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Infrastructure Development Institute—JAPAN

D Box®






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D・Box Method

D・Box Construction Method

1. Introduction

D・Box construction method (invented by Metry Technical Institute Co., Ltd.) is a very soft ground reinforcement technique that offers a combination of benefits such as vibration reduction and mitigation of liquefaction damage, while also having excellent environmental characteristics.

D・Box is a flat rectangular bag-shaped product (LS100: 1.0m × 1.0m × 0.25m, LS150: 1.5m×1.5m×0.45m), which is filled with crushed rock※1 or similar materials. D・Box can be lifted with a single lift band while maintaining its square shape, and even when installed on soft ground, its shape remains unchanged.

(※1 Recommended filling materials are C40-0 and RC40-0)

2. Outline

(1) Internal structure of D・Box

By incorporating internal restraining bands within D・Box (Photo-1), D・Box itself gains its own strength regardless of ground conditions. This allows for shape retention and enables easy transportation and installation using a single lift band (Photo-2), while minimizing deformation when placed on a very soft ground.

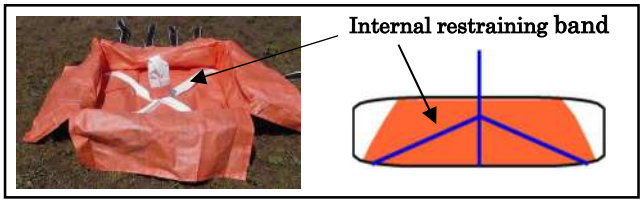


Photo -1 Internal structure of D・Box

Photo -2: Filling of the intermediate material and a lifting status of D・Box

(2) Comparison of other types of foundations

Figure-1 shows three types of foundations on a very soft ground: ①Concrete plate, ②Soil bag, and③ D・Box. When loaded, Concrete plates tend to sink unevenly due to eccentricity, while Soil bags deform into an arch shape with lateral flow and reduced support.

In contrast, D・Box maintains its shape through internal restraining bands, dissipating excess pore water pressure directly below the foundation, gradually increasing the ground strength. Soil particles that enter the depression create a resistance surface on the bottom of D・Box, providing a bearing capacity more than three times stronger than that of the original ground.

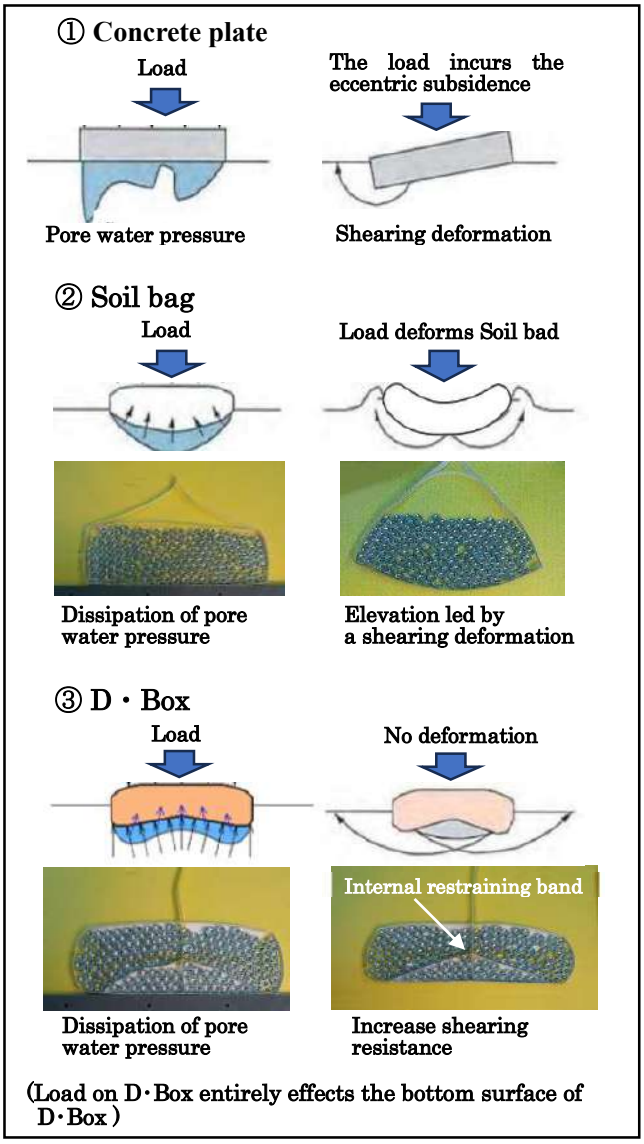


Figure -1: Comparison of 3 types of foundations on Soft ground

3. Detailed Description

(1) Description of D・Box

D ・ Box-LS series are products that effectively bring about Soil reinforcement,Vibration reduction measures, Liquefaction mitigation measures, Mud pumping measures, Anti-Erosion measures for forest roads, High water permeability enabling various structures, and Reduction in CO_2 emissions.

The shape and material characteristics of D・Box are shown in Tables 1 and 2.

