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OTTAWA January 21, 1946.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1991.

Research on Optimum Thread Form for Proposed Anglo-American-Canadian Screw Thread.

PART I. - Comparison of N.P.L. and P.M.R.L. Endurance Limit Determinations on Studs.

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(This research is performed in collaboration with the National Bureau of Standards, Washington, U. S. A., the National Physical Laboratory, Teddington, England, and the National Research Council, Ottawa, Canada.)

(Copy No. 18.)

Bureau of Mines
Division of Metallic
Minerals

Physical Metallurgy
Research Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

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Origin of Purpose of the Investigation:

During discussions held in London late in 1943 by individuals representing numerous interested manufacturers of the English-speaking countries of the world, the armed services of these countries, and various standards organizations, consideration was given to the possibility of adopting a common Anglo-American screw thread standard. The intention was to perform a research to determine the screw thread form that would give maximum fatigue strength, and to base further discussions on the results of such a research. Experimental work was to be done by the National Physical Laboratory, Teddington, England; the National Bureau of Standards, Washington, U.S.A.; and, in Ottawa, Canada, the Physical Metallurgy Research Laboratories of the Bureau of Mines, in collaboration with the National Research Council.

The subject of this report is a determination made

(Origin and Purpose of Investigation, cont'd) -

by the P.M.R.L., of the endurance limit of fatigue specimens supplied by the National Physical Laboratory, in order to compare the results of the two laboratories.

Description of Sample and Information Received:

The sample used is illustrated in Figure 1 (NPL Dwg. 552/163) and its thread form was No. 3, ground. The material was British-made high tensile steel. Specifications and the test results obtained from the N. P. L. for high tensile strength steel are given in Table I below:

TABLE I. - Summary of Results of N.P.L. Static Tests on Stud Material.

High Tensile Steel (D) -

Steel to Specification E_n 16T.

Chemical Composition: (In per cent)

Carbon	- 0.25-0.40	Phosphorus	- 0.05 max.
Silicon	- 0.10-0.35	Nickel	- 0.25 max.
Manganese	- 1.4-1.7	Chromium	- -
Sulphur	- 0.05 max.	Molybdenum	- 0.20-0.35

½-in. Bars -

Ultimate tensile strength, tons/in.^{2}	56.3-60.4	59.1	55-65
Elongation on 4$\sqrt{\text{area}}$, per cent	23-27	24.4	18 min.
Reduction of area, per cent -	60-66	62.9	

7/8-in. Bars -

Ultimate tensile strength, tons-in.^{2}	59.9-64.3	62.0	55-65
Elongation on 4$\sqrt{\text{area}}$, per cent	20-22.5	21.5	18 min.
Reduction of area, per cent	57-62	59.2	

N.B.: The above figures were obtained from 34 tests on each of two sizes of bar. The test diameter for the ½-in. bars was 0.358 in., and for the 7/8-in. bars, 0.564 in.

The Brinell hardness number (H_2/120) for the ½-in. bars ranged from 288 to 307, mean 297. The specified range is 241 to 311.

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Machine Used:

Tests were done on the 20-ton Avery-Schenck fatigue testing machine, using grips illustrated in Figure 3 (see Page 7).

Results:

The results obtained are given below in Table II. It should be noted that the maximum unit load during the stress-cycle is given. For simplicity in design of specimens and grips, the minimum load during the cycle has been fixed at 10,000 pounds per square inch. Tests were run on the samples till either the sample broke or ten megacycles had been completed.

TABLE II. - Summary of Results, Fatigue Tests on Studs G3D.

Stud No.	5	10	2	7	12	6	4	5	1
Kilo lb. min. load	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Kilo lb. max. load	40.0	40.0	37.5	42.0	40.0	40.0	38.0	39.0	38.5
N. megacycles	0.1954	0.7190	8.653	0.7594	-	0.4118	-	0.9837	4.507
End broken*	A	A		B		A		A	A
Remarks	(1)	(2)	(3)		(4)		(5)		

* A = end broken on vibrating beam side.
B = end broken on microscope side.

