

## Report 2015-Overseas activity of Fudo Tetra Corporation

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International Department/ Fudo Tetra Corporation

### 1. Our overseas activities

We specialize in the soft ground improvement work such as Deep Soil Mixing, Sand/Gravel Compaction Pile, Sand Drain method and MVT (Mammoth Vibro-Tamper for shallow densification), which is our best field of construction since 1950's, and we have resource who has capability of construction management, making design, analysis and other engineering works.

We have received both public and private work as a subcontractor in overseas. Ground improvement works that consist of eleven projects (Deep Soil Mixing) in Vietnam, eleven projects (Sand Compaction Pile; SCP, Deep Soil Mixing and shallow compaction; MVT) in the U.S.A., one project (Offshore SCP) in South Korea and two projects (Offshore Deep Soil Mixing) in Hong Kong have been completed so far until the end of 2015.

#### (1) U.S.A.

Fudo Tetra Corporation has established its U.S. subsidiary "Fudo Construction Inc. (FCI)" (URL:<http://www.fudo-const.com>) in San Mateo, California in 2005. FCI has performed some liquefaction mitigation works using the Sand Compaction Pile (SCP) and non-vibratory sand compaction pile method (called as SAVE-Compozer) for foundations of urban facilities in CA and WA states. There was no settlement/sand boiling in the improved area of UPS Cerritos project site where is so closed to the epicenter, during the earthquake on Mar. 29, 2014 in Los Angels.

In addition, FCI has conducted the huge amount of Deep Soil Mixing work for New Orleans Levee improvement in Louisiana at 2009-2011, and MVT (Shallow densification) at Fort Lauderdale Airport runway at 2012-2014.

<http://www.issmge.org/en/resources/issmge-bulletin/174-list-of-contents-for-issmge-bulletin-february-issue-2011>

#### (2) Asia

##### (a) Hong Kong

We have completed the Hong Kong International Airport Contract P552- Deep Mixing 2<sup>nd</sup> Trial Works (by Single Rig) in 2014-2015 with using local flat barge. The DCM barge was mobilized at local shipyard. All the work was done without any delay and any environmental impact.

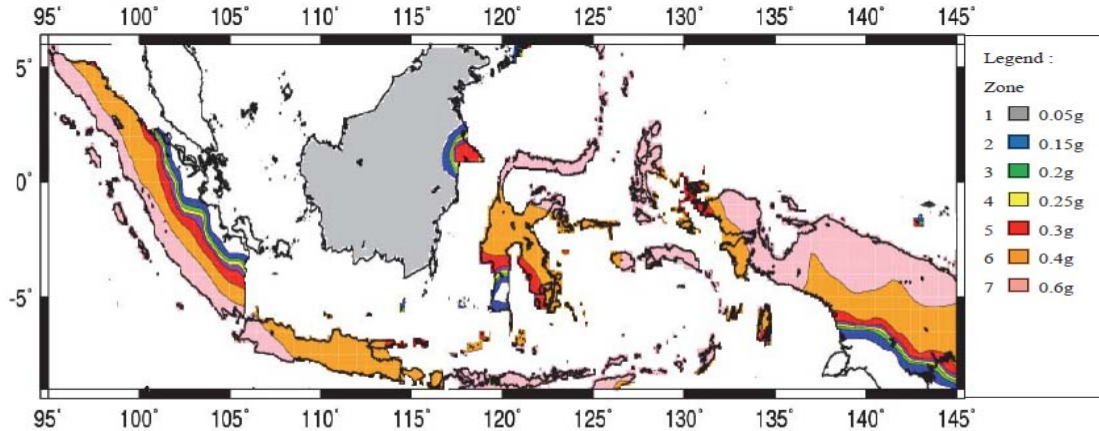


DCM barge and SEP for the core sampling in Hong Kong

**(b) Indonesia**

We have opened the new representative office in Jakarta, Indonesia in 2015. So, hopefully we would like to look at the local ground improvement projects which are expected in near future.

In particular, there is high potential seismic risk in Indonesia due to many subduction zones and faults (see following, (Rusnardi, R. P., et.al., Seismic hazard analysis for Indonesia, Journal of Natural Disaster Science, Vol. 33, Number 2, 2012). Therefore, liquefaction mitigation method like Sand Compaction Pile (SCP) is suitable and effective to protect the sandy ground.



**Fig. 12** Result, the seismic hazard map of Indonesia for return period 475 years, for engineering bedrock condition.

**(c) Bangladesh**

In Bangladesh, some Japan’s ODA projects are planned and ground improvement works are expected accordingly. Therefore, we are proposing our ground improvement technique such as the Sand Compaction Pile method to mitigate the potential seismic risk of liquefaction for the Depot of rail project (see following photo), and the Deep Soil mixing method to deal with the embankment settlement for the Power Plant project.



## **2. Technical paper published regarding our technology**

### **(Sand Compaction Pile, SCP)**

Kinoshita, H., Harada, K., Nozu, M. and Ohbayashi, J., Sand Compaction Pile Technology and its Performance in both Sandy and Clayey Grounds, TC 211 International Symposium on Ground Improvement, IS-GI Brussels 2012.

