

SUMMARY OF FATIGUE TESTING
RESULTS TO BS 4449 1988

UK CARES
Working with industry

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Third Edition



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Independent Fatigue Test Results

1.0 Introduction

The fatigue testing programme began in 1988 with CARES assessors monitoring the selection and sampling of material. Sampling and testing was in accordance with Appendix D of BS 4449 1988. Testing was performed at commercial testhouses, MTS Daventry (formerly Testwell) Ltd., RTD Ltd. and MET Ltd., that were NAMAS approved for the test.

Each defined bar shape and process route was to be tested with the full product range being tested on a three yearly cycle.

The test pieces were tested in the commercially straight condition.

The test pieces are required to endure 5 million cycles at a stress range dependent on the bar diameter, as shown in Table One.

Table One : Test stress ranges for nominal bar sizes

Bar Size	Stress Range N/mm ²
< = 16mm	200
20mm	185
25mm	170
32mm	160
40mm	150

The reduction in stress range with increasing bar diameter was introduced into the Standard because research had shown that larger bar sizes were weaker under fatigue loading conditions.

The stress ratio was 0.2 and the frequency was not to exceed 120 Hz. A sine wave form was used. The bars were tested under load control and the stresses were calculated using the nominal area.

2.0 Results

The results of the fatigue tests were collected and examined.

Table Two : Summary of Fatigue Testing Results

Diameter	Total Number of Tests	Total Number of Failures	% failures per size	% failures overall
8	131	9	6.9	0.8
10	160	16	10.0	1.4
12	191	32	16.8	2.8
16	198	36	18.2	3.1
20	133	14	10.5	1.2
25	127	10	7.9	0.9
32	127	7	5.5	0.6
40	65	0	0.0	0.0
50	17	2	11.8	0.2
Total	1149	126		11.0

All test results received for the period 1988 - 24th April 1996.

N.B. 75 % of the failures occurred within 2 million or fewer cycles.

Table Three : Summary of Test Statistics

Number of Producers in test programme	22
Total number of sets tested (5 per set)	267
Total number of individual tests performed	1149
Average number of cycles endured by failed samples	1.54 million
Standard deviation of failed samples	0.83 million
Minimum number of cycles to failure	0.12 million
Maximum number of cycles to failure	4.42 million
Range of cycles within failed samples	4.30 million
Number of failures below 2 million cycles	95

Statistics in terms of individual mills and analysis of failures are shown in Figures One and Two.

In order to maintain confidentiality each producer was allocated an identification number between 1 and 22.

