添付資料_003_第一回現地調査_セミナー①

Program

Date: November 5, 2013 Tuesday 9:00-12:00
Venue:

1. Opening remarks (Mr. Hiroshi Shimada): 5 minutes

2. Introduction and Concept of the D・BOX (Mr. Futoshi Nomoto)

3. Theory and Examples of Soil bag and D・BOX (Comment from Prof. Matsuoka by Video): 30 minutes

4. Coffee break: 15 minutes

5. Introduction of Japanese counter methods against soft ground and liquefaction; and additional explanation on examples of D・BOX at actual site (Mr. Koichi Kadota): 20 minutes

6. Introduction of the demonstration experimentation of the D・BOX; and Examples of utilization on Myanmar (Mr. Hiroshi Shimada): 20 minutes

7. Questionnaires (Mr. Takeshi Maeda): 15 minutes

8. Closing remarks: 5 minutes

Total: 2 hours and 40 minutes

Metry® DBox®

Metry Technical Instiute

DBox-LS100/LS150

D・BOX－LSの形状　左は閉口時（中詰材未投入）、右が上部を開口した状態（LS100）

D・BOX－LSシリーズ（吊上げ設置タイプ）　＊中詰材：C・RC30-0　C・RC40-0推奨

製　品	施工寸法	備　考
D・BOX－LS100	W1000×D1000×ｈ250	中詰材の投入容量　0.25m3
D・BOX－LS150	W1500×D1500×ｈ450	中詰材の投入容量　1.0m3

DBox-SS45/SS90

SS45（上段右写真）　SS90（上段左写真）
内部にガイドゲージがセットされた様子

D・BOXのパーツ写真（下段左写真の左から）
ガイドゲージ、ピンロック、ロックジョイント

D・BOX－SSシリーズ（連結タイプ）　＊中詰材：C・RC30-0　C・RC40-0推奨

製　品	施工寸法	備　考
D・BOX－SS45	W450×D450×ｈ80	中詰材の投入容量　0.0162m3
D・BOX－SS90	W900×D900×ｈ80	中詰材の投入容量　0.0648m3

Major merits of the **D-Box**

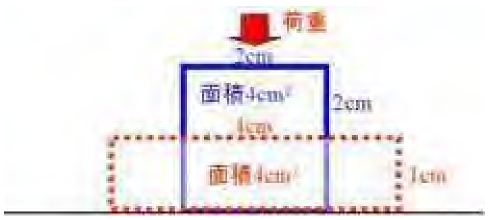
1) Reinforcement of ground condition
(Soft clay can be improved by this method.)

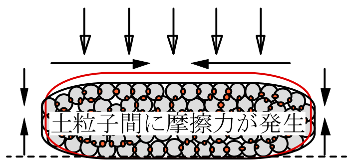
2) Reduction of machinery and traffic vibration influence

3) Reduction of seismic impacts

4) Prevention of liquefaction

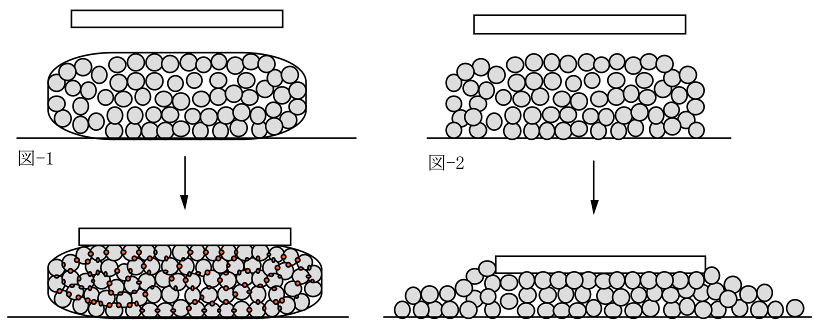
5) Prevention of freezing





袋が伸びるため張力が発生

This method was analyzed and advanced by Emeritus Prof. Matsuoka of Aichi Institute ofTechnology, and indicates that perfect confinement of particles can increase strength, owingto internal frictional energy to be generated among the particles.

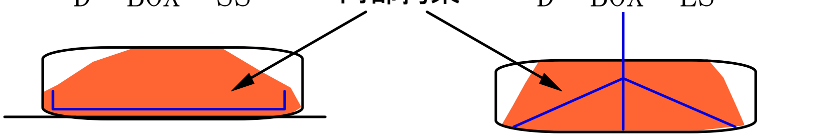


[redacted]

Binding force effects in inside of the D-box

内部拘束具による内部からの土粒子拘束（内部拘束効果）

D・BOX－SS　　内部拘束　　D・BOX－LS

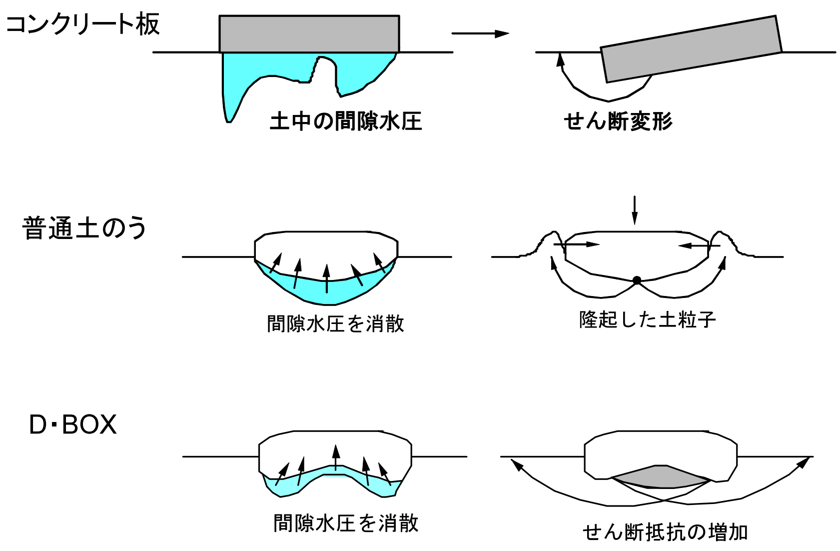


ガイドゲージによる内部拘束　　トラスバンドによる内部拘束

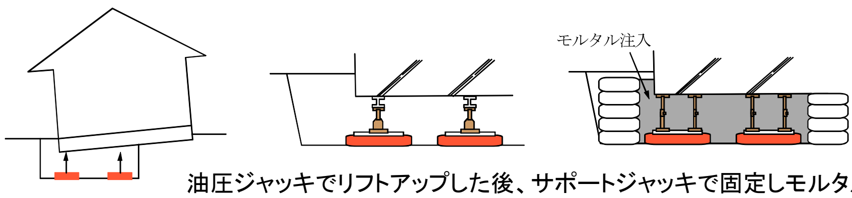
内部拘束無しの状態　　内部拘束有りの状態

D･BOX製作　LS150　　サイズ：1500×1500×450

D･BOX沈下抑制のメカニズム1　せん断抵抗



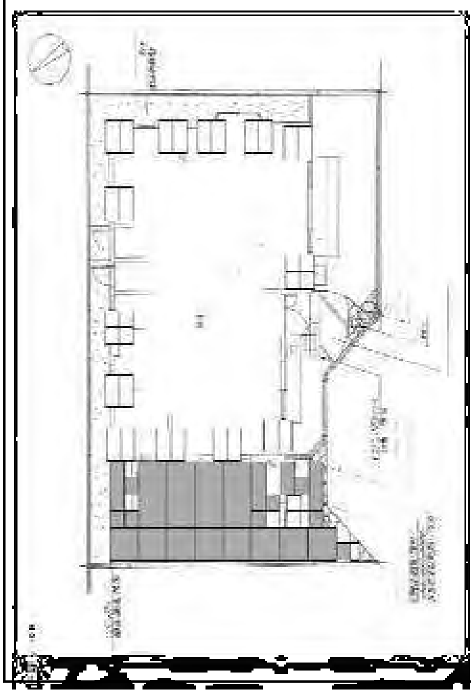
液状化地盤での施工例3　**D･BOXを反力とした住宅のリフトアップ工事**



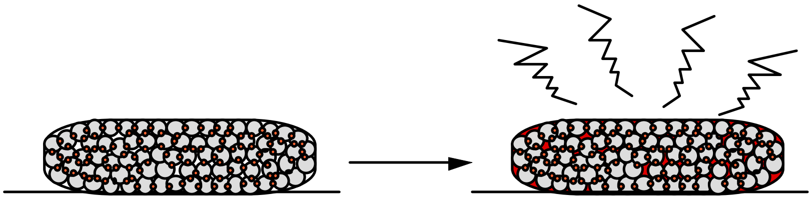
D･BOX上部に油圧ジャッキをセット

リフトアップ後サポートジャッキにて固定

液状化地盤での施工例　千葉県　液状化による陥没地盤の修正補強工事



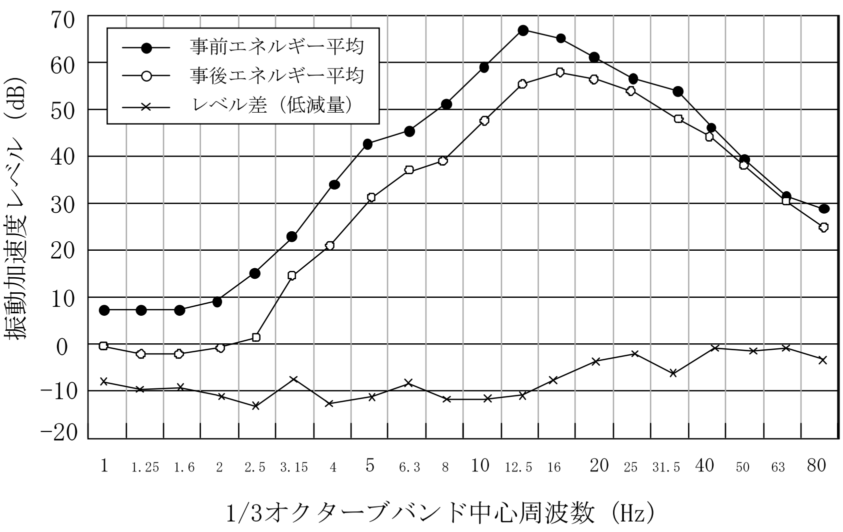
振動低減のメカニズム



外部より振動が入力されると、ごく微量ですがD・BOXに変形が生じます。この時D・BOX内部の粒子間に発生する新たな摩擦力により、振動エネルギーを熱エネルギーに変換する事で振動を減衰させる。

D･BOXでは、内部拘束効果により、より効率的な振動減衰が可能です。

滋賀県H市地盤補強･振動低減工事



事前と事後における振動加速度レベルの周波数特性の比較

資料:東海技術センター

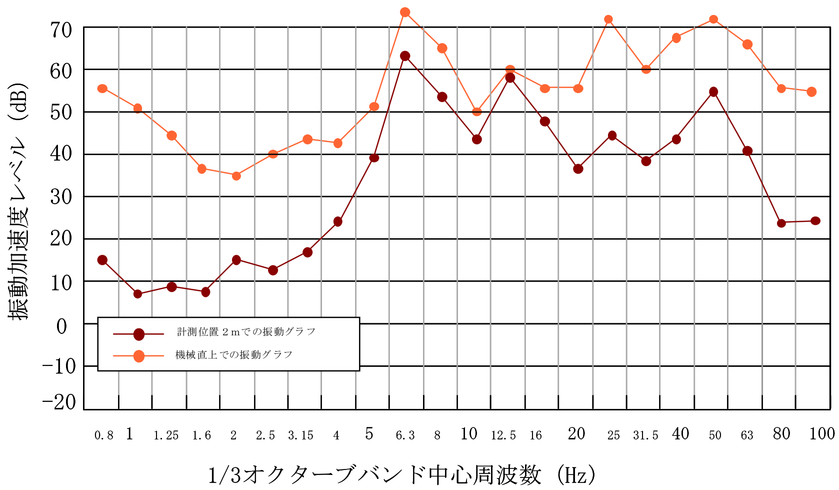
廃棄物処理施設　機械振動対策工事

ゴミ分別機の稼働状況

無対策時では70dBを超える激しい振動

D･BOX敷設状況

（D･BOX－LS100を1段　D･BOX－SSを1段）

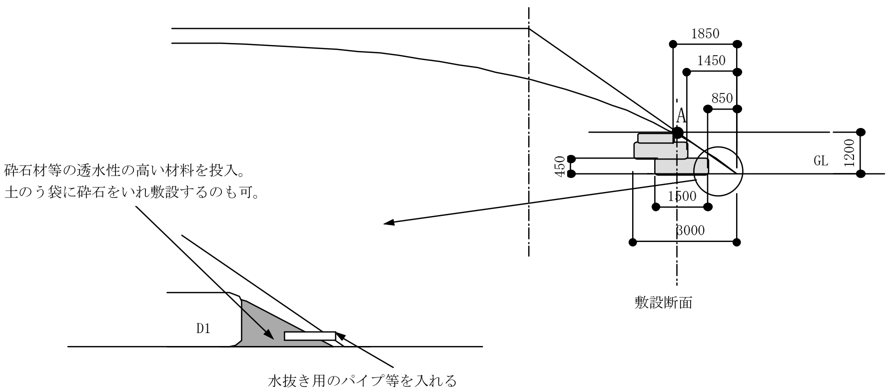


福島県　地震後の墓石状況

D・BOXが敷設された墓石

その他の工事例　盛土倒壊対策工事

大雨翌日の法面の倒壊状況



最下段部のD・BOXの側面からの排水量が多くなるため、
盛土部端部の土粒子が一部流される事が予想される。
（盛土部の倒壊は無いが）
そのためD・BOXの側面を埋め戻す際、D1部横に砕石等
の間隙の大きな材料を投入したり、水抜き用のパイプ
等（φ50mm程度）を敷設する。

D・BOX－LS150　敷設状況

D・BOX敷設後　台風翌日の状況
反対面の法面は倒壊している。

D・BOX　住宅施工例

橋脚ベント工事　D・BOXを使った地盤補強工事

東部労働センターでの説明会

製作しているのはD・BOX－SS90

D・BOX　製作作業の様子

D・BOX製作の一部は、県内を中心とする知的身障者施設で作られています。

Nov.2013

1. Situation of Landslide Damage of Residential Land and Liquefaction Damage due to the 2011 off the Pacific Coast of Tohoku Earthquake , and Recovery Method Against those Damages

2. Proposal of Design Method of D･BOX Countermeasure Against the soft Ground

Ph.D. Hirokazu.kadota

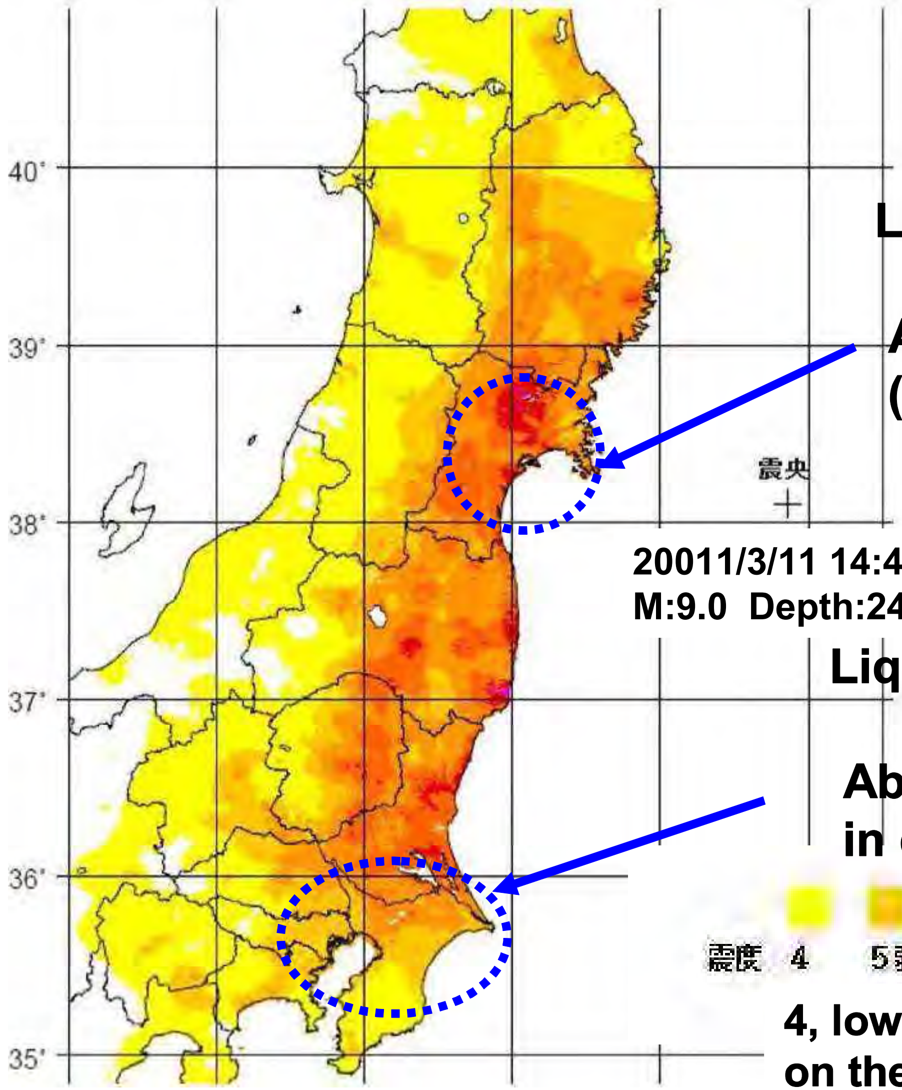
PACIFIC CONSUL TANTS CO.,LTD

1.Situation of Landslide damage of Residential Land and Liquefaction damage due to the 2011 off the Pacific Coast of Tohoku Earthquake , and recovery method against those damages

Landslide damage in the Residential Land

Liquefaction damage in the Residential Land

Scale (Seismic Intensity) of the 2011 off the Pacific Coast of Tohoku Earthquake



2001 1/3/11 14:46
M:9.0 Depth:24km

Landslide damages

About 5,700 residential quarters (in inland) in Sendai City

Liquefaction damages

About 64,000 residential quarters in coastal area of Kanto region

震度 4 5弱 5強 6弱 6強 7

4, lower 5, upper 5, lower 6, upper 6, 7 on the seven-point Japanese scale

1-1. The 2011 off the Pacific Coast of Tohoku Earthquake

Landslide Damages by the Earthquake and the Recovery Measures

Residential Land with high level of groundwater and with loose bank

Earthquake

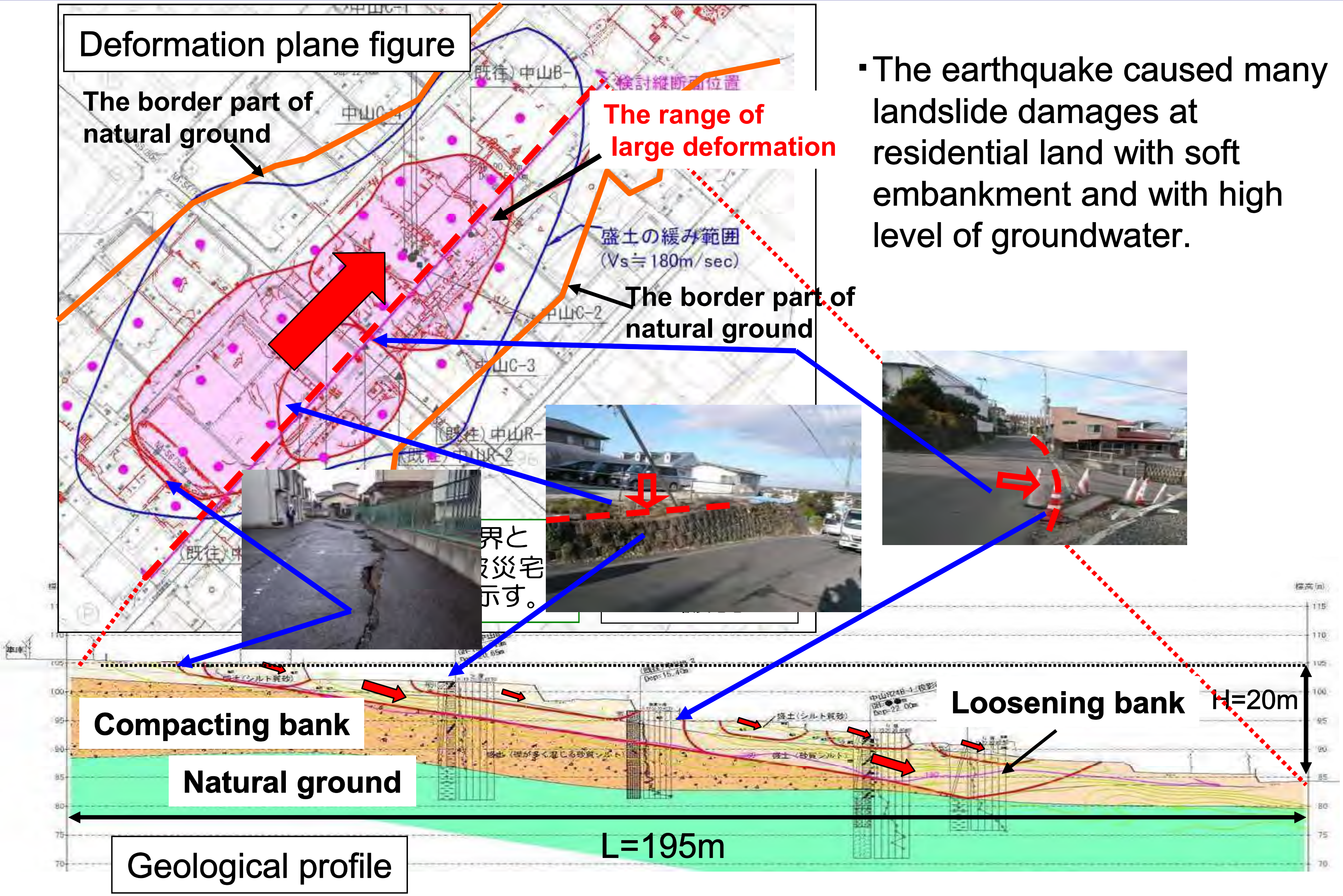
Landslide damage

Major types of Landslide Damages by the Earthquake at the Residential Land

Landslide deformation

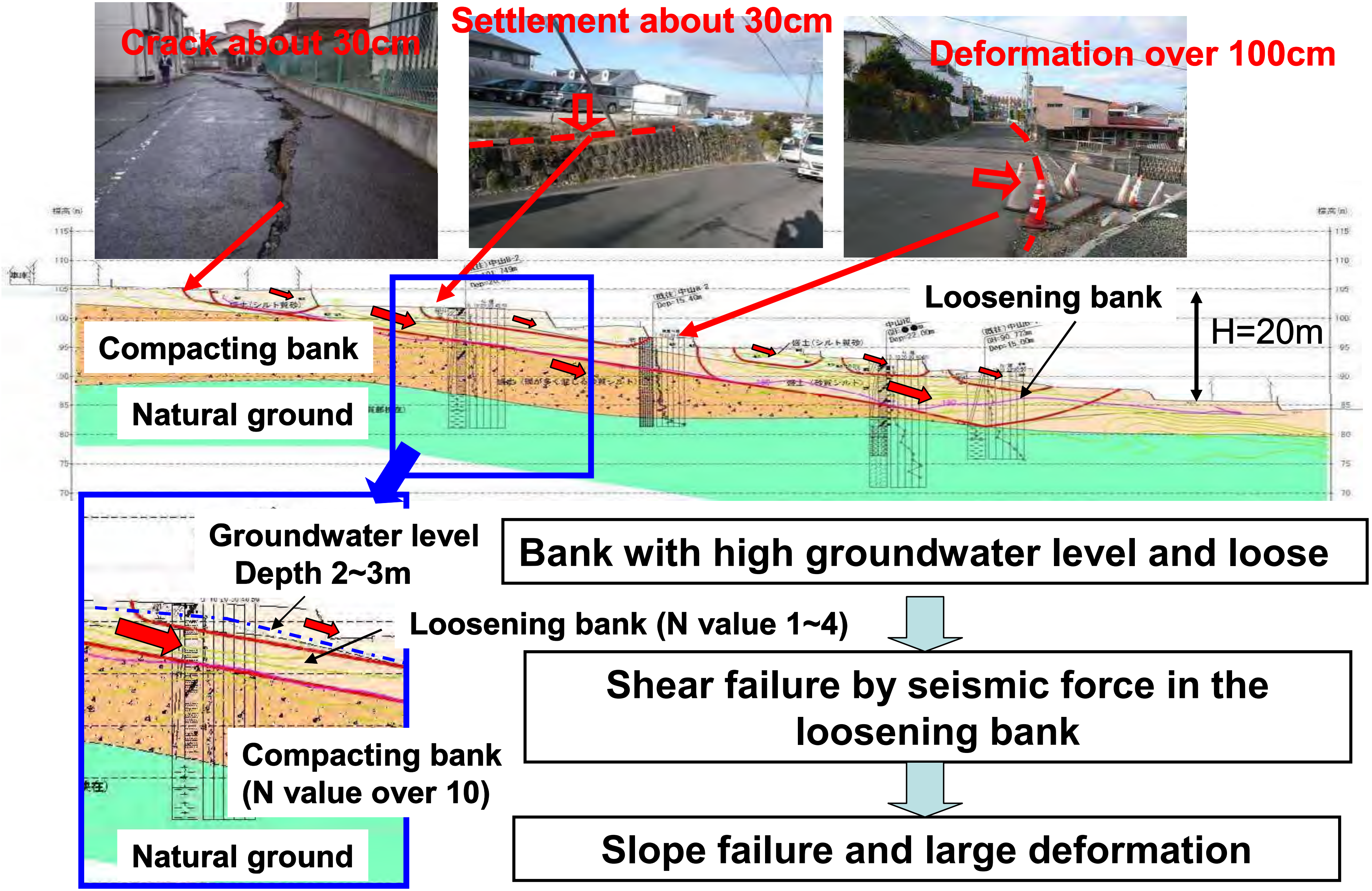
Clack, settlement at the border of embankment

The Main Factors of the Landslide



・The earthquake caused many landslide damages at residential land with soft embankment and with high level of groundwater.

The Main Factors of the Landslide

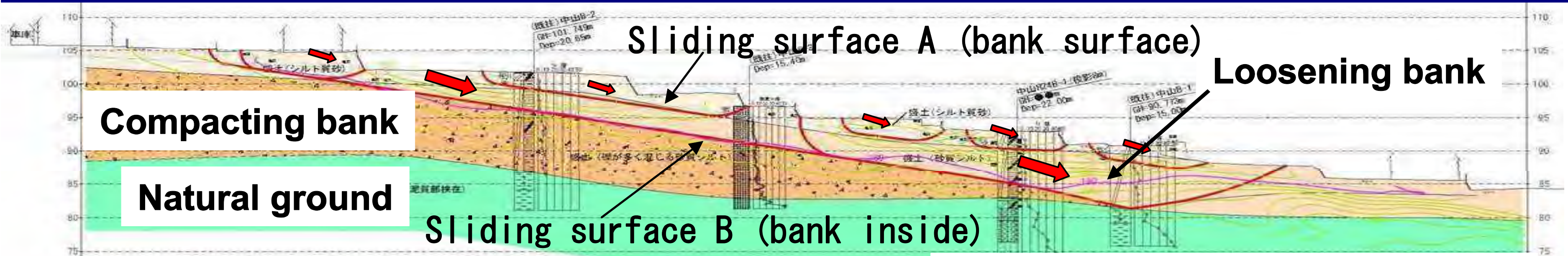


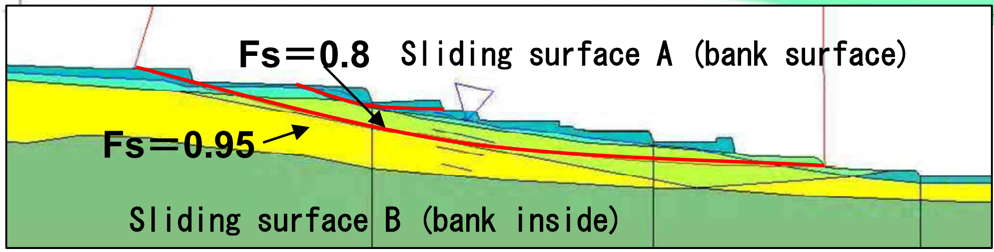
Bank with high groundwater level and loose

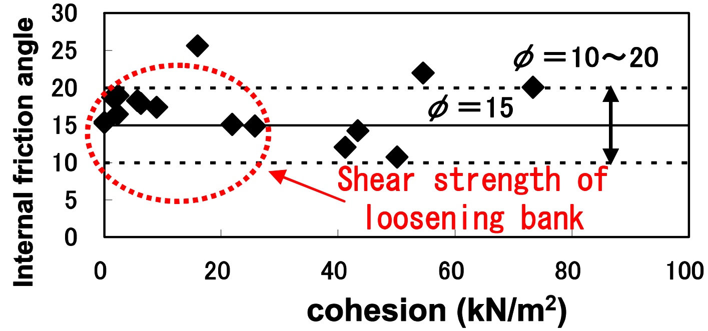
Shear failure by seismic force in the loosening bank

Slope failure and large deformation

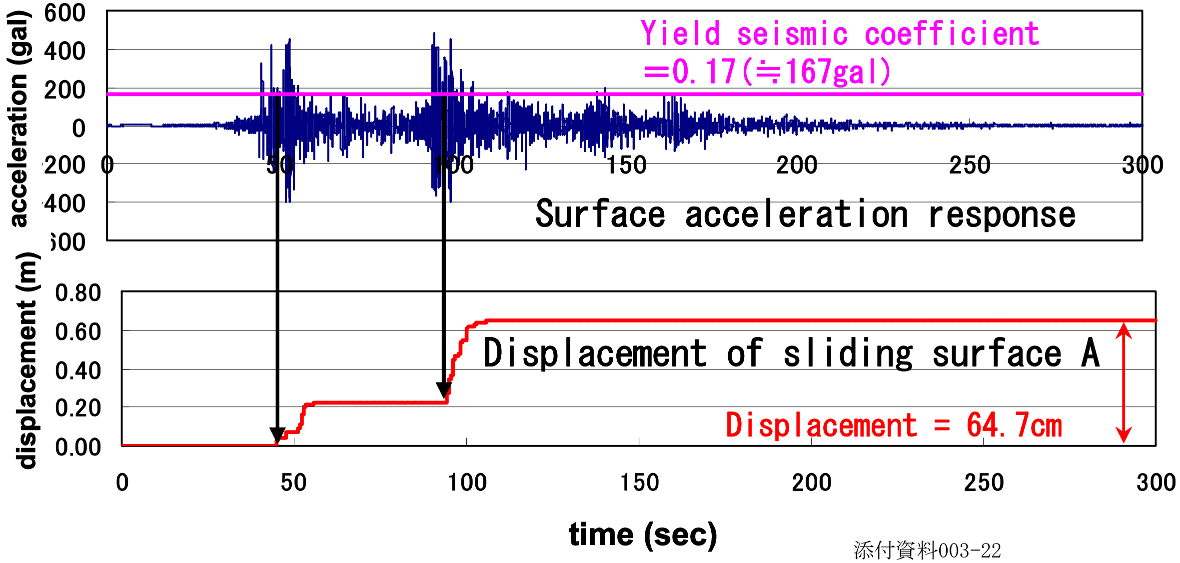
Replication Test of Landslide by Slope Stability Analysis with Newmark Method







Newmark Method Safety factor of sliding surface



The triaxial compression test result

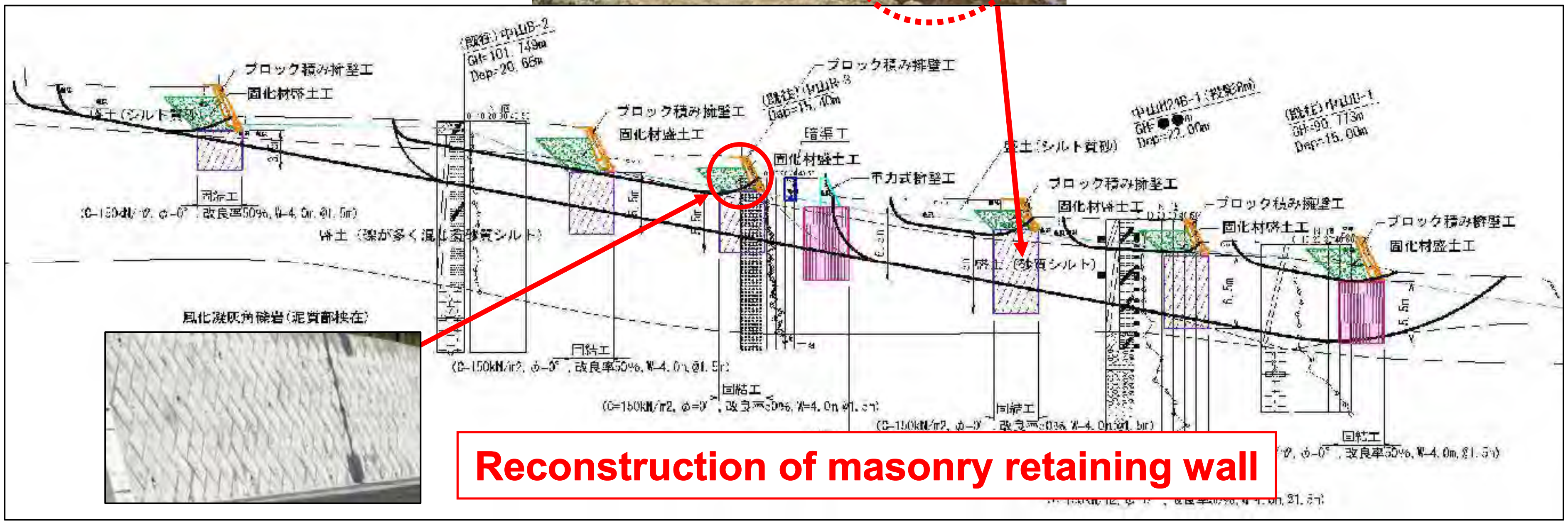
・The analysis result was at the same level as measurement displacement.

