

Effect of Shot Peening Treatment on Fatigue Strength

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ABSTRACT: Shot peening is a cold working process which improves fatigue strength and corrosion characteristics of the metallic component. Shot peening induces surface residual compressive stresses. The compressive stresses are created on the component surface by bombarding the stream of metallic or ceramic particles called shots. The objective of present study is investigating the effect of shot peening on fatigue life of EN 19 component by using glass beads as a shot material.

KEYWORDS: Shot peening; Fatigue; EN19; Glass beads

I. INTRODUCTION

Shot peening is a kind of surface cold working technology in which the surface of a part is bombarded with small spherical media called shot. Each piece of shot striking the material acts as a tiny hammer, imparting to the surface a small indentation or dimple as shown in fig 1.1.

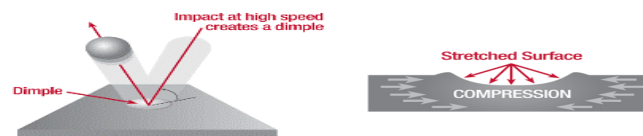


Figure 1.1 shot peening process

So this can provide fatigue life improvement by projecting of small particles. Since many components are subjected to fatigue failure due continuous loading and repeated work cycles, the components should be made without fatigue failures. For that shot peening process is preferred.

There are different types of shot peening process; the types of the shot peening process are as follows,

1. Water peening
2. Air peening
3. Material peening
4. Laser peening

II. MATERIAL SPECIFICATIONS

EN19 was originally introduced for the use in the machine tool and motor industries for gears, pinions, shafts, spindles and the like. Later its applications became much more extended and it is now widely used in areas such as the oil and gas industries. EN19 is suitable for applications such as gears, bolts, studs and a wide variety of applications such as

- Axles
- Conveyor parts
- Sprockets
- Pump shaft
- Rams

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- Ring gears

The composition of EN 19 steel of chemical are given in below table 2.1

Table 2.1 Chemical Composition of EN 19 steel (%)

C	Si	Mn	P(max)	S(max)	Cr	Mo
0.38-0.45	0.15-0.35	0.50-0.80	0.035	0.035	0.90-1.20	0.15-0.25

III. EXPERIMENTAL WORKS

1. Specimen preparation
2. Shot peening
3. Fatigue test

3.1 SPECIMEN PREPARATION

According to the ASTM E466 standard, Axial fatigue test specimens were manufactured from an EN19 steel plate (bare condition) with a thickness of 3.175 mm, as shown in Fig.3.1.

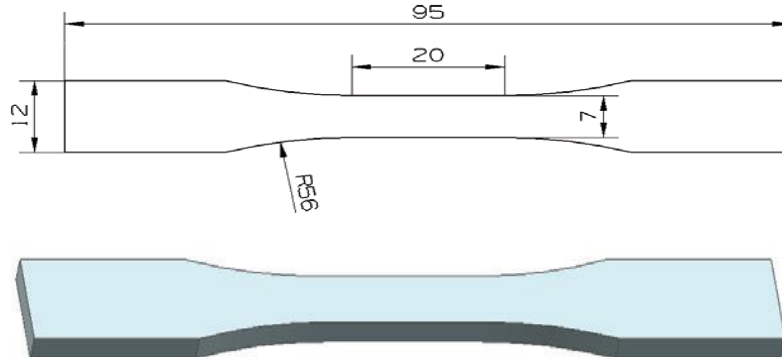


Fig.3.1. Fatigue test specimen, dimensions are in mm.

3.2 SHOT PEENING

Shot peening is one of the cold working process in which shot particles are ejected towards the target material. Out of different types of shot peening process, material shot peening process is preferred.

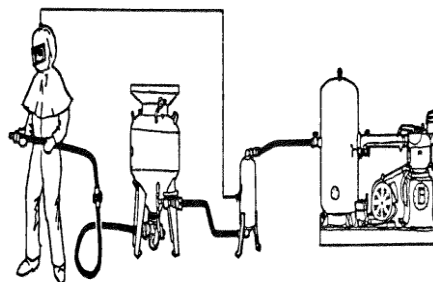


Figure 3.2 Shot peening machine set up

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In material shot peening process, the target material is fixed in a position. The nozzle is placed above the target material. The distance between the nozzle and target material is fixed as 50 mm. The diameter of the nozzle is \varnothing 8 mm. Now the shot peening machine is loaded with shot particles i.e. Glass beads. The size of the glass beads ranges from 0.6 – 0.8 mm diameter. The thickness of the target material is 3.175 mm and length and width of the target material is 95 and 12 mm. Now the pressure range is adjusted up to 1.0 bar and shot particles are ejected towards the plate. The plate is turned in the both sides so that all sides are shot peened show in fig 3.2.

