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Strength evaluation of the beam made of the titanium sheets Grade 2 and Grade 5 welded by Resistance Spot Welding

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ABSTRACT

The paper present the evaluate the bending load capacity of a composite beam made of titanium Grade 2 and titanium alloy Grade 5. The beam was made using the Resistance Spot Welding technology. All elements of the construction were cut from sheet thickness of 0.8 mm. Web and flanges of beams made from titanium alloy Grade 5 sheet. Flanges were joined with the web using the cold-formed brackets made of titanium Grade 2. The welding parameters of RSW were selected on the basic of strength tests and analysis of the microstructure. Grade 2 Grade 5 and Grade 5-Grade 5 sheets titanium were combined. Optimized parameters were also used to analyze joints with two welds: arranged parallel and perpendicular to the shear direction. The load capacity of joints, plastic strain distribution and the method of destruction was assessed. Results from the experimental research of joints with single welds are compared with the results of the numerical analysis. The numerical analysis was carried out using the ADINA system based on the Finite Element Method. Static tensile test was carried for titanium Grade 2 and Grade 5 with a thickness of 0.8 mm to numerical analysis. The composite beam made at paper was subjected to three-point bending.

1. Introduction

Titanium and its alloys is considered one of the most future-oriented materials which is applicable in various industries. It has excellent physical properties: low density and mechanical properties: high specific strength [1,2]. One of the most important features is its high resistance to corrosion in the air, tap water, sea water, chlorides, and most organic acids Elements made of titanium are lighter due to the low density, and at the same time characterized by high strength. They have application in many industries such as aerospace, automotive, medical engineering [3]. Increased application of titanium and its alloys entails the need to develop new methods and techniques of combine of parts and construction elements. The elements of titanium and its alloys can be joined by: gas tungsten arc welding (TIG), submerged arc welding, electroslag welding, pulse sas-shielded metal arc welding, electron beam welding in vacuum, laser, resistance, friction, diffusion, ultrasonic welding. Electron Beam Welding presented in the papers [4,5] enables the forming of titanium welded blanks. In this paper, the main attention was given to joining titanium and its alloys using resistance welding RSW. It has a significant position among other techniques due to the high productivity ease of operation and low cost [6,7]. According to work [8,9] Resistance Spot Welding consists in placing two metal sheets between two copper electrodes. The electrodes supply electric current to welded components.

During of the electric current flow, contact place of electrode and the material and joined elements are subject strong localized heating (due to the resistance opposed by an electric current). The weld is completed via solidification due to cooling through the electrodes. The welds quality depends on microstructures of the nugget affected by thermal processes and cooling rates. The quality of welds depends on microstructures of the nugget affected by thermal processes and cooling rates [10,11]. Resistance welding method is used for joining steel [7,12], aluminum alloys [13] and increasingly titanium and its alloys. Titanium alloys are used in the thin-walled constructions, which require high strength and relatively low weight and resistance to many of chemical compounds [14]. In works [15,16] presents the results of resistance welding sheets with a thickness of less than 0.5 mm (SSRSW). In work [17] has been studied the possibility perform the thin-walled beam with Grade 2 and Grade 5 titanium thick 0.8 mm using Resistance Spot Welding.

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2. Purpose and scope of work

The purpose of study was to evaluate the bending load capacity of a composite beam made of titanium Grade 2 and titanium alloy Grade 5 (6Al-4V) using Resistance Spot Welding technology (Figs. 1 and 2). The beam was made of the web and the flanges of titanium alloy Grade 5 sheets. The webs composed of two sheets of the same thickness and connected with flanges using cold formed brackets made of titanium Grade 2. Flanges have holes to reduce weight. All components a thickness of 0.8 mm were used. The length of the analyzed beam was 800 mm.

Was made the second the same beam and reinforced the composite for comparison the strength properties. Was used composite in the form of fiberglass sheets with a modulus of elasticity 24 GPa, which were glued to the belt of beam using epoxy glue (Fig. 3). The composite beams was subjected to three-point bending.

