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STUDY OF THE RV52 STEEL PLATES PROPERTIES AFTER THERMIC TREATMENT

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ABSTRACT

The thermal treatment of RV52 steel plates determines high mechanical properties such as: strength, wear resistance and tenacity. The normalized plate samples were studied to determine the effect of the tension release heat treatment on the properties of steel plates used for metallic welded construction. From the relations expressing the link between the strength and tenacity relation on one hand and the structural characteristics, on the other it is obvious that the only factor which leads both to increasing strength properties and decreasing transition temperature is the finishing of the ferrite grains.

KEYWORD: ingot, properties, steel, treatment, structure

1. Introduction

During the processing and operation in the basic steel mass a number of phenomena can occur such as: lamellar spreading, fissures in the welded areas and easy breaking. Occurrence of these phenomena depends on the steel chemical composition and the semi blanks elaboration and processing conditions.

The normalised plates of RV52 steel feature a ferite-perlite structure, the obvious tendency being that of reaching an as low as possible content of perlite with the corresponding decrease in the carbon content. The heat normalising treatment of the thick plates took place in the roller continuing furnaces from the rolling mill of ARCELOR-MITTAL Galati observing the following parameters: heating up to temperatures A_{C3} + 20 ^{o} C ÷ 40^o C, air cooling [1]. The analysis of the relationship between strength and tenacity, on the one hand, and structure characteristics, on the other hand, shows that the heat tension-relieving treatment and especially, the normalising treatment considerably increase the tension strength and decrease the transition temperature due to the ferrite grain shrinking process.

Manufacturing plates of high chemical (table 1) and structure homogeneity leads to an isotropy corresponding to these properties, which attracted the researchers' interest [2].

2. Experimental researches and results

In order to carry out the researches on the correlation of microstructure with the properties of steel RV52, normalized and tension relieved, the following working variants have been established:
- steel making in a 50t electrical furnace by 15 t ingot casting of thick rolled plates, normalising treatment, and sampling for heat treatment tension relieving in laboratory;
- steel making in a 150t converter, by 25t ingot casting and continuing casting in slab, of thick rolled plates, normalising treatment, and sampling for heat treatment for tension relieving.

Table 1. *Chemical composition*

C	Mn	Si	P	S	V	Al	Ni	N
[%]								[ppm]
0.14	1.40	0.26	0.01	0.01	0.05	0.02	0.28	120

Sampling the steel RV52 plates before and after normalising has been carried out according to the following scheme:

- the samples of the plates made by ingot rolling have been taken from the edges and the axis corresponding to the head, middle and leg parts;

- the samples of the plates made by cast slabs rolling have been taken from the edge and axis. The samples have been taken from the central axis of the plate corresponding to: a) head, b) middle part; and c) leg.

The samples of normalized plate have been prepared in longitudinal section and non- metallic inclusion score are given in Table 2.

Table 2. *Non- metallic inclusions score*

Score	*Types of non- metallic inclusions*				*Total score over the same field*
	Sulphides S)	Oxides OL+OP	Silicates SF+SP(SN)	Nitrides NT+NA	
	Non- metallic inclusions score				
1	2	3	4	5	6
a	1.0 0.5 1.0	1.5 1.5 1.0	1.0 1.0 1.5	0.5 0.5 0.5	4.0 3.5 4.0
Max. score of inclusions	1.0	1.5	1.5	0.5	
b	0.5 0.5 1.0	1.5 1.5 0.5	1.5 1.5 1.5	0.5 0 0	4.0 3.5 3.0
Max. score	1.0	1.5	1.5	0.5	
c	1.0 1.0 1.0	0.5 1.5 1.0	1.0 1.0 1.5	0.5 0 0	3.0 3.5 3.5
Max. score	1.0	1.5	1.5	0.5	

The impure zones, irrespective of the sample position, are those corresponding to the head and middle side of the ingot. In the axis purity is lower as compared with the sample edge. When elaborated in the electrical furnace, a higher purity is reached than in a converter. The metallographic structure of the heat treated plates is given in Figure 1 which highlights a fine-granulation ferrite-perlite structure.