Figure One

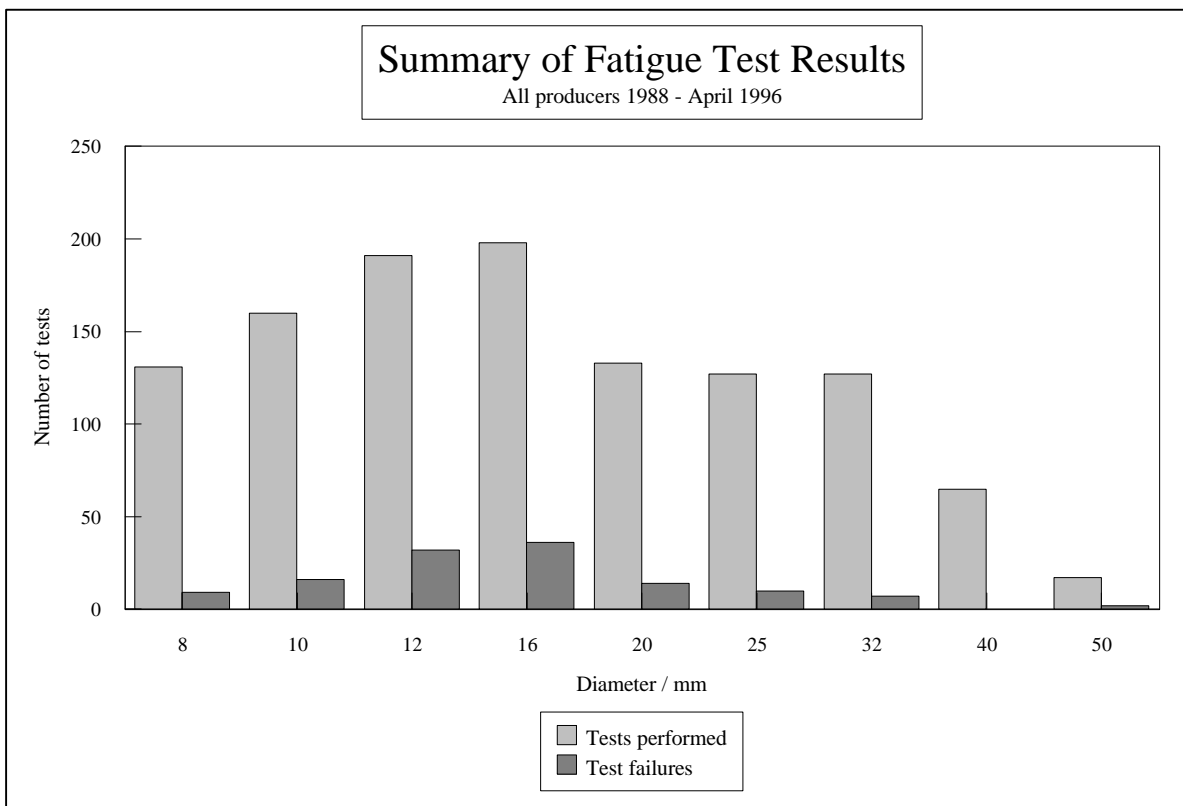
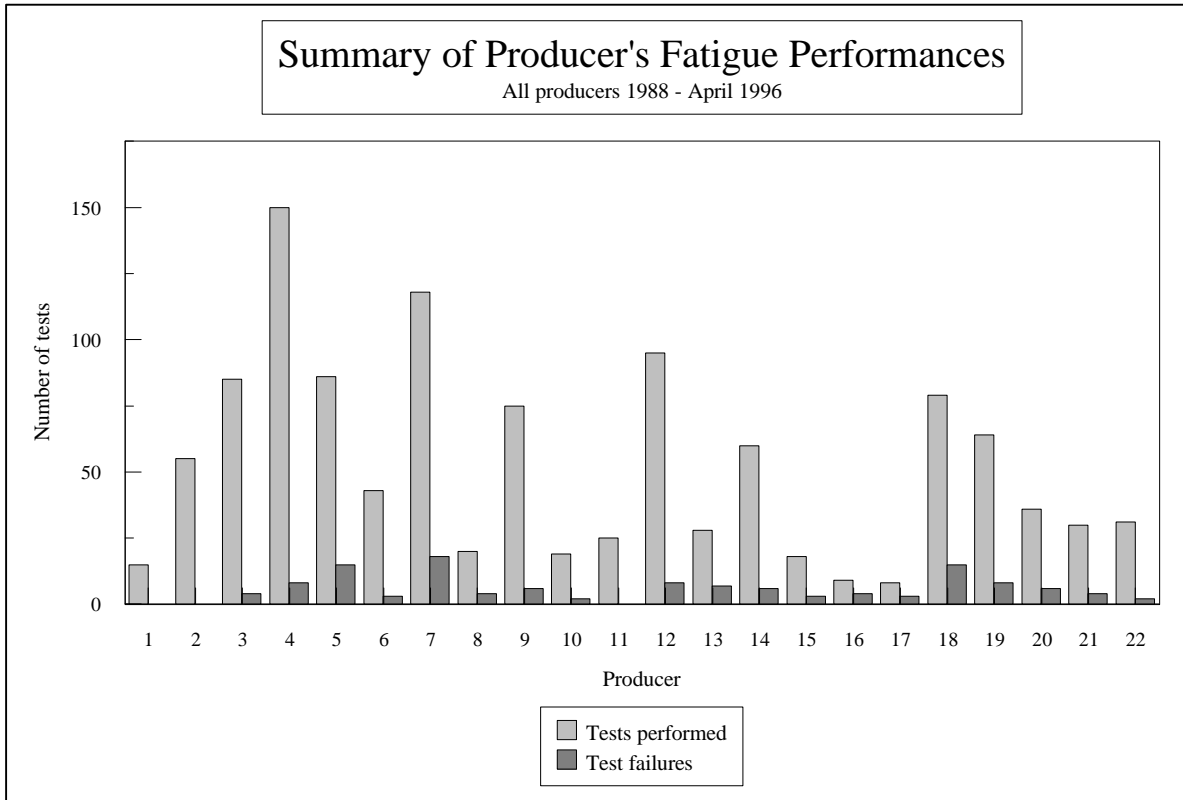