Table-1 Size of D・Box

Type	Size(mm)			Remarks
	Width	Depth	Height	
D・Box-LS100	1,000	1,000	250	Filling Material: 0.25 m^3
D・Box-LS150	1,500	1,500	450	Filling Material: 1.0m^3

Table-2 Specification of D・Box

		LS100/LS150		Internal Band Straps
		Vertical	Horizontal	
Tensile Strength (N)		1850 or more		16,000or more
Elongation (%)		18 or less		25 or less
Fiber Density	Vertical	30 strands/5cm		
	Horizontal	30 strands/5cm		
Material		Polypropylene (with UV inhibitor)		

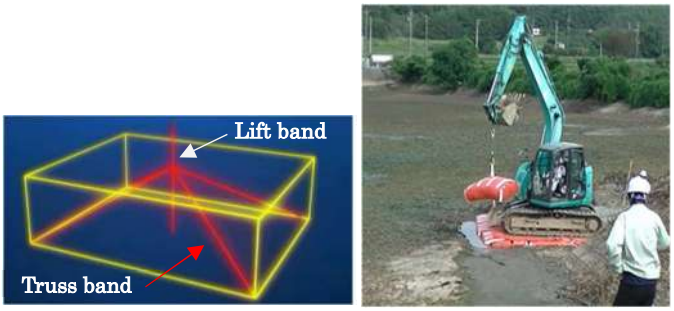
(2) Main Characteristics of D・Box

(a) When D・Box is lifted up, the truss bands connected with the lift band at the center will give strong compression stress to the filling material, in addition to the tension force of the bag.
This mechanism leads to solidification of the filling material and enables lifting without deformation (Photo-3).

(b) Working productivity is remarkably improved as one sling operation work can be done in a tidy shape.

(c) As the upper side opens thoroughly, filling works can be done effectively. Opening and closing works of the bag are also easy to handle with Velcro tapes.

(d) The fillings can be effectively bound and solidified by the internal binding effect of the truss bands.



Internal perspective view　　Lifting D・Box by a lift band

Photo-3: D・Box lifted by a lift band

4. Scope of application

D・Box has the capabilities as shown below.

(a) Reinforcement of Soft Ground

D ・ Box serves as a foundation for temporary road construction on very soft ground (Nvalue <1), distributing the load of superstructures evenly and providing stable ground reinforcement.

D・Box can increase the ground bearing capacity to more than three times that of the original ground.

Photo-4: Temporary bridge foundation in Ramsar Convention wetlands

(b) Vibration Reduction Measures

By installing D・Box in the lower layers of roads (subgrade or sub-base course), vibrations such as traffic-induced vibrations are reduced (vibration energy is reduced by 6-7 dB, or 1/4 to 1/5 of its original amount).

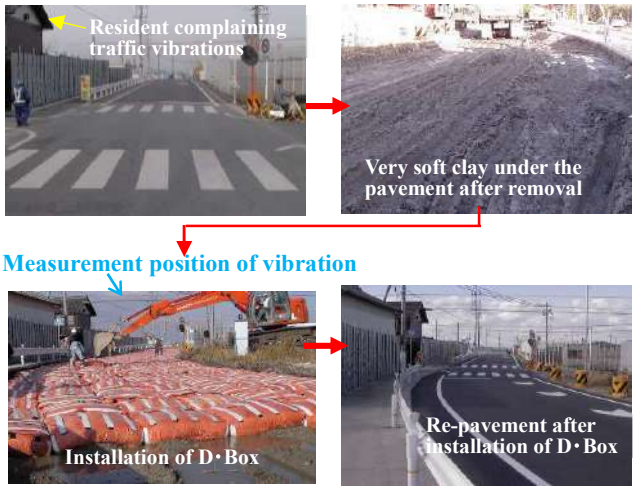


Photo-5: Reduction of traffic vibration

(c) Liquefaction Mitigation Measures

D・Box helps mitigate liquefaction damage in roads and other structures during earthquakes.

Photo-6: Liquefaction Mitigation Measures

(d) Mud Pumping Measures

The high permeability and increased ground bearing capacity (more than three times that of other foundations) of D・Box allow for mud pumping countermeasures in railways, roads, etc.

Photo-7: Mud pumping measures at Railway subgrade

(e) Anti-Erosion Measures for Forest Roads

Usage of highly permeable D・Box allows for repair of security forest roads that become impassable due to waterfall erosion from the mountain side during heavy rains.

Photo-8: Erosion measures for forest road

(f) Improvement of on the very soft ground

Even in viscous ground conditions such as marshes, the high permeability of D・Box allows it to absorb excess pore water generated during loading or rolling, increasing the adhesive strength of the cohesive soil at the bottom.

Furthermore, the concave shape of the lower surface of D・Box restrains the weak clay, resulting in an increase in shear resistance.

Installed 2 layers on the pond.

Photo-9: Construction road on the pond of designated National Park Area

5. Anticipated Results

Main effects (merits) of D・Box are shown below.

(a) Environmentally friendly as cement-based solidification materials are not used.

(b) Permeability similar to that of coarse sand will not bring negative effect to the original ground.

(c) D・Box can alleviate CO_2 emissions as its filling material consists only of soil particles (our company's comparison).

