COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1962/143

MONASH UNIVERSITY VIBRATION TESTS, MELBOURNE 1961

by

E.J. Polak

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SUMMARY

Tests were made of vibrations in the new chemical laboratories at Monash University. Three groups of vibrations were recorded; their frequencies ranged from 1 to 2½ c/s, 14 to 17 c/s, and 25 to 100 c/s.

1. INTRODUCTION

This Record describes a vibration investigation made by the Bureau of Mineral Resources, Geology and Geophysics, in the Chemistry Department of Monash University, Wellington Road, Clayton.

The chemical laboratories were under construction, and vibration measurements were made to determine the general level of vibration that can be expected in the building when the construction of the laboratory is completed.

The investigation was carried out by E.J. Polak on 18th July 1961 during normal construction work.

2. INSTRUMENT AND METHOD

The instrument used in the recording was a Sprengnether Portable Blast and Vibration Seismograph No. 1577. This instrument records three mutually perpendicular components of the vibration on a moving strip of photographic paper. The records show the motion magnified 100 times, with timing lines at intervals of 0.02 seconds.

3. RESULTS

Table 1 shows details of the records taken during the investigation. The components of displacement given are half the peak-to-trough amplitude. The directions of the X, Y, and Z components are shown on Plate 1, together with diagrams showing the locations where measurements were made. Plate 2 shows parts of records, taken during several seconds of recording.

Three types of vibration are noticeable in the results. The first type is of low frequency (1 to 2½ c/s) and low amplitude, and is recorded on most of the records. The amplitude of the vibration increases when the floor is subjected to repeated jumping.

A second vibration with a frequency of 14 to 17 c/s is present on many records. On Records 5 and 8 this vibration shows an increase in amplitude, because an electric drill was working in the room while the records were being taken. It is suggested that this vibration corresponds to the natural frequency of the floor, and that similar vibrations would be generated by any electrical rotary unit. Similar vibrations resulting from the operation of an electric fan were recorded in the Vacuum Oil Building, Melbourne (Jewell, 1960).

The third type, a transient high-frequency (25 to 100 c/s) vibration, is generated by a person jumping near the recorder.

4. CONCLUSIONS

Vibrations measured in the building show three groups of frequencies: 1 to 2½ c/s, 14 to 17 c/s, and 25 to 100 c/s. The maximum amplitude of vibration measured was 0.0009 in., on the main Z-component of vibration, with a frequency of about 2 c/s. The maximum amplitude in the secondary vibration was 0.0008 in. on the Z component. Both these maxima occur on Record 15b.

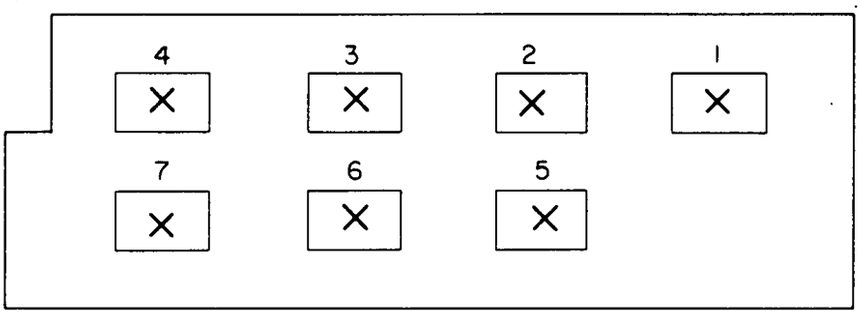
5. REFERENCES

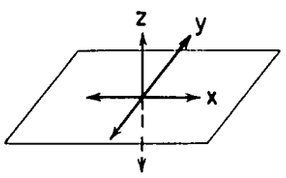
JEWELL, F. 1960 Vacuum Oil Building vibration tests, Melbourne 1960. Bur. Min. Resour. Aust. Rec. 1960/62.

TABLE 1.