Remarks:

(1) Machine found to be badly misaligned.
(2) " " " " slightly misaligned at end of test.
(3) Cracked in parallel portion due to fretting.
(4) Test useless due to improper procedure.
(5) Not broken.

One sample, No. 2 in Table II, broke at 8,653,000 cycles, at a crack initiated by frettage corrosion. This frettage was caused by misalignment of the machine. As frettage has caused a fracture at a number of cycles less than ten million, its results are disregarded for these specimens. The

(Results, cont'd) -

S-N diagram tested is given in Figure 3. Specimen No. 5 broke at a small number of cycles because the machine was very badly misaligned. A normal fracture is shown in Figure 4(a), on Page 8.

Conclusion:

The results indicate that the endurance limit of these studs, when subjected to a pulsating stress whose minimum value during a cycle is 10,000 p.s.i., is between 38,000 and 38,500 p.s.i., calculated as the stress on a cylinder of diameter equal to the minimum diameter of the threaded sample and bearing the same absolute load. This gives a range of stress of 28,000-28,500 p.s.i. This is substantially in agreement with the value of 29,000 p.s.i., for the same type of sample, that was obtained at the National Physical Laboratory. Further tests will be performed when samples become available.

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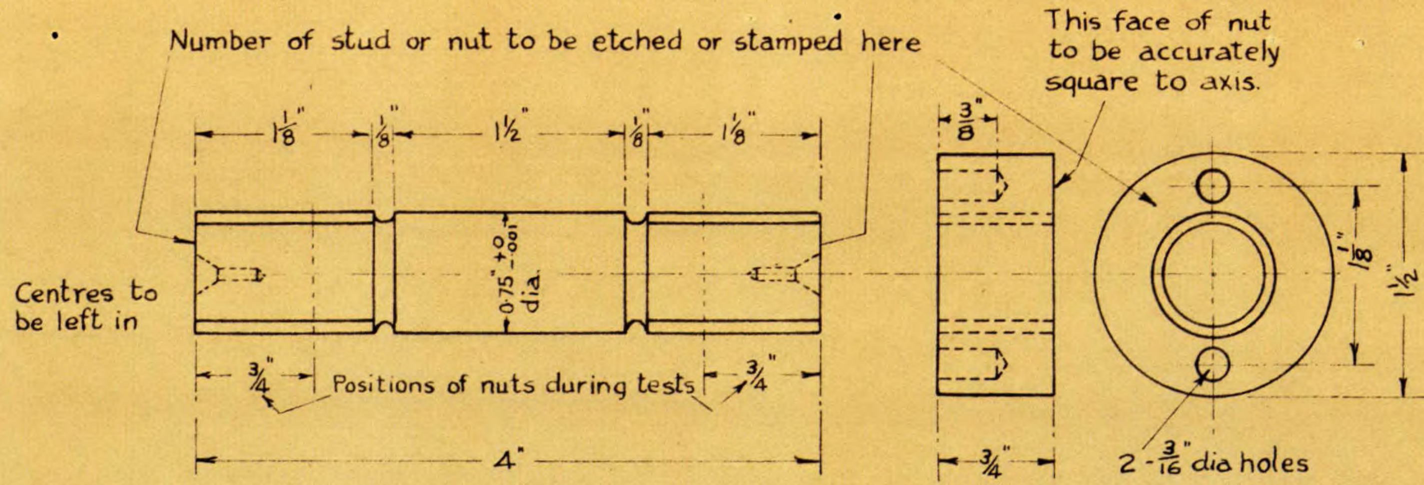
(Figures 1 to 4 follow,)
(on Pages 5 to 8.)