Figure Two

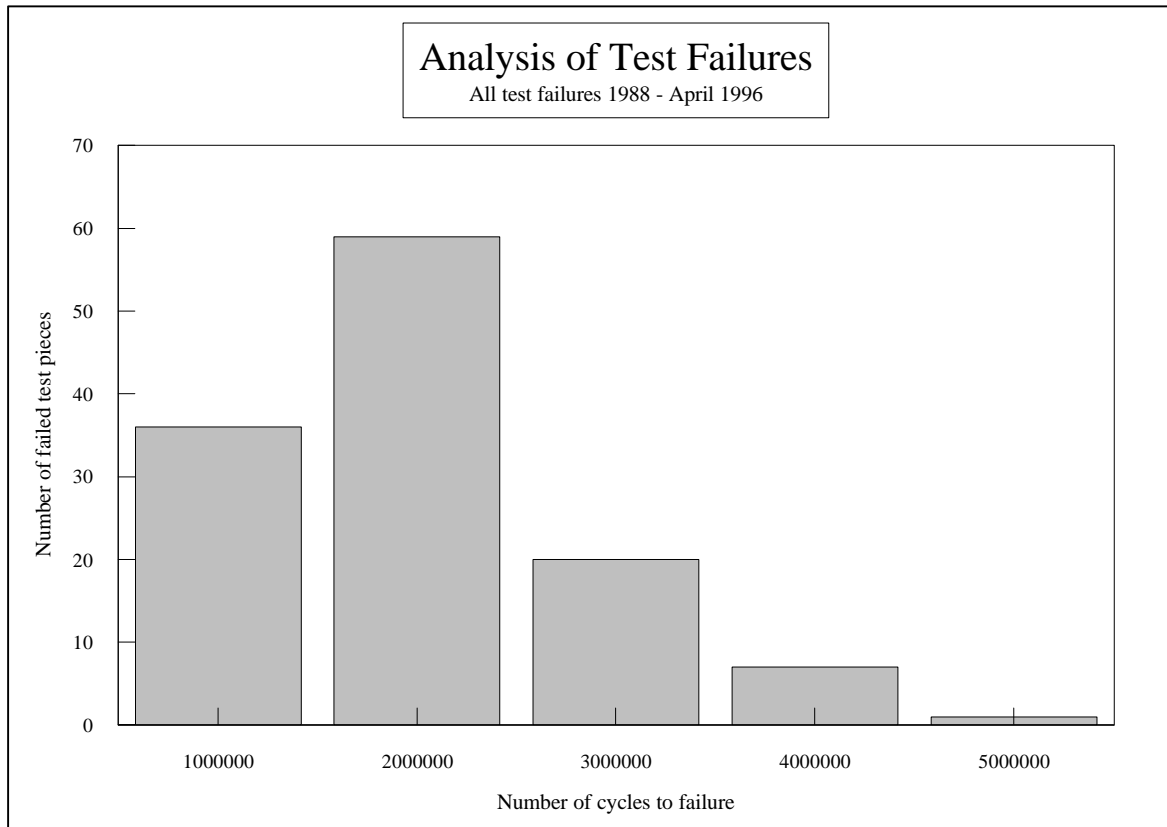


Key :

<u>Producer</u>	<u>Product(s)</u>
1	Bar
2	Bar
3	Bar
4	Bar and coil
5	Bar and coil
6	Bar
7	Bar and coil
8	Bar
9	Bar and coil
10	Bar
11	Bar
12	Bar
13	Coil
14	Bar
15	Bar
16	Coil
17	Bar and coil
18	Bar
19	Bar and coil
20	Bar
21	Bar
22	Coil

The individual producer's performances are attached in Appendix One.

Figure Three



3.0 Comparison of the fatigue test requirements of BS 4449 1988 and DD ENV 10080 1996

The differences in test conditions between BS 4449 and DD ENV 10080 are shown in Table Four, below, and presented graphically in Figure Four, overleaf.

