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厦门典型地基土的地震反应分析与评价

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摘要 为评价厦门地基抗震的稳定性, 用有限元法对4个典型场地进行了地震反应分析, 并用《建筑抗震设计规范》(GB50011-2001)推荐的方法和振动台模型试验结果作了综合评判。第1场地包含1层填土、2层砂土和1层软土, 第2场地为厚10 m的填土, 第3场地为厚26 m的软土, 第4场地为厚15.5 m的饱和含泥中粗砂。各种土的本构关系都采用等效非线性模型, 用提出的孔压模型计算砂土的动孔压变化, 用量软化法计算地基永久变形; 模型参数主要来自研究成果。场地用八节点等参元剖分, 采用单元集中质量矩阵和瑞利阻尼矩阵, 用Wilson- $\theta$ 法和波前法求解动力反应方程。共分析了20种工况: 包括3种输入地震波(2种厦门天然波和松潘波)、3种地震加速度峰值(0.15, 0.2和0.3 g)、4种静荷载强度(0, 50, 100, 150 kPa), 得到了各场地的变形场、孔压场、震陷量、隆起量和液化等级。研究表明: 在强震作用下, 填土地基的震陷量较小, 对环岛路影响不大; 深厚软粘土地基震陷量较大, 从局部剪切破坏向整体剪切破坏发展; 埋藏较浅的砂土会发生液化。研究成果对厦门市的地基抗震决策有重要参考价值。

关键词 [地震工程](#); [地震反应分析](#); [有限元方法](#); [液化](#); [震陷](#); [软土](#); [填土](#); [振动台试验](#)

分类号

ANALYSIS AND EVALUATION OF SEISMIC REACTION OF TYPICAL FOUNDATION SOILS IN XIAMEN

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Abstract

In order to evaluate the seismic stability of foundation

soil in Xiamen, earthquake reaction analysis for 4 typical sites were conducted using FEM and the way recommended by code for seismic design of buildings (GB50011–2001 of China) as well as shaking table test. The first site consists of a stratum of fill soil and two layers of sands as well as a layer of soft clay. The second site consists of only a stratum of fill soil with thickness of 10 meters. The third site is just a layer of soft clay with thickness of 26 meters. The fourth site is a middle-coarse sand containing some mud. The equivalent nonlinear constitutive model was adopted to describe the behaviors of various soils mentioned above. The pore water pressure model proposed by the authors was used to analyze the change of dynamic pore water pressure in the sand layers; The modulus softening method was applied to calculate the permanent deformation of the foundation soils. The sites were discretized by isoparameter element with 8 nodes. The dynamic reaction equations were solved with Wilson- $\theta$  method and frontal solution technique. Total of 20 cases were simulated numerically and analyzed including of three types of seismic waves (two kinds of natural earthquake waves of Xiamen and the earthquake wave of Songpan), three peak accelerations of earthquake (i.e., 0.15, 0.2, 0.3 g), 4 intensity of static loads (i.e., 0, 50, 100, 150 kPa). And the deformation fields, the pore water pressure fields, the seismic depression, the heave and the liquefaction grades for the four sites were obtained. The research results show that when strong earthquake takes place, the seismic depression of the fill foundation soil is not obvious and has small effect on the road of circle Amoy island. The seismic depression of the soft clay with large thickness is big; and failure patterns of the soft soil develops from local shear to general shear. The sand buried shallowly may be liquefaction. Above study results have an important consultation value to make aseismic decision of the foundation in Xiamen.

**Key words** [earthquake engineering](#); [earthquake reaction](#); [finite element method \(FEM\)](#); [liquefaction](#); [aseismic depression](#); [soft clay](#); [filled soil](#); [shaking table test](#)

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