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ADHESION ON GATE SURFACE: A CASE STUDY ON ROLE OF SURFACE ROUGHNESS

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ABSTRACT

Precise control of friction and wear is very important for the energy efficiency and sustainability in hydraulic systems. In the present study, the effect of tribological property- Surface roughness, is observed on the bonneted Gates of 990MW Hydropower Generation Project. The surface roughness of the gate was quantified using Visual Surface roughness comparator. The prescribed thickness of 0.5mm of Brushable ceramic, to be applied on the Gate surface being checked using the wet film thickness gauge. The study shows - when the composite based coating was applied onto surface with specified surface roughness gives 3-4 times long lasting protection than traditional approach, to the gate from physical phenomenon's and in turn it reduces generation cost.

Keywords: *Surface roughness, friction, gate, surface preparation, Ceramic based treatment.*

INTRODUCTION

Tribology is a multidisciplinary science dealing with friction, wear and lubrication. Every machine component is associated with the phenomenon of Friction wear and lubrication. It affects many aspects of everyday life and has played a central role in technology. The word tribology, which is based upon the Greek word "tribos" (rubbing), appeared in 1966. The literal translation would be the science of rubbing. Tribological phenomena occur whenever two material bodies are brought together and translated with respect to each other. The goals of exploration of these phenomena, dating back from the creation of fire by rubbing sticks together to current efforts to make nano devices, are to understand their physical and chemical origins, and to design ways and means for minimizing losses, e.g. energy dissipation and material degradation, which can cause huge economic loss [1]. Surface roughness is the most important aspect in the adhesion theory of tribology. Surface roughness has a huge influence on many important physical phenomena such as contact mechanics, sealing, adhesion and friction. Thus, for example, experiments have shown that a substrate with a root-mean-square (rms) roughness of the order ~1μm can completely remove the adhesion between a rubber ball and a substrate, while nano scale roughness will remove the adhesion between most hard solids, e.g., metals and minerals; this is the reason why adhesion is usually not observed in most macroscopic phenomena [2].Normally, it is very difficult to prepare surfaces really flat. Even on carefully polished surfaces, hills and valleys are large compared with the size of a molecule. If two solids are placed in contact, the upper surface will be supported on the summits of the irregularities, and large areas of the surfaces will be separated by a distance which is great compared with the molecular range of action [3, 4]. Although the techniques of grinding and polishing have advanced recently, it remains difficult to prepare surfaces of appreciable size that are flat on the scale of order 100 ° A, and most surfaces used in engineering practice have surface irregularities which are much greater.

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BEAS SATLUJ LINK PROJECT- A 990 MW GREEN ENERGY PROJECT

The Beas Satluj Link Project starts from Pandoh Dam- an Earth cum Rock filled Diversion dam diverting water through 13.2 km long tunnel with Diameter 6.2-meter ending Baggi Control Works followed by 11.80 km long open channel, balancing reservoir, 12.35 km long Intake tunnel ending at Power House at Slapper. Baggi control works, the only regulation center of water, equipped with 4 No. Emergency Gates and 4 No. Regulating Gates for the regulation of water from pandoh dam to the open hydel channel. The 2.67 X 4.27 m fixed wheel type Emergency gates are provided in upstream of the 2.67 X 4.27 m Slide type Regulating gates. The present study has been done for the Emergency gates provided at BCW, Baggi. The emergency gates are always under the immense pressure of around 55 m static head. These Gates are either fully open or fully closed, leading to drastic change in their sort of usage. In due course of time, the river come up with coarse silt, boulders, wooden logs which not only damage the gate surface, also accelerates the process of surface damage due to cavitation, pitting and rusting due to acidic nature of water. Though one gate is taken for repair and maintenance every year, the process repeats every 5th year. Since the gate keep submerged in water for approx. 4 years, it is very necessary to treat the gate with best possible solution to prevent it from Cavitation, pitting and rust and to enhance its life thereby reducing generation cost.

TRADITIONAL APPROACH

The Gate after being taken out from the Bonnet Box for its repair, was earlier treated with CA-50 Coal Tar paint as per 20 BSD specification. The basic treatment involves the cleaning and washing; removal of earlier paint using chipping hammers, wire brushes and then washing before final application of the 2 coat of CA-50 Paint. Though, 1 mm thick layer of the CA-50 paint is applied on the gate surface but the condition under which the gate remains for the 4 year are not good enough for the Protection of Gate. The Gate when taken out, shows a high value of Corrosion and Pitting.

Fig.1: Condition of Gate treated with CA-50 Paint when taken out for annual repair

MODERN TRIBOLOGICAL APPROACH

The modern approach includes the latest advancement in technology that has been applied on to gate surface in consideration of tribology aspects. The gate after being removed from the bonnet box are placed in the service bay for it repair and maintenance. The Procedure for Applying Ceramic Based Wear Resistant Putty and Brushable Paint is briefly given for the reference.

