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SEISMOGRAPHIC RECORDING OF BLASTS AT BHAKRA

In order to study the effects of large blasts on structures at and near the Bhakra Dam, records of ground movements due to test blasts ranging from 10 to 200 lb of dynamite were obtained by two India met. Dep. type Wood-Anderson Seismographs between 27 and 29 December 1959. These instruments were installed in Block No. 26 A, Gallery EL. 1428 ft of the dam. One of them recorded the component perpendicular to the axis of the dam and the other parallel to it. Both of them were set at a period of 2 seconds and nearly critical damping and had a static magnification of 900. The recording drum was run at a speed which gave to it a peripheral speed of 8 mm per second. Since the period of ground motion recorded during the experiments was very low, the amplitudes of the recorded waves divided by the static magnification gave directly the ground displacement.

The results of the experiments are shown in Table 1, which gives the weight of explosive employed, the distance of the seismograph from the explosive, the observed maximum displacement and the corresponding wave period for both the components. It will be seen that the maximum amplitude in the case of the transverse component is associated with a period of 0·22 second and for the parallel component with a period of 0·16 second.

The amplitudes given in Table 1 were reduced to 1000 ft on the assumption that amplitudes vary inversely as the square of the distance, and have been plotted for the transverse component in Fig. 1 on a double log graph-paper against the corresponding weight of explosive. The straight line which joins the points, supports the result obtained by Carder and Cloud (1959) that the displacements are proportional to 3/4 power of the charge, but all the observed points in the present case are less by a factor of 10 than

TABLE 1

Shot No.	Charge	Distance of shot from seismo-meter	Amplitude		Period		Remarks
			Component transverse to dam	Component parallel to dam	Component transverse to dam	Component parallel to dam	
	(lb.)	(ft)	(mm)	(mm)	(sec)	(sec)	
1	10	1077	0·0005	0·0005	0·16	0·16	
2	20	1064	0·001	0·0009	0·20	0·16	
3	60	1051	0·002	0·001	0·23	0·07	
4	150	1054	0·009	0·005	0·21	0·16	
5	10	1005	0·0007	0·0004	0·21	0·10	
6	30	993	0·002	0·001	0·21	0·15	
7	100	1087	0·004	0·003	0·20	0·16	
8	200	1080	0·005	0·006	0·23	0·16	Exploded in two holes
9	30	1071	0·001	0·00055	0·21	0·15	
10	60	1077	0·002	0·0011	0·23	0·16	
11	100	1064	0·0033	0·0022	0·21	0·16	
12	2258	2660	0·018	Trace faint	0·25		With 15 milli-second delays in 60 holes. Maximum in a single hole 70 lb

those to be expected from the formula—

$$A = 3{\cdot}6\,(W^{0{\cdot}75}/D^2)\times 10^4 \text{ cm}$$

given by them. Here A is the amplitude in cm, W the weight of explosive in tons and D is the distance between the explosive and the seismograph in ft. In the present case the dam on which the instruments were installed is founded on basement rock and the explosions were conducted in the overburden and hence the recorded ground displacement is much lower than expected.

Table 1 also includes one observation (No. 12 blast) which was obtained at a distance of 2660 ft due to a quarry blast of 2258 lb of explosive placed in 60 holes with a number of milli-second delays, the maximum charge in a single hole being not more than 70 lb. It was expected that this shot would give ground displacements considerably lower than those due to a single charge of 2258 lb but on the contrary the recorded displacement has been found to be of the same order as to be expected from a single charge of 2258 lb. This observation shows that at distances of