### **(Non-Vibration SCP)**

Nozu, M. Ohbayashi, J. and Matsunaga, Y (1998), Application of the static sand compaction pile method to loose sandy soil, Proc.of the International Symposium on Problematic Soils (IS-TOHOKU 98), pp.751-755.

### **(Deep Cement Mixing)**

Nozu, M: MANUAL FOR DESIGN AND CONSTRUCTION OF CEMENT COLUMN METHOD (1998), International cooperation and technology transfer in the field of soft ground were executed in the framework of JAPAN (JICA and Public Works Research Institute (Ministry of Construction)) - THAILAND (Department of Highway) Joint Study on Soft Clay Foundation

Bertero, A., Leoni, F, Filtz, G, Nozu, M., Drus, D., Bench-Scale Testing and Quality Control/Quality Assurance Testing for Deep Mixing at Levee LPV 111. ICOG2012 (4<sup>th</sup> International Conference on Grouting and Deep Mixing).

Nozu, M., Ngo Tuan Anh, Shinkawa, N and Matsushita K, Remedy of Deep Soil Mixing Quality for Montmorillonite Clay Deposited in the Mekong and Mississippi Deltas, TC 211 International Symposium on Ground Improvement, IS-GI Brussels 2012.




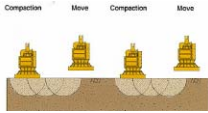
Takano, M., Suzuki, K., and Shinkawa, N., Cement Deep mixing in Lack Huyen Port Infrastructure Construction Project in Northern Vietnam, 2015 DFI Deep Mixing Conference, San Francisco.

Nozu, M., Masaru Sakakibara, and Ngo Tuan Anh, Securing of in-situ cement mixing quality for the expansive soil with the 'Montmorillonite' inclusion, 2015 DFI Deep Mixing Conference, San Francisco.

### **(MVT: Shallow Densification)**

Nozu, M., Sakakibara, M., and Matsushita, K, Application of Mammoth Vibro-Tamper (MVT) for the shallow compaction at airport runway expansion project in Florida, Asia Regional Conference (ARC) ISSMGE 2015.

### 3. Ground Improvement method for oversea project

Method	Features	Machine
Deep Mixing	<p>Soil-cement mixing column with 1,000-1,600mm in diameter is installed by mixing blades. This method was developed in 1970's in Japan. Both laboratory mixing test and check boring are required to keep its quality. This method does not need long curing/waiting time to obtain the strength.</p> <p>Recently, special design technique called <u>ALiCC method</u> which realizes low DM improvement ratio (12-20%) has been developed so that we can achieve more economical design.</p> <p>In the US, at Levee raising-up projects in the South, we have performed huge amount of DM (<u>CI-CMC method</u>) with large diameter of 1,600mm.</p> <p>In 2011 and 2014, we completed <u>offshore Deep Soil mixing</u> test projects in Hong Kong marine side by using local flat barge. This is the first trial of Deep Mixing in Hong Kong.</p>	
Sand/Gravel Compaction Pile (SCP,GCP)	<p>Very dense sand/gravel pile with 700-900mm in diameter is installed in both clayey and sandy ground. This method is effective for increasing stability of clayey ground and mitigating liquefaction of loose sandy ground.</p> <p>Recently, no-vibration (static) sand compaction pile machine has been introduced to the U.S. for mitigation of liquefaction in urban area.</p>	
Off-shore Sand Compaction Pile	<p>Large diameter sand pile (1600-2000mm) is installed by special barge. It is useful for foundation improvement at many harbor structures such as breakwater and various types of quay-wall. Construction speed is much faster than the other methods. Both gravel and sand are applicable as infilling materials; however, daily quantity of around 2,500m<sup>3</sup> is required.</p>	
MVT	<p>Crawler crane and attachments are used to suspend the heavy vibrator and vibrating plate.</p> <p>This method has higher energy, higher productivity yet lower noise/vibration than conventional Dynamic Compaction.</p>	

#### Contact Address;

##### FUDO TETRA CORPORATION

International Department  
 7-2 Nihonbashi-Koami-cho, Chuo-ku, Tokyo, JAPAN, 103-0016  
 Tel.:+81-3-5644-8535, Fax:+81-3-5644-8537  
 E-mail:webmaster@fudotetra.co.jp, URL:http://www.fudotetra.co.jp

##### FUDO Construction Inc. (USA)

1720 South Amphlett Boulevard, Suite 225, San Mateo, CA 94402, USA  
 Tel:+1-650-350-1120  
 URL: http://www.fudo-const.com

##### FUDO Resident Representative Office in Ho Chi Minh City, Vietnam

6<sup>th</sup> Floor, VITAMAS Building, 84 Nguyen Tat Thanh St., District 4, Ho Chi Minh city, Vietnam  
[Tel:+84-8-5401-2658](tel:+84-8-5401-2658)

##### FUDO Representative Office in Jakarta, Indonesia

Bakrie Tower 3rd Floor, JL.HR.Rasuna Said, Kuningan, South Jakarta 12940, Indonesia  
 Tel:+62-21-2991-2499