

Effect of Soil- Structure Interaction on Response of Building Frame with Piled-raft Foundation

R. Mahadev Swamy¹ and Dr. S.A. Rasal²

¹Associate Professor, Department of Civil Engineering, Shivajirao S. Jondhale College of Engineering and Technology, Asangaon

²Assistant Professor, Department of Civil Engineering, Datta Meghe College of Engineering, Navi Mumbai-400708, India.

Abstract: The effect of soil structure interaction on response of the three storeyed (G+2) building frame supported on piled-raft foundation is reported in this paper. The three storeyed frame comprises of two bays and columns of the frames are supported by a piled-raft. The pile is assumed to be embedded in the cohesive soil mass. For the purpose of the analysis, simplified idealizations made in the theory of finite elements. The slab of the frame is idealized as two dimensional plate elements, beams and columns of the superstructure frame and pile of the sub-structure are idealized as the one dimensional beam-column elements. The soil mass is idealized by equivalent springs. The effect of different raft thicknesses with uniform pile diameter is evaluated on the response of superstructure through a parametric study. The response of the superstructure considered includes the displacement of the frame.

Keywords: Pile-raft, soil modulus, raft thickness, displacement

1. Introduction

The type of foundation and its design is based on the magnitude of the loads on it and the type of founding strata which supports it. If the founding stratum is within a reasonable depth, a shallow foundation in the form of raft is adequate. However, if the material is weak, the loads need to be transferred down to capable strata by means of deeper basements or piles. This is true, especially in case of multistoreyed building frames resting on weak sub soil strata where heavy structural loads acting on the frames have to be transmitted safely below to the firm strata.

The analysis of piled-raft foundation is very challenging because the load in the piled-raft structures is transferred to the soil not only by the interaction between the soil and the piles but also by the interaction between foundation structure and superstructure. In this interaction, deformations in the soils are the key factor which will affect forces and deformation in foundation and superstructure. In the past few decades, there has been an increasing recognition that the use of pile groups in conjunction with the raft can lead to considerable economy without compromising the safety and performance of the foundation. Such a foundation makes use of both the raft and the piles, and is referred to here as a *piled-enhanced raft* or a *piled raft*. The piled-raft concept has also proven to be an economical way to improve the serviceability of foundation performance by reducing settlements to acceptable levels. Although the piled-raft concept has been most notably applied to new construction involving high-rise buildings it is also potentially useful for remedial works and moderate height structures.

Methods that have been used for the analysis range from simplified calculations to numerical methods such as the boundary element method (Butterfield and Banerjee [1], Brown and Wiesner [2], Kuwabara [3], Mendonca and De Paiva [4]) and the finite element method (Hooper [5], Ottaviani [6], Chow [7], Liu and Novak [8], Katzenbach and Reul [9], Prakoso and Kulhawy [10], Reul and Randolph [11]). In early years because of the limited availability of computer memory and processing speed, the use of numerical methods was confined to simple problems. In last three decades due to rapid development in computer technologies, numerical methods such as full three dimensional finite element methods are often used to solve the complex problems.

The foundation concept of piled rafts differs from traditional foundation design, where the loads are assumed to be carried either by the raft or by the piles, considering the safety factors in each case. Several methods of analyzing piled rafts have developed over the years include approximation methods, finite element method, boundary element method, combined boundary element and finite element method, combined finite layer and finite element method; and variational approach.

