The Effect of Shot Peening on Fatigue Performance of Anodised Aluminium 7010T7651

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Abstract
Shot peening was performed on aluminium 7010T7651 using cast steel shot at various intensities. Test specimens were then subsequently anodised prior to fatigue testing. There is a similar improvement in fatigue performance from shot peening using both intensities compared with unpeened and anodised test results. As part of the normal corrosion protection aluminium 7010T7651 parts are normally anodised. The anodising process is known to have an adverse effect on fatigue performance. These results indicate that the intensity of shot peening before anodising does not have a strong influence on fatigue performance of anodised aluminium 7010T7651 material.

Keywords : Intensity, fatigue, aluminium, anodised.

Introduction
The beneficial effect of shot peening in improving fatigue performance has long been recognised. This is important for aircraft components where protective treatments may have an adverse effect on fatigue. Chromic acid anodising is known to reduce fatigue performance and historically a number of approaches to address this have been made. As performance requirements have increased, these surface treatments prior to anodising have progressed from alumina blasting to glass bead peening and then to steel shot peening. Developments to produce ever more efficient structures has led to components with thinner pockets which may then be liable to 'oil canning' when shot peened. There are two obvious solutions to this difficulty, which are either to reduce the intensity used on the part or to mask the thin pockets prior to shot peening, which can be very time consuming.This work investigates the effect of Almen intensity on fatigue performance of aluminium 7010T7651 plate used for manufacture of various parts on Airbus aircraft e.g. ribs. Two intensity levels were selected & tested; with unpeened & unanodised specimens as a baseline.

Experimental Methods
Flat axial fatigue specimens with Kt=1,0 (see Figure 1) machined from 130mm thick 7010T7651 plate were prepared as detailed in Table 1 and Figures 1 & 2.

Specimens	Shot peened	Anodised	Quantity	Maximum stress
Baseline As Machined	No	No	20	250-450MPa
Baseline Anodised	No	Yes	20	120-530MPa
Low Intensity	Yes (0,15-0,30mmN)	Yes	20	180-580MPa
High Intensity	Yes (0,15-0,23mmA)	Yes	20	180-530MPa

Table 2 - Test Specimen Condition

Fatigue specimens were then tested to EN6072 at an R ratio of 0,1 with maximum stresses within the range quoted in Table 1 to produce S-N curves.

Discussion and Conclusions
Figure 3 shows the reference S-N curve on unpeened and unanodised material. The index of quality in fatigue (IQF) is 313 MPa. The effect of the chromic acid anodising process on fatigue performance is shown in Figure 2. The IQF here is approximately 75% of the baseline value

at 237 MPa. This confirms the need to introduce beneficial compressive surface stresses to recover this reduction in fatigue performance. Figure 4 shows the S-N curve for the specimens saturation peened at 0,15-0,23mmA and subsequently anodised. The IQF has been increased to 298 MPa, which has almost recovered fatigue performance to the level of the unanodised material. Figure 5 shows the S-N curve for specimens which have been saturation peened at a lower intensity of 0,15-0,30mmN prior to anodising. The IQF found here is 329 MPa, which is a 5% improvement from the baseline unanodised material fatigue performance. The results confirm that chromic acid anodising as part of the protective treatment scheme can give a significant reduction in fatigue performance of 7010T7651 plate. This reduction in performance can be alleviated by saturation shot peening.

Based on the results from these tests, it can be demonstrated that saturation peening 7010T7651 plate in the lower intensity range of 0.15-0,30mmN is as effective as peening in the 0,15-0,23mmA range to recover fatigue performance of chromic acid anodised 7010T7651 plate. These results allow consideration of the use of lower intensity saturation peening of parts with thin pockets, which will avoid the risk of "oil canning" and the need to mask these areas.

