GEOASIA Bulletin No.3

ALL SOILS ALL STATES ALL ROUND GEO-ANALYSIS INTEGRATION

For finding soil deformation and collapse in sandy, intermediate and clayey soils, and for static or dynamic interests Issued August 25, 2009 Edited by *GEOASIA* Research Society Office Furo-cho, Chikusa-ku, Nagoya, 464-8603, Japan TEL: +81-(0)52-789-3834 FAX: +81-(0)52-789-3836 E-mail: office@geoasia.jp URL: http://www.geoasia.jp

Message from the Society President

The **GEOASIA** Research Society was established as a voluntary association three years ago, by a directive of the Nagoya University Intellectual Property Office, with considerable support from Tetsuo Omura, then director of the Chubu Regional Bureau of the Ministry of Land, Infrastructure and Transport, and executives of numerous construction firms, especially of their Nagoya offices. We sincerely thank all those concerned.

The goal of the **GEOASIA** geo-analysis program is to perform time history analyses of what is occurring moment by moment in foundations and earth structures, for all types of soils and foundations from sand to clay, including intermediate and artificially produced ones ("All Soils"), without restrictions for mechanical states, but taking in a

full range of conditions from deformation to destruction, or from unstable to stable in cases such as sand subject to liquefaction and subsequent consolidation ("All States"), and with allowance made for variation over time in all kinds of external disturbances acting statically or dynamically on the foundations ("All round"). The Society has been fortunate enough to receive extensive expressions of support for this aim, including a 3-year large research grant by the Ministry of Land, Infrastructure, Transport and Tourism and a 5-year grant for scientific research by the Ministry of Education and Science, and this has helped it successfully through the first three years.

Up until now, as a voluntary association, the **GEOASIA** Research Society has had rather the character of a private organization involving civil engineering-related laboratories at Nagoya University. Under this arrangement, however, it is not possible to ensure that responsibilities towards members are fully met, and it is probably also difficult for firms to entrust the Society with tasks entailing responsibility. At a special general meeting on April 3, it was therefore decided to alter the organizational status of the Society to that of a general public non-profit organization. A "general public non-profit organization" here means an incorporated public association which seeks to serve the common interests of its members through mutually beneficial activities, and at the same time, and by means of these activities, to promote contributions to the wellbeing of society. With the cooperation of all concerned, the registration of the **GEOASIA** Research Society as an incorporated association was successfully finalized on July 2. I extend my sincerest thanks to all members and also to the many supporters in the administrative, commercial and scientific areas who have assisted with the society is activities so far, respectfully asking them for their continued cooperation in the activities which the society will be carrying out in its future existence as an incorporated association.

This change in the society's status comes accompanied by several other new initiatives, and two of these can be mentioned here. First, as you may have seen at the top of this first page of Bulletin No. 3, a society logo has been instituted. It embodies our aspiration at the time of founding this society that the diffusion of the *GEOASIA* analysis technology should conduce to an enhancement of the academic and social standing of geotechnical engineers, in Japan, Asia, and the world. We hope to benefit from the support of all our members in pursuing this aim. Second, the society has acquired its own independent web domain. Through the *GEOASIA* home page, we hope in the future to acquaint a wider public with the society's organization and with its achievements in activities undertaken so far. It is also intended that the home page should make it easier for existing members to participate in activities. Please view the *GEOASIA* home page, at:

URL:http://www.geoasia.jp







In addition, we are planning from this year on to put an increased effort into public relations work by means of activities such as exhibiting at a Construction and Technology Fair.

I should like to end this announcement of the society's new start as an incorporated association with a repetition of my request to our members that the society may continue to benefit from your generous advice and support.

Professor Akira Asaoka, Nagoya University Graduate School

[Summary of the patent contents]

Report: Grant of a Patent for the Analysis Technology

A patent has now been obtained for the water-soil skeleton coupled calculation program. The fundamental idea behind this was not to secure possession of the technology, but to make the technical details positively and publicly available.

