Comparisons of rapid load test, dynamic load test and static load test on driven piles

Bamrungwong, C., Chaisukhang, J. & Janmonta, K.
Department of Rural Roads, Thailand

Kitiyodom, P.
Geotechnical & Foundation Engineering Co., Ltd., Thailand

Matsumoto, T.
Kanazawa University, Japan

Matsuzawa, K.
International Association for Spring Hammer Rapid Load Test, Japan

Youwai, S.
King Mongkut's University of Technology Thonburi, Thailand

Keywords: rapid load test, driven pile, load-displacement relation, case study

ABSTRACT: Static load test (SLT) is usually used to obtain the bearing characteristics of a pile. However, it requires relatively high cost and testing period. In contrast, rapid load testing requires less cost and testing period. As one of rapid load test methods, Spring Hammer (SH, hereafter) rapid load test method has been developed in Japan. In this paper, validity of the SH test method with a simplified signal interpretation to estimate the static behaviour of a pile is discussed and demonstrated through comparison of the results from SLT and the SH test, as well as the results from dynamic load test (DLT).

1 INTRODUCTION

In Thailand, static load test (SLT) or dynamic load test (DLT) is employed to obtain the bearing characteristics of a pile. Due to the lack of capable dynamic load test result interpreter, it is widely believed that static load test is the most reliable method to obtain the load-settlement behaviour of a pile. However, static load test requires high cost and testing period. Therefore, pile design has been mainly based on empirical equations and soil information from borehole investigation without any load test by adopting excessive design requirements, i.e. high factor of safety.

In order to overcome the above situation, rapid load test methods have been proposed. As one of rapid load test methods, the Spring Hammer test (SH test) was developed in Japan (Matsumoto et al., 2004). Loading mechanism of the SH test is basically similar to Dynatest (Gonin & Leonard, 1984) Statnamic test (Bermingham & Janes, 1989) and Pseudo-static test (Schellingerhout & Revoort, 1996). In the SH test method, the simple non-linear damping interpretation method (Matsumoto et al., 1994) is usually used to derive static load-settlement curve.

In this paper, in order to verify the applicability of the SH test in Thailand. SH tests were conducted on driven concrete piles at five DRR (Dept. of Rural Roads) bridge construction sites in Thailand. The validity of the SH test method to estimate the static behaviour of a pile is examined through comparison of the results from SLT, DLT and the SH test.

2 SPRING HAMMER TEST METHOD

Several SH test devices are available, although their loading mechanism and measuring system are the same in the devices. Figure 1 shows the loading system and the measurement system of the SH test.

Figure 2 shows a SH test device used in this work. A spring unit is mounted on the leader mast of pile driving rig to prevent deviations of the central axis of pile, spring unit and hammer. Maximum load capacity is 2500 kN when using a hammer mass of 9.3 ton and a falling height of 1 m, which ensures confirmation of static pile capacity at least 2000 kN

A load cell is placed on the pile top directly, on which the spring unit is placed. A hammer mass is dropped onto the spring unit to provide impact loading on the pile top. The acceleration at the pile top is measured using two accelerometers.

The pile top displacement is measured by means of a laser or an optical displacement transducer. The dynamic signals are sampled at a sampling frequency greater than 1 kHz. The output dynamic signals are recorded through a computerised data acquisition system. The recorded dynamic signals are promptly processed to derive 'static' response of the pile using the Non-Linear Damping method.

The spring unit consists of a number of coned disc springs. The total spring stiffness of the spring unit is easily controlled by changing arrangement of the coned disc springs. The maximum load and loading duration can be widely varied by changing combination of the spring stiffness, the hammer mass and the falling height of hammer.

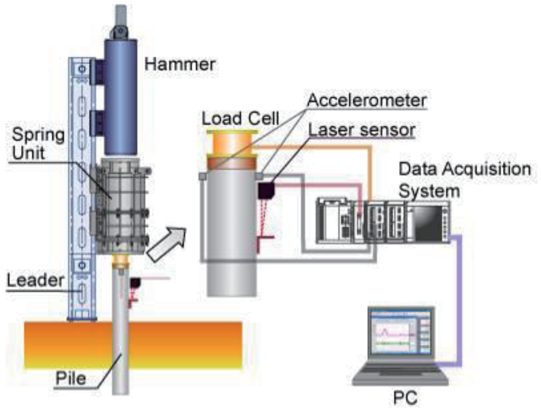


Figure 1. Loading system and measurement system.

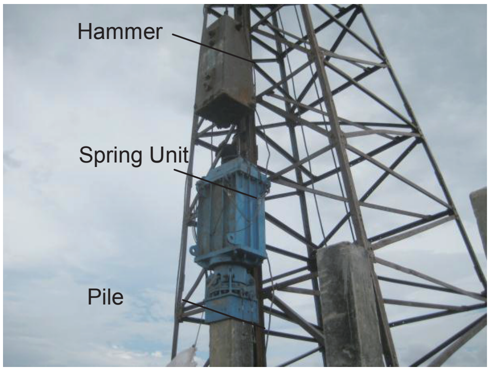


Figure 2. SH test device used in DRR construction sites.

