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Experimental Study of the Effect of Shot Peening Parameters on the Surface Texture - Influence on the Adhesion of a Paint Coating

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Abstract. The investigation presented in this paper focuses on the effect of surface texture on the adhesion of a paint coating as well as the influence of shot peening regime parameters on the surface isotropy indicator "Str" and on the fractal dimension "Df". The tests have been organized according to full factorial designs 2^3 , where three parameters have been examined, at their two levels (min, max), namely the pressure (P), the angle of attack (θ) and the time (t). 3D roughness measurements have been carried out to characterize the different surfaces after a shot peening operation. A mathematical model linking the input parameters (P, θ , t) and the output parameter "Str", in the study area has been established, and the fractal dimension (Df) has been used for the surface characterization. Paint deposit has been applied to surfaces and adhesion tests have been carried out. The results show the significant effect of the impact angle on "Str", and the interaction between the different parameters in the studied area. Furthermore, the greatest bond strength has been obtained with the sample 3 ($F = 4.25 \text{ N/mm}^2$), whose the isotropy indicator "Str" is equal to 0.6438 and the fractal dimension Df = is about 1.768.

INTRODUCTION

The control of the surface condition of parts is of great importance for manufacturers. So, depending on the application field an exhaustive characterization is essential. It consists in highlighting the most relevant roughness parameters related to the surface working conditions [1], to adopt the most suitable solution for their protection. Thus, coatings are the means widely used against external aggression such as corrosion and wear, despite the issue of adhesion to the surface. Hence the major role of the surface preparation in assuring a suitable coating protection value. Furthermore, many parameters related to the machining processes and / or to work piece properties influence the surface roughness. Therefore, studies of the surface topography of the manufactured elements are developed with two main objectives: the effect of machining parameters and the consequences in on the machined part properties [3], [2]. The surface texture is indicated by the roughness and the predominant direction the streaks across the surface. Such orientations that influence the coating adhesion are evaluated by the "Str" texture aspect ratio called the surface isotropy indicator. Thus, the parameter reflects the orientation of the roughness pattern, which is estimated by the ratio of the length to the width of a representative asperity. It takes a value between 0 and 1 or as a percentage between 0% and 100%. "Str" tends to 1 (100%) for an isotropic surface, and converges to 0 for a highly anisotropic surface. In addition, to provide a better estimate of the surface state, fractal geometry has been introduced for the characterization of surface state [review article]. This approach has been demonstrated thanks to Mandelbrot theory [4]. Fractal objects have the property of self-similarity or self-affinity [5]. Several fields of science and engineering have used fractal analysis to explain some phenomena [6-9], such as surface topographic changes caused by wear [10] and friction [11, 12]. In this experimental work, X52 steel samples underwent a shot peening operation followed by a surface paint deposit. The objective of this investigation is to observe the influence of surface texture on the adhesion of a paint coating and to