Title: Soil-water Coupled Analyzer and Soil-water Coupled Analysis Method

Application Number: 12/083, 302 Publication Number: US-2009-0164179

Publication Date: 06/25/2009

Inventor: Akira ASAOKA, Toshihiro NODA, Masaki, NAKANO



The soil-water coupled analysis program of the invention computes a global L matrix and a modified global L matrix regarding a volume change rate of a soil skeleton over time, a global H matrix regarding a water permeability of soil, a global M matrix regarding a mass, and a global K matrix regarding a tangent stiffness of the soil skeleton, based on input settings of soils, such as clay, intermediate soil, and sand, to respective elements of a soil foundation, input settings of a solid soil model, and input settings of analysis conditions (steps S140 The soil-water coupled to S165). analysis program formulates a global tangent stiffness equation (simultaneous linear equations) using all these computed matrixes and determines an unknown 'jerk field' and a 'pore water pressure field' under given boundary conditions, for example, a given deformation condition and a given stress rate condition (step S170). This enables highly-accurate dynamic and static analyses in soil foundations of various soils from sand to intermediate soils and clay.

The details of the patent contents can also be seen on the homepage of the Patent Office

(http://www.jpo.go.jp/indexj.htm).

Report of activities in Academic Year 2008

1 Seismic Behavior Analysis of a Coupled System Consisting of an Embankment and an Irregularly **Shaped Foundation**

A series of analyses based on the scenario of a centrifugal model experiment in a 40g field were used to investigate the influence of foundation irregularity and surface layer soil type on the deformations of the embankment and foundation and on the response acceleration. As the "boundary" constituted by the experiment model container results in an inhibition of the foundation deformation and in an amplification of the seismic waves, caution would be needed in applying these findings to a real foundation.



(surface layer: clay, foundation inclination: 20°)



2 Seismic Response Analysis of a Manmade Foundation Consisting of a Coastal Reclamation Site with a Seawall

An analysis of the seismic and post-seismic behavior of an artificial foundation at a reclaimed site in the port of Nagova, in the event of an earthquake of the serial Tokai-Tonankai-Nankai type. During the quake the most conspicuous strains occur directly beneath the mound breakwater because of its heavy upper load, but this is later followed by delayed consolidation settlement in the clay of the reclaimed area.







③ Foundation Modeling and Seismic Response Analysis for a Land Reclamation Site, Taking Account of a 200-year History

The reconstruction of the formation process of a reclamation site taking account of a 200-year history beginning from land drainage during the Edo period, with a seismic assessment of the site foundation in the event of an earthquake of the serial Tokai-Tonankai-Nankai type. Liquefaction occurs in spite of the presence of a diluvial sand layer with a relatively high N value, and is followed by delayed consolidation settlement in the clay layer. There is the possibility of a large horizontal displacement of the seawall, just as occurred on Port Island, Kobe at the time of the South Hyogo earthquake in 1995.



Fig. 5 Reconstruction of the site formation process and distribution of mean effective stresses

(4) Influence of Input Seismic Waves on the Deformation Patterns and Destruction States Occurring

during an Earthquake in a Road Embankment on a Sloping Foundation

A comparative analysis based on scenarios for a road embankment constructed on a sloping foundation in the Noto Peninsula. Two sets of seismic wave data recorded at other sites were fed into the model and the differences in the deformation and destruction states were compared. Slip faces occur after the earthquake, originating at the slope shoulder in the case of the Scenario A input, and near the center of the crown using the Scenario B input (see also Bulletin No. 2).



(5) Investigation of the Improving Effects of Various Kinds of Solidifying Materials on Soil Dredged from Nagoya Port

The soil dredged every year from Nagoya Port is treated by the addition of enhancing by-products from industry such as blast furnace cement, steelmaking slag and PS ash, after which the combined matter is crushed and mixed to produce improvement materials. The aim of this project was to assure the quality of these materials by conducting mechanical tests on them and using the SYS Cam-clay model to assess the improving effects. The stability and deformation performance of earth structures using the materials were also assessed using *GEOASIA*.



