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A COMPARATIVE ANALYSIS OF WELDED JOINTS IN BAND SAW BLADES FOR THE PROCESSING OF WOOD

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ABSTRACT
The paper presents the results of researches carried out on several band saw blades (endless blades) for the chainsaws used in the processing of wood, that have been welded through automated electrical butt welding by means of the MIG procedure (under argon) and by pressure (resistance) butt welding, respectively, in order to determine the influence of the mentioned procedures on the welded joints' durability.
Keywords: welded joints, band saw blades, wood processing

1. INTRODUCTION
In the wood processing industry, there are used several types of saws with the blades shaped as endless bands (band saw blades). These blades are subjected, during their usage, to high and complex stresses, the most affected areas on their surface being the ones located at the base of the vacancies between two consecutive saw teeth, where a notch effect occurs, characterised by a stress concentration coefficient K = 1.4 - 1.7.
The cutting speed (the circumferential speed of the driving flywheels) is usually comprised between 15 and 60 m/s, function of the type of wood and the type of saw, the blade's initial tensile stress being of 30-150 MPa depending on the nature of the task to be carried out and on the wood type being processed.
The blades are subjected to a fatigue stress according to a positive oscillatory cycle, the number of stresses being in the order of tens of thousands per hour, which leads to a theoretical, ideal durability of about 40-60 hours.
The initial tensile stress, associated with supplementary tensile (stretching) stresses determined by the actual cutting, by temperature differences along the band length, by the blade's winding on the flywheel and by the centrifugal force, leads to a total stress, in the blades, of up to 600-650 MPa under ideal exploitation conditions. This fact imposes the requirement of using blades made of steels that have a minimal ultimate (static) strength of 1300 - 1500 MPa.

2. EXPERIMENTAL RESEARCHES
The experimental tests carried out as part of the researches presented in this paper, had as goal a comparative study between blades realised from 1x35 mm band, butt-welded through automated electrical MIG (metal inert gas, under argon) welding and through automated pressure welding (RBW – resistance butt welding), respectively.
Both procedures have been optimised technologically as part of a complex laboratory and experimental research, extended over a period of several years, in a specialised company.
The studied band saw blades were realised from a low alloyed steel with following chemical composition (table 1):

Table 1: Chemical composition of the steel used for the manufacturing of band saw blades

Element	C	Si	Mn	Cr	P	S
Weight [%]	0.75-0.80	0.30-0.40	0.72-0.80	0.38-0.45	< 0.02	< 0.01

The band used for the manufacturing of the band saw blades was heat treated (quenched and tempered) to a hardness of 42 - 45 HRC.
Both welding procedures were followed by a tempering treatment which, for the MIG procedure took place in a nearby furnace and for the RBW procedure on the welding installation itself.
Test samples were extracted from band saw blades welded through MIG and through RBW procedure, respectively. These test samples were tempered to a final hardness level of 42 - 45 HRC and then subjected to following types of determinations and analyses:

- metallographical analyses (microstructure and HV0.1 microhardness) of the welded joints, fig. 1;
- tensile strength tests (fig. 2);
- dimensional determinations in the joint and in the heat-affected zone (HAZ);
- fatigue tests, after a positive oscillatory cycle on a laboratory installation that simulated a frequency of 36000 bendings per hour, on flywheels with a diameter of 800 mm;
- HRC hardness determinations.

