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Metallography and Mechanical Properties of Al5083 Sheets Processed Through Peen Forming

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Abstract: Peen forming is a die less forming process performed at room temperature. During the process, the surface of the work piece is impacted by pressure from small, round steel shot. Every piece of shot impacting the surface acts as a tiny hammer, producing elastic stretching of the upper surface. The impact pressure of the peening shot causes local plastic deformation that manifests itself as a residual compressive stress. The surface force of the residual compressive stress combined with the stretching causes the material to develop a compound, convex curvature on the peened side.

In the current project, As Al5083 is a corrosion resistance and non-heat treatable alloy, is chosen to deform through shot peening. The 0.5mm thickness sheet with length of 150mm and width of 60mm is placed in a Los Angles abrasive machine. 240gms of Steels balls (Six balls each weighing 60gms) were used for imposing impact load to compress the sheets during peening. The process is carried out for 100, 200 and 300 revolutions for 3minutes, 6minutes and 9minutes. The shot peened deformed sheets were tested for area and hardness to study the amount of deformation and strength. As the number of revolutions increases the area of the deformed sheets decreases, the hardness of deformed sheets increases with increase in no. of revolutions. The microstructure through optical microscope reveals the formations fine grains during peening. Highest hardness of 72HRB is found for 300 revolutions sheets during cold working of shot peening. The tensile specimens were prepared according to ASTM E-8 standards the strength increases from 285MPa to 325MPa with increase in no. of revolutions through shot peening.

Keywords: Al5083, shot peening, deformation, mechanical properties.

1. Introduction

Traditional shot peening is achieved with the aid of two strategies. The first approach includes accelerating shot fabric with compressed air. Shot is introduced into an excessive speed air circulation that hastens the shot to speeds of as much as 250 toes/s. The second technique. Involves accelerating the shot with a wheel. The shot receives dropped onto. The center of the wheel and hastens to the periphery where it leaves on a tangential path and forms a curvature route proven n parent.1[1,2]. In the modern-day research, 2d method is selected for appearing the shoe peening operation. The cold paintings technique, consisting of compressive residual stresses in close to floor layers, improving the fatigue energy of additives is known as shot peening as proven in parent.2 [3].

Whilst curvatures are being formed inside the elastic range of the metal, the core of the metallic stays elastic with a small, balancing, residual tensile stress. Other mechanical forming tactics that require over forming with subsequent spring lower back result in high tensile strain. Even though excessive tensile stress may be

minimized by way of stretch forming techniques, stretch forming is typically now not achieved on tapered or sculptured sections [4]. The size, speed, and attitude of impingement of the shot as well as the distance of the wheels or nozzles (the wheels or nozzles propel the shot) from the work piece are robotically controlled in in particular designed machines. Peen forming can be carried out with or without an outside load implemented at the work piece.

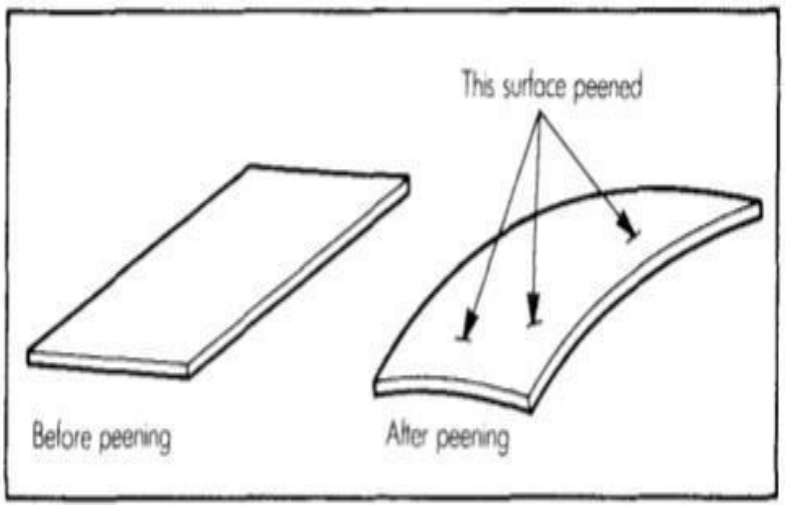

Figure.1 Compounds curvatures can be produced with peen forming

Peen forming is used to form huge or small panel-fashioned in gadgets that don't include abrupt changes in curvature. The system is able to rolling, stretching, or twisting the material to broaden the shape. Acquiring compound or saddle-subsidized shapes is also viable [5,6]. The aircraft enterprise uses peen forming to form the wing panels on civilian and military aircraft.

