COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS

1959   NO. 65

VIBRATION TESTS AT

KIRKSTALL-REPCO PTY LTD.

BY

E.J.POLAK.

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AT KIRKSTALL - REPCO PTY. LTD.

CLAYTON, VICTORIA

by

E.J. POLAK

CONTENTS

ABSTRACT

This report shows the results of vibration tests carried out near a heavy forging plant at Clayton, Victoria.

The predominant ground vibration frequencies caused by the impact of hammers, ranging in weight from 1.5 to 4 tons, are shown to be from 12 to 17 c.p.s.

The results indicate that no vibrations caused by the impact of the above-mentioned hammers could be recorded beyond a distance of 340 feet.

1. INTRODUCTION

In response to a request to the Bureau of Mineral Resources, Geology & Geophysics from the architectural firm of Hassell and McConnell of South Yarra, Victoria, ground movements were measured at and near the heavy press forging plant of Kirkstall-Repco Pty.Ltd. at Clayton, Victoria, during forging operations. The Cyclone Co. of Australia Ltd. is constructing a forge near the sites of the new Monash University and the new C.S.I.R.O. Laboratories. The foundation rock at the Kirkstall-Repco plant is similar to that at the Cyclone Co's site. Messrs.Hassell and McConnell, who are architects to the Cyclone Co., wished to know in advance whether the normal operation of the company's forging plant was likely to affect the working of scientific equipment in the neighbourhood.

"Normal operation" is a vague expression and it is outside the scope of this report to attempt to give it any clear definition. No figures were obtained of the height of fall of the hammers at Kirkstall-Repco or of the velocity of the hammer at the instant of impact. This last factor, velocity, is a most critical factor, since the velocity and mass together define the energy of the impact and the magnitude of any resultant vibration will have a direct relation to the energy. Furthermore, the type of foundation and the article being deformed must affect the percentage of the kinetic energy which is available for the generation of ground vibrations. It is possible that as much energy can be transferred to the ground in the impact of a 1.5 ton hammer as in the impact of a 4 ton hammer. The remainder of the report must be read with this in mind.

2. INSTRUMENT AND METHODS

The investigation described in this report was made on 12th May, 1959. A Leet 3-component vibrograph was used, which gave a photographic record of three mutually perpendicular components of the ground movement with an optical magnification of 50. The scale of the record is such that 0.02 inch of ground movement is represented by a movement of one inch on the record. The timing lines are at 10 millisecond intervals.

The amplitudes and frequencies of the three components of the vibration are measured on the record. The component amplitudes are measured as the maximum peak to trough amplitudes of the ground displacements in inches. The total resultant amplitude equals the square root of the sum of the squares of the component amplitudes. The frequency is defined as the predominant frequency in cycles per second at the maximum amplitude of the ground vibration. It is obtained by dividing 1000 by "t", where "t" is the time in milliseconds from one peak to the next one.

The United States Bureau of Mines has carried out experiments on damage to buildings resulting from ground vibration. They indicate that acceleration is the most important index for indication of possible damage.

From the values, the acceleration is calculated from the formula:-

$$a = \frac{4 \pi^2 f^2 A}{12g}$$

where a = acceleration in units of gravity

f = frequency in cycles per second

A = amplitude in inches

g = acceleration of gravity in feet per second^2

$$(32.2 \text{ ft/sec}^2)$$

that is, $a = \dfrac{4 \pi^2 f^2 A}{12 \times 32.2} \approx 0.1 f^2 A$

The instrument was placed in three positions (Plate 1),-

1st position: on a concrete roadway next to the entrance to the forging shop.

2nd position: on the other side of the roadway.

3rd position: on the concrete floor of the gate-house to the premises of B.A.L.M. Paints Pty.Ltd.

3. RESULTS

Samples of records obtained are shown on Plates 2 to 5. The values of the amplitudes (in 10^{-4} inches) and frequency measured from the records and accelerations computed are shown on Table 1.

On Plate 6 the logarithm of acceleration is plotted against the logarithm of distance using the data from Table 1.

