"Project Formulation Survey" under the Governmental Commission on the Projects for ODA Overseas Economic Cooperation in FY2013

Summary Report

The Republic of the Union of Myanmar

Project formulation survey on the infrastructure development in Myanmar with the D・BOX an innovative method of special countermeasures against the soft ground

March, 2014

Metry Technology Institute Co., Ltd., Pacific Consultants Co., Ltd., Oriental Consultants Co., Ltd. and Maeda Giken Kogyo Co., Ltd. /Joint Venture

The content of this report is a summary of the project formulation survey, which was commissioned by the Ministry of Foreign Affairs of Japan in the FY 2013 and is carried out by the consortium (Metry Technology Institute Co., Ltd., Pacific Consultants Co., Ltd., Oriental Consultants Co., Ltd. and Maeda Giken Kogyo Co., Ltd.). It does not represent the official view of the Ministry of Foreign Affairs.

Introduction

The Ayeyarwady Region located on the coast of the Republic of the Union of Myanmar (hereinafter referred to as Myanmar) is home to 6.6 million people, about 10% of Myanmar's population. However, as the region is in the delta of the Ayeyarwady River, the rice paddy region formed through the accumulation of weak strata has no high ground which leaves it extremely vulnerable to damage from cyclones, heavy rain and storm surges. In May 2008, Myanmar was hit by Cyclone Nargis which resulted in 140,000 dead or missing and a further 2.4 million confirmed to have been adversely affected. Embankment roads situated on soft foundations were limited to a height of about 2 meters and during the storm surge of 2008 the roads collapsed and were inundated which resulted in an even greater number of casualties. Despite the fact that there is a high possibility that flooding will occur again in the future, evacuation roads currently cannot adequately serve as transport roads for emergency supplies and therefore urgent development is required. In delta regions such as the Ayeyarwady Region, soil improvement is necessary for, not only roads, but also other infrastructure such as port facilities, railways, industrial estates and housing developments. However, it is necessary to give appropriate consideration to the environmental aspects of unique technology, heavy equipment, cement based mixtures, etc. that are used in conventional solidification processes for soft ground reinforcement. For this reason, countermeasures which satisfy the aspects of economic efficiency, workability and the environment are necessary.

This study has been carried out to demonstrate the possibility of reinforcing soft ground without specialized soft ground countermeasure technologies through the use of the D・BOX method. It intends to demonstrate the advantages of the D・BOX method, such as ①the use of materials available in the vicinity of the site, ②employment promotion through utilizing local residents for construction and ③ the inexpensive supply of D・BOX through local production. Furthermore, it seeks to demonstrate that the use of the D・BOX method for reinforcing soft ground is superior to other conventional techniques in the aspects of economic efficiency, workability and the environment. Through the spread of the D・BOX method, soft ground can be reinforced, enabling progression in the development of disaster prevention and infrastructure which will directly benefit the people of Myanmar and contribute to their fundamental human needs. In addition, guidance in proper use will be implemented through the development of a design and construction manual alongside the implementation of technical transfer. Furthermore, product development will be carried out in line with the local circumstances. Finally, production of the D・BOX will be carried out in Myanmar which will enable an inexpensive supply aimed at developing the infrastructure in Myanmar with a focus on disaster resistant roads, railways and so forth.

Chapter 1 Current situation and confirmation of needs regarding relevant development issue in Myanmar

On January 31st 2011, following the results of general election, a multi-party Government was convened for the first time in 49 years. On March 30th of the same year a new government was established under President Thein Sein and in response to the progress made in democratization under the Thein Sein administration, western countries have been relaxing economic sanctions against Myanmar. In the economy sector, since there has been an expansion in government spending following the general election, exports centered on natural gas have shown strong performance. Also, following the progress of democratization in 2012, the number of visitors from foreign countries has rapidly increased resulting in a booming service industry mainly in hotels, tourism and real estate. Furthermore, Myanmar hosted the South East Asian Games in December 2013 and, as it has been inaugurated as the ASEAN chair for 2014, is making preparation for various international conferences etc. which has contributed to the domestic economy, resulting in growth of 6.3%.