Peen forming is applicable to all metals and may be done on tapered or integrally stiffened machined panels, honeycomb skins, and isogrid (diamond patterned) panels. This method is commonly nice appropriate for forming curvatures having radii inside the metallic's elastic variety [7]. It has many makes use of in industry, in particular in the manufacture of parts as exclusive as helical springs, rockers, welded joints, plane components, transmission shafts, torsion bars, and many others. At a time whilst an finest function is being demanded of mechanical assemblies, shot peening is the surface treatment approach that's being increasingly more chosen with the aid of engineers [8].

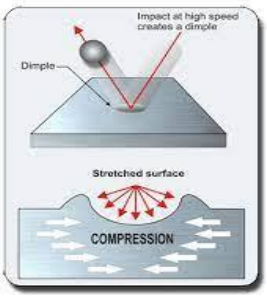

Figure.2 Compressive stretched surface

2. EXPERIMENTAL PROCEDURE

Shot peening technique become achieved the usage of Los Angles Abrasion system were optimized and parameters used for the peen forming have been indexed in table.1.

Table.1 Process parameters of peen forming

Process parameter	Specifications
Weight of the Balls	2400gms
No. of revolutions of the Drum	100revolutions, 200revolutions, 300revolutions
Time of Operation	9minutes, 6minutes, 3minutes

The Al5083 sheets are prepared in step with the required measurement of duration 150mm and width 60mm. The 6 balls of each 400gms weight had been loaded into the abrasion machine to make surprising load on the sheet. The Drum was rotated in clockwise direction for 100, 200, 300 revolutions to affect the sheet via the balls. The time taken to rotate the drum for a 100, 200 and 300 revolutions is 9minutes, 6minutes, 3minutes respectively. After the deformation, the peen formed sheets are removed from the device to look at the mechanical and metallurgical homes. The surface morphology become discovered the usage of optical microscopy. The deformation place became measured through the share method. The hardness turned into measured by using Rockwell hardness Tester. The weight carried out on the sheet is 150kg and live time is 20seconds. The 1/16'' ball intender is used to test the sheet. The scale used is B-scale and the price is represented through HRB. The tensile specimens have been prepared and examined using ASTM E-8 standards. The ball will induce deformation on the 30% of region of the sheet in keeping with a shot and has it moving in round route it will cove one hundred% of the sheet at some stage in experimentation. The formation of cracks was discovered on the Al5083sheets that are processed at 400RPM for 1minutes due to the brittleness of the sheets.

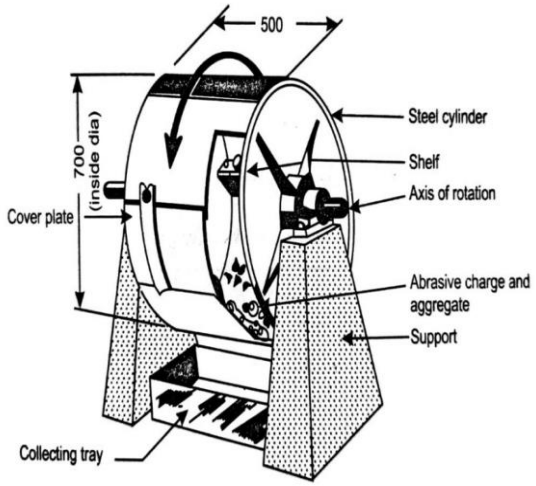

Figure 3 (a) Los angeles abrasion machine **3(b) arrangement of balls and plates**

Figure.4 Al5083 As received and shot peened sheets

3. Results And Discussions

3.1 Surface Morphology

The microstructure of as-acquired shows there is no deformation of the sheets. The microstructure of 100revolutions, 200revolutions, 300revolutions for 3minutes exhibits the formation of fine grains with increase in no. of revolutions, because the no. of revolutions will increase during shot peening the grain length decreases due to the unexpected impact of balls at the Al5083 sheets which results in deformation of the sheets which improves the mechanical houses of the sheets.