One of advantages of the rapid load test is that simplified interpretation methods, in which the pile is treated as a rigid mass neglecting wave propagation phenomena in the pile, could be used to derive a static load-displacement relation from the measured signals.

Figure 3 shows the modelling of pile and soil during rapid pile load testing. The pile is assumed as a rigid mass having mass of M_p, and the soil is modelled by a spring and a dashpot in parallel. This modelling has been advocated by Middendorp et al. (1992) and Kusakabe & Matsumoto (1995).

The additional soil mass beneath the end plate, M_s, can be estimated as follows following Randolph & Deeks (1992):

$$M_s = 2D^3 \frac{0.1 - \nu^4}{(1-\nu)} \rho_s \tag{1}$$

where ν and ρ_s are Poisson's ratio and density of the soil, and D is the plate diameter.

Figures 4 and 5 show the notations used in the non-linear damping method. The applied load, F_{rapid}, is equal to the sum of the soil resistance, F_{soil}, and the inertias of the pile mass and the additional soil mass:

$$\begin{aligned} F_{soil}(i) &= F_{rapid}(i) - (M_p + M_s)\cdot \alpha(i) \\ &= F_{rapid}(i) - M \cdot \alpha(i) \end{aligned} \tag{2}$$

where M is the sum of the pile mass and the additional soil mass, and $\alpha(i)$ is the measured pile acceleration at time step i.

The soil resistance, F_{soil}, is the sum of the spring resistance (static resistance), F_w, and the dashpot resistance, F_v.

$$F_{soil}(i) = F_w(i) + F_v(i) = F_w(i) + C(i)\cdot v(i) \tag{3}$$

where $C(i)$ is the damping factor and $v(i)$ is the pile velocity at time step i.

At the first step (i = 1), the initial stiffness, $K(1)$, is calculated by the initial static load, $F_w(1)$, divided by the initial displacement, $w(1)$.

$$K(1) = F_w(1)/w(1) = F_{static}/w_{static} \tag{4}$$

At the next step (at step i+1), the soil spring, $K(i+1)$ is assumed to be equal to K(i) as indicated by Eq. (5). Hence, the static resistance, $F_w(i+1)$, at step i+1 is calculated by Eq. (6). The value of $C(i+1)$ can be determined by means of Eq. (7).

$$K(i+1) = K(i) \tag{5}$$
$$F_w(i+1) = F_w(i) + K(i+1)\cdot \{w(i+1) - w(i)\} \tag{6}$$
$$C(i+1) = \{F_{soil}(i+1) - F_w(i+1)\}/v(i+1) \tag{7}$$

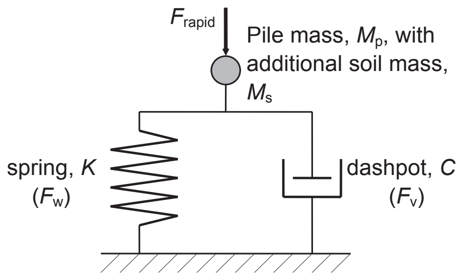


Figure .3 Modelling of rapid load test.

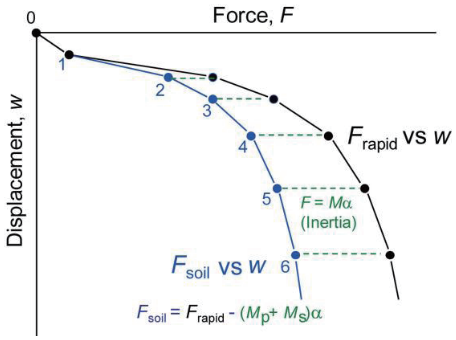


Figure 4. Correction of inertia to obtain soil resistance.

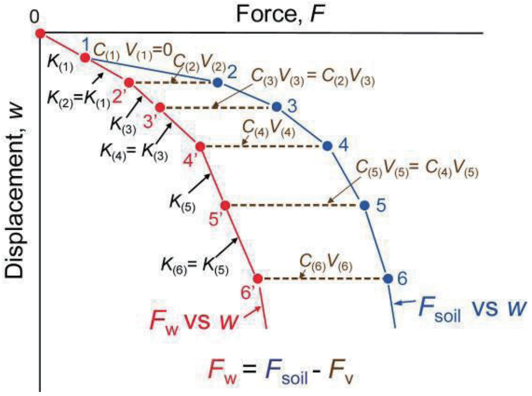


Figure 5. Non-Linear Damping interpretation.

At the following step i+2, C(i+2) is assumed to be equal to C(i+1) as indicated by Eq. (8). Therefore, the values of $F_w(i+2)$ and $K(i+2)$ can be determined by means of Eqs. (9) and (10), respectively.

$$C(i+2)=C(i+1) \tag{8}$$

$$F_w(i+2)=F_{soil}(i+1)-C(i+2)\cdot v(i+2) \tag{9}$$

$$K(i+2)=\frac{F_w(i+2)-F_w(i+1)}{w(i+2)-w(i+1)} \tag{10}$$

By repeating the procedure from Eq. (5) to Eq. (10), the values of K and C for following steps are alternately updated consecutively. Finally, the whole static load-displacement relation, F_w vs w, is constructed as shown in Figure 5.