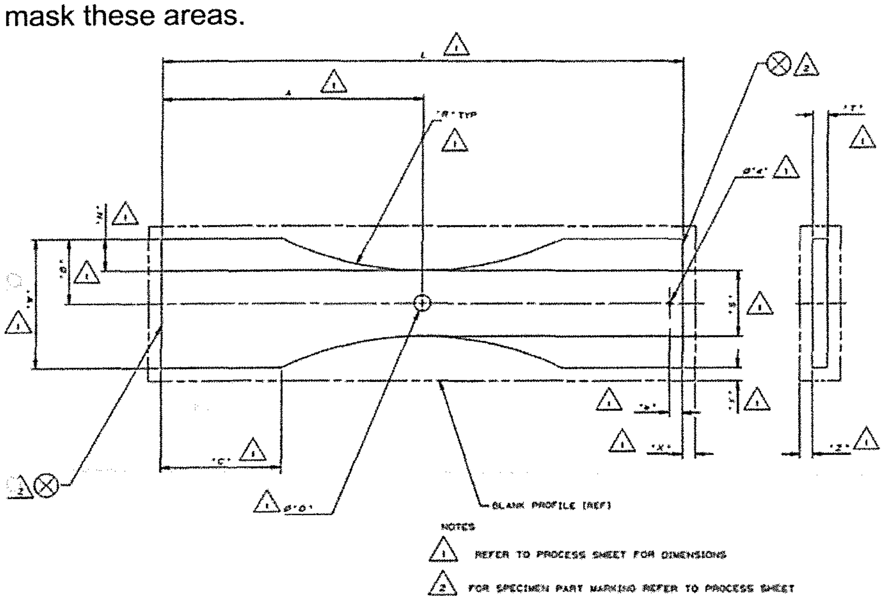

Figure 13 - Plain Fatigue Test Specimen

1.0 Specimen material: Aluminium alloy 7010T7651 plate
2.0 Dimensions :-

Do not produce hole in centre of specimen
X = 5,0mm
Y = 10,5mm
Z = 2,5± 0,5mm
L = 260,0± 0,1mm
W = 55,0± 0,1mm
T = 8,0± 0,1mm
A = 130± 0,1mm
B = 27.5± 0,05mm
N = 15,0± 0,1mm
S = 25,0± 0,1mm
R = 100,0± 0,1mm
D = No hole permitted
D = 6,35V
B = 10,0± 0,1mm

