ANNALS of Faculty Engineering Hunedoara
International Journal of Engineering
ISSN: 1584 - 2665

STUDIES PROPERTIES AND FORMABILITY OF HIGH-STRENGHT STEEL CP-W 800

Jozef BÍLIK, Miroslava KOŠŤÁLOVÁ, Mariana BALÁŽOVÁ

Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology, Institute of Production Technologies, Department of Forming, SLOVAKIA

ABSTRACT:
The article points out on verification mechanical properties and formability high-strength steel CP- W 800 using in the automobile industry, here are shown results acquired of basic tensile test, technological examinations, measuring of microhardness and structural analyses.
KEY WORDS:
formability, tensile test, Erichsen test, microhardness, bending test

1. INTRODUCTION

Application of steel metal sheet with high strength properties per thin bearing parts of segments allows increase of technical economic production level. The sheet as constructive material has profit that allows suggesting shapes complicated, rigid and stiff parts. Required rigidity of components from thin-walled plates does not achieve by maximize of metal plate wall thickness, but by using of steel sheets, that have better strength properties. It avoids increase weight of bearing parts of constructions with performance of demands on safety by using of sheet metal plates with high strength properties. Technological processing of materials with high strength properties has a lot of problems, because by increase of strength properties are worse indexes of pressability, therefore it is needed to obtain new knowledge about sheet metal pressability before using in production. It is possible to consider for steel with high strength properties that steel, whose yield point is Re≥210 MPa and they have at the same time good formability. Conventional carbon steels with such yield point have low pressability. It is possible to achieve concurrently improvement of strength and plastic properties by suitable choice of chemical conception, at which it knots mechanisms controlling of steel strengthening (hardening of solid solution by interstitial and substitute elements, dislocation strengthening, strengthening belong grains border, precipitation strengthening, transformation strengthening. The strongest effect per steel properties shows transformation strengthening, whereby consequential steel properties depend from several strengthening factors at the same time. [7]

It is the biggest attention devoted to progressive high-strength steels (AHSS) and ultra-height strength steels (UHSS) in research at the present. Into category AHSS are classified two-phase steels (DP), complex phase (CP) and steels with transformation induced plasticity (TRIP), containing residual austenite (RA). It is the biggest attention devoted to progressive high-strength steels (AHSS and ultra-height strength steels (UHSS in research at the present. Into category AHSS are classified two-phase steels (DP, complex phase (CP and steels with transformation induced plasticity (TRIP, containing residual austenite (RA). The martensitic steels belong in the first place into category UHSS. Mentioned groups of steels are good pressable, they have excellent combination of strength, lifetime, absorption of deformation velocity, deformation strengthening and good weldability. Conceived steel characteristics by this manner make possible to automotive designer to realize conceptions of construction weight decreasing and safety crew increase at accident.

The steels DP, CP, TRIP are also called multi-phase steels, because they contain minimum two different structural phase, e.g. relatively soft phase, that constitutes matrix (ferrite) and it allows reaching low yield point and good pressability and hard phase for achievement of high strength limit. Multi-phase steel are characterized by providing for carbon transportation in hard structural components, namely by means of alloying elements and cooling regimes, resp. By heat treatments, by that are influenced phase transformation conditions. [3]

2. CHARACTERISTICS AND REQUIRED MECHANICAL PROPERTIES EXAMINATION STEEL CP- W 800

Automobile industry is on the present time one of the biggest processer metal sheet in the Slovakia's as a world. Present in the area of automobile industry in term of increases security and decreasing weight cars, high strength steels have big importance. CP steels typify the transition to steel with very high ultimate tensile strengths. The microstructure of CP steels contains small amounts of martensite, retained austenite and pearlite within the ferrite/bainite matrix. An extreme grain refinement is created by retarded recrystallization or precipitation of microalloying elements like Ti or Cb. In comparison to DP steels, CP steels show significantly higher yield strengths at equal tensile strengths of 800 MPa and greater. CP steels are characterized by high energy absorption and high residual deformation capacity.
Report is focuses on analysis and verification of mechanical properties also formability of given steels using primarily in automobile industry production of carrying components bogie parts of cars. [1, 2, 3]

Steel CP- W 800 is multiphase high strength steel galvanized controlled rolled in hot. Test material is sheet with thickness with = 2mm. Chemical composition of steel is present in table 1 and required mechanical properties are present in table 2.

Table 1. Chemical composition of steel CP-W 800 (weight %)

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

Table 2. Required mechanical properties of steel CP-W 800

Yield point $R_{p0,2}$ [MPa]	Strength limit R_m [MPa]	Tensibility A_{50} [%]
Min. 680	800 - 980	Min. 12

3. EXPERIMENTAL PROCEDURES

3.1 Results of tensile test

Tensile test was perfected per STN EN 10 002-1 (STN 42 0310) on flat test samples (STN 42 0321). Shape and dimensions sample are introduce on figure 1.