Countermeasure Against Landslide with Ground Improvement

○ Landslide (with large deformation) prevention

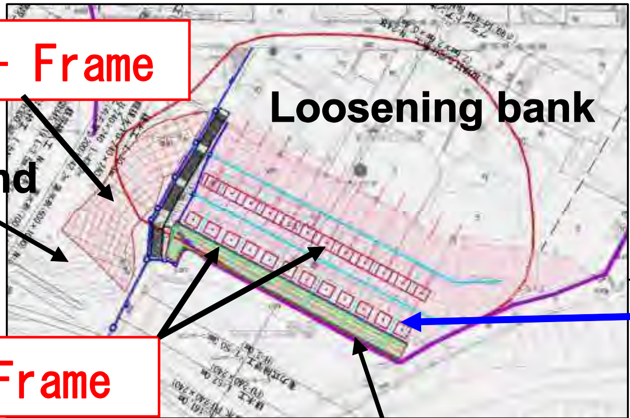
Cementation

- soft ground ⇒cementation
- Construction by a slit from ⇒Prevent to stagnant ground water

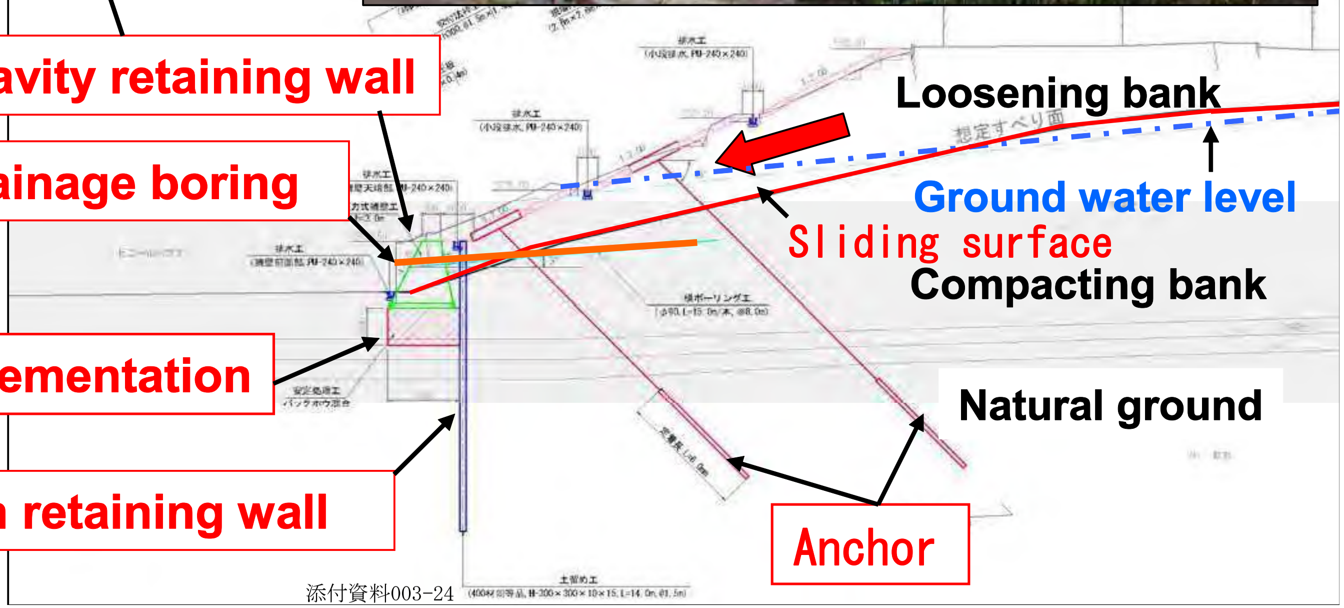


Countermeasure Against Landslide with Anchoring Method

○ Slope failure prevention

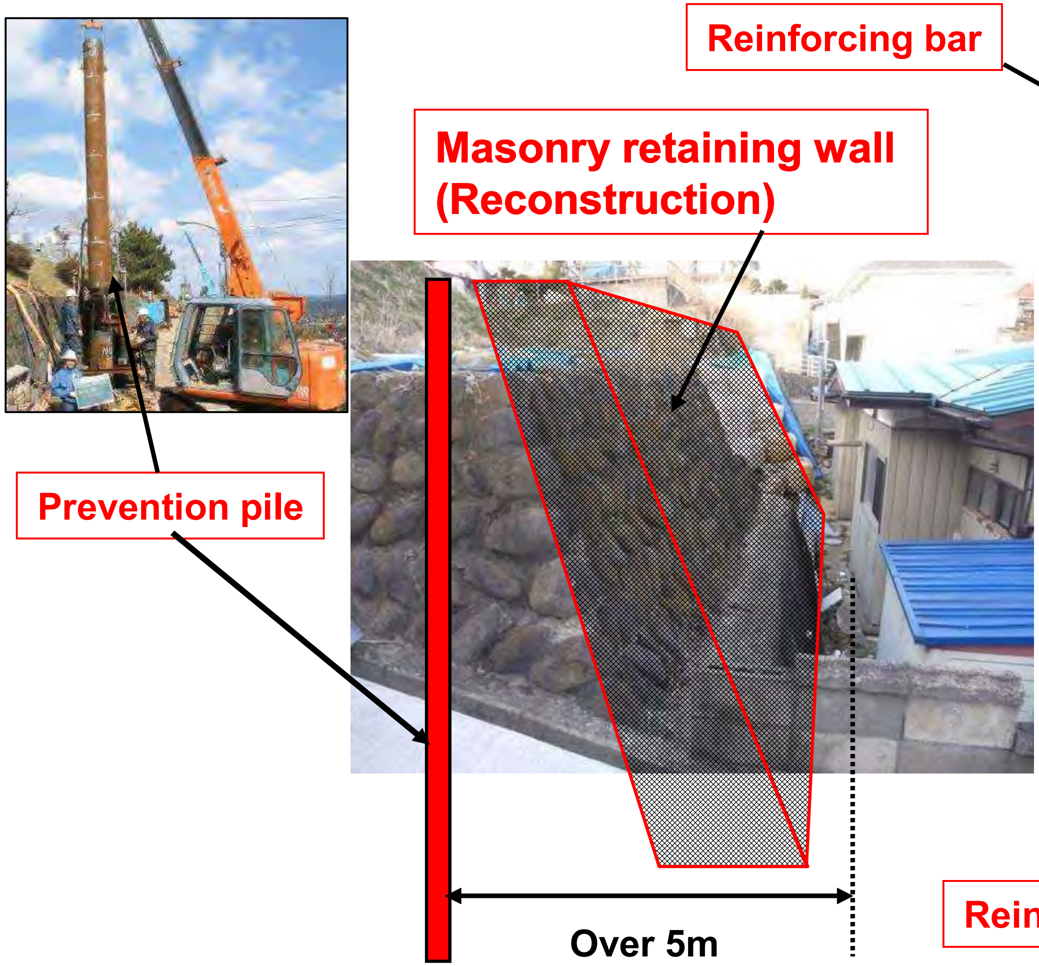


Slope failure
(aftermath of the earthquake)

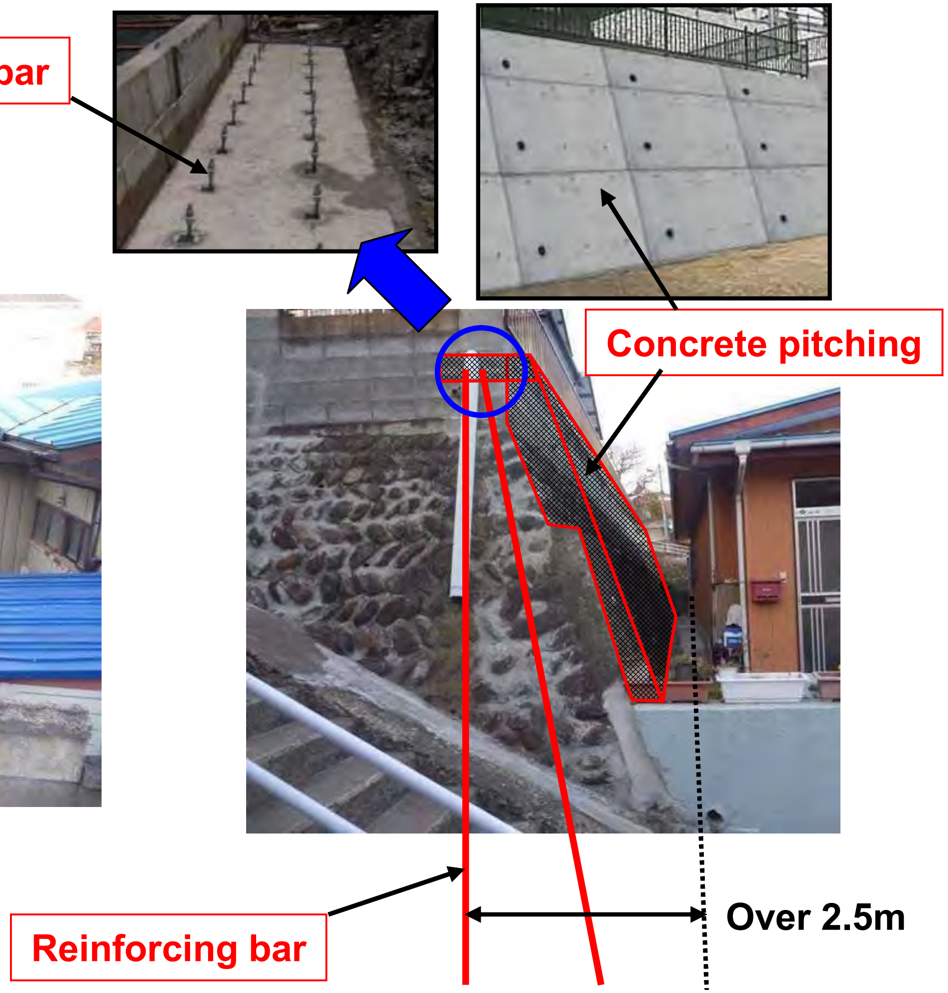


The Recovery measure and Countermeasure against Seismic for the Retaining Wall

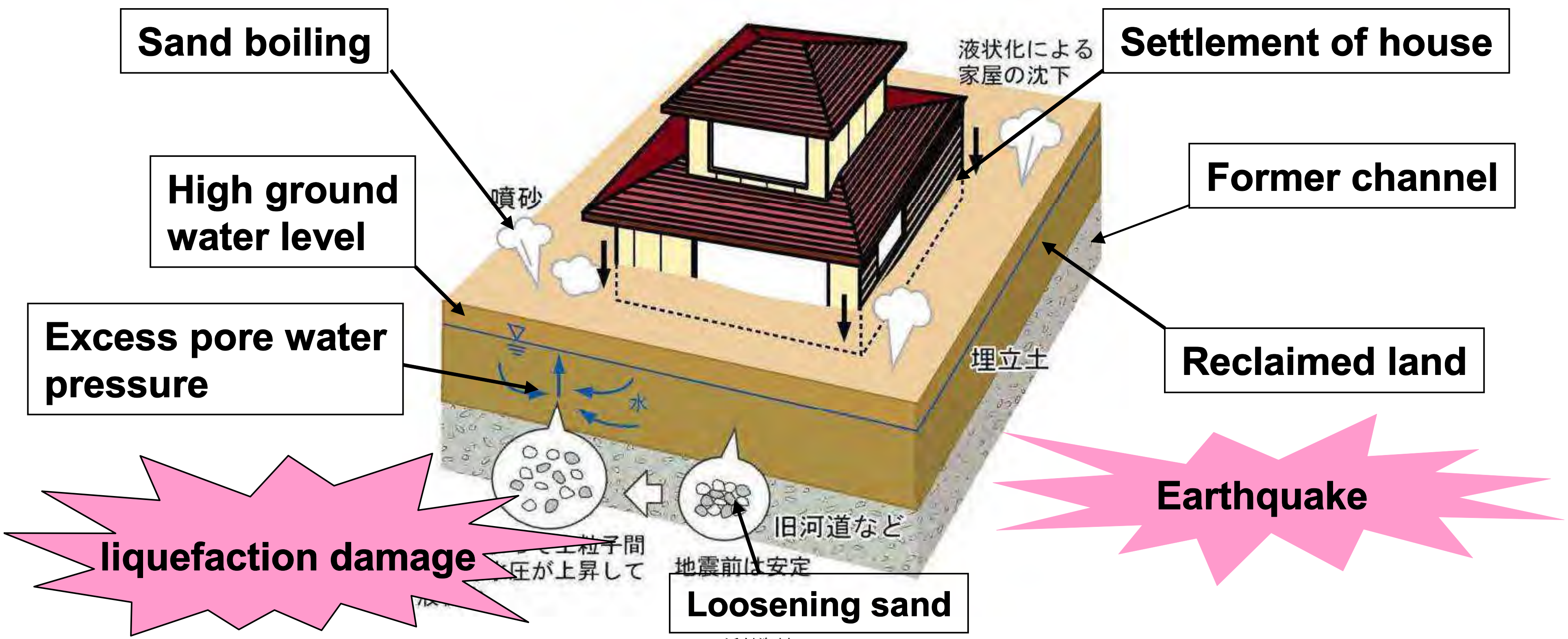
Prevention Pile＋Masonry Retaining Wall



Reinforced earth＋Concrete Pitching



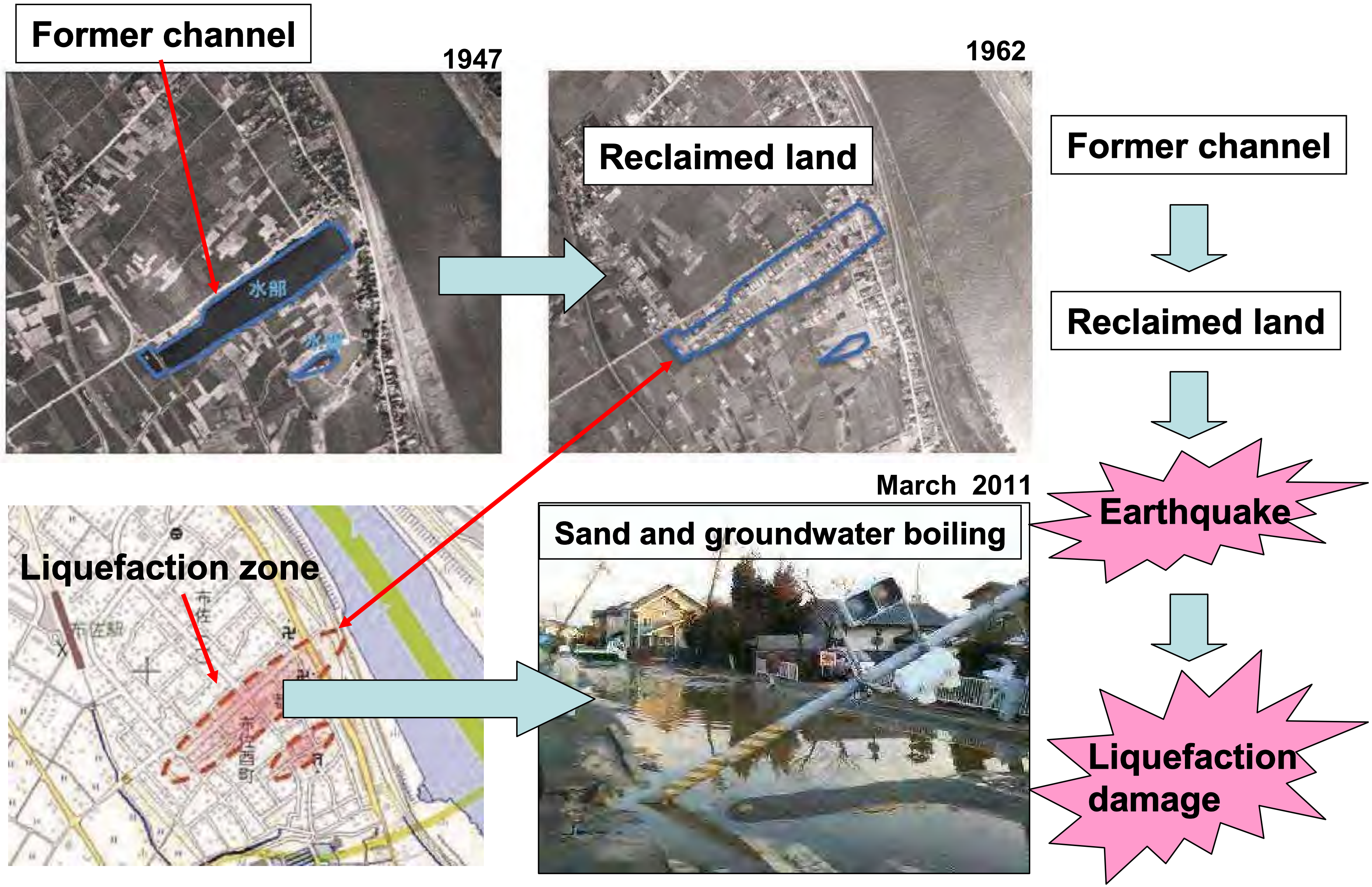
1-2. The 2011 off the Pacific Coast of Tohoku Earthquake　Liquefaction disaster Estimate Method of Liquefaction Damage in the Residential Land



Major types of **Liquefaction** Damages by the Earthquake at the Residential Land

Sand boiling, Groundwater boiling, Settlement of house

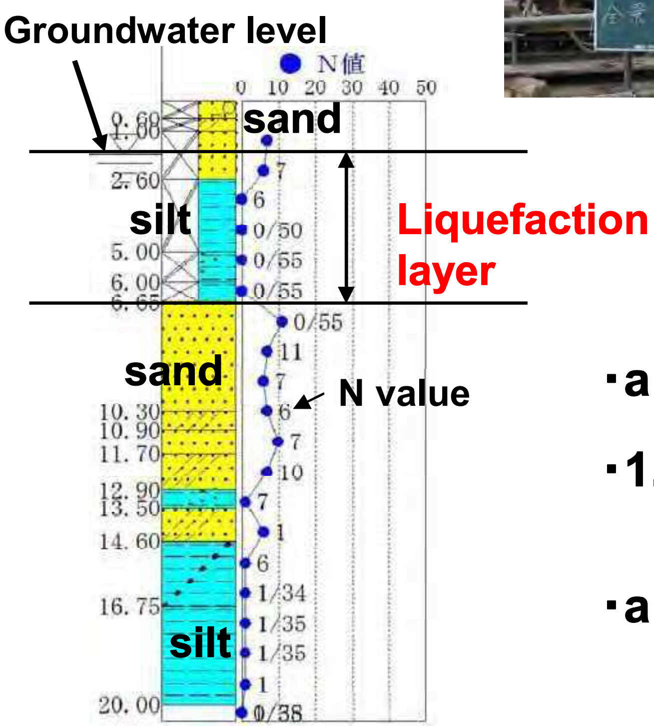
The Main Factors of the Liquefaction

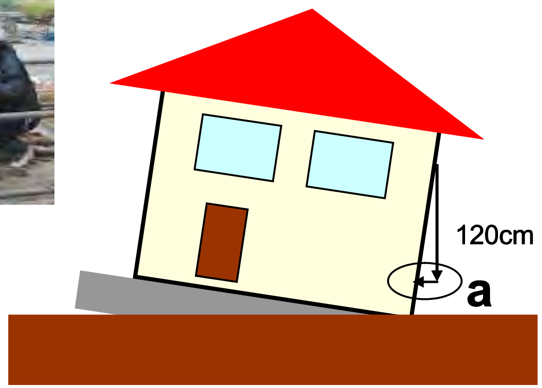


Estimate Method of Liquefaction Damage in the Residential Land

○ Investigation into liquefaction damage of the houses in Residential Land

Geological deta
In the affected areas





- a ≧ 2cm : large damage ●
- 1.2cm ≦ a < 2cm : middy damage ○
- a ≧ 2cm : small damage ~ no damage ●

large damage ●

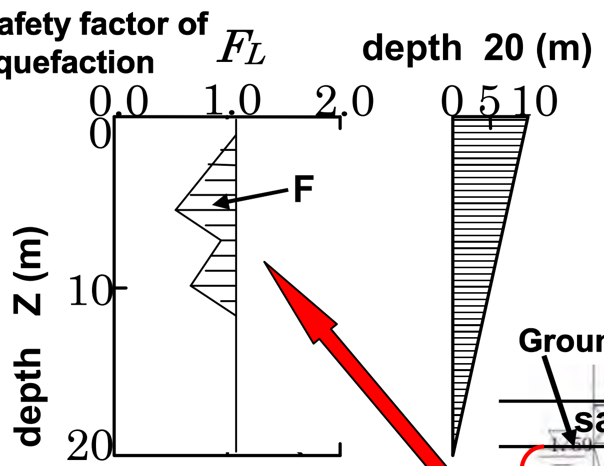
middy damage ○

small- no damage ●

Estimate Method for Liquefaction Damage in the Residential Land

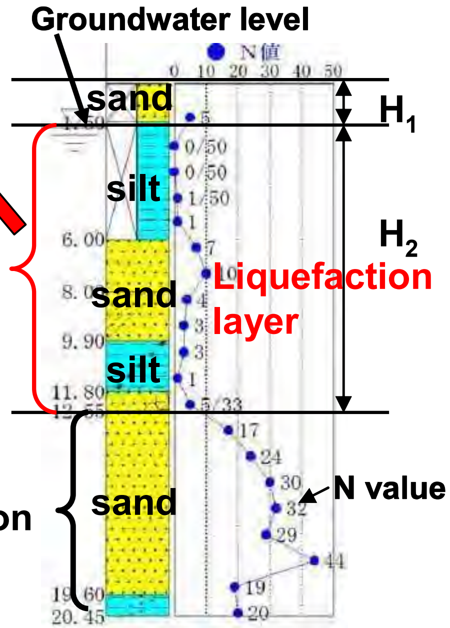
PL (potential of liquefaction)

$$PL = \Sigma F \cdot W(z) \cdot \Delta Z$$



$$F_L = \frac{\tau_l / \sigma'_z}{\tau_d / \sigma'_z} < 1.0$$

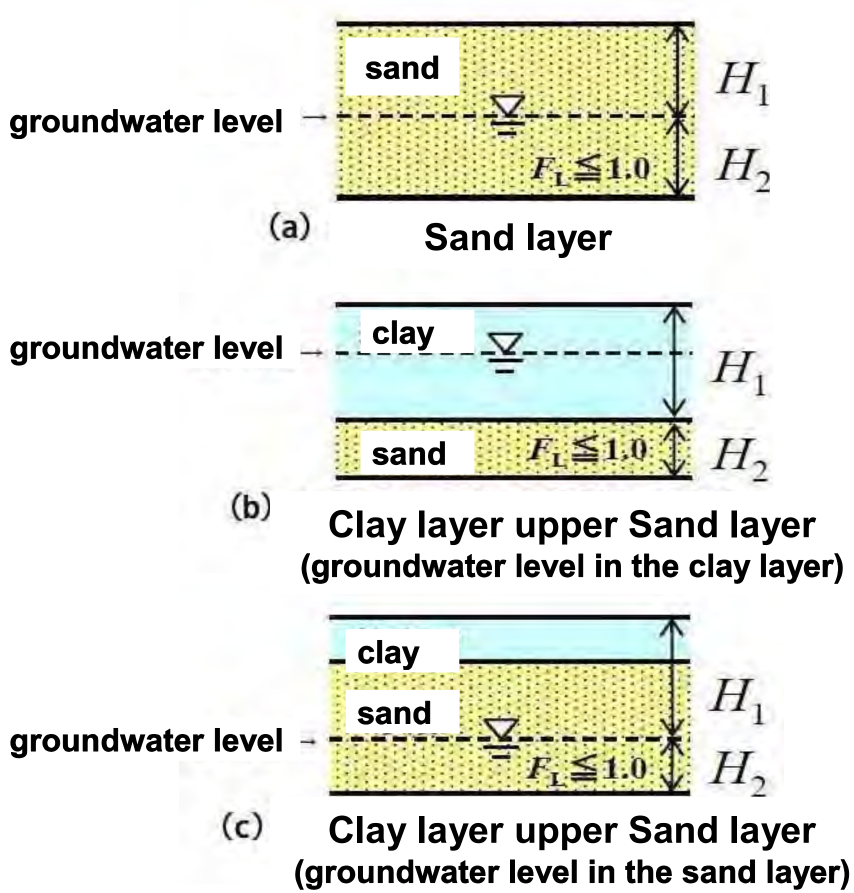
F_L=(Liquefaction resistance ratio) ÷(Repetition shear stress ratio)



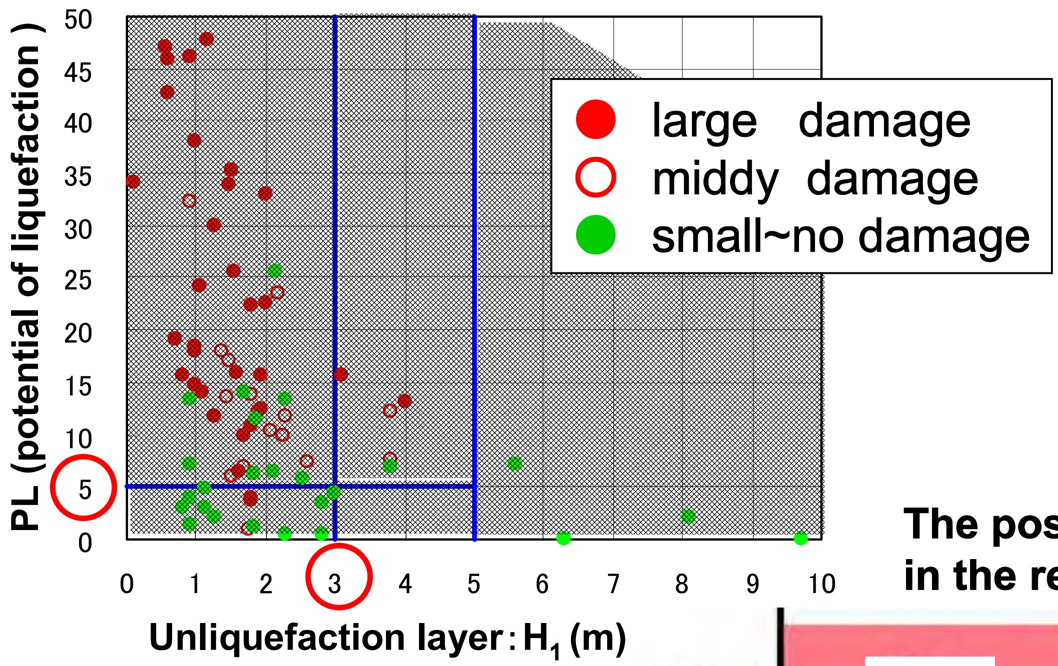
Unliquefaction

Unliquefaction layer : H_1

Liquefaction layer : H_2



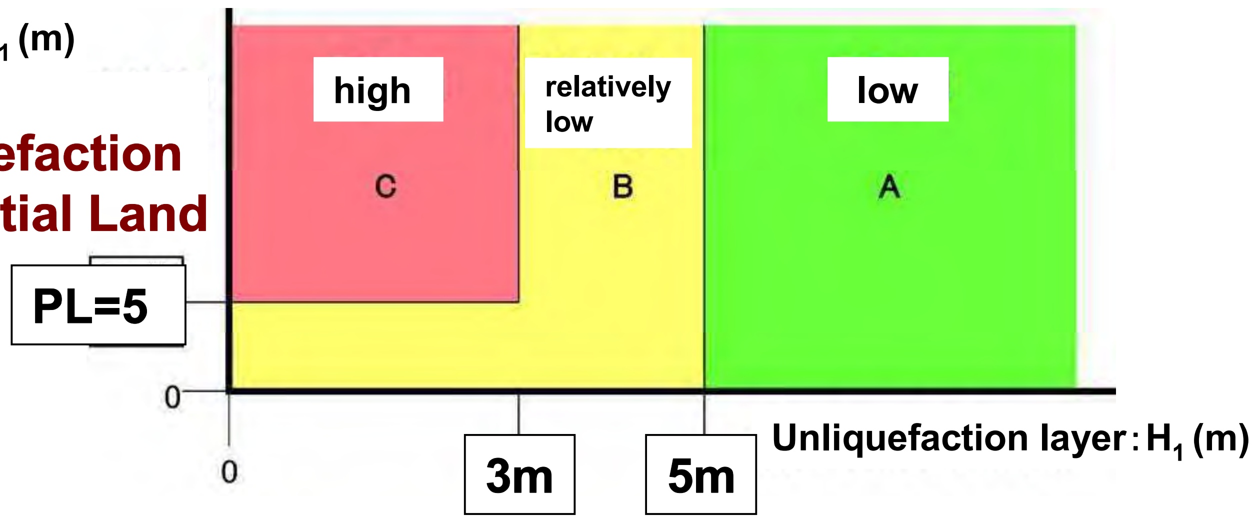
Estimate Method of Liquefaction Damages in the Residential Land



PL > 5 and H_1 < 3m

Large damage!

