COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS

1960 No. 62

VACUUM OIL BUILDING VIBRATION TESTS, MELBOURNE

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ABSTRACT.

Vibrations caused by two air-conditioning fans situated on the top floor of the new Vacuum Oil building in South Gate, Melbourne, were measured. It was found that the ground displacements and accelerations recorded on the upper floors were both less than the minimum regarded as annoying by various authorities.

Measurements near the fans showed that the cork lining of the fan foundations reduces the vibrations by about a half.

1. INTRODUCTION.

In the building being erected for Vacuum Oil Company at South Gate, Melbourne, the air-conditioning equipment has been installed by Frigrite Ltd. Frigrite Ltd. were concerned that the vibration produced by two "Aerex" fans on the top (14th) floor ... might cause annoyance to office workers, and they asked the Bureau of Mineral Resources to measure the amplitude and frequency of the vibration.

On 9th May 1960, the author made recordings of the vibration on the 11th, 12th, 13th and 14th floors; some of these recordings are reproduced on plate 2. On 13th May another set of recordings was made to determine how effectively the vibration is attenuated by the cork lining of the fan foundations. This set was made on the fan foundations and on the adjacent floor; examples are reproduced on plate 3.

All the recordings were made with a Sprengnether Portable Blast and Vibration Seismograph. This instrument records on a photographic strip the vibration in three mutually perpendicular directions; the record shows the ground displacement magnified 100 times, with timing lines at intervals of 0.02 seconds.

2. RESULTS.

Plate 1 shows the positions of the seismograph for the tests made on the 13th floor, the floor on which the vibrations had been thought to be perceptible.

Table 1 shows the magnitude of the three components of ground displacement (taken as half the peak-to-trough amplitude) corresponding to the various positions of the seismograph. The resultant displacement is computed by taking the square root of the sum of the squares of the three components.

The dominant frequency of the vertical component appears to be 12 c/s, which corresponds to the speed of rotation of the fans, roughly 700 r.p.m. That of the horizontal components is approximately 1.2 c/s.

Various authorities cite differing criteria for assessing the effect of vibrations on human beings. The following are taken from Special Report No. 19, 1952, of the Department of Scientific and Industrial Research, London. They comprise the results of both English and German work.

Authority	Minimum Displacement (ins) Causing Annoyance		
	5 c/s.	10 c/s.	20 c/s.
MALLOCK	0.0196	0.0049	0.00122
MELVILLE	0.0370	0.0046	0.00058
DIGBY and SANKEY	0.0039	0.00197	0.00098
REIHER and MEISTER	0.0032- 0.0160	0.0016- 0.0050	0.0008- 0.0018

Clearly none of these authorities would consider that the oscillations recorded in the Vacuum Oil Building could cause annoyance.

Mallock suggests that the perceptibility of vibrations depends on the magnitude of the maximum ground acceleration, accelerations greater than 0.01 g being perceptible. (g is the acceleration due to gravity, 386 in/sec^2). Although it has been proved that some people can detect vibrations whose acceleration is rather less than 0.01 g, this value may be taken as a very conservative minimum for accelerations which can be regarded as unpleasant.

Table 1 shows resultant accelerations derived from the present tests. They are calculated as follows :-

(1) The maximum acceleration of each component is calculated from the equation

$$a = 4\pi^2 f^2 A \quad \text{where}$$

A = displacement (in.)
f = frequency (c/s.)

(2) The resultant acceleration is the square root of the sum of the squares of the three component accelerations, expressed in terms of gravity.

All the resultant accelerations are less than 0.01 g, i.e. less than the perceptible minimum according to Mallock.

The tests carried out on 13th May showed that acceleration due to the vibrations on the floor adjacent to the fan foundations was only about half that recorded actually on the foundations; the cork lining is therefore a useful attenuator. Plate 3 is a reproduction of the strongest vibrations recorded in this series. On the foundation the acceleration is 0.013 g; on the adjacent floor it is only 0.06 g.

3. CONCLUSIONS.

The vibrations caused by the two Aerex fans are not strong enough to cause annoyance to office workers on the 13th floor.

Only on the actual foundation of the "hot" fans does the ground acceleration exceed the minimum considered to be perceptible by H.R.A. Mallock, an authority on ground vibrations.

Ground displacements are even smaller on the 12th and lower floors than on the 13th.

4. REFERENCE.

STEFFENS, R.J., 1952 The assessment of vibration intensity and its application to the study of building vibrations.

Nat. Build. Stud. Spec. Rep. 19.

