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EFFECT OF SHOT PEENING ON MECHANICAL AND WEAR PROPERTIES OF AISI1018 AND AISI 304 STEEL BY USING WHEEL BLAST SHOT PEENING MACHINE

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ABSTRACT

Shot peening is a cold working process to strengthen the surface of the components which leads to plastic deformations in localized regions, result in the development of residual stresses. In this paper attempts are made estimate mechanical behavior and tribological characteristics on AISI 1018 and AISI304 steel before and after shot peening. From the different mechanical tests like Brinell Hardness Test, tensile test, 3- point bending test and wear tests it is observed that surface properties and the wear resistance were enhanced with increase in the shot pering duration. Further, from the micro structure study it is noticed that several impressions of shot peening influence the surface integrity and affects ultra-fine crystalline layer thickness.

Keywords: *Shot Peening Wheel Blast, Mechanical Property, Surface treatment process.*

INTRODUCTION

Peening is a process of cold-working the surface of structural or machine parts by involving multiple and progressively repeated impact. This process is widely used to introduce compressive residual stresses or to relieve the tensile stresses which exist in the material. Generally, Peening is carried out By means of mechanical methods such as hammer blows, focusing laser beam, cavitating the jet of water, deep rolling and blasting of shots etc.,

Classification of peening process

- Shot Peening.
- Water jet peening
- Laser shock Peening.

Shot Peening

Shot Peening is a method for cold working the surface of metal parts by impact to froundmetal shot coordinated against the surface. In this bunch of spherical shots blow sencroached over the whole surface indenting the surface and creating plastic stream and work solidifying ofthe surfacemetal.This work solidifying of the surface metal builds its rigidity and yield point and a little rate of the useful consequences of shot peeningare owing to this impact [1-3]. This process widely used for steels, aluminum alloys, titanium alloys and other engineering materials [3]. Shot peening is also used in many mechanical components such as gears, crank shaft, turbine blades and springs [4].

Water jet peening

In Water jet peening, high velocity water droplets continuously impinge over the surface. These droplets produce high peak load that cause localized plastic deformation of material and stretching of the layers of the surface. Water jet peening results in the formation of compressive residual stress on the surface layers without modifying the surface topography.

Laser shock Peening

Laser shock peening is a cold working process where pulses hit the surface with high power intensity and shock waves are generated. These waves plastically deform the surface and compressive stresses are extended into the subsurface. These dynamic compressive stresses are highest on the surface and decrease with depth into the material.Layer depths up to 0.40” on carburized steel and 0.100” on aluminum alloys have been achieved. Mechanical peening methods can only produce 35% of these depths.

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Significance and types of shot peening machines
Shot peening can be applied in many cases: fatigue, hardness, roughness, and residual stresses, fretting wear, crack path propagation, crack arrest, stress corrosion cracking and microstructure refinement [5-7]. In all these cases shot peening increases performance of mechanical components.

Machines for shot peening fall into two particular classifications. One is the wheel sort machine where in a bladed wheel pivoting at rapid is gravity encouraged with peening shot and splashes this shot onto the work by the throwing activity of the cutting edges. The second is the air impact shot machine wherein the shot is affected onto the work by method for an impact of pressurized air.

The choice of shot peening parameters is dependent on a variety of conditions such as Information of the application of the component, Component geometry, and Mechanical properties of the base material, Strain sensitivity of the base material, Environment Service conditions, loads and cycles, Cost sensitivity [8-10].Process controls in peeningare Media, Intensity, Coverage, and Equipment & Process Integrity. The medium carbon steel is used as a compromise between the low strength mild steel and expensive higher strength alloy steels and is best suited for crankshafts, automobile axles, spindles, and lightly stressed gears.

General properties of plain carbon steel, by and large with an expansion in the carbon content from0.01 to 1.5% in the compound, its quality and hardness increments yet at the same time such an increment past 1.5% causes calculable decrease in the flexibility and pliability of the steel[11-12].

Low carbon steel or mellow steel, containing carbon upto 0.25% reacts to warmth treatment as change in the flexibility is concerned yet has no impact in appreciation of its quality properties.

Medium carbon steels, having carbon content running from 0.25 to 0.70% enhances in the machinability by warmth treatment. It should likewise be noticed that this steel is particularly versatile for machining or manufacturing and where surface hardness is low.
The aim of this paper is to investigate the effect of shot peening on the microstructure, hardness, bending strength, tensile strength and wear characteristics of an AISI1018 Steel and AISI304 Stainless Steel. Hardness, bending strength, tensile strength and wear rate are evaluated before and after shot peening.