The possibility of liquefaction damage in the residential land



Estimate Method of Liquefaction Damages in the Residential Land in Japan

2. Proposal of Design Method of D･BOX Countermeasure Against the Soft Ground

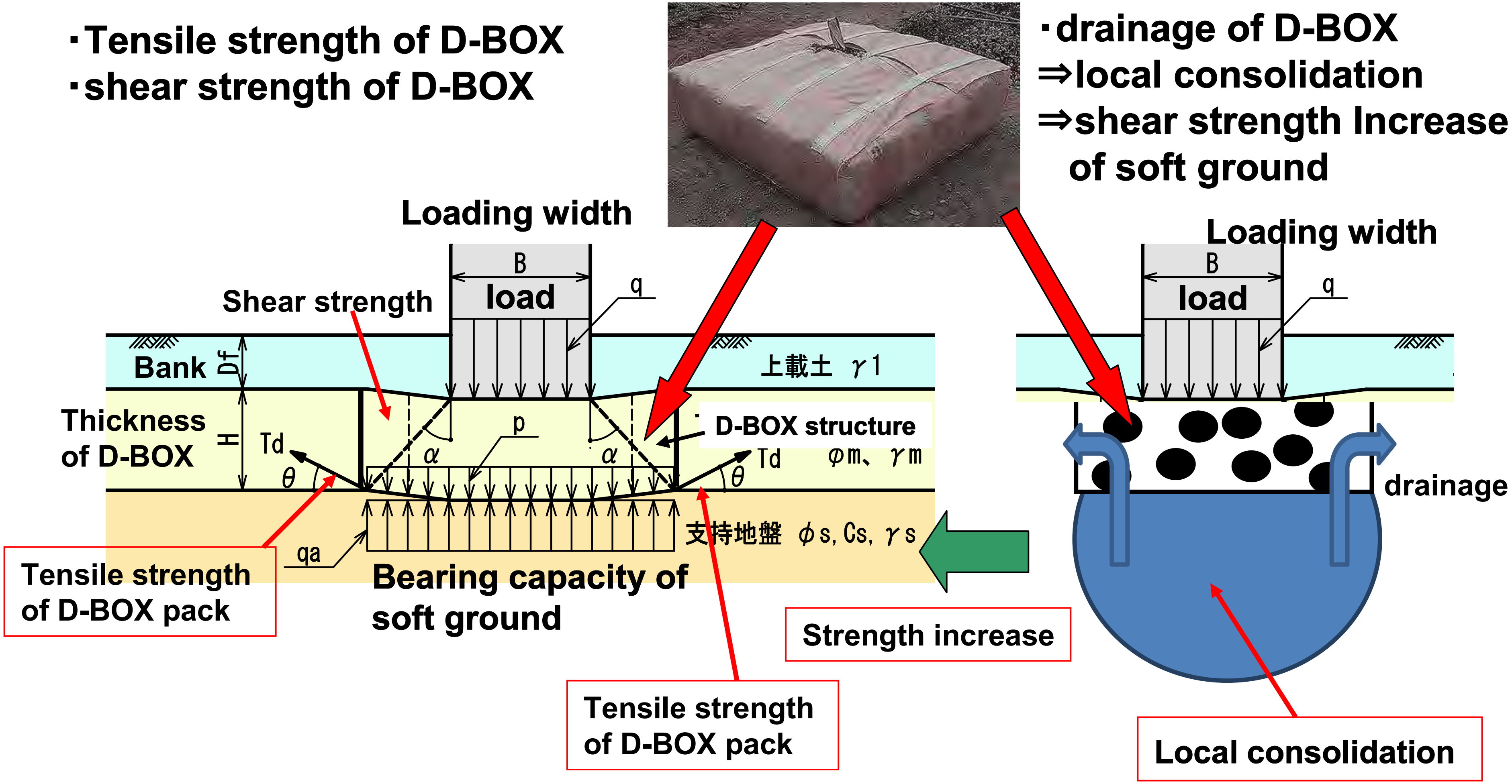
Reinforcing Effect of D･BOX Countermeasure Against the Soft Ground

Reinforcing effect 1

･Tensile strength of D-BOX
･shear strength of D-BOX

Reinforcing effect 2

･drainage of D-BOX
⇒local consolidation
⇒shear strength Increase of soft ground

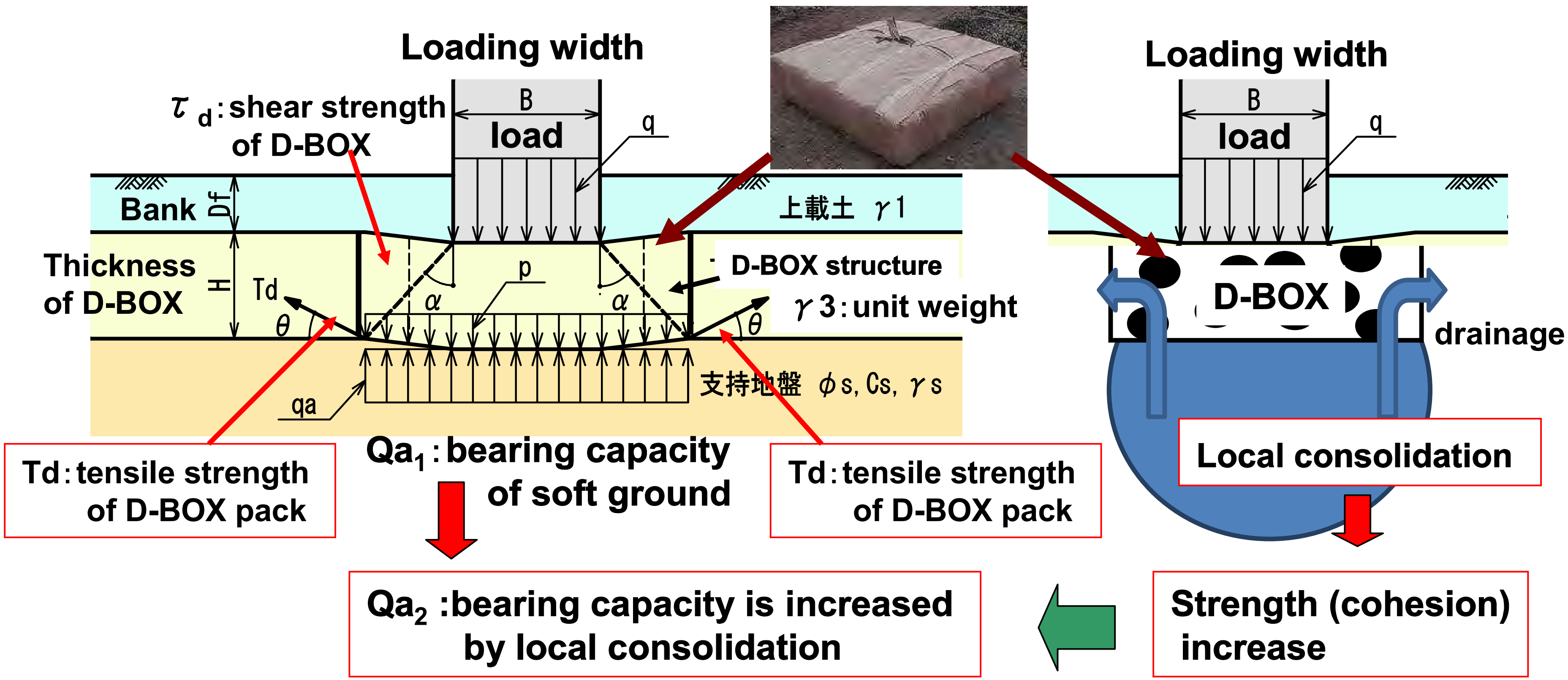


Proposal of Design Method of D･BOX Countermeasure Against the Soft Ground

Proposal of design method

$$\cdot (Qa_2 - \gamma_3 \cdot H) \times (B + 2H \cdot \tan\alpha) + \tau d + 2T_d \cdot \sin\theta \geqq q \times B$$

⇒Verifying proposal of design method of D-BOX by field test !



Thank you so much for your kind attention!

p1
p2

Where to use D-BOX?

November 2013

Pacific Consultants Hiroshi Shimada

Ⅰ Recommended Place of D-Box to use

Place

1:Road

・Base course or sub base on the soft ground

2:Bridge

・For the gap between bridge and road

3:Retaining wall/Dike or slope protection

4:Underground buried structure

5:Building foundation

6:Temporary road

Effect

①Increasing of Bearing capacity

②Prevention of liquefaction

③High water permeability and drainage function

④Reduction of machinery and traffic vibration influence

Ⅱ Where and How to use D.･BOX

Condition of existing ground in Myanmar

1)Soft ground
2) Waterway under ground
3)Liquefaction
4)Quake
5) Traffic vibration
6)Subsidence (consolidation)
7)Slope or Land sliding
8)Mud Squeezed
9)Boiling area

⇔

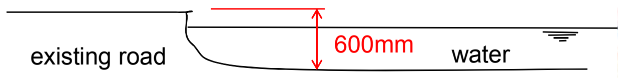
Structures to be constructed

- Road
- Rail way
- Building
- River slope protection
- Port Jetty & embankment
- Drainage utilities

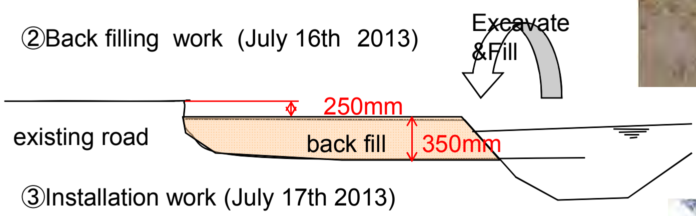
Ⅱ―1 Temporary road on the swamp area (soft ground)

D-BOX Experiment construction at Kalimantan Indonesia

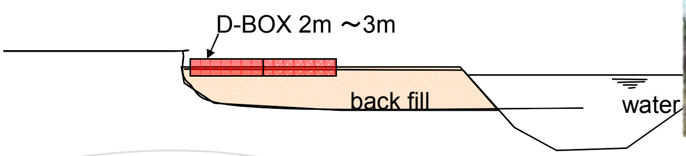
①Existing condition (July 16th 2013)



②Back filling work (July 16th 2013)



③Installation work (July 17th 2013)



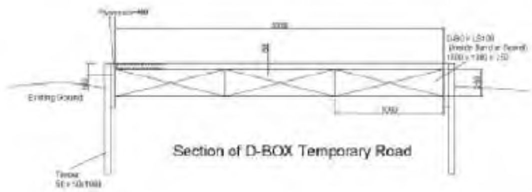
Existing Condition of temporary road

[redacted]

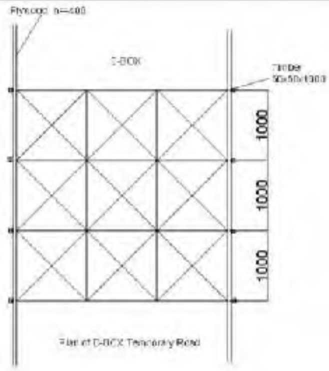
②Back filling work (July 16th 2013)
Using soft clay to adjust the elevation

Installation of D-BOX (breath 2.0m:1m × 2)

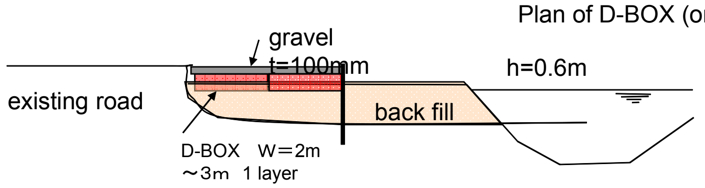
Plan and actual condition of D-BOX



Section of D-BOX (original plan)



Plan of D-BOX (original plan)



Actual section of D・BOX

Gravel surface on the D-BOX (t=100mm)

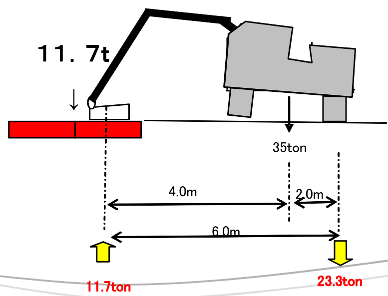
Estimated Counterforce with the backhoe pressure

3hours later

The bearing capacity is 11.7t/m^2

・Pressure with the backhoe is estimated about 11.7ton to one D-BOX(1.0m^2)

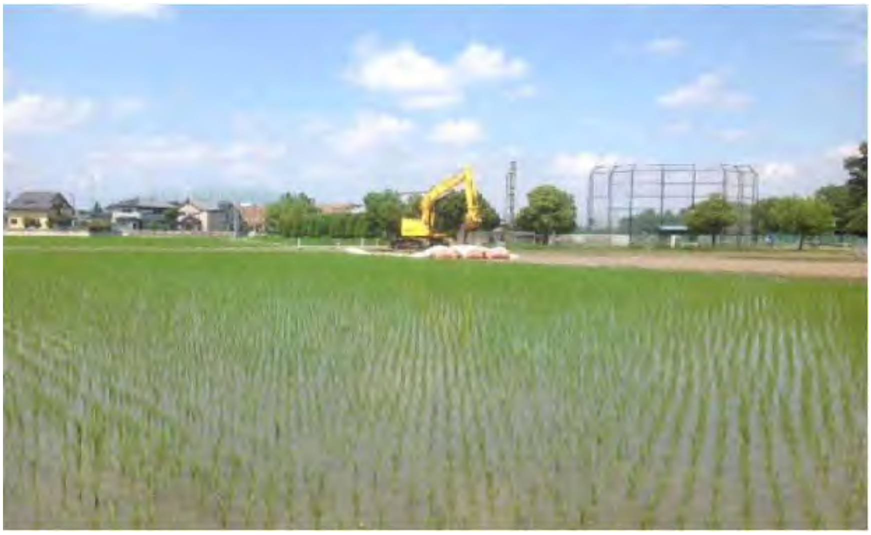
That means 11.7ton/m^2 bearing capacity is guaranteed



Use as temporary road for the vehicle after 3.5 month

Completion of D-BOX installation work(July 18th 2013)

Temporary road at the very soft ground of rice field



Steel sheet plates were installed on D.･BOX in order to prevent damage from a heavy equipment

Ⅱ—2 Foundation of Culvert Box on soft ground

1) existing ground condition

N=0

Clay depth 4m

N value =0 (very soft)

A sheet is required in order to walk.

Ⅱ—2 Foundation of Culvert Box on soft ground

2) Installation of D.･BOX for the foundation of Culvert Box

Ⅱ—2 Foundation of Culvert Box on soft ground

3）Cast base concrete on D.・BOX　directly

Base Concrete (casted a day after installed D-Box)

Ⅱ—2 Foundation of Culvert Box on soft ground

4）Installation of Culvert Box

Installation of the box culvert /settlement of five months after is 3 mm-5mm only

There is no subsequent subsidence as of now.

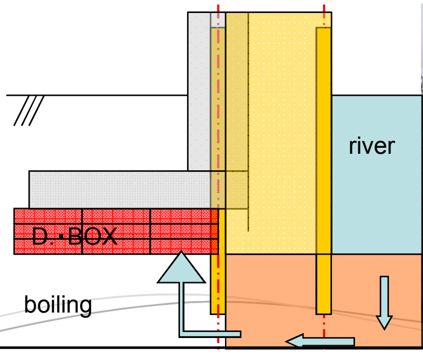
Ⅱ—3 Foundation of retaining wall on boiling ground

1）Phenomenon is the same as liquefaction.

①ground condition of L type retaining wall is to be liquefied easily (boiling phenomenon)

②water gushes shortly after excavating,･

③Four(4)layers of D-BOX-LS100 were required to the foundation



site

Ⅱ—3 Foundation of retaining wall on boiling ground

2）condition of the site

Ⅱ—3 Foundation of retaining wall on boiling ground

L type of Retaining wall with width 4m,heigt5m

Ⅱ—3 Foundation of retaining wall on boiling ground

Before excavation ,Water is oozed out.

Ⅱ—3 Foundation of retaining wall on boiling ground

3) Prevention of liquefaction

If it excavates, a lot of water will blow off immediately (boiling), and a construction site was in a riddled condition.

Ⅱ—3 Foundation of retaining wall on boiling ground

3) Prevention of liquefaction

Since the foundation after digging was not able to stand for a worker, either, the heavy machine constructed D-BOX directly, but the first step of D-BOX will sink completely. (One step of D-BOX was insttaled also at a worker's feet)

Ⅱ—3 Foundation of retaining wall on boiling ground

3）Prevention of liquefaction

When it became the 3rd step, even if the clear Increase of value in a hardness could be felt and it applied the pressure to D-BOX using the arm of back hoe(30t),。

Ⅱ—3 Foundation of retaining wall on boiling ground

2）Prevention of liquefaction

To excavate some area for small backhoe is put on D.・BOX

It took about 5-hours to install 60 Bags including the opposite side

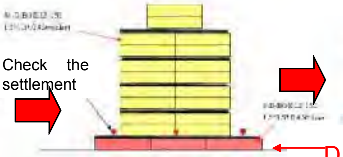
Ⅲ Demonstration work of D.・BOX
(November 6th ～8 th ,2013 at Bogaly)

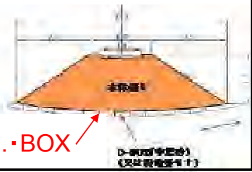
3 demonstration work with D.・BOX

①Temporary Road on soft ground

②Slope protection work

③ Load test of D.・BOX（check the settlement) and soil exploration



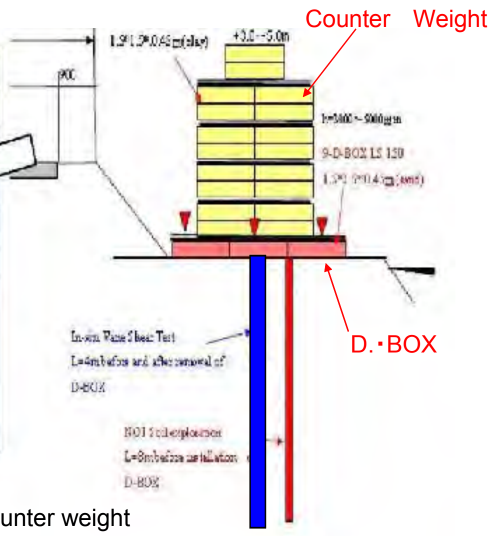


Ⅲ Demonstration work of D･BOX
(November7th～ 2013)

LOCATION Near Bogalay Yeyarwady

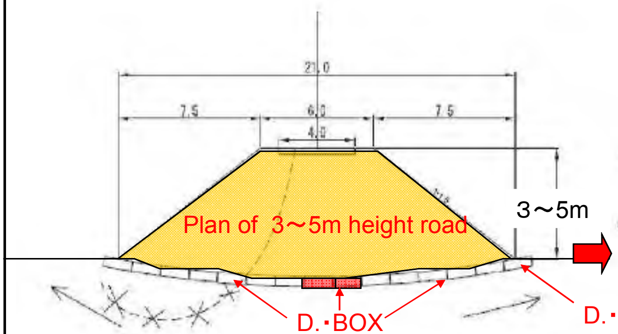
Ⅲ Demonstration work of D･BOX

Ⅲ Demonstration work of D･BOX

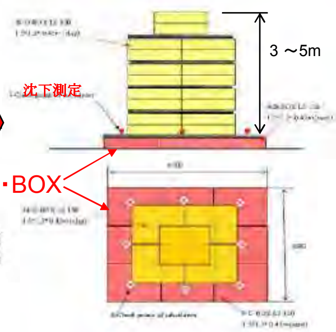


Load test of D.･BOX 3～5m counter weight

Ⅲ Demonstration work of D･BOX



Load test for 3～5m

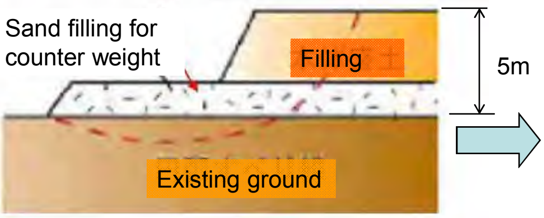


Soil exploration L=9.5m

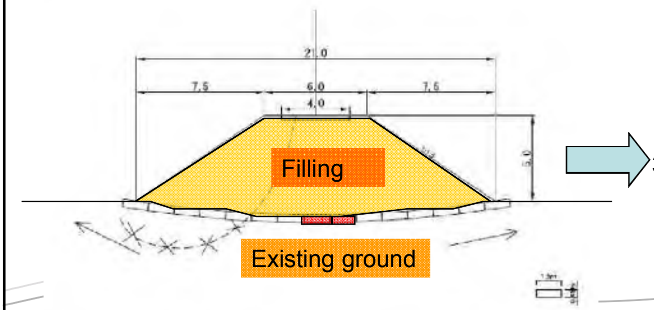
Load test of D.･BOX

fill 3～5m height

Comparison of construction cost
(rough estimate reference only)



1) Construction cost
2) Maintenance cost
×20years
3) Total cost for
20years →



1)Construction cost
2)Maintenance cost
×20years=
3)Total cost for
20years →

ありがとうございました。 Arigato

Patent

PATENT CAUTION

Mr. Futoshi Nomoto having resident at 1-13-18 Dote, Kazo-shi, Saitama, 347-0056, Japan, is the Owner and Proprietors of the following Patent:

SHAPE-RETENTION-TYPE HOISTING RECTANGULAR PARALLELEPIPED BAG

(Japanese Patent number 5160838; US Patent application number US 2011/0262056 A1 [Publication date: Oct 27, 2011])

Reg.No. IV/ 8275 /2013

The said Patent owner claims all rights in respect of the above Patent and will take all legal steps against any person, firm or corporation infringing their rights to the said Patent in Myanmar.

Khine Khine U, Advocate
LL.B, D.B.L, LL.M (UK)
For Mr. Futoshi Nomoto
#205/5, Thiri mingalar Housing, Strand Rd., Yangon
Dated. September 3, 2013

Trade Mark

TRADE MARK CAUTION

Mr. Futoshi Nomoto, a citizen of Japan and having resident at 1-13-18 Dote, Kazo-shi, Saitama, 347-0056, Japan, is the Owner and Sole Proprietor of the following Trade Mark–

D • Box

Reg.No.IV/ 8277 /2013

in respect of "Construction, Construction consultancy".

Any fraudulent imitation or unauthorized use of the said Trade Mark or other infringements whatsoever will be dealt according to law.

Khine Khine U, Advocate, LL.B, D.B.L, LL.M (UK)
For Mr. Futoshi Nomoto
#205/5, Thirimingalar Housing, Strand Rd., Yangon
Dated. September 3, 2013

Trade Mark

TRADEMARK CAUTION

Mr. Futoshi Nomoto, a citizen of Japan and having resident at 1-13-18 Dote, Kazo-shi, Saitama, 347-0056, Japan, is the Owner and Sole Proprietor of the following Trade Mark–

Metry

Reg.No.IV/ [illegible]

in respect of "Construction, Construction consultancy, Architectural design, Surveying, Geological surveys or research, Designing of machines, apparatus, instruments (including their parts) or systems composed of such machines, apparatus and instruments, Designing, Computer software design, computer programming, or maintenance of computer software, Research on building construction or city planning, Testing or research on prevention of pollution, Testing or research on civil engineering, Testing or research on machines, apparatus and instruments".

Any fraudulent imitation or unauthorized use of the said Trade Mark or other infringements whatsoever will be dealt according to law.

Khine Khine U, Advocate, LL.B, D.B.L, LL.M (UK)
For Mr. Futoshi Nomoto
#205/5, Thirimingalar Housing, [illegible], Yangon
Dated. September [illegible], 2013

D・BOX Seminar Questionnaire

(D・BOX Seminar နှင့် ပတ်သက်သော မေးခွန်းများ)

~Issues to be tackled on Soft Ground~

Thank you for joining the D・BOX seminar. We would like to ask you several questions about the soft ground issue. Thank you for your cooperation.

D・BOX Seminar သို့လာရောက်ခြင်းအတွက် အထူးကျေးဇူးတင်ရှိပါသည်။ ကျွန်တော်များအနေဖြင့် နွံ့မြေပျော့ (soft ground) နှင့်ပတ်သက်၍ သိလိုသည်များကို လူကြီးမင်းထံမေးမြန်းလိုပါသည်။ ကူညီဖြေကြားပေးခြင်းအတွက် ကျေးဇူးတင်ပါသည်။

Questions about Demand (Road, Port, Railway, Industrial Estate, Residential Area)

လုပ်ငန်းလိုအပ်ချက် မေးခွန်းများ (လမ်း၊ ဆိပ်ခံတံတား၊ မီးရထားလမ်း၊ စက်မှုဇုန်များ၊ လူနေအိမ်ယာများ)

- Q1: What kind of and where problems are there? (သင် မည်သည့်ပြဿနာများကို ကြုံတွေ့နေရပါသနည်း။)

  ☐Subsidence (မြေကျွံခြင်း) ☐Vibration (တုန်ခါခြင်း) ☐Swamps in rainy season (မိုးရာသီနွံ့မြေပျော့များ)

  ☐Landslide at embankment (မြေဘောင်၊ တာဘောင်များ ပြိုကျခြင်း)

  ☐Others (အခြား) (   )   Location (နေရာ) (   )

- Q2: Scale of damages with soft ground issue (Frequency, Relief Cost, Damage)

  မြေပျော့ (soft ground) ကြောင့်ဖြစ်ပေါ်သောပျက်စီးမှုများ (ဖြစ်ပေါ်မှု ကြိမ်နှုန်း၊ ကယ်ဆယ်ရေး ကုန်ကျစရိတ်၊ အပျက်အစီးများ)

  (   )

- Q3: Is there any Site and Project which you would like to apply D・BOX method?

  သင် ပါဝင်ပတ်သက်နေသည့် မည်သည့်လုပ်ငန်းခွင် သို့မဟုတ် မည်သည့်စီမံကိန်းများ တွင် D・BOX method ကိုအသုံးပြု လိုပါသနည်း။

  (   )

- Q4: Would you like to have an independent meeting with D・BOX team?

  သင့်အနေဖြင့် D・BOX Team နှင့် သီးသန့်ဆွေးနွေးလိုပါသလား။

  ☐Yes (ဆွေးနွေးလိုပါသည်) ☐No (မဆွေးနွေးလိုပါ)

Questions about Current countermeasure against the soft ground (Cost, Efficiency, Problems)

မြေပျော့ (soft ground) ပြုပြင်ခြင်းနှင့် ပတ်သက်သော မေးခွန်းများ (ကုန်ကျစရိတ်၊ ထိရောက်မှု၊ ပြဿနာများ)

- Q5: What kind of countermeasure against soft ground do you currently apply?

  မြေပျော့ (soft ground) များ ပြုပြင်ရန်အတွက် သင် မည်သည့်နည်းလမ်းကို လက်ရှိအသုံးပြု နေပါသနည်း။

  (   )

- Q6: What is the point of issue of current countermeasure against soft ground?

  မြေပျော့ (soft ground) များ ပြုပြင်ရန် အတွက် မည်သည့်အချက်သည် အဓိကကျပါသနည်း။

  (   )

- Q7: How much is the annual cost for the countermeasure against soft ground?

  မြေပျော့ (soft ground) များ ပြုပြင်ရန်အတွက် နှစ်စဉ်ကုန်ကျစရိတ်မည်မျှ ရှိပါမည်နည်း။

  (   )

Answered by (ဖြေဆိုသူ) :

Name (အမည်) :	
Position and rank (ရာထူး)	
E-mail	
Phone No. (ဖုန်းနံပါတ်)	
Company (ကုမ္ပဏီ) :	
Type of industry of your company (သင်၏ ကုမ္ပဏီအမျိုးအစား)	

【Free opinion regarding D.・BOX:】(D・BOX နှင့် ပတ်သက်သော သင်၏အမြင် များ)

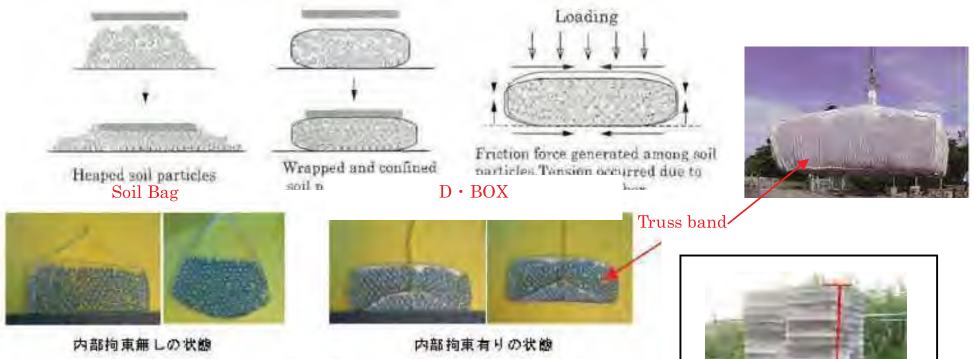
Thank you for your cooperation.
(ကျေးဇူးတင်ပါသည်)

What is D・BOX Method ?

D・BOX is a product which is developed by Mr. Futoshi NOMOTO of Metry Technical Institute, based upon the theory, merits and performance of the Soil-Bag(do-nou in Japanese) method invented by Prof. Emeritus Hajime MATSUOKA of Civil Engineering, Nagoya Institute of Technology, Japan. Therefore, the inventors of the D・BOX method are Hajime MATSUOKA and Futoshi NOMOTO.

4 amazing effects like "magic"

1) Extremely high bearing load: D・BOX can hold the weight of 1,100kN/m² to 1,900kN/m². This means D・BOX will not break even if it is placed under the basement of a skyscraper of 60 to 100 floors. We have the theoretical reason and the experimental results to prove this.



2) Soft clay soil becomes compact and strong with D・BOX:

D・BOX with sand and gravel causes the "local consolidation" in a very soft ground, such as a marsh, making the soft ground compact and strong. Using our method, the soft ground beneath D・BOX is able to support a building and a road. D・BOX consisting of sand and gravel acts as a permeable layer bringing about "local consolidation" in the surrounding earth.

"Local consolidation and strengthening" by permeable D・BOX

D・BOX with permeable materials such as sand and gravel has the feature to pass water easily, but not soil. The more the water passes, the more the clay becomes compact, and the soft clay ground under D・BOX grows more and more solid and strong.

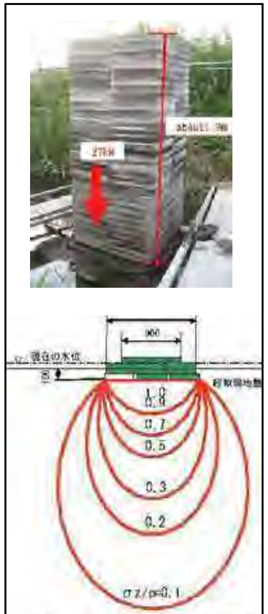


Figure of "pressure bulb" under permeable do-nou

3) High quality of vibration reduction:

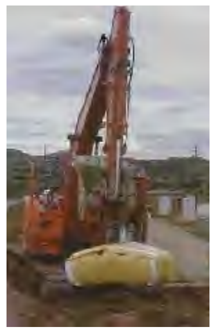
D・BOX absorbs a high degree of traffic vibration, machine vibration and earthquake movement (5~15dB reduction by the vibration level). This is because vibration energy is dissipated as frictional heat energy between particles due to little flexibility within the D・BOX. It is able to function as an apparatus for high vibration reduction in a wide range of scenarios.

4) Prevention of the frost heave in a cold district: D・BOX consisting of coarse granular materials such as sand and gravel are able to prevent capillary rise of water and thus can prevent frost heave in areas subject to cold weather conditions.

