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EFFECT OF SHOT PEENIG WITH VARYING PARAMETERS AND BORON ADDITION ON SURFACE WEAR OF MEDIUM CARBON ALLOY STEEL

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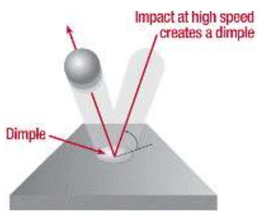
Abstract: The present work aims at studying the synergic effect of boron addition and shot peening on the abrasive wear resistance of medium carbon steel. Medium carbon steels have wide uses in structural and railways also along with agricutcural applications. So if the working life of these steels may be increased it will be a significant in controlling the cost. it is proved that addition of boron, in small quantity, may lead to the improvement in wear resistance of steel. On other hand shot peening is the process used for increasing surface toughness and reduces wear of the surface. It is a cold working method and have many advantage over traditional heat treatment processes. Even though effect of boron and shot peening on wear resistance has been studied separately by limited attempts, the synergic effect of boron and shot peening has not been studied systematically. Present work shows that there is a significant increase in the surface roughness of medium carbon boron steel with shot peening at varying parameters of the shot peening process.

I. INTRODUCTION

Medium carbon steels are widely used as agricultural implements especially for soil engaging components. These components are subjected to severe abrasive conditions which resulting in greater extent of wears. As a result, the life of component becomes considerably less (one to two season). This becomes more problematic, as no standard composition or heat treatment or procedures is followed for manufacturing these components. Thus, it is expected, that selection of suitable composition, heat treatment schedule and manufacturing procedure would be very important for considerations in manufacturing of such components. The uses of medium carbon manganese steels include shafts, couplings, crankshafts, axles, gears and forgings. Steels in the range 0.40 to 0.60% C are also used for rails, railway wheels, and rail axles. In addition to these, these steels are widely used in other structural engineering applications. In order to improve strength, toughness and wear resistance, the medium carbon steels are alloyed with Cr, V, Ni, Mo, Ti, B etc. Boron form interstitial solid solution like that of carbon in steel and improve the strength and hardness significantly. Thus, it is expected that addition of boron, in small quantity, may lead to the improvement in wear resistance of steel. Furthermore, the wear is a surface phenomenon. Thus by improving the strength and hardness of the surface, the wear resistance of the steel could be improved. Most of the agricultural components also subjected to fatigue type of loading during operation. Thus improvement in fatigue life in addition to the hardness is expected to improve the life of the agricultural component. Thus, in recent years, boron steel is being attempted in agricultural implements. The surface hardness strength is also improved by surface hardening techniques like surface heat treatment (carburising, nitriding, cyaniding etc), induction hardening, hard facing, surface coating etc. Most of these methods are energy and cost intensive. However, performance to cost ratio may be beneficial. Shot peening is a cold working process 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 peening hammer, imparting to the surface a small indentation or dimple. In order to create dimple, the surface fibers of the material must be yielded in tension. Below the surface, the fibers try to restore the surface to its original shape, thereby producing below the dimple, a hemisphere of cold-worked material highly stressed in compression as shown in fig. below. Overlapping dimples develop almost an even layer of metal in residual compressive stress.

Impact of shot creating dimple on the surface.



Cold worked material highly stressed in compression

It is well known that cracks initiation or propagation is delayed in a compressively stressed zone. Since nearly all fatigue and stress corrosion failures originate at the surface of a part, compressive stresses induced by shot peening provide considerable resistance to fatigue and thus increase in life of the parts. The maximum compressive residual stress produced at or under the surface of a part by shot peening is at least as great as half the yield strength of the material being peened.The surface hardness of the material also increases due to the cold working effect of shot peening. Selection of shot peening parameters for medium carbon steels

The quality and effectiveness of peening depends on the following parameters:

- Type and sizes of shot
- Shot peening intensity
- Surface coverage

II. LITERATURE

A number of researchers have worked on shot peening process on different metals in fact from ancient time shot peening was used in the form of hammering of metalic parts for extra toughness.]. Champaigne. Jack.[1] worked on the concept of shot peening. They elobrate that what is actualy shot peening and its advatages. George Leghorn[2] talked about the history of shot peening by his work as it is used as hammer hardening from ancient times. SAE New york [3] has written in its shot peening manuals that stress propogation is less in compressively stressed zones. J.O. Almen[4] worked on the theory that shot peenig have compressive stress and cold working both advantages. Fuchs, H.O.[5] described that plastic deformation occured during the peening process is useful for hard and soft both metals. K.Keto[6] has studied about the mechanism of surface wear. Ferroalloys & Alloying Additives Online Handbook-Boron[7] has shown that boron increases the hardenablity. Bharat Bhushan[8] has talked about the the tribology of surface wear. T. S. Eyre[9] showed the types and their portion of total wear in indusries. Holm R[10] showed the relationship between hardness and sliding wear.

