III-401

SAND CONE BEHAVIOR DURING EARTHQUAKE DISPLACEMENT (N-S COMPONENT)

Stojnic Nedeljko, Researcher Stud., Earthquake Research Institute
Hiromichi Higashihara, Prof., Earthquake Research Institute

1. Introduction

Big accumulation of the sand material in areas that exposed to strong motion during earthquake occurrence, can bring in endanger people and facilities in the nearness. The study summarized behavior of the sand cone during Hokkaido earthquake, August 8. 1993. (max. accel. 1.6g at Otobe-cho, M=7.9), using DEM (Distinct Element Method). The method proposed by Cundall 1971., already demonstrated its efficiency for assessing destruction process in noncohesiv media exposed to large material transport.

2. Simulation of sand cone shaking

In this study the hypotethical sand cone situated on the horizontal surface with length of 10.75m and height of 3.30m (Fig.1.) is used. Dimension of the sand cone we decided on the assumption that in many places where exist artificially made sand accumulations in purpose of some engineering activities, sand cone of few meters in the height are so frequently. Shape of the hypothetical sand cone (Fig.1.) is used as the base for sand cone modeling by DEM. The DEM model of the sand cone material with flat base is shown on Fig.2. To study dynamic behavior from the bothom to the top the sand cone model is divided into three same thickness zones; lower, middle and upper (Fig.1.). Sand as the uniform material is modeled by 356 circular elements with diameter 0.25m. Base of the sand cone is modeled with 228 circular elements with diameter 0.125m. Parameters of analysis are calculated according to Meguro and Hakuno (1988). Displacement data of the horizontal (N-S) component used in sand cone simulation, are recorded on location 42.0355 N, 140.0908 E, first floor of a two story reinforced concrete building (Fig.3.).

During the 27.9(s) of simulation it is visible that process of the collapse start at the top has tendency to extend to the bottom of the sand cone (Fig.4.). Sand cone behavior from 7(s) to 10(s) of the simulation show that except value of amplitude, also frequency of base displacement has influence on sand cone collapse. The collapse material from the top of the cone gradually move to the middle and lower part. In that way initial shape of the sand cone step by step change into one round form. During all process of the simulation only few sand particles reach model base. The results of response spectra (acceleration, velocity and displacement) obtained from divided zones is calculated as average value of all particles belong to the divided zones (Fig.5.). Considering results of the response spectra we can see that maximum energy is concentrated at the top of the sand cone. The sand cone model during the process of simulation until first collapse, show that maximum energy concentration occur at the upper zone. From the top to the bottom zone energy concentration in the zones gradually decrease, what is typical behavior for objects exposed to process of shaking.

3. Conclusions

Results presented indicate the following:

1) Response spectra of divided zones during the process of shaking until first collapse is in agreement with response spectra obtain by Finite Element Method (FEM) before the collapse process of the similar model (Fig.6.).

2) Collapse of the sand cone that start from the top of the model is natural response on the horizontal displacement of its base.

3) Horizontal displacement in N-S direction of the Hokkaido earthquake (M=7.9) could not distroyed sand cone in the way to endanger people and surrounding facilities on the recorded place.

4) DEM modeling and analyzes technic might predict behavior of the sand cone during strong motion as well as endanger zone caused by cone collapse

4. References

1) Hirosi. I. and Hiroyuki. W. Experimental and Analytical Study on Stability Evaluation of a Large Slope Under Strong Seismic Motion. Jurnal of JSCE, No.406., Vol. III-11. pp. 233-241., 1989.

2) Iwashita. k. and Hakuno.M., Granular Assembly Simulation for Dynamic Cliff Collapse due to Earthquake, Proc.JSCE. No. 380/I-7. 1987.

3) Meguro.K and Hakuno.M. Fracture Analyses of Concrete Struçtures by Granular Assembly Simulation. Bulletin of the ERI, University of Tokyo. Vol.63. Part.4. 1988.

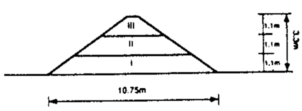

Fig.1. Shape of the sand cone model

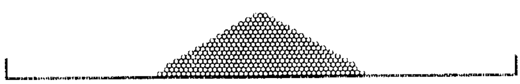
Fig.2. DEM model of the sand cone

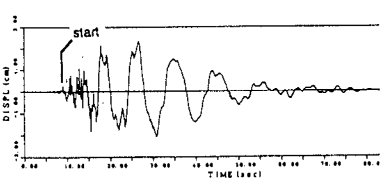

Fig.3. Displacement of Hokkaido earthquake N-S componten location 42.0355N, 140.0908E

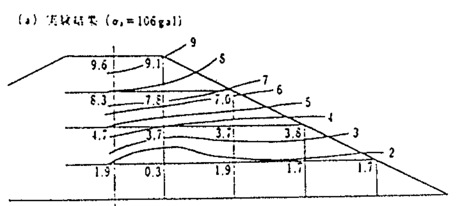
Fig.6. Result of the embankment simulation by FEM during seismic strong motion.

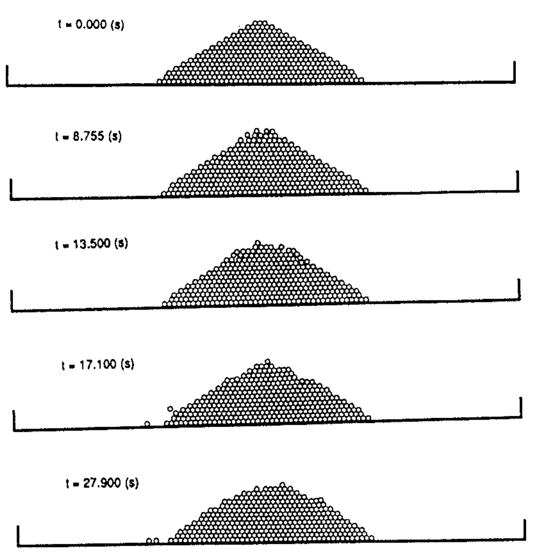

Fig.4. Results of DEM simulation

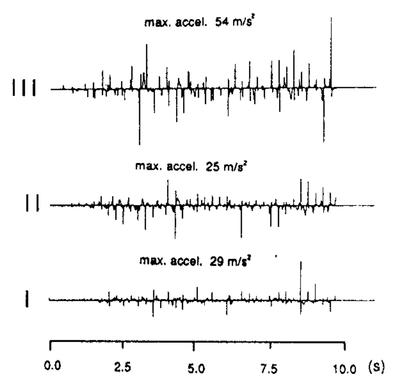

Fig.5. Response acceleration of the sand cone zones in N-S direction