Record No.	Location No.	Position of Seismograph	Vibration No. 1 X (in.)	Y (in.)	Z (in.)	Freq. (c/s)	Vibration No. 2 X (in.)	Y (in.)	Z (in.)	Freq. (c/s)	Remarks
1	5	On centre of bench	0.00015	0.0002	0.00015	1¼		0.0001		17	
2	5	On centre of bench	0.00015	0.0002	0.00015	1¼		0.0001		17	
3	5	Below bench	0.00015	0.0002	0.0002	1¼					
4	5	On concrete near bench	0.0002	0.0002	0.0002	2–1¼					
5	5	On centre of bench (as Record 1)		0.00025		14	0.0001		0.0002	33	Person jumping on floor
6	5	On concrete near bench (as Record 4)			0.0004	2¼–2	0.0001		0.0005	50	" " " "
7	5	Below bench (as Record 3)	0.00015	0.0002	0.00015						" " " "
8	5	On bench over support	0.0002			14		0.0001		50	" " " "
9	1	On concrete			0.0002	2¼–2	0.0001		0.0004	50	" " " "
10	3	On concrete			0.0001	2¼					
11	2	On concrete	0.0001	0.0001	0.0001	2½			0.0001	25	Person jumping on floor
12	4	On concrete	0.00015	0.00015	0.0002	1			0.0002	25	" " " "
13	6	On concrete	0.00015	0.00015	0.0002	1					
14a	8	On concrete	0.0001	0.0001	0.0001	1					
14b	8	On concrete (as Record 14a)	0.00015	0.0002	0.0002	1½		0.00015 0.0002	0.00025	50 100	Person jumping on floor
15a	9	On concrete			0.0001	33					
15b	9	On concrete (as Record 15a)			0.0009	2–1.7	0.00015	0.0002	0.0008	36	Person jumping on floor
16a	10	On concrete			0.0001	33					
16b	10	On concrete (as Record 16a)	0.0001	0.0001	0.0002	2¼–2			0.00025	14	Person jumping on floor
17a	11	On concrete	0.0001	0.0001	0.0001	1¼					
17b	11	On concrete (as Record 17a)	0.0001	0.0001	0.0001	1¼	0.00015	0.0002		50	Person jumping on floor

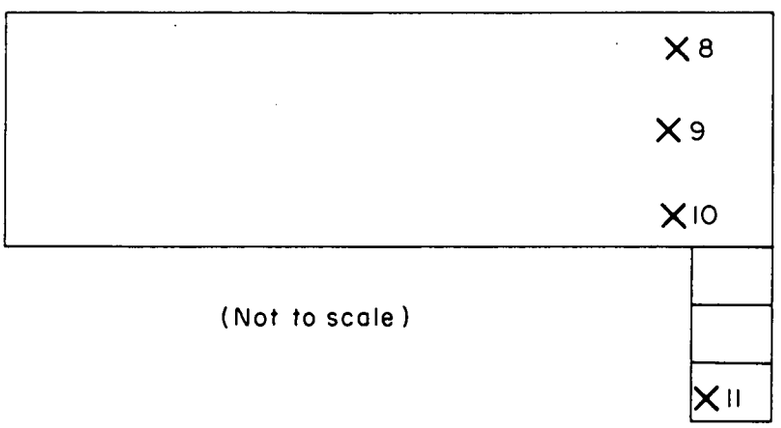
(a) Spectographic Laboratory (ground floor)





ORIENTATION FOR RECORDS 1 TO 17, EXCEPT FOR RECORD 8 WHERE THE x AND y DIRECTIONS WERE INTERCHANGED

(b) Vibration-free area (third floor)



(Not to scale)

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SEISMOGRAPH LOCATIONS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G344-102