4. CONCLUSIONS

The following conclusions are derived from this investigation:-

1. All the points, except one relating to the smallest (0.75 ton) hammer, on the graph (Plate 6) lie approximately on a straight line irrespective of the size of the hammer. From this it is concluded that the kinetic energy of the 1.5, 2.5 and 4.0 ton hammers at the instant of impact was controlled so that practically the same energy was transferred to the ground for all hammers.

2. The graph indicates that no vibration should be recorded by the Leet Vibrograph beyond 340 ft. under these conditions. The record taken at the B.A.L.M. Paints Pty.Ltd., 310 ft. from the 4 ton hammer shows a very small amplitude of ground movement (Plate 5). For comparison a record of vibrations resulting from an 8 ton tanker driven slowly on a concrete road approximately 100 ft. from the recording instrument

is shown on Plate 5.

3. The predominant frequency of ground vibration is indicated as from 12 to 17 cycles per second.

4. In all discussions the case of a single vibration has been considered. If by chance two hammers should strike within three milliseconds of each other the value of the resultant acceleration will be equal to the square root of the sum of the squares of the component amplitudes. Plate 2 shows that the blows of the 4 ton hammer are repeated at intervals of 1.65 seconds and that the vibrations are practically completely attenuated between blows.

5. REFERENCES

KLEIN, A.M., and   1953   - Design and construction of a fully
CROCKETT, J.H.A.   vibration controlled forging hammer
                                   foundation. J. Amer. Concrete Inst.
                                   24, 421-444, Jan. 1953.

U.S. DEPT. OF INTERIOR   - Seismic effect of quarry blasting.
BUREAU OF MINES   Bulletin 442.

TABLE 1

Recording position	Weight of Hammer	Distance in ft. Hammer to Recorder	Recorded amplitude in 10^{-4} inch				Recorded frequency c.p.s.	Acceleration in units of g	Remarks
			Long.	Vertical	Transverse	Total			
1	4	45	17	32	22	42.5	17	0.123	
1	2.5	80	12	10	10	18.6	14	0.0365	
1	1.5	120	5	5	2	7.8	13	0.0132	
1	0.75	116	4	4	1	5.7	12	0.0084	
2	4.0	62	12	17	8	22.1	16	0.057	
2	2.5	110	8	5	4	10.1	14	0.0198	
2	1.5	142	3	1	1	3.3	14	0.0065	
2	0.75	138			1				Too small to read accurately.
3	4.0	310							Too small to read accurately.

PLATE I

Oakleigh — PRINCES Hwy. — Dandenong

1st POSITION		2nd POSITION		3rd POSITION	
4 ton stamp	45'	4 ton stamp	62'	4 ton stamp	310'
50 cwt stamp	80'	50 cwt stamp	110'	50 cwt stamp	352'
30 cwt stamp	120'	30 cwt stamp	142'	30 cwt stamp	392'
15 cwt stamp	116'	15 cwt stamp	138'	15 cwt stamp	390'

MACHINE SHOP

ADMINISTRATION

KIRKSTALL-
REPCO LTD.

