Journal of Metals, Materials and Minerals. Vol.15 No.2 pp.53-56, 2005

Mechanical Properties of Blasting Steel Sheet

Mária Mihaliková, Marián Buršák, Ján Micheľ and Katarína Kovalová

Department of Material Science, Faculty of Metallurgy, Technical Unniversity of Košice, Letná 9, 042 00Košice, Slovakia

Abstract

The paper expresses the influence of blasting conditions on the properties of steel sheet RSt 37 – 2 having a the gauge of 3 mm. Due to blasting, the surface roughness increases by an order and the surface strain hardening takes place to the depth of ca 0.06 mm, which results in compressive stress on the sheet surface. The increase of the yield point is more significant if the diameter of the blasting medium (within the tested interval from 0.56 to 0.9 mm) and the impact angle (30 to 75^o) are greater at an air pressure of 0.4 – 0.5 MPa.

Key words: blasting, hardness, roughness, yield point, ultimate strength,

Intoduction

Blasting is one of the basic technologies of surface pretreatment of metal structures and parts to achieve a suitable surface for a future coating, so that it can have the required properties and durability(1). The main goal of blasting is to remove any impurities from the metal surface, to create a clean metal surface with a suitable microgeometry and physical and mechanical properties(2). The basic blasting conditions include: shape, dimensions and size of blasting particles, energy, total quantity and impact angle of particles. Blasting also causes intensive plastic deformation of a thin surface layer, which consequently creates residual compressive stress in this layer and residual tensile stress underneath(3). This positive effect of residual compressive stress will mainly depend on the surface qualities, mainly on its roughness. Since in the case of surface blasting two opposite tendencies of its effect are shown, this paper is aimed at the investigation of the influence of blasting conditions, such as the particle size, the air pressure and the impact angle on the basic mechanical properties.

Materials and Experimental Methods

The influence of blasting conditions on the mechanical properties was investigated on steel sheet grade RSt 37 – 2 having a gauge of 3 mm. The chemical composition is shown in Table 1. The basic mechanical properties are: R_e = 279 MPa, R_m = 395 MPa, A_5 = 33 %, Z = 71 %. The steel has a fine-grained ferrite–pearlitic structure with the grain size $d_{str.}$ = 0.012 mm. The as-ground test bars were blasted from both sides. Blasting was made using a pneumatic blasting device from Wonisch company, which makes it possible to regulate the air pressure in the range from 0.4 to 0.7 MPa. The nozzle diameter is 8.8 mm. Blasting was made under the following conditions: air pressure: p = 0.4 and 0.5 MPa, blasting medium grain size: d_Z = 0.56, 0.71 and 0.9 mm and the impact angle α = 30, 45 and 75^o. On as-ground and as-blasted specimens, the surface roughness was measured and the mean arithmetical deviation R_a was evaluated using a contact profile meter Hommel Tester, type T, and the micro-hardness HV 0.01 was measured across the thickness of the blasted sheet using a micro-hardness testing machine HANEMAN. The test specimens were used to determine basic mechanical properties. Tensile tests were made on a tensile testing machine INSTRON 1185.

Table 1. Chemical composition of steel Grade RSt 37-2

C	Mn	Si	P	S	Al	Cu
0,15	0,57	0,22	0,011	0,011	0,017	0,229

Results and Discussion

The roughness results are shown in Table 2. The results show that the surface roughness of the as-blasted specimens is higher by an order, which is represented by the mean arithmetical deviation Ra. The Ra value is influenced by all the observed blasting parameters.

With the change of the air pressure from 0.4 to 0.5 MPa, the Ra value increases by 0.1 μm; with the change of the grain diameter from 0.56 to 0.9 mm, the Ra value increases by 2.79 μm and with the change of the impact angle from 30 to 75, the Ra value increases by 2.4 μm. The highest Ra value was achieved under the following blasting conditions: $\alpha = 75^o$, $d_Z = 0.9$ mm and p = 0.5. The grain size has the most significant effect on the surface hardness of the as-blasted sheet (Figure 1).
.

The results of measuring the micro-hardness HV 0.01 across the sheet thickness *h* under selected blasting conditions are shown in Table 3 and Figure 2. It results From the micro-hardness values, the surface of as-blasted sheet is hardened to a maximum depth of 0.06 mm. The impact angle of the blasting medium influences the strain hardening only slightly. The mean value of HV 0.01 of the strain-hardened layer at the impact angle $\alpha = 30^o$ is 161, at $\alpha = 45^o$ is 162 and at $\alpha = 75^o$ is 165. From above, the mean strength value of the strain-hardened layer increases by ca 62 MPa (at $\alpha = 30^o$) up to 75 MPa (at $\alpha = 75^o$) when compared with the basic material.

