INVESTIGATION OF TRAFFIC-INDUCED VIBRATIONS AT 3018 WOODRUFF ST., LANSING

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

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This report covers the results of an investigation of purported traffic-induced vibration at an apartment complex, 3006-3018 Woodruff Street, Lansing, Michigan. The study was requested in a November 18, 1974 letter from J. H. Williams to K. A. Allemeier, and was the result of a letter of complaint to the Department from Mr. Irving Palman, of Detroit.

Background Information

The apartment building at 3018 Woodruff is the only building in the complex which the owners report to have structural damage, and also is the closest to US 127 (Fig. 1). The building contains individual apartments, and is a brick veneer, two-story structure with a full basement. It is approximately eight years old.

Mr. I. Grand, partner with Mr. Palman in ownership of the apartment buildings, met with Research Laboratory representatives at the site on December 11, 1974. Although Mr. Grand indicated that the main problem was noise from the freeway traffic, he also claimed that vibration due to traffic on US 127 was the cause for structural damage to one of the buildings. He states that he did not notice damage at the time of highway construction but did notice it in the fall of 1974 with the full opening of US 127 when traffic worsened.

Reported damage consists of cracks in the lobby where light-weight walls join the two main block walls of the building (Fig. 2). The cracks are slightly wider at the top, and indicate in some cases that the light-weight walls have moved downward about 1/8 in. relative to the block walls.

Vibration Measurements

Vibration measurements were made at the site on December 19, 1974. Two accelerometers were used to make simultaneous measurements of horizontal and vertical accelerations in the ground. The accelerometers were mounted on the same steel stake driven into the ground at the southeast corner of the building. Their outputs were recorded on a low speed, two-channel oscillograph, for several trucks in the traffic stream. Sixteen vibration events were used for evaluation and the maximum acceleration peak noted for each event. Results of these tests are shown in Table 1 along with the type of vehicle.

Discussion

Table 1 shows that the averages were 0.0007 g (vertical acceleration) and 0.0024 g (horizontal acceleration). Both of these values are far below any values which have been known to cause structural damage or human annoyance. According to R. W. Shoenberger (1) in his paper "Human Responses to Whole Body Vibration," ground vibrations with a frequency from

0 to 5 Hz are NOT perceptible until an acceleration of 0.003 g is attained. The accelerations are not classified as unpleasant until an acceleration of 0.05 g is reached, and none of the recorded values were this high. With an increase of frequency, the tolerance for acceleration due to ground vibrations is also increased. For a frequency of 30 Hz, an acceleration of 0.02 g is necessary to be perceptible.

Harris and Crede (2) deal with accelerations in the ground in Chapter 50: "Early tests indicated that for typical small dwelling units, a peak acceleration of 0.1 g corresponded to a caution limit which marks the beginning of minor plaster cracking, etc." Langefors in Sweden, Edwards (3, 4) in Canada, and the Bureau of Mines (5) in this country have conducted experiments correlating peak particle velocity in the earth with damage to structures. All of them agree quite closely with one another, and with the acceleration criteria of Harris and Crede.

Conclusions

Comparing the accelerations measured at the apartments with the specifications stated previously shows that the ground vibrations present at the site were far below the levels required to cause structural damage. The values were also well below the levels unpleasant to humans. When standing on the floor inside the building, no vibrations were felt.

Therefore, we must conclude that the structural damage in this apartment building was not because of ground vibrations. The appearance of the fractures indicates the probability that the light-weight walls at either end of the entrance hallway, were simply laid up against the block walls of the main sections of the building without adequate ties and without provision for expansion and contraction of the structure. There is no evidence of major settlements or cracking of the foundation.

REFERENCES

1. Shoenberger, R. W., "Human Responses to Whole Body Vibration," AMRL-TR, p. 71-68.

2. Harris and Crede, "The Shock and Vibrations Handbook," Vol. 3, McGraw-Hill, New York, 1971.

3. Edwards, A. T., Northwood, T D., and Crawford, R., "Blasting Vibrations and Building Damage," The Engineer, Vol. 215, No. 5601, May 31, 1963.

4. Edwards, A. T., and Northwood, T. D., "Experimental Studies of the Effects of Blasting on Structures," The Engineer, Vol. 210, September 30, 1960.

5. U. S. Bureau of Mines, "Blasting Vibrations and Their Effects on Structures," Bulletin No. 656, 1971.

TABLE 1
RECORDED ACCELERATIONS[1]
(Accelerometer located on pole at SE corner of apt.)

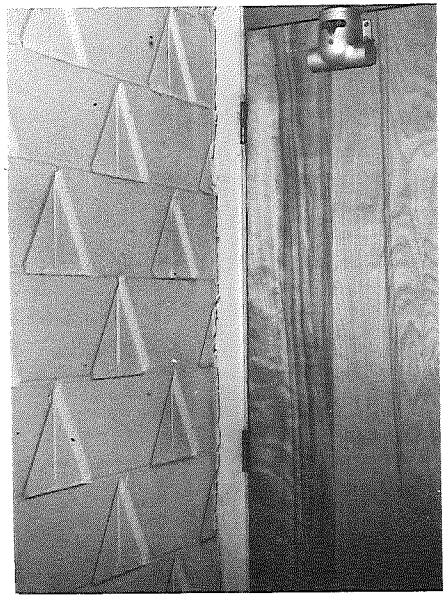
Event	Peak Acceleration, g		Vehicle Type
	Accelerometer vertical	Accelerometer horizontal	
1	0.0020	0.0068	Person stomping 8 ft from accelerometer
2	0.0002	0.0016	Salt truck
3	0.0012	0.0024	3D empty
4	0.0004	0.0020	3S2
5	0.0004	0.0012	2D
6	0.0008	0.0040	Salt truck
7	0.0008	0.0020	3S2 tanker
8	0.0008	0.0024	3S2 loaded
9	0.0012	0.0020	3S2-2 passed by a 2D empty
10	0.0002	0.0020	3S2
11	0.0008	0.0016	Salt truck
12	0.0002	0.0012	4D cement truck
13	0.0008	0.0016	3S2
14	0.0010	0.0024	3S8 empty flat-bed
15	0.0002	0.0036	2S1
16	0.0002	0.0016	School bus
Average	0.0007	0.0024	

[1] All vehicles were in southbound lanes which are closer to the apartment building than the northbound lanes.

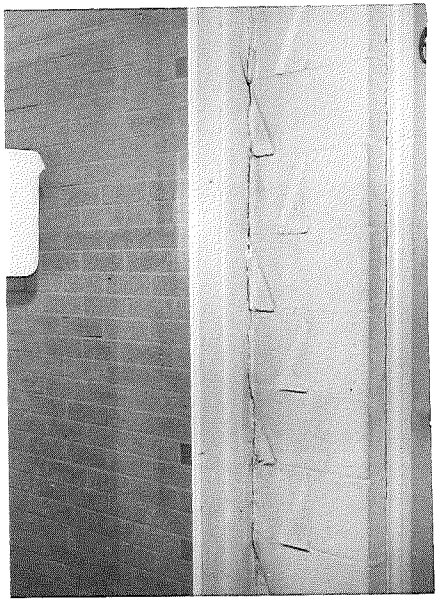
Figure 1. Building at 3018 Woodruff St, Lansing, Michigan.

North Entrance, West Corner

North Entrance, East Corner



South Entrance, East Corner



South Entrance, West Corner

Figure 2. Cracks in building at 3018 Woodruff St.