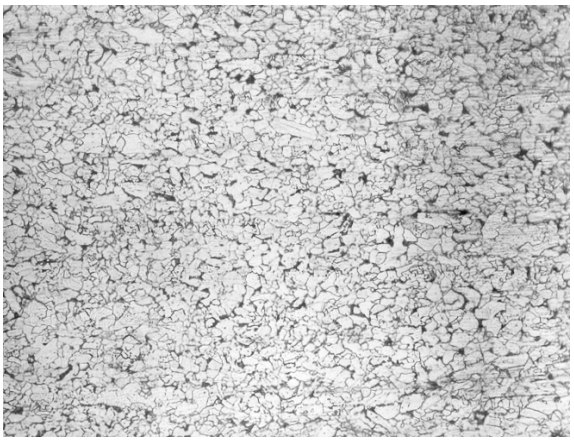


Fig. 1. *Microstructure of normalized RV52 steel plates Magnified x 100*

Variations and distributions of the mechanical properties: tensile strength (R_m), yield strength ($Rp_{0,2}$), elongation (A_5%), resilience on-v-grooved longitudinal samples, tested to - 20 ^{o}C and –50^{o}C, from head, middle and leg sides are graphically illustrated in Figures 2, 3, 4.

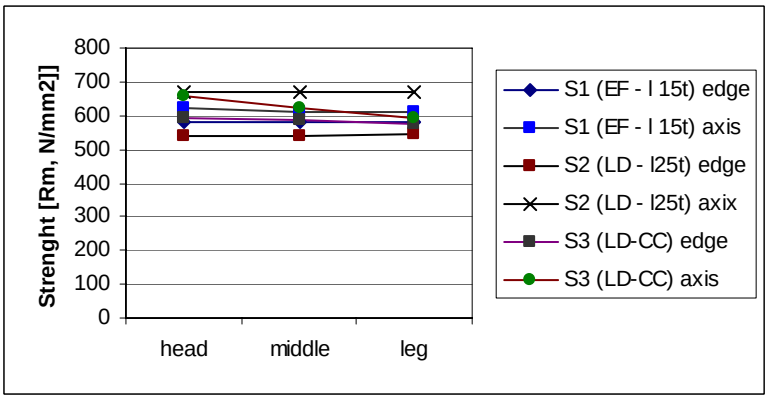
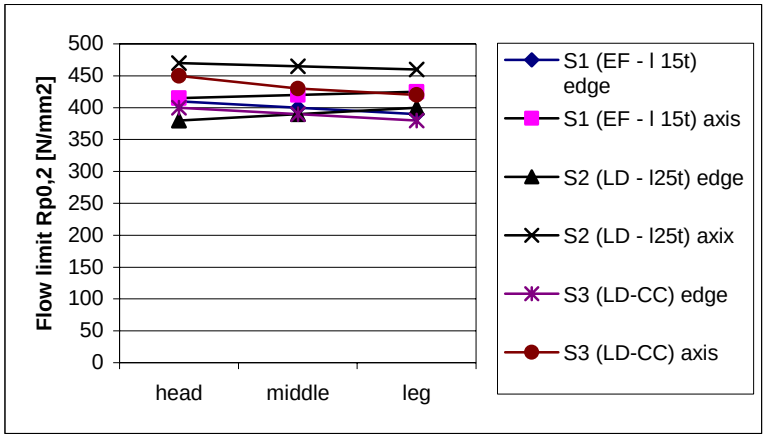
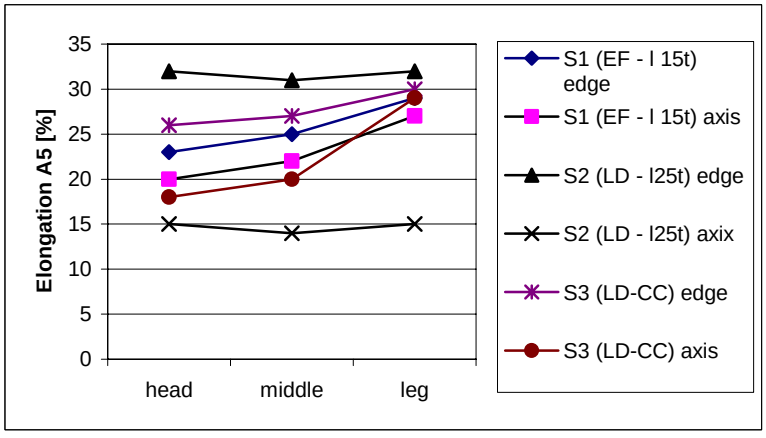


Fig. 2. *Tensil strength (Rm) values distribution of samples in various zone of the sheet*



Sample position in comparison with the ingot

Fig. 3. *Yield strength (Rp $_{0.2}$) values distribution of samples in various zone of the sheet*



Sample position in comparison with the ingot

Fig. 4. *Elongation A_5 values distribution of samples in various zone of the sheet*

The resilience of the cold - deformed and heat-treated samples under the above mentioned conditions has been determined at temperatures of - 20^{o}C.