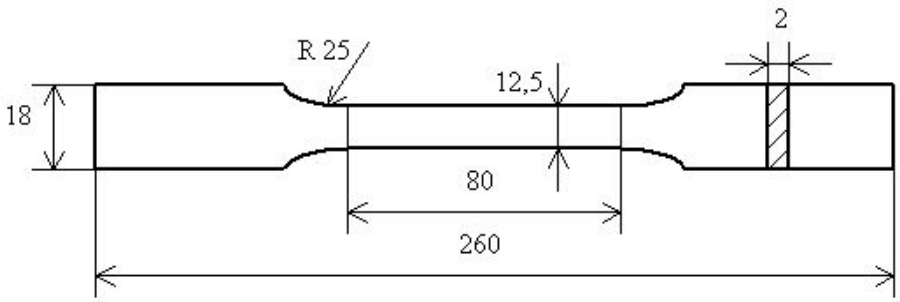

Figure 1. Shape and dimensions test sample for tensile test

Results get from perfected tensile test are present in table 3. In table 3 is besides strength limit establishing normative introduced too effective strength limit establishing the make provision for cross-section variation waist sample. In the tablet is introducing too tensibility in start of creation cervix and exponent strengthening.

Table 3. Results static tensile test for material CP-W 800

CP-W 800							
Number of sample	Characterization of strength		Effective strength limit	Characterization tenacity		Tensibility in start of creation cervix	Exponent of strengthening
	$R_{p0,2}$	R_m	R_{ms}	A_{80}	Z	$A_{krč}$	n
	[MPa]	[MPa]	[MPa]	[%]	[%]	[%]	[-]
1.	799,90	860,04	1068,16	15,38	28,49	9,75	0,0744091
2.	824,46	891,64	1046,59	13,81	40,36	9,19	0,0623280
3.	830,63	899,85	1083,34	15,63	38,30	9,75	0,0683168
Median	818,33	883,84	1066,03	14,94	35,72	9,56	0,0683513

It results from values determined from tensile test that the test material verifies required values in term of mechanical properties.

3.2 Results from technological test and measurement of microhardness

Technological test was employed by Erichsen test. Erichsen test was performance normative STN 42 0406. As test samples were employed straps with dimension 90 x 420 x 2mm. Measured values of depth impression into failure are presented in table 4. Whereas the samples are from sheet from high strength steel with thickness 2mm, it was perfected for comparison Erichsen test with samples with dimension 90 x 420 x 2mm from steels STN 411331, which belong to deep - drawing steels designated for medium drawing. Results for steel STN 411331 are presented in table 5.

Table 4. Results from Erichsen test for material CP-W 800

CP-W 800		
Number of impress	Depth impress into failure IE_{21} [mm]	Quartering way
1.	12,00	Crack start up after contour line
2.	11,70	
3.	11,80	
4.	11,65	
5.	11,70	
6.	11,50	
Median	11,73	

Table 5. Results from Erichsen test for material STN 411331

11331		
Number of impress	Depth impress into failure IE_{21} [mm]	Quartering way
1.	13,25	Crack start up after contour line
2.	13,35	
3.	13,20	
4.	13,15	
5.	13,10	
6.	13,00	
Median	13,175	

Measured values from Erichsen test points to suitability of mentioned material for drawing. It results from comparison results from Erichsen test of steel CP-W 800 and steel 41 1331 suitability surveyed high strength steel CP-W 800 for drawing. It was done test by bend with bend radius R = 1mm with material CP-W 800. The first nucleus appearances in bend test at bend angle 159° 30´. Measurement of microhardness was realized with metallographic prepared specimens at loading 0,05N, the time of loading was 10sec. It was used for measurement measuring devices BUEHLER INDENTAMET 1105.

Table 6. Results of microhardness measurement for material CP-W 800

CP-W 800					
Microhardness HV 0,05					Median
1.	2.	3.	4.	5.	
304,5	296,0	227,2	251,5	241,4	264,1

3.3 Micro structured material analyze

It was used optical microscopy for microstructure analyze on metallographic prepared cross section of specimens. Analyze was done on optical microscope NEOPHOT 30. Metallographic preparation consists of samples removal with length approximately 15 mm, mechanical grinding by help of set metallographic papers with graded granularity (in order 220, 320, 400, 600, 800 a 1200), mechanical polishing with diamant pastes with granularity 3, 2 and 1μm, microstructure development by chemical etching in 3% Nital. [4, 5, 6] On figures 2 and 3 is microstructure of steel CP-W 800 on surface and in grain, the structure consists of ferrite, bainite, martensite and with islets of residual austenite.

