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RESURFACING MONOBLOCK OF STEEL R7T WHEEL RIMS (MBW) FOR THE TRAIN WAGONS

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Preliminary note – Prethodno priopćenje

The steel R7T monoblock wheel material properties are defined by the International Declaration UIC 812-3. Taking into consideration the resurfacing of the rim, the analyzed conditions for the resurfacing, as well as the analysis of the chemical compounds, mechanical characteristics (material hardness, pulling strength, and tenacity), ultrasound and metallographic testing, which proved that the resurfaced rim area has the required characteristics, according to the Declaration UIC 812-3

Key words: resurfacing, wheel, characteristics/properties, analysis

Navarivanje vijenaca monoblok točka (MBT) čelika R7T za željeznička vozila. Svojstva materijala monobloka točkova čelika R7T su određeni po međunarodnoj objavi UIC 812-3. Na temelju navarivanja vijenca ovih točkova, istraživanih uvjeta za navarivanje, te ispitivanjem kemijskog sastava, mehničkih svojstava (tvrdoće, vlačne čvrstoće, žilavosti), ultrazvučnim i metalograpskim ispitivanjima, dokazano je da navareni sloj vijenca ima osobine sukladne traženim po objavi UIC 812-3.

Ključne riječi: navarivanje, točak, svojstva, ispitivanja

INTRODUCTION

One of the most important things concerning the usage of the railroad trains and wagons is the monoblock R7T quality wheel. The maintenance of the wheel so far is based mostly on the mechanical processing of the wheel, which can be done two or three times during its lifetime. Such maintenance is uneconomical procedure. In order to decrease the metal waste due to the machining process, as well as achieving the desired rim profile and the contact surface area, it is more reasonable to perform the resurface the monoblock wheel rim.

The Figure 1 shows the material loss during the nowadays maintenance process, and the Table 1 represents Chemical compound, and the mechanical characteristics of the R7T monoblock wheel quality are given in the Table 2.

Taking into consideration possible cracks beneath the resurfaced area, one of the biggest mistakes, they can be eliminated by the limiting the number of the resurfacing processes, maximum 3 times, as well as the strictly defined technological procedure, defined in this research paper, and by that we extend the usage of the monoblock wheel from 1 to 2 times.

The aim of this research paper is to examine and define a new technological procedure by resurfacing worn R7T monoblock wheel rim, reaching the satisfied level of liability, economical justification and doable even in the regular workshops for the maintenance of the wheels.

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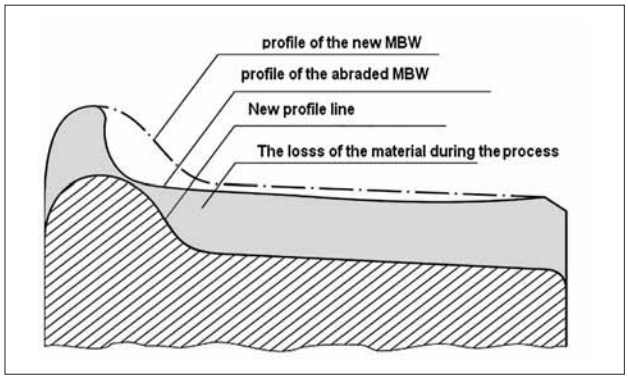


Figure 1 The loss of the materials and the wheel surface during nowadays maintenance process

EXPERIMENTAL RESEARCH

The main and the most influential element for a reliable quality of resurfacing process of the wheel rim, is the chemical compound of the monoblock wheel material and the thermal state. The quality R7T monoblock wheel material is plain steel with highly noticeable mechanical characteristics, which influences on the resurfacing of the material. If we take into consideration the chemical compound of the material, the material of the quality R7T monoblock wheel is thought to belong to the group of conditionally resurfaced steels, i.e. it requires certain measures to be taken in order to increase the technological resurfacing. On the basis of the carbon content and its equivalent, appropriate pre-heating temperature is required.

However, it is important to know [1], that the speed of the cooling process (after welding) during the the

Table 1 **The chemical compound of the monoblock wheel quality R7T by the International Declaration UIC 812-3/Wt.%**

C ≤	Mn ≤	Si ≤	P ≤	S ≤	Cr ≤	Ni ≤	Mo ≤	Cu ≤	V ≤
0,52	0,80	0,40	0,04	0,04	0,30	0,30	0,05	0,30	0,05

Table 2 **Mechanical properties of the monoblock wheel quality R7T**

Rm N/mm^2	Min. A %	Min. toughness Nm/cm^2	Stiffness HB	Equivalence C
820-940	14	15	240-285	0,68

temperature ranging from 200 ÷ 150 °C, in relation with a certain "critical cooling speed", is the crucial to prevent the deformation of the material and the emergence of the cracks [1].

In order to calculate the pre-heating temperature of the Tp monoblock wheel arch, the following method is applied [2].

$$Tp = 350\sqrt{[C]-0{,}48}$$

where:

(C) it represents the entire participation of the equivalent carbon, which is equal to the sum of the entire chemically equivalent carbon (C) h, gained on the bases of the chemical steel compound, and the equivalent carbon thickness (C) d, which depends on the thickness of the welded monoblock wheel arch.

