

## Report 2014-Overseas activity of Fudo Tetra Corporation

May 2015

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 of manpower who has capability of construction management, making design, analysis and other engineering works.

We receive 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 May 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, 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.

#### # Shallow Compaction (MVT)

We have already completed the huge surface densification project in Fort Lauderdale airport runway expansion project (2012-2014), in Florida by using MVT (Mammoth Vibro-Tamper) system. MVT is capable of compacting loose sandy ground up to -10 to 15ft (3-4.5m) in depth by using a heavy steel plate and a strong vibrator on it. MVT was developed by Fudo Tetra Corporation and has been receiving superior reputation in both Japan and U.S. We have compacted around 567,800 square yards (474,700m<sup>2</sup>) of the runway area within 10 months (1,000-1,500sy/shift/rig).

Vibration level (velocity) was measured less than 0.5in/sec at 25ft distance from tamping plate while 0.2in/sec at 50ft distance. It is definitely lower than DDC (Conventional Deep Dynamic Compaction). Accordingly, we could perform tamping work adjacent to the existing airport structure.



Reference: M.Nozu et al: Application of Mammoth Vibro-Tamper (MVT) for the shallow compaction at airport runway expansion project in Florida, ARC(Asian regional conference), ISSMGE, 2015

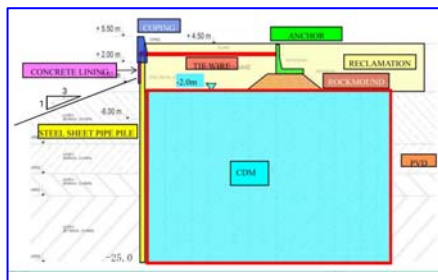
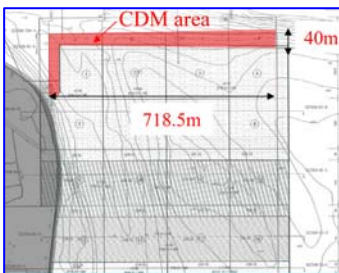
**(2) Asia**

**(a) Vietnam**

Since 2006, Fudo Tetra has performed the deep soil mixing work in Vietnam by using FT's machine and equipment (See following table). In 2014, we have completed the huge amount of offshore deep soil mixing work in Hai Phong, Vietnam with using three local flat barges (Lach Huyen Port Infrastructure Project Package-6). These barges have been designed and mobilized in Vietnam by our special technical team.

# Improved soil quatity: Deep Mixing, dia.1,300mm, Depth:-36m, Q'ty:501,000m3 (all offshore)

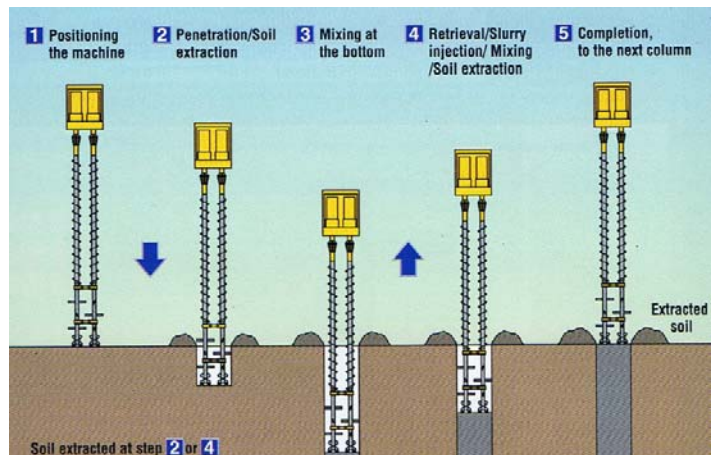
Reference: M. Takano et al: Cement Deep mixing in Lack Huyen Port Infrastructure Construction Project in Northern Vietnam, DM2015, DFI-conference), 2015



In Ninh Binh city, just around 130km south from Hanoi, we have performed the CDM-LODIC work, which is patented method. It can reduce the lateral deformation and protect the existing rail through the mixing work. There was no such deformation even in 3m distance from existing railway in this project.



Ninh Binh project



CDM-LODIC method®

Previous projects in Vietnam

Project	Year	Location	Remarks
Can Tho airport	2006	Can Tho	Test of deep mixing (wet type)
Thermal Power Plant	2006	Can Tho	Deep Mixing, dia.1,600mm Q'ty:230,000m <sup>3</sup>
Container Terminal	2007	Ho Chi Minh	Deep Mixing, dia.1,600mm, Depth:-39m, Q'ty:300,000m <sup>3</sup>
Container Terminal	2008	Ho Chi Minh	Deep Mixing (ALiCC), dia.1,000mm-1,300mm, Depth:-33m, Q'ty:838,000m <sup>3</sup> (partly offshore)
Container Terminal	2009	Ho Chi Minh	Deep Mixing, dia.1,300mm, Depth:-33m, Q'ty:182,000m <sup>3</sup> (partly offshore)
Container Terminal	2010	Ho Chi Minh	Deep Mixing, dia.1,300mm, Depth:-33m, Q'ty:97,000m <sup>3</sup>
Railway (Hanoi-HCMC)	2012-2015	Ninh Binh	Deep Mixing (Low Displacement type, CDM-LODIC method), dia.1,000mm, Depth:-25m to -9m, Q'ty:26,500m <sup>3</sup>
Container Terminal (Lach Huyen Port, Package 6)	2013-2014	Hai Phong, South of Cat Hai	Deep Mixing, dia.1,300mm, Depth:-36m, Q'ty:501,000m <sup>3</sup> (all offshore)

(b) Hong Kong

We have joined the Hong Kong International Airport Contract P555- Deep Mixing Trial Works (by Single Rig) in 2014-2015 with using local flat barge and local shipyard.



(c) Indonesia

We intend to open the representative office in Jakarta, Indonesia in 2015.

## 2. Technical paper published regarding our technology

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.

A.Asaoka, M.Nakano, G.S.K.Fernando, M.Nozu, Mass permeability Concept in the analysis of treated ground with sand drains, *Soils and Foundations*, Vol.35, No.3, 43-53, 1995. Japanese Geotechnical Society

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).

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.



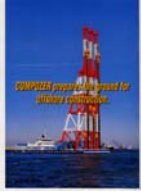
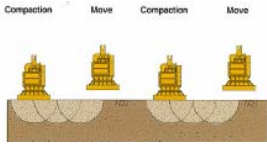
Nozu, M., Ngo Tuan Anh, Shinkawa, N and Matsushita K, Remedy of Deep Soil Mixing Quality for Montmorillonite Clay Deposited in the Mekong and Mississippi Deltas, TC 211 International Symposium on Ground Improvement, IS-GI Brussels 2012.

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.

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 Vietnam, at a container terminal construction projects, we have assembled the DM special barges by renting local flat barge. Increase of stability of inclined river dike has been achieved by the DM method.</p> <p>In 2011 and 2014, we completed offshore Deep Soil mixing test projects in Hong Kong marine side. 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>	

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(Under registration)