1996030

International Conference on Shot Peening and Blast Cleaning

DESIGN AND DEVELOPMENT OF A REVERSED BENDING FATIGUE TESTING EQUIPMENT FOR LABORATORY USE

L.N. Ojha H.B. Khurasia A.D. Telang
Maulana Azad College of Technology,
Bhopal, India

ABSTRACT

The fatigue testing of welded components is expensive, time consuming and requires larger capacity equipment. The method of loading should simulate to loading condition, that is likely to occur in service.

With this in view, a reversed bending fatigue testing machine, was designed and developed with required control circuits and test specimens.

1. INTRODUCTION

Fatigue testing machines are generally used for various research and laboratory test work each of which has its unique design features as per the size of specimen and type of loading. Reversed bending machines have been developed by several researchers all which operate mechanically or electromagnetically.

All fatigue systems, regardless of complexity, consist of the common basic elements, such as The loading train , Power supply and Controls. Different excitations considered are compared below as in table 1. The circular cam or eccentric cam was found to be most suitable for the use.

Table 1. Excitations

S.No	Criterion	Vertical crank	Horizontal crank	Circular cam or eccentric
1.	Load	Adjustable I	Adjustable I	Adjustable I
2.	Design	Complex I	Complex I	Simple II
3.	Fabrication	Not easy II	Not easy II	Complex I
4.	Flexibility	Flexible I	Flexible I	Flexible I
5.	Structure	Delicate I	Delicate I	Strong II

A specimen is representative sample of the material under investigation and *its type used depends on the objective* of the *investigations*, availability of the testing equipment and the form of material. The fatigue test specimen consists essentially of three parts. The centre or test section of which is the region where the required test conditions are simulated as closely as possible, and the two ends, which serve only to transfer the local load from the grips, into the centre section.

Two criteria for the design of specimen are that the failure should occur in the test section and the unintentional stress raisers should be avoided.

In addition, it is desirable that the dimensions of the section should be such that, the loads required are not disproportionately low with respect to the capacity of the machine, and the natural frequency of the specimen is well removed from the machine.

The obtained dimensions, their ratios, tolerances for the designed specimen are tabulated below as in table - 2.

Table 2. The obtained dimensions

Dimension (mm)	Value (mm)	Ratio	Value	limit	Portion	Accuracy (+/- %)
Overall length(L)	120	R/b	3.4	8	General	0.100
Transition length(L)	20	L/b	3.4	3	Test section	0.025
Transition radius (R)	20	BGL/bt	3.0	2	Concentricity	0.025
Overall width (B)	12	b/t	1.0	2-6	Total Ind.Read.	0.012
Test section width(b)	6	e/D	0.5	1.5-2	Rootradius	0.012-0.005
Sample thickness(t)	6	GL/D	1.5	3	Measurements	1.0
Gripping length(GL)	9	btsq.mm	28	13-325		
Pin hole diameter (D)	6	-	-	-		
Hole distance (e)	3	-	-	-		

The standard force-deflection (F-D) *relations* for the cantilever beam specimen are tabulated below as in table 3.

Table 3. The F-D relations

S.No.	Fixed	Middle	Free end	Quantities
1.	d/I.I.I	5F/48EI	F/3EI	Deflection
2.	F.I	FI/2	0	BM
3.	F	F	F	SF
4.	720 cu mm	240 cu mm	720 cu mm	Z

The force F at middle of the specimen will be given as 158 = (F x 150/2) / 240 or F = 505 N

The corresponding fixed end stress and the deflections at middle and free end will be (505 x 150) / 720 = 105 MPa, and [5 x 505 x 150 x 150 x 150] / [48 x 2.I x 100000 x (10 x 12 x 12 x 12) / 12] = 0.60 mm and [505 x 150 x 150 x 150] / [3 x 2.1 x 100000 x (30 x 12 x 12 x 12) / 12] = 0.63 mm respectively.

The maximum eccentricity = 25 mm, and the force at free end corresponding this will be given by 25 = [F x 150 x 150 x 150] / [3 x 2.I x 100000 x (30 x 1212 x 12 x 12 / 12] = 20.16kN.

This will be devolved by the eccentric and will be transmitted to the free end of the specimen through the connecting rod.

Effective length I = 210 mm and the mean radius r = 10 mm, for I/r = 21, fc = 136.7MPa hence the load carrying capacity of the collecting rod = [3.14 7 x (20x 20) x 136. 7] / 4 = 42.95 kN.