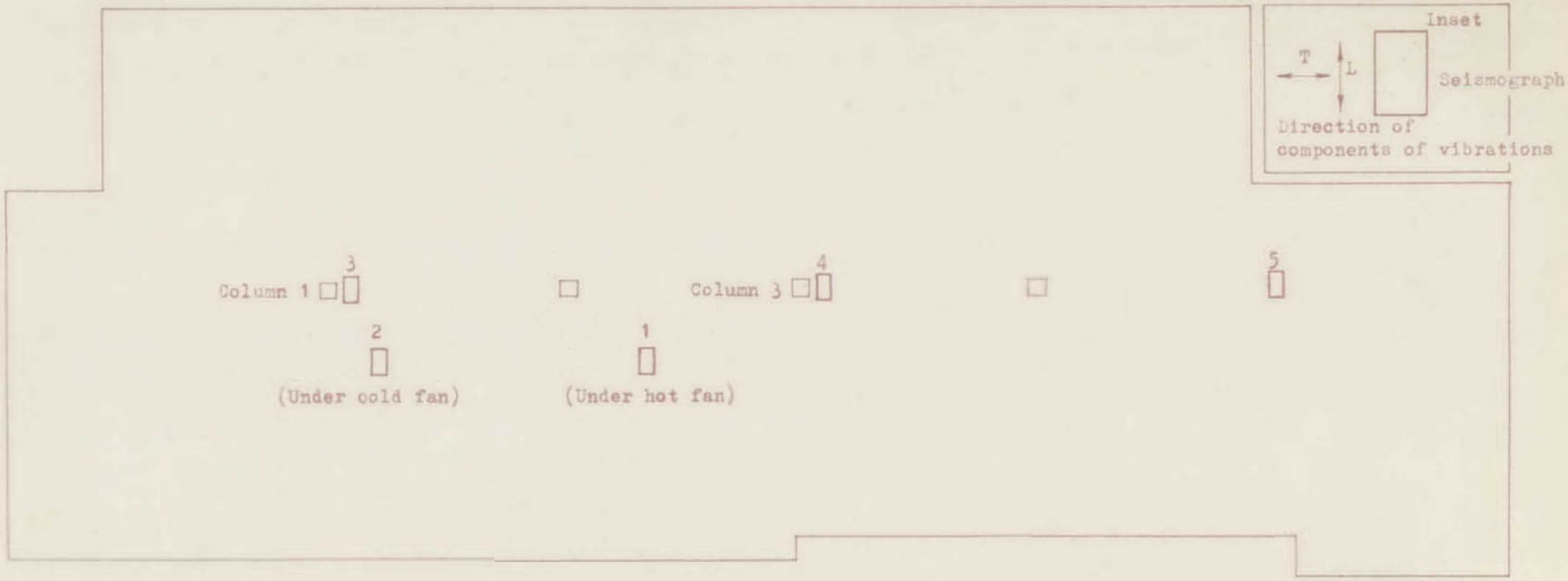
TABLE 1.

No.	Location	Fans	Displacement A (in.)				Frequency (c/s)			Resultant Acceleration in terms of g.
			L	V	T	Resultant	L	V	T	
1	13th floor : under hot fan	ON	0.0002	0.0004	0.0002	0.00049	1.2	12	1.2	0.0058g
2	" : " cold "	ON	0.0002	0.0004	0.0003	0.00054	1.2	12	1.2	0.0058g
3	" : column 1	ON	0.0002	0.0002	0.0002	0.00035	1.6	12?	1.0	0.0029g
4	" : column 3	ON	-	0.0002	0.0001	0.00022		12?	2.0	0.0029g
5	" : position +	ON	0.0001	0.0001	0.0001	0.00017	1.6	12	1.6	0.0015g
6	12th floor : under hot fan	ON	0.0001	0.0002		0.00017	(slow)	12		0.0029g
7	" : " cold "	ON		0.0002		0.0002		12		0.0029g
8	11th floor : " hot "	ON	0.0001	0.0002	0.0001	0.00025	(slow)	12	(slow)	0.0029g
9	" : " cold "	ON	0.0001	0.0001	-	0.00014	(slow)	12		0.0015g
10	" : " hot "	OFF	0.0001	-	-	0.0001	1.0			0.00001g
11	14th floor : 15 feet from hot fan	hot fan only on	0.0002	0.0001	0.0002	0.0003	1.6	24	1.6	0.0059g

Remarks

At locations beneath the cold fan, the displacement of the vertical component varies at a frequency of approximately 1.2 cycles per second. Displacements shown are the maxima attained.

