The comparative analysis of the soil seismic response procedures and the measured records

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Abstract

SHAKE2000 and LSSRI-1 are the two most widely used one-dimensional equivalent linear soil seismic response analysis programs. Both the programs use the equivalent linearization method to solve nonlinear seismic response analysis of soil. In order to test the accuracy of the two programs, a strong earthquake ground motion record which is selected from the NMRH05station class Ⅲ site of the KiK-net Network is as input ground motion. By using these two programs to calculate the peak ground acceleration, soil maximum shear strain and acceleration response spectra. By comparing the results of the two procedures and the measured results to evaluate the proximity of these two methods and then judge which program is closer to the real situation. Studies have shown that the dynamic nonlinear of the soil has a serious effect on the surface ground motion, besides, the results of SHAKE2000 and LSSRLI-1 differ little. But according to the measured records, there are some differences between the two programs results and the measured records.

Keywords

Equivalent linearization, LSSRLI-1, SHAKE2000, result, Strong motion records.

1. Introduction

Seismic response analysis of soil as an essential part of seismic design, from research to date, has nearly a decade of history, rapid and accurate determination of ground motion, the direct impact of the earthquake safety of engineering structures, while the question of the project cost also have a significant impact, therefore, study the seismic response analysis of soil is significant[1,2].

SHAKE2000 and LSSRI-1 are the two most widely used one-dimensional equivalent linear soil seismic response analysis programs [3]. LSSRLI-1 program is the " Project site seismic safety evaluation of technical specifications " recommended method，and is mainly used for soil seismic response analysis of the problem.

This article use these two procedures to calculate the specific logging section, compared the results of the calculation of the surface with the measured results, in order to test the ability of these two procedures and the accuracy of practical problems, in order to better serve the engineering practice services, but also to promote research work in this field.

2. KiK-net Introduction

KiK-net name is Kiban Kyoshin network, both underground bedrock acceleration record and when the ground acceleration process are can be recorded, in Japan, about 700 observation stations. After the earthquake, KiK-net stations recorded the earthquake data can be transferred immediately to the NIED (NIED) data management center, these data open, cross-sectional views of stations also open to the public, people can log data and information from (http://www.kyoshin.bosai.go.jp/), and use this information to carry out site response analysis of soil classification and calculation.

3. Site Data

This paper uses a NMRH05 station profile, there is a complete record of down hole and surface bedrock. The venue of standards by the Chinese as Class III sites [4], logging depth of 220m, the details are shown in Table 1.

Table 1 NMRH05 Station information

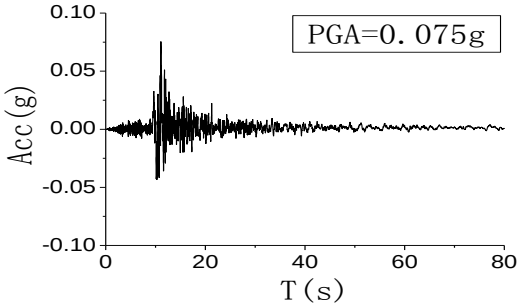
Number	Soil thickness (m)	Depth (m)	Vp (m/s)	Vs (m/s)
1	4	4	310	130
2	4	8	310	190
3	12	20	1640	190
4	40	60	1640	350
5	100	160	1640	390
6	60	220	1640	540

4. The Calculation Parameter

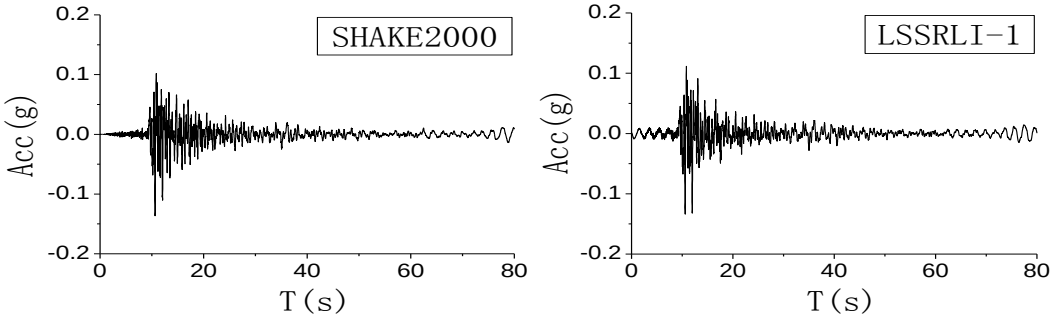
According to the uncertainty of non-linear dynamic shear modulus ratio and damping ratio of soil, under the same section and the same input ground motions, three nonlinear cases are used, the weakly nonlinear condition, the mean nonlinear condition and the strong nonlinear condition. The weakly nonlinear condition is the dynamic shear modulus using maxima value and the damping ratio using minimum value; the mean condition is the dynamic shear modulus ratio and damping ratio all taking the average values; the strongly nonlinear condition is the dynamic shear modulus using the minimum value and the damping ratio using the maxima value[5].

5. The Results

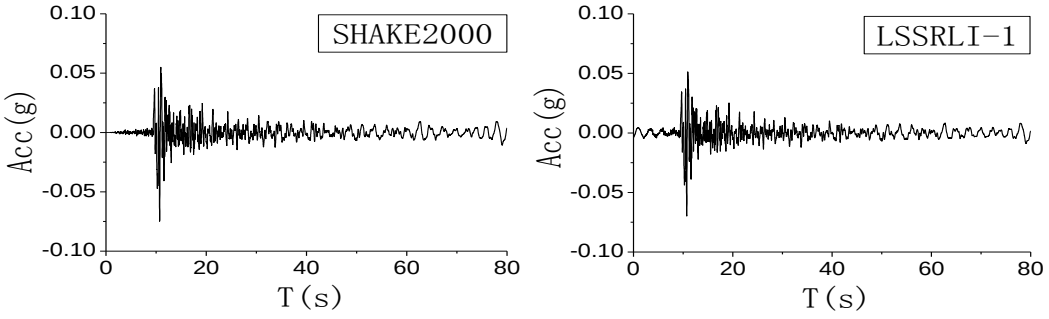
This paper compared SHAKE2000 with LSSRLI-1 from the acceleration, response spectra and soil shear strain variation with depth three aspects. the acceleration just as Figure 1, the response spectra and soil shear strain are shown in Figure 2 and Figure 3.