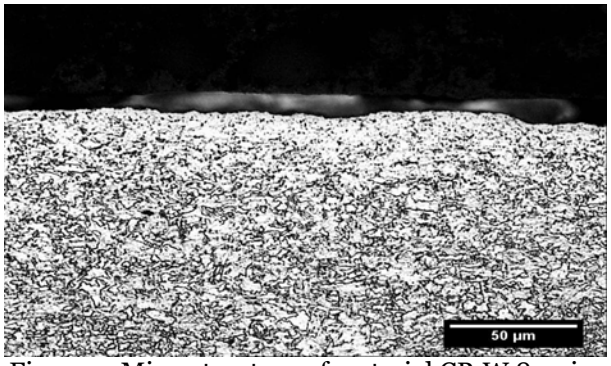

Figure 2. Microstructure of material CP-W 800 in surface layer

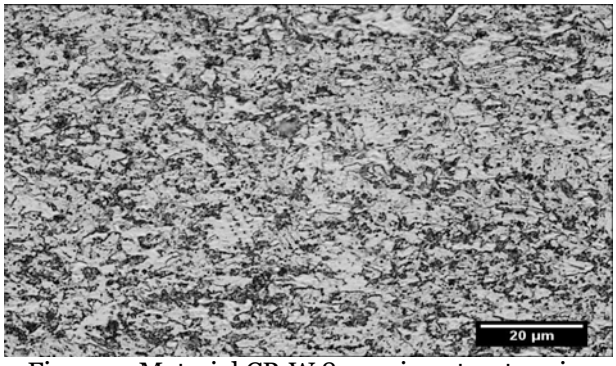

Figure 3. Material CP-W 800 microstructure in nucleus

4. CONCLUSION

Basic test and technological tests were performed on material CP-W 800 and they validated suitability of this material for its processing by forming in production of drawing parts and bended components for automotive industry and for consumer, electrical and energetic industry too. Measured values of yield point were in range from 799MPa to 830MPa, required value of yield point is Rp0,2 = min.680 MPa. Measured values of strength limit Rm was in range from 860MPa to 900MPa. required strength limit , is in range Rm = 800 till 980 MPa. Measured values of tensibility A80 were in range from 13,8% to 15,6%, required tensibility is A_{80} = min12%. High criteria from Erichsen test – average value from indentation test was IE_{21} = 11,73 mm, for sheet thickness s = 2 mm, it makes out suitability of given material for drawing. It was performed Erichsen test for comparison of results with material 11 331 STN 411331, with the same thickness s = 2mm, where average value from indentation test was IE_{21} = 13,175 mm.

Acknowledgements
The paper was created with thanks of grant VEGA 1/0060/08

REFERENCES

[1.] *HRIVŇÁK, A., EVIN, E. Lisovateľnosť plechov : predikcia lisovateľnosti a oceľových plechov s vyššími pevnostnými vlastnosťami. Košice : STU, 2004. 223 s. ISBN 80-89066-933*
[2.] *HUDÁK, J., TOMÁŠ, M. Hodnotenie hlbokoťažnosti ocele s vyššou pevnosťou pre automobilový priemysel. In Transfer inovácií [online]. 10/2007 [cit. 2008-03-11;16:33]. Dostupné na internete <http://www.sjf.tuke.sk/transferinovacii/pages/archiv/transfer/10-2007/pdf/136-139.pdf.> ISBN 80-7093-6.*
[3.] *KVAČKAJ, Tibor. Výskum oceľových materiálov pre uľtraľahkú karosériu osobných automobilov. In Acta Metallurgica Slovaca, 2005, roč. 11, č. 4, s. 389 - 403.*
[4.] *MARTINKOVIČ, M., ŽÚBOR, P. Mechanické skúšky a defektoskopia materiálov. Bratislava STU, 2005, 114 s. ISBN 80-227-831-1.*
[5.] *ČAPLOVIČ, Ľubomír: Methodology of physical metallurgy analysis in materials engineering. 1. vyd. – Trnava: Alumni Press, 2008. – 91s. – (vedecké monografie); 4/2008). ISBN 978-80-8096-061-2.*
[6.] *PERNIS, R. Teória tvárnenia kovov. Trenčín: TnUAD, 2007., 168 s. , ISBN 978–80-8075-244-6*
[7.] *HRUBÝ, J., RUSZ,S., ČADAR,R. Strojírenské tváření. Ostrava, ES VŠB-TU. 160 s. ISBN 80-248-1218-5*

ANNALS OF FACULTY ENGINEERING HUNEDOARA
– INTERNATIONAL JOURNAL OF ENGINEERING