Table 2. Mean values of roughness surface Ra

Blasting mode α°	75°	75°	75°	45°	30°	75°	As-ground surface
d_z /mm/	0.56	0.71	0.9	0.71	0.71	0.71	
p/MPa/	0.5	0.5	0.5	0.5	0.4	0.4	
Ra/μm/	8.31	10.6	11.2	8.52	8.2	10.5	0.394

The experimental results show that the roughness of the as-blasted specimens is higher by an order when compared with the original state and that the surface layer is strain-hardened and its mean hardness increases by 16-20 HV0.01. The mentioned facts will influence the resulting mechanical properties. It results from the analysis of the above-mentioned results that blasting does not influence the tensile strength, but increases the yield point Re and decreases the elongation (A_5) and the reduction of area (Z) of blasted sheet in dependence on the blasting conditions. The air pressure ranging from 0.4 to 0.5 MPa does not influence the above-mentioned properties. With an increasing grain diameter and impact angle of the blasting medium, the yield point increases and the deformation properties change slightly. The most significant changes of the as-blasted surface when compared with the as-ground surface were measured under the following blasting conditions: $\alpha = 75^o$ and $d_Z = 0.9$ mm. The yield point increased by 30 MPa (i.e. ca 10 %) and the deformation properties decreased by 5 % (A_5) and 2 % (Z) when compared with the as-ground surface.The increase of Re and the decrease of A_5 and Z of the as-blasted surface when compared with the as-ground surface is mainly due to the strain hardening of the surface layer. The micro-hardness results showed that the greatest hardening of the surface layer was measured under the following blasting conditions: $\alpha = 75^o$ and $d_Z = 0.9$ mm (see Table 3), which corresponds with the results determined using the tensile test. It should be emphasized that the tensile test results apply to a sheet with a gauge of 3 mm. In case of less gauges, the blasting effect would be more significant and vice versa.

During microscopic observations of the cross-sections of the surface layer, significant deformation of grains was found out, but no cracks were observed (see Figure 3 and Figure 4).

Table 3. Micro-hardness HV0,01 from the surface of as-blasted specimens under the following conditions: p = 0.5 MPa, $d_z = 0.9$ mm, α = 30, 45 and 75°

HV 0,01								
h [mm]	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08
α = 30°	181	163	160	153	149	145	145	145
α = 45°	180	165	160	157	149	145	145	145
α = 75°	180	170	165	160	151	145	145	145

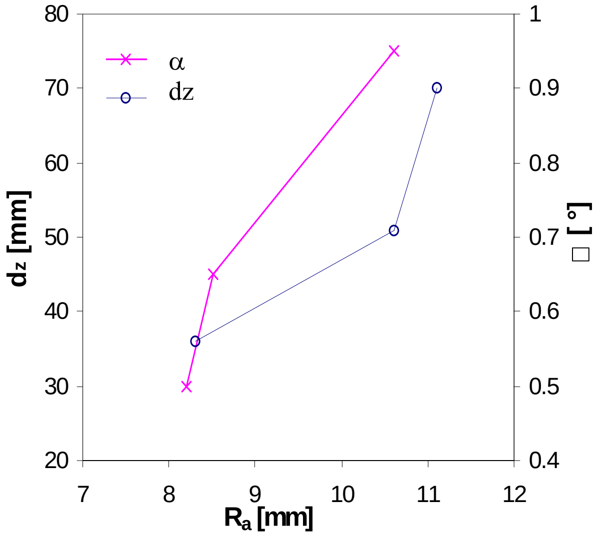

Figure.1 Influence of the grain diameter d_z and the impact angle α of the blasting medium on the roughness R_a of the tested sheet at the air