****The material (Polyethylene or Polypropylene) for D・BOX is susceptible to degradation from sunshine (ultraviolet ray). It is a vital that D・BOX should be covered with soil or a light-tight sheet whenever they are employed.***

Prof. Hajime MATSUOKA
E-mail:hajime.matsuoka@md.ccnw.ne.jp
URL: http://www.soilbag.com/

Mr. Futoshi NOMOTO
Metry Technical Institute
E-mail:info@metry.jp
URL:http://www.metry.jp/



添付資料_004_第一回現地調査_セミナー②

Program of the D・BOX Seminar in NayPyi Taw

Date: November 12, 2013 Tuesday 9:00-12:00
Venue: MyatTawWin Hotel, Nay Pyi Taw

1. Opening remarks (Mr. Hiroshi Shimada): 9:00-9:05

2. Introduction and Concept of the D・BOX (Mr. Futoshi Nomoto): 9:05-9:35

3. Theory and Examples of Soil bag and D・BOX (Comment from Prof. Matsuoka by Video): 9:35-10:05

4. Coffee break: 10:05-10:25

5. Introduction of Japanese counter methods against softground ,liquefaction; and additional explanation on examples of D・BOX at actual site (Mr. Koichi Kadota): 10:25-10:55

6. Introduction of the demonstration experimentation of the D・BOX; and Examples of utilization on Myanmar (Mr. Hiroshi Shimada) 10:55-11:15

7. Questionnaires (Mr. Takeshi Maeda)： 11:15-11:30

8. Closing remarks: 11:30-11:35

Total: 2 hours and 35 minutes

Contact person: Mr. Hiroshi SHIMADA (hiroshi.shimada@ss.pacific.co.jp)
Ms. Yuko MATSUDA (yuuko.matsuda@ss.pacific.co.jp)

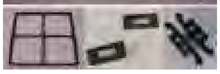
Metry® DBox®

Metry Technical Instiute

DBox-LS100/LS150

D・BOX－LSの形状　左は閉口時（中詰材未投入）、右が上部を開口した状態（LS100）

DBox-SS45/SS90



SS45（上段右写真）　SS90（上段左写真）
内部にガイドゲージがセットされた様子

D・BOXのパーツ写真（下段左写真の左から）
ガイドゲージ、ピンロック、ロックジョイント

D・BOX－LSシリーズ（吊上げ設置タイプ）　　＊中詰材：C・RC30-0　C・RC40-0推奨

製　品	施工寸法	備　考
D・BOX－LS100	W1000×D1000×ｈ250	中詰材の投入容量　0.25m3
D・BOX－LS150	W1500×D1500×ｈ450	中詰材の投入容量　1.0m3

D・BOX－SSシリーズ（連結タイプ）　　＊中詰材：C・RC30-0　C・RC40-0推奨

製　品	施工寸法	備　考
D・BOX－SS45	W450×D450×ｈ80	中詰材の投入容量　0.0162m3
D・BOX－SS90	W900×D900×ｈ80	中詰材の投入容量　0.0648m3

Major merits of the **D-Box**

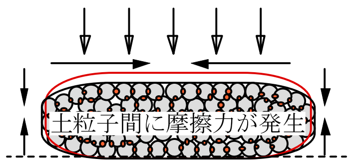
1) Reinforcement of ground condition
(Soft clay can be improved by this method.)

2) Reduction of machinery and traffic vibration influence

3) Reduction of seismic impacts

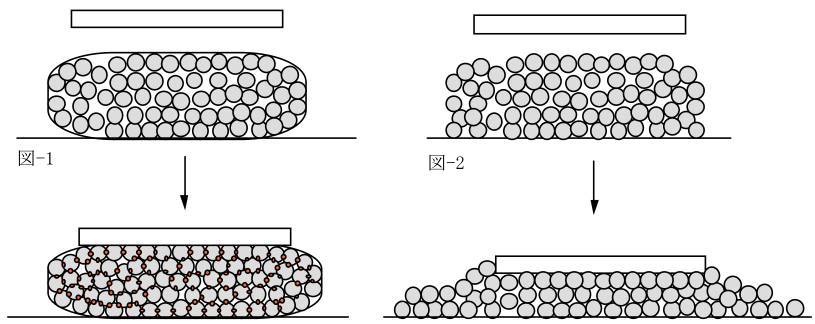
4) Prevention of liquefaction

5) Prevention of freezing



袋が伸びるため張力が発生

This method was analyzed and advanced by Emeritus Prof. Matsuoka of Aichi Institute ofTechnology, and indicates that perfect confinement of particles can increase strength, owingto internal frictional energy to be generated among the particles.

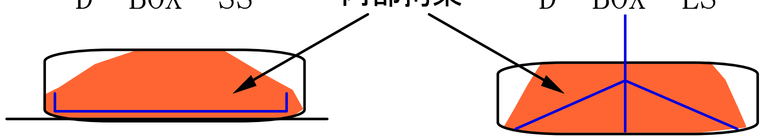


[redacted]

Binding force effects in inside of the D-box

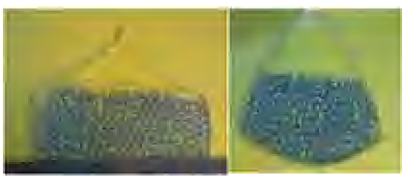
内部拘束具による内部からの土粒子拘束（内部拘束効果）

D・BOX－SS　　内部拘束　　D・BOX－LS

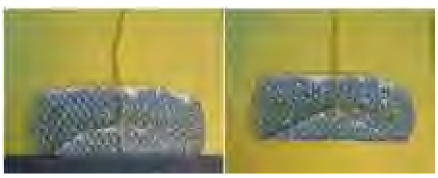


ガイドゲージによる内部拘束　　トラスバンドによる内部拘束

内部拘束無しの状態

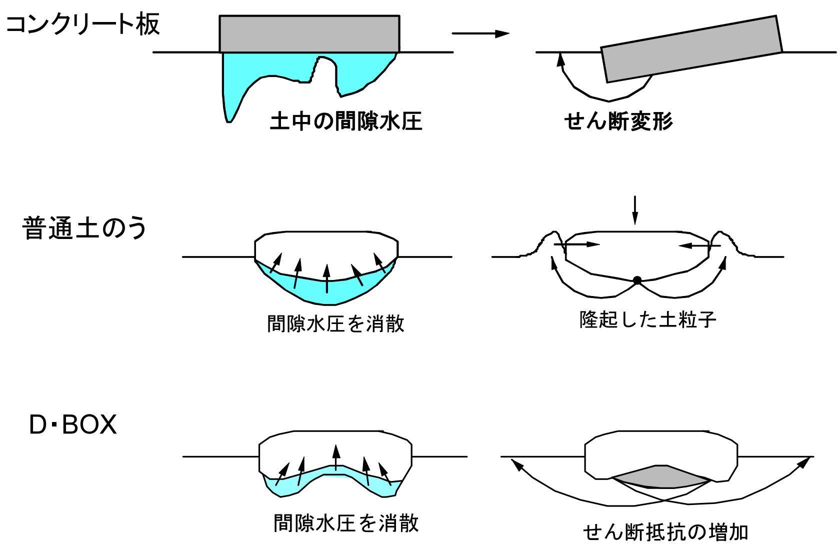


内部拘束有りの状態

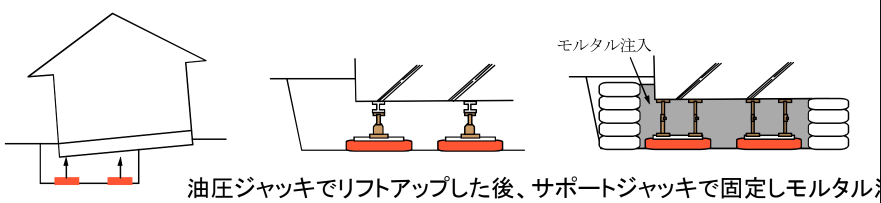


D･BOX製作　LS150　　サイズ:1500×1500×450

D・BOX沈下抑制のメカニズム1　せん断抵抗



液状化地盤での施工例3　**D・BOXを反力とした住宅のリフトアップ工事**

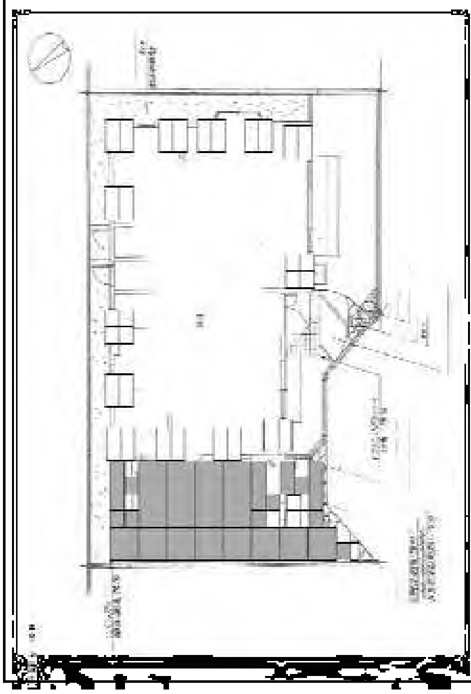


油圧ジャッキでリフトアップした後、サポートジャッキで固定しモルタル注

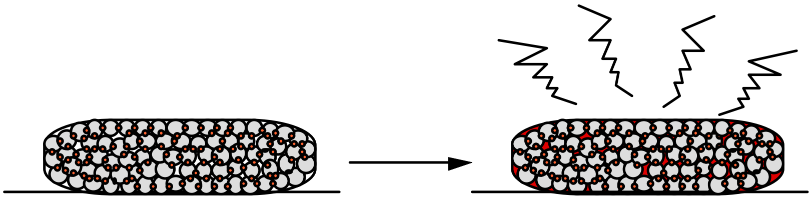
D・BOX上部に油圧ジャッキをセット

リフトアップ後サポートジャッキにて固定

液状化地盤での施工例　千葉県　液状化による陥没地盤の修正補強工事



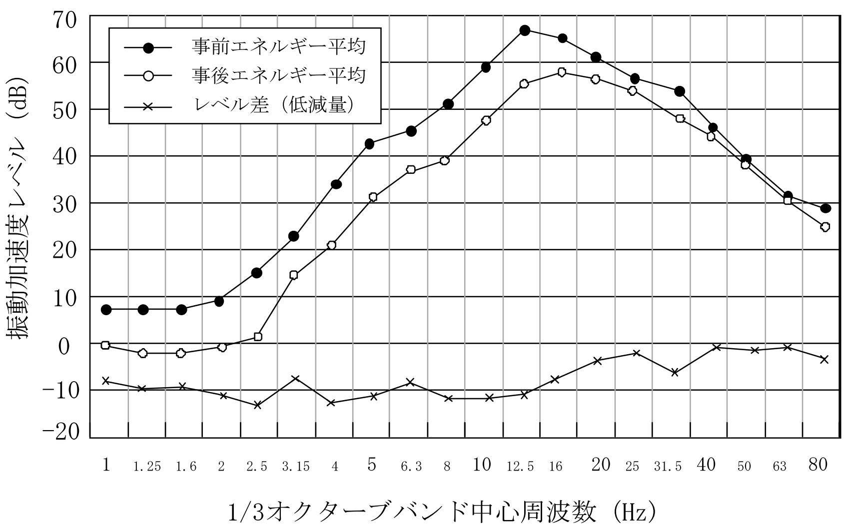
振動低減のメカニズム



外部より振動が入力されると、ごく微量ですがD・BOXに変形が生じます。この時D・BOX内部の粒子間に発生する新たな摩擦力により、振動エネルギーを熱エネルギーに変換する事で振動を減衰させる。

D・BOXでは、内部拘束効果により、より効率的な振動減衰が可能です。

滋賀県H市地盤補強・振動低減工事



事前と事後における振動加速度レベルの周波数特性の比較

資料：東海技術センター

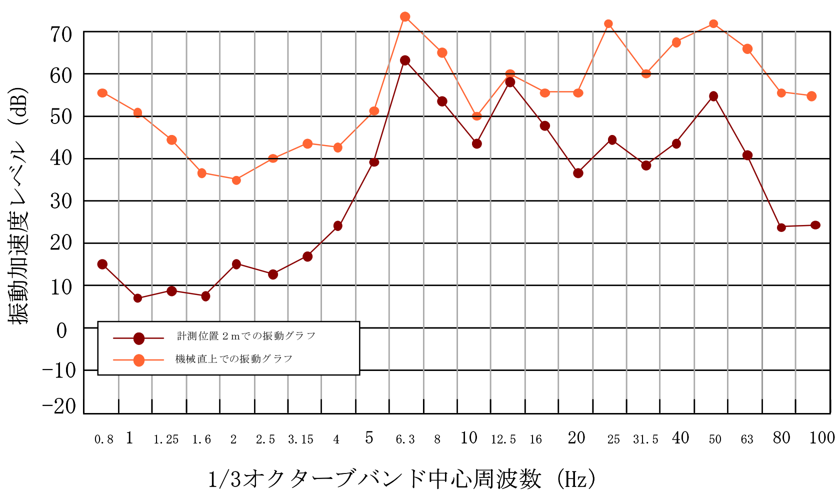
廃棄物処理施設　機械振動対策工事

ゴミ分別機の稼働状況

無対策時では70dBを超える激しい振動

D・BOX敷設状況

（D・BOX－LS100を1段　D・BOX－SSを1段）

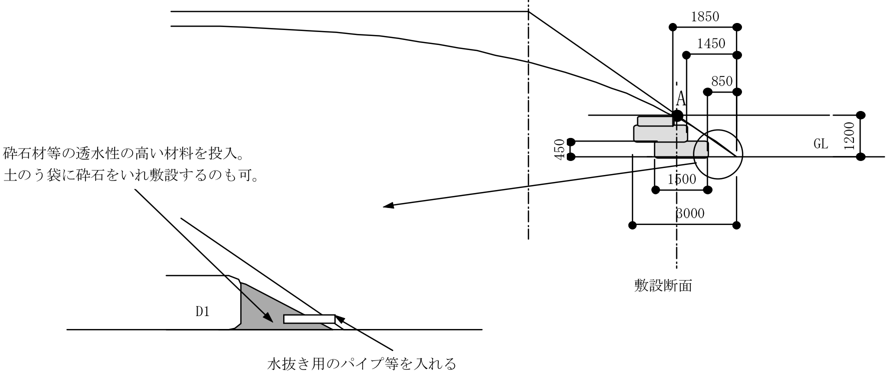


福島県　地震後の墓石状況

D・BOXが敷設された墓石

その他の工事例　盛土倒壊対策工事

大雨翌日の法面の倒壊状況



最下段部のD・BOXの側面からの排水量が多くなるため、
盛土部端部の土粒子が一部流される事が予想される。
（盛土部の倒壊は無いが）
そのためD・BOXの側面を埋め戻す際、D1部横に砕石等
の間隙の大きな材料を投入したり、水抜き用のパイプ
等（φ50mm程度）を敷設する。

D･BOX－LS150　敷設状況

D･BOX敷設後　台風翌日の状況
反対面の法面は倒壊している。

D･BOX　住宅施工例

橋脚ベント工事　D･BOXを使った地盤補強工事

東部労働センターでの説明会

製作しているのはD・BOX－SS90

D・BOX　製作作業の様子

D・BOX製作の一部は、県内を中心とする知的身障者施設で作られています。

Nov.2013

1. Situation of Landslide Damage of Residential Land and Liquefaction Damage due to the 2011 off the Pacific Coast of Tohoku Earthquake , and Recovery Method Against those Damages

2. Proposal of Design Method of D･BOX Countermeasure Against the soft Ground

Ph.D. Hirokazu.kadota

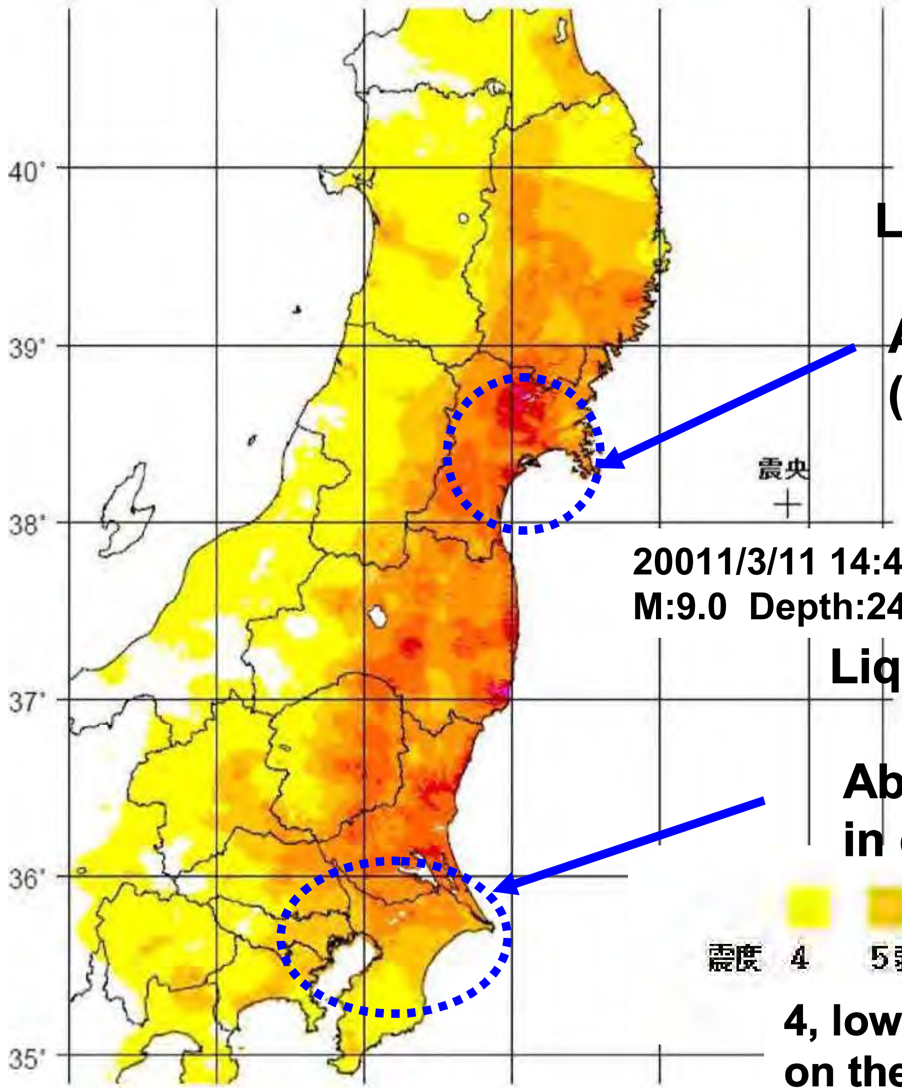
PACIFIC CONSUL TANTS CO.,LTD

1.Situation of Landslide damage of Residential Land and Liquefaction damage due to the 2011 off the Pacific Coast of Tohoku Earthquake , and recovery method against those damages

Landslide damage in the Residential Land

Liquefaction damage in the Residential Land

Scale (Seismic Intensity) of the 2011 off the Pacific Coast of Tohoku Earthquake



2001 1/3/11 14:46
M:9.0 Depth:24km

Landslide damages

⇩

About 5,700 residential quarters (in inland) in Sendai City

Liquefaction damages

⇩

About 64,000 residential quarters in coastal area of Kanto region

4, lower 5, upper 5, lower 6, upper 6, 7 on the seven-point Japanese scale

1-1. The 2011 off the Pacific Coast of Tohoku Earthquake

Landslide Damages by the Earthquake and the Recovery Measures

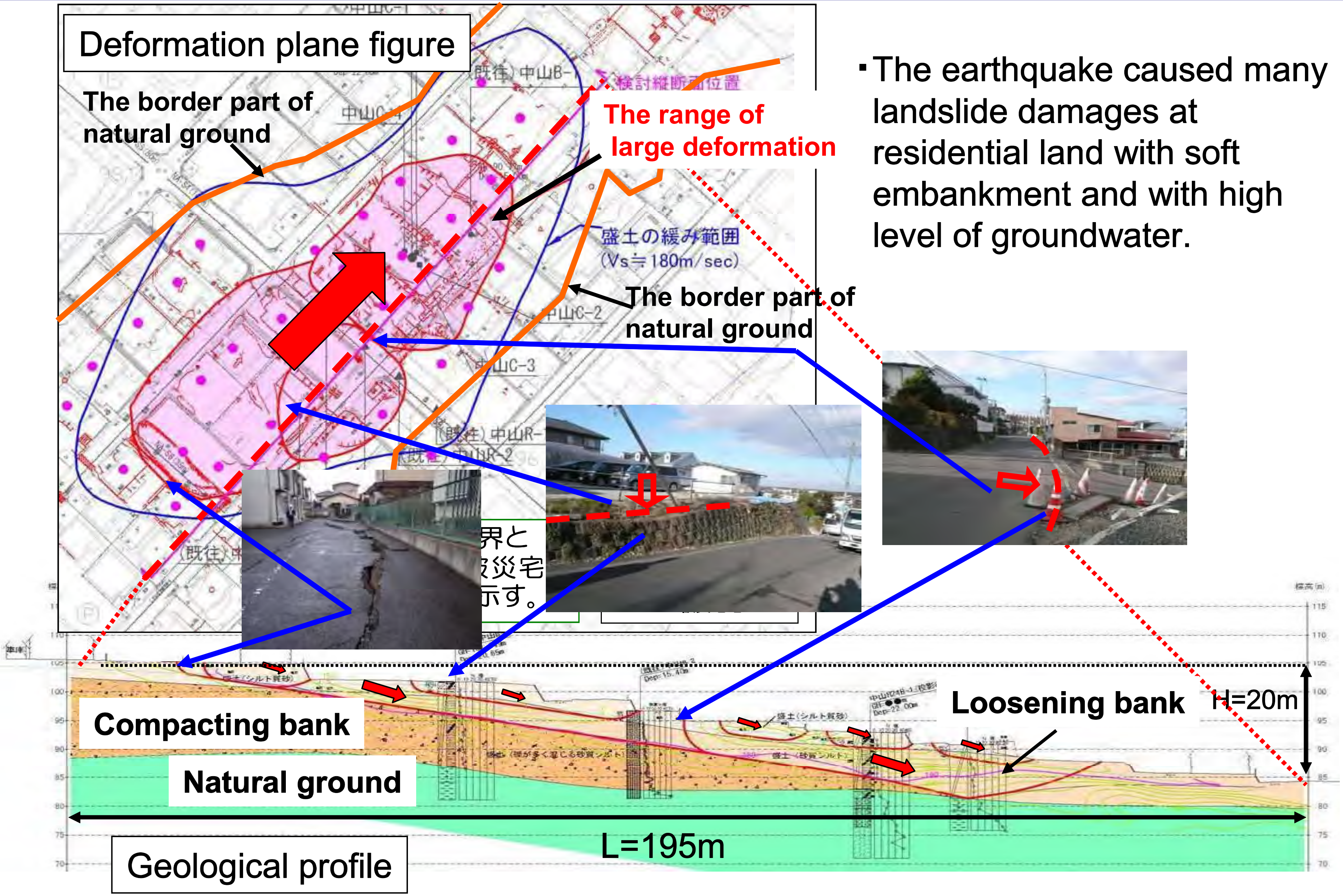
Residential Land with high level of groundwater and with loose bank

Earthquake

Landslide damage

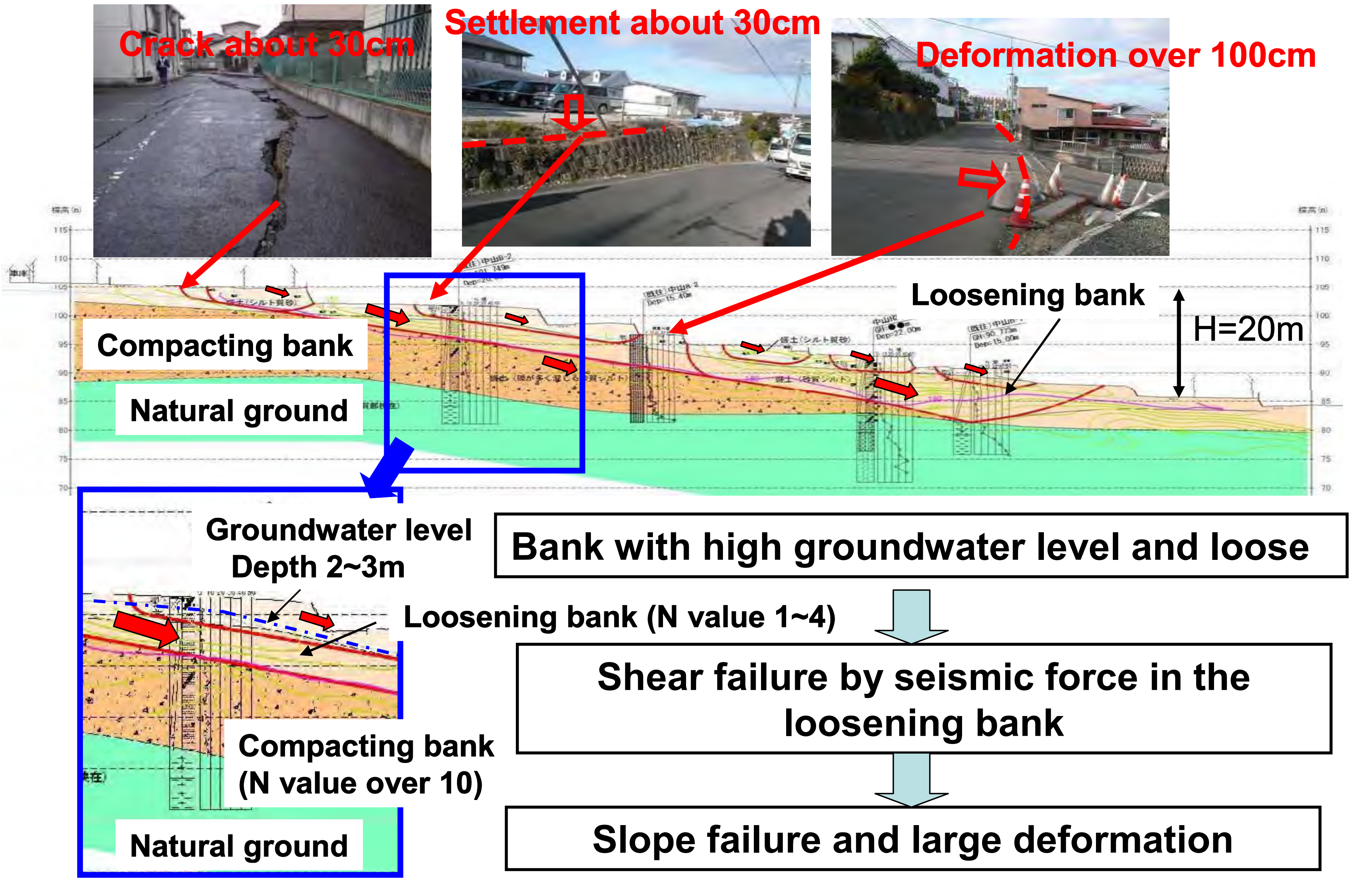
Major types of Landslide Damages by the Earthquake at the Residential Land

The Main Factors of the Landslide



・The earthquake caused many landslide damages at residential land with soft embankment and with high level of groundwater.

The Main Factors of the Landslide

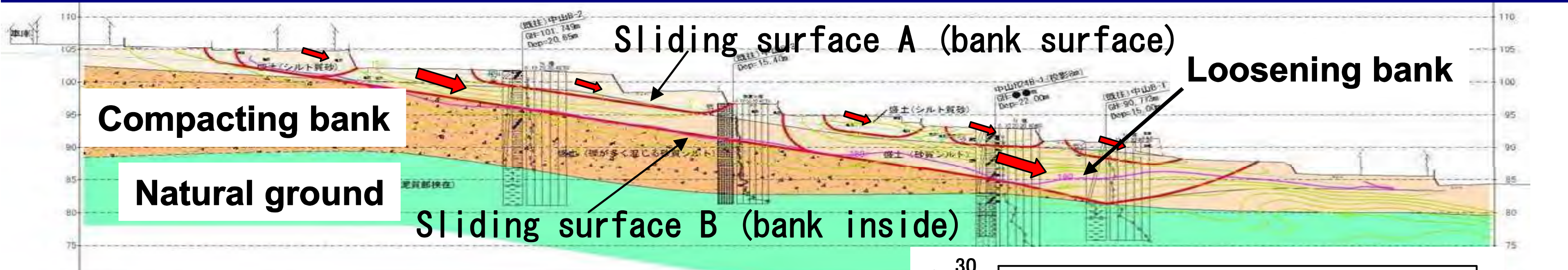


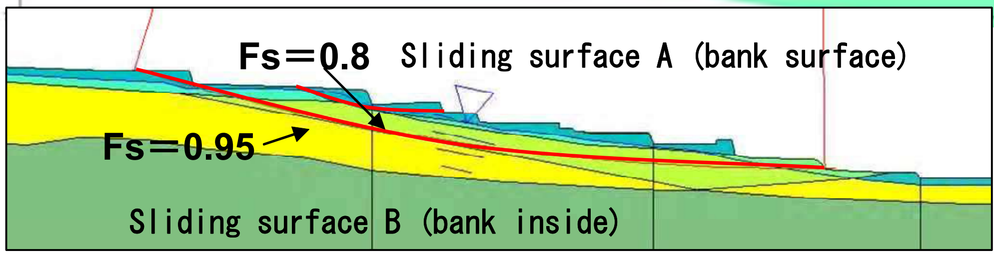
Bank with high groundwater level and loose

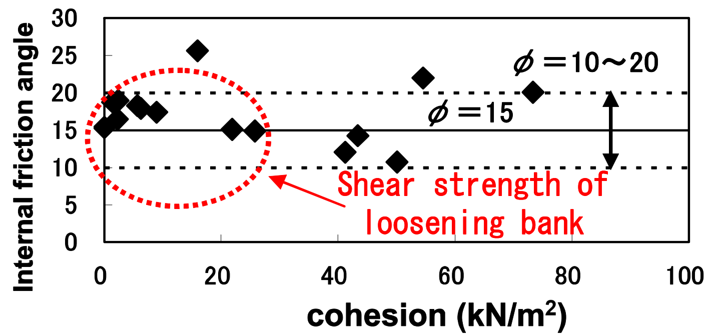
Shear failure by seismic force in the loosening bank

Slope failure and large deformation

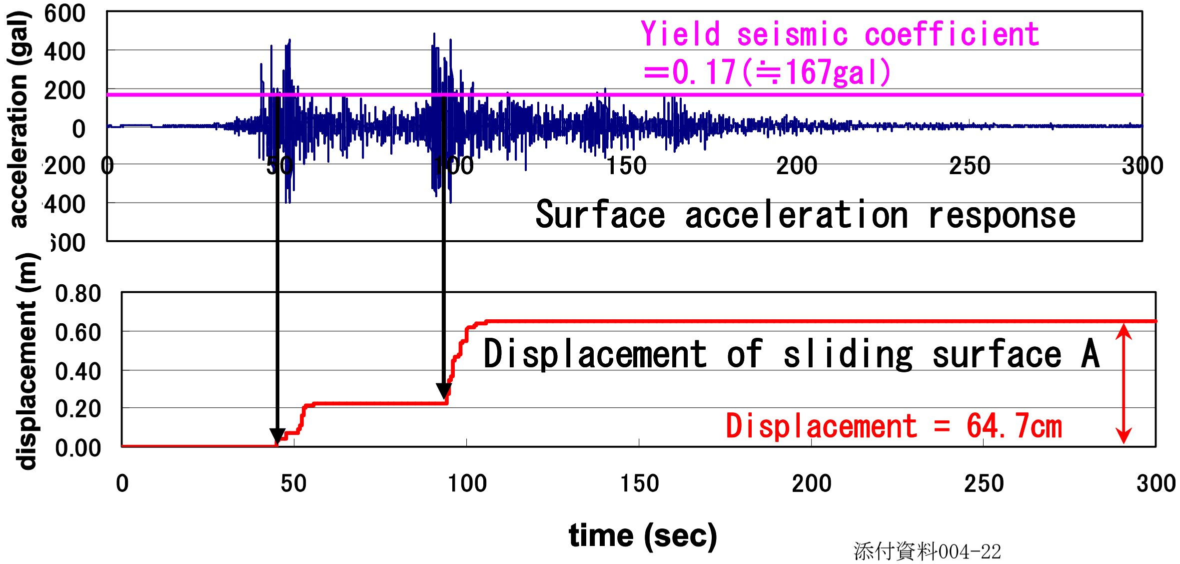
Replication Test of Landslide by Slope Stability Analysis with Newmark Method







Newmark Method Safety factor of sliding surface



The triaxial compression test result

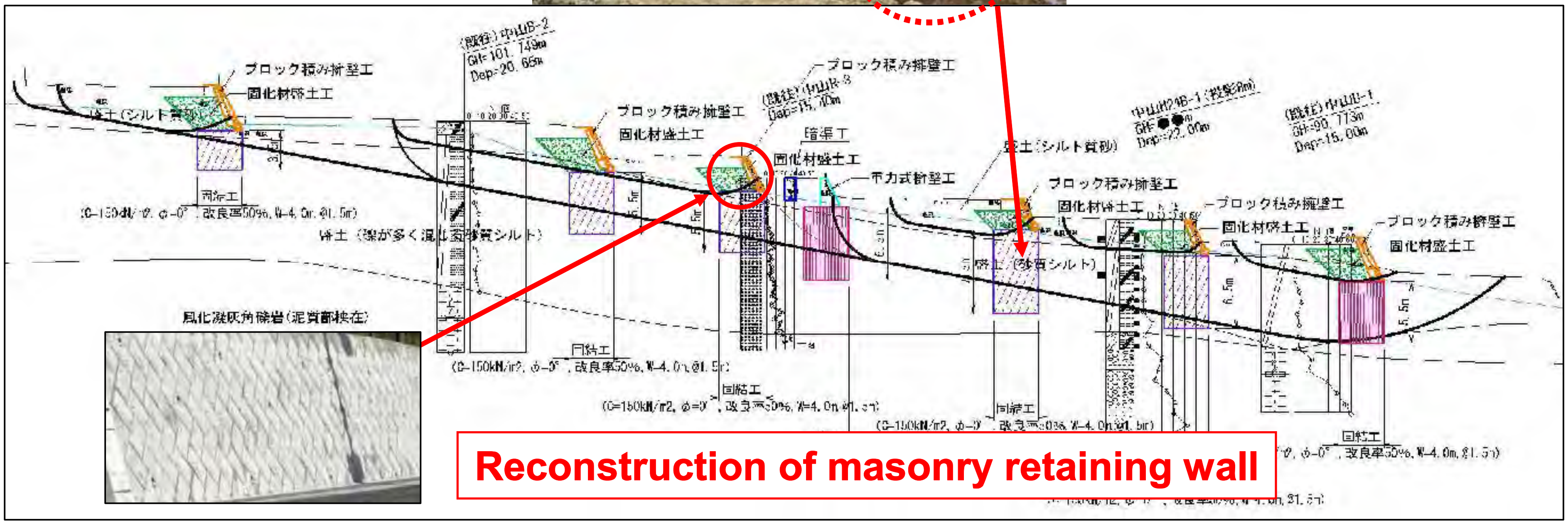
・The analysis result was at the same level as measurement displacement.