BOILER
HOUSE

AMENITIES

HEAT TREATMENT

15 cwt. stamp

30 cwt. stamp

50 cwt stamp

4 ton. stamp

STAMP SHOP

1st position
2nd position
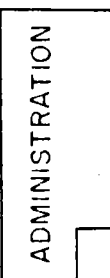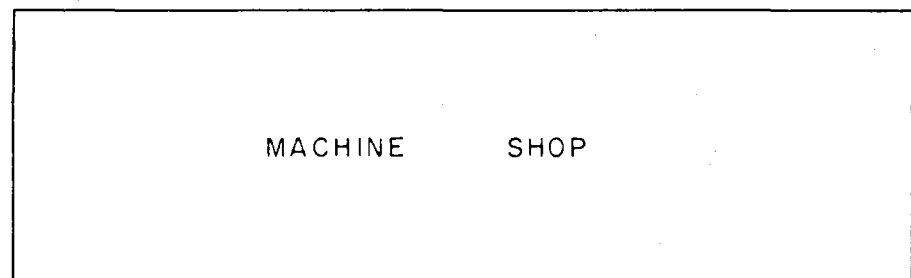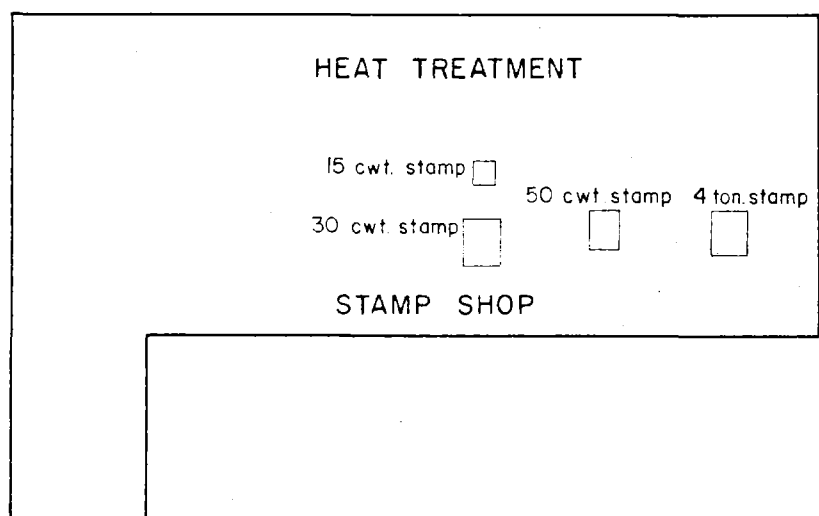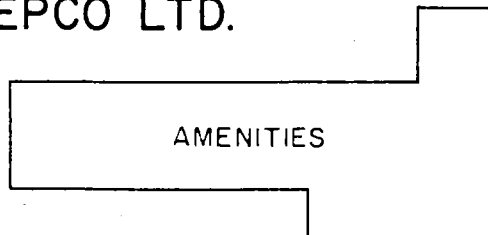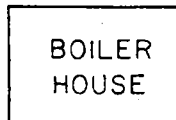
McNAUGHTON Rd.

GATEHOUSE

3rd. position

BALM PAINTS
PTY. LTD.

ADMINISTRATION

AMENITIES

LABORATORY
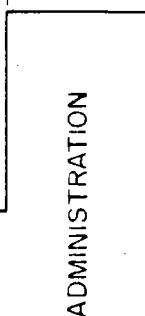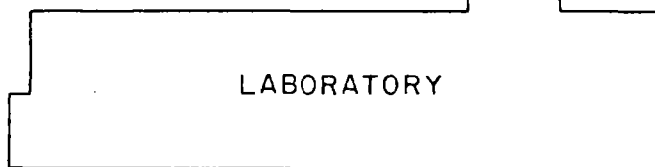
VIBRATION TESTS AT KIRKSTALL-REPCO PTY. LTD.

CLAYTON, VICTORIA.