III. FACTORIAL DESIGN APPROACH

There are basically two general issues to which Experimental Design is addressed: 1. How to design an optimal experiment, and 2. How to analyze the results of an experiment. Factorial Experiments are experiments that investigate the effects of two or more factors or input parameters on the output response of a process. Factorial experiment design, or simply factorial design, is a systematic method for formulating the steps needed to successfully implement a factorial experiment. Estimating the effects of various factors on the output of a process with a minimal number of observations is crucial to being able to optimize the output of the process. For instance, if the effects of two factors A and B on the output of a process are investigated, and A has 3 levels of intensity (e.g., weak, moderate, and strong presence) while B has 2 levels (weak and strong), then one would need to run 6 treatment combinations to complete the experiment, observing the process output for each of the combinations: weak A-weak B, weak A-strong B, moderate A-weak B, moderate A-strong B, strong A-weak B, strong A, strong B. The amount of change produced in the process output for a change in the 'level' of a given factor is referred to as the 'main effect' of that factor. Table.2.8 shows an example of a simple factorial experiment involving two factors with two levels each. The two levels of each factor may be denoted as 'low' and 'high', which are usually symbolized by '-' and '+' in factorial designs, respectively [81].

1.	Peening pressure, MPa	0.589
2.	Peening nozzle dia, mm	6.00
3.	Shot size, mm	0.825 (5330)
4.	Shot hardness, HRc	45
5.	Standoff height, mm	154.00
6.	Average mass flow rate, t/h	0.400
7.	Angle of peening, degree	90
8.	Almen strip used	Almen "A"
9.	Surface coverage, %	98-100

A Simple 2-Factorial Experiment

	A (-1)	A (+1)
B (-1)	20	40
B (+1)	30	52

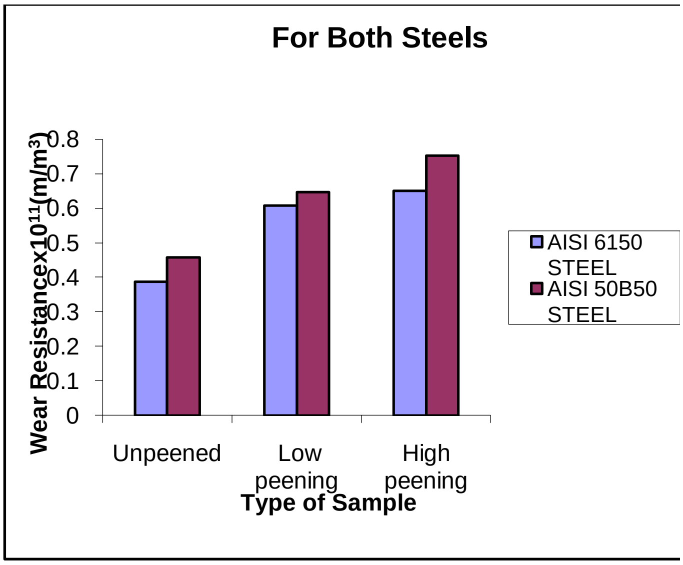
Shot peening parameters

The samples were shot peened at different peening parameters are shown in table

Sl. No.	Peening Time, sec	Peening Intensity, mm ALMEN"A"
1.	10	0.117
2.	60	0.486

IV. RESULTS AND DISCUSSION

Combined histogram for both the materials is shown in Fig



It is evident from these figures that irrespective of peening intensity, the wear resistance of the steel increased by 10% to 20% due to addition of boron. This primarily attributed to increase in strength and hardness of the steel due to boron addition. The hardness of these two steels is noted to be 210 VHN and 220 VHN, for AISI 6150 steel and AISI 50B50 steel respectively. These figures also demonstrate that the wear resistance increases with increase in peening intensity. Increase in wear resistance with peening intensity attributed to the fact of surface work hardening and generation of compressive stress field on the specimen surface. The work hardening increases the surface hardness of the specimens whereas the compressive stress reduces the tendency of micro cracking during abrasive wear. The work hardening behaviour and the compressive stress field on the peened sample are demonstrated with the variation of micro-hardness as a function of distance from the peened surface. Converted stresses from the micro-hardness, agree well with the reported literature. It thus, suggests that micro-hardness distribution could be an excellent methodology for identifying the stress distribution in shot peened steel. The roughness of the steel surface due to peening also increases, which makes lot of protuberances on the specimen surface, which ultimately reduces contact area between the abrasives and the specimen surface and thus causing less wear.

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