

## OVERVIEW

The Symposium on Design, Construction and Testing of Deep Foundation Improvements was held on January 25, 1990 in Las Vegas, Nevada. The focus of the symposium was to be the improvement of deep foundation conditions through the construction of stone columns and/or similar inclusions. In fact, a broader perspective was provided by the authors, enhancing the value of the Symposium and the papers included herein.

The twenty-two papers presented at the Symposium and included in this publication are grouped into two main categories: those related to deep foundation improvements through the formation of "composite ground" and those related to improvement through "compaction and densification." Composite ground is formed by the introduction of columns of sand or stone through a "weak" deposit of sand, silt or clay or by the introduction of cement grout or chemical grout into a soil mass through an injection or mixing process. Compaction and densification techniques are used for fill or natural materials and do not involve the introduction of other materials. Nineteen of the papers address some aspect of composite ground. The remaining three are on compaction and densification techniques, specifically, deep vibratory compaction of loose sand deposits. For this publication the papers are subdivided as follows: (i) five papers on construction and analysis of composite ground; (ii) two papers on construction guidelines and specifications; (iii) eight papers on case history presentations; (iv) four papers on introducing grout to the soil; and (v) three papers on compaction and densification techniques.

The papers by Barksdale and Takefumi, Enoki et al., Aboshi et al., and Terashi et al., provide information on the design, construction, testing and performance of ground stabilized by sand piles or sand compaction piles. These four papers, combined with the paper by Priebe in which design criteria for stone columns are provided, present important information on analysis of the stability of composite ground. It is quite clear that a consensus has not been reached on the best approach for analyzing composite ground and, therefore, the presentation in this publication of diverse approaches is believed by the editors to be of considerable value to practitioners.

Stark and Yacyshyn suggest guidelines for performance specifications for the construction and testing of stone columns in cohesive soils. These were

developed from a critical review of specifications used in U.S. and British practice. Additional information on the performance of equipment during installation of stone columns as well as on load testing techniques is provided by Slocombe and Moseley. This latter contribution is based on British practice. Taken together, these papers are likely to be of help to engineers seeking to specify the installation of stone columns.

The eight papers that follow are case histories of the use of stone columns in several engineering applications in the United States and the United Kingdom. Papers by Allen et al., Hayden and Welch, and Goughnour, Sung and Ramsey describe how stone columns were used for natural ground and for slope stabilization. The papers by Davie, et al. and Snethen and Homan report on the stabilization of waste materials in areas once associated with coal mining. Of more-than-passing interest is the report by Greenwood of the full-scale loading response of ground improved by stone columns. Greenwood's observations are significant for those who design stone column installations and specify load tests or field instrumentation. Additional comments on the types of commonly referenced load tests are provided by Watts and Charles. Hussin and Baez present the procedures and results of short term load tests conducted on several recent U.S. stone column projects. In all, a wide range of valuable experience is provided in these papers.

Four papers follow in which the focus is on the introduction of grout into soil for purposes of ground modification and stabilization. Seismic testing methods to evaluate ground improvement from compaction grouting are described and evaluated by Byle, et al. Gambin describes a new, more scientific approach to compaction grouting which has been developed in France and suggests that the approach be applied in future practice. Munfakh provides a case study that led to the use of chemical stabilization to protect an old tunnel from the effects of constructing two new tunnels within 2m of its invert. Babasaki et al. describe the use of deep cement mixing in Japan to provide the foundation for a three-story building on loose silty sand and to avoid liquefaction in an earthquake.

The last three papers deal with the compaction of loose granular soils by vibratory means. Castelli reports on the relative effectiveness of several methods of deep compaction. One of them is the vibro wing system, also reported on by Massarsch, in which the vibration frequency can be varied during

construction. The benefits for compaction using a Y-shaped probe are described by Neely and Leroy. These three papers provide valuable information to the profession on the new tools available for compaction of deep soil deposits and on the results that can be expected. Furthermore, they describe the effectiveness of the methods and the variability of results. Massarsch cautions that the high energies associated with deep compaction may potentially densify sands beneath existing buildings near construction sites causing settlements.

The editors are grateful to the authors for their efforts in preparing the excellent papers included in this publication. The papers in this volume provide a valuable contribution to the literature and effectively demonstrate the advances that have been achieved since publication of proceedings from a similar Symposium sponsored by the Institution of Civil Engineers in 1976. The authors have helped provide to the profession significant information on which to base current decisions on deep foundation improvement and on which to build for future developments.

Robert C. Bachus  
Geosyntec Consultants  
Norcross, GA.

Melvin I. Esrig  
Woodward-Clyde Consultants  
Wayne, New Jersey