TEST LAYOUT

SCALE IN FEET

64   0   64   128
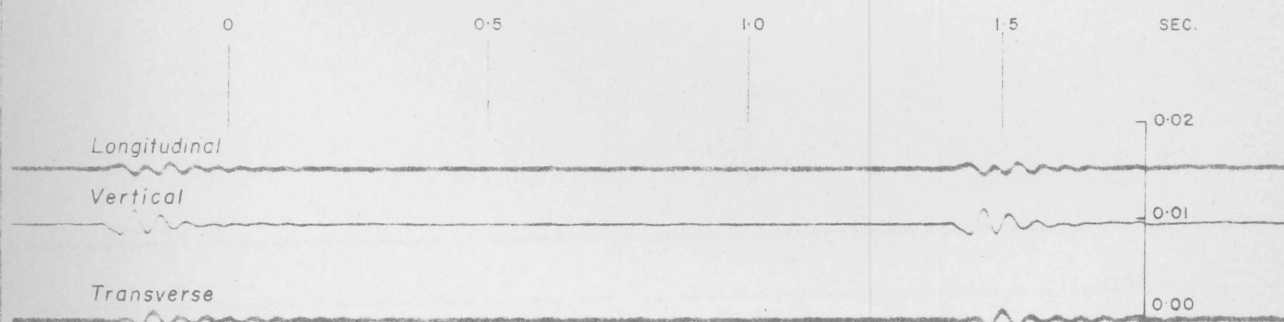
PLATE 2
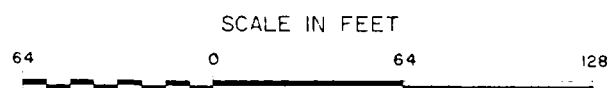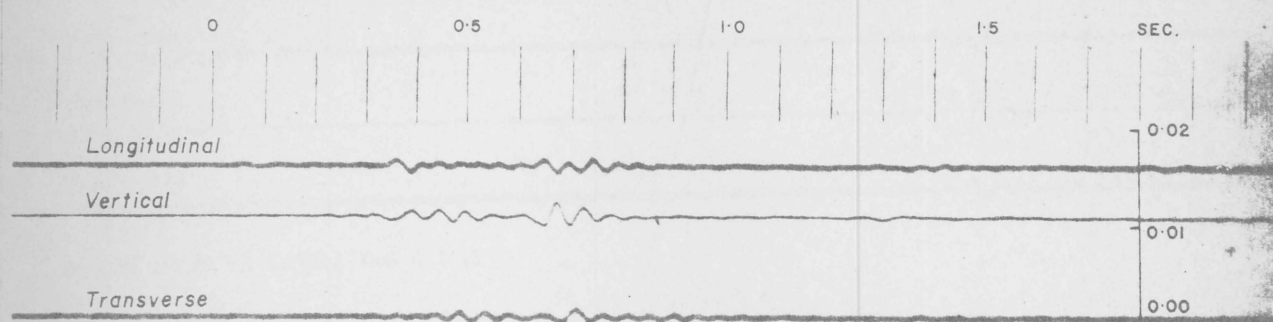
RECORD TAKEN WHEN FACTORY IN NORMAL OPERATION

