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Research paper

Improving Astm A516 Grade 70 Mechanical Properties by Sandblasting Process

Omar Suliman Zaroog[1*], S.A.P.Sughanthy[2], Mohd Rashdan Isa[3], M.N.M.Ansari[4]

[1]*Institute of Power Engineering, Universiti Tenaga Nasional, Kajang 43000, Selangor*
[2] *Department of mechanical Engineering, Universiti Tenaga Nasional, Kajang 43000, Selangor*
**Corresponding author E-mail: omars@uniten.edu.my*

Abstract

Nowadays, sandblasting is commonly use in industries. The ability of sandblasting is to remove any stain, unwanted matter and many other functions making this process generally used worldwide. The effect of sandblasting on mechanical properties of ASTM A516 grade 70 was investigated in this study. Samples of the material have been sandblasted with different size of grits and times. Surface roughness, hardness and tensile was measured before and after sandblasting. The roughness test result showed that when the time duration of sandblasting increased, the roughness of the specimen also increased. Based on hardness test result, it showed that the hardness improved when the smallest size of grits was applied. However, the hardness decreased when the size of grits and time was increased. The tensile test result pattern showed quite similar to hardness test result. The size of grits and time duration for sandblasting need to set depending on application of the sandblasting process usage applied to the samples or materials.

Keywords: *Sand blasting; ASTM A516 Grade 70; Sand grit size; Roughness Test; Hardness Test; Tensile Test*

1. Introduction

Sandblasting which is also known as abrasive blasting is the process that forcing propelling a stream of abrasive material in high speed to the rough surface under the high pressure. To propel the blasting material against the surface, compressed air, pressurized fluid and centrifugal wheel are used. The typical way is using compressed air. The main sandblasting function is to smooth the surface and remove surface contaminants cause by oxidation process that is causing the present of rust. Actually, there is many other use of this process, for example is to do surface preparation prior to painting, bonding or other coating. Abrasive blasting also includes removal of rust, scale, sand or paint from fabricated components. For instant, the usage of sandblasting process at material is for surface modification [1], surface strengthening [2], surface cleaning [3] and rust removal. There are a few types of the sandblasting process media, some are very high abrasive while others are milder. The most abrasive shot is by using metal shot and sandblasting using sand. The moderately abrasive variants include glass bead blasting by using glass beads and media blasting with ground-up plastic stock or walnut shells and corncobs. A mild version is soda blasting with using of baking soda. Due to the dangers of inhaling dust during the process, sandblasting is carefully controlled, using an alternate air supply, protective wear, and proper ventilation. The different type of blasting will produce a different result and different application. Another factor to be considered is grit or mesh size, since it plays role in having different result.
ASTM A516 or also known as ASME SA516 is the carbon steel that is commonly used in industry for boiler and pressure vessel due to weld-able material and also improves the notch toughness [4]. Solvent degreasing is important, because it removes contaminant materials which inhibit the formation of the chemical bonds. However, solvent degreasing, while providing a clean surface, does not promote the formation of acceptable surface conditions for longer term bond durability [5]. The metal performed very well for moderate and lower temperature services. The yield strength and tensile strength of this metal is high when compared to other metal with different grade such as ASTM grade 65 [6]. It is suited for exclusive expectation set by the oil, gas and petrochemical industry. The tensile strength of this metal is around 510 (N/mm2) to 650 (N/mm2) and the yield stress of ASTM A516 grade 70 is 335 (N/mm2).
The aim of this paper project is to investigate the mechanical effect of sand blasting on ASTM a516 grade 70 using different sandblasting size grits and different time. The mechanical properties have been investigated such as surface roughness, hardness and tensile.

2. Materials and Method

2.1. Sample Preparation

The sample cut into flat dog-bone shape based ASTM standard E 8 [7] the material used is ASTM A516 grade 70. Mechanical properties of the material are in Table 1.

Table 1: ASTM A516 mechanical properties

Parameter	Value	Unit
Tensile strength	485-620	MPa
Yield strength	260	MPa
Elongation in 200 mm (min)	17	%
Elongation in 50 mm (min)	21	%

2.1. Sandblasting Process

Sandblasting process was performed on the ASTM A516 grade 70 sample. The sandblasting process consisted different size of the sand grit which are 60, 100 and 220 in µm. A compressed air is used to propel the abrasive media. There are many media can be used for the sandblasting process, but the chosen media for this project is aluminum oxide with three above different sizes. Three different time used for each grit size which are 7 minutes, 17 minutes and 27 minutes.

3. Testing

Hardness test was carried out to determine the effect of sandblasting in the samples using Universal Tester machine. The Universal Tester machine used Brinell hardness principle. The hardness was tested at five different points of the sample and the average was taken.The surface roughness test was done by using TR 200 device. The TR 200 was calibrated first before the testing started. The calibration need to be done every time before the testing starts. The reading was repeated several times and the average value was taken. Tensile test was done using ZWICK Z100 machine in accordance with ASTM E8 standard.