3 TEST DESCRIPTION

Figure 6 shows the profiles of soil layers and SPT N-values at the five DRR bridge construction sites in Petchaburi, Lampang, Chaiyapum, Pangnga and Rayong, together with driven concrete piles. The driven concrete piles were used for the foundations of the bridges. Properties of the piles are summarised in Table 1.

Three piles at each construction site were subjected to the dynamic load tests and the SH rapid load tests. The tests were conducted after a curing period of 14 days from the end of the pile driving. Load tests were carried out to confirm proof load (2 times of allowable load).

In addition, static load tests were carried out on one of the three piles at each site approximately 1 to 2 months after the DLT and SH tests. Note that due to the site condition at Rayong site, static load test was not conducted on the same pile as the DLT and SH tests, but a SLT was carried out on the pile located in the next bridge abutment foundation about 100 m away from the pile which the DLT and SH tests were carried out.

Table 1. Properties of the piles.

Site No.	Site name	Dimension	Allowable pile capacity
1	Petchaburi	0.40×0.40m	500 kN
2	Lampang	0.40×0.40m	500 kN
3	Chaiyapum	0.40×0.40m	500 kN
4	Pangnga	0.40×0.40m	500 kN
5	Rayong	0.65×0.65m	800 kN

4 RESULTS OF PILE LOAD TESTS

4.1 *Results of SH tests in Pangnga site*

Figure 7 shows examples of dynamic signals from rapid load test on pile No. 2 in Pangnga Site: (a) pile head force, (b) acceleration, (c) velocity and (d) displacement. The pile head velocity was obtained by integration of the measured acceleration with respect to time. The pile head displacement was obtained by double time integration of the measured acceleration.

The loading duration, t_L, was 60 ms that corresponded to the relative loading duration T_r = $t_L/(2L/c)$ = 12, where L and c are the pile length and the wave propagation speed (c = 4000 m/s) in the RC driven pile, respectively. In the Method for Rapid Load Test of Single Pile by Japanese Geotechnical Society (2002), load test with T_r greater than 5 is regarded as rapid loading where wave propagation phenomena in the pile can be neglected.

Figure 8 shows the measured F_{rapid} vs w from 5 different hammer dropping heights varied from 0.4 to 2.0 m.

Figure 9 shows the derived static load-displacement F_w vs w, together with the static load-displacement obtained from SLT and DLT with wave matching analysis. It can be seen that there is good agreement between load test results.

4.2 *Results of Load Tests in Other Sites*

Figures 10 to 13 show comparisons of load-displacement relations from SLT, DLT and SH tests in Chaiyapum, Petchaburi, Rayong and Lampang sites, respectively. Good agreement between load test results of Chaiyapum and Petchaburi sites are seen in the figures. In Rayong site although the SLT was carried out on different pile which DLT and SH tests were conducted, there is good agreement between load test results as shown in Figure 12.

Good agreement between DLT and SH tests results of Lampang site is shown in Figure 13. However, SLT result shows a different trend. This is thought to be due to that the pile tip of the test pile during the static load test penetrated into the silty sand layer that have lower SPT N-value than the above sand layer.