Countermeasure Against Landslide with Ground Improvement

○ Landslide (with large deformation) prevention

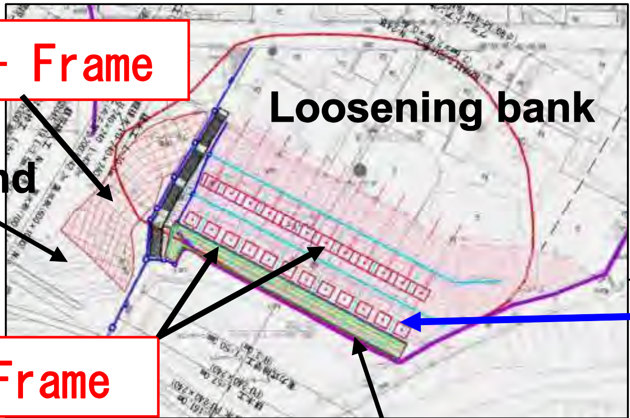
Cementation

- soft ground ⇒cementation
- Construction by a slit from
⇒Prevent to stagnant ground water

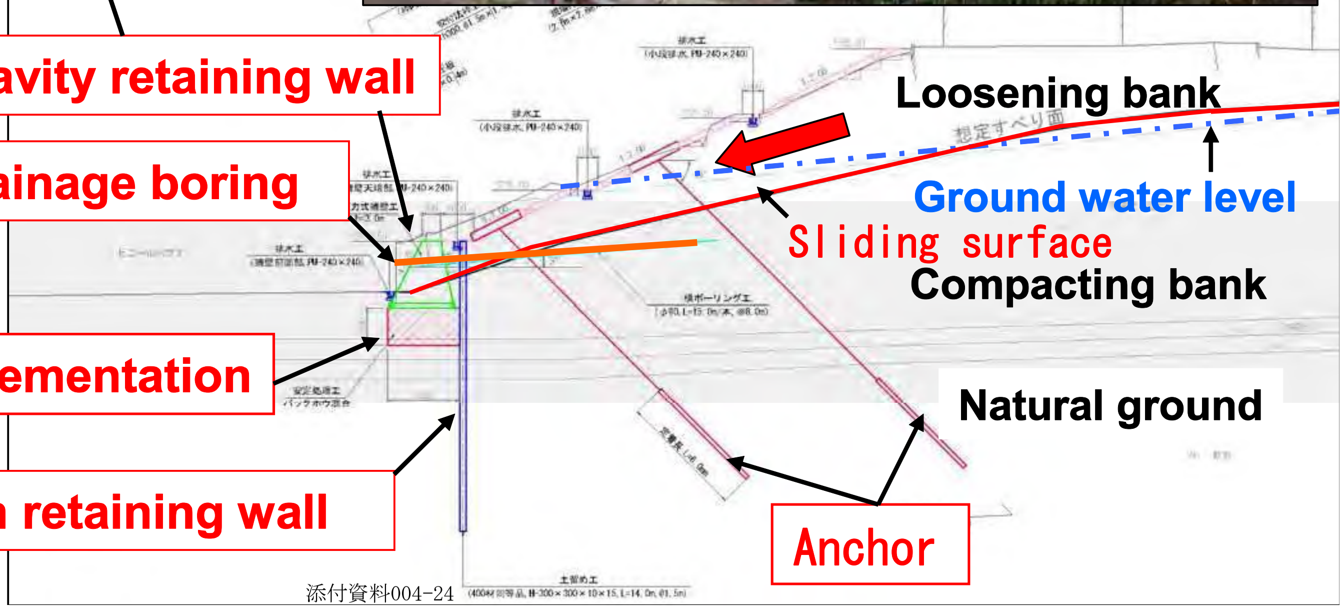


Countermeasure Against Landslide with Anchoring Method

○ Slope failure prevention

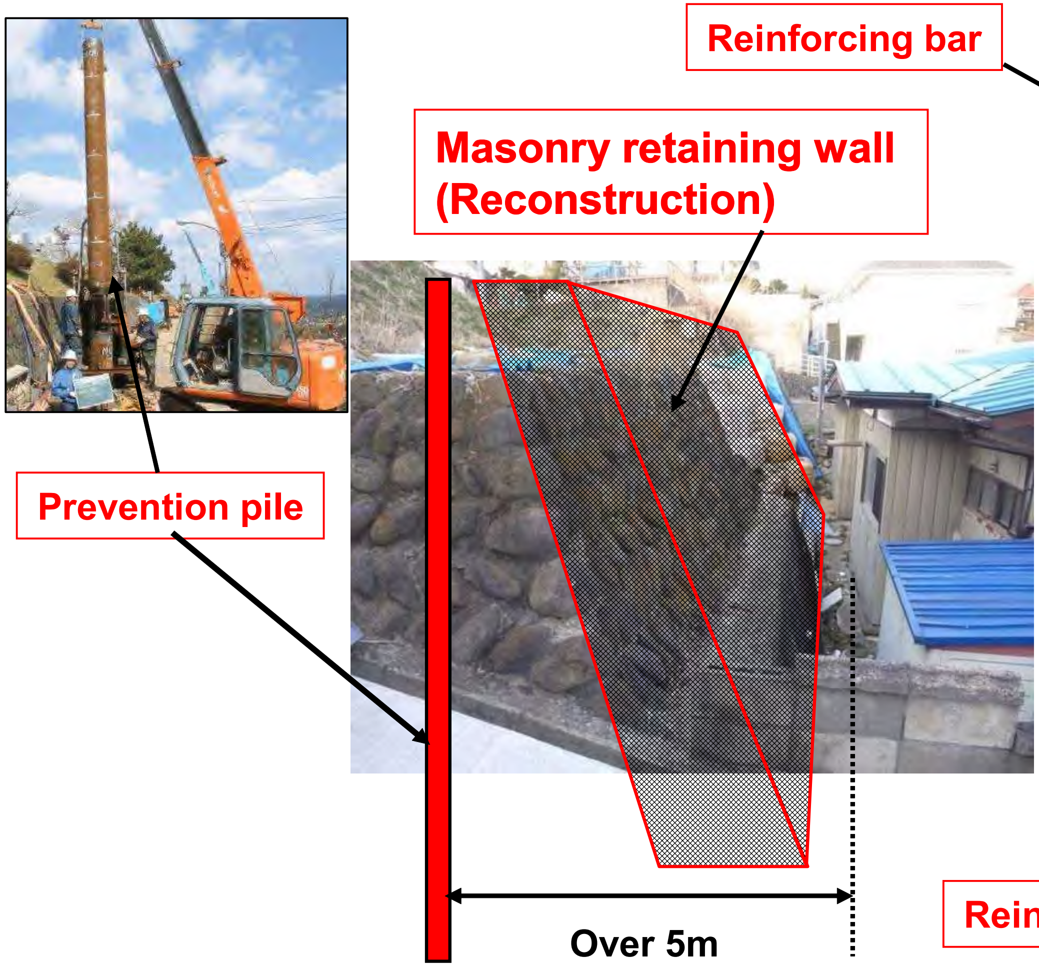


Slope failure
(aftermath of
the earthquake)

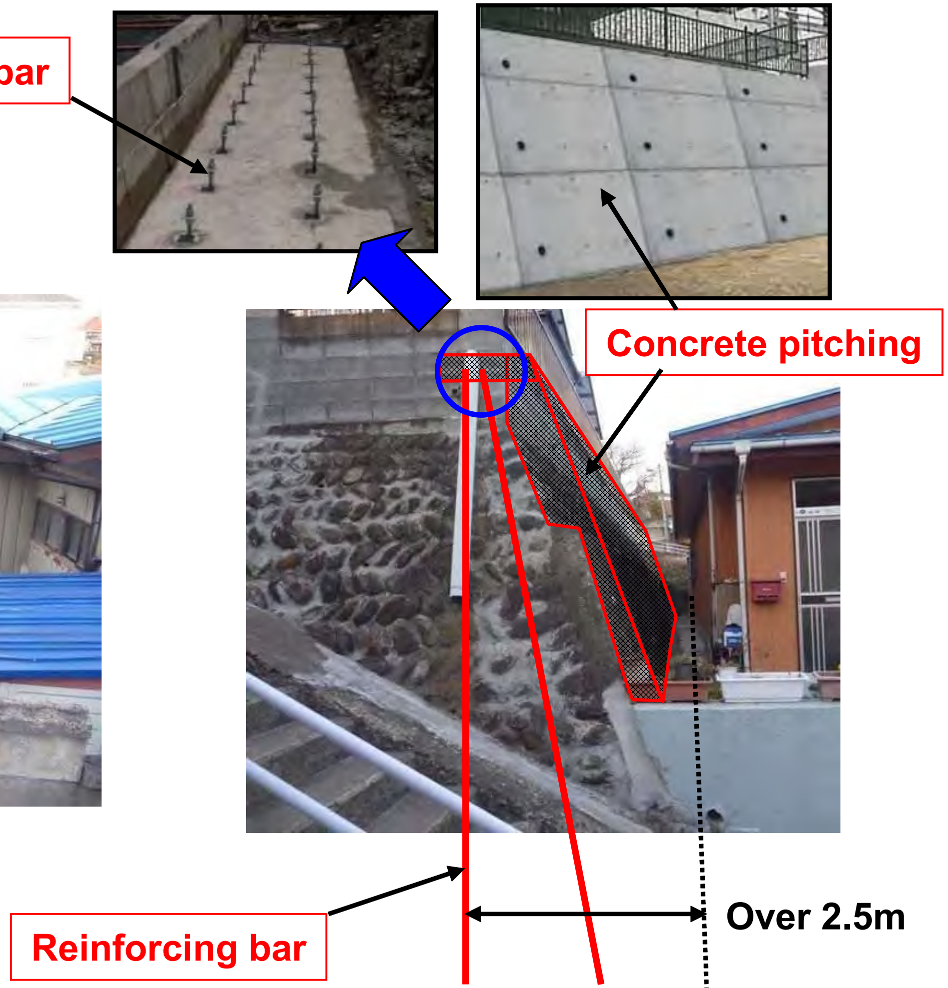


The Recovery measure and Countermeasure against Seismic for the Retaining Wall

Prevention Pile＋Masonry Retaining Wall

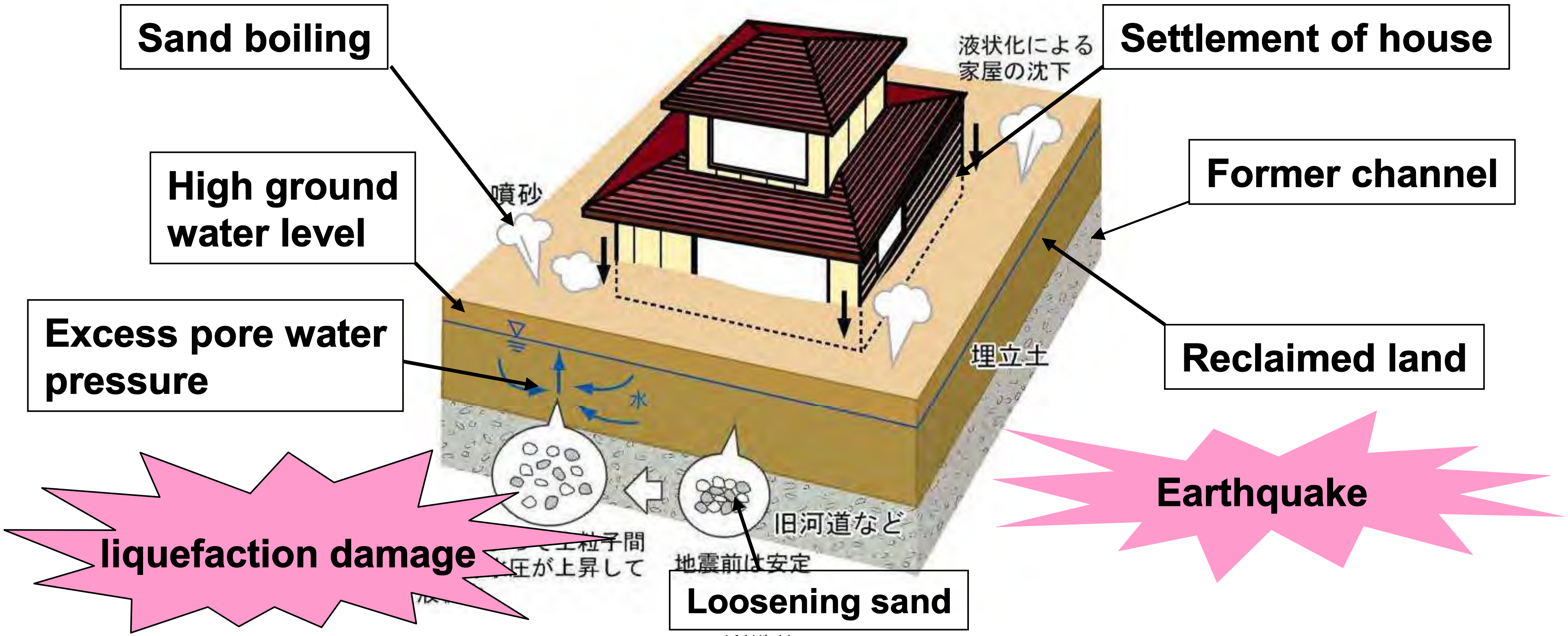


Reinforced earth＋Concrete Pitching



1-2. The 2011 off the Pacific Coast of Tohoku Earthquake Liquefaction disaster

Estimate Method of Liquefaction Damage in the Residential Land



Major types of **Liquefaction** Damages by the Earthquake at the Residential Land

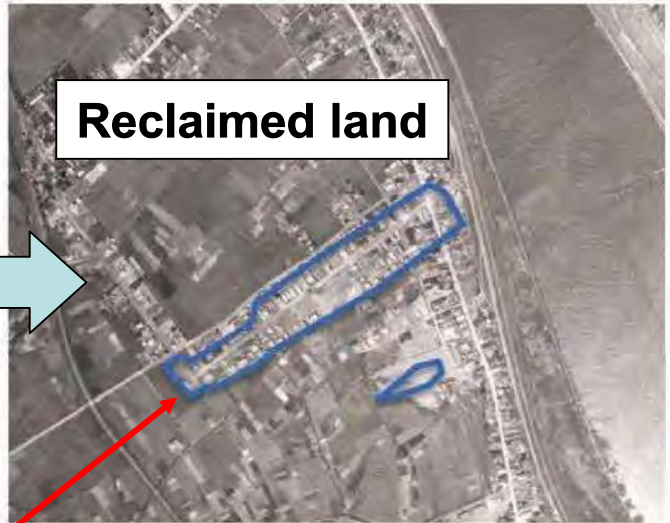
Sand boiling, Groundwater boiling, Settlement of house

The Main Factors of the Liquefaction

Former channel

1947

1962



March 2011

Former channel

Reclaimed land

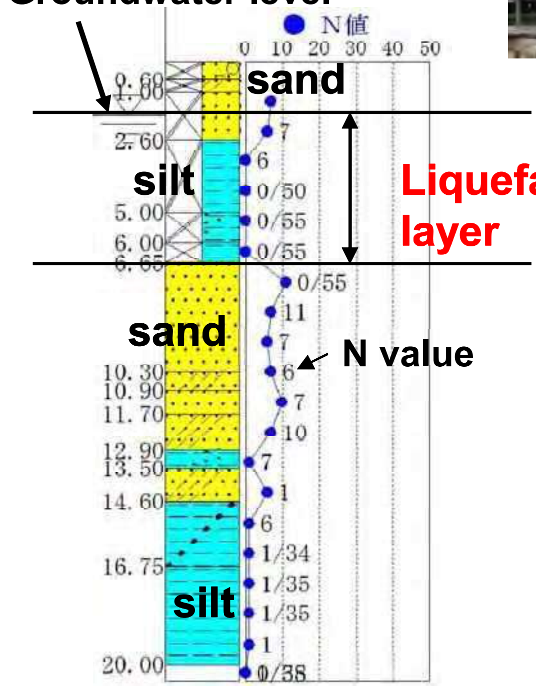
Earthquake

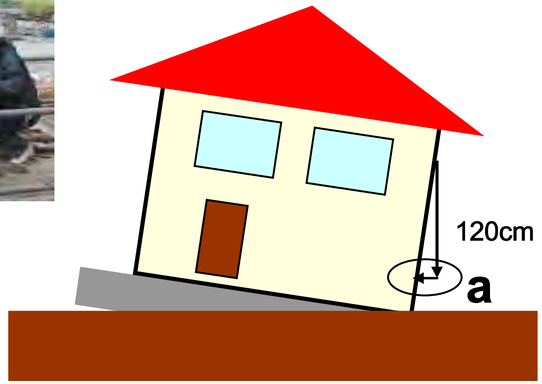
Liquefaction damage

Estimate Method of Liquefaction Damage in the Residential Land

○ Investigation into liquefaction damage of the houses in Residential Land

Geological deta
In the affected areas





・a ≧ 2cm : large damage ●

・1.2cm ≦ a < 2cm : middy damage ○

・a ≧ 2cm : small damage ~ no damage ●

large damage ●

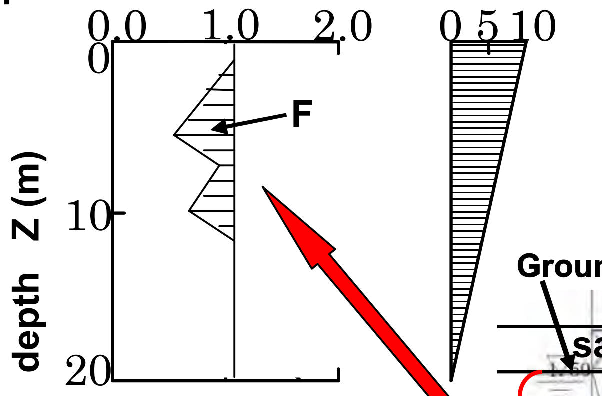
middy damage ○

small- no damage ●

Estimate Method for Liquefaction Damage in the Residential Land

PL (potential of liquefaction)

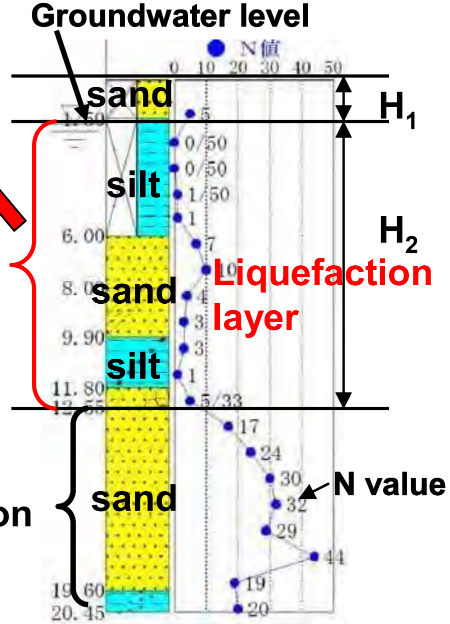
$$PL = \Sigma F \cdot W(z) \cdot \Delta Z$$



$$F_L = \frac{\tau_l / \sigma'_z}{\tau_d / \sigma'_z} < 1.0$$

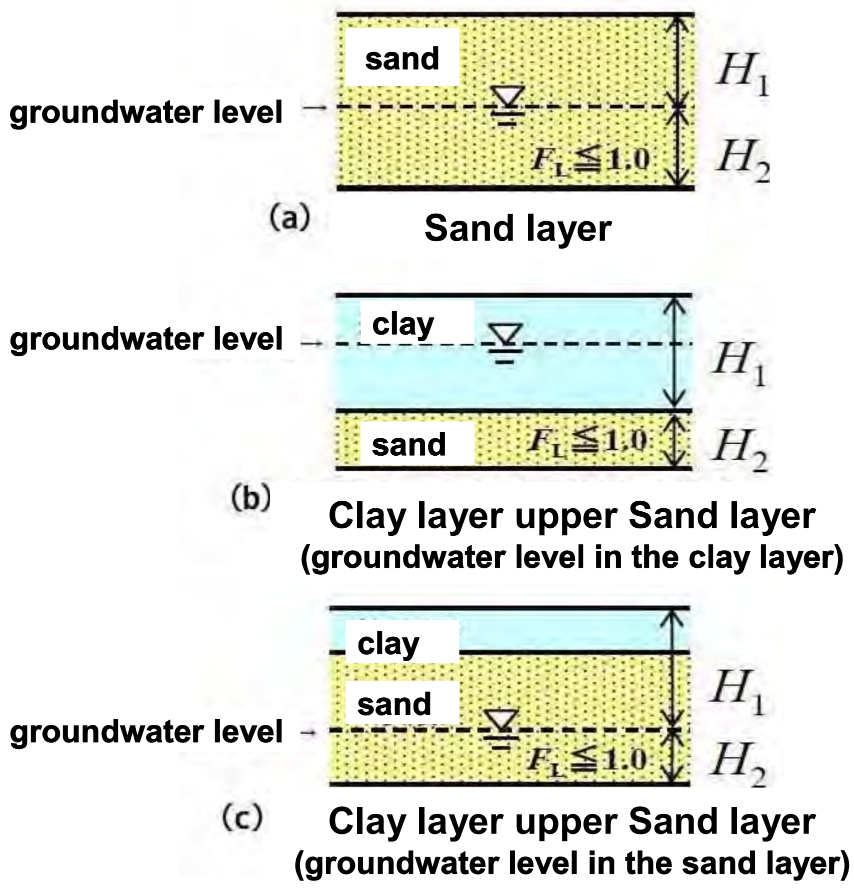
F_L=(Liquefaction resistance ratio)

÷(Repetition shear stress ratio)

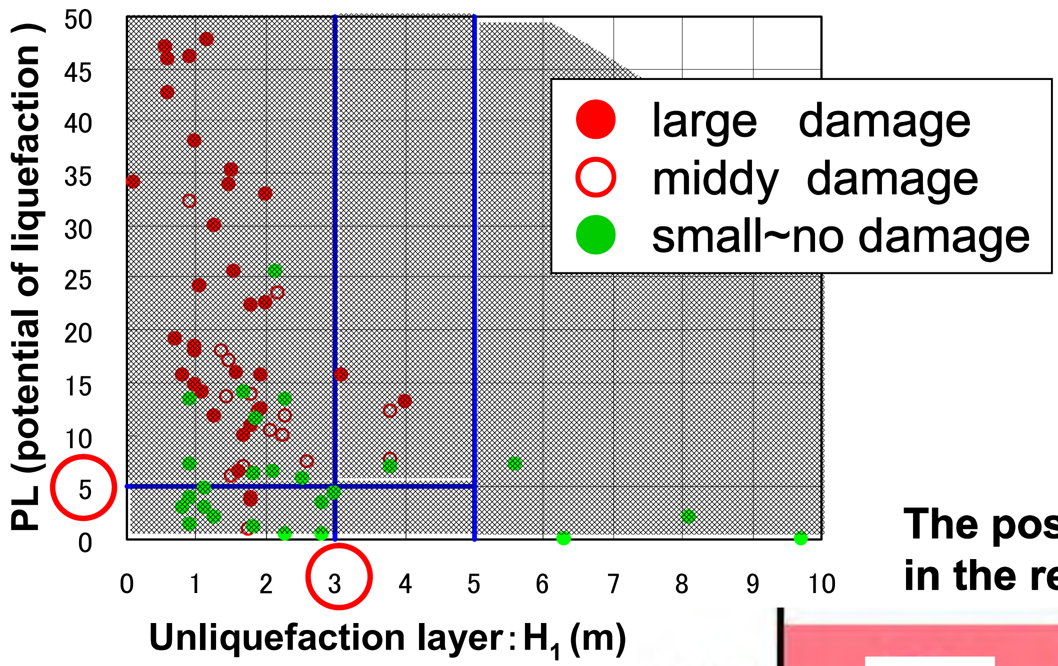


Unliquefaction layer : H_1

Liquefaction layer : H_2



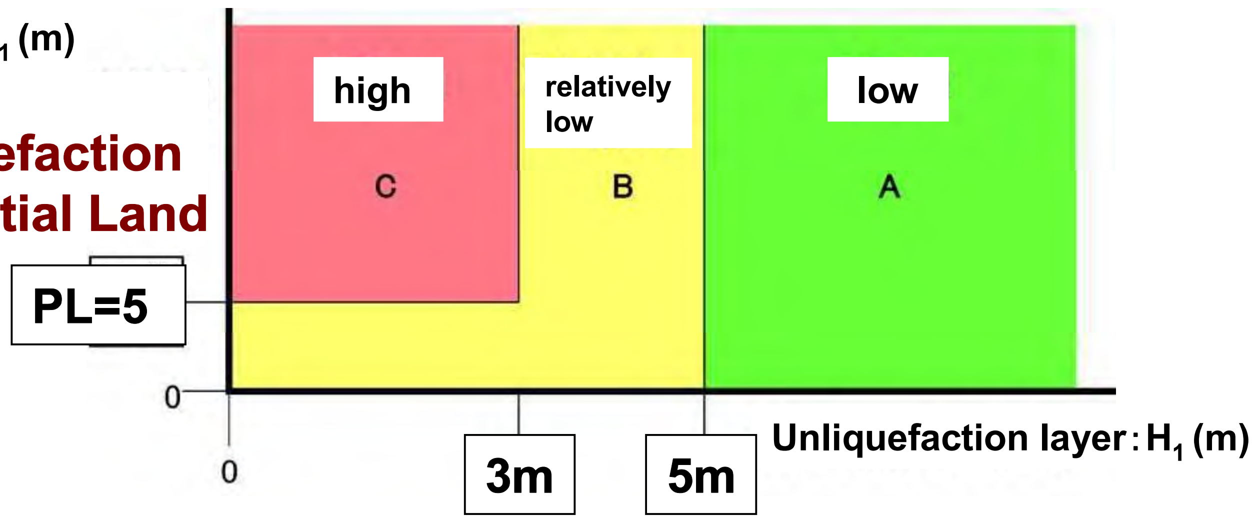
Estimate Method of Liquefaction Damages in the Residential Land



PL > 5 and H_1 < 3m

Large damage!