Figure 14 - Plain Fatigue Specimen Process Sheet

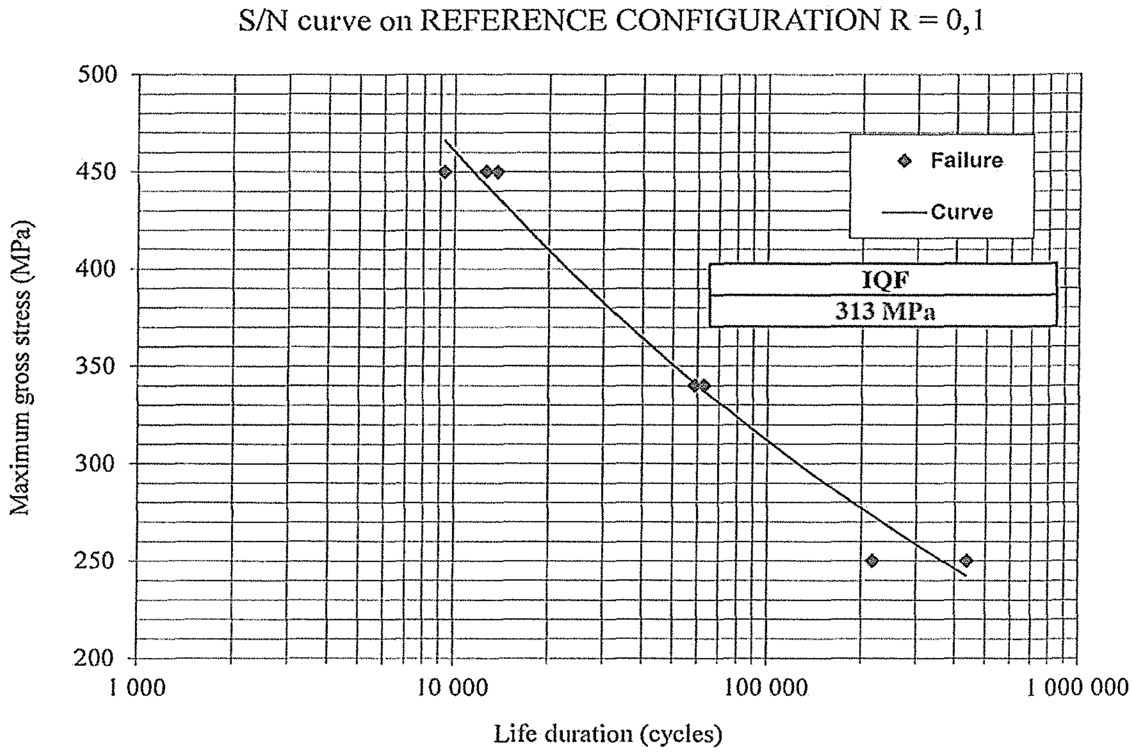

Figure 15 - Reference S-N Curve on Unpeened and Unanodised 7010 T7651 Plate

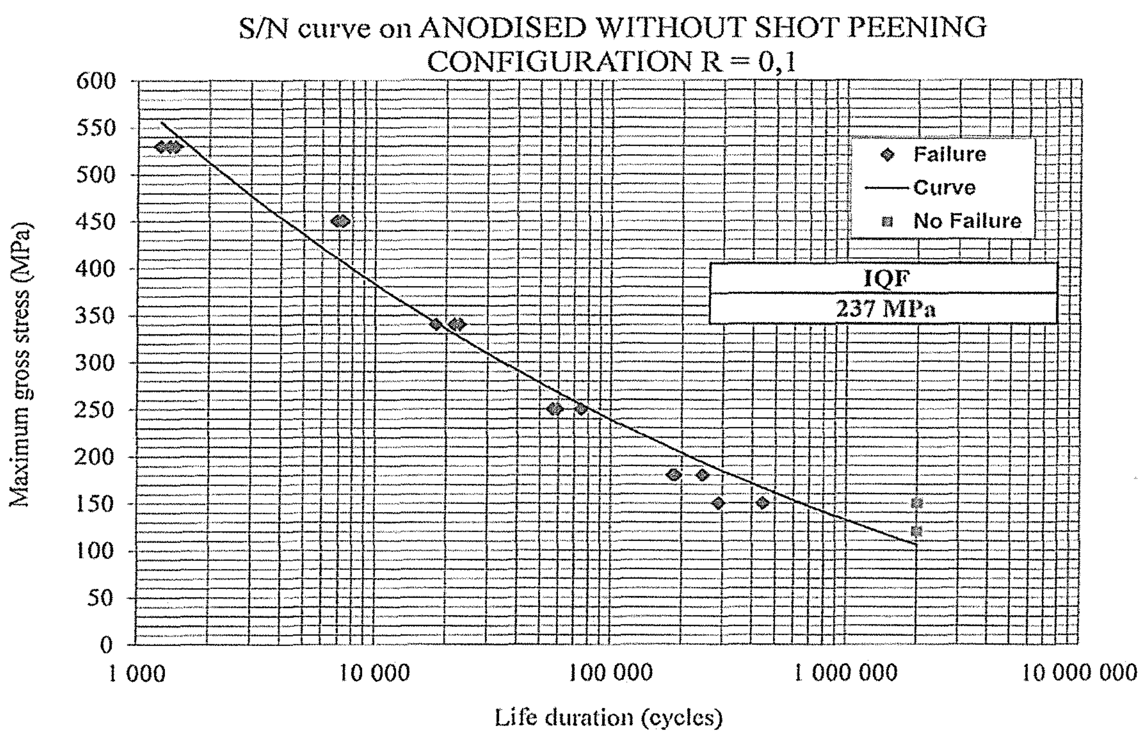

Figure 16 - S-N Curve on Unpeened and Anodised 7010 T7651 Plate

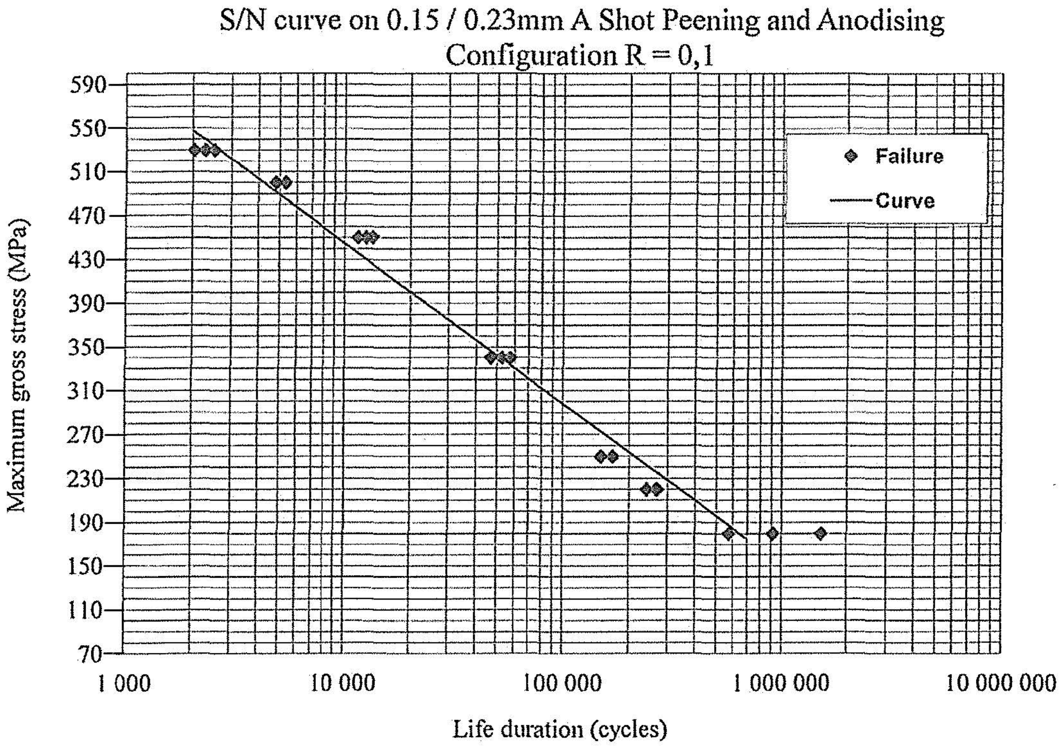

