

Finite Element Analysis for Stress Distribution in Welded Zones Used In RPD Technology

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INTRODUCTION: By applying finite element analysis we can make experiments regarding the efficiency of welded joints, used for the repair of removable partial dentures components.

METHODS: For testing it was used "C" alloy, (Vaskut Kohászati Kft., Hungary), which has the following chemical composition: Co-85%, Cr-29%, Mo-5% and mechanic parameters: $R_m=760\text{MPa}$, $R_{p0.2}=560\text{MPa}$, $E=219000\text{MPa}$. XXS Laser (Orotig, Italy) welding equipment was used. The welding method was in butt joint configuration with filling material on two surfaces (fig.1).

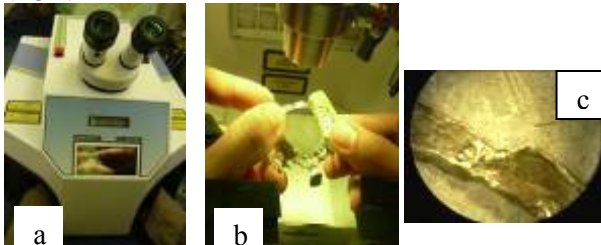


Fig. 1: Welding in Dental laboratory: a. Welding equipment; b. welding a removable partial denture major connector; c. welded area aspect.

It was used a geometrical three-dimensional cast, which was meshed into solid elements (65960 elements, 294623 junctions), using Solid Works 2007 program. The analysis consists of tension state simulation evaluation for a welding procedure, applied to "C" alloy parameters. There was made a static analysis of tension state (resulted after welding) regarding temperature and heat flux distribution. The thermal parameters used for estimation were: coefficient of linear expansion- $\beta=3,36 \cdot 10^{-5} \text{ W/mm}^2 \cdot \text{°C}$, coefficient of heat conductivity- $\lambda=6,05 \cdot 10^{-2} \text{ W/mm} \cdot \text{°C}$; Specific heat- $C=434 \text{ J/Kg} \cdot \text{°C}$.

RESULTS: Figure 2 presents the meshed geometrical model and the welding afferent to stress areas.

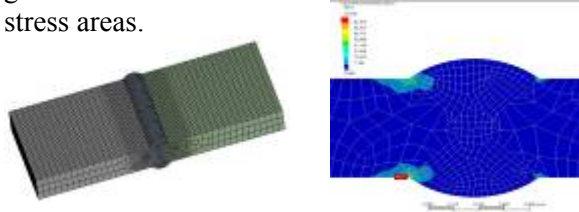


Fig. 2: Welding with filling material on two surfaces: a. meshed geometrical model, b. stress areas, pointed out through numerical analysis.

The results of the analysis consist in temperature distribution on a period of 1-5s (a,b), total heat flux distribution of the fusion zones (c,d) and equivalent tension at 1s (e) and 5s (f) after application of welding arch.

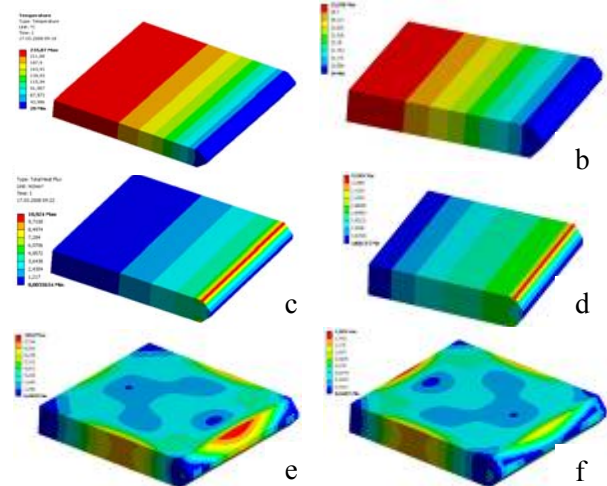


Fig. 3: a,b. Temperature fields for 1-5 s; c,d. Total heat flux distribution for 1s and 5s.; e,f. Equivalent von-Mises stress distribution for 1s and 5s.

DISCUSSIONS & CONCLUSIONS: The welded area has the peak tensile residual stresses longitudinal to weld direction and perpendicularly to welding arch. Study results reveal that around the fusion zone there is a stress gradient and this is the one that forms cracks in the fusion zone in steel [1,2]. Welding is a useful method in metallic prostheses repairs, and the decrease of alloys hardness in the welded zone is a priority. So, it is important to control welding heat input, in order to reduce welding stress and avoid cracks.

REFERENCES: ¹ Li. Yajiang, Wang Juan, Chen Maoai, Shen Xiaoqin (2004), *Finite element analysis of residual stress in the welded zone of a high strength steel*. Bull. Mater. Sci., Vol. 27, No. 2, pp. 127-132. ² J.D.Francis (2002), *Welding Simulations of Aluminum Alloy Joints by Finite Element Analysis*, Thesis-Faculty of the Virginia Polytechnic Institute and State University.

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