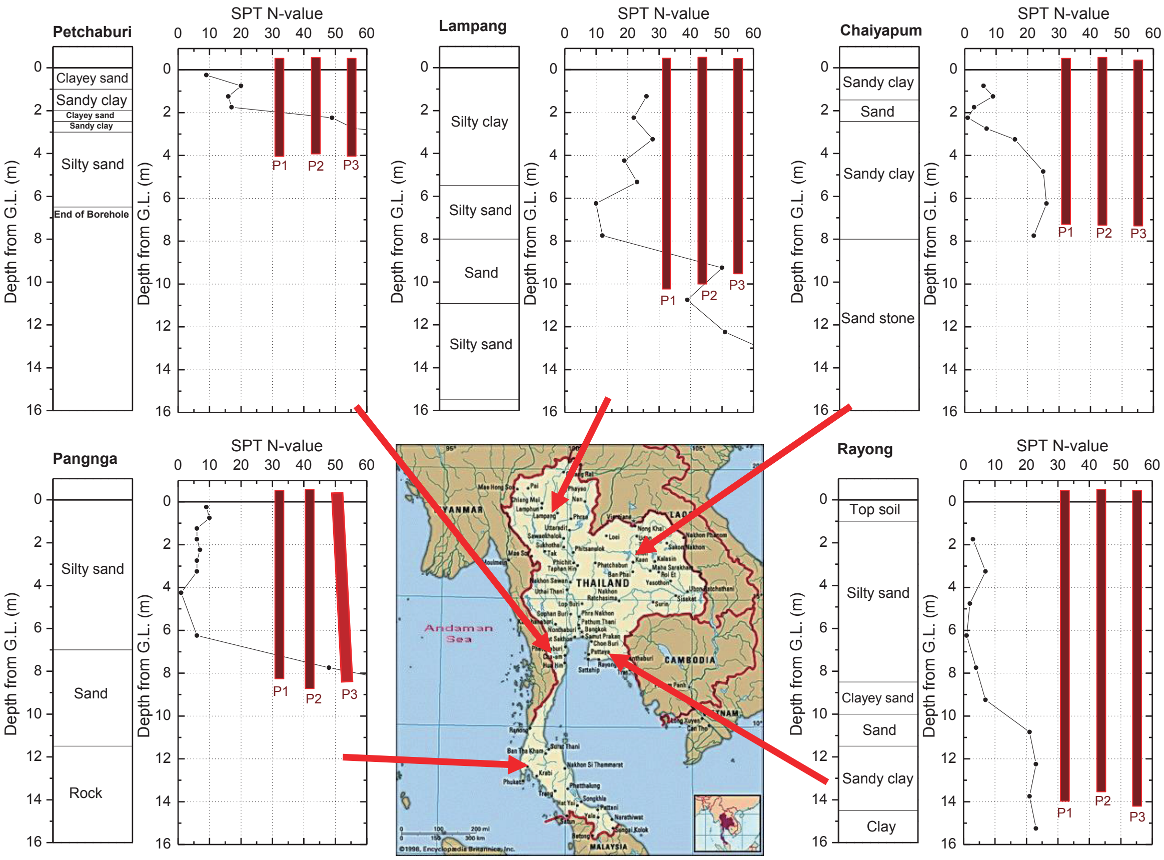
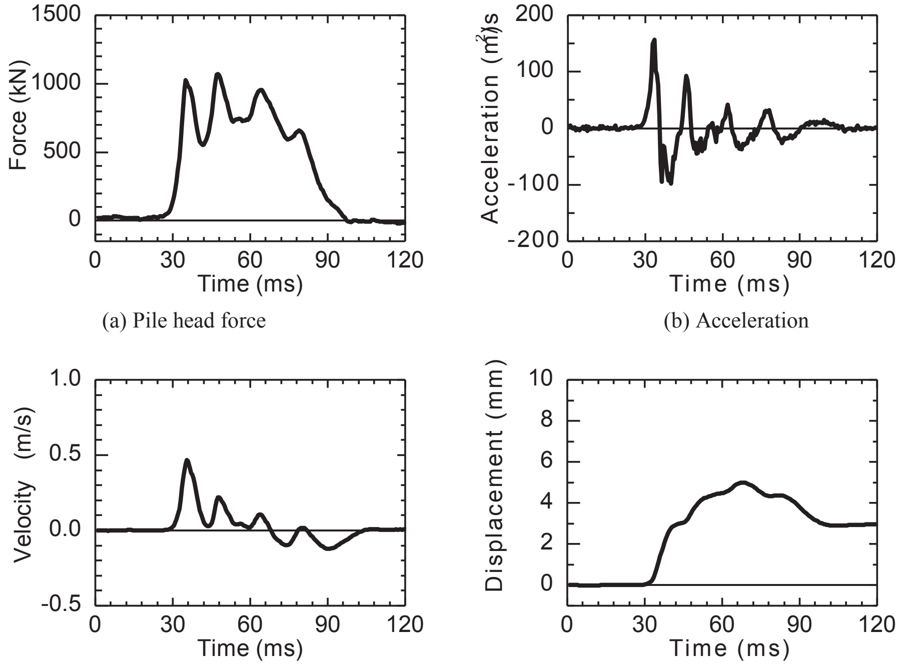


Figure 6. Profiles of soil layers and SPT *N*-values in DRR bridge construction sites, together with pile lengths.



(a) Pile head force

(b) Acceleration

(c) Velocity

(d) Displacement

Figure 7. Examples of measured dynamic signals.

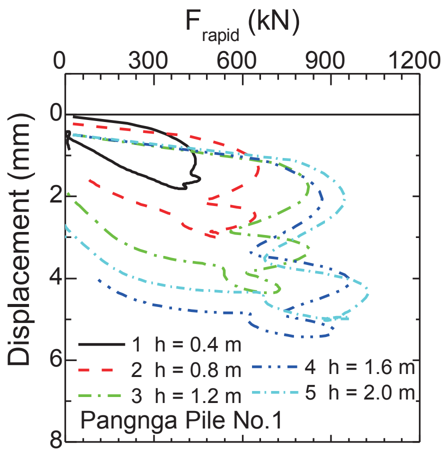


Figure 8. Measured rapid load-displacement.

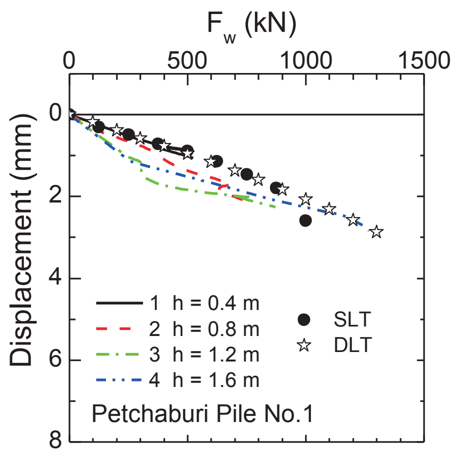


Figure 11. Comparisons of load-displacement relations from SLT, DLT and SH tests of Petchaburi site.

