

FATIGUE STRENGTH OF STEEL SCREW THREADS WITH LARGE ROOT RADII UNDER AXIAL LOADING

1. NOTATION

f_t	tensile strength of material	N/m ²	lbf/in ²
N	endurance		
S_a	alternating stress (that is, half the range of stress) based on core area	N/m ²	lbf/in ²
S_m	mean stress based on core area	N/m ²	lbf/in ²

Both SI and British units are quoted but any coherent system of units may be used.

2. NOTES

The results of about 270 fatigue tests on solid steel bolts have been analysed to give curves of S_a/f_t against N .

The ranges of the experimental variables are listed in Table 2.1.

TABLE 2.1

Variable	Figure 1	Figure 2
f_t	151 000 to 161 000 lbf/in ² (1040 to 1110 MN/m ²)	150 000 to 324 000 lbf/in ² (1030 to 2250 MN/m ²)
S_m/f_t	0.1 to 0.3	0.1 to 0.5
Nominal diameter	0.25 to 0.75 in (6 to 19 mm)	
Thread form	Unified	
Thread root radius	0.147 to 0.180 of thread pitch	
Method of thread manufacture	Thread form-rolled and then heat treated (Method A)	Material fully heat treated, then surface ground before form-rolling of thread (Method B)

All tests were carried out at room temperature under a fluctuating tensile load. Care was taken to maintain axially of loading during the tests. All failures occurred in the threaded portion of the bolt just inside the nut, close to the loaded face. Steel nuts of standard thickness were used in all cases. About 75 per cent of the bolts were cadmium plated.

Figures 1 and 2 each show a mean line and a scatter band including 90 per cent of the results; these bands have been drawn so that 5 per cent of the results lie above the band and 5 per cent lie below.

Figure 3 compares the scatter bands from Figure 1 and Figure 2 with results from similarly manufactured screw threads of standard root radius.

Individual series of tests on threads form-rolled after heat treatment show a small reduction in fatigue strength with increasing mean stress but the curves in both figures may be assumed independent of mean stress, except when the maximum load in the cycle is sufficient to cause yielding over the whole core area. In practice the calculated mean stress in the bolt must include any pre-tension applied during assembly of the joint.

This Item applies only to axially loaded threads. Any bending, for example, that induced by a slightly out-of-square seating for the nut, can produce a severe reduction in the endurance of a screw thread.

Further information on the fatigue strength of standard thread forms and the effect of non-axial loading may be located by reference to the Engineering Sciences Data Index.

3. DERIVATION

1. BAUMGARTNER, T.C. Tension – tension fatigue investigation of high strength aircraft bolts –
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