Piled Raft Foundation International Journal Of Civil

**Andrew McNamara, Sam Divall, Richard
Goodey, Neil Taylor, Sarah
Stallebrass, Jignasha Panchal**

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Combined Pile-Raft Foundations Oliver Reul, Mark Randolph, 2024-12-16 This book presents the fundamental features of the design and performance of combined pile raft foundations CPRFs Whereas in a traditional foundation the loads are carried either by the raft or by the piles the capacity of CPRFs is assessed for the foundation as a whole reducing total and differential settlements economically The five chapters provide an overview of the historical development of piled rafts in practice and research and of the design concepts developed for piled rafts over the last decades Fundamental aspects of their bearing behaviour are presented as well as an overview of the framework of the design process for CPRFs including the safety concept the design approach summarised in the ISSMGE Combined Pile Raft Foundation Guideline ISSMGE TC 212 2013 and the interaction between structural and geotechnical engineering For numerical analysis based on the finite element method guidance is given on creating the model and performing the calculations before providing basic information on the requirements for the site investigation supervision of the construction process and monitoring of the foundation performance Detailed case studies illustrate the design and performance of CPRFs and a design example for the foundation of a multi storey office building founded in non cohesive soil is investigated carrying out 3D finite element analysis to estimate deformations and design parameters for structural engineering Based on the combined experience of the authors obtained in the last decades working in the industry and research the book particularly suits consulting engineers engaged in foundation engineering as well as graduate students and researchers interested in the bearing behaviour of piled rafts and pile groups

Deep Foundations for Infrastructure Development in India, Volume 2 Purnanand Savoikar, Sunil S. Basarkar, Jaykumar Shukla, Boominathan Adimoolam, 2025-09-10 This book presents select proceedings of the DFI India 2024 Conference showcasing cutting edge research and advancements in deep foundation technologies and sustainable infrastructure development It covers a wide array of topics including innovative foundation solutions ground improvement techniques deep excavation practices and seismic resilience in geotechnical design Special emphasis is placed on sustainability efficiency and durability in foundation engineering integrating emerging materials advanced construction methodologies and digital technologies such as AI and automation in geotechnical applications The book serves as a valuable reference for researchers engineers and professionals engaged in deep foundations geotechnical engineering and related disciplines Civil and Environmental Engineering for Resilient, Smart and Sustainable Solutions Tahar Ayadat, 2025-03-25 The book focusses on recent developments in the area of infrastructures that are resilient smart and sustainable It presents an important guideline for policy makers engineers and researchers interested in various infrastructure issues faced by societies Keywords Earthquakes Damage Localization Global Warming Machine Learning Seismic Assessment Reinforced Concrete Fire Behavior Shape Memory Alloys Green Sustainable Concrete Geotechnical Parameters Cement Paste Plasticity Index Urban Environment Underground Pipeline Soil Stabilization Groundwater Monitoring Solar Photovoltaic Systems

Climate Change Pollution Monitoring Cost Estimation Model

Foundation Systems for High-Rise Structures Rolf

Katzenbach, Steffen Leppa, Deepankar Choudhury, 2016-09-19 The book deals with the geotechnical analysis and design of foundation systems for high rise buildings and other complex structures with a distinctive soil structure interaction The basics of the analysis of stability and serviceability necessary soil investigations important technical regulations and quality and safety assurance are explained and possibilities for optimised foundation systems are given Additionally special aspects of foundation systems such as geothermal activated foundation systems and the reuse of existing foundations are described and illustrated by examples from engineering practice

GeoVadis Ashish Juneja, Anil Joseph, Dasaka S. Murty, 2025-09-16 This book contains a prolific compilation of research on geotechnical engineering presented at the First Geotech Asia International Conference GAIC 2025 The papers reflect dynamic engagement of researchers engineers and professionals from all over Asia to offer insights into ongoing developments and applied problem solving This publication brings together contributions across 19 technical themes including cold region geotechnics deep excavations earthquake engineering foundation systems and underground construction It also delves into artificial intelligence and machine learning applications environmental and transportation geotechnics site characterisation slope stability embankments and dams and ground improvement techniques It is intended for academics practising engineers consultants contractors industry professionals government authorities and students involved in geotechnical research education and design and implementation The Open Access version of this book available at <http://www.taylorfrancis.com> has been made available under a Creative Commons Attribution Non Commercial No Derivatives CC BY NC ND 4.0 license

