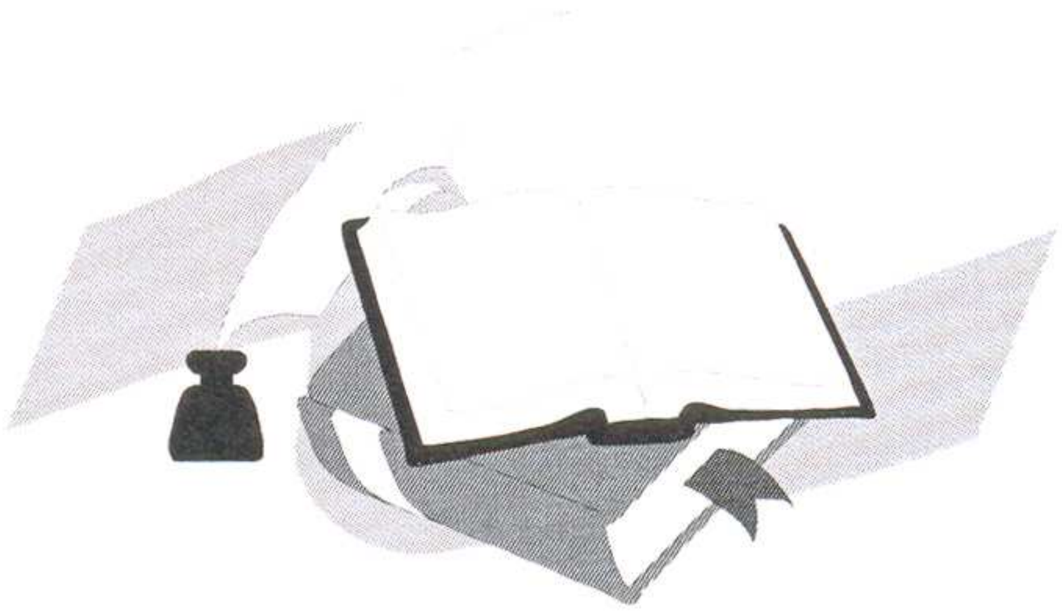
UNIVERSITY OF ŽILINA
Faculty of Mechanical Engineering
Department of Materials Engineering

SEMDOK 2014

19th International seminar of Ph.D. students

under the auspices of
prof. Dr. Ing. Milan Sága
dean of the Faculty of Mechanical Engineering of the University of Žilina



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SELECTING THE OPTIMAL WELDING TECHNOLOGY OF HIGH STRENGTH STEEL OF THE S690QL CLASS

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Abstract

In this paper is presented the detailed procedure for selecting the optimal technology for welding of the responsible welded structures made of high strength steel S690QL. This steel belongs into category of steels that possess exquisite mechanical properties, especially what concerns the strength and impact toughness, both at room and elevated temperatures. On the other hand, this steel is prone to appearance of cold cracks, what makes its welding difficult. Selection of the optimal welding technology, which is the subject of this work, is aimed at preserving the favorable mechanical properties both in the welded metal and the melting zone, as well as in the heat affected zone as the most critical zone of the welded joint.

Key words: *High strength steel, S690QL, Mechanical properties, Weldability.*

1. Introduction

There are several factors that influence weldability of the high strength steel: chemical composition of the base metal (BM), type of the filler metal (FM) and welding procedure. The further influential factors are: the quantity of hydrogen diffused from the weld into the base metal, thickness, type and distribution of joints, kind of applied heat treatment, order of deposition of individual welds, etc. This is why the weldability should be estimated first. The next to be conducted are the mechanical investigations, both at room and elevated temperatures, for the purpose of establishing the mechanical properties of the welded joints. The model investigations are to be performed next; their output parameters include results of mechanical investigations, visual appearance of the weld, measured hardness and metallographic recordings of certain zones of the welded joint, as well as the impact toughness of the welded joint critical zones.

The S690QL class steel belongs into a group of special thermo-mechanical (TMO) low alloyed steels; the producer provides declaration of chemical composition on delivery [1-3]. The carbon content is limited to 0.20 %, so the steel should possess good weldability. Microalloying elements cause improvement of mechanical properties of those steels; especially effective are niobium and boron which are deoxidizing the steels and cause the fragmentation of metal grains. There are three different modifications of the S690 steels: S690Q, S690QL and S690L1, which only differ with regard to guaranteed impact toughness: S690Q – KV = 27 *J* at -20°C; S690QL – KV = 69 *J* at -40°C, S690QL1 – KV = 27 *J* at -60°C [2, 3]. Mass application of the high strength steel of this class occurred due to exceptional mechanical characteristics (tensile strength and yield stress) as well as favorable impact toughness. Basic data provided by the steel manufacturer can be found in corresponding references [1-3, 5].

It should be emphasized that application of these steels is limited for the working conditions when the temperature does not exceed 500 °C, since above this limit the mechanical properties worsen [2, 3].