The possibility of liquefaction damage in the residential land



Estimate Method of Liquefaction Damages in the Residential Land in Japan

2. Proposal of Design Method of D･BOX Countermeasure Against the Soft Ground

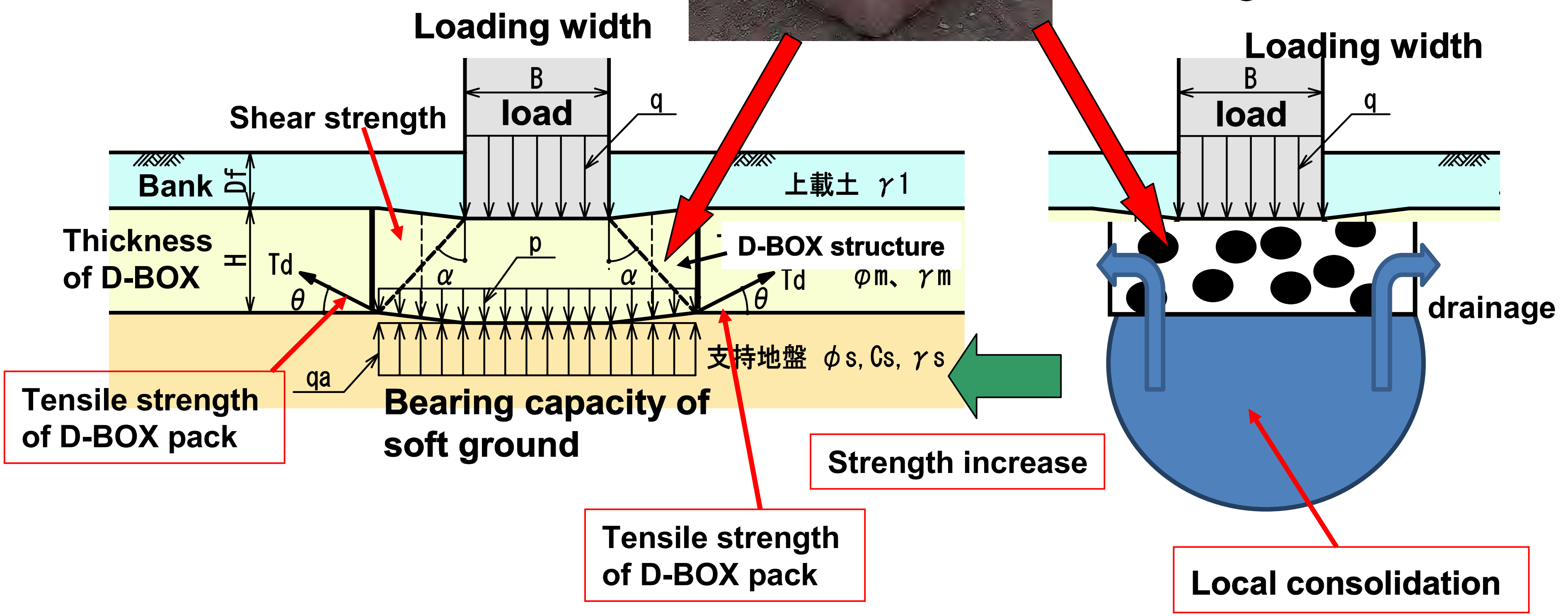
Reinforcing Effect of D･BOX Countermeasure Against the Soft Ground

Reinforcing effect 1

･Tensile strength of D-BOX
･shear strength of D-BOX

Reinforcing effect 2

･drainage of D-BOX
⇒local consolidation
⇒shear strength Increase of soft ground

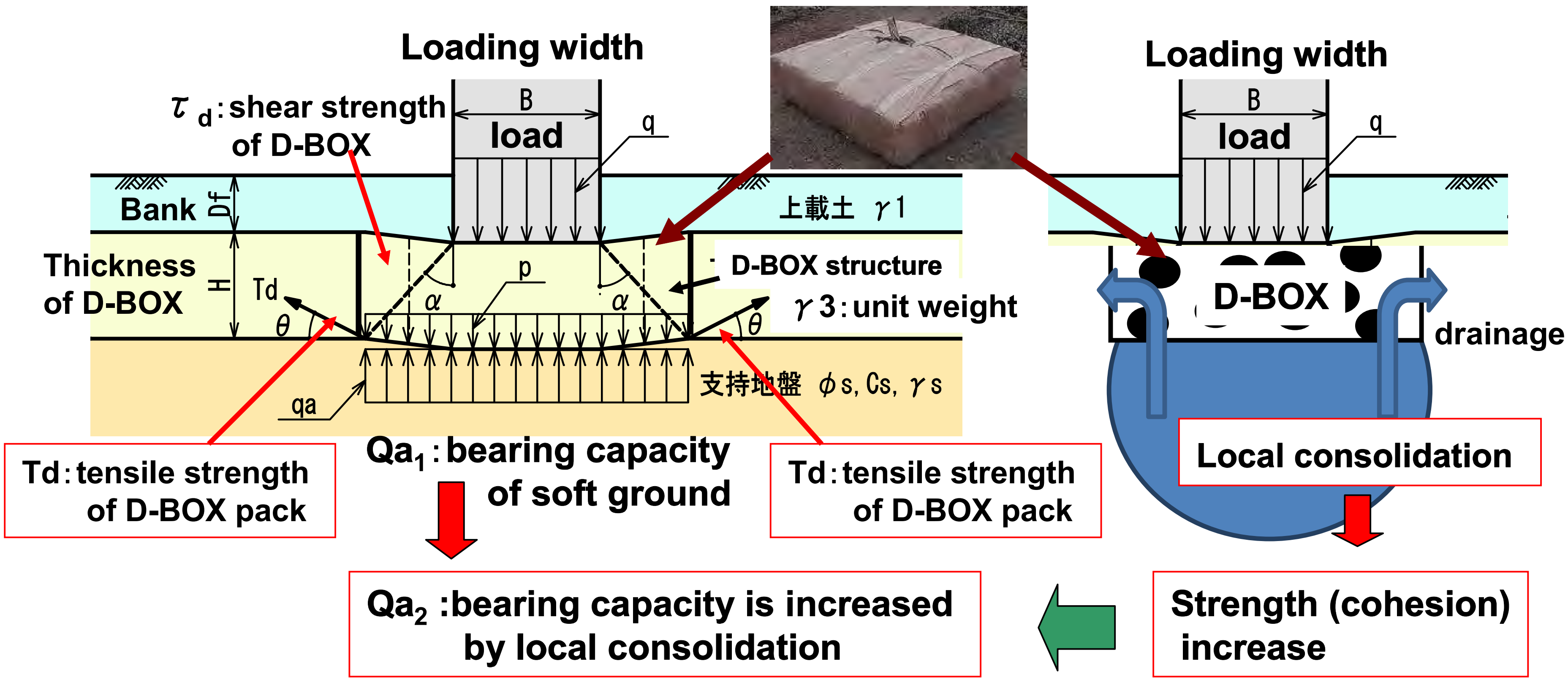


Proposal of Design Method of D･BOX Countermeasure Against the Soft Ground

Proposal of design method

・$(Qa_2 - \gamma_3 \cdot H) \times (B + 2H \cdot \tan\alpha) + \tau d + 2T_d \cdot \sin\theta \geqq q \times B$

⇒Verifying proposal of design method of D-BOX by field test !




Thank you so much
for your kind attention!

p1

p2

Where to use D-BOX?

November 2013

Pacific Consultants Hiroshi Shimada

Ⅰ Recommended Place of D-Box to use

Place

1:Road
- ・Base course or sub base on the soft ground

2:Bridge
- ・For the gap between bridge and road

3:Retaining wall/Dike or slope protection

4:Underground buried structure

5:Building foundation

6:Temporary road

Effect

①Increasing of Bearing capacity

②Prevention of liquefaction

③High water permeability and drainage function

④Reduction of machinery and traffic vibration influence

1

Ⅱ Where and How to use D.･BOX

Condition of existing ground in Myanmar

1)Soft ground
2) Waterway under ground
3)Liquefaction
4)Quake
5) Traffic vibration
6)Subsidence (consolidation)
7)Slope or Land sliding
8)Mud Squeezed
9)Boiling area

Structures to be constructed

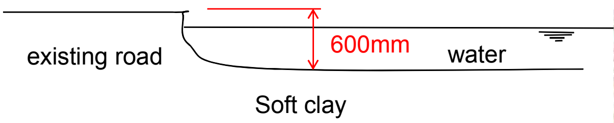
- Road
- Rail way
- Building
- River slope protection
- Port Jetty & embankment
- Drainage utilities

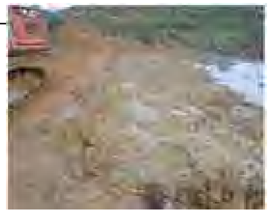
2

Ⅱ—1 Temporary road on the swamp area (soft ground)

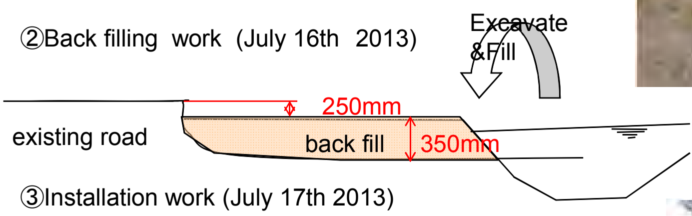
D-BOX Experiment construction at Kalimantan Indonesia

①Existing condition (July 16th 2013)

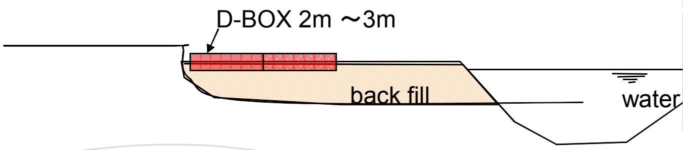




②Back filling work (July 16th 2013)



③Installation work (July 17th 2013)



3

Existing condition before installation of temporary road

[redacted]

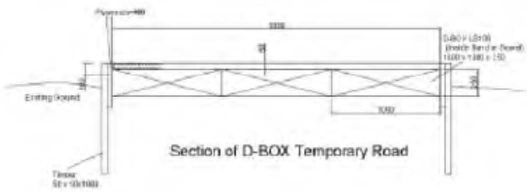
4

②Back filling work (July 16th 2013)
Using soft clay to adjust the elevation

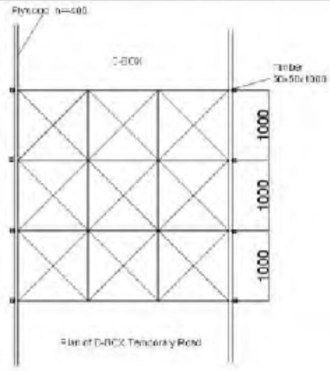
5

Installation of D-BOX (breath 2.0m:1m × 2)

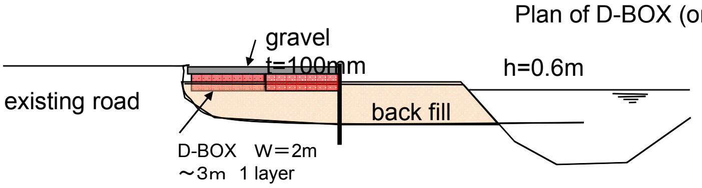
Plan and actual condition of D-BOX



Section of D-BOX (original plan)



Plan of D-BOX (original plan)



Actual section of D･BOX

Gravel surface on the D-BOX (t=100mm)

8

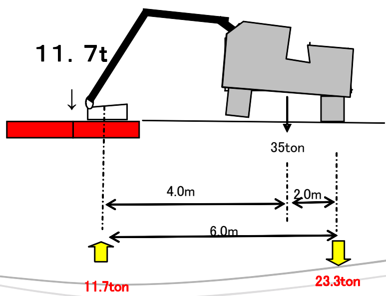
Estimated Counterforce with the backhoe pressure

3hours later

The bearing capacity is 11.7t/m^2

・Pressure with the backhoe is estimated about 11.7ton to one D-BOX(1.0m^2)

That means 11.7ton/m^2 bearing capacity is guaranteed



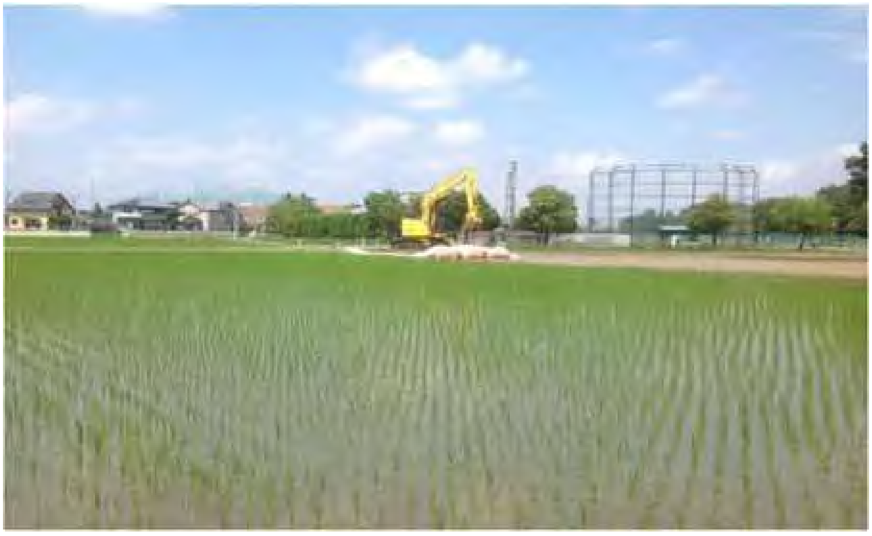
9

Use as temporary road for the vehicle after 3.5 month

10

Completion of D-BOX installation work(July 18th 2013)

Temporary road on the very soft ground of rice field



12

Steel sheet plates were installed on D.･BOX in order to prevent damage from a heavy equipment

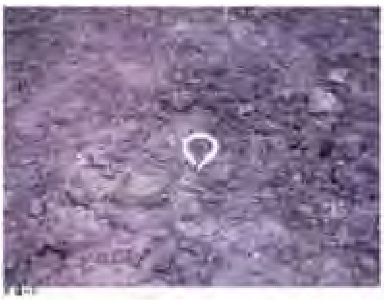
13

Ⅱ—2 Foundation of Culvert Box on soft ground

1）existing ground condition

N=0

Clay depth 4m



N value =0 (very soft)

A sheet is required in order to walk.

14

Ⅱ—2 Foundation of Culvert Box on soft ground

2) Installation of D.･BOX for the foundation of Culvert Box

15

Ⅱ—2 Foundation of Culvert Box on soft ground

3）Cast base concrete on D.･BOX　directly

Base Concrete (casted a day after installed D-Box)

16

Ⅱ—2 Foundation of Culvert Box on soft ground

4）Installation of Culvert Box

Installation of the culvert box /settlement of five months after is 3 mm-5mm only

There is no subsequent subsidence as of now.

17

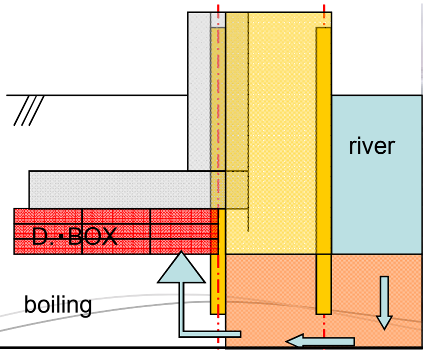
Ⅱ—3 Foundation of retaining wall on boiling ground

1) Phenomenon is the same as liquefaction.

①ground condition of L type retaining wall is to be liquefied easily (boiling phenomenon)

②water gushes shortly after excavating,･

③Four(4)layers of D-BOX-LS100 were required to the foundation



Ⅱ—3 Foundation of retaining wall on boiling ground

2) condition of the site

Ⅱ—3 Foundation of retaining wall on boiling ground

L type of Retaining wall with width 4m,heigt5m

Ⅱ—3 Foundation of retaining wall on boiling ground

Before excavation ,Water is oozed out.

Ⅱ—3 Foundation of retaining wall on boiling ground

3）Prevention of liquefaction

If it excavates, a lot of water will blow off immediately (boiling), and a construction site was in a riddled condition.

Ⅱ—3 Foundation of retaining wall on boiling ground

3）Prevention of liquefaction

Since the foundation after digging was not able to stand for a worker, either, the heavy machine constructed D-BOX directly, but the first step of D-BOX will sink completely. (One step of D-BOX was insttaled also at a worker's feet)

Ⅱ—3 Foundation of retaining wall on boiling ground

3）Prevention of liquefaction

When it became the 3rd step, even if the clear Increase of value in a hardness could be felt and it applied the pressure to D-BOX using the arm of back hoe(30t),。

24

Ⅱ—3 Foundation of retaining wall on boiling ground

2）Prevention of liquefaction

To excavate some area for small backhoe is put on D.・BOX

It took about 5-hours to install 60 Bags including the opposite side

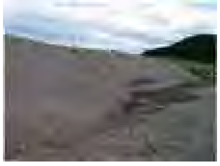
25

Ⅲ Demonstration work of D.・BOX (November 6th ～8 th ,2013 at Bogaly)

3 demonstration work with D.・BOX

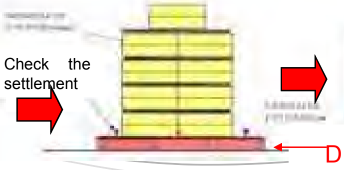
①Temporary Road on soft ground

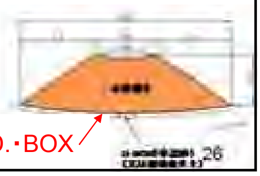
②Slope protection work



③ Load test of D.・BOX（check the settlement) and soil exploration

Gap 1m





26

Ⅲ Demonstration work of D・BOX (November7th～ 2013)

LOCATION Near Bogalay Yeyarwady

27

Existing condition of the site

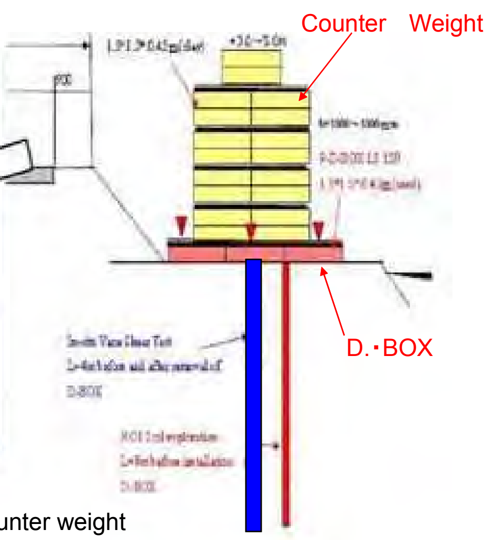
28

Ⅲ Demonstration work of D･BOX

9

Slope　Protection

Ⅲ　Demonstration work of D･BOX



Load test of D.･BOX　3～5m counter weight

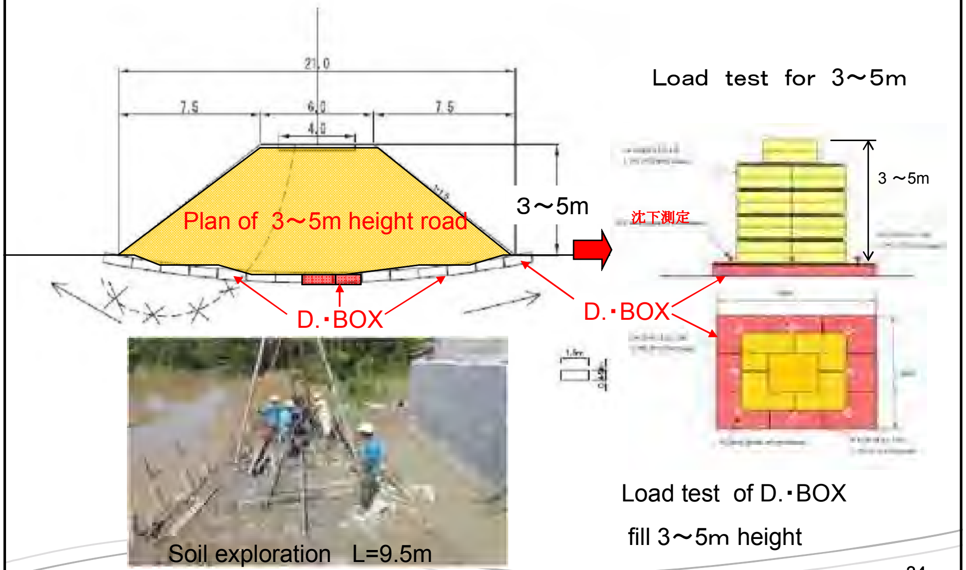
31

Experiment of Temporary Road (Stage)

[redacted]

D.･BOX are installed without heavy equipment due to no access

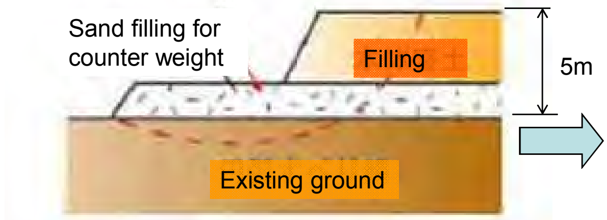
Ⅲ Demonstration work of D･BOX



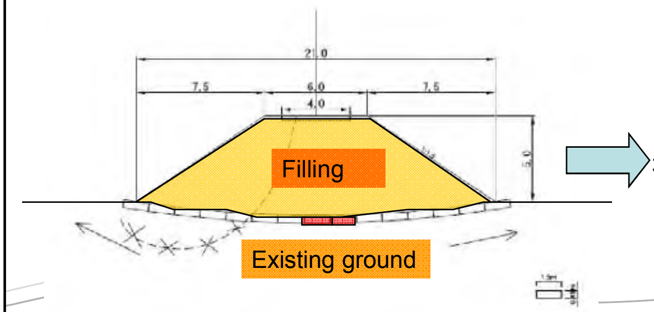
34

Foundation of D.･BOX LS 150 with sand for loading of counter weight 3～5m

Comparison of construction cost (rough estimate reference only)



1) Construction cost
2) Maintenance cost ×20years
3) Total cost for 20years →



1)Construction cost
2)Maintenance cost ×20years=
3)Total cost for 20years →

ありがとうございました。 Arigato

Patent


PATENT CAUTION

SHAPE-RETENTION-TYPE HOISTING RECTANGULAR PARALLELEPIPED BAG

Dated. September 3, 2013

Trade Mark


TRADE MARK CAUTION

D • Box

Dated. September 3, 2013

Trade Mark


TRADE MARK CAUTION

Metry

D・BOX Seminar Questionnaire

(D・BOX Seminar နှင့် ပတ်သက်သော မေးခွန်းများ)

~Issues to be tackled on Soft Ground~

Thank you for joining the D・BOX seminar. We would like to ask you several questions about the soft ground issue. Thank you for your cooperation.

D・BOX Seminar သို့လာရောက်ခြင်းအတွက် အထူးကျေးဇူးတင်ရှိပါသည်။ ကျွန်တော်များအနေဖြင့် နွံ့မြေပျော့ (soft ground) နှင့်ပတ်သက်၍ သိလိုသည်များကို လူကြီးမင်းထံမေးမြန်းလိုပါသည်။ ကူညီဖြေကြားပေးခြင်းအတွက် ကျေးဇူးတင်ပါသည်။

Questions about Demand (Road, Port, Railway, Industrial Estate, Residential Area)

လုပ်ငန်းလိုအပ်ချက် မေးခွန်းများ (လမ်း၊ ဆိပ်ခံတံတား၊ မီးရထားလမ်း၊ စက်မှုဇုန်များ၊ လူနေအိမ်ယာများ)

➢ Q1: What kind of and where problems are there? (သင် မည်သည့်ပြဿနာများကို ကြုံတွေ့နေရပါသနည်း။)

☐Subsidence (မြေကျွံခြင်း) ☐Vibration (တုန်ခါခြင်း) ☐Swamps in rainy season (မိုးရာသီနွံ့မြေပျော့များ)

☐Landslide at embankment (မြေဘောင်၊ တာဘောင်များ ပြိုကျခြင်း)

☐Others (အခြား) (   )   Location (နေရာ) (   )

➢ Q2: Scale of damages with soft ground issue (Frequency, Relief Cost, Damage)

မြေပျော့ (soft ground) ကြောင့်ဖြစ်ပေါ်သောပျက်စီးမှုများ (ဖြစ်ပေါ်မှု ကြိမ်နှုန်း၊ ကယ်ဆယ်ရေး ကုန်ကျစရိတ်၊ အပျက်အစီးများ)

(   )

➢ Q3: Is there any Site and Project which you would like to apply D・BOX method?

သင် ပါဝင်ပတ်သက်နေသည့် မည်သည့်လုပ်ငန်းခွင် သို့မဟုတ် မည်သည့်စီမံကိန်းများ တွင် D・BOX method ကိုအသုံးပြု လိုပါသနည်း။

(   )

➢ Q4: Would you like to have an independent meeting with D・BOX team?

သင့်အနေဖြင့် D・BOX Team နှင့် သီးသန့်ဆွေးနွေးလိုပါသလား။

☐Yes (ဆွေးနွေးလိုပါသည်) ☐No (မဆွေးနွေးလိုပါ)

Questions about Current countermeasure against the soft ground (Cost, Efficiency, Problems)

မြေပျော့ (soft ground) ပြုပြင်ခြင်းနှင့် ပတ်သက်သော မေးခွန်းများ (ကုန်ကျစရိတ်၊ ထိရောက်မှု၊ ပြဿနာများ)

➢ Q5: What kind of countermeasure against soft ground do you currently apply?

မြေပျော့ (soft ground) များ ပြုပြင်ရန်အတွက် သင် မည်သည့်နည်းလမ်းကို လက်ရှိအသုံးပြု နေပါသနည်း။

(   )

➢ Q6: What is the point of issue of current countermeasure against soft ground?

မြေပျော့ (soft ground) များ ပြုပြင်ရန် အတွက် မည်သည့်အချက်သည် အဓိကကျပါသနည်း။

(   )

➢ Q7: How much is the annual cost for the countermeasure against soft ground?

မြေပျော့ (soft ground) များ ပြုပြင်ရန်အတွက် နှစ်စဉ်ကုန်ကျစရိတ်မည်မျှ ရှိပါမည်နည်း။

(   )

Answered by (ဖြေဆိုသူ) :

Name (အမည်) :	
Position and rank (ရာထူး)	
E-mail	
Phone No. (ဖုန်းနံပါတ်)	
Company (ကုမ္ပဏီ) :	
Type of industry of your company (သင်၏ ကုမ္ပဏီအမျိုးအစား)	

【Free opinion regarding D.・BOX:】(D・BOX နှင့် ပတ်သက်သော သင်၏အမြင် များ)

Thank you for your cooperation.

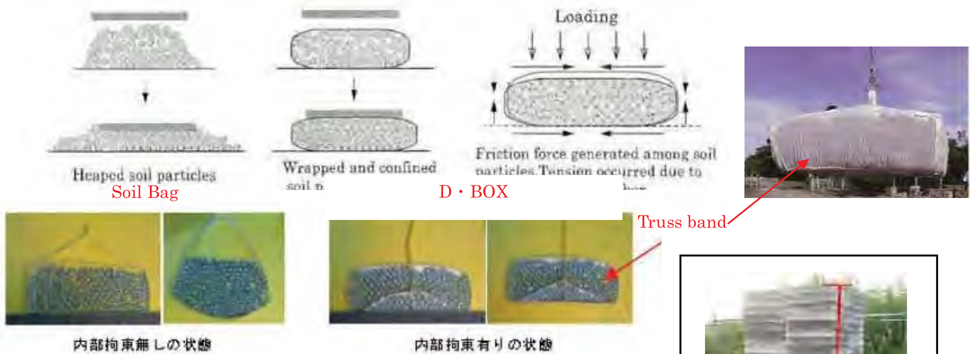
(ကျေးဇူးတင်ပါသည်)

What is D・BOX Method ?

D・BOX is a product which is developed by Mr. Futoshi NOMOTO of Metry Technical Institute, based upon the theory, merits and performance of the Soil-Bag(do-nou in Japanese) method invented by Prof. Emeritus Hajime MATSUOKA of Civil Engineering, Nagoya Institute of Technology, Japan. Therefore, the inventors of the D・BOX method are Hajime MATSUOKA and Futoshi NOMOTO.

4 amazing effects like "magic"

1) Extremely high bearing load: D・BOX can hold the weight of 1,100kN/m^2 to 1,900kN/m^2. This means D・BOX will not break even if it is placed under the basement of a skyscraper of 60 to 100 floors. We have the theoretical reason and the experimental results to prove this.



2) Soft clay soil becomes compact and strong with D・BOX:

D・BOX with sand and gravel causes the "local consolidation" in a very soft ground, such as a marsh, making the soft ground compact and strong. Using our method, the soft ground beneath D・BOX is able to support a building and a road. D・BOX consisting of sand and gravel acts as a permeable layer bringing about "local consolidation" in the surrounding earth.

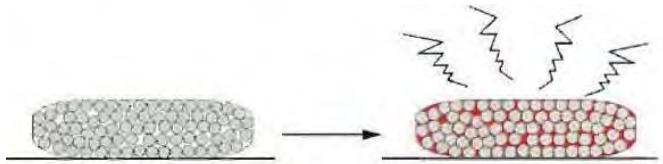
Figure of "pressure bulb" under permeable do-nou

"Local consolidation and strengthening" by permeable D・BOX

D・BOX with permeable materials such as sand and gravel has the feature to pass water easily, but not soil. The more the water passes, the more the clay becomes compact, and the soft clay ground under D・BOX grows more and more solid and strong.

Metry Technical Institute

3) High quality of vibration reduction:
D・BOX absorbs a high degree of traffic vibration, machine vibration and earthquake movement (5~15dB reduction by the vibration level). This is because vibration energy is dissipated as frictional heat energy between particles due to little flexibility within the D・BOX. It is able to function as an apparatus for high vibration reduction in a wide range of scenarios.



4) Prevention of the frost heave in a cold district: D・BOX consisting of coarse granular materials such as sand and gravel are able to prevent capillary rise of water and thus can prevent frost heave in areas subject to cold weather conditions.

**The material (Polyethylene or Polypropylene) for D・BOX is susceptible to degradation from sunshine (ultraviolet ray). It is a vital that D・BOX should be covered with soil or a light-tight sheet whenever they are employed.*

Prof. Hajime MATSUOKA
E-mail:hajime.matsuoka@md.ccnw.ne.jp
URL: http://www.soilbag.com/

Mr. Futoshi NOMOTO
Metry Technical Institute
E-mail:info@metry.jp
URL:http://www.metry.jp/

添付資料_005_第二回現地調査_セミナー③

D・BOX Seminar

Date: December 7, 2013 Saturday 13:30-15:00
Venue: MES in Yangon

---------------------------------- Program ----------------------------------

1. Opening remarks
   (Prof. Win Naing Htun, CIVIL SOLUTION CONSULTANTS LTD.)

2. Introduction of the D・BOX &
   Introduction of the demonstrational construction in Ayawardy Region
   ～Introduction of the D・BOX by Video
   ～Demonstrational construction
   ～Local production of D・BOX
   (Mr. Futoshi NOMOTO, Metry Technology Institute Co., Ltd.)

3. Coffee break: 15 minutes

4. D・BOX effect to the soft ground at the demonstrational construction
   (Mr. Hiroshi SHIMADA, Pacific Consultants Co., Ltd.)
   ～Ground situation & Settlement
   ～D・BOX Effect
   ～Comparison between D・BOX method and current methods

5. Technical Intern Training in Japan
   (Mr. Fujito MAEDA, Maedagiken Kougyou Co., Ltd.)

6. Questionnaires

7. Closing remarks
   (Myanmar Engineering Society)

Metry® DBox®

Metry Technical Instiute

DBox−LS100/LS150

D・BOX−LSの形状　左は閉口時（中詰材未投入）、右が上部を開口した状態（LS100）

D・BOX−LSシリーズ（吊上げ設置タイプ）　　＊中詰材：C・RC30-0　C・RC40-0推奨

製　品	施工寸法	備　考
D・BOX−LS100	W1000×D1000×ｈ250	中詰材の投入容量　0.25m3
D・BOX−LS150	W1500×D1500×ｈ450	中詰材の投入容量　1.0m3

DBox−SS45/SS90

SS45（上段右写真）　SS90（上段左写真）
内部にガイドゲージがセットされた様子

D・BOXのパーツ写真（下段左写真の左から）
ガイドゲージ、ピンロック、ロックジョイント

D・BOX−SSシリーズ（連結タイプ）　　＊中詰材：C・RC30-0　C・RC40-0推奨

製　品	施工寸法	備　考
D・BOX−SS45	W450×D450×ｈ80	中詰材の投入容量　0.0162m3
D・BOX−SS90	W900×D900×ｈ80	中詰材の投入容量　0.0648m3

Major merits of the **D-Box**

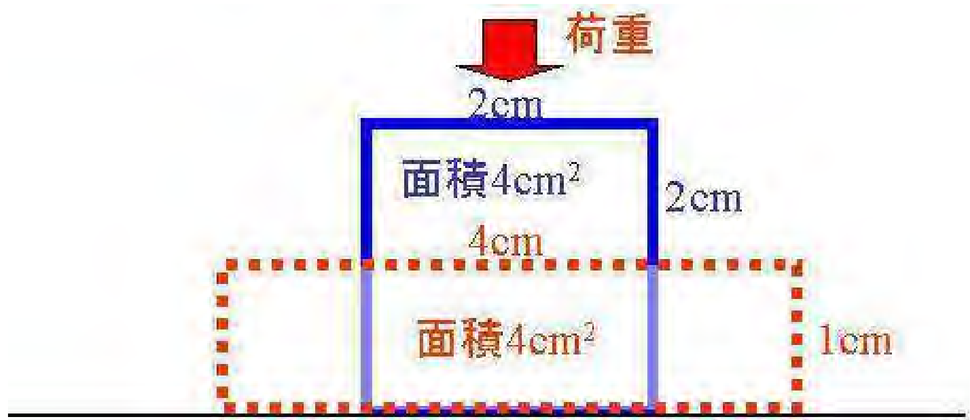
1) Reinforcement of ground condition
(Soft clay can be improved by this method.)