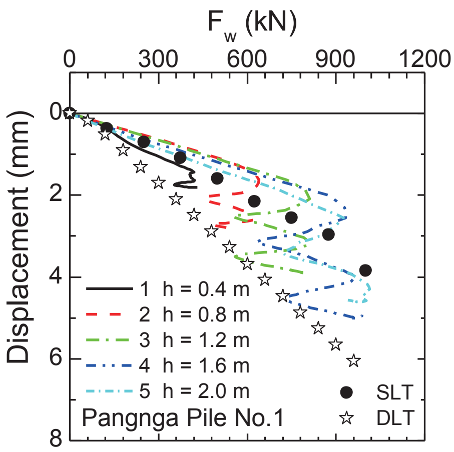


Figure 9. Comparisons of load-displacement relations from SLT, DLT and SH tests of Pangnga site.

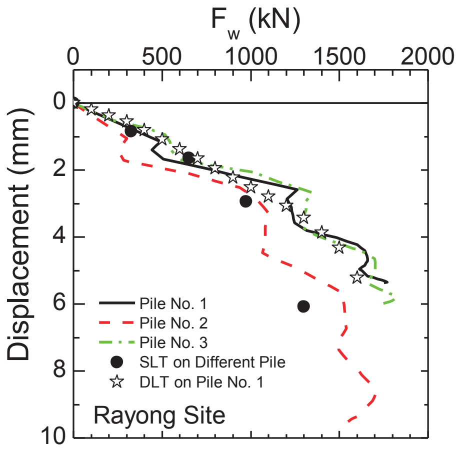


Figure 12. Comparisons of load-displacement relations from SLT, DLT and SH tests of Rayong site.

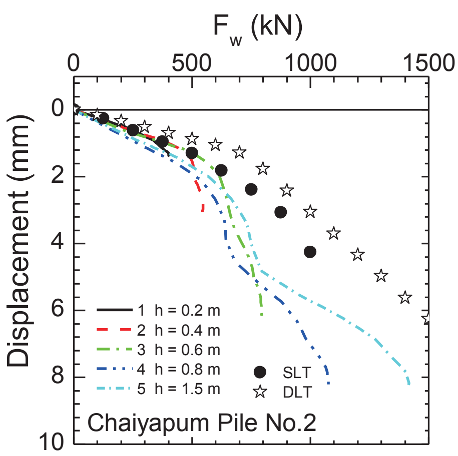


Figure 10. Comparisons of load-displacement relations from SLT, DLT and SH tests of Chaiyapum site.

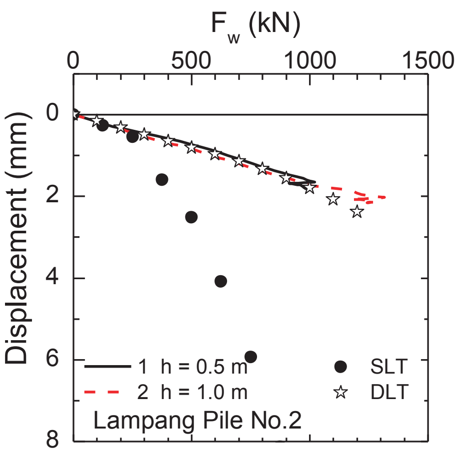


Figure 13. Comparisons of load-displacement relations from SLT, DLT and SH tests of Lampang site.

5 CONCLUDING REMARKS

The validity of the SH rapid load test was examined through comparisons of static, dynamic and rapid load tests on the RC driven piles.

The RC driven piles were used for foundations of bridges in five construction sites. It was confirmed that all the piles in the five sites have the pile capacity greater than the required values.

The case studies presented in this paper encourage the use of rapid pile load testing for construction and quality controls of the constructed piles in Thailand.

REFERENCES

Bermingham, P. and Janes, M. (1989). "An innovative approach to load testing of high capacity piles", Proc. of Int. Conf. on Piling and Deep Foundations, Stresa, Italy, pp.409-413.

Gonin, H.G.C. and Leonard, M.S.M. (1984). "Theory and performance of a new dynamic method of pile testing, Proc. of 2nd Int. Conf. of Application of Stress-Wave Theory to Piles, Stockholm, Sweden, pp.403-410.

Japanese Geotechnical Society (2002). Method for Rapid Load Test of Single Piles, JGS 1815-2002, Standards of Japanese Geotechnical Society for Vertical Load Tests of Piles, 2002.

Kusakabe, O. and Matsumoto, T. (1995). "Statnamic tests of Shonan test program with review of signal interpretation", Proc. of 1st Int. Statnamic Seminar, Vancouver, Canada, pp.113-122.

Matsumoto, T., Tsuzuki, M. and Michi, Y. (1994). "Comparative study of static loading test and statnamic on a steel pipe pile driven in a soft rock", Proc. of 5th Int. Conf. and Exhibition on Piling and Deep Foundations, Bruges, Belgium, pp.531 - 537.

Matsumoto, T., Wakisaka, T., Wang, F.W., Takeda, K. and Yabuuchi, N. (2004). "Development of a rapid pile load test method using a falling mass attached with spring and damper", Proc. of 7th Int. Conf. on the Appl. of Stress-Wave Theory to Piles, Selangor, Malaysia,pp. 351-358.