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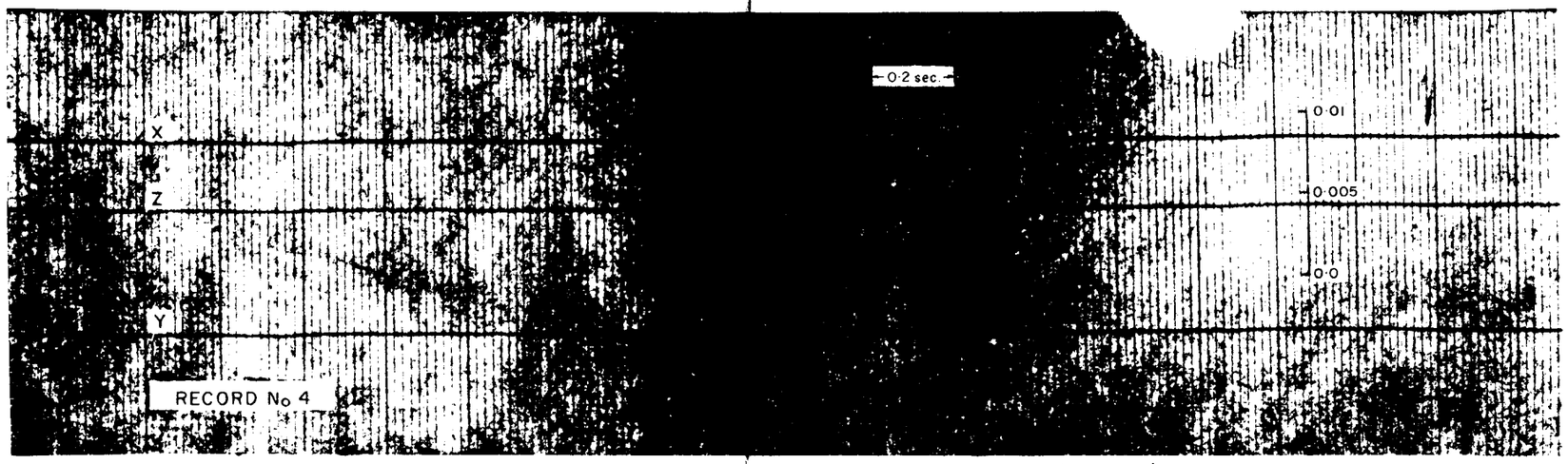
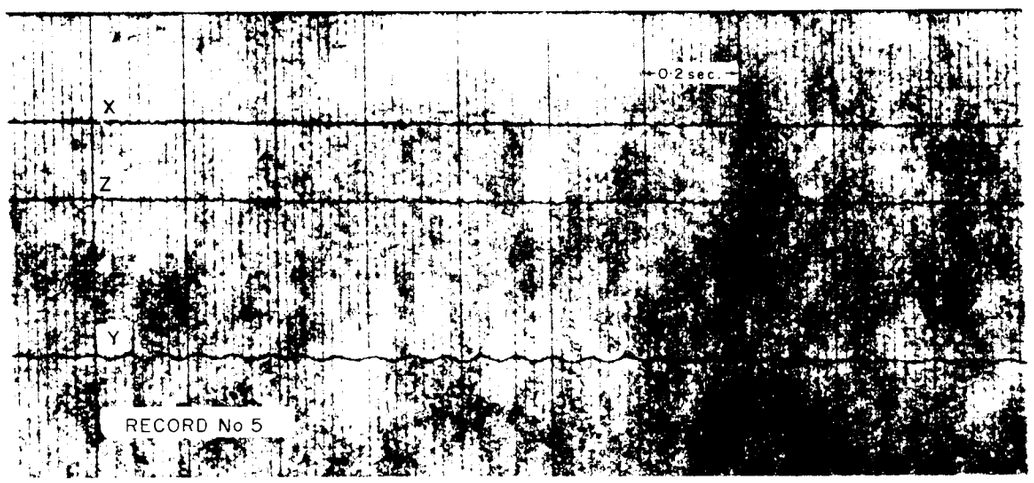
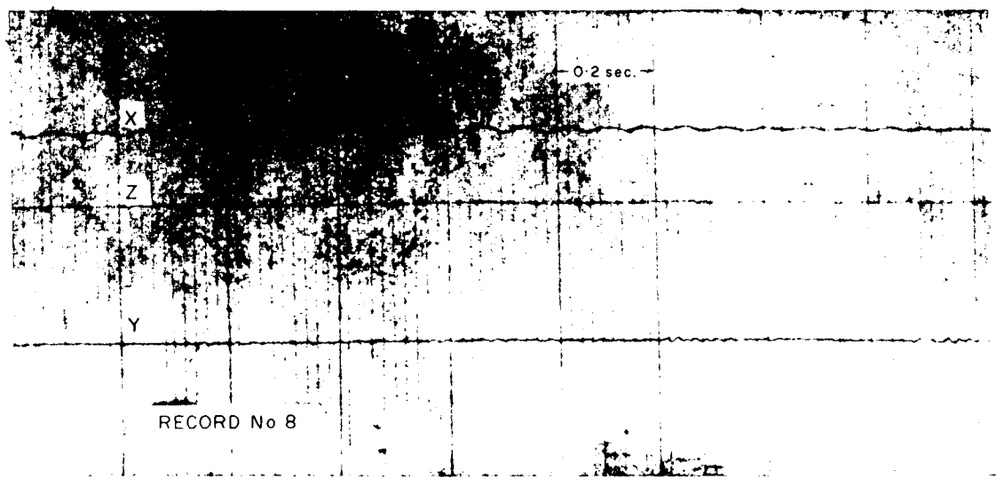
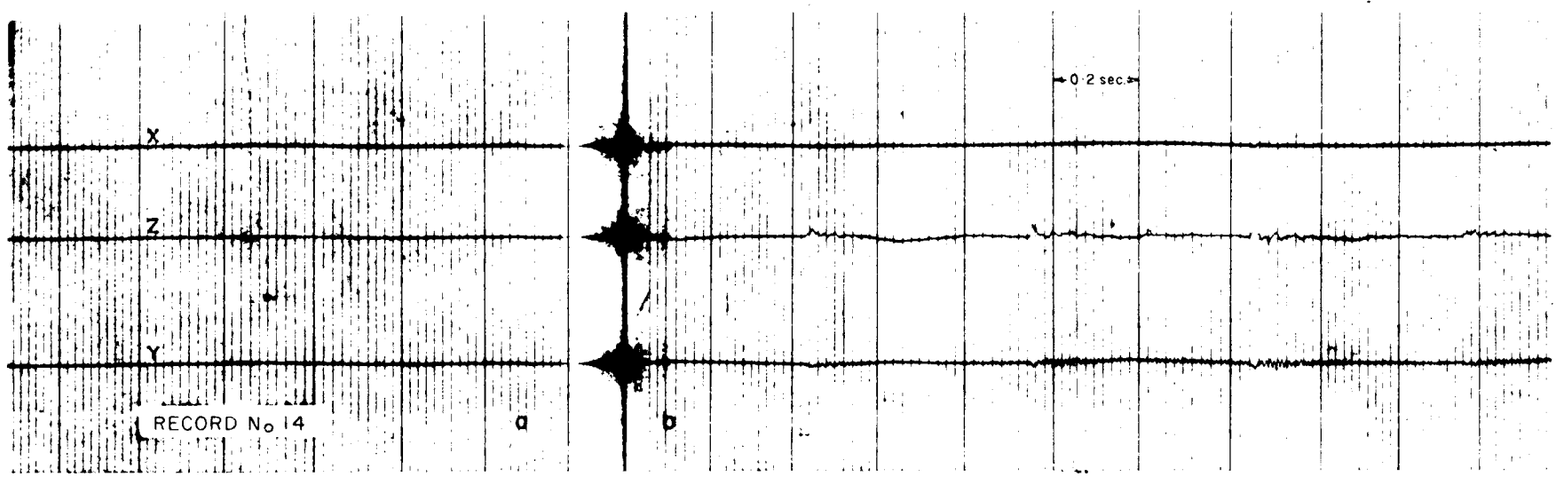
PLATE No 2.