Within the economic policy of the Thein Sein administration, infrastructure development takes a particularly important place. Some of the most important areas emphasized for infrastructure development are rural development, poverty reduction and industrial development. In particular, an increasingly high priority is being placed on the development of road networks to enable a stable supply of electricity and the smooth distribution of materials essential for advancing industrial growth.

If we explore the soil stratum of Myanmar we see that there is a lot of ground composed of a soft layer consisting of soil containing large amounts of clay, alluvial soil in the coastal areas, saline soil, and so on. In particular, the Ayeyarwady delta region in the south, which extends 250km north-south with swampy lowlands spread over an area of 30,000 km^2, has low ground, approx. 1/6th of which is lower than the hide tide mark during spring tide. For this reason damage from heavy rain and storm surges occurs almost yearly and this results in the formation of soft ground that consistently contains a great deal of moisture. This creates problems such as ground that is incapable of supporting the construction of roads, railways and buildings, and an increased danger of ground subsidence.

At present, as there are no effective methods for countering soft ground subsidence in Myanmar, measures are being explored. Due to budget constraints it is not possible to supply specialized heavy equipment and improvement materials (crushed stone),nor develop the access roads required for bringing in heavy equipment necessary for implementing the kind of ground improvement carried out in Japan. Furthermore, as the target area is a vast rice producing area, proper consideration must be given to environmental aspects and the use of cement based improvement methods must be examined with a great deal of caution.

Due to budgetary and annual construction period constraints, when roads are actually constructed on soft ground, the construction is carried out without any land subsidence countermeasures. This creates a vicious cycle in which road repairs must be implemented separately for each respective case when problems arise in the transport network due to subsidence.

In order to achieve the basic ODA policy of developing "infrastructure necessary for sustainable economic growth," it is considered necessary for the targeted infrastructure to be inexpensive and of high quality. In Myanmar, in particular, where there is a great deal of soft ground, it is essential to introduce soft ground countermeasure technology which can withstand long term use. Furthermore, from the point of view of improving the technical level of local residents, technology transfer to local engineers needs to be undertaken while implementing practical infrastructure. From this, we can see that there is a high need for soft ground countermeasures utilizing the D・BOX method to contribute to the future infrastructure development of Myanmar.

Chapter 2　Feasibility of utilizing the proposal company's technology and the outlook of its future business development

The proposal company's D・BOX is a product that can be hoisted with a single truss band by utilizing the binding force of inner materials through the use of a truss band within a bag. By using the tension force of the bag, frictional strength is generated between soil particles contained within the D・BOX creating solidification without the use of cement based solidification agents. It is a flexible structure that can preserve the shape of the bag even in ultra-soft ground through the binding effect of the internal truss band. This allows an even distribution of the load within the ground and thus this method can achieve a large ground bearing capacity. In addition, vibrational energy by a heavy traffic is converted to frictional heat energy from internal crushed stones, which has a vibration damping effect.

The features of the D・BOX, which would prove to be a key point for implementation in Myanmar, are outlined below.

- It is capable of ground reinforcement in ultra-soft ground like rice paddies.
- It can be installed solely through the manual labor of local resident workers and without the use of heavy equipment.
- Although the use of sand and crushed stone is desirable for inner material, in some cases it is possible to use locally generated soil for ground reinforcement.
- Through using crushed stone in inner materials it is possible to create a paving subgrade with high level drainage capacity.
- Soft-ground countermeasures such as cement mixing treatment are unnecessary, enabling environmentally friendly, on site construction.
- It has good workability with a capacity to construct more than 100 m^2 per day.

In addition, this method can be applied for locations with ultra-soft ground, which makes construction difficult and impedes the introduction of heavy equipment, small scale locations and where environmental consideration should be taken into account. There are no other methods that are capable of stand-alone use in the manner D・BOX can.

Furthermore, in order to protect intellectual property rights, 1 patent and 2 trademarks were registered within Myanmar on September of 2013.