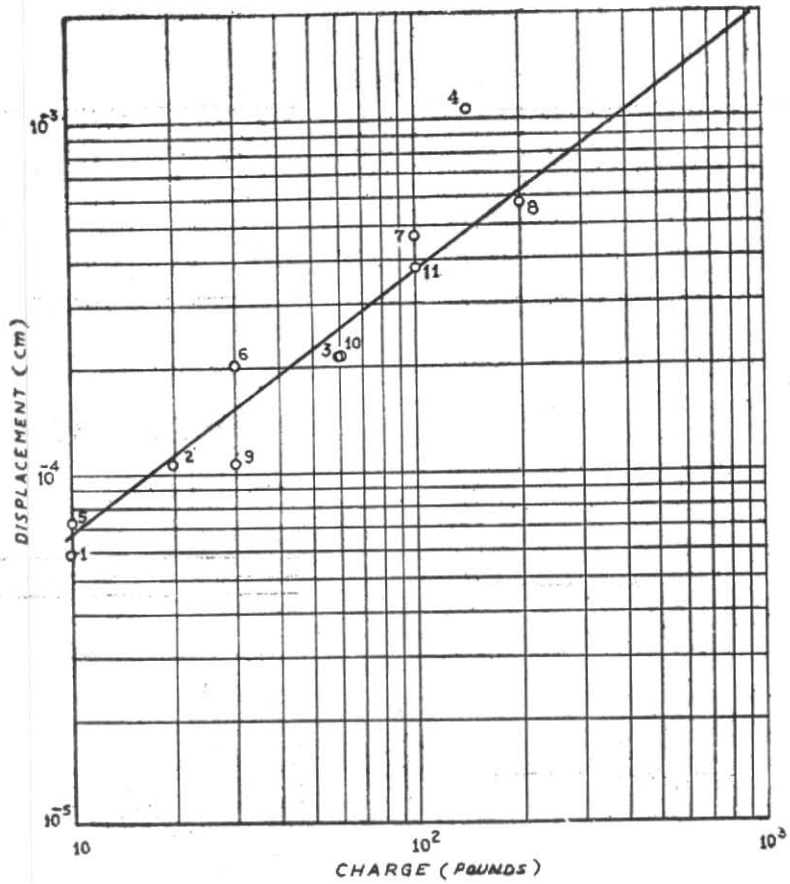

Fig. 1

the order of 2500 ft or more, milli-second delayed blasting does not always help in reducing vibrations.

Tracings of records of a few blasts are reproduced in Fig. 2 for both the components. The coda of nearly all the record contains a predominant period of 0·32 for the transverse component and 0·22 for the longitudinal component. Apparently these give the natural period of the dam in its present state of construction in the transverse and longitudinal components respectively.

The above account is only a preliminary report. It is proposed to undertake a detailed study of the records in due course.

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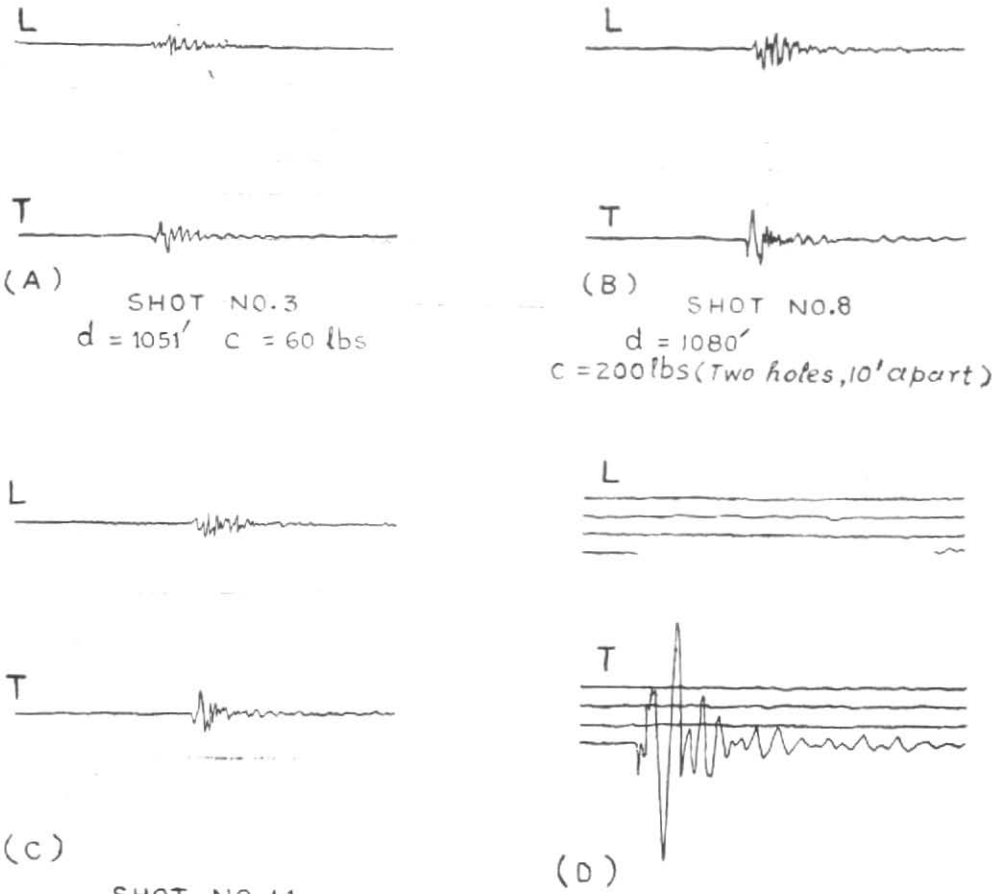

(A)-(D): T_o = 2 Sec; V_S = 900; h = 1

L = Vibrations parallel to axis of Dam

T = Vibrations perpendicular to axis of Dam

SCALE

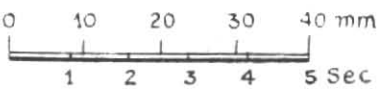

Fig. 2