3. Results and Discussion

3.1. Surface Roughness Test

Figure 1 shows the overall result of roughness surface after the sandblasting process of three different sizes with three different time duration. For the of size 220 µm, initially, the Ra value for the first duration of sandblasting which is 7 min showed the surface roughness is 2.024 µm. However, the surface roughness for duration of 17 min decreased to 1.508 µm and kept increasing when the duration of the sandblasting increased to 27 min. Based on the result, it shows that surface roughness at 7 min is higher than 17 min, this is due to the size 220 µm is too fine and do not influence the surface roughness due to the short duration. However, when it came to 17 min, the grit size 220 µm had enough time to remove the rust on the sample and affect the surface roughness to become smoother than 7 min duration. In addition, when it continued into 27 min, the surface roughness become rougher due to the duration increased and the Ra value was 2.483.
Referring to the medium size of the experiment which was 100µm, the initial surface roughness value was 0.827. This is smoother than same duration of sandblasting for size 220 µm due to the bigger size that can repair the surface or remove the rust on the surface of the sample. When time increased, the surface roughness for the sample also was increasing. It shows that 100 µm is suitable to have a smooth surface because it can improve the surface roughness and remove the contaminant and rust surface from the sample.
The size of 60 µm, the duration of sandblasting at 7 min, the surface roughness value is 2.647 which was the roughest among the same duration 7 min if compare to size 220 µm and 100 µm. Furthermore, the surface roughness was directly proportional with the time. When the size of grit is bigger, the surface roughness will increase respect to the duration of sandblasting. Based on past study, if the time of sandblasting process increasing, the surface roughness will be rougher due to over blasting [8, 9].

3.2. Hardness Test

Based on the result shown in Figure 2, the hardness of the sample after the sandblasting process was nearly the same. It showed that the sandblasting process did not affect the hardness of the sample. This might happen because of the grit sizes was considered too small or fine. For the duration of 7 min, the higher hardness was 15.12 kN and it was for size 60 µm. Meanwhile, the hardness for size 220 µm and 100 µm was 14.73 and 14.72 respectively. In terms of 17 min of duration sandblasting, the highest hardness was recorded 15.15 µm which was for the size 100 µm. For the size 220 µm the hardness result showed 15.01. The result for size 60 µm was 14.89 and this was not so much different between all grit sizes. The result of hardness test for 27 min of sandblasting showed more consistent with margin between the highest and lowest was only 0.11 kN. The hardest was for size 100 µm with 15.14, followed by for size 220 µm with 15.12 and for size 60 µm with 15.03. This may be due to the longer cooling rate of sandblasting process being deposited first [9, 13].

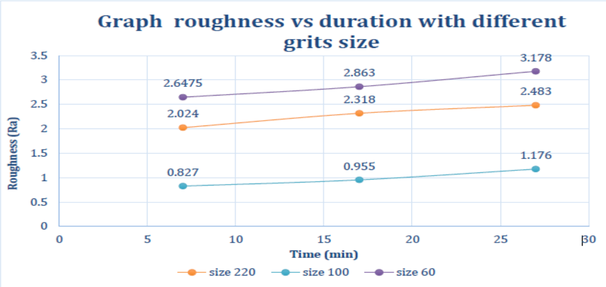

Fig.1: The result of surface roughness testing

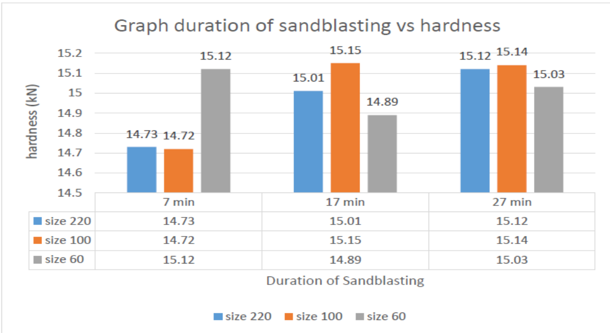

Fig.2: The result of hardness test

3.3. Tensile Test

The maximum tensile strength test for ASTM A516 grade 70 is 485 to 620 MPa [10, 11]. Figure 3, shows the result of the yield strength with respect to the duration time of sandblasting. The grit size 220 result showed the yield strength were kept increasing with respect to the time of sandblasting process. The highest yield strength value for size 220 was 446 MPa and the lowest was at 410.5 MPa. The graph pattern shown for size 220 µm kept increasing matched with previous study [12]. This is due to surface strengthening induced by the impact of sand particle to the surface of specimen [13]. This is just like shoot peening process effect that most of the impact energy converted into surface plastic deformation.

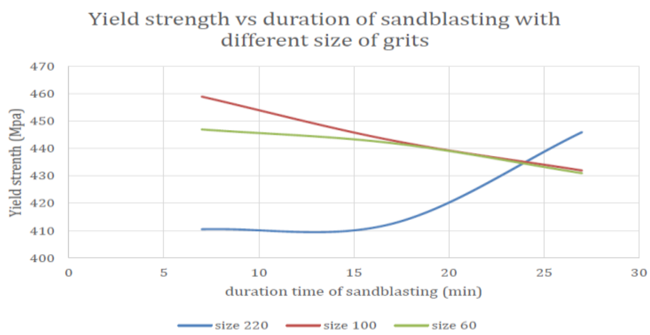

Fig.3: The result of yield strength

4. Conclusion

This paper showed that the roughness of the specimen is directly proportional to the sandblasting time duration. Besides, when the size of grits increased, the roughness of specimen also increased. When referring to the all result, it can be conclude that the smaller size of grits which 220μm is suitable for rust remover and surface cleaning. Meanwhile, the 100μm size grit is suitable for surface modification use and the biggest size of grits which is 60μm for surface strengthening use by other process such as thermal spray coating. The sandblasting process aids material to improve the hardness. However, it is not applicable for the bigger size of grit which is 60μm. The hardness was not improved but kept decreasing. This was due to the sharp edge produced by the grit and produced crack initiator that damaged the surface. From the tensile test, 220μm size grit showed some improvement on the material in terms of yield strength and ultimate strength. Meanwhile, the ultimate strength, yield strength and rapture for the 100μm and 60μm showed decreasing pattern result.

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