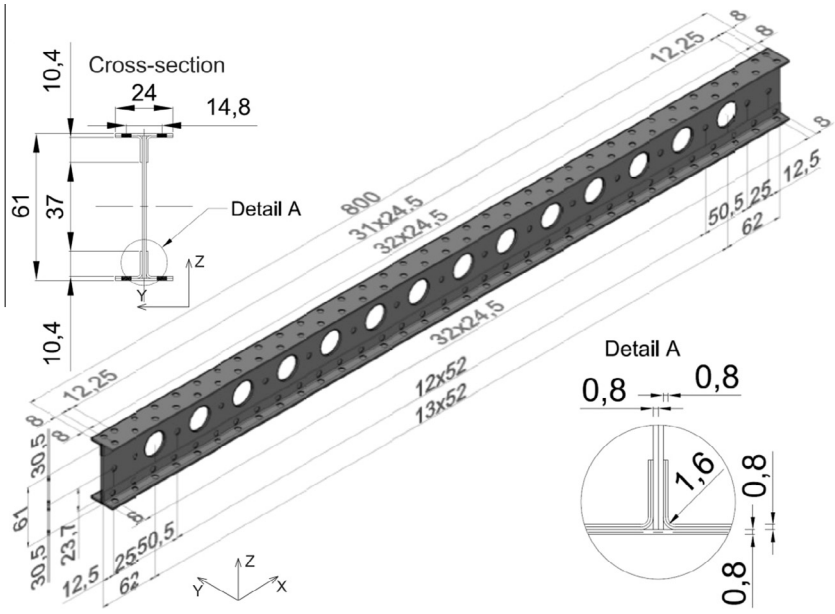

Fig. 1. Geometry of the analyzed beams.

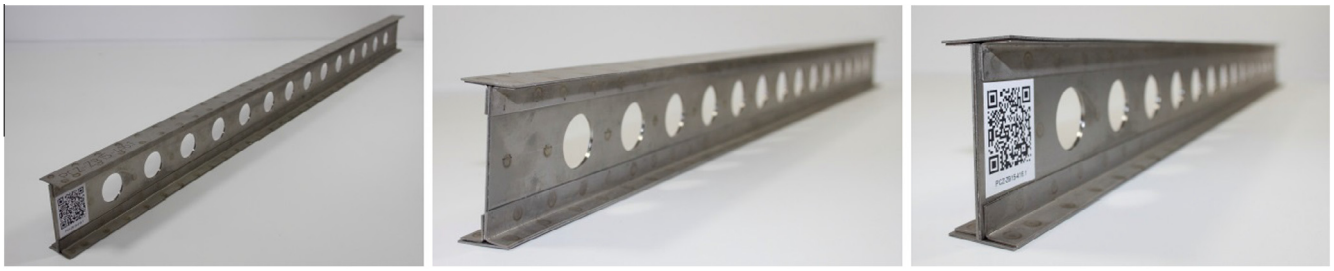

Fig. 2. Photos of beams before attempting a three-point bending.

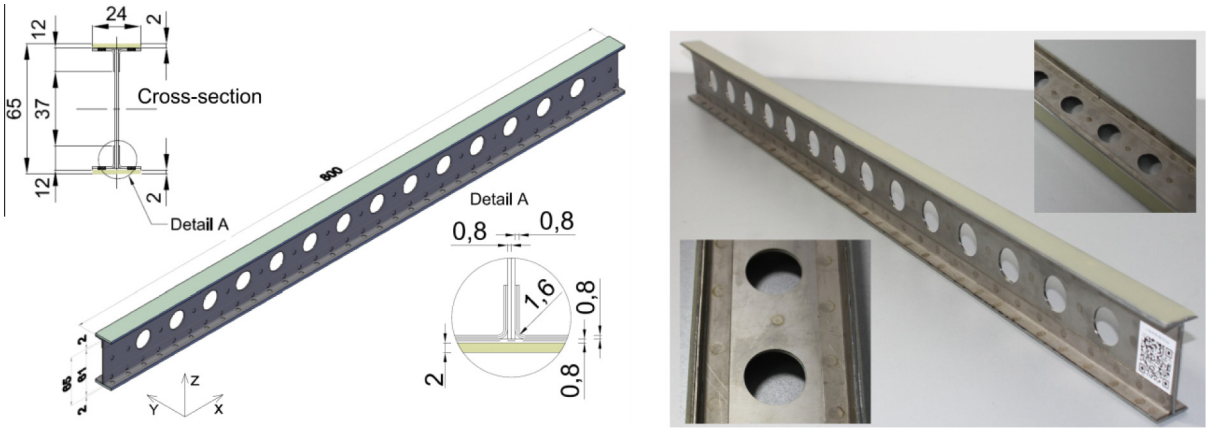

Fig. 3. Geometry and photos of beams reinforced fiberglass sheets.