Fig. 8 Improvement of dredged soil

Principal publications etc. in Academic Year 2008 (including the first half of AY 2009)

Academic papers:

Soils and Foundations

- ① Ground improvement of intermediate reclaimed land by compaction through cavity expansion of sand piles, Vol.48, No.5, pp.653-671, 2008.
- ② Soil-water coupled finite deformation analysis based on a rate-type equation of motion incorporating the SYS Cam-clay model, Vol.48, No.6, pp.771-790, 2008.

[Journal of Applied Mechanics JSCE]

- ① Drained bearing capacity analysis of an overconsolidated soil, pp.247-254.
- ② Elasto-plastic description of mechanical behavior on treated soils of the dredged soil of Nagoya Port, pp.413-420.
- ③ Numerical simulations of seismic performance of a duct buried in the saturated sand, pp.1021-1028.

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[*Theoretical and applied mechanics* JAPAN]

- ① Consolidation of clay and compaction/liquefaction of sand A structural theoretical approach -, Vol.57, pp.3-21.
- ② Delayed failure of a clay foundation-embankment system after the occurrence of an earthquake, Vol.57, pp.41-47.

International conferences:

[*IWS-Pittsburgh* (USA, Pittsburgh, October 21-23, 2008)]

- ① Numerical simulation of centrifugal model tests on seismic response of embankment-foundation system, pp.29-32.
- 2 Post-seismic consolidation settlement of clayey soil due to the co-seismic disturbance, pp.57-60.

[IS-Kyoto (Japan, Kyoto, May 25-27, 2009)]

Numerical analysis on deformation/failure patterns of embankments observed in 2004 Chuetsu earthquake, pp.103-109.

[IS-Tokyo (Japan, Tsukuba, June 15-18, 2009)]

- ① Evaluation of seismic performance of a box culvert buried in saturated sand with centrifuge and its numerical simulation, pp.1087-1093.
- ② Co-seismic and post-seismic behavior of intermediate soil ground improved by sand compaction pile method, pp.1199-1205.
- [17th International Conference on SMGE (Egypt, Alexandria, October 5-9, 2009)]
- ① Elasto-plastic description of mechanical behavior of silt improved by lime, pp.558-561.
- ② Structure upgradation concept applied to cyclic mobility of sand and high ductility of natural clay, pp.175-178. **Domestic conferences:**
- [63rd Japan Society of Civil Engineers 2008 Annual Meeting (Sendai, September 2008)] 4 papers.
- [45th Japan National conference on Geotechnical Engineering (Yokohama, August 2009)] 12papers.
- [58th National Congress of Theoretical and Applied Mechanics (Tokyo, June 2009)]
- Soil-water coupled analysis on seismic behavior of embankment-irregular ground systems, pp.261-262.
- [14th Conference of the Japan Society for Computational Engineering and Science (Tokyo, May 2009)] Modeling and seismic analysis of reclaimed main-made ground, pp.465-468.

Main Forthcoming Activities in 2009

In addition to publishing this year's research results in academic journals such as Soils and Foundations, there is also a plan to present at the 17th (quadrennial) International Geotechnical Conference, which will be held in Egypt in October, 2009.

In September, two mature doctoral candidates from among the members of this society are due to be awarded their Ph.D. (Eng.) degrees at Nagoya University, having written up their research results obtained through the use of the *GEOASIA* analysis technology. Also, another seven members have been passed as *GEOASIA* MASTERS. This year training workshops are being held for society members, so we urge many of you to take part.

On the public relations front, apart from the launching of the homepage, we plan to exhibit at the Construction and Technology Fair 2009 in Chubu (to be held on October 28, 29, in the premises of the Chubu Technology Office, Ministry of Land, Infrastructure and Transport).

Editorial Afterword

To mark the society's new status as an incorporated association, a logo mark has been instituted, which can be seen at the top of the first page of this Bulletin No. 3. Also, readers are urged to visit the newly launched society home page (URL:http://www.geoasia.jp).