Report on Vibration Tests - Clifton Brick and Tile Company's Brick Pit Preston, Vic

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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REPORT

ON

VIBRATION TESTS

CLIFTON BRICK AND TILE COMPANY'S BRICK PIT, PRESTON, VICTORIA

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REPORT ON VIBRATION TESTS

CLIFTON BRICK AND TILE COMPANY'S BRICK PIT,

PRESTON, VICTORIA.

In August, 1947 the Bureau of Mineral Resources, Geology and Geophysics was requested by the Clifton Brick and Tile Company to carry out vibration tests on that Company's Brick pit at Preston, Victoria.

At some time previously a portion of the brick pit wall collapsed and in doing so broke a number of watermains. It has been claimed that vibration due to blasting in the pit in the vicinity of the collapsed portion was in part or wholly responsible for the collapse and consequent damage to water mains although no blasting was done within 24 hours immediately preceeding the collapse.

Tests were carried out at the brick pit on December 17th, 1947 and February 2nd, 1948 by officers of the Bureau. Six charges of explosive were detonated at different points in the brick pit and the amplitude of the ground movement was recorded. Additional records were made of ground movement due to other causes, such as vehicular traffic on a public roadway adjacent to the brick pit.

It is the purpose of this report to summarise the results of the tests by tabulating the vertical ground movement recorded and to compare one with another, the amplitudes due to different causes.

TECHNICAL MATTERS

Two types of recording instruments were used - one a mechanical Seismograph in which the vertical movement of the ground is amplified by a system of levers and recorded by pen on paper attached to revolving drum. The other type comprised a number of electromagnetic pickups (geophones) which covert the vertical ground movement into electrical impulses which are then recorded photographically by the medium of vibration galvanometers. With this instrument it was possible to record simultaneously the ground movement at three separate Stations A, B, and C due to a single explosion.

Although the measurements made at the Preston brick pit were restricted to vertical ground movement, the vibration due to any cause is not confined to this direction.

The ground movement may be considered as comprising two components, a vertical component (V) and a horizontal one (H) which may be bigger that the vertical.. In experimental work carried out by the Imperial Geophysical Experiment Survey and by the U.S. Bureau of Mines on seismic waves generated by explosives, the ratio of H/V has been found to vary from 0.7 to 1.35. For the purposes of this report however it will be assumed that the total amplitude (i.e. the combination of horizontal and vertical components) will not exceed twice the vertical component.

It is an experimental fact that ground amplitudes due to seismic waves are greater in soil than in solid rock, other factors being equal. In tests carried out by the U.S. Bureau of Mines it was found that amplitudes measured on overburden (thick soil) were from 3 to 10 times greater than those recorded on solid rock.

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Beneath station A (see accompanying plan) is approximately 15 feet of highly weathered shale of clay-like consistency. One would expect therefore that ground amplitudes measured at Station A would be approximately from three to five times as great as corresponding amplitudes in the underlying shale. For the purposes of this report however it will be assumed that the amplitude at Station A is four (4) times as great as the corresponding amplitude in the underlying shale. It is seen therefore that the total amplitude in the shale underlying Station A will be considered to be approximately one half the vertical amplitude recorded at that station.

RESULTS

The results of the tests are shown in Tables I and II. The amplitudes of the seismograph records have been reduced by the application of appropriate amplification factors to their equivalent ground movements in inches. The figures tabulated in the right hand column in each table are maximum vertical displacements of the ground either up or down from the rest position, (i.e. maximum amplitudes).

Considering first the ground movement due to explosions in the brick pit (Table I) it will be seen that the maximum ground movement recorded was 0.0038 inch at Station A when 20 lbs. of black powder was exploded at shot point 1.d. (see accompanying plan). This is the vertical amplitude in the soil immediately beneath Station A. The total amplitude in the shales beneath the soil is approximately one half this value or .0019 inch.

There are valid reasons for assuming that this amplitude (0.0019 inch) would be greater than the maximum amplitude to which the rocks of the collapsed portion of the pit wall were subjected by explosive waves during the few days prior to their collapse. These reasons are briefly:-

(1) The distance between shot point 1.d. and Station A (180 feet) is less than that between the collapsed area and the position of the shot fired nearest to it in the few days preceeding the collapse.