VIBRATION FROM   A - 2 5 TON HAMMER

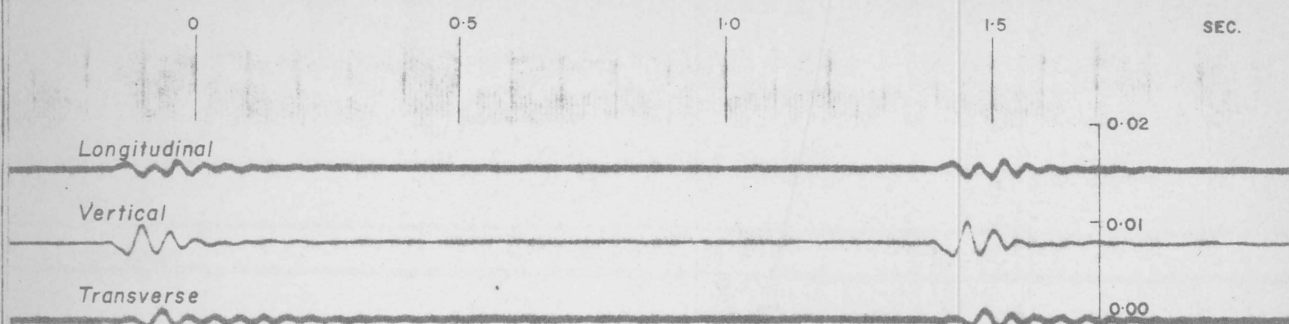   B - 4 TON HAMMER

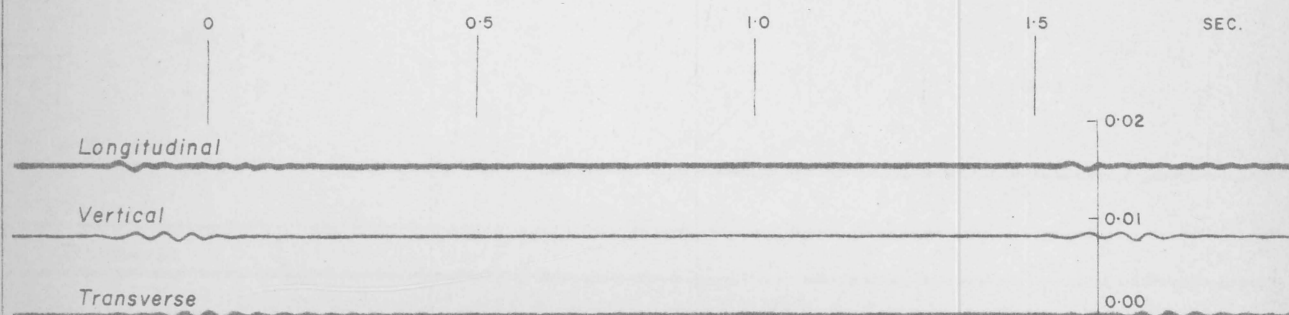   C - 1 5 TON HAMMER

4 TON HAMMER OPERATING ALONE (BLOWS 1·65 SECONDS APART)

VIBRATION TESTS AT KIRKSTALL-REPCO PTY. LTD.
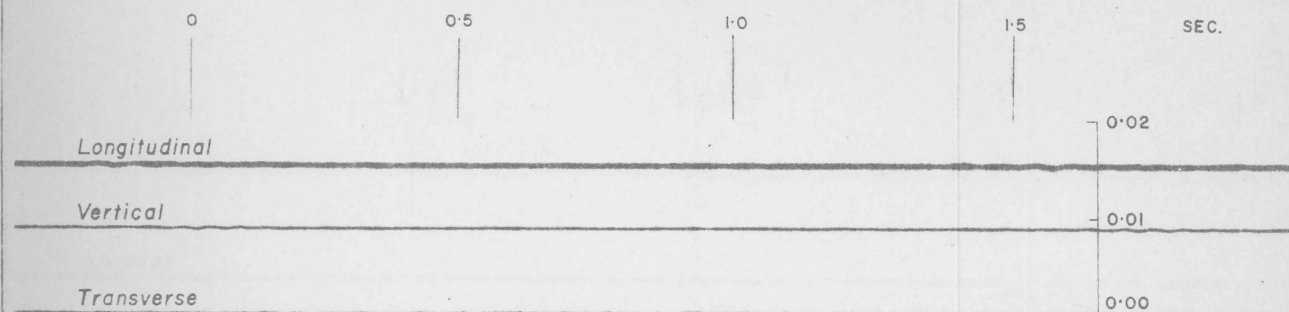
CLAYTON, VICTORIA

RECORDS TAKEN WITH LEET 3-VIBROGRAPH
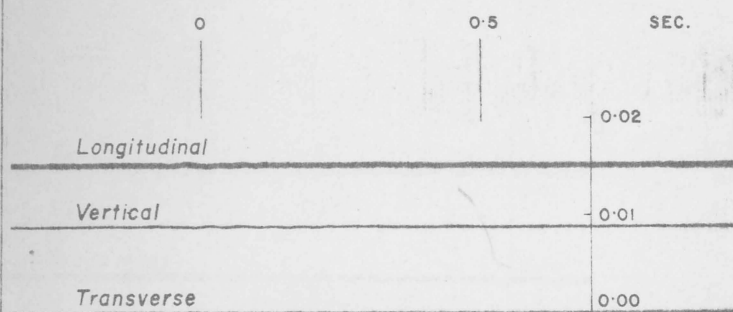
ON 1st. POSITION

PLATE 3

SEC.

Longitudinal
Vertical
Transverse

4 TON HAMMER OPERATING ALONE

SEC.

Longitudinal
Vertical
Transverse

2·5 TON HAMMER OPERATING ALONE

SEC.

Longitudinal
Vertical
Transverse

1·5 TON HAMMER OPERATING ALONE

SEC.

