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INVESTIGATION OF EFFECT OF DAMPING OF THE WORK PIECE ON COATING REMOVAL RATE AND SURFACE ROUGHNESS DURING THE SHOT BLASTING PROCESS

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ABSTRACT

Shot blasting is a method used to clean, strengthen or polish metal. Shot blasting emerged as one of the most effective technique for surface preparation prior to operations such as galvanizing, electroplating, welding, enamelling, glass coating and rubberizing [1]. As it is very important in the common industrial usage, there emerges a need to study about the functional and operating parameters relating to shot blasting method, which in turns improves overall production rates, improved finishing and economical viability [2]. This research work is focused on studying the surface finish rate by providing damping on the work piece during the shot blasting process and compares it with a conventional shot blasting process without providing cushioning action for the work piece. Also investigations have been carried out to evaluate parameters which are affecting the coating removal rate during shot blasting process. An experimental set up for the same has been designed and fabricated. Garnet of mesh size 30-60 mesh has been used as blasting abrasive [8]. Springs having stiffness of 120 kgf/mm and 60 kgf/mm have been used to provide cushioning effect for the aluminium, GI and mild steel [6] specimens were used for experiments. Compressor with pressure of 10 bar has been used as air supply. Experiments were conducted to evaluate the effect of cushioning of work piece on surface roughness and coating removal time (CRT) .Experiments revealed that the cushioning effect provided for the work pieces improves the surface finish, coating removal rate and reduces the coating removal time. This approach also helps the shot blasting method to become economically viable [3].

Keywords: shot blasting, cushioning, spring stiffness, coating removal, surface finish.

INTRODUCTION

Shot Blasting is a surface treatment process using high velocity abrasive. Shot blasting methods are used for cleaning and surface preparation for secondary finishing operations [1]. Conventional Machining Processes mostly remove material in the form of chips by applying forces on the work material with a wedge shaped cutting tool that is harder than the work material under machining condition and leads to chip formation. Material removal in the shot blasting process is accomplished by the use of a continuous jet, which is produced by mixing abrasive particles with a high velocity air jet, which latter imparts momentum to the abrasive particles, accelerating them prior to their impingement on the work piece.

Shot blasting is commonly used for the cleaning and surface finish process of iron, steel, non-cast parts, forgings, sheets, rods, coils and to carry out the shot peening to alter the mechanical properties. In general shot blasting concentrates abrasive particles at high speed (65-110 m/second) in a controlled manner at the material there by removing surface contaminate and coating due to the abrasive impact. The study of effect of the work piece materials is essential as the efficiency of the coating removal also depends on materials [7].

In this research the shot blasting process has been modified to suit for coating removal process of aluminium, GI and mild steel materials. The criteria used for selecting the type of shot blasting system depends on the size and shape of the parts, the condition of the surface coating to be removed , final surface finish and surface roughness required [8]. The standoff distance was adjusted to 30mm ,40mm and 50mm [12]. A flexible work table with springs having stiffness of 120 kgf/mm and 60 kgf/mm has been designed to support the work pieces and the surface coating of the specimens were removed by using shot blasting process. Experiments were carried out to evaluate the effect of cushioning, absence of cushioning of work pieces on coating removal rate and surface roughness of work pieces. Garnet was selected as abrasive material with mesh sizes of 30-60#, as the size of the abrasive plays a major role on the coating removal rate [9]. The time taken for coating removal and surface roughness were measured for various experimental conditions.

EXPERIMENTAL SET UP

In the blasting process the blast media is pneumatically accelerated by compressed air. A work table which is supported by the springs was fabricated to hold the work piece which is to be blasted for removing the surface coating by use of shot blasting process. As the work table is supported by the springs, the springs provide a cushioning effect to the work piece during the blasting process. In this work two springs, which are having 2mm thickness, stiffness of 60 kgf/mm, 120 kgf/mm and internal diameter of 23.5 mm were used to provide cushioning effect for the work pieces. Spring stiffness was

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changed for every experimental condition to investigate the best conditions for coating removal.

Figure-1. Shot blasting machine with fixtures.

Figure-2. Shot blasting abrasive jet.

EXPERIMENTATION

Coated Aluminum, Mild Steel and GI sheets sizes of 4cm×4cm were used as specimens .Initially the aluminium specimen is mounted on the work table and the spring stiffness is adjusted to 120 kgf/mm .The Pressure for blasting is adjusted as 75 kg/cm^{2,} after the few trials as the process parameters also influences the coating removal rate and surface roughness [2].Surface roughness tester “Mitutoyo SJ210” is used for measuring the surface roughness of the work pieces after the blasting process.

The Standoff distance (SOD) between abrasive blasting nozzle tip to work piece is kept as 30mm [12]. In the blast generator , air and abrasives are mixed together and flows through a pitch valve at a controlled pressure to the nozzle .As the abrasive particles strikes the work piece, coating will be removed [11] .The time taken for the coating removal and the surface roughness of the specimens after the blasting process are noted. The experiments were repeated by changing the specimens as aluminium, GI and mild steel [14]. Spring stiffness is changed as 60kgf/mm and 120kgf/mm and SOD from 40mm to 50mm.

