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DAMPING CAPACITY OF BOSTON BLUE CLAY

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This report presents the results of the determination of the damping capacity of undisturbed samples of Boston Blue Clay obtained using Massachusetts Institute of Technology's Hardin Oscillator. Two methods of determining damping were used and are illustrated. In the Log Decrement method a photograph of the decaying vibration is used to determine the log decrement of the apparatus and of the system with specimen at the resonant frequency. Equations are then used to compute the damping ratios. In the Frequency and Amplitude of Vibration method, the frequencies and amplitudes of vibration at resonance and at a higher frequency are used to determine the damping capacity. The values of damping of Boston Blue Clay as determined by this testing program are between 1 percent and 3 percent.

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DAMPING CAPACITY OF BOSTON BLUE CLAY

This report presents the results of the determination of the damping capacity of Boston Blue Clay obtained using MIT's Hardin Oscillator. For a description of the testing program see Trudeau (1973). The procedures used in calculating the damping capacity are outlined in Hardin (1970). A sample calculation for Test G-1 is included in Appendix A of this report.

These tests were performed on undisturbed samples of Boston Blue Clay. The purpose of these tests was to determine the shear wave velocity of Boston Blue Clay to be used in soil amplification studies in the design of structures in the Boston area against earthquakes; however, values of damping capacity of the specimens tested were also obtained. Inexperience and faulty electronic equipment led to erroneous values of damping for the earlier tests. However, the values of damping reported in Table 1 were obtained after the electronic equipment was repaired and more experience had been gained. Therefore, it is the opinion of the author that these values are good.

Two methods of determining damping were used and are illustrated in Appendix A. In the Log Decrement method a photograph of the decaying vibration is used to determine the log decrement of the apparatus and of the system (with specimen) at the resonant frequency. Equations presented in Hardin (1970) are then used to compute the damping ratios. In the Frequency and Amplitude of Vibration method, the frequencies and amplitudes of vibration at resonance and at a higher frequency (equal to f_n^2 / f_o) are used to determine the damping capacity.

As can be seen in Table 1, the values of damping of Boston Blue Clay as determined by this testing program are between 1 and 3%. The values for Tests L-1 and AA-1 of 1-1.5% were obtained after an elapsed time of approximately one day whereas the values of 3% for Test G-1 were obtained after four days of testing. Past testing of clay soils (Hardin and Drnevich, 1972; and Richart, Hall, and Woods, 1970) has indicated damping ratios within this range; therefore, these values appear to be reasonable.

LIST OF REFERENCES

Hardin, Bobby O., "Suggested Methods of Test for Shear Modulus and Damping of Soils by the Resonant Column," ASTM, STP 479, pp. 516 - 529, 1970.

Hardin, Bobby O., and Drnevich, V. P., "Shear Modulus and Damping in Soils: Measurement and Parameter Effects," JSMFD, ASCE, Volume 98, SM 6, June, 1972.

Richart, F. E., Jr.; Hall, J. R., Jr.; and Woods, R. D.; Vibrations of Soils and Foundations, Prentice - Hall, New Jersey, 1970.

Trudeau, P. J., "The Shear Wave Velocity of Boston Blue Clay," MIT Department of Civil Engineering Research Report R73-12, Soils Publication # 317, 1973.

DAMPING CAPACITY

OF

BOSTON BLUE CLAY

TABLE I

TEST	LOG DECREMENT	FREQ. & AMP. OF VIBRATION	ELAPSED TIME
	%	%	DAYS
L-1	1.20	1.02	1
AA-1	1.57	1.41	1
G-1	2.91	2.92	4

NOTE: VALUES OBTAINED AT IN SITU $\bar{\sigma}_{OCT}$

APPENDIX A

CALCULATION OF DAMPING FOR TEST G-1

CALCULATION OF DAMPING FOR TEST G-1

$$S = \frac{2 K_o L}{\pi C_m G_{usc} r^4 \, 981 \times 10^3} = \frac{(2)(3.389 \times 10^9)(8.00)}{\pi (1.005)(483)(1.79)^4 \, 981 \times 10^3}$$

$$S = 3.53$$

$$D = \frac{1}{2\pi} \left[\delta_s (1+S) - \delta_A S \right] \times 100\%$$

$$\delta_A = 0.029 \qquad \delta_s = 0.063$$

$$\rightarrow \quad D = 2.91\ \%$$

LOG
DECREMENT

CALCULATION OF DAMPING FOR TEST G-1

$T_n = 4.787$ m Sec $\rightarrow$ $f_n = 208.9$ CPS

$T_o = 5.33$ m Sec $\rightarrow$ $f_o = 187.6$ CPS

$\frac{f_n}{f_o} = 1.114$ $\rightarrow$ $C_1 = 0.867$ $C_2 = 1.25$

$$R = \frac{A_{T_n}}{A_{T_1}} = \frac{27.0}{2.95} = 9.15$$

$$D = \frac{1}{2}\left[\frac{C_1}{R} - C_2 \delta_A\right] \times 100\%$$

$\rightarrow$ $D = 2.92\ \%$

FREQUENCY AND AMPLITUDE OF VIBRATION