Longitudinal
Vertical
Transverse
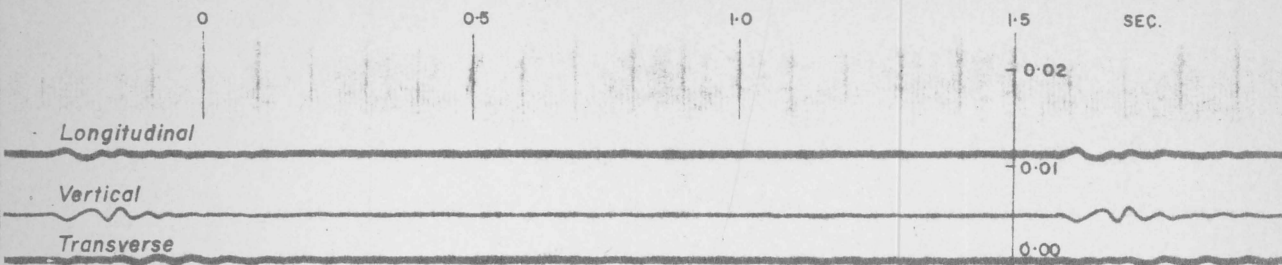
0·75 TON HAMMER OPERATING ALONE

Vibration Tests At
Kirstall-Repco Pty. Ltd.
Clayton, Victoria

RECORDS TAKEN WITH
LEET 3 - VIBROGRAPH
ON 1st. POSITION

PLATE 4

0   0·5   1·0   1·5   SEC.

0·02

Longitudinal

0·01

Vertical

Transverse   0·00

4 TON HAMMER OPERATING ALONE

0   0·5   1·0   1·5   SEC.

0·02

Longitudinal

0·01

Vertical

Transverse   0·00

2·5 TON HAMMER OPERATING ALONE

0   0·5   1·0   1·5   SEC.