Table Four : Summary of fatigue test conditions of BS 4449 1988 and DD ENV 10080

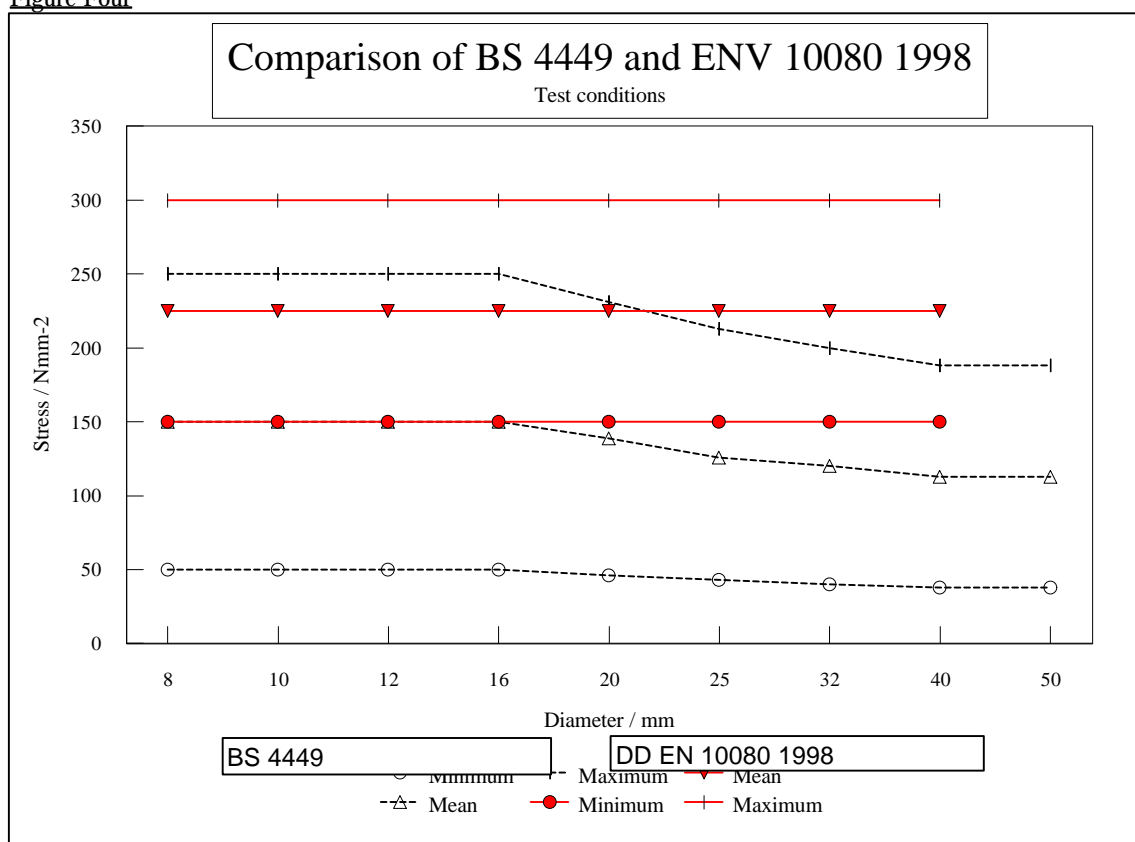
Size	<u>Stress conditions</u>			<u>Stress conditions</u>		
	<u>BS 4449 1988</u>			<u>ENV 10080 1998</u>		
/mm	Minimum /Nmm-2	Mean /Nmm-2	Maximum /Nmm-2	Minimum /Nmm-2	Mean /Nmm-2	Maximum /Nmm-2
8	50	150	250	150	225	300
10	50	150	250	150	225	300
12	50	150	250	150	225	300
16	50	150	250	150	225	300
20	46	139	231	150	225	300
25	43	126	213	150	225	300
32	40	120	200	150	225	300
40	38	113	188	150	225	300
50	38	113	188	N/A	N/A	N/A

<u>BS 4449 1988</u>	<u>ENV 10080 1998</u>
Load control.	Load control.
Frequency not to exceed 120 Hz	Frequency 1-200 Hz
5 million stress cycles	2 million stress cycles
Stress ratio = 0.2.	Stress ratio = 0.4.

Table Four : Summary of the differences in the fatigue test conditions of BS 4449 1988 and DD ENV 10080

Size /mm	BS 4449 1988 Stress Range	ENV 10080 1998 Stress Range	Difference in stress ranges relative to BS 4449	Difference in means relative to BS 4449
8	200	150	-50	+ 60
10	200	150	-50	+ 60
12	200	150	-50	+ 60
16	200	150	-50	+ 60
20	185	150	-35	+ 71
25	170	150	-20	+ 84
32	160	150	-10	+ 90
40	150	150	0	+ 97
50	150	N/A	N/A	N/A

Figure Four



4.0 Conclusions

The 12 and 16 mm bars represented 34% of the samples tested but accounted for 54% of the total failures.

It appears that the reduction in the stress range of BS 4449 material should begin below 20mm.

BS 4449 parameters appear successful in not discriminating against the larger bar sizes, which were shown by research to be weaker under fatigue conditions.

The effect of the higher mean stress level, the higher stress range of large diameter bars and the reduction in the number of stress cycles proposed in DD ENV 10080 require further experimental investigation. In addition the effect of maintaining the same mean stress for larger diameter bars should be investigated.