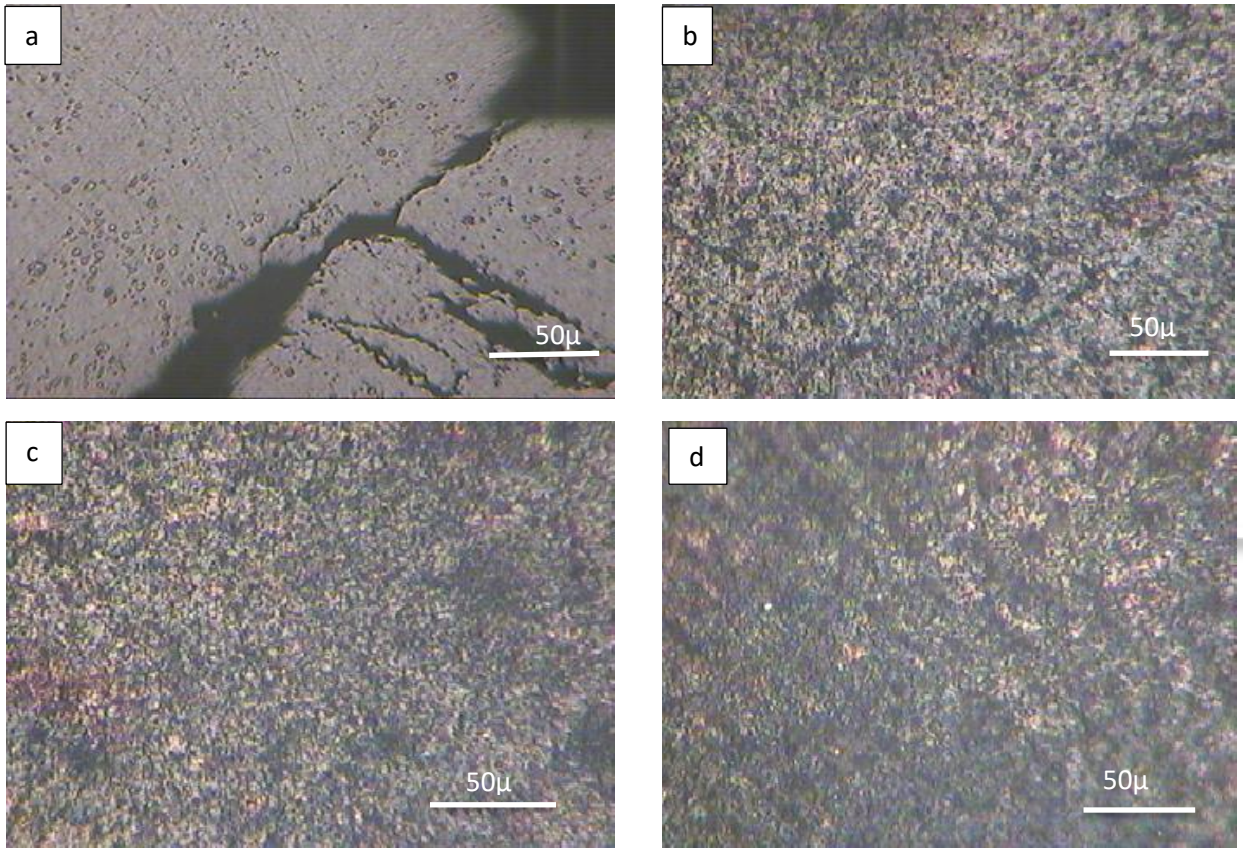

Figure.5 Micrographs of surface morphology a) As Received b) 100revolutions c) 200revolutions d) 300revolutions

Grain size was measures using line intercept method. The grain size of shot peened surface for different revolution were tabulated in table.2. As the RPM increases the grain size decreases which confirms the grain refinement due to deformation of sheets caused by sudden impact of balls during shot peening.