3.3 FATIGUE

Fatigue failure is the phenomenon leading to fracture under repeated or fluctuating stress that are less than the tensile strength of the material. The fatigue fractures are progressive and beginning as minute cracks that grow under action of fluctuating loads. The fatigue failure occurs after four different stages, namely:

1. Crack initiation at points of stress concentration
2. Crack growth
3. Crack propagation
4. Final rupture

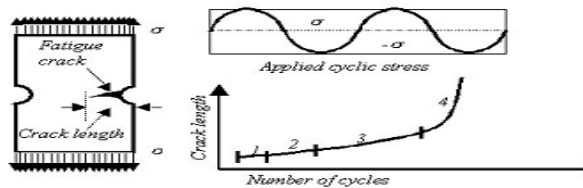


Figure 3.3 Crack growth and fatigue failure under cyclic load

The development of fatigue crack growth and the various stages mentioned above are symbolically represented in Fig 3.3. Fatigue failure can be defined as the number of cycles and hence time taken to reach a pre-defined or a threshold failure criterion. Fatigue failures are classified into two categories namely the high cycle and low cycle fatigue failures, depending upon the number of cycles necessary to create rupture. Low cycle fatigue could be classified as the failures occurring in few cycles to a few tens of thousands of cycles, normally under high stress/ strain ranges. High cycle fatigue requires about several millions of cycles to initiate a failure. The type of cyclic stresses applied on structural systems and the terminologies used in fatigue resistant design are illustrated in Fig 3.4.

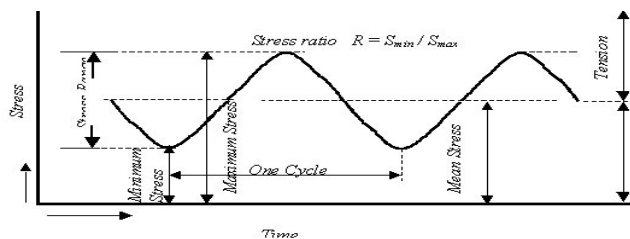


Figure 3.4 Terminology used in fatigue resistant design of structural steel work

IV. RESULTS AND DISCUSSIONS

The shot peening process is successfully carried out on EN 19 steel material by using glass beads as a shot material specimen has the following specification.

1. Original length of the EN19 material – 95 mm
2. Original width of the EN19 material – 12 mm
3. Fatigue length of the EN19 material – 20 mm
4. Fatigue width of the EN19 material – 7 mm
5. Radius of the dog bone curve – 56 mm

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The size of the glass beads ranges from 0.6 – 0.8 mm diameter. Now the pressure range is adjusted up to 1.0 bar and shot particles are ejected towards the plate. The nozzle is placed above the target material. The distance between the nozzle and target material is fixed as 50 mm. The diameter of the nozzle is 8 mm. the selected fatigue testing capacity of 2010 kg, where used for testing purpose and our specimen has the tensile strength of 850 Mpa and 50%(425 Mpa) of the tensile strength where used as the fatigue testing load. This shows that the fatigue life of the peened material is higher than the unpeened material. Since many engineering components are made of EN 19 it is necessary to increase the life cycle of the material. Shot peening process can make the material with increase in life cycle. The material mechanical properties will be improved by shot peening. The shot peening process will also increase hardness of the material

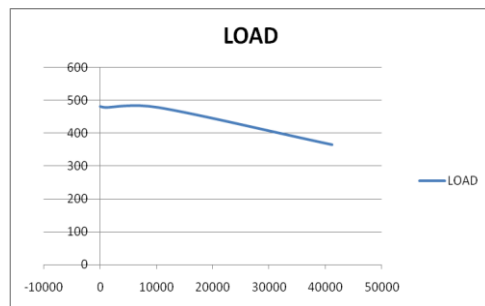


Figure 4.1 loads and cycle of the peened material

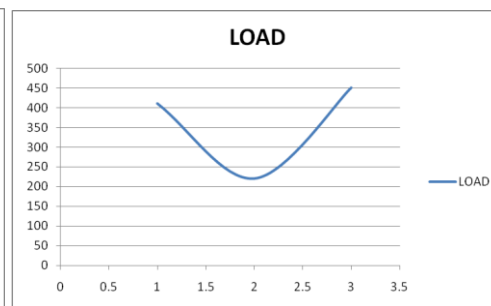


Figure 4.2 loads and cycle of the unpeened material

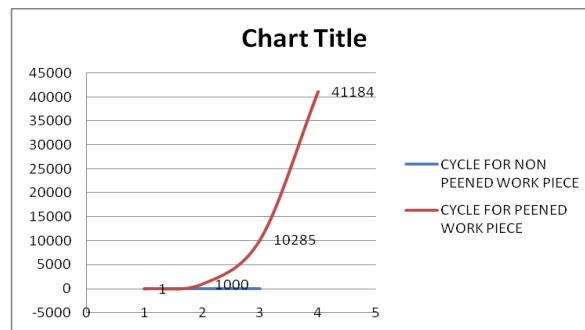


Figure 4.3 cycle of peened and unpeened material

V. CONCLUSION

In this work, the effects of shot peening on the fatigue characteristics of EN19 material will be studied by using glass beads. The result shows that shot peening improves the fatigue characteristics of EN19 material.

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