RESULTS AND DISCUSSIONS

i) Effect of standoff distance (SOD) and spring stiffness on coating removal time (CRT)

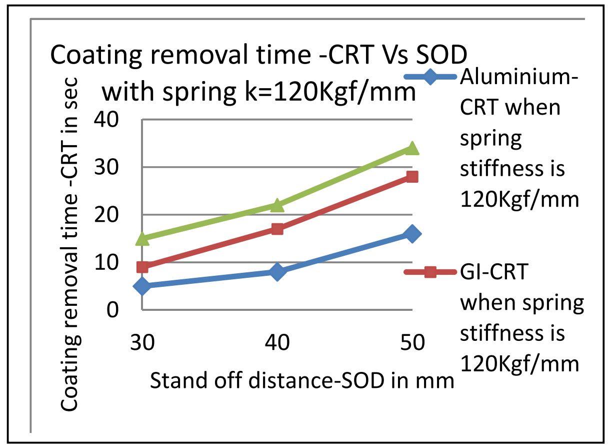

Figure-3. Effect of SOD on CRT when spring stiffness is 120kgf/mm.

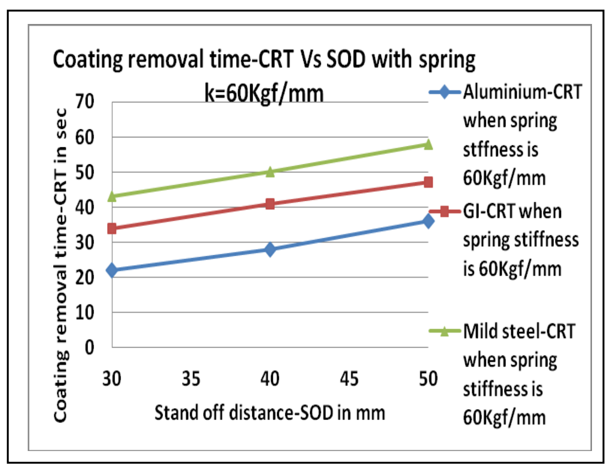

Figure-4. Effect of SOD on CRT when spring stiffness is 60kgf/mm.

The Figure 3 and 4 shows the relation between the standoff distance (SOD) and coating removal time (CRT) for the aluminum, GI and mild steel specimens. This analysis clearly reveals that coating removal time increases with the increase in SOD. As the SOD is increasing 30 to 50mm the abrasive particles loses its kinetic energy and the coating removal time is increasing [12]. The optimum SOD is 30mm and below 30mm the

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blasted abrasives are bouncing back and blocking the exit of abrasive nozzle.

When the spring stiffness is increased above the 60kgf/mm to 120kgf/mm it is clear that the coating removal time is increasing as the blasted abrasives are bouncing back due to the less cushioning effect .The coating removal time is decreasing as the spring stiffness decreased to 60Kgf/mm the blasted abrasives slides over the specimen surface and provides slicing, and shear action [11] due to the more cushioning effect [5]. Also when the spring stiffness is lesser, it leads to increase in retention period of abrasives and increase in shear .Hence the coating removal rate increasing with the reduction in coating removal time (CRT).

When the coating removal rate and CRT are compared for the materials aluminium, GI and Mild steel, it was observed that the coating removal time for aluminium is less than the GI and mild steel as the bonding between the base metal and coating is lesser [12]. From the Figure 3 and 4 it is clear that, as the bonding between the GI material and coating is usually stronger, the coating removal time is increasing and the coating removal rate is decreasing.

ii) Effect of absence of cushioning effect (with out spring) on coating removal time (CRT)

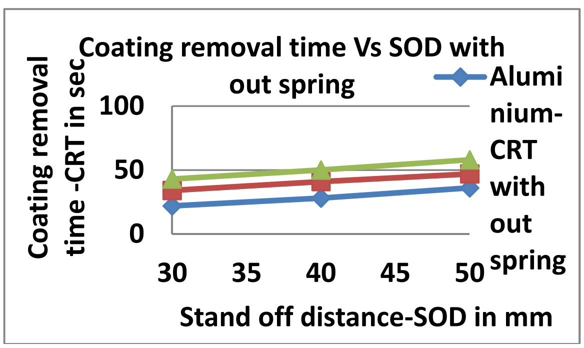

Figure-5. Effect of SOD on CRT without spring action.

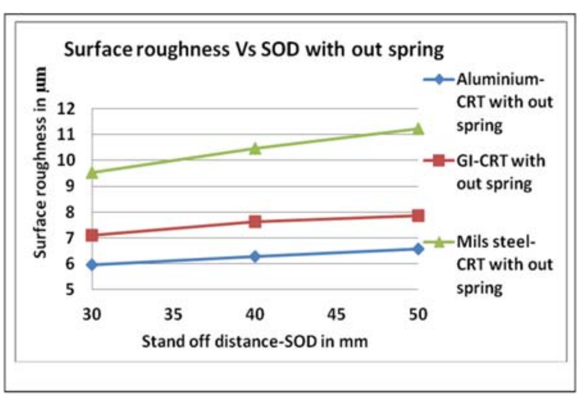

Figure-6. Effect of SOD on surface roughness without spring action.