Physical Modelling in Geotechnics, Volume 2

Andrew McNamara, Sam Divall, Richard Goodey, Neil Taylor, Sarah Stallebrass, Jignasha Panchal, 2018-07-11 Physical Modelling in Geotechnics collects more than 1500 pages of peer reviewed papers written by researchers from over 30 countries and presented at the 9th International Conference on Physical Modelling in Geotechnics 2018 City University of London UK 17-20 July 2018 The ICPMG series has grown such that two volumes of proceedings were required to publish all contributions The books represent a substantial body of work in four years Physical Modelling in Geotechnics contains 230 papers including eight keynote and themed lectures representing the state of the art in physical modelling research in aspects as diverse as fundamental modelling including sensors imaging modelling techniques and scaling onshore and offshore foundations dams and embankments retaining walls and deep excavations ground improvement and environmental engineering tunnels and geohazards including significant contributions in the area of seismic engineering ISSMGE TC104 have identified areas for special attention including education in physical modelling and the promotion of physical modelling to industry With this in mind there is a special themed paper on education focusing on both undergraduate and postgraduate teaching as well as practicing geotechnical engineers Physical modelling has entered a new era with the advent of exciting work on real time interfaces between physical and numerical modelling and the growth of facilities and expertise that enable

development of so called megafuges of 1000gtonne capacity or more capable of modelling the largest and most complex of geotechnical challenges Physical Modelling in Geotechnics will be of interest to professionals engineers and academics interested or involved in geotechnics geotechnical engineering and related areas The 9th International Conference on Physical Modelling in Geotechnics was organised by the Multi Scale Geotechnical Engineering Research Centre at City University of London under the auspices of Technical Committee 104 of the International Society for Soil Mechanics and Geotechnical Engineering ISSMGE City University of London are pleased to host the prestigious international conference for the first time having initiated and hosted the first regional conference Eurofuge ten years ago in 2008 Quadrennial regional conferences in both Europe and Asia are now well established events giving doctoral researchers in particular the opportunity to attend an international conference in this rapidly evolving specialist area This is volume 2 of a 2 volume set

ICE Manual of Geotechnical Engineering Volume 2 Hilary Skinner,D G Toll,Kelvin Higgins,Mike Brown,John Burland,2023-11-17 ICE Manual of Geotechnical Engineering Second edition brings together an exceptional breadth of material to provide a definitive reference on geotechnical engineering solutions Written and edited by leading specialists each chapter provides contemporary guidance and best practice knowledge for civil and structural engineers in the field

Advances in Civil and Industrial Engineering IV Guang Fan Li,Chao He Chen,Bi Feng Jiang,Qi Zhong Shen,2014-07-04 Selected peer reviewed papers from the 4th International Conference on Civil Engineering Architecture and Building Materials CEABM 2014 May 24 25 2014 Haikou China *Earthquake Geotechnical Engineering for Protection and Development of Environment and Constructions* Francesco Silvestri,Nicola Moraci,2019-10-22 Earthquake Geotechnical Engineering for Protection and Development of Environment and Constructions contains invited keynote and theme lectures and regular papers presented at the 7th International Conference on Earthquake Geotechnical Engineering Rome Italy 17 20 June 2019 The contributions deal with recent developments and advancements as well as case histories field monitoring experimental characterization physical and analytical modelling and applications related to the variety of environmental phenomena induced by earthquakes in soils and their effects on engineered systems interacting with them The book is divided in the sections below Invited papers Keynote papers Theme lectures Special Session on Large Scale Testing Special Session on Liquefaction Projects Special Session on Lessons learned from recent earthquakes Special Session on the Central Italy earthquake Regular papers Earthquake Geotechnical Engineering for Protection and Development of Environment and Constructions provides a significant up to date collection of recent experiences and developments and aims at engineers geologists and seismologists consultants public and private contractors local national and international authorities and to all those involved in research and practice related to Earthquake Geotechnical Engineering **Smart Geotechnics for Smart Societies** Askar Zhussupbekov,Assel Sarsembayeva,Victor N. Kaliakin,2023-08-04 Smart Geotechnics for Smart Societies contains the contributions presented at the 17th Asian Regional Conference on Soil Mechanics and Geotechnical Engineering