As there are a large number of development plans for constructing important infrastructure facilities on soft ground in Myanmar, the necessity for soft ground countermeasures is exceedingly large. Considering positive responses of government agencies etc. in this study, business development of the proposed company is expected to take place.

Chapter 3　Introduction / trial of the product and implementation of various tests to verify local compatibility (demonstrations / pilot studies)

The following compatibility verifications activities were implemented for the introduction of D・BOX and its applicability as an ultra-soft ground countermeasure in Myanmar.

①Introduce the product through the creation of a promotional video using examples from Japan and trial construction in Indonesia

②Implement verification experiments which will act as demonstrations on ultra-soft ground in Myanmar's Ayeyarwady delta region.

③Through seminars, present experiment results and conduct a questionnaire regarding locations for D・BOX application and its utilization

First of all, an explanation focussing on the product's introduction was carried out for related organizations through the D・BOX promotional video. The 10 minute promotional video was put together to introduce the D・BOX and showed verification experiments in Japan as well as those done on temporary roads built on ultra-soft ground in Indonesia' s Kalimantan island. The video also presented information such as efficacy verification through trial experiments for liquefaction using D・BOX implemented by Pacific Consultants Co., Ltd (PCKK) and Metry Technology Institute Co., Ltd (Metry) at Gunma University. The video's narration was translated from Japanese into English and Burmese to further deepen the understanding of D・BOX.

In the field demonstration tests, verification experiments were conducted on the following three items.

(1) Slope protection [application to road revetments with extreme differences in tide level]
The target locations run perpendicular to waterways and revetments have collapsed many times during the rainy season. In order to suppress subsidence and slip, a sand filled D・BOX (LS-150) was installed in soft ground sections on top of which an 8-layer LS100 (a height of 2m) was placed. Although the effect was checked during the present consultation period, verification of the effect through subsidence monitoring and situational confirmation during the short dry season is insufficient. Due to this, and on the requests of the Public Works, Ministry of Construction (PW), the D・BOX will be maintained over the following year's rainy season (June-September) and furthermore, confirmation of the effect made through subsidence measurement and situational confirmation.

In addition, in the present situation subsidence is being resolved and the conditions are stable.
(2) Temporary roads (temporary work platforms for heavy equipment)
To confirm the effectiveness of D・BOX temporary roads (work platforms) located on ultra-soft ground, 6 D・BOX (LS150 sand filled) bags (4.5m x 3.0m)were installed on a 5 meter soft ground 0 N-value soil layer. This was implemented without the use of heavy equipment and through the use of manual labor alone. Also, in order to ensure that the load was distributed equally, a plywood foothold was created. Next, a backhoe (27t) was unloaded on top from a carrying vessel and this acted as a loading test work platform. The work platform was used over four days between November 9th– 12th with subsidence of about 7-29cm and, although there was about 70% subsidence on the first day of operation, the platform remained stable thereafter. In addition, after the work was completed, just by removing the sand packed within each D・BOX and washing them with water, they were ready to be reused.
(3) Loading Test
In order to verify the effectiveness of placing a D・BOX (LS150: sand filled) in one layer (approx. 40cm) of ultra-soft ground as a slip failure and subsidence control measure for loading embankments (approx. 3m), the loading embankment was made on ultra-soft ground located on the edge of a river. As a loading weight, sludge generated in the field during waterway excavation was used as filling material (weight 16.7KN/m^3) for the D・BOX (LS150: approx. 1.0m^3). The difference between high and low tide was about 2m.

In this experiment, it order to confirm the suppressing effect of D・BOX on sliding failure and consolidation settlement, subsidence observation has been carried out at 9 points since installation was completed on November 12th, 2013 (subsidence measurements are scheduled to be continued for one year based on the requests of the PW). On the first day the amount of subsidence was approx. 65-80% of the final predicted amount and after about two weeks it had mostly settled. Furthermore, on the requests of the PW, taking into account the circumstances during the monsoon season, subsidence observation will be continued for one year and the stability of the D・BOX confirmed.