(2) The explosive charge used in the test (20 lbs. of black powder) was equal to the maximum charge used in the few days prior to the collapse.

Referring now to Table II it is seen that the vertical ground movement recorded at Station D, 20 feet from the centre of the concrete road on the west side of the brick pit varied with the type of vehicle passing on the road. The maximum amplitude recorded, however, (when a truck loaded with cement was passing the recording instrument) was only 0.00002 inch. Attempts to record the ground movement simultaneously at Station A, 70 feet from the road centre, were unsuccessful because these amplitudes were too small to record i.e. they were less than 0.000002 inch.

An attempt was made on December 17th to record, by means of the mechanical seismograph, the ground movement at Station A when two trucks loaded with bricks were driven along the concrete road but the ground amplitudes were too small to be recorded.

A record was made of the ground amplitude near Station A due to a man jumping on the ground 5 feet from the

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recording instrument. The vertical amplitude was just sufficiently large to be recorded on the mechanical seismograph and was approximately 0.00015 inch.

At another place (1) the writer has recorded the ground movement due to a man walking briskly past an electromagnetic vibration recorder, the recorder and man both being on a Macadam road. When approximately five (5) feet from the recorder footsteps caused ground vibrations of the order of 0.00001 inch. Records made at the same time and place of a sedan car being driven at 25 m.p.h. past the instrument (nearest approach 15 feet) gave ground amplitudes of the same order namely 0.00001 inch.

L. Don Leet (2) has listed amplitudes originating from various sources recorded in 1936 by the U.S. Bureau of Mines and of these the Vibrations due to causes other than blasting are shown in Table III. Table IV is copied from a report by J. M. Rayner and F. N. Hanlon (3) and it listsamplitudes due to causes other than blasting recorded by these authors and by other observers.

The majority of the amplitudes tabulated in Tables III and IV were measured inside houses and it is an experimental fact that such amplitudes are bigger than would be recorded on the ground (soil) at equivalent distances. Rayner and Hanlon observed that the vertical amplitudes measured on the ground floors of houses were on the average 1.4 times the amplitude measured on the ground outside the house and that the vertical movement of the upper floors was much larger and generally several times greater than the corresponding ground amplitudes. Applying the results of these observations to the values listed in Tables III and IV it is seen that with the exception of jumping and heavy walking on the floor of a room on which the seismograph was placed (see Table IV Rockwell) the ground (soil) amplitudes due to the sources and at the distances listed would generally be less than 0.001 inch. Amplitudes in the solid rock beneath the ground surface would be still smaller.

Tests of vibrations in the ground at Preston brick pit due to causes other than explosive waves were not as exhaustive as they could have been but from the results of the limited number done and from experience elsewhere it is evident that the greatest amplitudes in the rocks in the pit face prior to the collapse of the wall would have been those due to explosive waves. It is probable that these amplitudes did not exceed 0.002 inch.

Whether or not such extremely small amplitudes could in any way have been responsible for the collapse of the pit wall the writer is not competent to say.

(1) Hamilton, Vic. Vibration tests.

(2) Vibration from blasting L. Don Leet, Hercules Power Company.

(3) Earth Vibrations from blasting at Balls Head, Sydney. Mineral Resources Survey, Report No. 1943/25.

(R. F. THYER)
Supt. Geophysicist.

Melbourne.
March 30th, 1948.