The number from the formula above (0,48) is equal to the carbon compound in the monoblock wheel.

The chemically equivalent carbon is calculated from the following formula:

$$360\,(C)\ h = 360\,C + 40\,(Mn + Cr) + 20\,Ni + 28\,Mo$$

The calculated pre-heating temperature of the monoblock wheel rim is: Tp=156,38 °C

The low-graded electrode core with diameter 03 mm would be used for resurfacing the monoblock quality R7T wheel arch, whose chemical compounds are: C-0,29; Si-0,51; Mn-1,06; P-0,012; S-0,006; Cr-1,03; Al-0,093; Cu-0,94 i Ti-0,25.

This electrode belongs to the class of so called low-hydrogenated electrodes, which have a very strong influence during the resurfacing process, that is, the gas absorption within the weld, both as a hydrogen product and the mixture of oxygen and nitrogen from the air.

The protective powder of the low-alloyed electrode wire is not just made from the stabilizer and the chemicals which produce metallurgical shreds, but as well from the deoxidizers and alloyed components intended for ensuring needed mechanical characteristics of the resurfaced wheel arch. The powder is specially made for a certain electrode wire, and for the quality of the main material, that is the monoblock R7T quality wheel.

The resurfacing order has its special meaning when taking into consideration the prevention of the cold crack emergence, also having in mind the temperature pre-heating limitations from 156 °C. The resurfacing's direction is from the root towards the top of the arch, not forgetting the overlapping of the weld seam (similar to the fish scale). The Figure 2 shows the schematic process of the resurfacing process of the rim.

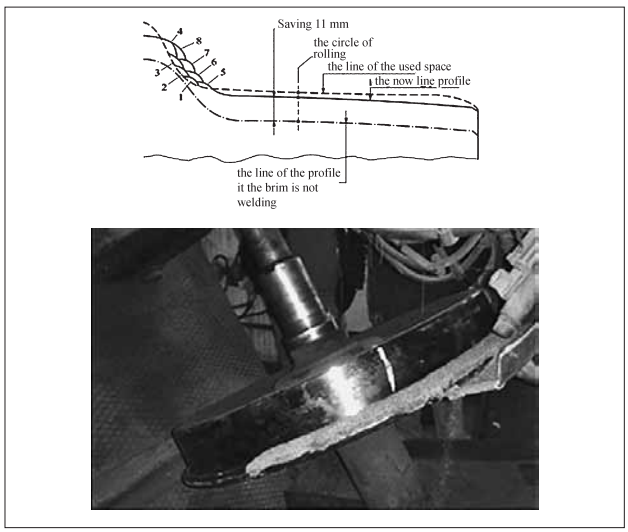


Figure 2 Technological resurfacing of the monoblock wheel arches

RESULTS AND DISCUSSION

Testing and proving the wheel quality, renewed arches by resurfacing, those methods and procedures specified by UIC 812-3 are applied in this paper work, and they are: chemical, mechanical, ultrasound and metallographic testing.

The results of the chemical analysis of the weld materials

According to the performed chemical analysis, we can conclude that the chemical compound of the addi-

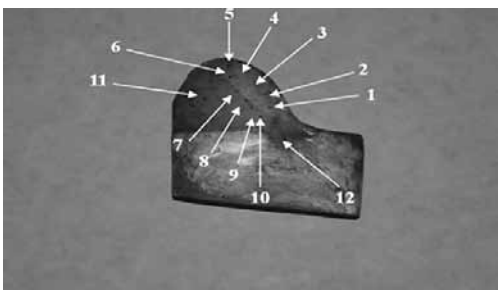


Figure 3 Measurement of the diameters' stiffness of a wheel arch: primary and additional material within the merging zone.

Table 3 **Results for the weld stiffness measurement, basic material and merging zone**

Sample number	Testing spot	1	2	3	4	5	6	7	8	9	10	11	12
1	Stffness HB	265	266	285	285	262	248	241	244	238	235	229	220
2		265	269	273	269	265	252	248	244	241	235	229	226
3		265	263	269	273	265	248	248	241	244	238	220	229
4		243	252	248	246	240	250	253	240	248	240	222	223

tional material on the monoblock wheel contains all the key chemical elements prescribed by the UIC 812-3.

Mechanical testing

The international statement of the UIC 812-3about the creation and control of the monoblock wheel are prescribing the following mechanical testing:

- Testing the stiffness
- Testing the resilience
- Testing the pulling tension.

Testing the contact surface stiffness and the diagonal profile of the monoblock rim

Testing of the contact surface stiffness, diagonal profile and repaired arches MBW was performed with the portable measurement device "EQUO" type "Proceq". The Figure 3 shows spots where the measurements of stiffness were made, and the Table 3 shows the results of the stiffness examinations. The results of the stiffness examination were according to the UIC 812-3 declaration, i.e. the contact stiffness of the MBW profile is within 240-285 HB.

