

THE EFFECT OF MEAN STRESS ON THE ENDURANCE OF ALUMINIUM ALLOYS

1. NOTATION

f_t	tensile strength of material	N/m ²	lbf/in ²
f_p	0.1 per cent proof strength of material	N/m ²	lbf/in ²
K_a'	geometric stress concentration factor based on net area, appropriate to alternating loading		
K_m'	geometric stress concentration factor based on net area, appropriate to mean loading		
m	a parameter characterising the shape of the semi-range/mean stress diagram for unnotched specimens		
S_{a0}	fatigue strength of material at zero mean stress	N/m ²	lbf/in ²
S_a'	alternating stress on net cross-sectional area	N/m ²	lbf/in ²
S_m'	mean stress on net cross-sectional area	N/m ²	lbf/in ²
S_a	highest value of alternating stress on the cross section = $K_a' S_a'$	N/m ²	lbf/in ²
S_m	highest value of mean stress on the cross section = $K_m' S_m'$ when $S_a + K_m' S_m' \leq f_p = f_p - S_a$ when $S_a + K_m' S_m' \leq f_p$	N/m ²	lbf/in ²
N	endurance		

2. NOTES

This Data Sheet gives curves of S_a against N for a range of S_m/f_t for aluminium alloy materials.

The curves have been derived from the mean curve of E.07.01 which applies when $S_m = 0$, assuming that the effect of mean stress may be represented by the expression

$$\frac{S_a}{S_{a0}} = 1 - \left(\frac{S_m}{f_t} \right)^m$$

given in A.00.01. Values of $m = 1.0, 1.2$ and 1.4 have been assumed in computing the curves.

It is not possible to ascribe a unique value of m to a particular group of materials. The table gives the ranges of m values that can arise in practice.

Type of alloy	m
Naturally aged Al-Cu-Mg	1.2 – 1.8
Artificially aged A1-Cu-Mg	1.4 – 2.0
Artificially aged A1-Zn-Mg	1.0 – 1.4

The curves on this Sheet give a direct indication of the unnotched fatigue properties of aluminium alloy materials. They may also be used to estimate the strength of components or specimens containing stress concentrations. In such cases, the stresses at the root of the notch given by

$$\begin{aligned}
 S_a &= K_a' S_a' \\
 S_m &= K_m' S_m' \quad \text{when} \quad S_a + K_m' S_m' \leq f_p \\
 \text{or} \quad S_m &= f_p - K_a' S_a' \quad \text{when} \quad S_a + K_m' S_m' \leq f_p, K_m' > 1
 \end{aligned}$$

are to be used with the curves of this Sheet. The simple correction for yielding at the root of the notch is equivalent to the procedure of A.00.02. Values of K_a' and K_m' have been distinguished since the mean and alternating loadings are not necessarily of the same type.

While the above procedure may, in principle, be used to estimate the endurance of joints as well as simple notched components, the occurrence of fretting may cause a larger fatigue strength reduction than is indicated solely by the stress concentration in the joint. Reference should be made to Data Sheet A.05.02 for a method of estimating the endurance of pin joints.

3. DERIVATION

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