The Figure 5 and 6 shows that the comparison of coating removal time and surface roughness of aluminium, GI, mild steel without providing springs and cushioning effect. Also Figure 5 and 6 clearly reveals that the coating removal time has been increased to 58 sec from 34 sec and increase in surface roughness, when there is no spring or cushioning action provided. There is no much of slicing and shear action of blasted abrasives with out cushioning effect. As there is no spring and cushioning action, the blasted abrasives are striking the material and bouncing back. This leads to decrease in coating removal rate and increase in coating removal time.

iii) Effect of coating removal on surface roughness with springs

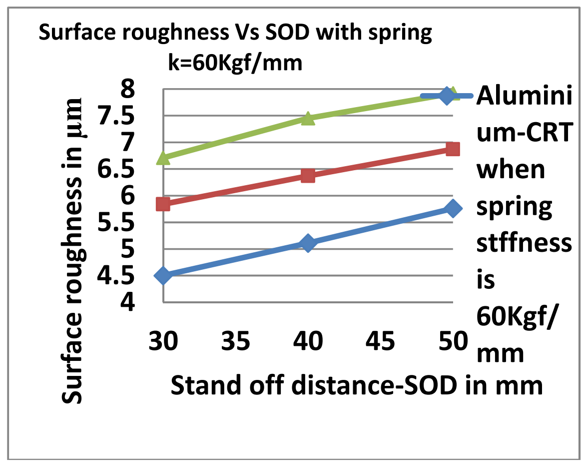

Figure-7. Surface roughness vs SOD when the spring stiffness stiffness is 60 kgf/mm.

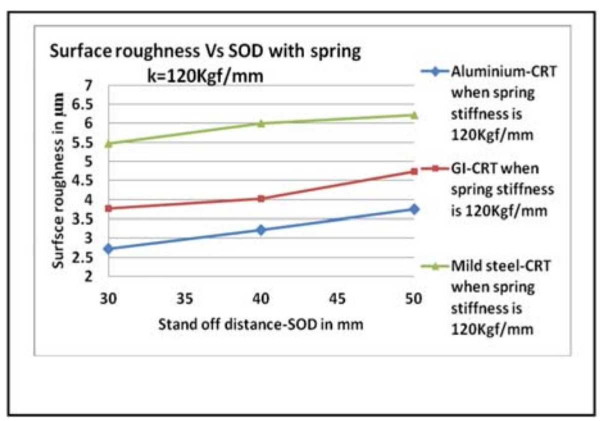

Figure-8. Surface roughness vs SOD when the spring is 120 kgf/mm.

The Figures 7 and 8 shows the relation between the surface roughness obtained after removal of coating from Al, GI and Mild steel materials and the standoff distance (SOD). Also from the Figures 5 to 8 it is clear that the surface roughness is increasing to above 11μm during the absence of spring action and reducing below 6.5μm with the presence of spring action. This analysis revealed that the materials which are processed and supported by the springs and cushioning arrangement, the surface roughness is decreased when compared with the surface roughness of materials which were processed without any springs arrangement. As the abrasives strikes the work piece, due to the spring/cushioning effect the abrasives slides over the work piece and the surface roughness is getting decreased with the increase in surface finish [5]. Usually the bonding between the coating and base materials such as mild steel and GI will be more than the aluminium and GI .This shows that there are some effect of material parameters on coating removal rate [13, 14]. Due to this effect the coating removal time of mild steel is increasing and the surface is exposed to more abrasive force, which leads to the increase in surface roughness than the GI and aluminium.

CONCLUSIONS

An experimental set up has been developed to study the effect of SOD, spring stiffness of work table ,on the surface finish of the work piece and coating removal rate of shot blasting process. Garnet was used as the abrasive material. Comparison has been made between surface roughness and coating removal rate with and without damping effect at various standoff distances.

The experiments revealed that the coating removal time decreases with the increase in coating removal rate when the SOD is 30mm.Also it was found out that the stiffness of the spring which has been provided with the work table to give the damping effect of work piece plays a major role in the coating removal rate (CRR) and coating removal time (CRT). The surface finish and coating removal rates are increasing with the increase in spring stiffness. This clearly shows that, a springing action to be provided with the work table during the blasting process to improve the surface finish of the blasted components. The coating removal rate, coating removal time and the surface finish of the coating removed Mild steel, GI and Aluminium specimens were compared. It was found out that the coating removal time of aluminum is less than the GI and mild steel and better surface finish was obtained.

In overall it was observed that, when the spring stiffness of the work piece holder decreases the surface roughness increases and the surface roughness decrease with the increase in spring stiffness. This clearly shows that the cushioning effect improves the surface finish [5]. When the standoff distance increases, the surface finish decreases and the surface roughness increases .Also it was noticed that, the material removal rate is decreasing with the decrease in spring stiffness and increasing with the increases in spring stiffness. The above results conclude that the damping of the work piece improve the quality of surface roughness when compared to a conventional shot blasting process.

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