17th ARC Astana Kazakhstan 14 18 August 2023 The topics covered include Geomaterials for soil improvement Tunneling and rock engineering Slope embankments and dams Shallow and deep foundations Soil dynamics and geotechnical earthquake engineering Geoenvironmental engineering and frost geotechnics Investigation of foundations of historical structures and monitoring Offshore harbor geotechnics and GeoEnergy Megaprojects and transportation geotechnics Smart Geotechnics for Smart Societies will be of interest to academics and engineers interested or involved in geotechnical engineering

Seismic Design and Performance T.G. Sitharam,Raghuveer Rao Palapati,Sreevalsa Kolathayar,2021-03-26 This volume presents select papers presented at the 7th International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics The papers discuss advances in the fields of soil dynamics and geotechnical earthquake engineering Some of the themes include seismic design of deep shallow foundations soil structure interaction under dynamic loading marine structures etc A strong emphasis is placed on connecting academic research and field practice with many examples case studies best practices and discussions on performance based design This volume will be of interest to researchers and practicing engineers alike

Civil Engineering And Urban Planning - Proceedings Of The 5th International Conference On Civil Engineering And Urban Planning (Ceup2016) Ahmed Mebarki,2017-06-02 The 5th International Conference on Civil Engineering and Urban Planning CEUP2016 was held in Xi an China on August 23 26 2016 CEUP2016 gathered outstanding scientists and researchers worldwide to exchange and discuss new findings in civil engineering and urban planning associated with transportation and environmental topics The conference program committee is also greatly honored to have four renowned experts for taking time off to present their keynotes to the conference The conference had received a total of 410 submissions which after peer review by the Technical Program Committee only 108 were selected to be included in this conference proceedings which covers Architecture and Urban Planning Civil Engineering and Transportation Engineering

Geotechnics for Sustainable Infrastructure Development Phung Duc Long,Nguyen Tien Dung,2019-11-28 This book presents 09 keynote and invited lectures and 177 technical papers from the 4th International Conference on Geotechnics for Sustainable Infrastructure Development held on 28 29 Nov 2019 in Hanoi Vietnam The papers come from 35 countries of the five different continents and are grouped in six conference themes 1 Deep Foundations 2 Tunnelling and Underground Spaces 3 Ground Improvement 4 Landslide and Erosion 5 Geotechnical Modelling and Monitoring and 6 Coastal Foundation Engineering The keynote lectures are devoted by Prof Harry Poulos Australia Prof Adam Bezuijen Belgium Prof Delwyn Fredlund Canada Prof Lidija Zdravkovic UK Prof Masaki Kitazume Japan and Prof Mark Randolph Australia Four invited lectures are given by Prof Charles Ng ISSMGE President Prof Eun Chul Shin ISSMGE Vice President for Asia Prof Norikazu Shimizu Japan and Dr Kenji Mori Japan

Modern Applications of Geotechnical Engineering and Construction Mahdi O. Karkush,Deepankar Choudhury,2020-12-21 p This book contains select papers from the International Conference on Geotechnical Engineering Iraq discussing the challenges opportunities

and problems of application of geotechnical engineering in projects The contents cover a wide spectrum of themes in geotechnical engineering including but not limited to sustainability geotechnical engineering modeling of foundations slope stability seismic analysis soil mechanics construction materials and construction management of projects This volume will prove a valuable resource for practicing engineers and researchers in the field of geotechnical engineering structural engineering and construction and management of projects

Design of Foundation Systems N. P. Kurian, Nainan P. Kurian, 2005 This textbook first published in 1992 now appearing in its third edition retains the best features from the earlier editions and adds significantly to the contents which include developments in the 1990s