In addition, 3 seminars were carried out in order to introduce the D・BOX, sandbag theory and the applicability of the D・BOX to Myanmar. These seminars were held twice in Yangon and once in Naypyidaw. The 2 Yangon seminars were held at the Myanmar Engineering Society (MES) and participants from a wide range of fields, such as individuals from relevant organizations, MES members and students were invited to take part. The seminar in Naypyidaw was held in a location of limited capacity and therefore only people from relevant organizations considered to be closely related to soft ground countermeasures were invited. At the seminars, a questionnaire was conducted regarding the applicability of D・BOX and locations for its utilization while the needs of Myanmar and the possibility of incorporating D・BOX into a future ODA project were examined.

From the results of the survey, the evaluation of the D・BOX was exceedingly positive and the majority of respondents expressed a desire to make practical use on soft ground in locations such as Myanmar's delta area.

Through these activities it was confirmed that there is a high demand for soft ground countermeasures in Myanmar through the use of the D・BOX. Furthermore, we were able to attain a great deal of understanding regarding the effectiveness of D・BOX from related government agencies and so on.

Chapter 4 Effects related to the development impacts in Myanmar and the business expansion of the proposed company through the implementation of an ODA project

Figure-1shows challenges and development impacts in Myanmar through the introduction of the D・BOX method. It is expected that high effectiveness, which existing ground improvement methods have not realized can be achieved.

In addition, through the implementation of an ODA project, the effectiveness of D・BOX can be demonstrated through actual use. This would further enable the spread of D・BOX to structures in Myanmar's southern Ayeyarwady delta district as well as other areas that are currently facing challenges such as countermeasures for soft ground, vibration and drainage (culverts).