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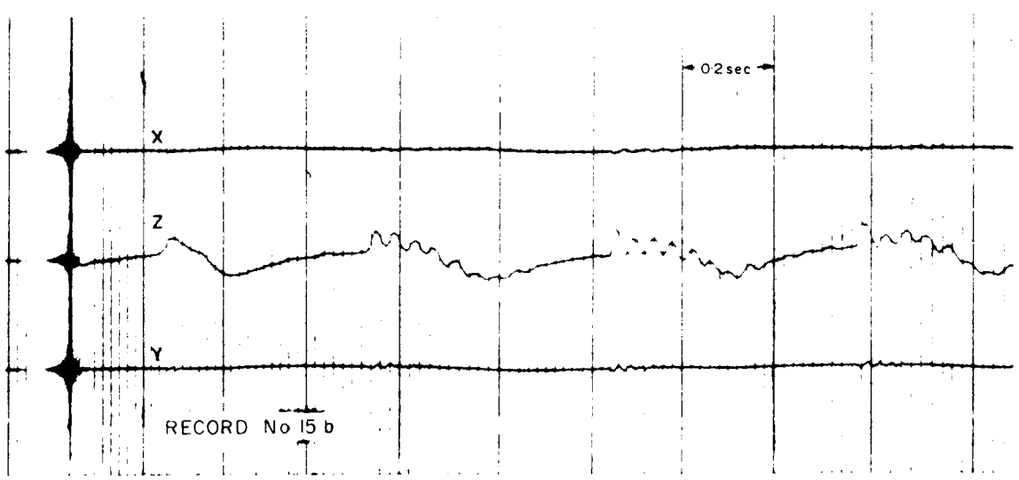
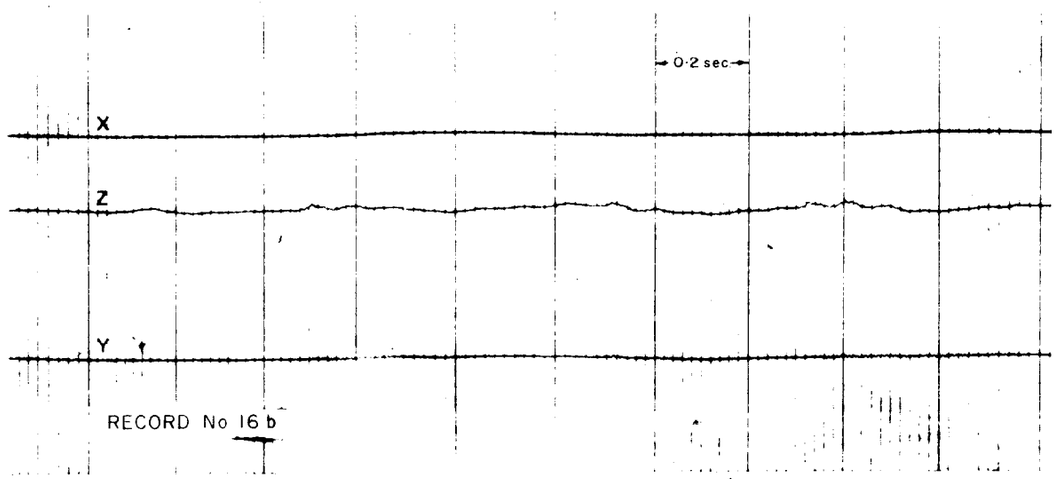
VIBRATION TEST, 18/7/1961.