MATERIALS AND EXPERIMENTION

Material selection
The chemical composition of the AISI 1018and AISI304 is given in Table 1 and Table 2.the material is provided in the form of flat of thickness 5mm. widely used automobile components, fixtures and food processing equipment.

Evaluation of Mechanical properties
Shot peening process on specimens were carried out under the process parameters (Table. 3) by Abrator wheel blast shot peening machine. The treatment employs steel shots were propelled by a bladed wheel. Machine uses a combination of radial and tangential forces to impart the necessary peening velocity to the shots. We used MRB 250 Brinell hardness tester to measure hardness. Bending test was carried out using three point bending test machine of TUE-C-600 model. Tensile test was conducted using UTM PST-VGST/KFIST-05 model machine.

Microstructural characterization
The samples were characterized by Field Emission scanning electron microscope. The microstructure of specimens peened with different time durations were observed by using scanning electron microscope (SEM) operated at 30KV. Specimens were prepared for metallographic examination using standard procedures and etched in a chemical solution.

Wear Test
The wear characteristics of shot peened specimen were studied using pin and disc type machine. The specimen considered for this experiment is mild steel samples which is shot peened under different coverage time with dimensions 6mm×9mm×50mm. The tests were conducted at ambient condition with the load of 2.5 kg. Disc

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speed was kept at 1000-1050 rpm, resulting in a sliding velocity of 3.92 m/s. The tests were conducted for ten minutes. Wear of the materials considered was measured by loss in weight which is then converted into wear volume using measured cross sectional area data.

Table.1: Chemical composition of the AISI 1018 steel

Material	Chemical Composition in wt %				
	C	Fe	Mn	Ph	Su
AISI 1018 Steel	0.14	98.81	0.60	0.040	0.050
	0.2	99.26	0.90	-	-

Table.2: Chemical composition of the AISI304 steel

Material	Chemical Composition in wt %						
	C	*Mn*	SiC	Cr	Ni	Ph	S
AISI 1018 Steel	*0.08*	2	*0.75*	*18*	8	0.045	0.03
			1	*20*	*12*		

Table 3: Process Parameters for Shot Peening

Shot Material	Steel Shots
Size of Shot	0.18 mm
Velocity of Shot	65.5 m/s
Angle of Impingement	All around the Specimen
Exposure Time	20 minutes

RESULTS AND DISCUSSION

Microscopic observations

Several impressions of shot influence on the surface integrity of shot peened specimens, representing ultra-fine grained layer. Different time durations is related to plastic deformation level and directly affects ultra-fine crystalline layer thickness and its mechanical properties. Due to the limitations of shot peening equipment, the speed of each shot is different. Due to these craters emerged irregular distribution and size of craters are different.

Fig. 1 and 2 shows unpeened and peened AISI1018 low carbon steel microstructure. It is observed that different time duration causes the increase of ultra-fine grained layer thickness. High plastic deformation effect on grains can be observed.

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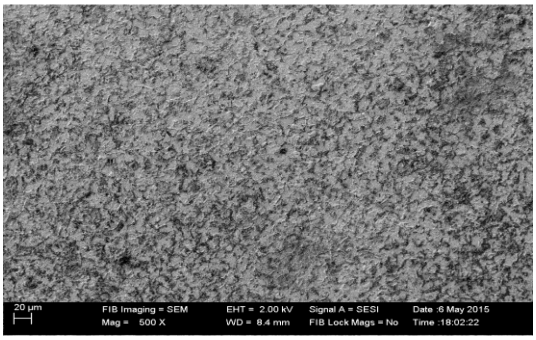

Figure.1: SEM microstructure of unpeened specimen

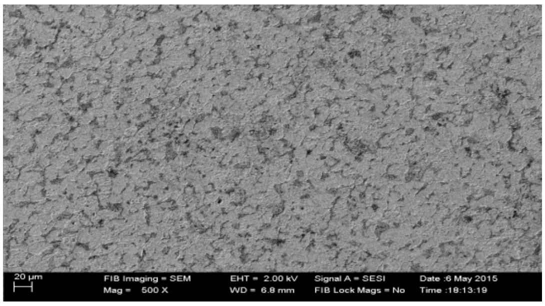

Figure.2: SEM microstructure of peened specimen

Hardness Measurement

The Hardness measurements of non-peened and shot peened specimens are shown in Table 4. Maximum hardness value after shot peening of AISI 1018 steel is 225BHN and for stainless steel 127BHN. The improvement in hardness is 5.61% and 3.25% respectively. As the time duration is increased hardness is also increased. During shot peening process, the surface is exposed continuously by steel shots. Therefore, surface hardening effect will cause increase in hardness

.