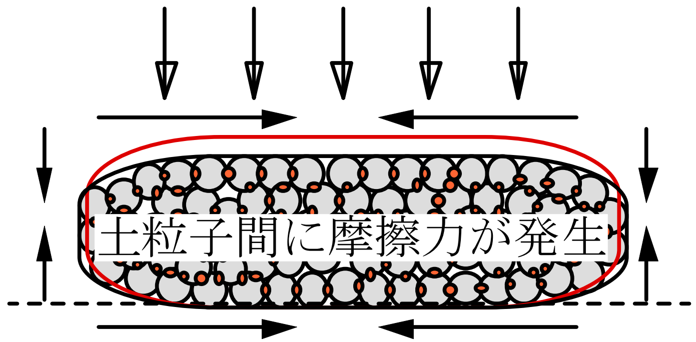
2) Reduction of machinery and traffic vibration influence

3) Reduction of seismic impacts

4) Prevention of liquefaction

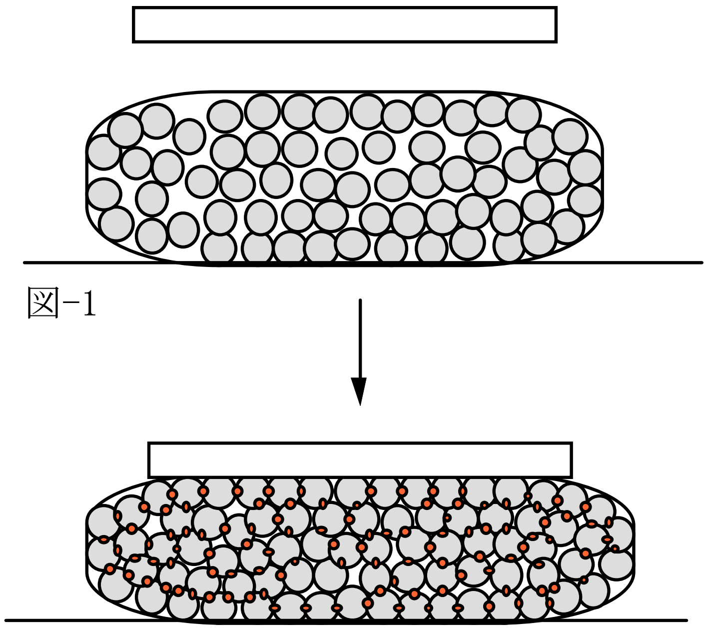
5) Prevention of freezing



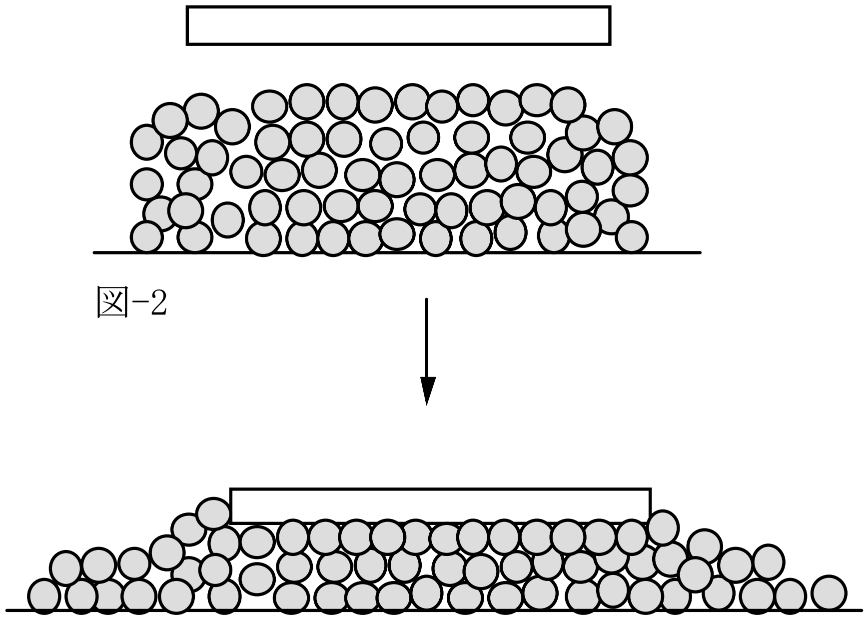


袋が伸びるため張力が発生

This method was analyzed and advanced by Emeritus Prof. Matsuoka of Aichi Institute ofTechnology, and indicates that perfect confinement of particles can increase strength, owingto internal frictional energy to be generated among the particles.



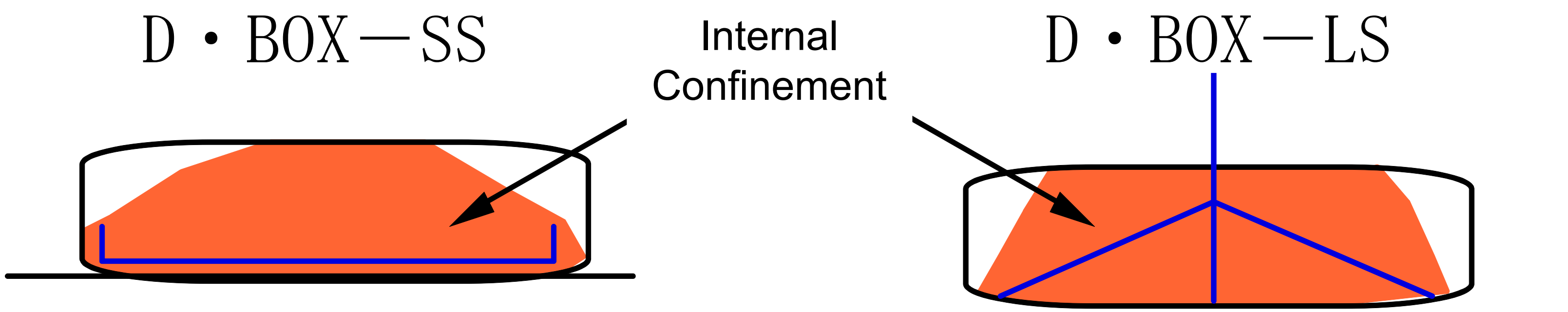
図−1



図−2

Binding force effects in inside of the D-box

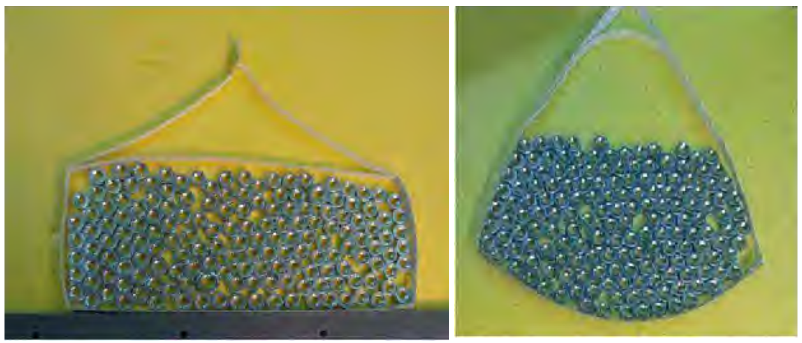
Apparatus for confinement are fixed inside of every box, in order to increase its efficiency, and to develop its reduction effects against vibration influence as well as to realize its strength against point load.



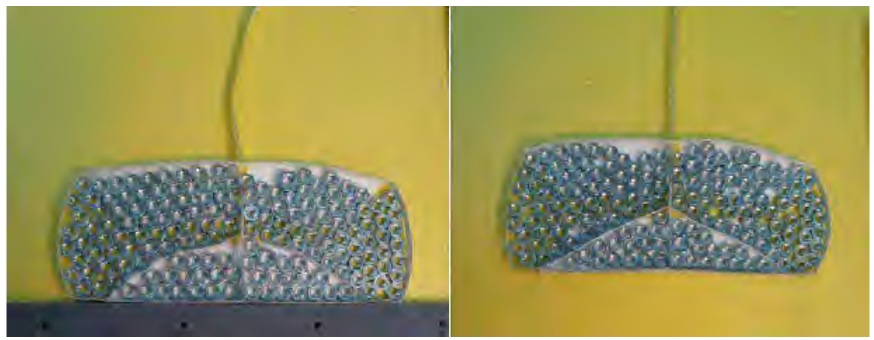
Internal Confinement with Guide gage

Internal Confinement with Truss band

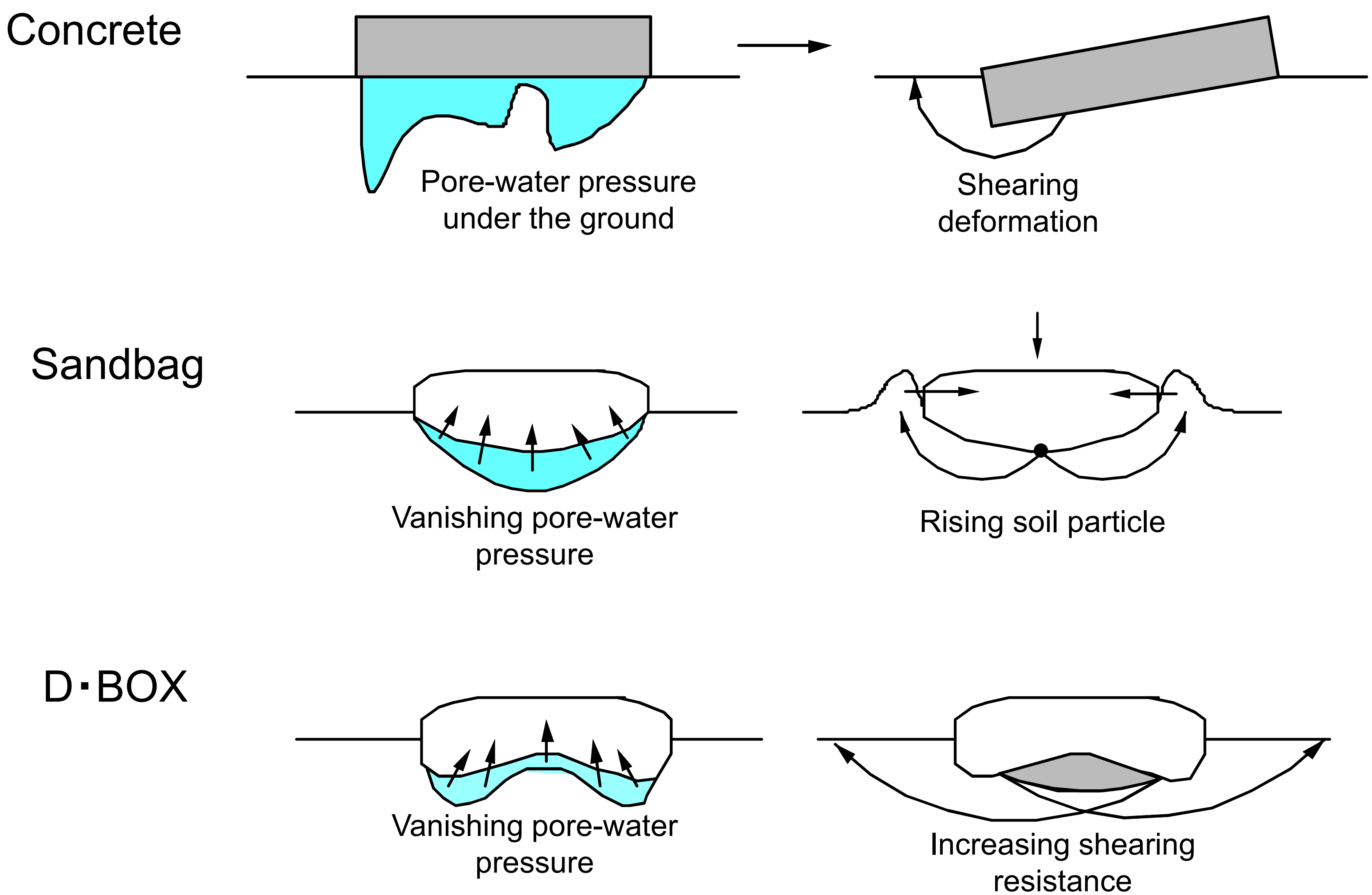
Without internal confinement



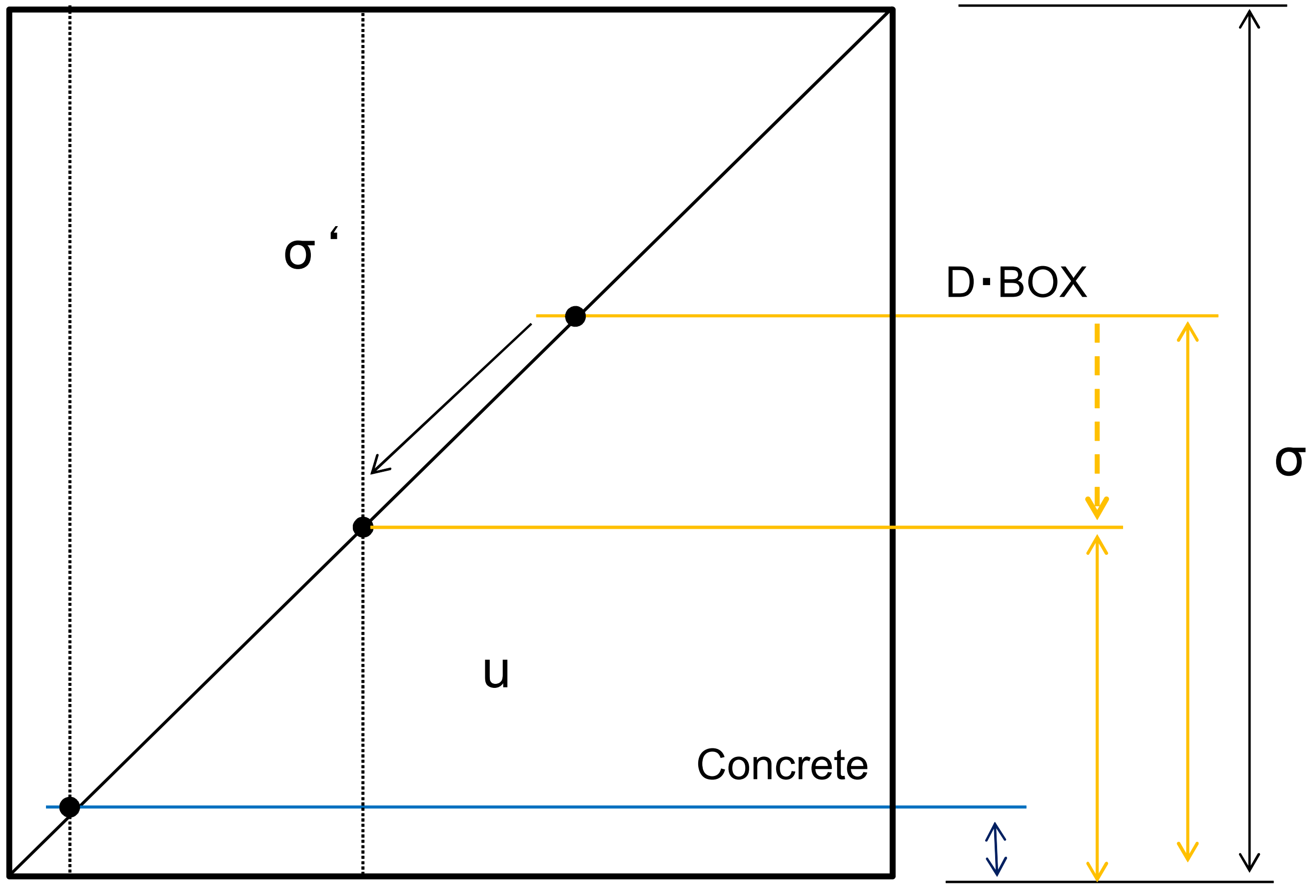
With internal confinement



D･BOX：Structure of subsidence control



$\sigma = \sigma' + u$



Slope protection

添付資料005-12

Temporary load for backhoe

Cannot land the back-ho directly to the soft ground.


Tried to land the back-ho with using general soil bag and plywood,
However, the back-ho sunk when it landed 1/3 of its body.

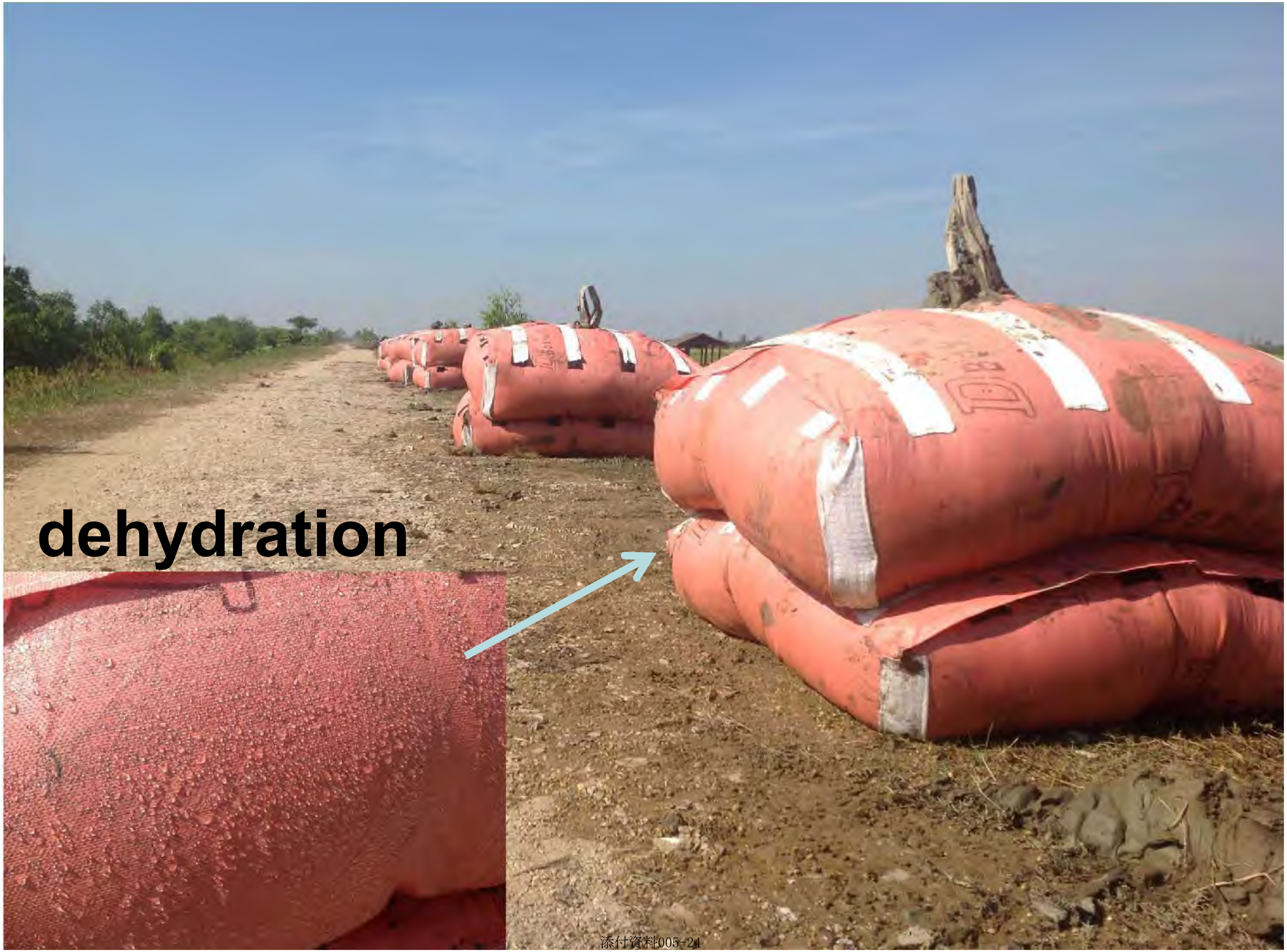

Install D･BOX by man-power without using back-ho


Set the plywood on the D・BOX.
The weight of back-ho would be loaded equal to each D・BOX.
DBOX


Landed back-ho

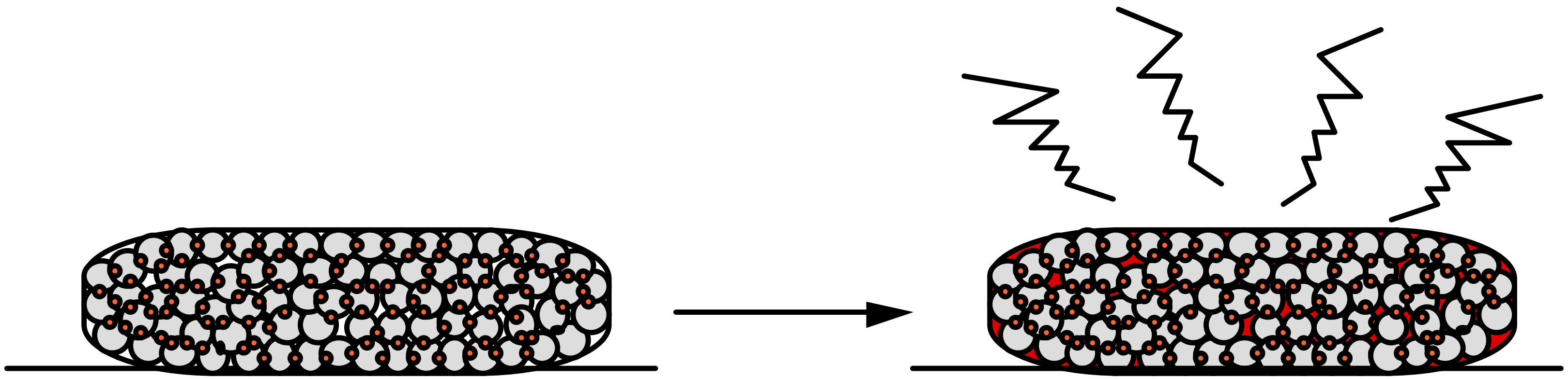

1F-015/NG-09
SE
210


Load test


dehydration

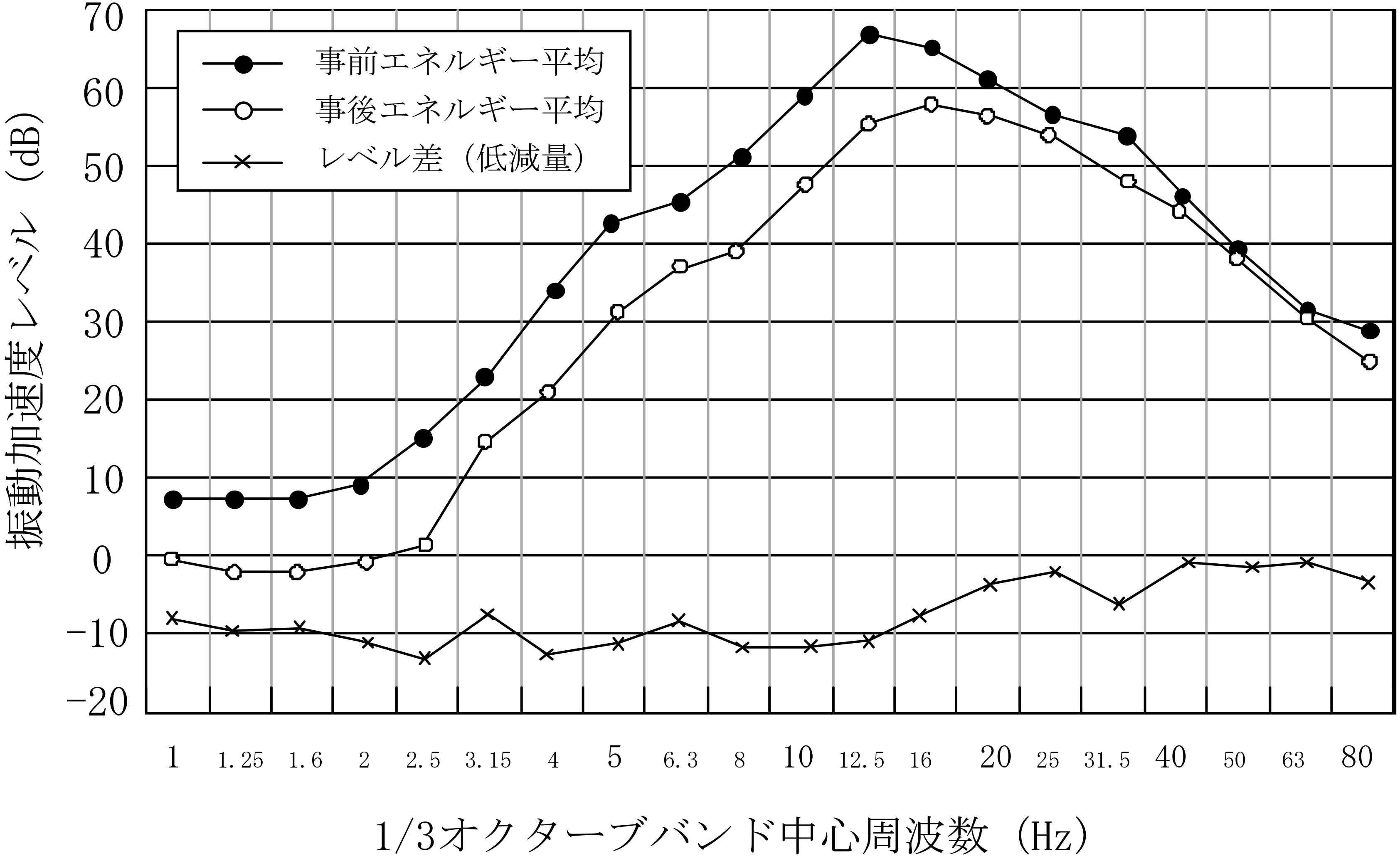

D BOX
Metry
http://www.metry.jp

Mechanism to reduce vibration of D･BOX



In case of vibration coming from outside, slight deformation will occur to the box. The soil particles contained inside may apt to move around, and consequently it brings further friction energy. Therefore, the D-Box is reducing and weakening vibration influence by introducing outside vibration energy into friction energy inside.

Shiga Prefecture　Foundation reinforcement and an oscillating measure



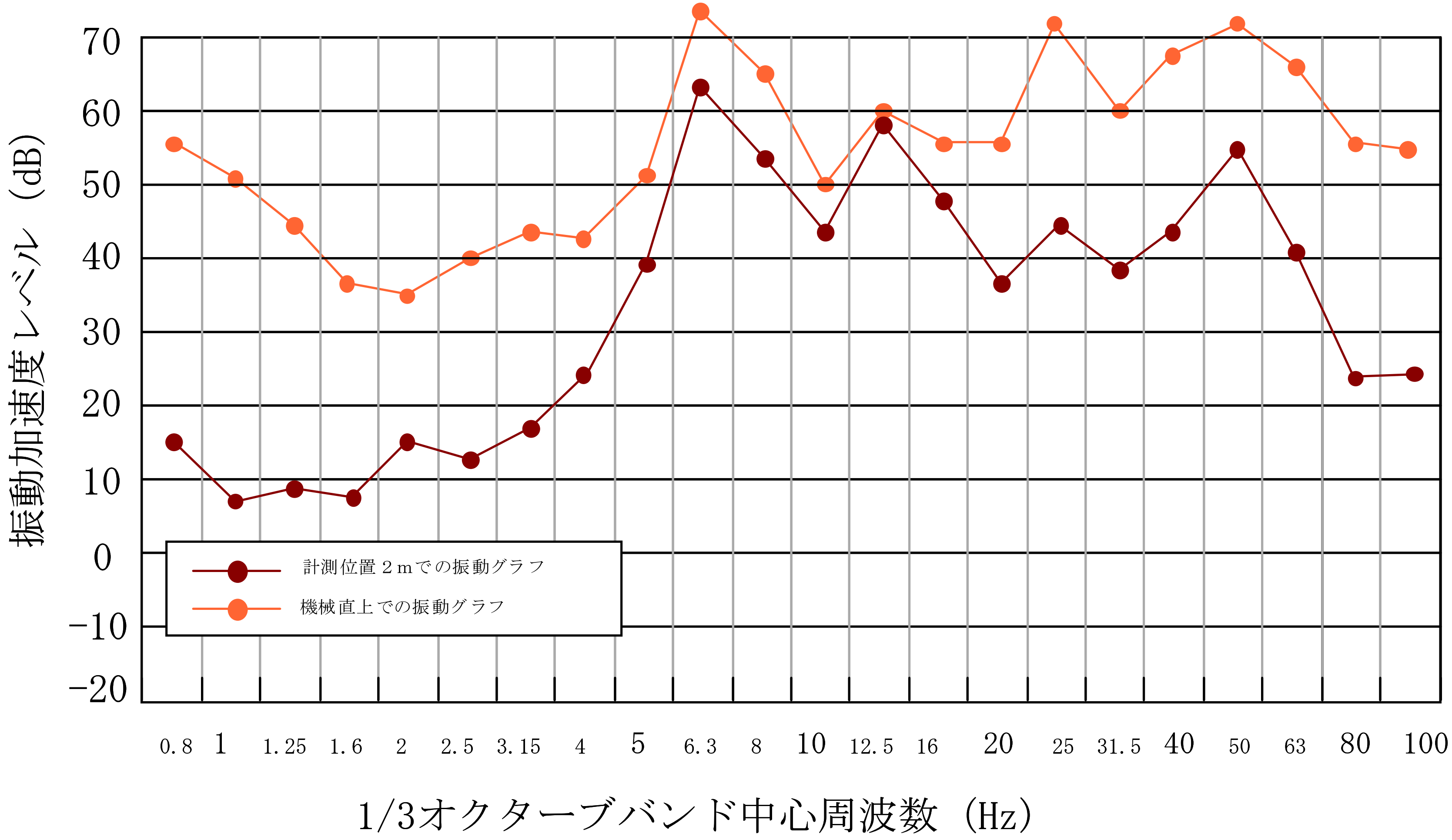
事前と事後における振動加速度レベルの周波数特性の比較

資料：東海技術センター

Reduction of machine vibration

A mechanical situation

The installation situation of D・BOX
D・BOX-LS100＋D・BOX-SS90



振動加速度レベル（dB）
70
60
50
40
30
20
10
0
−10
−20
0.8
1
1.25
1.6
2
2.5
3.15
4
5
6.3
8
10
12.5
16
20
25
31.5
40
50
63
80
100
1/3オクターブバンド中心周波数（Hz）
計測位置２mでの振動グラフ
機械直上での振動グラフ

Fukushima Prefecture

The situation after an earthquake

The situation of the grave constructed by D・BOX

D･BOX is used for reinforcement work of a bridge pier


2 layers of D･BOX-LS100

東部労働センターでの説明会

D･BOX－SS90

The situation of manufacture

A part of D･BOX is manufactured with a mentally handicapped person institution

Effect of BOX on the soft ground in Ayeyarwady (Bogalay)

December 7th 2013

Pacific Consultants　Hiroshi Shimada

D・BOX　Demonstration Experiment

1.Location

1)Location (Root No5:Bogalay to Kadonkani)

D･BOX Demonstration Experiment

2.Purpose of D･BOX Demonstration Experiment

1) Can **D･BOX** get enough bearing capacity on the soft ground using cheaper material(local sand or clay)?

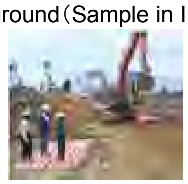
2) Can **D･BOX** be installed easily by local people without special equipment ?

3) Can D･BOX be used on the soft ground comparing with ordinary construction procedure cost on the soft ground?