0·02

Longitudinal

0·01

Vertical

Transverse   0·00

1·5 TON HAMMER OPERATING ALONE

0   0·5   SEC

0·02

Longitudinal
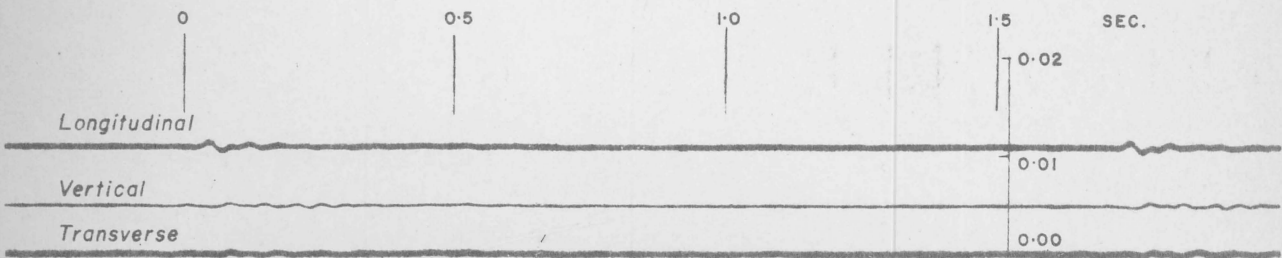
0·01

Vertical

Transverse   0·00

0·75 TON HAMMER OPERATING ALONE

Vibration Tests At
Kirstall-Repco Pty. Ltd.
Clayton, Victoria

RECORDS TAKEN WITH
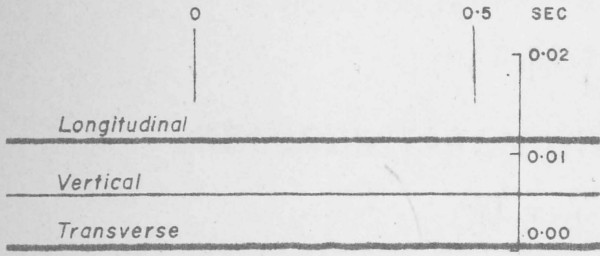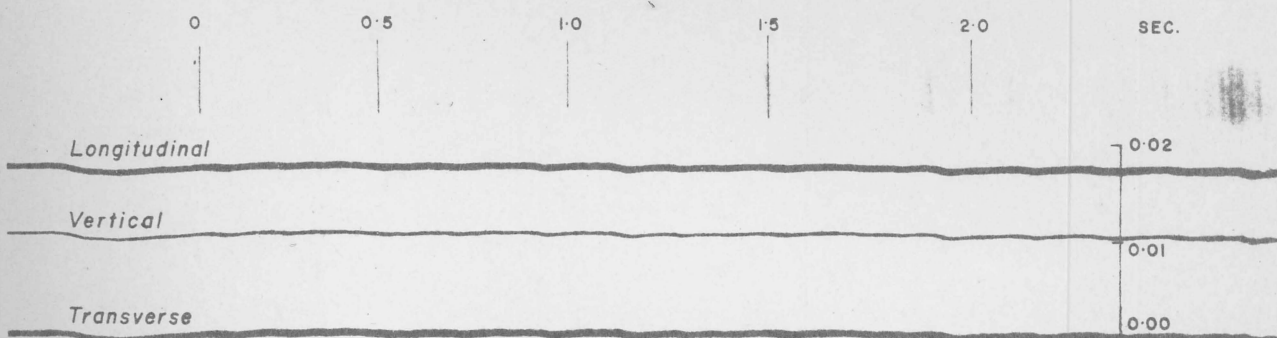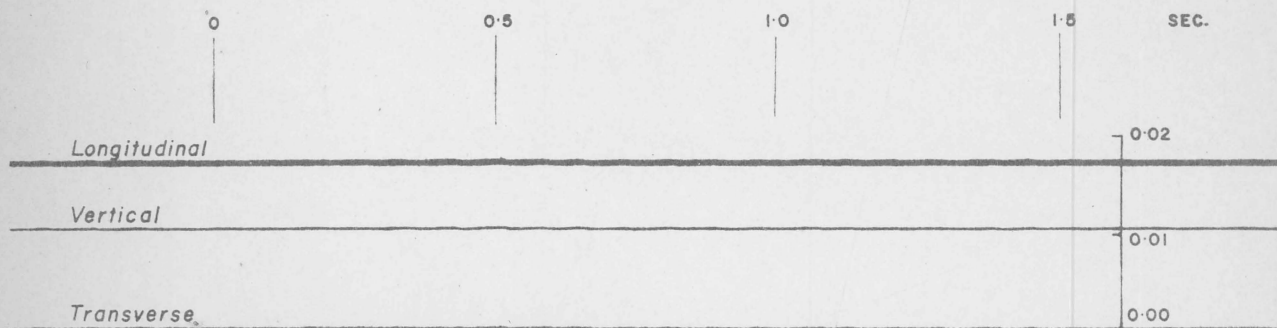LEET 3 – VIBROGRAPH
ON 2nd. POSITION

PLATE 5

0   0·5   1·0   1·5   SEC.

Longitudinal   0·02

Vertical

                                            0·01

Transverse   0·00

4 TON HAMMER OPERATING ALONE

0   0·5   1·0   1·5   2·0   SEC.