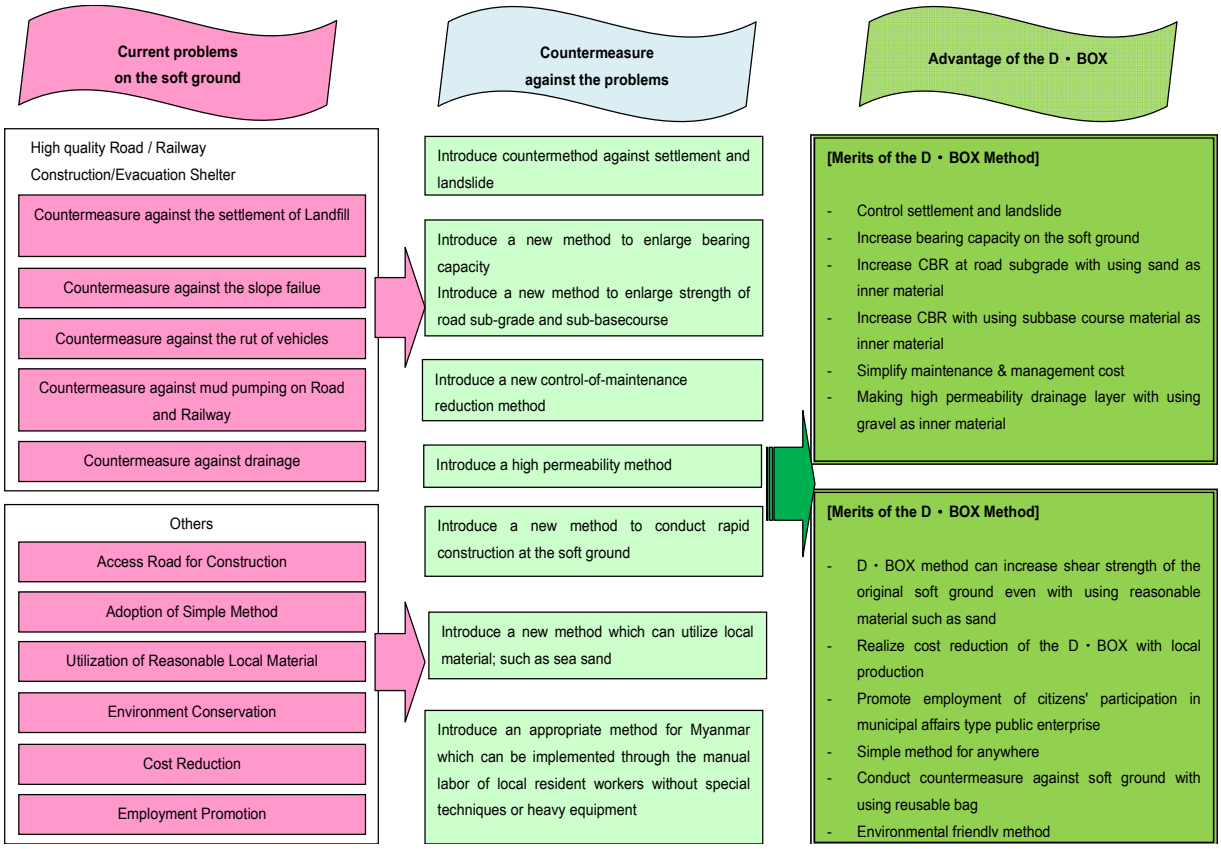

Figure-1 Soft ground infrastructure challenges in Myanmar and the solutions provided by D・BOX

Source: created by the study team

Chapter 5　Concrete Proposal for ODA Project

It is expected that the proposed techniques and product will be utilized on a large scale in infrastructure development and achieve positive results within the main users -- Myanmar's government agencies and infrastructure related businesses. However, in order to achieve full-fledged utilization it is necessary to implement on site demonstrations as well as to discover, confirm, propose and initiate public relations for additional potential sites for performance evaluation of the proposed product. Furthermore, it is necessary to deepen relations with local partners, discover new partners and further verify the feasibility of various business models for the proposed product. These initial dissemination activities are expected to be carried out through the application of ODA.

This study has attained exceedingly positive feedback through demonstration experiments implemented within PW, acting as a counterpart, and through introductions of the technology and the promotion of understanding through seminars at the MES. With this in mind we wish consideration will be given for a specific ODA project based on "private proposal diffusion and demonstration projects", the "acceptance of trainees for technical cooperation" and a "grant aid" scheme.

Project Formulation Survey
Myanmar, Project Formulation Survey on Infrastructure Development at Super Soft Ground with D・BOX

SMEs and Counterpart Organization

- Name of SME : Metry Technology Institute Co., Ltd
- Location of SME : Saitama Pref., Japan
- Survey Site ・ Counterpart Organization : Public Works of Ayeyarwady Region, Myanma Railways etc.

Concerned Development Issues

Myanmar has yet to establish infrastructure development and economical countermeasure against soft ground, settlement, slope failure and etc., for the delta area in Ayeyarwady region.

- Countermeasures against settlement and slope failure at embanked road and railways are required every year.
- Employment strategy: There are few job opportunity in infrastructure development.

Product and Technologies of SMEs

- It can control settlement and increase bearing power of the soft ground with simple construction.
- No need to use heavy equipment. It can be installed by human power with local residents alone.
- It can strengthen ground with local economical material for fillings; such as sea sand.
- It can be economical countermeasure with local production.
- It can be semi-permanent reinforcement if UV is avoided.
- No need to use cements, which means, eco-friendly.

Proposed ODA Projects and Expected Impact

Our aim is to show & install DBOX method as appropriate countermeasure against soft ground in Myanmar, which will contribute to Myanmar. Conduct demonstration in construction (strengthening bearing capacity, settlement control & vibration abbreviation with simple construction) utilizing pilot survey for disseminating SME's technologies & grant aid.
Target: Infrastructure development at soft ground; such as in Ayeyarwady region
C/P: Myanma Railways, Public Works, etc.
Contribution: Infrastructure development, Employment strategy

Future Business Development of SMEs

- Set up a local subsidiary. Do quality control, marketing & technical guidance. Develop appropriate product to local. Promote local business through partnership with local factory, dealers & agents.
- Reduce sales cost by localization. Expand business by targeting public & private construction. Future expansion to export business to foreign countries including Japan.