Analysis of Shear Walls on Piled Raft under Earthquake Excitations

Abstract:

Analysis of the behavior of piles, pile groups, rafts and piled rafts subjected to both

lateral and vertical loadings as well as moments has been particular interest in geotechnical

engineering. However, the behavior of rafts and piled rafts with 3D shear wall-frame structure

subjected to horizontal and vertical loading has not received as much attention. In this paper, a

new version of computer program ASTN3 was developed in order to examine the behavior of

piled raft with 3D-superstructure of shear walls supported by non-identical piles. Shear walls were

used here to resist lateral loads from a side and from another side to control lateral displacements

of top floors. Full interaction between raft, piles and the soil, was considered in the software

based on both Framework analogy and composed coefficient technique. Results of ASTN3 were

verified by comparing to published results. Herein, a parametric study of 3D-space -structures

shear walls with piled raft on Port-Said soil medium exposed to seismic loads beside gravity loads

were analyzed by ASTN3. Discussion for the numerical results is performed and conclusions

were drawn

2-The positioning and thickness effect for soft clay layeron 3D-building resting on piled raft.

Abstract

The effect of both of the positioning and the thickness of soft clay layer on 3D-building
resting on piled raft has not received much attention. Herein, a computer program ASTNII is developed
by the author in order to examine the behavior of a layer of soft clay with different hypothetical
positions and thicknesses. Composed coefficient technique is employed in ASTNII to save time.

Many cases of different positions and thicknesses are diagnosed to cover practical cases.
Based on finite element method, ASTNII is used to analyze three dimensional buildings on piled
raft in a parametric study. That study is developed to include two different structural models of
square and rectangular shapes. Different cases are analyzed to reflect the effect of changing of both
of position and thickness of soft clay on the system. Discussions on the numerical results are performed
and conclusions are drawn

3-Nonlinear analysis of piled raft with 3D-space structure

Abstract
As an extension for the analysis of a 3D-space structure on a raft, a numerical analysis based on the
elastic theory is developed for axially loaded 3D-space structures with piled raft embedded into a
non-homogenous soil medium. In this study, a developed model is employed in which the raft is
presented as plates using the Framework Analogy, piles are modeled by rigid beam elements, while
the soil is treated as continuum medium. Full interactions among structural members pile–soil–pile,
pile–soil–raft and raft–soil–raft are taken into account. A new version of computer program *ASTNII*
to achieve the research goals is developed. A real simulation model for 3D-space structures resting
on piled raft is introduced. Herein, the effect of superstructure and non-homogeneity of soil is
considered to add more reality to the model. The nonlinear analysis of raft on continuum model of
soil using Composed Coefficient Technique is employed to be applicable for piled raft structures in
order to reduce the stiffness matrix size and consequently saving time. A parametric study of 3Dspace
structures with piled rafts on Port-Said soil medium is carried out. Discussion for the numerical results is performed and conclusions are drawn.

MSC

The entire structure can be defined as the combination of three media: superstructure, foundation and soil. The analysis of the entire structure as one unit is very important to determine its true deformations and internal forces. However, most of the practical analyses of structures

neglect the interaction among the three media to avoid the three-dimensional analysis and modeling. Such accurate analysis of the entire structure is extremely complex. The analysis of the structure as one unit has been established by using the Finite Element Method[17,29]. An actual modeling for the structure may be used, where columns, walls, slabs and the foundation are modeled as a three dimensional problem using plate element and frame element having six degrees of freedom at each node. In spite of the success of this method in the analysis of structure, the analysis is time-consuming and requires large computer capacity. The use of such analysis leads to a great overall stiffness matrix of the structure.

In the present study, the space structure is composed of two element types. Beams and columns have been represented by a frame element, while, floor slabs and raft foundation have been represented by a plate element. The deduction of the stiffness matrices of both plate and frame elements has been introduced using Framework Analogy and Finite Element Method. Using Framework Analogy is an old technique and has been discussed by Hrennikpoff[16], Lightfoot[21], Yettram[28] and Szilard[31]. It has been used widely in the analysis of plates without superstructures. Herein, the Framework Analogy method is used modeling in the raft foundation and floor slabs to achieve the compatibility between the types of elements and to reduce the time of execution the job. Each type of element's stiffness matrix has been deduced individually but all elements in the structure will strength the forces in compatibility. For iteration procedure, the soil behavior is represented by Winkler model[15]. In former iteration stages, Winkler medium is represented as an infinite number of springs with nonlinear pressure-settlement

relationship. While in the latter, values of nodes' displacements obtained from the hyperbolic equation are modified to coincide with nonlinear pressure-settlement curve. In this model, the contact pressure is taken to be proportional to the foundation settlement. The factor of proportionality is designated as a modulus of subgrade. Using the present procedure, the computational algorithm is significantly reduced comparing with the traditional analysis of soil-structure problems. In order to perform the interactive structure-foundation analysis, a computer program is developed to analyze the 3D-space structure with foundation and the subsoil interactive behavior simultaneously.