The maximum tensile and share stresses in eccentric will be = [2 x 20.16 x 10 x 10 x 10] / [3.14 x 80 x 20] = 8 MPa. and = [2 x 20.16 x 1010 x 10] / [80 x 20] = 12.6 MPa, while the bending stress = [20.16 x 10 x 10 x 10 / 2] / [20 x 30 x 30 / 6] = 131 MPa.

The maximum SF at the left and right the shaft will be [20.16 x 10 x 10 x 10 x 10 x 6] / 16 = 7.56 kN, & [20.16 x 10 x 10 x 10 x 10] / 16 = 12.60 kN.

Therefore, the max. bending moment BM = 7.56 x 0.10 = 0.756 kNm.

Hence the bending and share stresses in the shaft will be [0./56 x 1000000] / [30 x 30 x 30 / 6] = 168 and [20.16 x 10 x 10 x 10] / [30 x 30 x 30] = 22.4 MPa respectively.

The elapsed time in two million cycles @1400rpm will be [2 x 1000000] / [1400 x 60] = 24 hours.

2. DISCUSSION

The design was revised secondly due to the frictional heat generation between cam and supporting sliding.

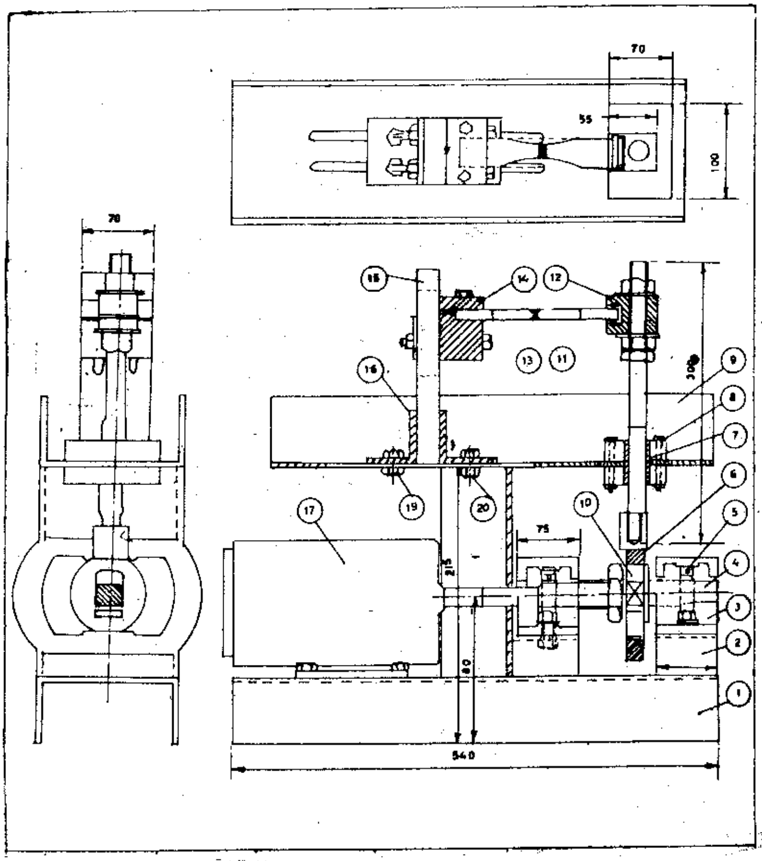

Fig. 1. Flexurel fatigue testing machine

The oil cooling was not found to be satisfactory, hence the sliding was replaced through a roller bearing between the eccentric and eccentric sieve.

This was also not found to be satisfactory then these were replaced with a eccentric flange and the connecting rod through the vertical sliding.

The preliminary performance of this design was found to be satisfactory. The designed data are tabulated below as in table 4.

Table 4. Designed data

1.	Exciter	Eccentric
2.	Excitation frequency	1400 rpm
3.	Average specimen length	180 mm, adjustable
4.	Maximum static force	20 kN, adjustable
5.	Maximum displacement	25 mm, adjustable
6.	Power supply	0.75 kw, 3ph, 440V, 50 Hz
7.	Weight approximately	50 kg
8.	Overall size	750 x 200 sq mm & 500 mm high

ACKNOWLEDGEMENT

CSIR-India and MACT Bhopal, are gratefully acknowledgement for granting the fellowship and providing research facilities respectively.

3. REFERENCES

Anon 1949. Manual on Fatigue testing ASTM STP : 51.

Welch W.A. and Wilson W.A. 1941. A New high temperature fatigue machine Proc. ASTM-41 : 33.

Dolan T.J. Electrically excited resonant type fatigue testing equipment ASTM Bull No. 1/5, 195.

Handbook of fatigue testing ASTM-STP-566.

Gurney T.R. 1968. Fatigue of welded structures. Cambridge at the University Press.