RESPONSE OF AN EARTH DAM FOUNDED ON A SOIL DEPOSIT TO TRAVELLING SEISMIC WAVES

by
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SUMMARY

The usual assumption made in the earthquake analysis of structures is that the spacial variation in the input motion applied at the base of the structure may be ignored.However, for structures whose length is of the same order of magnitude as the wavelengths of the significant components of the earthquake motion,the speed of the travelling wave can greatly influence the structural response.Various types of soil-structure system have been investigated(1),but herein only the results for an earth dam are reported. The system with the material properties is shown in Fig.1.The underground consists of a horizontal isotropic soil layer,terminated at the sides by vertical dissipating boundaries of the type proposed by Lysmer and Kuhlemeyer. The wave motion characteristics are those of the underlying medium through which the earthquake propagates. In the analysis it is assumed that no energy is returned to this medium. To solve the problem of the dynamic interaction of the dam-layer system the method of finite differences is adopted. Details of the method are given in (1). The equations of plane wave propagation are discretized using central finite differences in space and time.Simple relations at boundaries and interfaces are achieved using interlacing nets for the field variables.

RESULTS

Some numerical results are given in Table 1 for 16 sec of the horizontal component S 69^{o}E of the Taft 1952 Earthquake, having a maximum acceleration of 174.5 gals. 2000 time integration steps were required. Computed displacements and velocities presented in Table 1 are absolute values,i.e. not relative to the input base motion. Two speeds of travelling wave, namely infinity (the usual assumption) and that equal to the shear wave velocity of the layer,indicate approximately the extreme values likely to be obtained for the given elastic system. Damping of about zero and 15% critical for the first mode of vibration is introduced into the wave equations. This, together with dissipation on the transmitting boundaries, substantially reduces the response, cf. stresses in Table 1.

(1) REFERENCES: Prater E.G. and M.Wieland:
'Hydrodynamic Pressures on Dams', Symposium on Numerical Analysis of Dams, Swansea, U.K., Sept.1975, pp. 685-707.

'Response of Structures embedded in the Ground to Travelling Seismic Waves', Symposium on Earthquake Structural Engineering, St.Louis, U.S.A., August 1976.

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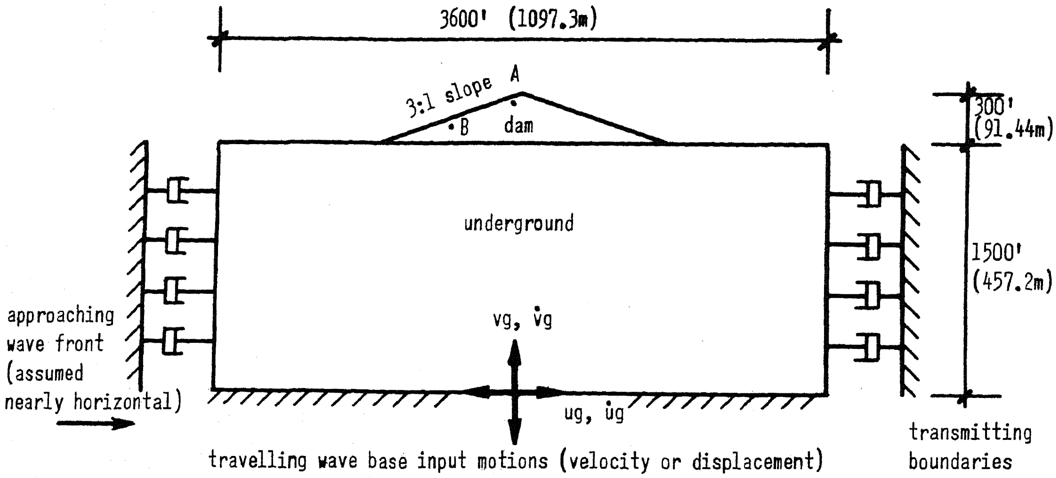

Fig. 1 Geometry of dam - soil layer system.

Fundamental frequency of system (with rigid side boundaries) equals ca. 1 rad/sec. Material properties (same for dam and soil layer):

Elastic constants $E = 57160\ t/m^2$, $\nu = 0.45$

Unit weight $\gamma = 2.08\ t/m^3$

Side boundary condition		RIGID		TRANSMITTING	
Travelling wave speed (m/sec)		305	infinite	305	infinite
	Damping (%)				
A. hor. disp. (m)	0.7	0.42	0.46	0.36	0.38
	15	0.29	0.31	0.26	0.29
velocity (m/sec)	0.7	1.55	1.39	1.02	1.48
	15	0.74	0.86	0.59	0.86
octahedral normal stress (t/m^2)	0.7	11.24	19.45	7.28	19.16
	15	4.89	9.64	4.12	11.05
B. hor. disp. (m)	0.7	0.41	0.37	0.35	0.32
	15	0.28	0.29	0.26	0.27
velocity (m/sec)	0.7	0.94	0.74	0.62	0.56
	15	0.42	0.40	0.40	0.37
octahedral normal stress (t/m^2)	0.7	36.30	38.70	24.54	30.91
	15	18.89	20.52	18.07	18.41

Table 1. Some maximum response values for 2 points in dam
A. a point near the apex of the dam
B. a point near the middle of the slope

Notes: stresses given are exclusive of static values; the computed max. input displacement and velocity = 23 cm , and 14.8 cm/sec respectively.