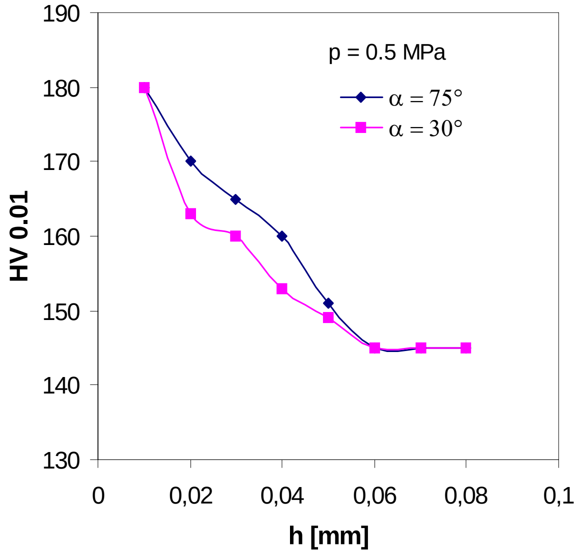

Figure.2 Course of the micro-hardness HV 0,01 from the specimen surface h at various impact angles of the blasting medium

Table 4. Basic mechanical properties of as-blasted specimens under various blasting conditions

Measuring parameters	Blasting mode α [°], d_z [mm], p [MPa]						
	75° 0.56 mm 0.5 MPa	75° 0.71 mm 0.5 MPa	75° 0.9 mm 0.5 MPa	45° 0.71 mm 0.5 MPa	30° 0.71mm 0.5 MPa	75° 0.71 mm 0.4 MPa	Ground surface
R_m [MPa]	394	395	395	394	395	395	395
R_e[Mpa]	297	302	309	298	290	298	279
A_5 [%]	32	29	28	28	27	30	33
Z [%]	71	70	69	71	69	69	71

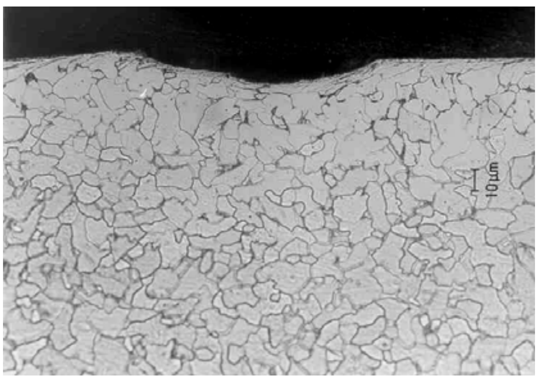

Figure 3. Microstructure of the as-blasted sheet surface under the following blasting condition : d_z = 0,9 mm, α = 45°, p= 0,5 MPa

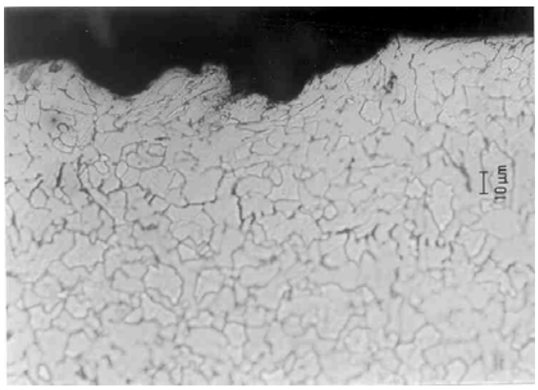

Figure 4. Microstructure of the as-blasted sheet surface under the following blasting condition : d_z = 0,9 mm, α = 75°, p= 0,5 MPa

Conclusion

The paper analyses the influence of blasting conditions on the properties of steel sheet RSt 37 – 2. During blasting, the air pressure (0.4 and 0.5 MPa), the grain diameter of the blasting medium (0.56; 0.71 and 0.9 mm) and the impact angle (30, 45 and 75^o) were varied From the experimental results :

-Blasting results in an increase of the surface roughness by an order, the strain haredening of the surface layer to a depth of ca 0.6 mm, and an increase of the yield point.

-Among the selected blasting conditions, the grain diameter and the impact angle of the blasting medium have the greatest effect on the change of the observed properties.The least changes of the yield point were under the following blasting conditions: p = 0.4 MPa, $\alpha = 30^o$ and d_Z = 0.56 mm and the greatest changes were at p = 0.5 MPa, $\alpha = 75^o$ and d_Z = 0.9 mm.

References

(1) Bačová, V. 1996. Secondary effects of blasting in sheet surface pretreatment, In. : *Eurometal working 96,Bratislava* : 178

(2) Kniewald, D. 1998 .Blasting surface preparation under coatings. In : *Koroze a ochrana materiálů, 32, : 42.*

(3) Sedláček, V. 1992. Surfaces and coatings of metals, In : Praha