Table 4: Hardness Comparison of specimens before and after Shot Peening

Material	Before Peening	After Peening	% Enhancement of Hardness
AISI-1018 Steel	213	225	5.61%
AISI-304 Stainless Steel	123	127	3.25%

Bending strength measurement

The bending strength results of AISI1018 before and after peening are shown in fig.3 and fig.4. For Maximum bending load after peening is 11.85KN and Bending stress is 59.25MPa. Improvement of bending strength of peened specimen is 41.61%.

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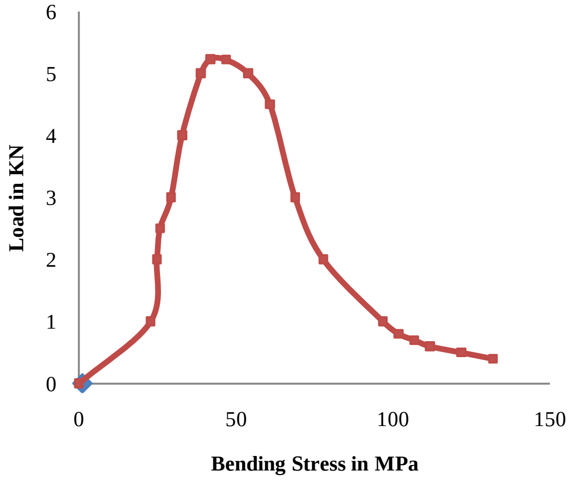

Figure 3: Bending curve of AISI1018 steel before Peening.

The bending strength results of AISI304 stainless steel before and after peening are shown in figure 5 and figure 6. Shot peened specimen exhibit Maximum bending load 25.64kN and stress 85.46MPa.

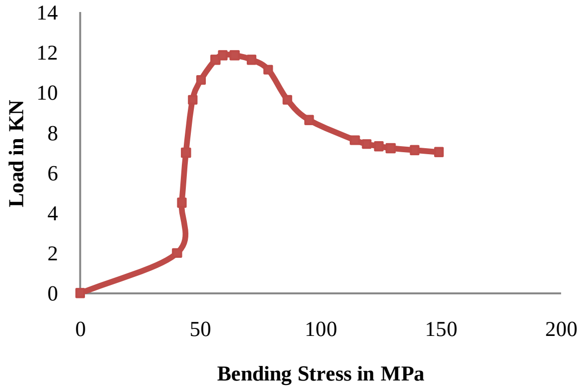

Figure.4: Bending curve of AISI1018 steel after peening.

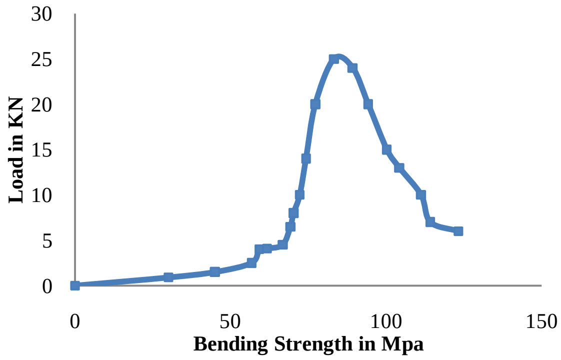

Figure.5: Bending curve of AISI304 stainless steel before peening.

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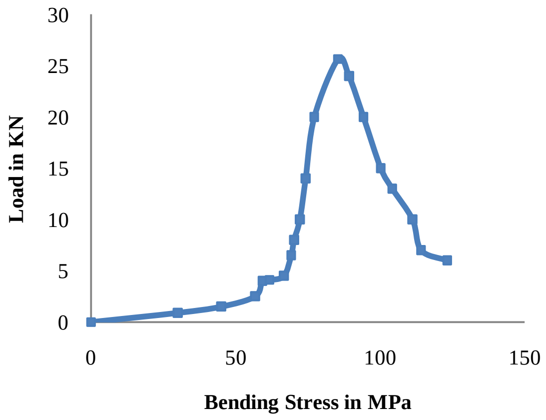

Figure.6: Bending curve of AISI304 stainless steel after peening.

