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FORMABILITY OF CP-W 800 STEEL SHEETS

Jozef BÍLIK, Viktor TITTEL, Mariana DOBIŠOVÁ, Roland ŠUBA

Abstract

The paper is focused on the verification of CP-W 800 high strength steel mechanical properties and formability. This steel is used in automotive industry. There are results of tensile test and microhardness measurements and technological tests.

Key words

formability, uniaxial tensile test, Erichsen cup test, microhardness

Introduction

Very important role at sheet forming beside technological parameters and technological operations plays also the properties of formed materials. Recently automotive industry tries to improve safety and decrease mass of cars by using high strentgh materials. One of such materials is CP-W 800 steel. The aim of this paper is to analyze mechanical properties and formability of this steel used for production of chassis parts. [1, 2, 3]

Mechanical properties of CP-W 800 steel

CP-W 800 is high strength steel processed by controlled hot rolling. The material with 2 mm thickness is zinc plated. Its chemical composition is in Table 1 and required mechanical properties in Table 2.

CHEMICAL COMPOSITION OF CP-W 800 STEEL Table 1

C	Si	Mn	P	S	Nb	Ti	Al	Cr	Mo
≤ 0,18	≤ 0,80	≤ 2,20	≤ 0,025	≤ 0,010	≤ 0,08	≤ 0,18	-	≤ 0,60	≤ 0,40

Jozef Bílik, Assoc. Professor, PhD., Viktor Tittel, Assoc. Professor, PhD., Mariana Dobišová, MSc. Eng., Roland Šuba, PhD. - Institute of Production Technologies, Faculty of Materials Science and Technology in Trnava, Slovak University of Technology Bratislava, Paulínska 16, 917 24 Trnava, Slovak Republic, e-mail: jozef.bilik@stuba.sk, viktor.tittel@stuba.sk, mariana.dobisova@stuba.sk, roland.suba@stuba.sk

REQUIRED MECHANICAL PROPERTIES OF CP-W 800 STEEL Table 2

Yield strength $R_{p0,2}$ [MPa]	UTS R_m [MPa]	Ductility A_5 [%]
Min. 680	800 - 980	min. 12

Test results

The tensile test was made after standard STN EN 10 002-1 (STN 42 0310) on sheet tensile test specimens (STN 42 0321). The shape and dimensions of sheet tensile test specimens can be seen on Fig. 1.

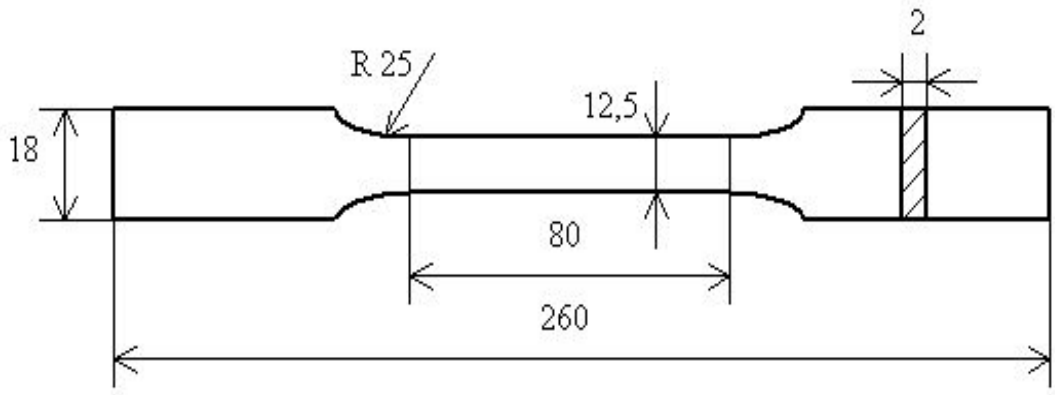

Fig. 1. *Shape and dimensions of tensile test specimen*

The measured and computed values from tensile tests are in Table 3. The Table 3 shows beside the ultimate tensile strength determined by the standard also effective ultimate tensile strength determined for change of the test specimen neck cross-section. Table also shows ductility up to neck creation beginning.

THE RESULTS OF THE STATIC TENSILE STRENGTH TEST
FOR CP-W 800 MATERIAL Table 3

CP-W 800						
Specimen No.	Strenth characteristics		Effective ultimate tensile strength	Ductility characteristics		Ductility up to neck creation beginning
	$R_{p0,2}$ [MPa]	R_m [MPa]	R_{ms} [MPa]	A_{80} [%]	Z [%]	A_{neck} [%]
1.	799,90	860,04	1068,16	15,38	28,49	9,75
2.	824,46	891,64	1046,59	13,81	40,36	9,19
3.	830,63	899,85	1083,34	15,63	38,30	9,75
Average value	**818,33**	**883,84**	**1066,03**	**14,94**	**35,72**	**9,56**

From the measured and computed values of the tensile test is obvious that tested material fulfill required mechanical properties.

Erichsen cup test was made according to standard STN 42 0406.The test specimens were strips with dimensions 90 x 420 x 2 mm. The measured cup height at fracture are in Table 4.

THE RESULTS OF ERICHSEN CUP TEST OF CP-W 800 MATERIAL Table 4

CP-W 800	
Specimen No.	**The cup height at fracture h_{crit} [mm]**
1.	12,00
2.	11,70
3.	11,80
4.	11,65
5.	11,70
6.	11,50
Average value	**11,73**

The measured values from Erichsen cup test indicate that given material is suitable for deep drawing.

This material is tested by bend test and the cracking begins at angle 159º 30´.

