IOP Conference Series: Earth and Environmental Science

PAPER • OPEN ACCESS

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To cite this article: A Namdar 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **289** 012009

IOP Conf. Series: Earth and Environmental Science **289** (2019) 012009 doi:10.1088/1755-1315/289/1/012009

The concrete footing-soil foundation seismic interaction, strain energy and stress mechanism

A Namdar

Faculty of Architecture and Civil Engineering, Huaiyin Institute of Technology, Huaian 200300, China

ab_namdar@yahoo.com

Abstract. The seismic stress-strain soil foundation response needs to evaluate with high quality in geotechnical earthquake engineering design. The stress and strain are controllable in soil foundation design. In the present study, the simulated near-fault ground motion has been applied on the model and the seismic resistance of concrete footing to produce shape and magnitude of seismic stress investigated. The main objective of this study is to understand, the concept of strain energy density dissipation mechanism in geotechnical earthquake engineering. The strain energy has been discussed based on results of numerical analysis and those have been reported in the literature. The results have been found that the strain energy density dissipation mechanism meaningfully effects on concrete foundation stress mechanism production and it leads to produce seismic differential settlement mechanism for concrete footing.

1. Introduction

From the literature, analysis has been realized that the displacement mechanism of the concrete footing, failure mitigation of soil foundation, soil bearing capacity, soil-concrete foundation interaction, Seismic bearing capacity factors for spread foundations and liquefaction are predictable [1-6]. And on the other hand, the shape of a cross-section is played main responsibility in strain energy density dissipation mechanism [7-8]. The concept of strain energy density and strain energy dissipation mechanism is a complex issue, especially in geotechnical earthquake engineering. The magnitude of stored and radiated strain energy depends on a model elasticity characteristics and produce damping ratio. The damping ratio of a model can be modified by model configuration enhancement. The main objective of this study is to understand, effect simulated near-fault ground motion in stress mechanism production and strain energy density dissipation mechanism. The concept of strain energy density dissipation mechanism in geotechnical earthquake engineering has not been reported in the literature. In the present study, stress mechanism production in strain energy density dissipation mechanism have been evaluated and compared with those have been reported in the literature.

2. Modeling

The model configuration is a concrete footing and soil foundation. It has been subjected to the near-fault ground motion. The boundary condition has been made based on the real problem and the strain energy density realizing based on the model seismic response. The strain energy density dissipation mechanism in stress developing has been discussed in consider concrete footing-soil foundation interaction. In the present study, stress mechanism production in displacement mechanism has been evaluated. Two models have been compared, and the strain energy function was explained with respect to the seismic response of the concrete footing-soil foundation.

3. Discussion and analysis

The seismic acceleration load response versus stress has been interpreted in details [1], the novelty of present study is different scale has been used for more explanation stress mechanism production in strain energy density dissipation mechanism, while the concrete footing-soil foundation has seismic interaction. The shape and depth of embedded concrete footing in soil foundation is responsible to produce stress with different magnitude and mechanism. Figures 1 and 2 show that the strain energy has been dissipated with two different mechanisms, and results to produce different stress paths for each model. The dissipated hysteretic energy is not recoverable in all models. The dissipated viscous damping energy more effects with respect to resonance and causes the seismic differential settlement of concrete footing. The cyclic stress mechanism is appeared based on dissipated hysteretic energy. The strain energy density is minimized with respect to the depth of embedded concrete footing in soil foundation, but the concentration strain energy density has more occurred with full embedment of concrete footing in the soil foundation. This concentration strain energy density is a function of full embedded concrete footing in soil foundation and results in elastic strain energy reduction. From the energy point of view in a seismic load-stress diagram the strain energy stored 10 times reduced stress at the base of the concrete footing. The hysteresis loop shows recover strain energy dissipated. It has been observed that with the same magnitude of the applied load, the nonlinear elastic response develop stress mechanism. The strain energy density can be design in earthquake geotechnical engineering with artistic concrete footing design. The boundary condition governs strain energy density dissipation and concentration at each model when the model is subjected to simulated near-fault ground motion at any instant of time and causes modification of seismic acceleration load response, stress and strain energy in the models.

The accumulation of strain energy density causes a vibration mechanism and failure pattern of soil foundation. The magnitude of strain energy released at each model is different. The numerical analysis revealed that the radiated seismic loading and the strain energy dissipation change in respect to the configuration of soil foundation and concrete footing at each model. The strain energy density significantly influences by soil foundation-concrete footing interaction and develops differential displacement, internal elastic energy, and shear stress.