L = Longitudinal V = Vertical T = Transverse



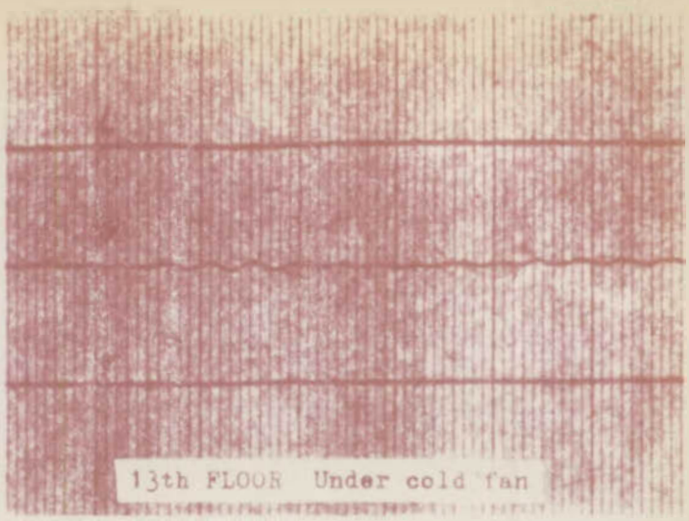
Vacuum Oil Building, South Gate, Melbourne
9th May 1960, Vibration Tests