In order to establish the influence of the heating temperature subsequent to cold deformation of the samples subject to 4%,8% and 12% degree of deformation, these have been treated acc to the treatment cycle described below:

- heating: 250^{0}C; 500^{0}C; 650^{0}C;

- exposure: 160 min. as a result of 2 min/ mm exposure;
- air cooling.

From the analysis of the tension relieving treatment graphics, it has been found that:

- as a result of the tension relieving heat treatment at 250 ^{o}C, the break energy at shock KV at -20^{o}C and –50^{o}C decreases with respect to the values of the samples from plates of 4%,8% and 12% degree of deformations, and the values of the normalized samples, Figures 5, 6.

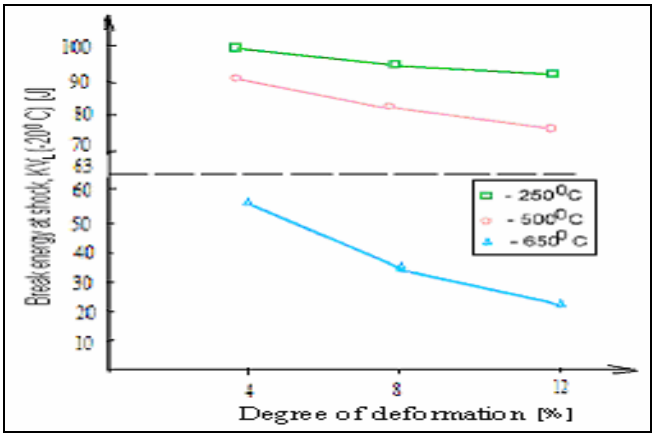


Fig. 5. *The degrees of deformation and heating influence for values of break energy at shock, KV_L (-20^{o}C)*

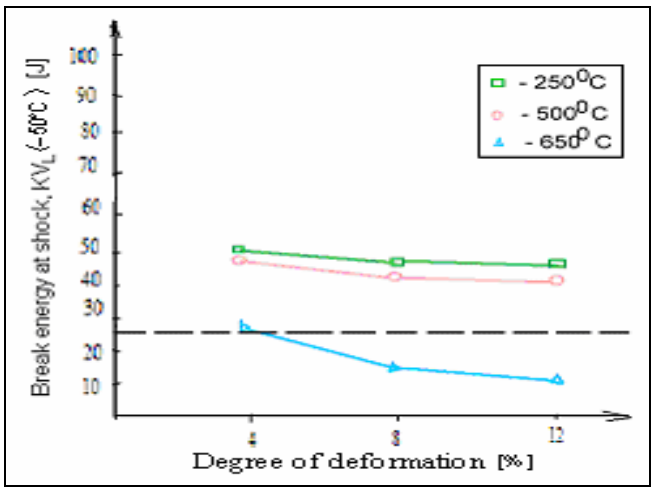


Fig.6. *The degrees of deformation and heating influence for values of break energy at shock, KV_L (-50^{o}C)*

Determining the shock behaviour is more obvious when the degree of deformation is higher.

With degrees of deformation of 12%, the shock ultimate strength at -20 ^{o}C and –50^{o}C takes lower values than that min admissible.

Heating at 650^{o}C results in recovery of the tenacity properties of RV52 steel, without having reached the level of normalization.

Heating at 250^{o}C has disastrous consequences, because tenacity is completely damaged both with respect to normalization and deformation states.

By heating at 500^{o}C, the values of the shock ultimate strength increase as compared with those obtained by cold deformation, while keeping however the influence of the cold deformation, i. e. lower values for higher degrees of deformation.

3. Conclusions

The researches were focused on determining the factors that cause properties variation in different zones of the RV52 steel plates manufactured by Arcelor- Mittal Galati.

In order to obtain highly improved properties a good correlation should be achieved between the conditions of elaboration, deformation and heat treatments highlighted by the chemical composition and structure.

The cold plastic deformation of low degrees of deformation: 4, 8, 12% results in poorer tenacity properties as compared with the normalised state values, which is more sensitive with higher degrees of deformation.

The best values of shock ultimate strength both at -20^{o}C and –50^{o}C have been obtained after a tension relieving treatment at 650 ^{o}C for 8 % degree of deformation.

References

[1]. Constantinescu S. - *Metals properties and physical control methods*, Didactica and Pedagogica, Publishing House, Bucharest Romania, 2004, p.128.
[2]. Sugiyama T. - *Kobe Seel,* Engineering Reports, 1995, Vol.25, nr.4, p.4.