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## Effect of Surface Roughness on Fatigue Life of Al 6160 Alloy

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**ABSTRACT:** Surface roughness is an important parameter that affects the fatigue life/ strength of a material. The effect of surface roughness on the fatigue life of Al 6160 alloy is investigated in the current research. Standard fatigue specimens are fabricated as per the requirement of the 25KN axial fatigue testing machine and tested for low cycle fatigue life. Specimens of three categories are tested for the fatigue life and the results are compared. Firstly, smooth specimen as per the standard is tested, followed by specimen with first grade of roughness, followed by the specimen with second grade of roughness. It is clearly evident from the test results that, as the surface roughness increases, the fatigue life decreases drastically.

**KEYWORDS:** Surface roughness, fatigue limit, aluminium 6160, surface fracture.

### I. INTRODUCTION

The term Fatigue failure is a cause for many factors such as material type, notch geometry, surface quality, environment effect and etc. However, three parameters are usually projected to describe the surface quality: geometrical parameter or surface roughness, residual stress and microstructure. These parameters can be vary unconnectedly, according to the machining conditions[1]

Then the surface finish on the machine elements which is considered has the very significant process influencing the fatigue crack initiation life, that predominantly determines the total fatigue life. Then along with the surface roughness, the residual stress and the structure of the surface layer are main characteristics depending on the surface finish process [2]. Now a days, the effects of these preffered factors that effecting on the fatigue strength was not yet been evaluate precisely; in strength design, engineers have, to introduce the surface finish factor or roughness factor to make some modificaton in the fatigue limit in practical strength design. though, this modification method is measured not therefore reasonable and accurate for the evaluation of the effects of the surface circumstances on the fatigue strength [3].

The fatigue life of the machined part depends powerfully on its surface roughness. As so long been recognized that fatigue cracks usually begin from free surfaces. that is of fact that surface layers know-how the highest load are exposed to environmental effects. Stress concentration, oxidation, and burning where out of alloy elements (at high operational temperatures) are the factors acting along the surface layers that supply to crack initiation. Crack initiation and propagation, in most cases, can be attributed to surface integrity, produced by machining.[4]

The surface of a member has two important aspects that must have to be defined and controlled. The first aspect are geometric irregularities, on the surface, and secondly, the metallurgical alterations, of the surface and with surface layer[5].

This second feature has been termed as the surface integrity. Field and Kahles, both describe surface probity as the relationshi in between surface geometric values and also the physical properties such as residual stress, hardness and

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microstructure of the surface layers. These Surface integrity influence the quality of the machined surface and subsurface, which both become extremely significant, and when manufacturing structural components that have to withstand the very high static and dynamic stresses. Then the Tonshoff, and several other authors have reported how to make hard turning influences the surface probity of a machined parts. Surface integrity was suggested to point toward the surface characteristics such as microstructure, hardness, surface roughness, residual stress that influence the part functionality.[6]

## II. EXPERIMENTAL SETUP

### MATERIAL

The material used in this study was ALUMINIUM 6061 .The chemical compositions and of the material have been identified by using spectrometer machine. The chemical compositions and mechanical properties of the specimens' material are tabulated in Table I and Table II respectively.

PROPERTIES	
Ultimate tensile strength	310 MPa
Tensile yield strength	276 MPa
Modulus of elasticity	68.9 GPa
Poissons ratio	0.33
Fatigue strength	96.5MPa
Shear strength	207MPa
Shear modulus	26 GPa

COMPONENT	WT%
AL	95.8-98.6
CR	0.04-0.35
CU	0.15-0.4
FE	MAX 0.7
MG	0.8-1.2
SL	0.4-0.8

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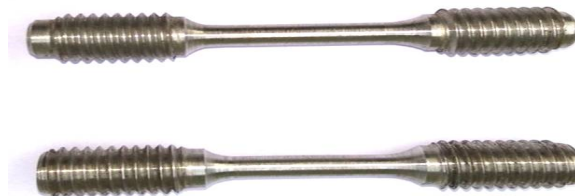
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### SPECIMEN

The specimens were fabricated using CNC lathe machine. Three specimens are prepared with three different surface roughness levels. Roughness was introduced by rubbing the circumference of the specimen at center with emery paper when the specimen was rotating on a lathe machine. Two specimens are fabricated per scenario and the average of the two results would be taken as the fatigue life of the specimen.