Sketch of 13th Floor

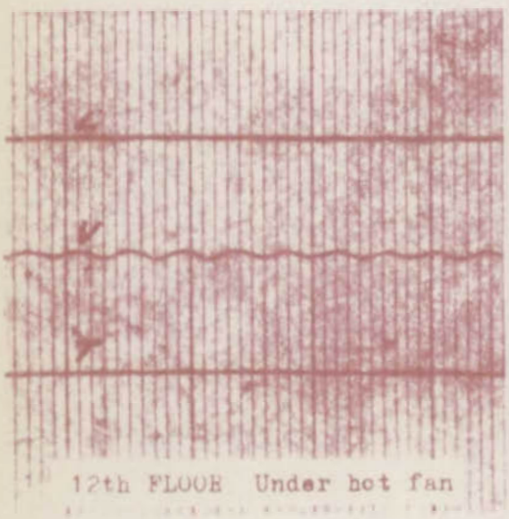
SEISMOGRAPH LOCATIONS

PLATE 1

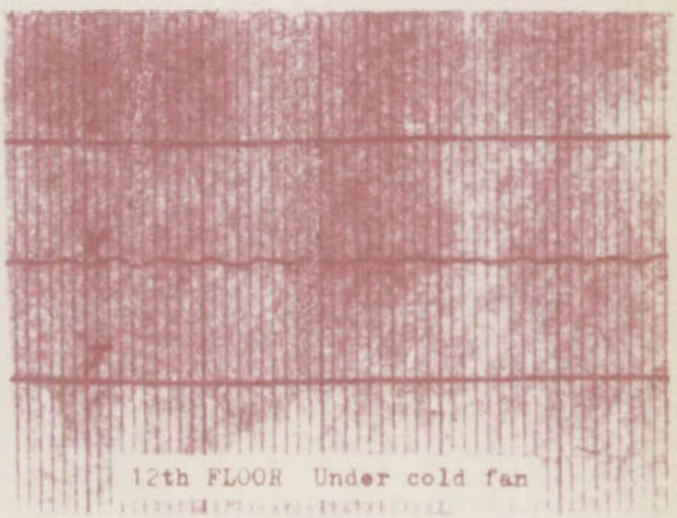
13th FLOOR Under hot fan



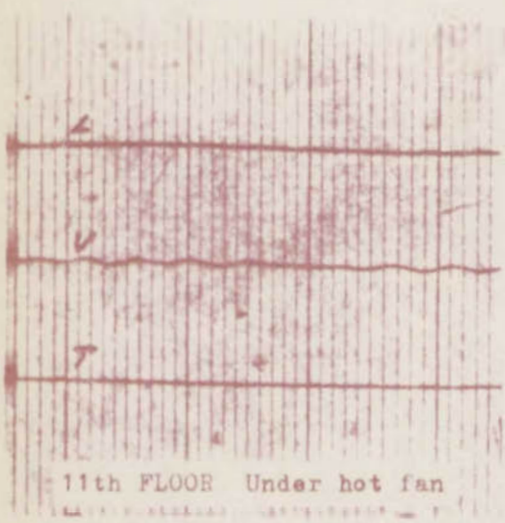
13th FLOOR Under cold fan



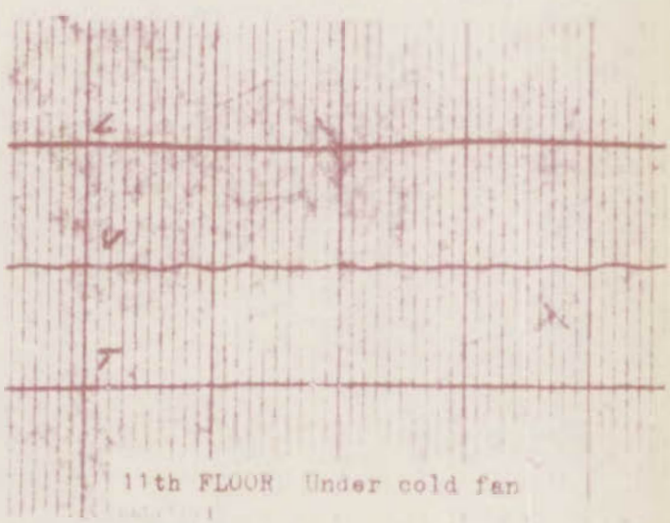
12th FLOOR Under hot fan



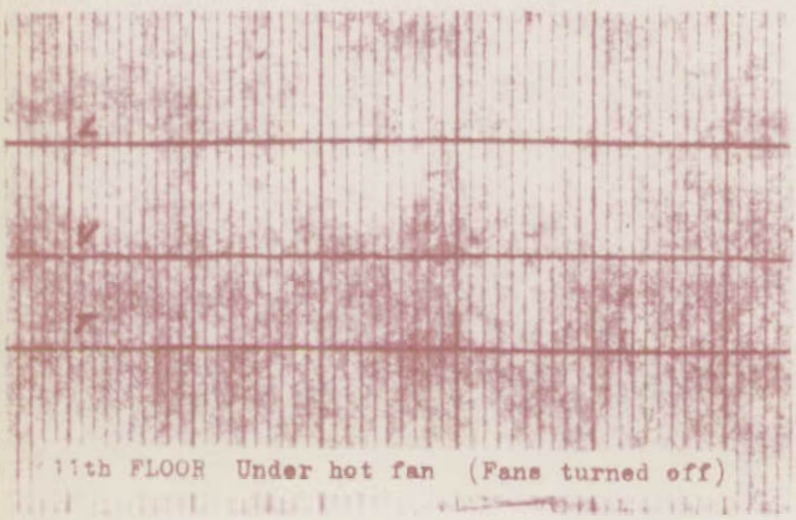
12th FLOOR Under cold fan



11th FLOOR Under hot fan



11th FLOOR Under cold fan



11th FLOOR Under hot fan (Fans turned off)

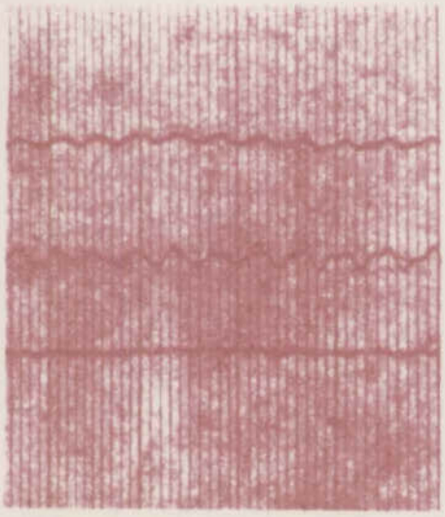
Vacuum Oil Building,
South Gate, Melbourne,
9th May 1960

VIBRATION RECORDS

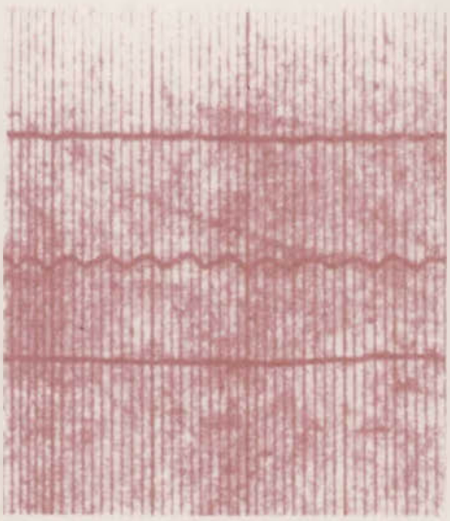
(Using Sprengnether
Vibration Seismograph)

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G344-50

Seismograph positions for attenuation test



1. On Foundation



2. On Floor

Vacuum Oil Building,
South Gate, Melbourne, 13th May 1960

Vibration Tests

VIBRATION RECORDS SHOWING ATTENUATION
DUE TO CORK INLAY IN FOUNDATION