Middendorp, P., Bermingham, P. and Kuiper, B. (1992). "Statnamic loading testing of foundation piles", Proc. of 3rd Int. Conf. on Application of Stress-Wave Theory to Piles, The Hague, The Netherlands, pp.581-588.

Randolph, M.F. and Deeks, A.J. (1992). "Dynamic and static soil models for axial pile response", Proc. of 4th Int. Conf. on Appl. of Stress-Wave Theory to Piles, The Hague, The Netherlands, 3-14.

Schellingerhout, A.J.G., Revoort, E. (1996). "Pseudo static pile load tester", Proc. of 5th Int. Conf. on Application of Stress-Wave Theory to Piles, Orland, USA, pp.1031-1037.

IS-Kanazawa 2012

18 - 20 September, 2012, Kanazawa, Japan

The 9th International Conference on Testing and Design Methods for Deep Foundations

Intoroduction

The 9th International Conference on Testing and Design Methods for Deep Foundations (IS-Kanazawa 2012) is the international conference subsequent to the series of 1st through 8th "International Conferences on the Application of Stress-Wave Theory to Piles", held from 1980 through 2008.

Japanese Geotechnical Society
International Society for Soil Mechanics and Geotechnical Engineering
Kanazawa University

Japanese Geotechnical Society

SIMSG ISSMGE
International Society for Soil Mechanics and Geotechnical Engineering

KANAZAWA UNIVERSITY 1862 ~ 1949 ~
金沢大学
Kanazawa University

Conference Objectives

Foundation design is changing from conventional design methods to design frameworks such as limit state approaches; performance-based design; load and resistance factor design or probabilistic design. In this context, load tests of single piles and plate-load tests on a construction site are necessary as 'element tests' for design of foundation systems such as pile groups (and rafts). The number of tests on site is also a key factor in the foundation design. Hence, the role of dynamic tests including rapid load and vibratory test methods are becoming increasingly important in the processes of the new design frameworks.

The objective of the conference is to provide an international forum for practitioners, academics and researchers from various countries to share and disseminate their knowledge, experience and expertise in the field of pile engineering. Emphasis will be placed on the effective use of pile testing applied to design of foundation systems.

Conference Themes

The word "Testing" covers the full range of test methods including Dynamic Load Testing (DLT), Rapid Load Testing (RLT), Sonic Integrity Testing (SIT), other integrity testing, Static Load Testing (SLT), ground investigations and related numerical and physical modeling while "Design" implies the use of the test and experimental results in the design of whole foundation systems such as pile groups and piled raft foundations.

The conference will also include papers relating to the testing of shallow foundations and informative case histories involving 'testing' and 'design'.

1. Application of stress-wave theory to piles
   - 1. 1. Wave mechanics applied to pile engineering
   - 1. 2. Relationship between static resistance to driving and long-term static soil resistance
   - 1. 3. Case histories involving measurement and analysis of stress waves
   - 1. 4. Dynamic monitoring of driven piles
   - 1. 5. Numerical and physical modeling of dynamic soil-pile interaction
   - 1. 6. High-strain dynamic testing
   - 1. 7. Low-strain dynamic testing
   - 1. 8. Rapid load testing
   - 1. 9. Monitoring and analysis of vibratory driven piles
   - 1.10. Correlation of dynamic and static pile load tests
   - 1.11. Quality assurance of deep foundations using dynamic methods
   - 1.12. Incorporation of dynamic testing into design codes and testing standards
   - 1.13. Ground vibrations (environmental impact) induced by pile motions
   - 1.14. Drivability analysis for impact and vibratory hammers
   - 1.15. Dynamic horizontal load testing

2. Other pile load test and analysis methods
    2.1. Static load testing
    2.2. Osterberg cell tests
    2.3. Horizontal load testing
    2.4. Tension load testing
    2.5. Numerical and physical modeling of static soil-pile interaction
    2.6. New test methods for deep foundation
3. Pile integrity test methods other than sonic integrity (low-strain) testing
4. Testing other than pile testing
    4.1. Static and dynamic plate load testing
    4.2. Dynamic methods for ground investigations
5. Use of test results in the design of a foundation system (such as a pile group, piled raft, etc.)
    5. 1. Construction control of piles
    5. 2. Testing programs of quality control techniques for piling projects
    5. 3. Re-use of existing old foundations
    5. 4. Applying pile test results to design of piled foundations
    5. 5. Design of foundation systems based on reliability, probabilistic, or statistical approaches
    5. 6. Design of foundation systems based on performance-based design approach
    5. 7. Application of pile test results to design in an LRFD context
    5. 8. Statistical methods for designing test programs and evaluating test results
    5. 9. Economic considerations for deep foundation design and testing
    5.10. Environmental considerations for deep foundation design and testing
    5.11. Correlation of results of pile tests, soil tests, and site investigations
    5.12. Incorporation of pile testing into design codes and testing standards
6. Testing and design methods for energy piles
7. Case histories involving testing and design
8. Others

Official Language

The official conference language will be English.

Submission of Abstract

Abstracts should be submitted in the prescribed format. The abstract format will be provided later through the homepage.