The value of bending strength increased about 2.62% compared to unpeened specimen. Bending strength comparison is shown in table.4. In shot peening impact of shots creates compressive residual stresses that reduces the level of tensile stresses applied, thus improves the bending strength.

Table.5: Comparison of Bending Strength **(MPa)**

Material	Before Shot Peening	After Shot Peening	% Enhancement of Bending Strength
AISI 1018 Steel	41.84	59.25	41.61%
AISI304 Stainless Steel	83.27	85.467	2.62%

Table.6: Comparison of Tensile Strength

Material	Before Shot Peening	After Shot Peening	% Enhancement of Tensile Strength
AISI 1018 Steel	430.02	450.18	4.68%
AISI304 Stainless Steel	502.42	507.32	0.97%

Tensile strength measurement

The tensile strength results of AISI1018 before and after peening are shown in fig.7. and fig.8. For Maximum tensile strength after peening is 450.18 MPa. Increase in tensile strength of peened specimen is 4.68% compared to unpeened one. Tensile strength of AISI304 stainless steel after shot peening is 507.32MPa.Tensile strength comparison is shown in table.5. Because of compressive residual stresses induced during shot peening Tensile strength is enhanced

WEAR CHARACTERISTICS

In the present experimental work, speed and time were kept constant while the load applied was 24.52N. Parameters that remained constant throughout all the experiments. The wear rate of each sample was calculated from the weight loss method, the amount of wear was determined.

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Table 6: Wear rate and resistance for AISI1018 Steel

Sl. No	Duration (AISI 1018)	W_1 (mg)	W_2 (mg)	(W_1-W_2) (mg)	Wear rate, N-s/m	Wear resistance m/N-s
1	0 min	189.1	180.1	9.02	1.42×10^{-3}	704.22
2	10 min	186.7	178.6	8.14	1.28×10^{-3}	781.25
3	20 min	185.8	178.2	7.65	1.20×10^{-3}	833.33

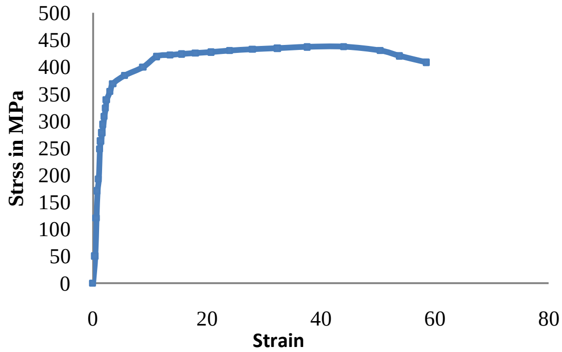

Figure.7: Stress-strain curve for AISI1018 steel before

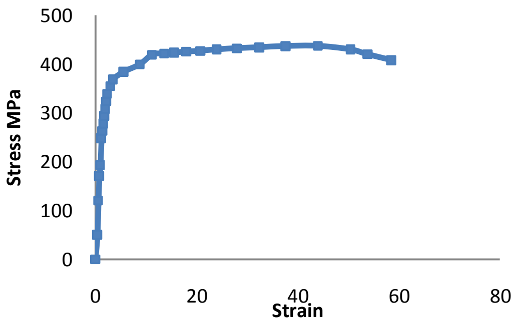

Figure.8: Stress-strain curve for AISI1018 steel after peening.

CONCLUSION

In this paper, AISI 1018 Steel and AISI304 Stainless Steel were selected to study the mechanical properties and wear behavior before and after shot peening. It is found that there is an improvement in mechanical properties of the material.

Microscopic observations showed that ultrafine grained layer has occurred on the surface. With increase in plastic deformation rate the grain size reduced.

There is an increase in hardness values of different grade steels after shot peening is due to grain refinement and work hardening. By increasing time duration in peening hardness value is also increased in both the specimens.
In bending strength AISI1018 is mostly influenced with an increase of about 42% in bending strength after Shot Peening and AISI304 is most lightly influenced with increase in its bending strength to about 3%. In tensile strength AISI1018 is increased by 4.68% compared to unpeened specimen.

It is observed wear rate is decreases with increase of coverage time and wear resistance increases with increase of coverage time.

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