Advances in Deep Foundations Yoshiaki Kikuchi, Jun Otani, Makoto Kimura, Yoshiyuki Morikawa, 2007-06-21 Civil Engineering has recently seen enormous progress in the core field of the construction of deep foundations This book is the result of the International Workshop on Recent Advances in Deep Foundations IWDPF07 which was held in Yokosuka Japan from the 1st to the 2nd of February 2007 Topics under discussion in this book include recent rese

Geomechanics in Soil, Rock, and Environmental Engineering John Small, 2018-09-03 Utilizes both Computer and Hand Based Calculations Modern practice in geomechanics is becoming increasingly reliant on computer based software much of which can be obtained through the Internet In Geomechanics in Soil Rock and Environmental Engineering the application of these numerical techniques is examined not only for soil mechanics but also for rock mechanics and environmental applications For Use in Complex Analysis It deals with the modern analysis of shallow foundations deep foundations retaining structures and excavation and tunneling In recent years the environment has become more and more important and so it also deals with municipal and mining waste and solutions for the disposal and containment of the waste Many fresh solutions to problems are presented to enable more accurate and advanced designs to be carried out A Practical Reference for Industry Professionals This Illuminating Book Offers a broad range of coverage in soil mechanics rock mechanics and environmental engineering Incorporates the author s more than 40 years of academic and practical design experience Describes the latest applications that have emerged in the last ten years Supplies references readily available online for further research Geomechanics in Soil Rock and Environmental Engineering should appeal to students in their final undergraduate course in geomechanics or master s students and should also serve as a useful reference to practitioners in the field of geomechanics reflecting the author s background in both industry and academia

Linear and Non-linear Numerical Analysis of Foundations John W. Bull, 2009-01-30 Correctly understanding designing and analyzing the foundations that support structures is fundamental to their safety This book by a range of academic design and contracting world experts provides a review of the state of the art techniques for modelling foundations using both linear and non linear numerical analysis It applies to a range of i

Numerical Methods in Geotechnical Engineering IX, Volume 1 José Marques, 2018-06-22 NUMGE 2018 is the ninth in a series of conferences on Numerical Methods in Geotechnical Engineering organized by the ERTC7 under the auspices of the International Society for

Soil Mechanics and Geotechnical Engineering ISSMGE The first conference was held in 1986 in Stuttgart Germany and the series continued every four years 1990 Santander Spain 1994 Manchester United Kingdom 1998 Udine Italy 2002 Paris France 2006 Graz Austria 2010 Trondheim Norway 2014 Delft The Netherlands The conference provides a forum for exchange of ideas and discussion on topics related to numerical modelling in geotechnical engineering Both senior and young researchers as well as scientists and engineers from Europe and overseas are invited to attend this conference to share and exchange their knowledge and experiences This work is the first volume of NUMGE 2018

Shell Structures: Theory and Applications Volume 4 Wojciech Pietraszkiewicz, Wojciech Witkowski, 2017-10-30 Shells are basic structural elements of modern technology and everyday life Examples of shell structures in technology include automobile bodies water and oil tanks pipelines silos wind turbine towers and nanotubes Nature is full of living shells such as leaves of trees blooming flowers seashells cell membranes or wings of insects In the human body arteries the eye shell the diaphragm the skin and the pericardium are all shells as well Shell Structures Theory and Applications Volume 4 contains 132 contributions presented at the 11th Conference on Shell Structures Theory and Applications Gdansk Poland 11-13 October 2017 The papers reflect a wide spectrum of scientific and engineering problems from theoretical modelling through strength stability and dynamic behaviour numerical analyses biomechanic applications up to engineering design of shell structures Shell Structures Theory and Applications Volume 4 will be of interest to academics researchers designers and engineers dealing with modelling and analyses of shell structures It may also provide supplementary reading to graduate students in Civil Mechanical Naval and Aerospace Engineering

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