In order to have best result, it is necessary to understand the topology of the surface and studying its tribological properties. The process of coating to be applied on surface starts with surface preparation followed by paint activity. The steps showing how the overall procedure for the Coating including the surface preparation are as under:

STEP-1. SURFACE PREPARATION

a) The first step of surface preparation involve Chipping by means of Chipping hammer to remove the corrosion pits and removing the earlier applied CA-50 paint to get the parent metal for further treatment.

b) After successful execution of chipping methodology, now the main aim is to achieve surface roughness of 0.65-0.75 microns which is essential requirement for application of Brushable ceramic paint. In order to attain the requisite surface roughness, CI Grit Blasting treatment was given to surface. The SA-25 grade of CI grit blasting was adopted which says "when any surface with SA-25 grade of blasting is applied to a point for 2.5 minutes, 0.65-0.70 microns of surface roughness is achieved". The achieved surface roughness was measured with Elcometer Grit Surface Comparator E125-1 by visual method.

Fig. 2: Preparation of Gate Surface using CI Grit Blasting

STEP-2. APPLICATION OF WEAR RESISTANT PUTTY AND BRUSHABLE CERAMIC

a) The prepared surface was cleaned using soft brush in order to remove any dust particles if any present on surface.

b) In the upstream of gate, the major portion was found pitted and cavities were present. The cavities were first filled with Ceramic wear resistant putty for smoothening the surface and letting it to dry for 6 hours. The wear resistant putty was provided with resin and hardener mixed uniformly before final application on surface. After curing, brushable ceramic paint was applied on the surface. The brushable ceramic was also provided with a resin and hardener in order to achieve superior adhesion property.

c) The brushable ceramic was provided with brush which gives a thickness of 0.25 mm on coat. The thickness was confirmed by using wet film thickness gauge. Two coat of brushable ceramic was given in order to achieve the recommended surface thickness of 0.50 mm, a total 24 hours of curing time was given to gate before finally placing it into bonnet box.

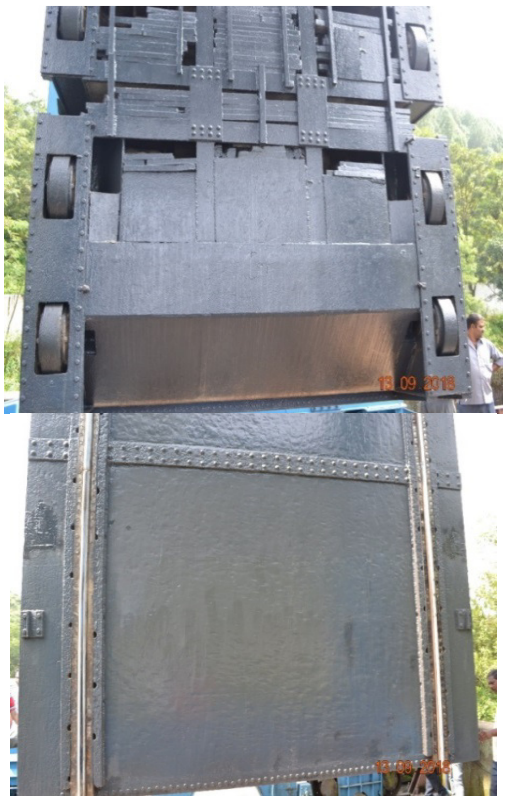

Fig.3 Gate surface (u/s & d/s) after application of Ceramic coating and has given glossy and shiny look.

RESULTS

The Traditional CA-50 Coal Tar based treatment was done since commissioning of the project. The gate when taken out after successive 4th year, the condition was almost shocking as it was heavily pitted and rusted when treated with CA-50 Paint. Ceramic based treatment was given first time in year 2009-10 to Emergency gate no 1. The gate when taken out for inspection after one year, it was as it was after treatment with ceramic paint. The gate was then taken out after 3 year and it was un-imaginable to find the gate as it was after treatment. Though, the Traditional CA-50 paint though protects the gate from Rust but does not have hardened strength. Ceramic based treatment not only provides a long-lasting protection from rust, pitting and cavitation but also a life of approximate 15 to 20 years.

Fig.4: Comparision for Gate surface before and after treatment with ceramic paint.

CONCLUSION

Though the Engineers working on the project components do their best to maintain/manufacture the component. But, the changing technology give birth to new technique which ease the activity with better properties than in past. The Surface engineering applied on the gate surface with the tribological factors to enhance the life of the gate approx. 3-4 time than traditional approach for the smooth functioning of a component requires its preventive maintenance with the latest technological aids and approach for ensuring the best results, which not only reduces the overall cost of maintenance but also gives a long, trouble free life.

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