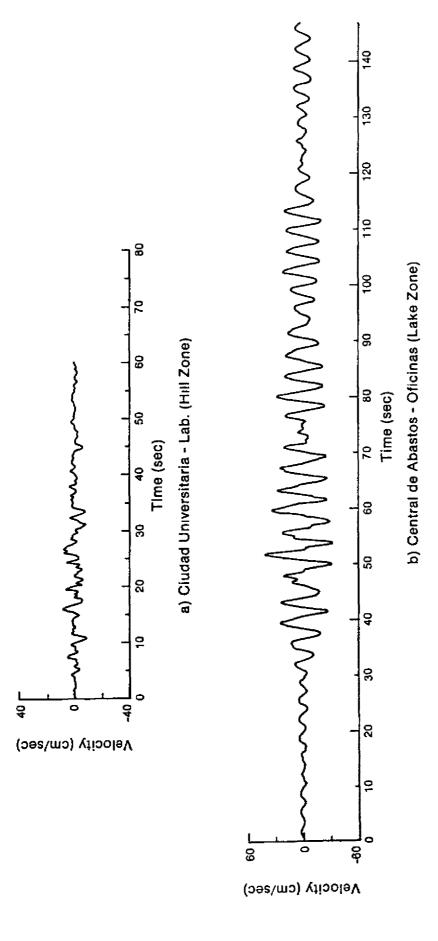


FIGURE 7-5 Reported Failures Along Steel Pipelines In Ciudad Nezahualcoyotl (E.de.M.) in 1985



East-West Velocity Time Histories In Hill And Lake Zones Of Mexico City - 1985 Michoacan Earthquakc FIGURE 7-7

figure 7-1, the resulting R-wave dispersion curves for Poisson ratios (ν) of 0.25 and 0.48 are shown in figure 7-8. Notice for low frequencies (long wavelengths) the R-wave phase velocity is close to the shear wave velocity of the rock half space while at high frequencies (short wavelengths) the phase velocity is close to V_S for the soft top layer.

Having the R-wave dispersion curve plot of phase velocity versus frequency, the ground strain as a function of separation distance can be generated by equation 7.1. This calculation is presented in table 7-I and utilizes the relationship between phase velocity C, wavelength λ and frequency f;

The variation of soil strain $\varepsilon_{\rm S}$ with quarter wavelength separation distance is shown in figure 7-9 for an assumed Poissons ratio of 0.48. Note that the ground strain is a decreasing function of the quarter wavelength separation distance.

7.2.2 Frictional Strain

Strain in the pipeline is induced by friction at the soil pipeline interface. The friction force per unit length $f_{\rm m}$ at this interface is taken as the coefficient of friction times the product of the average overburden pressure and the circumference

$$f_{\rm m} = \mu \cdot \gamma \ z(\frac{1+ko}{2})\pi D.$$
 (7.3)

when μ is the coefficient of friction, γ is the unit weight of the soil, z is the burial depth, ko is the coefficient of lateral earth pressure and D is the outside dimeter of the pipe.

For a ground wave with wavelength λ , the points of zero ground strain are separated by $\lambda/2$. The maximum friction force which such a wave could induce in a pipeline is the friction force per unit length times a quarter wavelength.

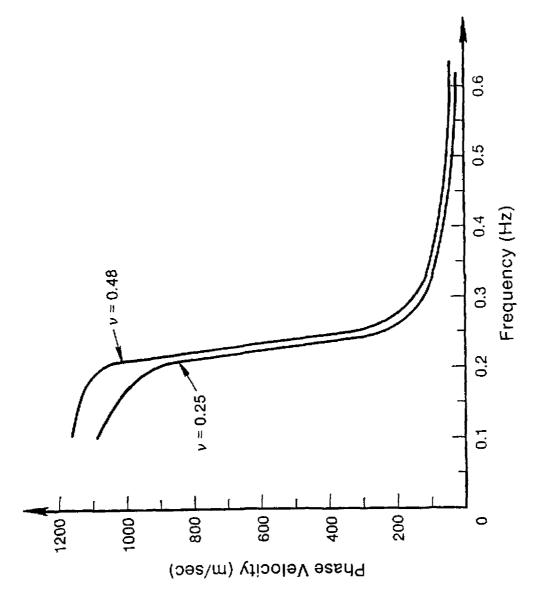


FIGURE 7-8 R-wave Dispersion Curve For Cludad Nezahualcoyotl Site

TABLE 7-I Calculation Of Soil Strain Vs. Quarter Wavelength Separation Distance For Ciudad Nezahualcoyotl Site

Frequency f (hz)	Phase Velocity C (m/sec)	Wavelength $\lambda = C/f$	Quarter Wavelength Separation Distance $L = \lambda/4$ (m)	Soil Strain $\epsilon_{ m s}=v_{ m max}/{ m C}$
0.15	1140	7600	1900	.0003
0.20	1110	5550	1388	.0003
0.25	330	1320	330	.00105
0.30	137	456	114	.0025
0.35	107	306	76.5	.00325
0.40	91.6	229	57	.0038