The concept of strain energy has numerically been applied to predict timber structural element seismic design with reference to small displacement theory, evaluation of strain energy or internal energy release analysis, seismic loading interaction and seismic excitation in structural element vibration. It has been found that the timber frame geometry modified strain energy dissipation characteristics. The strain paths at each model indicate the directions, density, and magnitude of strain energy [9]. The excess pore water pressure modified nonlinear collapse of an embankment when the embankment has been subjected to horizontal cyclic loading [10]. The geological site condition and groundwater level are two important factors in strain energy release and dissipation. The stressed concrete footing-soil foundation dissipated strain energy based on two surface interaction and model geometry. Figures 1-3 are shown that the concrete footing-soil foundation interaction at nonlinear low strain rates and high strain rates has two different seismic response. The nonlinear strain rates have highly affected by model geometry. The maximum model strain causes permanent displacement. With reference to the small displacement theory, the cyclic nonlinear displacement directly related to maximum strain energy propagation due to seismic wave excitation. The shear based applied on concrete footing is less effective when concrete footing full embedded in soil foundation. This displacement is not absolute related to near-fault ground motion, the concrete footing-soil foundation interaction also has influenced on the displacement. The nonlinear base shear base shear has negative effects to strain energy density concentration. With attention to small displacement theory the displacement design, is the best compromise in seismic soil foundation design. The increasing higher time damping ratio of a model results in the higher efficiency of acceleration to displacement mechanism through the more shear stress effective, however, this is an important design principle in earthquake geotechnical engineering to enhance the safety of the structure. The displacement of the concrete footing is a function of strain energy density in continuous model shaking in time basis. This displacement is based on the strain energy in produce stress, the maximum displacement is repeated for several cyclic strain energy releasing. It means cyclic differential settlement repeated as the basis, the strain energy propagation, and dissipation magnitude and mechanism. The displacement can be varied base on internal energy interaction at any configuration. The dynamic response of concrete footing develops nonlinear damping based on strain energy propagation and leads to occurrence vibration at each model with a specific dynamic response. The complex characteristics of nonlinear displacement are an important issue in concrete footing seismic design. The energy dissipation for concrete footing appeared in form of displacement after the stress has been applied to the concrete footing. This leads to the concept of equivalent strain energy density and dissipation. Therefore, the strain energy will be dissipated by concrete footing seismic characteristics. The comparative figure 1 with figure 2, it has been understood with increase strain energy the shape of stress paths leads to behaving with more nonlinearity in shape. In case two strain energy has released with the same magnitude if the stress path is more nonlinear in one case, that case shows more vibration of the model. The magnitude of strain energy is different from the strain energy function. The function of strain energy is related to the magnitude of energy and seismic response of the model. In study soil foundation-concrete footing seismic interaction the realistic model is necessary. The accurate model and applied force support geotechnical earthquake engineering. The seismic analysis of concrete footing-soil foundation interaction requires more investigation for improvement in design point of view.

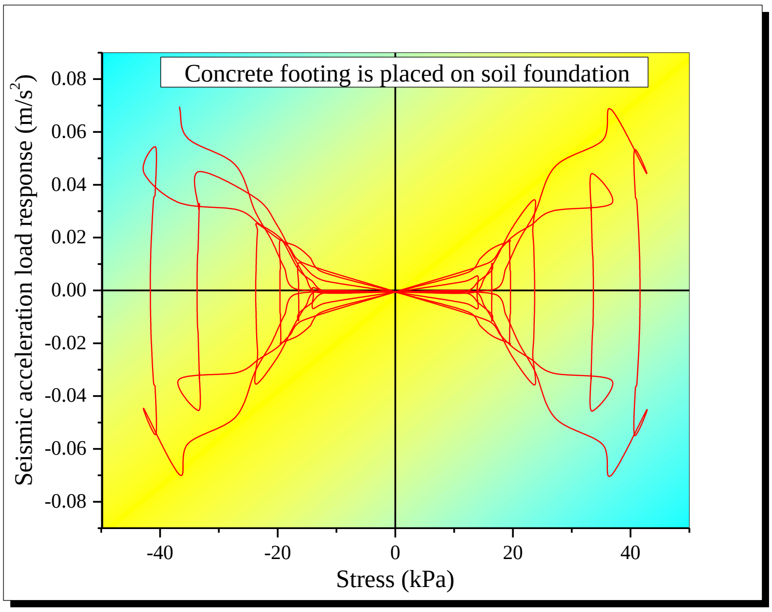

Figure 1. Seismic acceleration load response vs stress at the base of a concrete footing, during concrete footing-soil foundation interaction [1].