NUMBER OF THREAD FORM		1	2	3	4	5
INCLUDED ANGLE	DEG.	45	50	55	60	65
PITCH	IN.	0.1000	0.1000	0.1000	0.1000	0.1000
ROOT RADIUS	IN.	0.0163	0.0152	0.0141	0.0129	0.0115
STUD MAJOR DIAMETER	IN	0.7411	0.7386	0.7362	0.7339	0.7317
STUD EFFECTIVE DIAMETER	IN	0.6931	0.6906	0.6882	0.6859	0.6837
STUD MINOR DIAMETER	IN	0.6250	0.6250	0.6250	0.6250	0.6250
NUT MAJOR DIAMETER	IN	0.7612	0.7562	0.7514	0.7468	0.7424
NUT EFFECTIVE DIAMETER	IN	0.6931	0.6906	0.6882	0.6859	0.6837
NUT MINOR DIAMETER	IN	0.6451	0.6426	0.6402	0.6379	0.6357

THESE PARTICULARS ARE IN ACCORDANCE WITH DWG. # C103/202. NATIONAL PHYSICAL LABORATORIES ENG. DIVISION. (GREAT BRITAIN).

FIG. 1.

PHYSICAL METALLURGY RESEARCH LABORATORIES BOOTH ST. OTTAWA

DEPARTMENT OF MINES & RESOURCES

STUD & NUT FOR FATIGUE TEST

DESIGNED N.P.L.	DRAWN W.A.E.	TRACED W.A.E.
SCALE: NONE DATE: 3.11.45	APPROVED	CHECKED

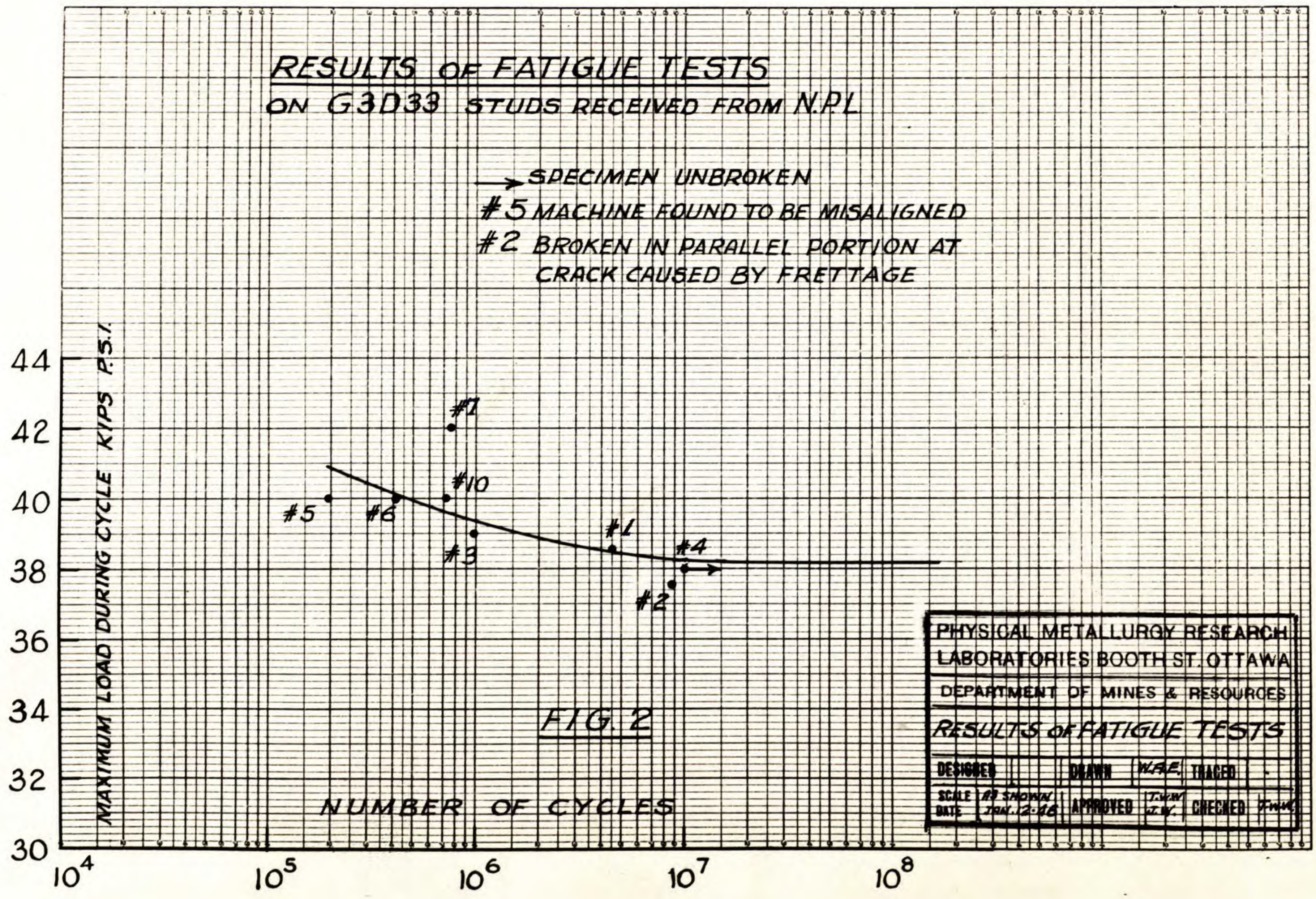
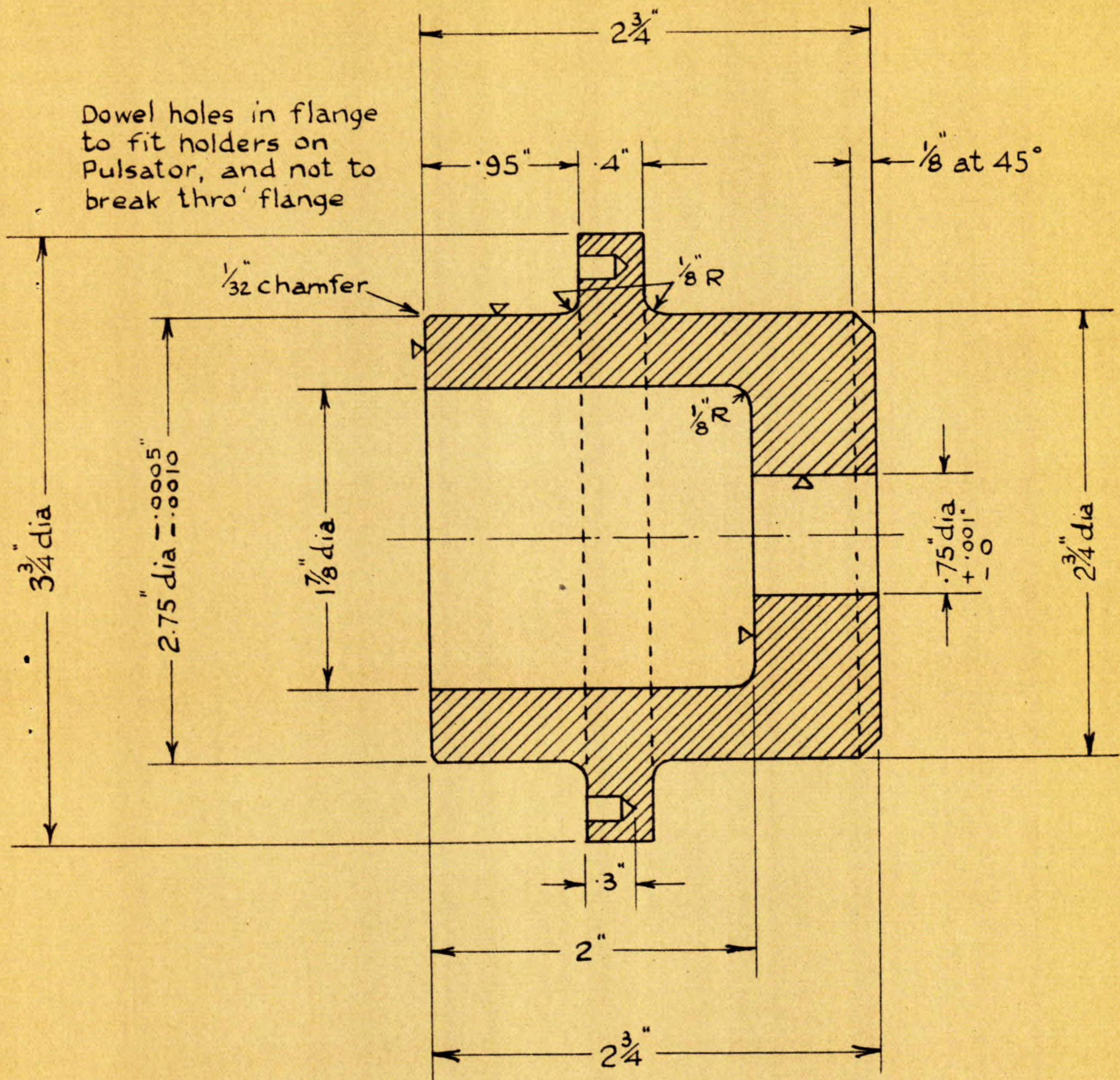

