SOME RECENT REFERENCES ON IMPROVEMENT OF LIQUEFIABLE SOILS

For the 1999 TRB Workshop on

NEW APPROACHES TO LIQUEFACTION ANALYSIS

January 10, 1999

The following publications provide background information, details of the topics covered, and reference lists for the presentation by James K. Mitchell, Sc.D., P.E. scheduled for 2:50 – 3:20 pm

Engineering Guidelines on Ground Improvement for Civil Works Structures and Facilities, by James K. Mitchell and Patricia M. Gallagher (1998) prepared for the U. S. Army Corps of Engineers, Engineering Division, Directorate of Civil Works, Washington, D.C. 109 pp.

This just-completed guidelines document is focused on the practical applications of recent and rapidly developing methods of ground improvement. Ground improvement at the sites of both new and existing structures is considered. The following questions are addressed by means of text, flow charts, tables and figures:

1. Is ground improvement necessary?
2. If it is necessary, what methods are available?
3. How is ground improvement designed?
4. What are the QA/QC requirements for improved ground?
5. What has been the performance of improved ground?

Design Considerations in Ground Improvement for Seismic Risk Mitigation, by James K. Mitchell, Harry G. Cooke, and Jennifer A. Schaeffer, (1998), Emerging Art Paper, *Geotechnical Earthquake Engineering and Soil Dynamics III*, A.S.C.E. Special Geotechnical Publication No. 75, (P. Dakoulas, M. Yegian, R.D. Holtz, eds.), Vol. 1, pp. 580-613.

This recent paper addresses several important issues in ground improvement methodology, analysis and design:

1. Methods and their applications, considered in two categories: (1) large, open undeveloped sites and (2) constrained and/or developed sites.
2. Needs and expectations in ground improvement – some potential new and improved treatment technologies are indicated and design and performance evaluation needs are listed.

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3. Design procedures for ground improvement
4. Design problems in ground improvement. These problems, many of which are currently under study, relate to (1) factors affecting performance, and (2) methods for stability and deformation analysis.
5. Some design recommendations.

Performance of Improved Ground During Earthquakes, by James K. Mitchell, Christopher D. P. Baxter, and Travis C. Munson (1995), *Soil Improvement for Earthquake Hazard Mitigation,* (R. D. Hryciw, ed.). A.S.C.E. Geotechnical Special Publication No. 49, pp. 1-36.

Ground improvement using deep densification, replacement, or in-situ hardening of potentially liquefiable soils has now been used at many sites, but until the Loma Prieta earthquake in California in 1989 and the Kobe earthquake in Japan in 1995, few of these sites had actually been subjected to earthquake shaking. More than 30 case histories for which earthquake performance data are available are summarized to include information about the project type, methods of soil improvement, pre- and post-ground treatment soil conditions, earthquake characteristics, and effects of the earthquake on improved and unimproved ground.

Preparation of an updated version of this paper containing some additional cases and reanalysis of some of the data is planned for the near future.

Assessment, Design, and Construction of Remedial Measures for Liquefaction Mitigation at Existing Highway Bridges, by Harry G. Cooke and James K. Mitchell, MCEER Technical Report under FHWA Contract Number DTFH61-92-C-00106, in press.

This report is focused on the applications of ground improvement for the mitigation of liquefaction risk to existing bridges. Recommendations and guidance are presented to aid in the identification of potentially liquefiable soils, characterization of the materials, selection of ground improvement method, considerations during construction, and evaluation of the results.

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