It is also tested by 180° bend test (Fig. 2). There can be seen visible cracks on the external side of bend.

Fig. 2. *The crack shape at 180° bend test (CP-W 800)*

The microhardness was measured on specimens prepared for metallographic analysis with loading 0,05N during 10 seconds. For this measurement BUEHLER INDENTAMET 1105 test machine was used.

THE RESULTS OF CP-W 800 MATERIAL MICROHARDNESS TESTING Table 5

CP-W 800					
Hardness HV 0,05					**Average value**
1.	2.	3.	4.	5.	
304,5	296,0	227,2	251,5	241,4	**264,1**

Analysis of material´s microstructure

The microstructure was analyzed by light microscope on cross-cuts of specimens prepared for metallographic analysis. The specimens were analyzed on NEOPHOT 30 light microscope. The preparations consists from cutting of specimens 15 mm long, grinding by abrasive coated paper with various abrasive grain size (abrasive coated paper codes in order of their use 220, 320, 400, 600, 800 a 1200), polishing with abrasive diamond paste (with grain size 3, 2 or 1 μm), etching by 3 % Nital. [4, 5, 6].

Fig. 3 and 4 shows the microstructure of CP-W 800 steel in surface layer and in the centre. It contains ferite, bainite and martensite and residual austenite.

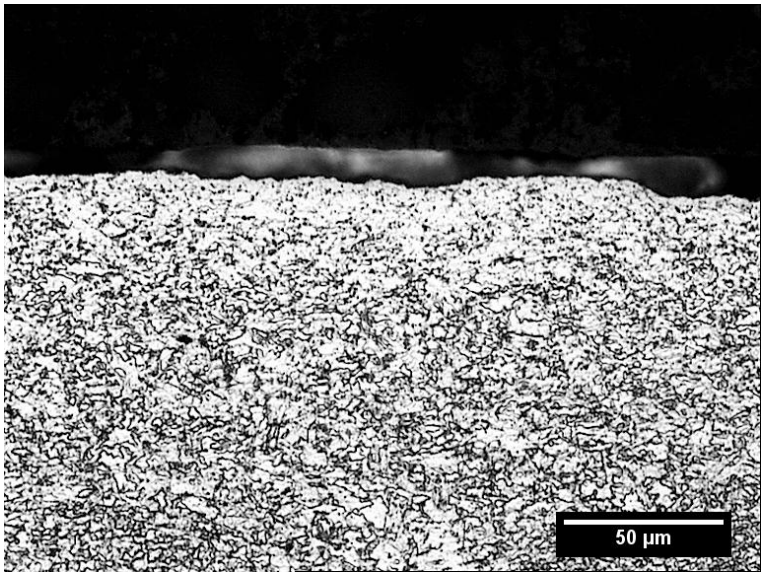

Fig. 3. *The mikrostructure of CP-W 800 material`s surface layer*

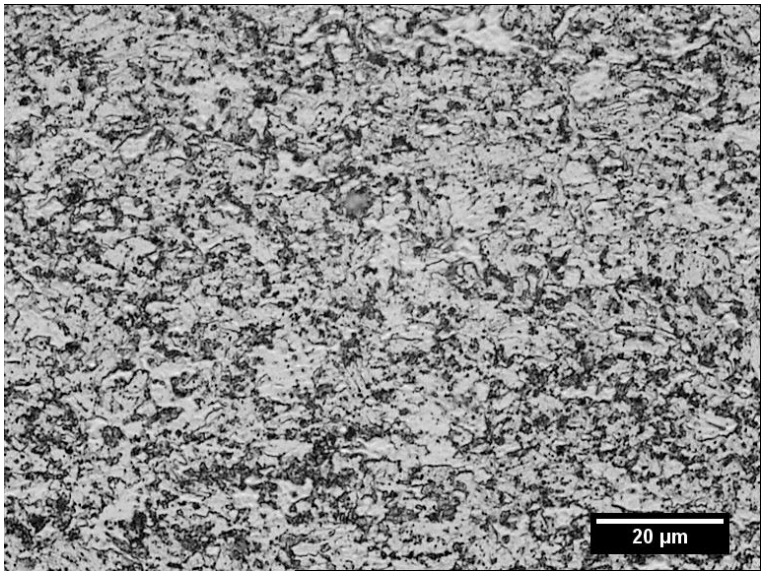

Fig. 4. *The mikrostructure of CP-W 800 material, centre*

Paper`s contribution

The knowledges and data about higher and high strength automotive industry materials properties and formability are not widely obtainable from sources. The main paper`s contribution are mechanical properties of CP-W 800 high strength steel, the results of its basic and technological tests. The sheet test specimen was to designed in compliance with standard to prevent the sliding of clamping jaws on the heads of test specimens.

Conclusions

The basic test and technological tests made for material CP-W 800 proved that the material is suitable for processing by forming technologies to make drawings and bended parts for automotive, electrotechnic and power generating industries. The measured ultimate tensile strengths R_m were in range from 860 to 900 MPa. The required ultimate tensile strength R_m have to be from 800 to 980 MPa and the values of tested material were from this range so the material fulfills this requirement. The measured values of ductility A_{80} were from 13,8 to 15,6 % and required ductility is minimum 12 % so the material fulfills also this requirement. The main parameter from Erichsen cup test cup height at fracture was h_{crit} = 11,73 mm, which proves suitability of this material for streching“.

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Reviewers:

Mária Kapustová, Assoc. Professor, PhD. – Institute of Production Technologies, Faculty of Materials Science and Technology in Trnava, SUT Bratislava

Prof. Ing. Emil Evin, CSc. – Faculty of Mechanical Engineering, TU Košice