TABLE I

Shot Point Number	Size and Type of Charge	Recording Station	Distance Shot to Station		Maximum Double Amplitude Recorded				Maximum Vertical Ground Movement - Displacement from rest position
			Direct	Earth Path	Mechanical Seismography	Geophones			
						Direct Coupled	Through 2500 ohms	Equivalent Mechanical Amplitude	
1 d	20 lbs Black Powder	A	180'	182'	0.52 inch	--	--	--	0.0038 inch
2 d	1 To 1b. Black Powder	A	300'	305'	Too small to record	--	--	--	-----
3 d	15 lbs. Black Powder	A	294'	296'	0.20 inch	--	--	--	0.0014 inch
1	1 lb	A	318'	320'	----	0.0[illegible]"	--	0.004"	0.00003"
	50 %	B	135'	135'	Too small to record	--	0.07"	0.009"	0.00065"
	Delig-nite	C	138'	138'	----	0.21"	--	0.01"	0.0007"
2	3lb.	A	332'	334'	----	0.15"	--	0.008"	0.000055"
	50%	B	160'	160'	0.025" ?	--	0.16"	0.023"	0.00016"
	Delig-nite	C	217'	218'	----	0.50"	--	0.024"	0.00017"
3	10 lbs.	A	275'	277'	----	0.38"	--	0.018"	0.00013"
	50 %	B	130'	130'	0.065"	--	0.52"	0.065"	0.00046"
	Delig-nite	C	188'	188'	----	0.87"	--	0.045"	0.00332"

TABLE II

VIBRATION DUE TO TRAFFIC ON CONCRETE ROAD NEAR BRICK PIT

RECORDED AT STATION D ON EDGE OF ROAD

Record No.	Vehical and Approx. Gross Weight	Max. Double Amplitude		Maximum Vertical Ground Movement - Displacement from Rest Position
		Recorded Direct Coupled	Equivalent Mechanical	
A	Nil	--	--	--
B	Furniture Van empty (3 tons)	0.02"	0.0009"	0.000006"
C	Truck loaded with cement (6 tons)	0.04"	0.0019"	0.000014"
D	Horse & Buggy	0.01"	0.0005"	0.0000035"
E	Small Truck loaded (3 tons)	0.06"	0.0029"	0.000021"
F	Furniture Van loaded (4 tons)	Too small to record	--	--
G	Furniture Van loaded (5 tons)	0.02"	0.0009"	0.000006"
H	Big semi-trailer with large water pipe (10 tons)	0.04"	0.0019"	0.000014"

Amplitude of records taken simultaneously at Station "A" were too small to measure-is.ground amplitudes were less than 0.000002

TABLE III

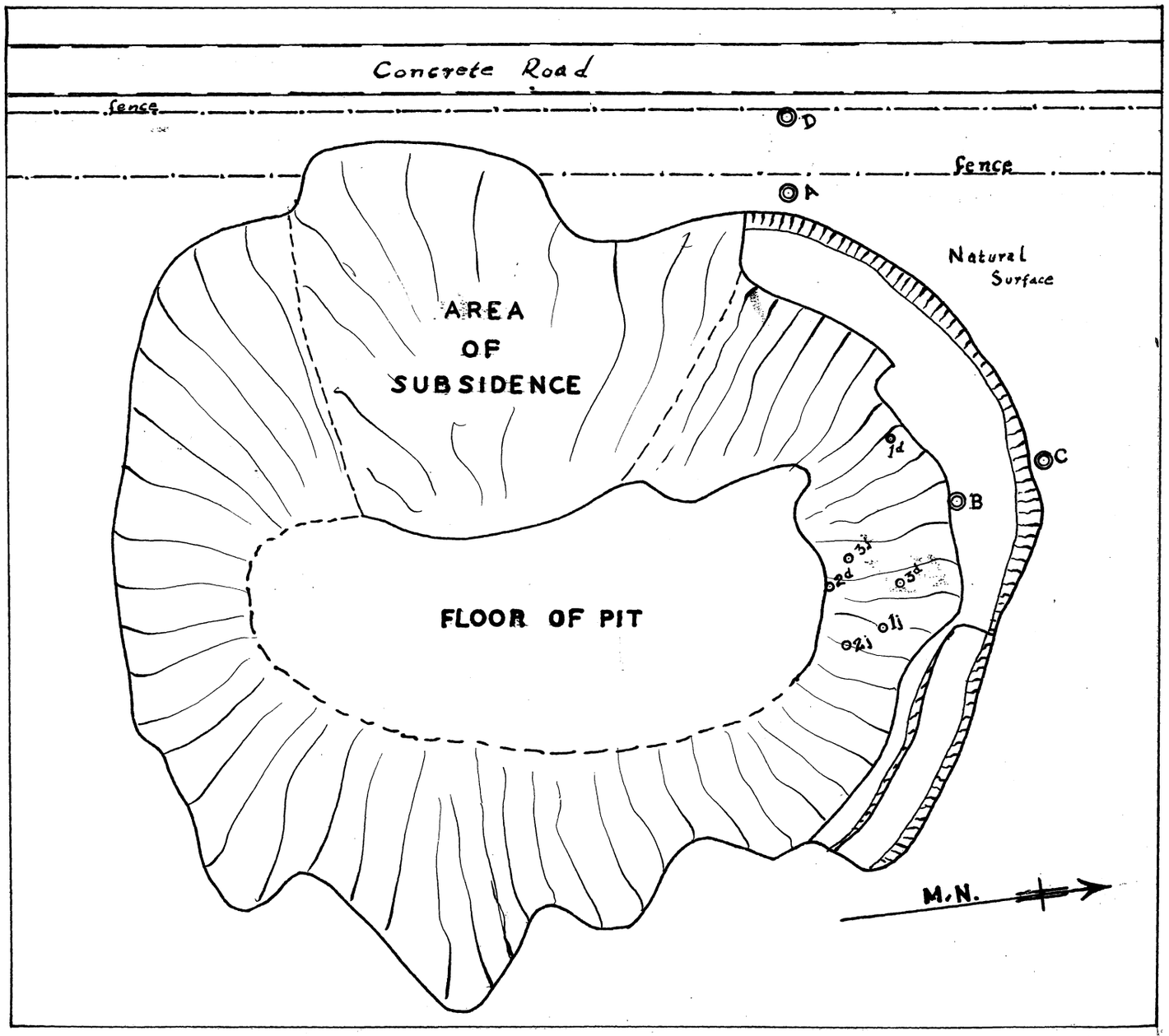
(AFTER L.D. LEET & U. S. BUREAU OF MINES)

