and welded joints keep their high strength values.

Dependance of mechanical properties of the BM and WJ on the temperature has been subject of numerous investigations, [1-6]. The paper [1] analyses the influence of elevated temperatures on the mechanical properties of two high strength steel grades - S460 and S690.

The experiments involved uniaxial tensile testing at 12 different temperatures from 20 to 1 000 °C. The results indicated that the yield stress and tensile strength remain unchanged up to 600 °C. At temperatures higher than 600 °C a significant decrease in yield stress is noticed, particularly with the steel grade S690. The paper [2] studied the influence of elevated temperatures on mechanical properties of construction steel grades S350, S355, S420 and S460, as well as austenitic steel grade X5CrNi18-10. Tensile testings were performed at temperatures in the range from 20 to 900 °C. The decrease in mechanical properties is noticed at 600 °C for construction steels, and at 670 °C for austenitic steel. The paper [3] studied the influence of temperature on mechanical properties of a group of high strength steels including the steel grade S690Q. The results have shown that good mechanical properties can be guaranteed up to the temperature of 540 °C. The paper [4], which also studied the steel grade S690Q at elevated temperatures, reported changes in yield stress, tensile strength and modulus of elasticity. The test temperatures varied from 20 to 700 °C. Unlike with other investigations, [1-3], a significant decrease in properties was noted at 400 °C. In addition to the given results of the papers [1-4], it should be stated that, in their recommendations [5], some of the leading manufactors of the steel grade S690QL do not guarantee its mechanical properties at temperatures higher than 580 °C. Moreover, the maximum recommended preheating temperature is about 200 °C, depending on the equivalent thickness of the parts. The paper [6] analyses mechanical behaviour of materials at elevated temperatures under conditions of thermal stresses, the paper [7] studies the influence of elevated temperatures under conditions of fatigue loading, while the paper [8] measures the level of inner stresses in WJ.

The results shown in the papers [1-4, 6-8] represent a good starting point to understanding the influence of temperature on the base material mechanical properties. However, this influence has not been analysed particularly for the WJ of high strength steels, which are very sensitive not only to local input of heat that ocurrs during the welding process but also to elevated working temperatures. Due to these reasons we have chosen to

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