Testing the Charpy notch toughness and R_m

Results showed that the during the welding process no changes of resistance were caused as well as the rest of the mechanical characteristics in the basic material which are within the statement UIC 812-3.

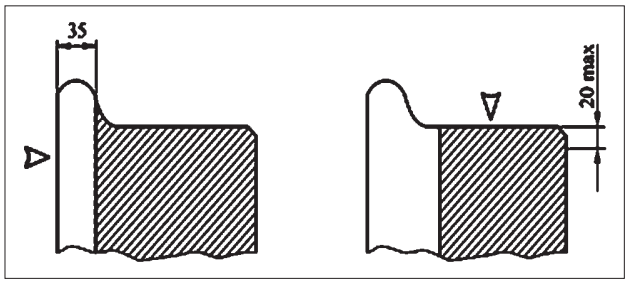
Ultrasound testing

The ultrasound testing is one of the best indirect methods, and they were applied on:

- Finding the faults within the welded material and within the arch of MBT
- Measurements of the remaining tension within the monoblock wheel arch
- Defect analysis within the material and the brim of the monoblock wheel was executed in two different ways of probe usage - Figure 4:
- Vertically on inner side (axial probing) and
- Vertically on the contact area (radial probing)

According to the international statement UIC 510, the remaining tension within the material of the monoblock wheel is allowed not to exceed 300 MPa.

The measurement of the remaining tensions before and after the resurfacing was done almost on the exact (marked) testing points on the brim of the wheel. The results of the tension state are within the allowed limits, according to the national and international railroad regulations.



a) b)

Figure 4 The probing positions within the wheel brim and wheel itself a) axial probing b) radial probing

Metallographic researches

The samples of the monoblock profile are grounded on the flat grinder by abrasive paper fineness 180, and then macro abraded by 10 % aqueous solution of nitric acid.

The microstructure of the main material is shown on the Figure 5/a, whose structure is ferritic – pearlitic, pearlitic lamellar. This structural composition is considered to be satisfying and auspicious.

Figure 5/b, the zone of the main and additional material composition, it can easily be seen that the microstructure is auspicious, that is, it consists a mixture of pearlite with a small amount of martensite. The dimension of the grain is a bit smaller when observing from the welding point of view, but from the main material's point of view it is significantly bigger and it slowly shifts into the main material. The zone of the heat influence (ZHI) is without the tempering presence.

Figure 5/c, It can easily be seen that the welding material, that is, the additional material, is clean and free of inclusions. The microstructure of the lengthways observed height of the weld is clearly different, since each following weld influences the structure. All four experimental samples of the welded part are martensite structure with a bigger part of the liberated ferrite.

This kind of structure content is considered to be very auspicious, realizing that it is about the part of the monoblock wheel profile, which is foremost exposed to the attrition, and such a structure characterizes elements of improvement, in fact, the amplification of the stiffness and the attrition resistance, what in our case was the aim at the first place.

a) b) c)

Figure 5 Micro plate a-the main material, b-the emerging zone and, c-welded layer

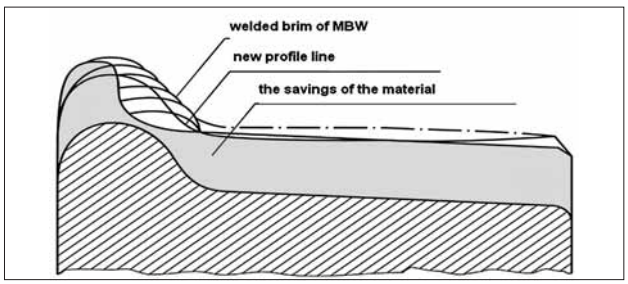


Figure 6 Saving of the discarded material and the contact surface area of monoblock wheel R7T by resurfacing.

Bauman's print obvious that the spotlessness rate of the main and additional material is auspicious, as well as the rate of the remodeling of the main and the additional material, whereas the structure is equalized and fragmented, and as such characterizes bigger stiffness and attrition resistance.

The characteristics, determined by the experimental research of the restored monoblock wheel arch, are within allowed limits, pursuant to the conditions of the UIC 812-3. It is also noticeable that the stiffness of the arch is improved (attrition resistance). It has also been proved that the time of exploitation between the two profilings is longer. Saving of surface rolling circle material by the arch welding is shown on Figure 6.

CONCLUSION

In order to resurface quality R7T monoblock wheel the pre-heating conditions, additional material and technological process of the resurfacing as well as the speed of the cooling (after the resurfacing) were improved. By examining the welded layer of the rim, it has been established that all the characteristics (chemical, mechanical, structural), values of behindhand strains are according to the regulations prescribed by the UIC 812-3. Additional analysis actually confirms economical justification of this resurfacing procedure, especially when extending the lifetime of wheel usage, at least for the one time.

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Note: The responsible for English language is professional lecturer of Railways of Republika Srpska, B and H