I-339 COMPARISON OF GROUND STRAINS EVALUATED BY A DENSE SEISMOGRAPH ARRAY WITH OBSERVED BURIED PIPE STRAINS

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INTRODUCTION: A very densely located seismometer array network was installed in Chiba Experiment Station of the Institute of Industrial Science, the University of Tokyo and has been operating since April , 1982. The network is composed of 36 three-component accelerometers which are capable of simultaneous recording of 108 components of ground accelerations. A complementary system, which includes the direct measurement of strains in ground and buried steel as well as ductile-cast-iron pipes, was completed and began operation in December, 1982.

Using the ground acceleration records obtained by this network, the ground strains have been evaluated. In this paper it is shown that the evaluated ground strains show quite good agreement with the directly observed strains in buried steel pipes.

METHOD OF ANALYSIS: Finite element method in three dimensional space has been employed. A tetrahedron element with an assumed linear shape function constitutes a basic element. Fast Fourier transform was applied throughout the analyses. All the integrations for calculation of velocities and displacements were performed in frequency domain.

RESULTS: In the present study the earthquake of March 6, 1984 which occurred near Torishima Island is analyzed. The magnitude of this event was 7.9 on the Richter scale with focal depth of 460 Km and epicentral distance of 690 Km. The maximum recorded acceleration at the observation site was about 28 Gals.

An element with approximate sides of 100 m and 30 m was chosen. Figure 1a shows the observed strain in steel pipe and the ground strain evaluated in the same direction as that of the pipe for the initial 40 s of this event. The calculated strain shows surprisingly good agreement with that directly observed in the steel pipe. The EW components of recorded acceleration, calculated velocity and displacement of a typical point are shown in Fig. 2a.

It is very important to notice that although with the lapse of time the acceleration amplitude shows dramatic decrease, the strain amplitude does not decrease significantly. However, the longer period components become dominant. This aspect can be clearly seen in Fig. 1b. This figure shows the observed pipe strain and the evaluated ground strain time histories after a time lapse of almost 80 s. Two interesting points are particularly noticeable. 1) The similarity between evaluated and observed strains. 2) The longer predominant period components in the latter part of the ground motion duration. The acceleration as well as velocity and displacement time histories of the same part are shown in Fig. 2b. It is shown that the high frequency components are greatly suppressed and, particularly, the acceleration amplitude decreases significantly with the maximum value of less than 4 Gals. The velocity also shows some decrease but the amplitude of displacement is almost the same.

CONCLUSIONS: In the present study the effectiveness of the method used to evaluate the seismic-induced ground strain by a very dense seismometer array observation was discussed. For the especial event considered here, it was revealed that higher frequency components are predominant for the initial part, but as the time lapses and the amplitude of acceleration decreases, the lower frequency components become predominant without any significant decrease of strain amplitude.

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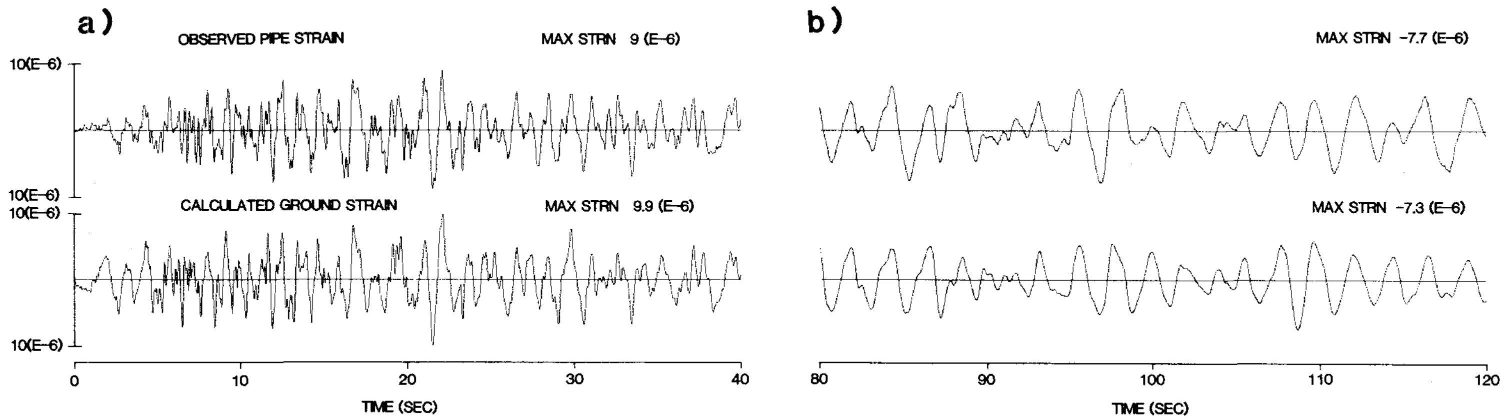

Fig. 1 Observed Pipe Strain and Calculated Ground Strain Time Histories

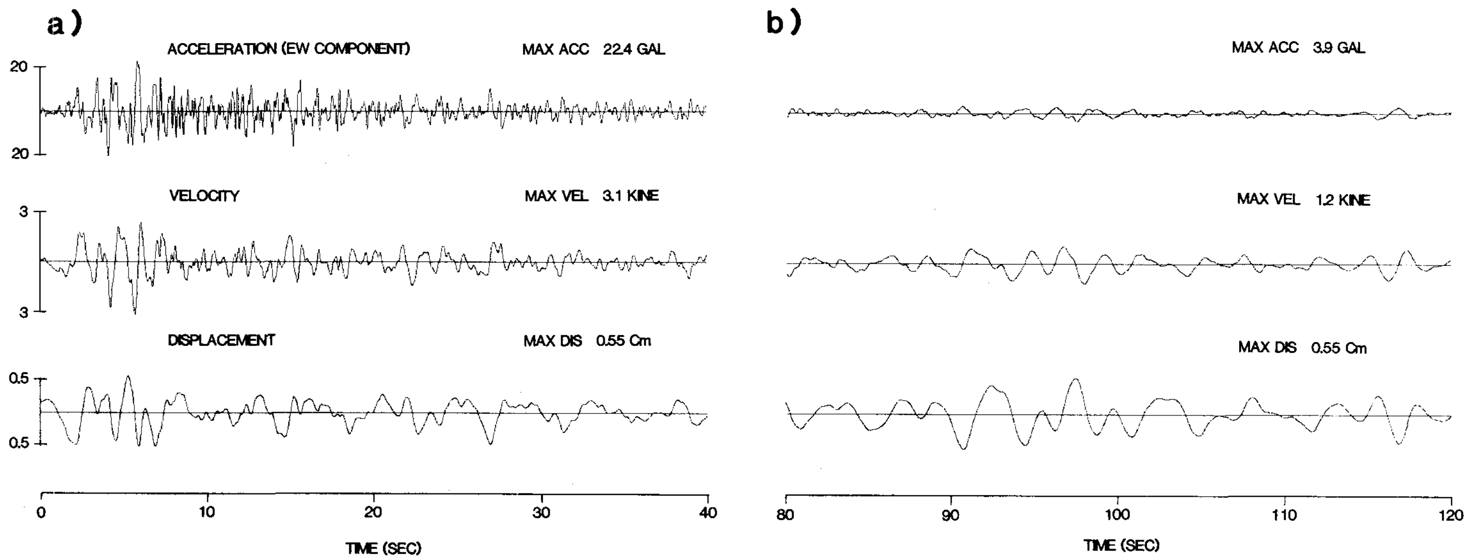

Fig. 2 Acceleration, Velocity, and Displacement Time Histories at a Typical Point (EW Component)