Longitudinal   0·02

Vertical

                                            0·01

Transverse   0·00

RECORD OF VIBRATION CAUSED BY AN 8 TON TANKER FULLY-LOADED DRIVING SLOWLY ALONG
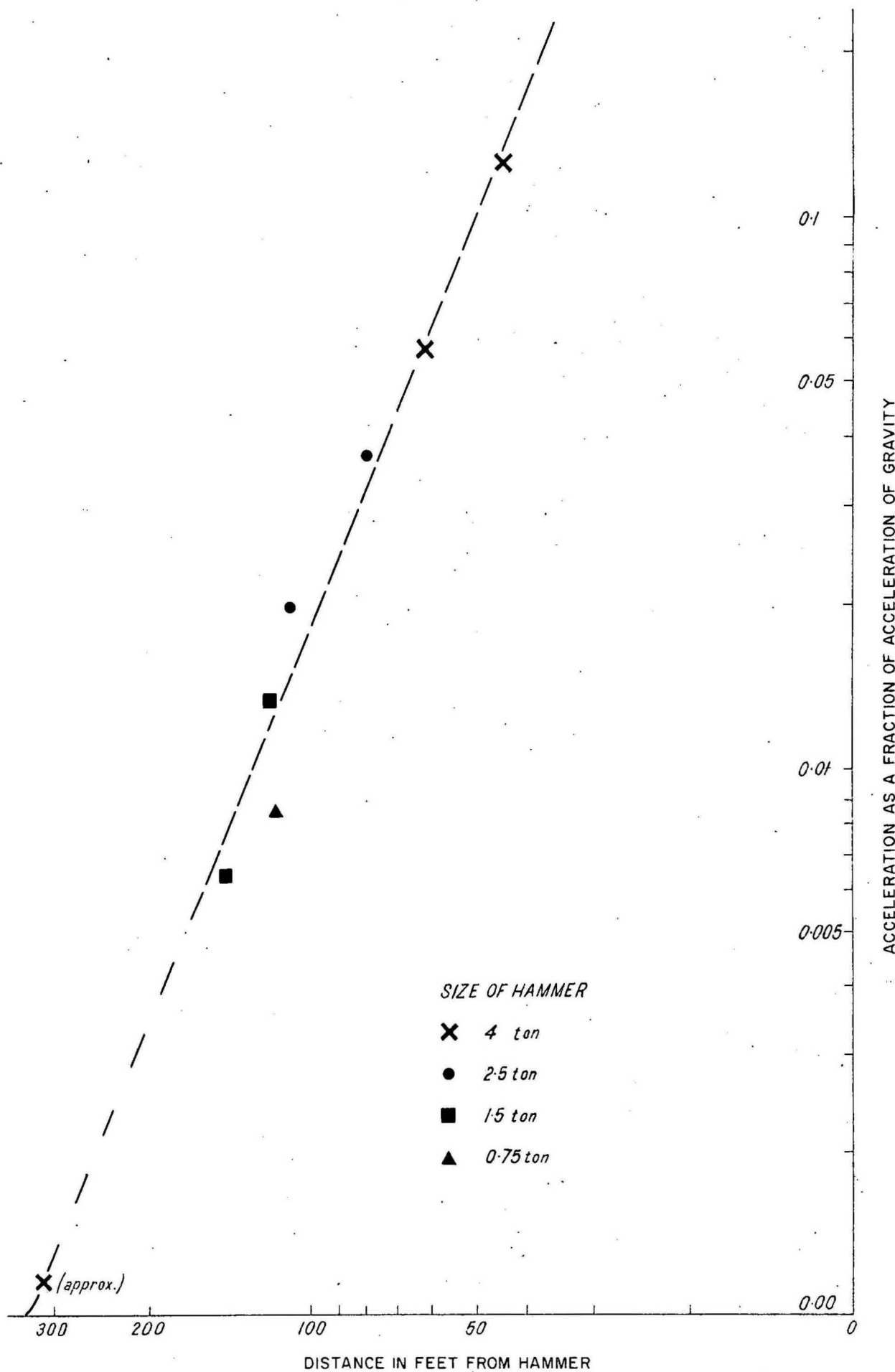CONCRETE ROAD (APPROXIMATLY 100 FEET FROM RECORDING INSTRUMENT).

VIBRATION TESTS AT KIRKSTALL-REPCO PTY. LTD.

CLAYTON, VICTORIA

RECORDS TAKEN WITH LEET 3-VIBROGRAPH

ON 3rd. POSITION

PLATE 6

SIZE OF HAMMER

✕ 4 ton

● 2·5 ton

■ 1·5 ton

▲ 0·75 ton

ACCELERATION AS A FRACTION OF ACCELERATION OF GRAVITY

DISTANCE IN FEET FROM HAMMER

VIBRATION TESTS AT KIRKSTALL-REPCO PTY. LTD.

CLAYTON, VICTORIA

GRAPH SHOWING RELATION OF AMPLITUDE TO DISTANCE FROM HAMMER