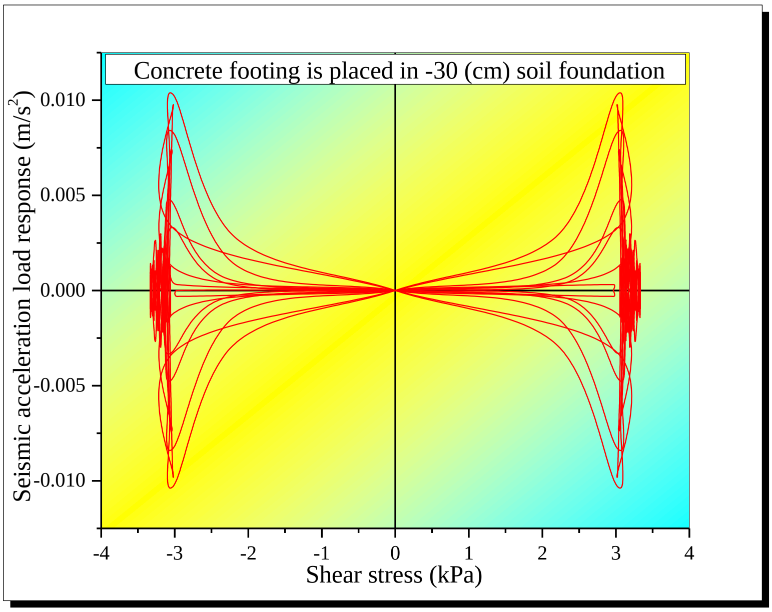

Figure 2. Seismic acceleration load response vs stress at the base of a concrete footing, during concrete footing-soil foundation interaction [1].

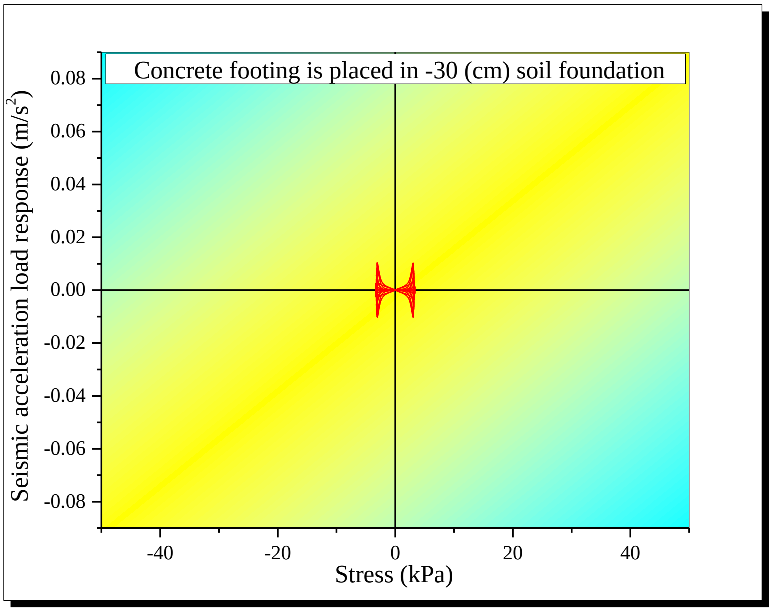

Figure 3. Depict figure 1 same scale used in depict figure 2 [1].

4. Conclusion

In the present study, the core investigation is stress and effect of stress to develop concrete footing displacement has been evaluated with respect to the results of numerical simulation. The shape and depth of embedded concrete footing in soil foundation are responsible for producing stress with different magnitude and mechanism. The strain energy density dissipation mechanism influence to concrete foundation stress mechanism. The seismic differential settlement of concrete footing has been produced respect to cyclic stress mechanism. The release strain energy density is minimized with respect to the depth of embedded concrete footing in soil foundation. The concentration strain energy density has more occurred with full embedment of concrete footing in the soil foundation. The strain energy density can be design in earthquake geotechnical engineering with artistic concrete footing design. The boundary condition governs strain energy density at each model. The increasing higher time damping ratio of a model results in higher efficiency of acceleration to displacement mechanism through the more shear stress effective. The dynamic response of concrete footing develops nonlinear damping based on strain energy propagation and leads to occurrence vibration at each model with a specific dynamic response. The function of strain energy is related to the magnitude of energy and seismic response of the model.

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