Source	Distance (Ft)	Recording Location	Amplitude (inches
Freight Train	110	2nd Storey Frame House	Less than .0005
Passenger "	280	Overburden	" " "
2 Ton Truck	30	"	" " "
Freight Train	110	2nd Storey Frame House	" " "
Coal Truck	30	Overburden	" " "
4 ton Truck	63	4th Storey Frame House	.0005
Freight Train	110	2nd " " "	.001
4 Ton Truck	63	" " " "	.001
7 " "	63	3rd " " "	.001
7 " "	63	4th " " "	.002
7 " "	63	3rd " " "	.002
7 " "	63	2nd " " "	.003
Slamming Front Door		2nd " " "	.005
Walking on Floor Supporting Seismograph		2nd " " "	.008

TABLE IV

(AFTER RAYNER & HAMLOM)

Source of Vibration	Distance from Source in Feet	Frequency Vibration	Amp. Vibration in inches	Floor	Type Structure	Authority
Motor Car 40 m.p.h.	30	36	0.000066			Rl.3319
Motor Truck 32,500 lb.	50		0.00027	2nd	Stone	Rl.3431
Motor Truck 14,000 lb.	63		0.0032	2nd	Wood	Rl.3431
Motor Truck 10 ton, 25 m.p.h.	30	22	0.004			Rl.3319
Train, 8 cars, 35 m.p.h.	110	22	0.000125	2nd	Wood	Rl.3319 Rl.3431
Freight Train 17 m.p.h.	110		0.00058	2nd	Wood	Rl.3431
Man 140 lb. dropping 2 ft.	10		0.00075	1st	Concrete	Rl.3431
Man 140 lb. dropping 1 ft.	3		0.0041	2nd	Wood	Rl.3431
Walking)H)V	8	24 20	0.0012 0.0043	1st		Rockwell
Heavy Walking V	8 ±	12	0.05	2nd		Rockwell
Jumping V	10	14	0.02	1st		Rockwell



SKETCH PLAN

CLIFTON BRICK & TILE CO.
BRICK PIT
PRESTON

SEISMOGRAPH STATIONS SHOWN A◎

SHOT POINTS SHOWN 1j ○

SCALE 100 FT = 1 INCH

R. G. Thyer

Bureau of Mineral Resources

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