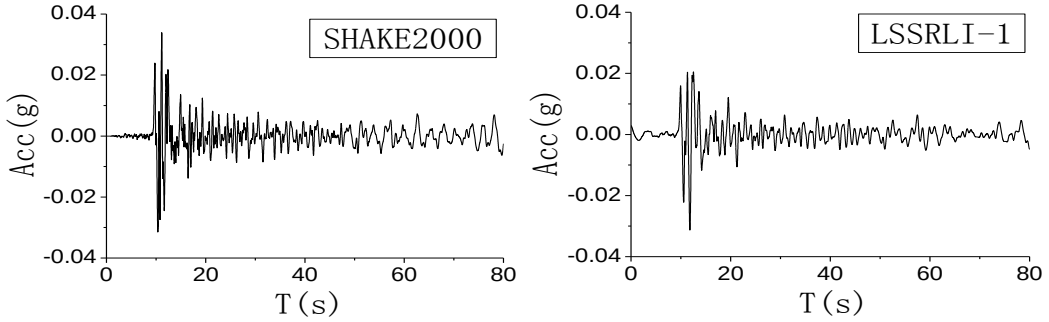
(a) Measured ground acceleration



(b) weakly nonlinear

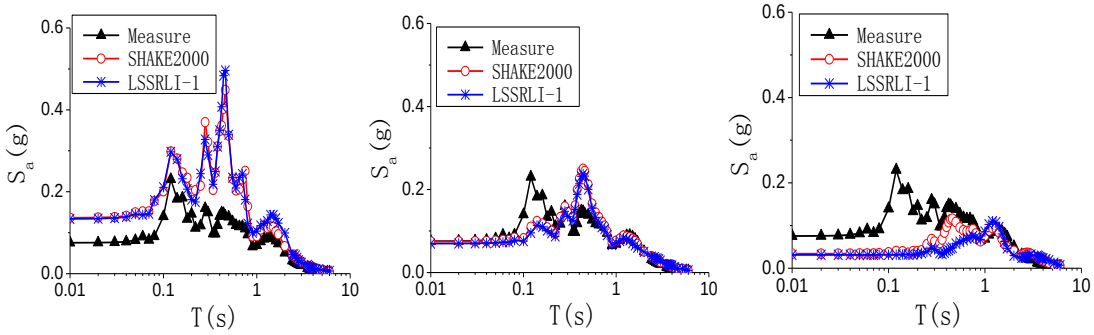


(c) mean nonlinear



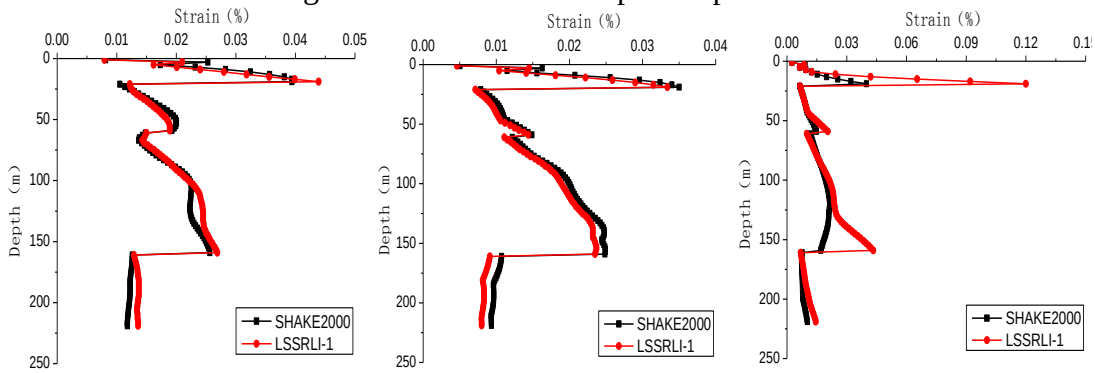
(d) strongly nonlinear

Fig.1 NMRH05 station acceleration



weakly nonlinear mean nonlinear strongly nonlinear

Fig.2 NMRH05 station response spectrum



weakly nonlinear mean nonlinear strongly nonlinear

Fig.3 NMRH05 station maximum shear strain distribution along the depth

6. Conclusion

This paper is based on the soil profile and the measured data of NMRH05 station at the KiK-net network and uses SHAKE2000 and LSSRLI-1 two equivalent linear programs to compare the calculation. Results showed that:

(1) Under three nonlinear, SHAKE2000 and LSSRLI-1 ground acceleration, response spectrum, shear strain less, basically the same.

(2) According to the record ground acceleration and the acceleration response spectrum, under the weakly nonlinear, the results of SHAKE2000 and LSSRLI-1 are big than the measured results, under the mean nonlinear, the results of SHAKE2000 and LSSRLI-1 are nearly the measured results, under the strongly nonlinear, the results of SHAKE2000 and LSSRLI-1 are less than the measured results,

(3) Under the same venue and the same waves, for all conditions, the results of the two programs has large different, the result of weakly nonlinear case is the maximum, followed by the mean, the minimum is strongly nonlinear case, reflects the dynamic nonlinear effect on the surface ground motion.

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