Registration Fee

ISSMGE member	50,000 Yen
Non ISSMGE member	55,000 Yen
Student	15,000 Yen
Accompanying person	15,000 Yen

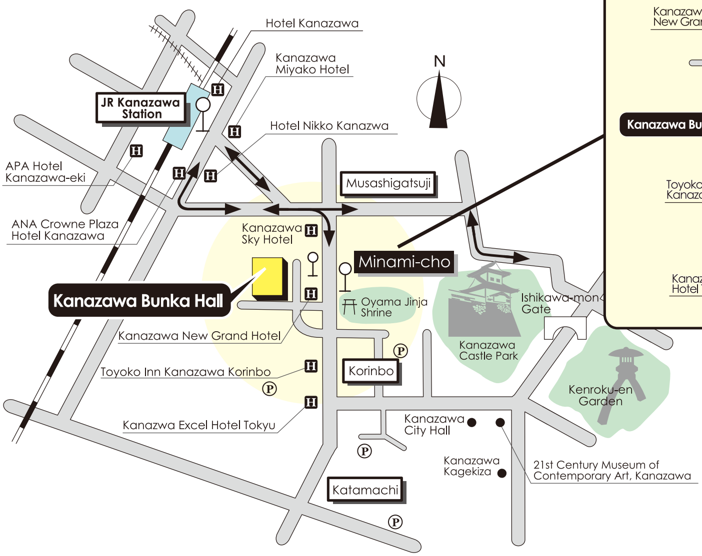
The conference organizers have negotiated 50% discounts with several hotels for the foreign delegates for the duration of the conference from 17th to 21st September 2012 (Six nights maximum). See Registration & Accommodation for details.

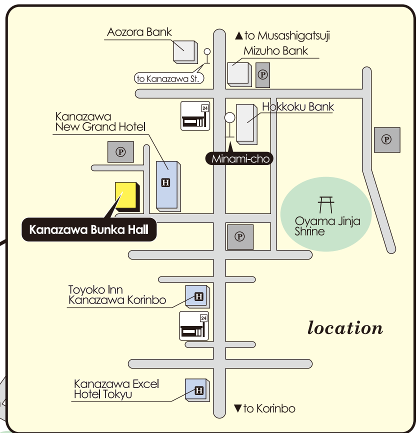
Important Dates

Submission of abstracts	30th June 2011
Notification of acceptance of abstracts	31st August 2011
Submission of papers in prescribed format	31st December 2011
Notification of final acceptance of paper	31st March 2012

Venue, Access and Hotels

Kanazawa Bunka Hall
15-1, Takaoka-machi, Kanazawa, 920-0864, Japan
Tel (+81) (0)76-223-1221





Organization

Host organization :

Japanese Geotechnical Society (JGS) under the auspices of ISSMGE

Co-host:

Kanazawa University

Chairman of the conference:

Tatsunori Matsumoto (Kanazawa University)

Honor chairman of the conference:

Keiichi Fujita (former President of JGS)

Local Organizing Committee:

Chairman: Osamu Kusakabe (Tokyo Institute of Technology)

Secretary General: Shun-ichi Kobayashi (Kanazawa University)

Secretary: Shinya Shimono (Kanazawa University)

Akira Asaoka (President of JGS)

Takashi Nakai (President of JGS Hokuriku Branch)

Kazuyuki Matsuzawa (Marubeni Construction Material Lease Co.)

Advisory Committee:

Jean-Louis Briaud (President of ISSMGE, Texas A & M University, USA)

Zuyu Chen (Vice-President Asia ISSMGE, China Institute of Water Resources and Hydropower Research, China)

Chung-Tien Chin (President of Southeast Asian Geotechnical Society, Moh& Associates, Taiwan)

Askar Zhusupbekov (Eurasian National University, President of KGS, Kazakhstan)

Bengt Fellenius (Consulting Engineer, Canada)

Eun Chul Shin (Civil and Environmental System Eng., University of Incheon, Korea)

Fumio Kuwabara (Nippon Institute of Technology, Japan)

Frits van Tol (Deltares, The Netherlands)

George Goble (George Goble Consulting Engineering, LLC, USA)

Harry Poulos (Coffey Geotechnics, Australia)

Jaime Santos (Instituto Superior Técnico, Portugal)

Mark Randolph (UWA, Australia)

Rashid Mangushev (St. Petersburg State University of Architecture and Civil Engineering, Russia, Board member of Russian Geotechnical Society)

Technical Committee:

TC18 (Deep Foundations) core members

Chairman: Rolf Katzenbach (TechnischeUniversität Darmstadt, Germany, Chairman of TC18 ISSMGE)

TC23 (Limit State Design in Geotechnical Engineering)

Chairman: Yusuke Honjo (Gifu University, TC23 member, Japan)

Samuel Paikowsky (University of Massachusetts, USA)

Kenji Matsui (CTI Engineering, Co., TC23 member, Japan)

Makoto Suzuki (Shimizu Co., Japan)

International Members:

Adrian Hyde (Sheffield University, UK)

Frank Rausche (GRL Engineers, Inc., USA)

Garland Likins (Pile Dynamics, USA)

Jorge Beim (Pile Dynamics, Inc., USA)

Michael Brown (University of Dundee, UK)

Pastsakorn Kitiyodom(Geotechnical & Foundation Engineering Co., Ltd., Thailand)