Table.2: Grain Size during shot peening

No. of Revolutions	Grain Size (µm)
As-received	45
100RPM	32
200RPM	28
300RPM	24

3.2 Calculation of Deformed Area

Reduction in the Area of Al5083 sheets are calculated after peen forming using the following equations.

$$Reduced\ Area\ (Ra) = \frac{FinalArea\ (Fa) - Initial\ Area(Ia)}{Initial\ Area\ (Ia)} x100\ \%$$

From the table.3 we concluded that there is a reduction in area as the number of revolutionsare increasing. The 300 revolutions sample shows higher reduction in the area as there the sheets tend withstand the cold working. The Al5083 sheet thickness and width are reduces to the sudden impact load of steel balls on to the sheets. The reduction in thickness and width showsthe refinement of the grain structure which is to be confirmed from morphological analysis.

As the number of revolutions are increasing there is a change in the radius of curvature ofthe increases which shows the sheets tends to good deformation during cold working.

Table.3 calculation of area

No. of REVOLUTIONS (RPM)	INITIALAREA (mm^2)	FINALAREA (mm^2)	REDUCTION AREA (%)
100	155x60	150x60	3.3
200	155x60	148x60	5.3
300	155x60	145x60	6.4

4.3 Hardness

The hardness of shot peened sheets were plotted in Figure.5. The hardness increases with increase in no. of revolutions. The Actual Hardness of Al5083 at annealed condition is 54 HRB and Hardness of As-received plate is 65HRB. The hardness is increase from 68HRB to 72HRB with increases in no. of revolutions. The impact load on the sheets leads compression which in turn in grain refinement. The grain refinement increases the hardness value from 65 HRB to 72 HRB. The increase in curvature along the sheet with increase in no. of revolutions of Al5083 sheets shows better mechanical properties during cold working. The sheets can bedeformed under cold working which can be applicable in marine and sea water applications.

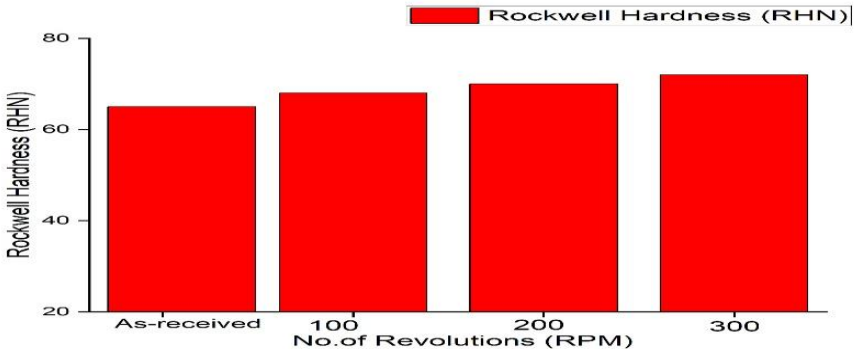

Figure.5 Hardness of peened sheets

3.4 Tensile Strength

The specimens prepared for the tensile strength according to ASTM-E8 standard were shown in figure.6. Actual tensile strength of Al5083 at 275MPa. The Tensile strength of As- Received sheet is found to be 285MPa. The tensile strength increases from 285MPa to 325MPa to shot peened sheets which is to be concluded with an experiment, this is due to fine grain formation in sheets during cold working conditions of Al5083 shot peened sheets. The tensile strength of peened deformation sheets was shown in table.4

Figure.6 Peen formed Al5083 Tensile specimen for testing

Table.4 Tensile strength of peened sheets

NO. OF REVOLUTIONS	Tensile Strength (MPa)
AS RECIEVED	285
100	297
200	312
300	325

Shot peening causes plastic deformation in the surface of the peened part. This mitigates surface tensile stresses

that may have been introduced in machining the component, and more importantly it introduces a salutary compressive residual stress that accommodates to invigorate the surface of the component [4].

4. Conclusions

Al5083 sheets are successfully processed through Peen forming. Cold Working of the sheets during peen forming results in improvement of mechanicalproperties. The reduction in width of the sheets leads to reduction in area of the sheets whichresults in successful deformation of the sheets during peening. The deformation tends to increase in reduction area and grain refinement which is confirmed from optical micrograph. Peen Forming increases the hardness of Al5083 sheets from 60HRB to 72 HRB. As the no. of revolutions increases the hardness increases and there is reduction in areaof the sheets. The strength of the sheets increases from 285MPa to 325MPa with shot peening with tends to applicable for marine and structural applications.

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