Fig. 1 Test samples prepared for the microstructural and microhardness testing

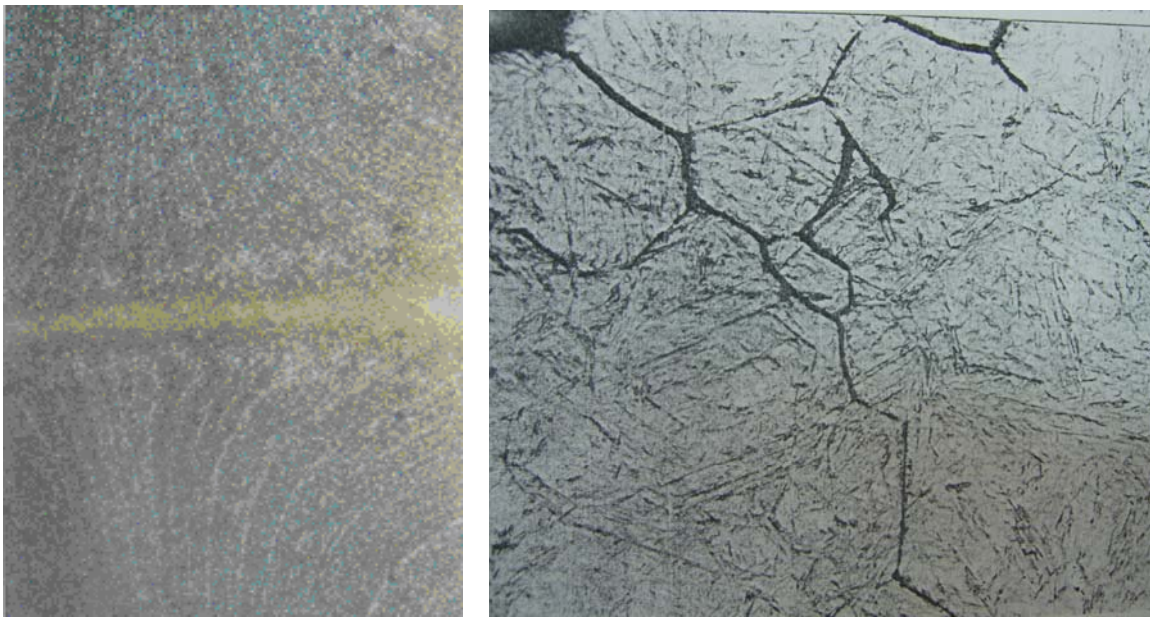
The main elements revealed by the research are the following ones:

- the tensile-tested samples displayed similar ultimate strengths and elongations, respectively, situated in the range R_m = 132 - 145 MPa and A_5 = 5 - 10 %, without there existing a clear difference between MIG-welded and RBW-welded samples;
- in RBW test samples, the tensile fracturing occurred, to a proportion of 92%, in the heat-affected zone (HAZ); the fracture appeared in the (very narrow) areas where the hardness decreased, locally, to values of 39 - 41 HRC;
- in MIG-welded test samples, the tensile fracturing phenomenon occurred, to a proportion of 38%, in the joint area, where, locally, lower hardness values of up to 38-40 HRC have been recorded; in 4 test samples there were found also intergranular microfractures (fig. 3b), determined by an inadequate manipulation of the blades after welding, during the transportation to the tempering furnace;
- the fatigue tests, carried out under the already-mentioned conditions, have shown that the average number of cycles until the appearance of a fracture was by about 12% higher for RBW blades

than for MIG-welded blades, a fact that was confirmed also by reports from actual users of these band saw blades.

a) *b)*

Fig. 2 a) The uniaxial tensile testing machine INSTRON 4003 on which the tensile tests were carried out and b) test samples used during the tensile tests.



a) *b*

Fig. 3. a) The microstructure of a RB-welded joint (100x) and b) the microstructure of a MIG-welded joint displaying intergranular fractures caused by an incorrect manipulation after welding (500x).

3. CONCLUSIONS

The researches carried out with regard to the properties of band saw blades subjected to two different types of welding, metal-inert gas (MIG) welding and resistance butt (RB) welding led, among others, to following conclusions:

- The MIG welding in argon atmosphere of the band saw blades taken into consideration for the study presented in this paper determines, in comparison with the RBW procedure, a higher heterogeneity of the welded joint; although it does not appear to influence significantly the results of the tensile testing, this heterogeneity is affecting the fatigue behaviour of the welded blades, which display a durability that is by up to 12% lower than in the case of RB-welded band saw blades;
- The tempering heat treatment in a separate furnace after the MIG welding can lead to the occurrence of intergranular fractures, if the manipulation of the band saw blades towards and within the furnace is not done with the required attention and equipment.

4. REFERENCES

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