RESULTS OF FATIGUE TESTS
ON G3D33 STUDS RECEIVED FROM N.P.L
→ SPECIMEN UNBROKEN
#5 MACHINE FOUND TO BE MISALIGNED
#2 BROKEN IN PARALLEL PORTION AT CRACK CAUSED BY FRETTAGE
MAXIMUM LOAD DURING CYCLE KIPS P.S.I.
44
42
40
38
36
34
32
30
#7
#10
#5
#6
#3
#1
#4
#2
NUMBER OF CYCLES
10^4
10^5
10^6
10^7
10^8
PHYSICAL METALLURGY RESEARCH LABORATORIES BOOTH ST. OTTAWA
DEPARTMENT OF MINES & RESOURCES
RESULTS OF FATIGUE TESTS
DESIGNED
DRAWN W.A.E.
TRACED
SCALE AS SHOWN
DATE JAN. 12-46
APPROVED
CHECKED

FIG. 2



Faces marked △ must be square and concentric

Two Off – Ni. Cr Steel

FIG. 3.

Dimensions are in accordance with Dwg. No B 103/1, National Physical Laboratories, Eng. Div^n

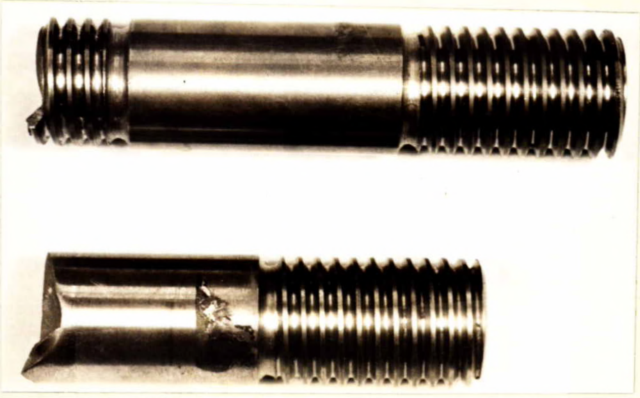
PHYSICAL METALLURGY RESEARCH LABORATORIES BOOTH ST. OTTAWA

DEPARTMENT OF MINES & RESOURCES

ADAPTOR FOR STUDS
AVERY PULSATOR FATIGUE M/C

DESIGNED M.J.C DRAWN M.J.C TRACED W.A.E.
SCALE FULL SIZE
DATE 18·12·45 APPROVED CHECKED

Figure 4.



(a) Normal fracture of threaded sample.

(b) Sample broken in cylindrical point due to frettage corrosion.

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