SELECTED RECORDS





Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 344 – 103

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APPENDIX

The following are references to and extracts from regulations and authoritative publications in the United States and Great Britain covering or recommending safe amplitudes of vibrations that may be applicable to buildings:

(Note: f = frequency in cycles per second.
A = ½ peak to trough amplitude, inches).

Reference 1

State of New Jersey, U.S.A. Extract from rules and regulations governing Quarry Blasting and Related Operations. 26th March 1954.

'6.1 Allowable Limits. Allowable Limits of ground motion and sound pressure contained in this section shall be considered neither to produce structural damage in any structure that has been reasonably well constructed according to accepted engineering practice nor to constitute a nuisance to persons.'

'6.3 Frequency - amplitude relations. When ground frequency and displacement characteristics in relation to known quantities of detonated explosives in primary blasts have been determined by approved means of instrumentation to the satisfaction of the Commissioner, the allowable limits of the maximum amplitude of ground vibrations related to frequencies of vibration shall be as indicated in the following table:

Frequency of ground motion in cycles per second.	Maximum amplitude of ground movement, in inches.
up to 10	not more than 0.0305
20	0.0153
30	0.0102
40	0.0076
50	0.0061
60	0.0051'

Reference 2

Rules Concerning Blasting in Strip Mine Operations in the Anthracite Region, Pennsylvania, Act No. 472, 27th June 1947.

'Section 20

... in no case shall the ground displacement be in excess of 0.03 inches at any dwelling house, public building, school, church, commercial or institutional building.'

Reference 3

Teichman, G.A. & Westwater, R. 1955 Blasting and associated vibration. Engineering 460-465, 12th April.

'Because of the variation in the types of structure it has been recommended that they should be broadly classified into four groups:

(a) structures of great value and frailty. This will include certain ancient monuments, such as churches and certain badly designed properties.

(b) Property, houses etc. closely congested.

(c) Isolated property.

(d) Civil engineering structures.

Taking suitable safety factors and after the site has been investigated by a vibrograph caution limits are applied. These limits usually are 0.004, 0.008, 0.016, 0.030 inches, respectively.'

Reference 4

Crandell, working on behalf of a United States Insurance Co., suggests fA as a suitable relationship and quotes:

'fA = 0.745 as the damaging level

fA 0.527 as safe level.'

Reference 5

Morris, C. 1950 Vibrations due to blasting and their effect on building structures. The Engineer 394-395 & 414-418, 3rd November.

'the limiting amplitude of 8.2×10^{-3} (0.0082) inches gives a conservative estimate of the limiting amplitude for conventional structures. The state of repair of the building does not seriously affect this estimate, as an old building technically less strong than a new one will have benefitted by a process of "bedding in" due to long-continued small movement.'

Reference 6

Thoenen, F.R. and Windes, S.L. 1942 Seismic effects of quarry blasting. Bull. U.S. Bur. Min. 442.

' $f^2A > 10$ Damage

$f^2A < 1$ Safe

'Vibrations of very low amplitude and short duration were neglected, even though the accelerations may have been high, because these conditions were noticeable in the records of many tests that did not cause damage'.