S.NO	Emery Paper Grit	Roughness, Ra [ $\mu\text{m}$ ]
1.	#220	3.680
2.	#120	4.484

### III. SURFACE ROUGHNESS MEASUREMENT

Once the scratching process was done, the surface roughness of the specimens was then measured. The tally surf device was used for the measurement. The fatigue strength of the  $R_a = 4.484\mu\text{m}$  and  $R_a = 3.680\mu\text{m}$  roughness specimens are slightly lower in the higher stress level or shorter life side region than the finer specimen. In the lower stress level or longer life side region, however, the degree of decrease in fatigue strength is larger. The finer specimens gave much higher number of fatigue cycles to failure compared to courser specimens. In order to reduce human errors during the measurement, the reading was taken for three times at different points.[8] The process was repeated to all specimens. Then, the average surface roughness,  $R_a$  is calculated and is summarized in Table III.

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### IV. LOW CYCLE FATIGUE TEST

The fatigue testing machine used was low cycle fatigue as per specimen requirement of 25KN axial fatigue test. Fatigue tests were carried out at room temperature (293 K) with constant frequency of 0.4Hz. The specimen was gripped using the chuck at one end while the load is applied from both ends whereby was connected to the load bearing. The load is applied just after the specimen started to rotate[9]. Once the specimen was broken, the shut down sensor stopped the machine automatically. The number of cycle to failure was then counted and displayed on the screen of the machine[10].



### V. RESULTS AND DISCUSSIONS

The smoother specimen gives more number of fatigue cycles to failure when compared to courser specimens. so it summarized in below table of surface roughness on fatigue limits of all machined specimens. The fatigue limit decreases with increases of surface roughness



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S.No	Specimen			
	Specimen details	Run-1	Run-2	Average Runs
1	Smooth specimen	12048	12238	12143
2	Specimen with 3.680RA	10230	10278	10254
3	Specimen with 4.484 RA	6152	6012	6082

### VI.CONCLUSION

A series of low-cycle fatigue tests has been performed on aluminium to evaluate the importance of surface roughness. The fatigue life decreases with an increase in surface roughness. The decrease in the number of cycles required resulting from surface roughness [12]

1. There is no significant difference in fatigue life among specimens at low fatigue cycle region of  $N < 105$ . However, at high fatigue cycle region,  $N > 105$  the finer specimens give much higher fatigue cycle compared to others.

2. Based on failure surface observation, the number of possible crack initiation sites increase for courser specimens that introduce the stress raiser on the specimens and reduces the crack initiation life. In addition, failure was observed for all specimens

### REFERENCES

- [1] N. a Alang, N. a Razak, and a K. Miskam, "Effect of Surface Roughness on Fatigue Life of Notched Carbon Steel," *Int. J. Eng. Technol.*, vol. 11, no. February, pp. 160–163, 2011.
- [2] W. D. Miao, X. J. Mi, H. C. Li, and B. De Qi, "Effect of Different Surface Treatments on Fatigue Life of NiTi Wires," *Mater. Sci. Forum*, vol. 561–565, pp. 2265–2268, 2007.
- [3] J. H. Ryu and S. W. Nam, "Effect of surface roughness on low-cycle fatigue life of CrMoV steel at 550 °C," *Int. J. Fatigue*, vol. 11, no. 6, pp. 433–436, 1989.
- [4] G. Deng, K. Nagamoto, Y. Nakano, and T. Nakanishi, "Evaluation of the Effect of Surface Roughness on Crack Initiation Life," pp. 1–8.
- [5] R. Horváth and Á. Drégelyi-Kiss, "Analysis of surface roughness of aluminum alloys fine turned: United phenomenological models and multi-performance optimization," *Meas. J. Int. Meas. Confed.*, vol. 65, pp. 181–192, 2015.
- [6] A. Javidi, U. Rieger, and W. Eichlseder, "International Journal of Fatigue The effect of machining on the surface integrity and fatigue life," vol. 30, pp. 2050–2055, 2008.
- [7] S. S. Raman and K. Padmanabhan, "Effect of surface roughness on the room temperature low cycle fatigue life of alloy Nimonic 90," *J. Mater. Sci. ...*, vol. 13, pp. 708–710, 1994.
- [8] Y. Murakami, "Effect of Surface Roughness on Fatigue Strength," *Met. Fatigue Eff. Small Defects Nonmet. Inclusions*, pp. 305–320, 2002.
- [9] M. Fonte, F. Romeiro, and M. Freitas, "Environment effects and surface roughness on fatigue crack growth at negative R-ratios," *Int. J. Fatigue*, vol. 29, no. 9–11, pp. 1971–1977, 2007.
- [10] J. Talati, "Surface Roughness – Significance and symbol interpretation in drawing."
- [11] H. Itoga, K. Tokaji, M. Nakajima, and H. N. Ko, "Effect of surface roughness on step-wise S-N characteristics in high strength steel," *Int. J. Fatigue*, vol. 25, no. 5, pp. 379–385, 2003.
- [12] P. S. Maiya and D. E. Busch, "Effect of surface roughness on low-cycle fatigue behavior of type 304 stainless steel," *Metall. Trans. A*, vol. 6, no. 9, pp. 1761–1766, 1975.