Patrick Bermingham (Bermingham Construction Ltd., Canada)

Peter Middendorp (Profound BV, The Netherlands)

Roger Frank (CERMES, France)

Sangseom Jeong (Prof. of Yonsei University in Seoul, Korea)

Yean Khow Chow (National University of Singapore, Singapore)

Japanese members:

Akio Abe (Tokyo Soil Research Co., Japan)

Feng Zhang (Nagoya Institute of Technology)

Hideki Fujisawa (System Measurement Co., Japan)

Isamu Sandanbata (Hazama Co., Japan)

Jiro Takemura (Tokyo Institute of Technology, Japan)

Jun Otani (Kumamoto University, Japan)

Katsutoshi Kita (Tokai University, Japan)

Kazuaki Miyamoto (Japan Foundations Engineering Association)

Kenichi Horikoshi (Taisei Co., Japan)

Koichi Isobe (Nagaoka University of Technology, Japan)

Koichi Tomisawa (Civil Engineering Research Institute for Cold Region, Japan)

Koji Watanabe (Obayashi Co., Japan)

Makoto Kimura (Kyoto University, Japan)

Masayuki Kouda (Railway Technical Research Institute, Japan)

Noriyuki Yasufuku (Kyushu University, Japan)

Naoaki Suemasa (Tokyo City University)

Satoru Ohtsuka (Nagaoka University of Technology, Japan)

Shigeo Kanai (Chiyoda Geotech Co., Japan)

Shinichiro Mori (Ehime University, Japan)

Shinji Nishimura (Jibanshikenjo Co., Japan)

Shoichi Nakai (Chiba University, Japan)
Shuji Tamura (Kyoto University, Japan)
Takahiro Hayashi (COPITA, Japan)
Takashi Hara (Gifu University, TC23 member, Japan)
Takeshi Oki (Japanese Technical Association for Steel Pipe Piles and Sheet Piles)
Tatsuhiko Kojima (Tama Blasting Engineering Co. , Japan)
Tomoaki Shiotani (Kyoto University, Japan)
Yoshiaki Kikuchi (Port & Airport Research Institute, Japan)
Yoshiyuki Morikawa (Port & Airport Research Institute, Japan)
Yukihiro Ishihara (Giken, International Press-in Association, Japan)

Call for Papers

Engineers, researchers, designers, teachers and other professionals are invited to submit papers for review, dealing with one or more of the Conference subjects relating to pile engineering and technology. Emphasis will be placed on pile testing and the use of test results in the design of pile foundation systems as well as well-documented case histories.

Registration and Accommodation

Registration

The registration page will open later in 2011.

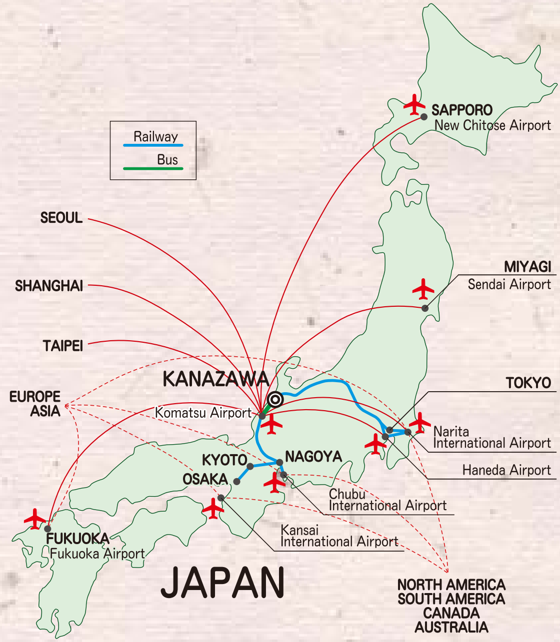
Hotel accommodation

Three official hotels are available with special rates as follows:

Grade	Hotel name	Single room	Twin room	
			Single use	Twin use
A	Kanazawa New Grand Hotel	8,500	12,000	16,000
B	Kanazawa Excel Hotel	9,500	12,500	16,000
C	Toyoko Inn Kanazawa Korinbo	5,000	7,000	7,000

Discount rates for registered person from foreign countries

The rates of the official hotels are discounted by 50 % for registered persons from foreign countries from 16th to 21st September 2012 (Six nights maximum). At least one registered person is required for each room.



Kanazawa is known widely as "sho-Kyoto" or "little Kyoto", and has provision for a wide range of post-conference tours and activities, as well as possibilities for custom programs. Kanazawa, along with the outlying areas of natural beauty, offers virtually endless combinations for its visitors. Flights to Komatsu International Airport near Kanazawa from Tokyo (Narita), Tokyo (Haneda), Shanghai, Seoul and Taiwan are available. Kanazawa is also accessible by trains to and from major cities in Japan.

Corresponding Address

E-mail: office@ is-kanazawa2012.jp

Homepage: http://www.is-kanazawa2012.jp

Address: IS-Kanazawa 2012 Organizing Committee

Att. Prof. Tatsunori Matsumoto

Department of Civil Engineering, Kanazawa University,

Kanazawa, 920-1192, JAPAN

Phone and Fax: (+81) 76-234-4625