Figure 17 - S-N Curve for 7010 T7651 Plate Saturation Peened at 0,15-0,23mmA and Subsequently Anodised.

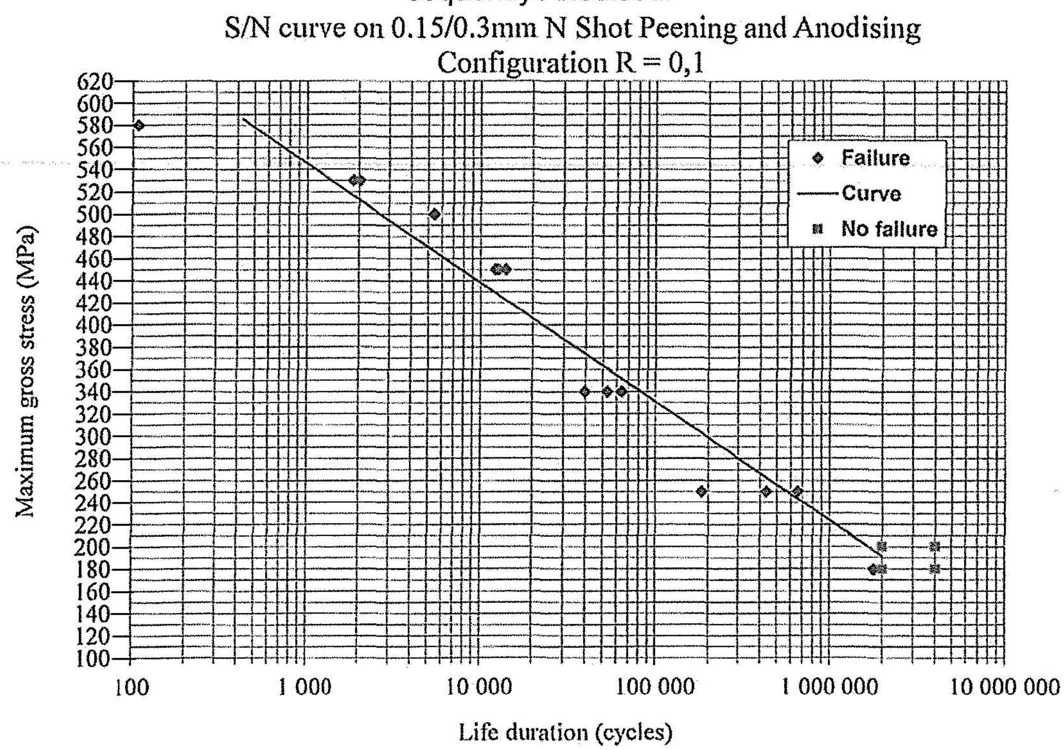

Figure 18 - The S-N Curve for Specimens Which Have Been Saturation Peened at a Lower Intensity of 0,15-0,30mmN Prior to Anodising.