(d) Cost effective as ground reinforcement and vibration reduction can be attained at the same time.

(e) D・Box can be easily and accurately installed, as each box can be lifted by only one lift band retaining its cuboid shape.

6. Record of implementation

From past construction examples using D・Box, three typical works are shown below.

(a) Residents complained about the traffic vibration in 2016 (Photo-5).

The vibration was occured due to the construction of a tempomrary detour road on the soft ground. D・Box were installed under the sub-base course of the improved detour road of about 80m long to reduce the traffic vibration (Figure-2).

After installation of the D・Box, the residents expressed their gratitude for being able to sleep soundly for the first time since the detour road was constructed.

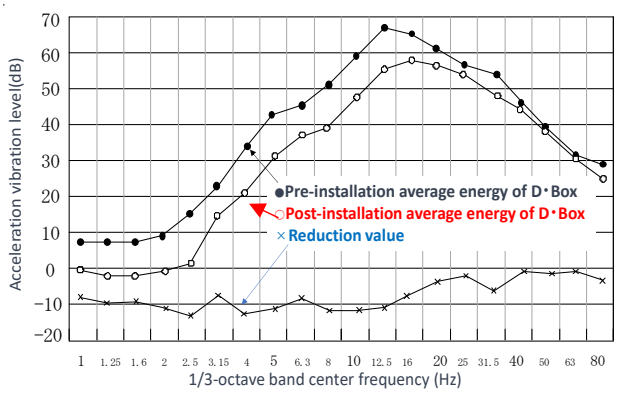


Figure -2: Vibration Reduction by D・Box

(b) The countermeasure against the mud pumping in 2017 (Photo-6).

D・Box was used in Myanmar Railway (360m) in the JICA project to improve the soft ground of rail tracks, to prevent mud pumping and improve the bearing capacity of the soft ground.

Photo-10: Improvement of the railway subgrade using D・Box

(c) The countermeasure against the liquefaction in 2012 (Photo-6&11).

D・Box were installed under the lower road base (thickness: 25cm).

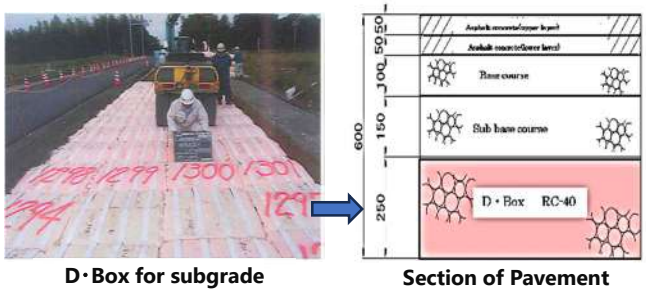


Photo-11: Liquefaction Mitigation Measures

7. Conclusion

D・Box is useful for the soft ground reinforcement, vibration impact reduction, and countermeasures against liquefaction.

Especially, the D・Box method can be carried out by hand alone if sand or crushed stones are available, and it is one of the effective construction methods in developing countries where countermeasures for soft ground are required. We hope to develop dissemination activities with a view to local production.

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Introduction of the Brochure and Videos introducing the winners of the Minister's Award and the Minister's Encouragement Award for Outstanding International Infrastructure Engineers

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has been certifying Japanese Engineers' achievements in infrastructure projects abroad, further awarding those who have exceeded in their technical and management skills since 2020.

It is part of the "International Infrastructure Project Engineer Certification and Award System", which aims to promote the participation of Japanese infrastructure engineers in both domestic and international projects.

The MLIT aims to promote the international development of Japanese Quality Infrastructure Systems through allowing engineers to work both domestically and internationally, contributing to the economic development and the problem solving of developing countries.

This year, the MLIT has certified the achievements of 237 engineers in 73 projects. The "Minister's Award for Outstanding International Infrastructure Engineer" was awarded to 13 engineers, while the "Minister's Encouragement Award for Outstanding International Infrastructure Engineer" was awarded to 4 engineers.

The brochure introducing the winners of both awards is available at the following URL.
https://www.mlit.go.jp/kokusai/content/001745513.pdf

In addition, six award winners presented their award-winning international infrastructure projects.

Please click on the URL below to watch their presentation videos.
https://www.youtube.com/playlist?list=PL2RgY_hjimJR_t_KnHBuf0_3XN5TMeakr

About IDI and IDI-quarterly

Infrastructure Development Institute-Japan (IDI) is a general incorporated association operating under the guidance of Ministry of Land, Infrastructure, Transport and Tourism of Japanese Government.

IDI provides consulting services to facilitate international assistance to developing countries, to promote international exchange of information and human resources, and to support globalization of project implementation systems targeting both developed and developing countries in the field of infrastructure.

IDI has been publishing a free quarterly journal called “IDI Quarterly” since1996 to introduce information related to public works and construction technologies developed in Japan, to foreign countries. We have distributed the journal to administration officials in more than 90 countries around the world via e-mail.

It will be highly appreciated if you could send us your opinions, impressions, etc. regarding the articles. We also welcome your specific requests regrading technologies you would like to see on following Quarterly issues.