D･BOX Demonstration Experiment

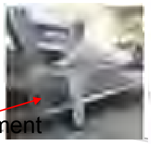
3 Demonstration work with D.･BOX (Image) Nov 6～13 th ,2013 at Bogalay

①Temporary Road on soft ground（Sample in Indonesia)

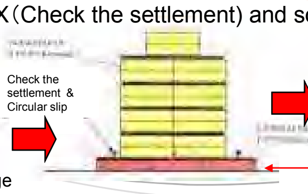


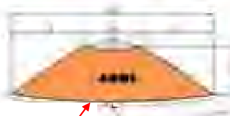

②Slope protection work (Sample in Japanese river dike)


③ Loading test of D.･BOX（Check the settlement) and soil exploration

Bayint Naung Bridge





D・BOX Demonstration Experiment

4.Temporary Road (stage) for a Back-hoe

4-1 Demonstration of temporary stage for a back-hoe

①Back hoe(27t) was requested to land on the very soft ground site from the river

② 6 D・BOX were Installed for temporary stage of Back-hoe by man power only

③Back-hoe was able to land on the soft clay at Kyon Sein bridge using D・BOX

D・BOX Demonstration Experiment

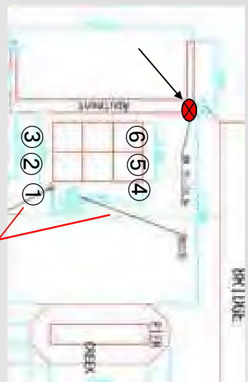
4-2 Settlement of the stage by a back-hoe(27t)

Settlement of the temporary stage for Back-hoe

point	9 nov	10 nov(am)	10 nov(pm)	11 nov(pm)	12 nov(am)	Settlement Total(m)
1	97.588	97.583	97.345	97.340	97.302	0.286
2	97.699	97.696	97.587	97.584	97.569	0.130
3	97.592	97.602	97.473	97.477	97.450	0.142
4	97.797	97.757	97.585	97.538	97.508	0.289
5	97.831	97.805	97.776	97.772	97.757	0.073
6	97.879	97.827	97.822	97.750	97.750	0.129

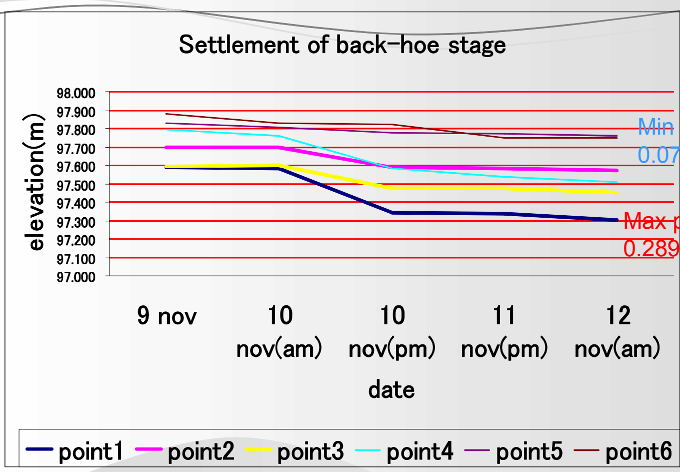
Set BM as EL+100. 0m(for settlement survey only)

BM EL+100. 0m



D･BOX Demonstration Experiment

4-3 Settlement of the back-hoe stage



Settlement became very small on the 3rd day

D･BOX Demonstration Experiment

4－4 Removal of the back-hoe stage

D・BOX Demonstration Experiment

5 Slope protection Work

5-1 Site Conditions

D・BOX Demonstration Experiment

5 Slope protection Work

5-1 Site Conditions

SECTION of D・BOX SLOPE PROTECTION

D･BOX Demonstration Experiment

5 Slope protection Work

5-1 Site Conditions

Damaged shoulder every year

D･BOX Demonstration Experiment

5 Slope protection Work

5-2 Ordinary slope protection construction work

D･BOX　Demonstration Experiment

5 Slope protection Work

5-2 Ordinary slope protection construction work

Near the site 、ordinary method of slope protection

D･BOX　Demonstration Experiment

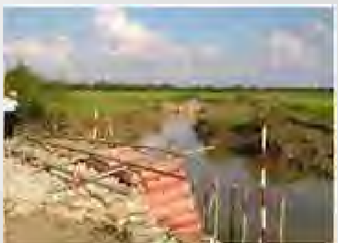
5 Slope protection Work

5-3 Construction of slope protection

①Damaged shoulder every year

②Basement of slope　LS150

③　Installation　of　LS-100 with　 sand



④　Completion of Slope by LS-100

D･BOX Demonstration Experiment

5-4 Survey points and covered with a sheet

Point of settlemen

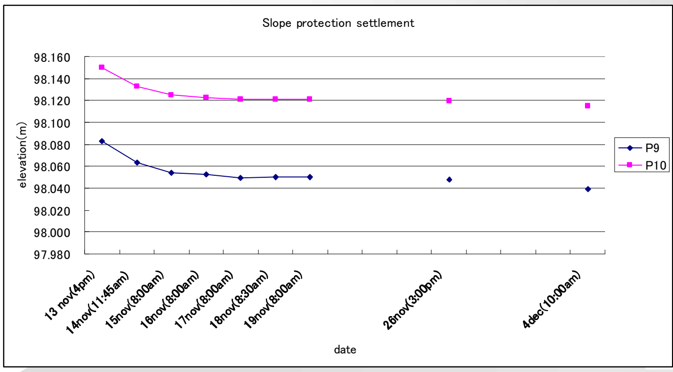
D･BOX is covered with blue sheet in order to protect from ultraviolet rays.

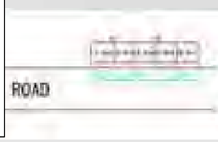
D･BOX Demonstration Experiment

5-5 Settlement of slope protection

Slope protection settlement(m)

	13 nov(4pm)	14nov(11:45am)	15nov(8:00am)	16nov(8:00am)	17nov(8:00am)	18nov(8:30am)	19nov(8:00am)	26nov(3:00pm)	4dec(10:00am)	total settlement
P9(slope)	98.083	98.063	98.054	98.052	98.049	98.051	98.050	98.048	98.039	0.044
P10(slope)	98.150	98.133	98.125	98.123	98.121	98.121	98.121	98.119	98.115	0.035

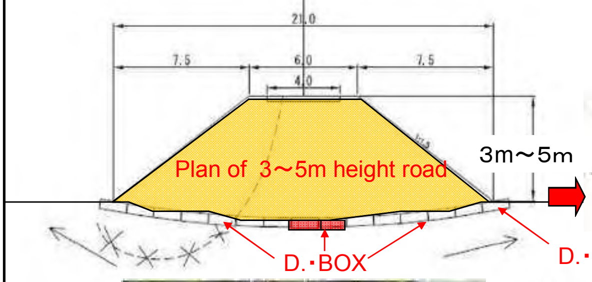




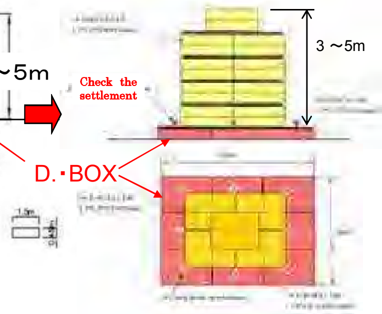
D･BOX Demonstration Experiment

6. LOADING TEST

(1) Plan of loading test



Load test for 3m



Soil exploration L=9.5m

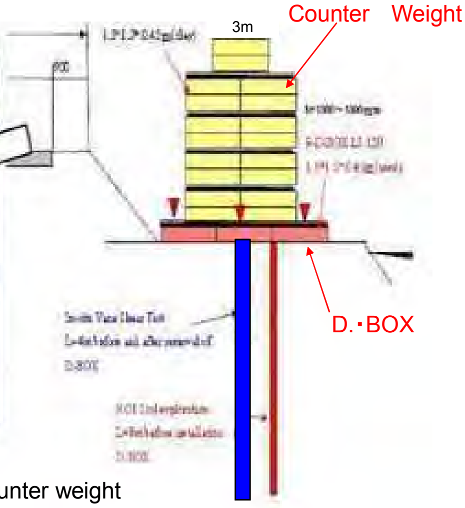
Load test of D.･BOX

accumulated on about 3 m

16

D･BOX Demonstration Experiment

6-2 Location of loading test



Load test of D.･BOX 3～5m counter weight

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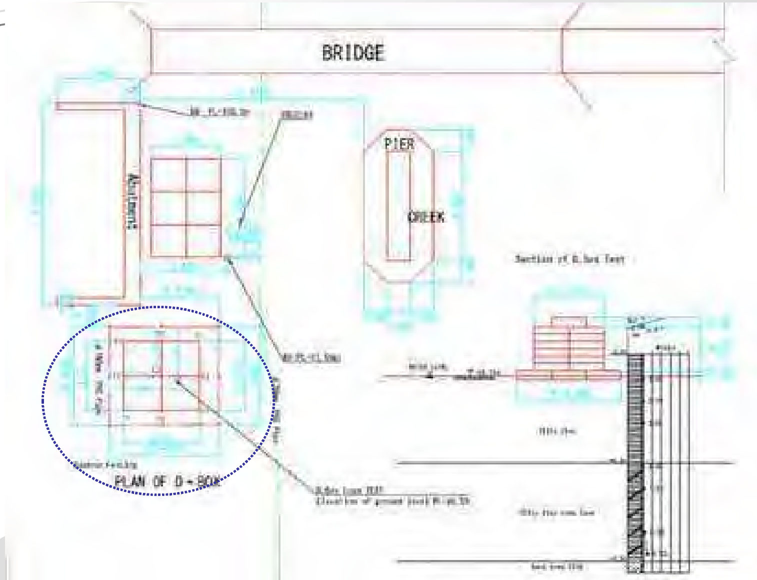
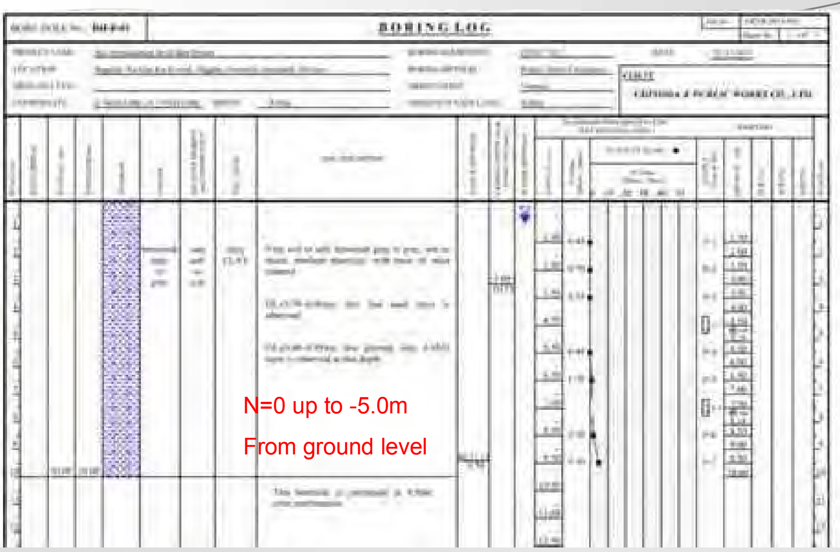
D・BOX Demonstration Experiment

Location of loading test



D・BOX Demonstration Experiment

6-3 Soil Exploration result



D･BOX　Demonstration Experiment

6-3 Check Shear stress (τ KN/m^2)　at the surface　of　the ground

τ＝1.8 KN/m（by　direct shear test)

D･BOX　Demonstration Experiment

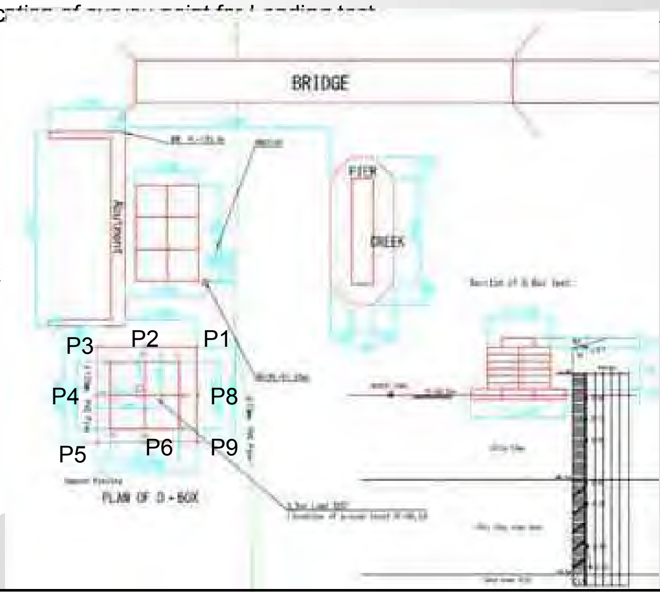
6-4 Location of Loading Test

Installation of　D.･BOX　for slope protection

D･BOX Demonstration Experiment

6-5 Loc

Check



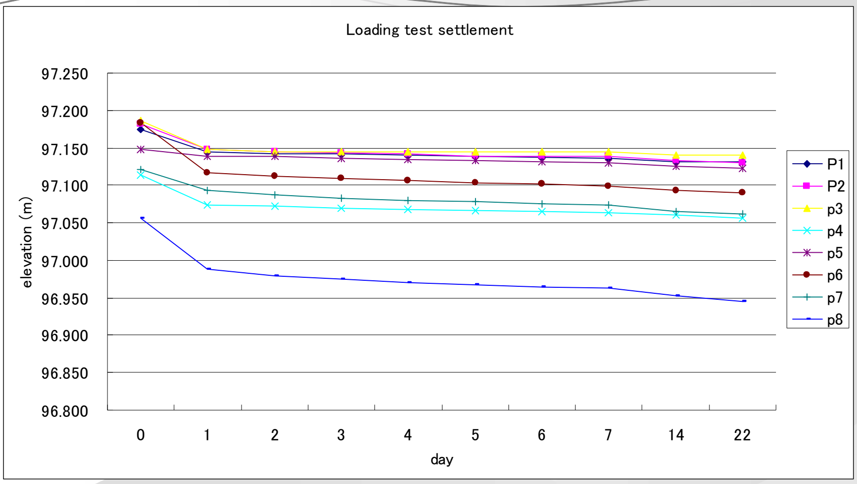
D･BOX Demonstration Experiment

6-6 Settlement of Loading Test

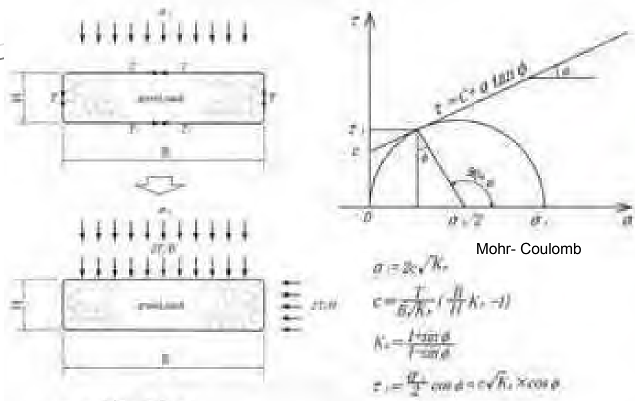
Settlement of Loading Test 2013.12.4

Date	12-Nov	13-Nov	14-Nov	15-Nov	16-Nov	17-Nov	18-Nov	19-Nov	26-Nov	4-Dec	total settlement
day	0	1	2	3	4	5	6	7	14	22	
P1	97.174	97.145	97.143	97.142	97.140	97.139	97.138	97.136	97.132	97.131	0.043
P2	97.183	97.149	97.145	97.143	97.141	97.140	97.140	97.138	97.133	97.130	0.052
P3	97.187	97.148	97.144	97.145	97.145	97.144	97.145	97.145	97.141	97.141	0.046
P4	97.114	97.073	97.072	97.070	97.067	97.066	97.065	97.064	97.060	97.056	0.058
P5	97.148	97.140	97.139	97.136	97.134	97.133	97.131	97.130	97.126	97.123	0.024
P6	97.183	97.117	97.112	97.109	97.106	97.104	97.102	97.099	97.093	97.090	0.093
P7	97.121	97.093	97.087	97.083	97.080	97.078	97.075	97.073	97.066	97.061	0.059
P8	97.057	96.988	96.979	96.975	96.971	96.967	96.964	96.963	96.952	96.946	0.111
Top PVC	98.478							99.387	99.377	99.368	0.019
						slope protect	kyone sein				
height of PVC pipe from base			2.320			slope protect	san maung				

D･BOX Demonstration Experiment



7.Calculation Method for Shear Strength of D･BOX



$$\sigma_1 + \frac{2T}{B} = \frac{2T}{H} \times K_P$$

$$\sigma_1 = \frac{2T}{H} K_P - \frac{2T}{B} = \frac{2T}{B}\left(\frac{B}{H} K_P - 1\right)$$

H : hight of D-Box

B : width of D-Box

T : tensile strength of pack

$$\sigma_1 = 2c\sqrt{K_P}$$

$$c = \frac{T}{B\sqrt{K_P}}\left(\frac{B}{H} K_P - 1\right)$$

$$K_P = \frac{1+\sin\phi}{1-\sin\phi}$$

$$\tau_1 = \frac{\sigma_1}{2}\cos\phi = c\sqrt{K_P} \times \cos\phi$$

σ : pricipal stress

τ : shear strength

c : cohesion

φ : internal friction angle

K_P: coefficient of passive earth pressure

D-BOX: LS150

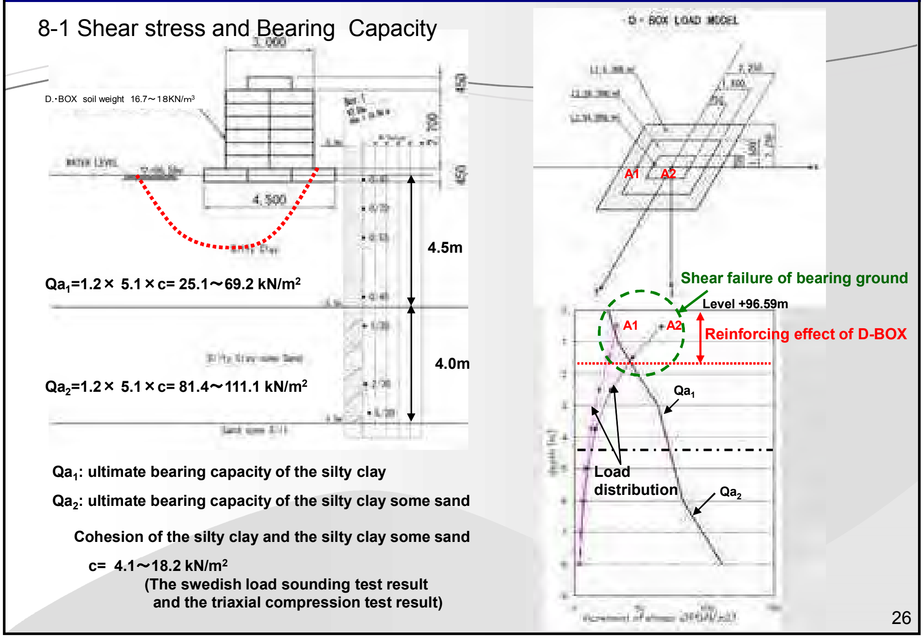
B=1.5m
H=0.45m
T= 37.8kN/m
Φ=30
c= 129kN/m²
Kp= 3.0
σ_1=446.9kN/m²
τ_1=193.5kN/m²

D･BOX shearing strength;193.5KN/m²

25

8.Reinforcing Effect of D･BOX : Bearing Capacity

8-1 Shear stress and Bearing Capacity



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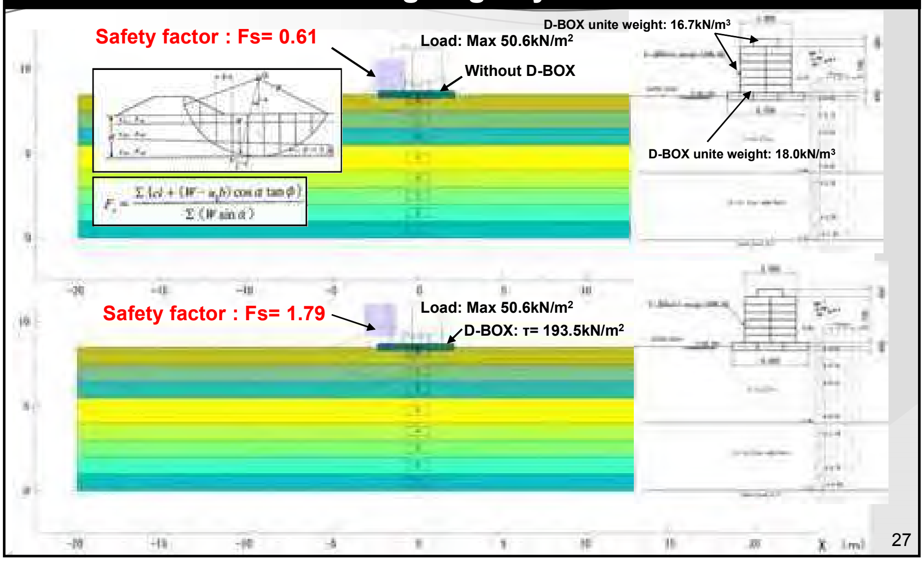
Reinforcing Effect of D･BOX : Bearing Capacity

8-2 Design calculation model of bearing capacity
Circular arc method : High rigidity effect of D-BOX



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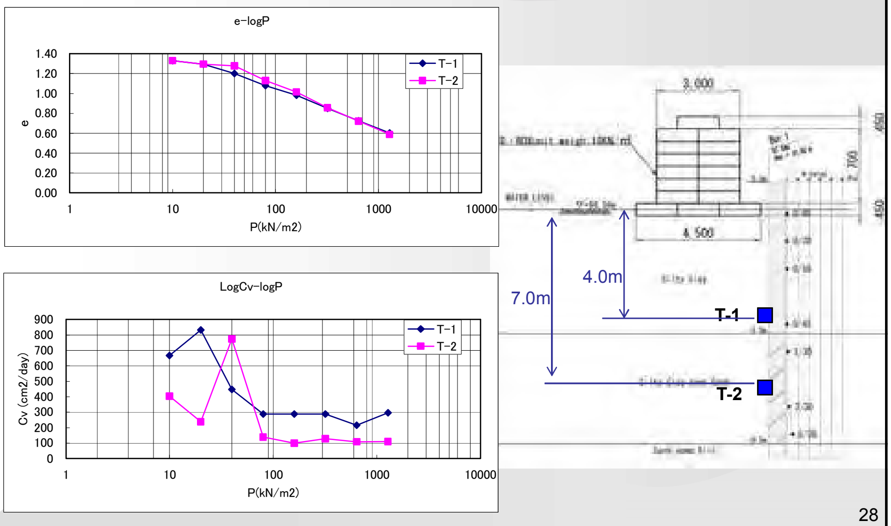
Reinforcing Effect of D･BOX :
8-3Reduction of Consolidation Settlement

(1) Consolidation test result



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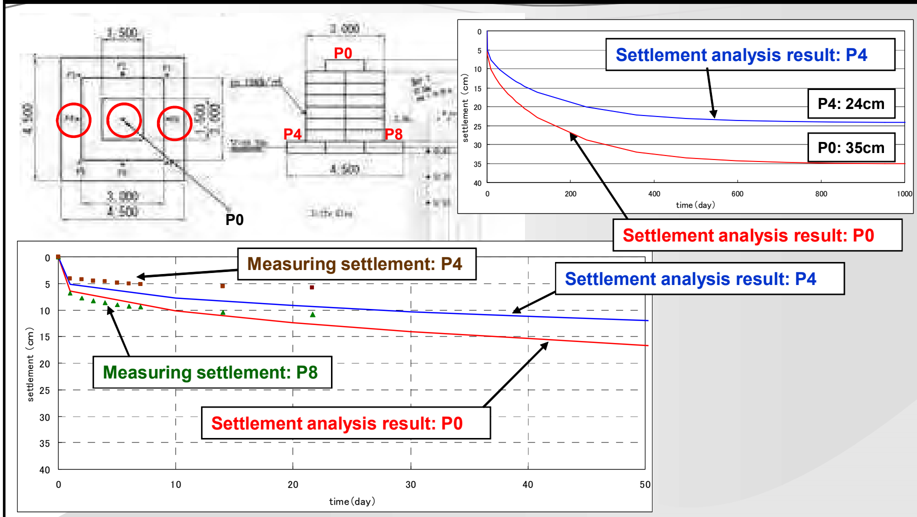
Reinforcing Effect of D･BOX : Reduction of Consolidation Settlement

(2)Consolidation settlement (tentative) analysis



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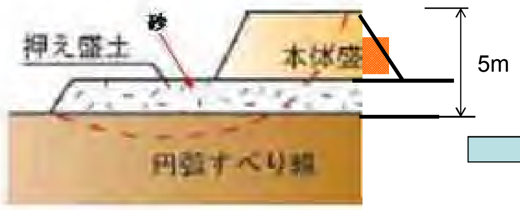
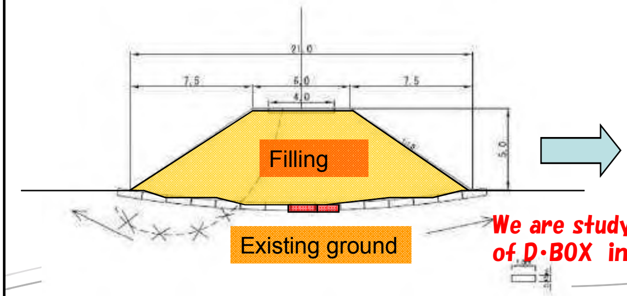
Comparison of construction cost
(Rough estimate reference only)



Ratio of construction cost

1.0



Ratio of construction cost

1.1 ～1.2

We are studying the production cost of D·BOX in Myanmar

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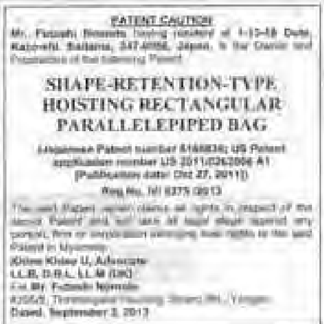
Thank you （Arigato）

Patent



PATENT CAUTION

SHAPE-RETENTION-TYPE HOISTING RECTANGULAR PARALLELEPIPED BAG

Dated, September 3, 2013

Trade Mark

TRADE MARK CAUTION

D • Box

Trade Mark

TRADE MARK CAUTION

Metry

31

Myanmar Side

Myanmar company applies to Japanese company's trainee system
(Temporary Employment Agency in Myanmar)

↔ Check the identification reference of the trainee

↓

Interview by Japanese Company

Note: Tranee openings will be depends on company's scale, however, almost up to 3 trainees

↓ Get permission by Myanmar Labor Authority

Japanese Language Training
(5-6 months)

→

Japan Side

JOB Category:
Construction---Architecture
Civil Work
Agriculture
Fishery
Food Processing
Germent Factory

Temporary Employment Agency in Japan

↕ Submit documents to JITCO

Japanese Language Training, Leaning Japanese Custom and Culture.
(2 months)

↓

Get a job in Japanese company as an Intern
Intern period: 3 years
If the trainee got the special engineer license during the training, intern period will be extended to 5 years

Note: Wage will be the minimum wage of each province (Approx. $6-7/hr)
Housing fee, Electricity & Water charge, Meal should be managed by the trainee.
Working hour should be 8hrs/day.

D・BOX Seminar in Yangon
Questionnaire for the targeted site for the next D・BOX project
(D-Box အသုံးပြုရန်ရည်ရွယ်ထားသည့် လုပ်ငန်းခွင်နှင့်ပတ်သက်သော မေးခွန်းများ)

1. Name of the targeted site: (လုပ်ငန်းခွင်အမည်)

(____)

It would be much helpful if you would provide the copy of google map through email.
(Google Map ဖြင့်ပြ၍ e-mail ဖြင့်ပို့ ပေးပါကများစွာ အဆင်ပြေပါသည်။)
If you would like to propose several sites, please use the copy of this sheet. (Hand up please)
(အကယ်၍ လုပ်ငန်းခွင်များစွာကိုပြပေးနိုင်ပါက ဤစာရွက်မိတ္တူများဖြင့် ဖြည့်စွက်ဖော်ပြနိုင်ပါသည်။)

2. Situation of the ground at the targeted site: (လုပ်ငန်းခွင်အခြေအနေ)

(____)

It would be much helpful if you would provide the pictures at the site through email.
(လုပ်ငန်းခွင်ဓာတ်ပုံများကို e-mail ဖြင့်ပေးပို့ပါက ပိုမိုထိရောက်နိုင်ပါသည်။)

3. Problems at the targeted site: (လုပ်ငန်းခွင်ပြဿနာများ)

(____)

4. What kind of support would you provide for the Pilot Project?
(ကနဦးစီမံကိန်း အကောင်အထည်ဖော်ရန်အတွက် မည်သည့်အထောက်အပံ့ များသင်ရရှိလိုပါနည်း။)

☐ Heavy equipment (စက်ကရိယာ/ယန္တရား) ☐ Workers (အလုပ်သမားများ) ☐ Gravel (ကျောက်)
☐ Sand (သဲ) ☐ Others (အခြားလိုအပ်ချက်များ)

(____)

5. With whom we should contact? (Please write your information)(ဆက်သွယ်ရန်လိပ်စာ)

Name (အမည်)		Title (ရာထူး)	
Office (ရုံး)			
Phone (ဖုန်း)		Fax (ဖက်စ်)	
Email (အီးမေးလ်)			

Thank you for your cooperation. (ကျေးဇူးတင်ပါသည်။)

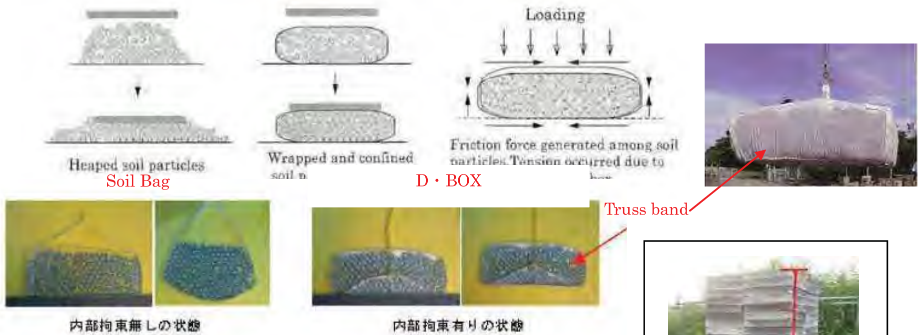
Contact person: Mr. Hiroshi SHIMADA (hiroshi.shimada@ss.pacific.co.jp)
(ဆက်သွယ်ရန်) Ms. Yuko MATSUDA (yuuko.matsuda@ss.pacific.co.jp)

What is D・BOX Method ?

D・BOX is a product which is developed by Mr. Futoshi NOMOTO of Metry Technical Institute, based upon the theory, merits and performance of the Soil-Bag(do-nou in Japanese) method invented by Prof. Emeritus Hajime MATSUOKA of Civil Engineering, Nagoya Institute of Technology, Japan. Therefore, the inventors of the D・BOX method are Hajime MATSUOKA and Futoshi NOMOTO.

4 amazing effects like "magic"

1) Extremely high bearing load: D・BOX can hold the weight of 1,100kN/m² to 1,900kN/m². This means D・BOX will not break even if it is placed under the basement of a skyscraper of 60 to 100 floors. We have the theoretical reason and the experimental results to prove this.



2) Soft clay soil becomes compact and strong with D・BOX:

D・BOX with sand and gravel causes the "local consolidation" in a very soft ground, such as a marsh, making the soft ground compact and strong. Using our method, the soft ground beneath D・BOX is able to support a building and a road. D・BOX consisting of sand and gravel acts as a permeable layer bringing about "local consolidation" in the surrounding earth.

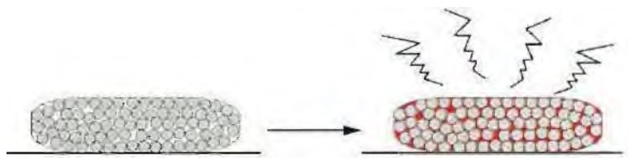
Figure of "pressure bulb" under permeable do-nou

"Local consolidation and strengthening" by permeable D・BOX

D・BOX with permeable materials such as sand and gravel has the feature to pass water easily, but not soil. The more the water passes, the more the clay becomes compact, and the soft clay ground under D・BOX grows more and more solid and strong.

3) High quality of vibration reduction:

D・BOX absorbs a high degree of traffic vibration, machine vibration and earthquake movement (5~15dB reduction by the vibration level). This is because vibration energy is dissipated as frictional heat energy between particles due to little flexibility within the D・BOX. It is able to function as an apparatus for high vibration reduction in a wide range of scenarios.



4) Prevention of the frost heave in a cold district: D・BOX consisting of coarse granular materials such as sand and gravel are able to prevent capillary rise of water and thus can prevent frost heave in areas subject to cold weather conditions.

****The material (Polyethylene or Polypropylene) for D・BOX is susceptible to degradation from sunshine (ultraviolet ray). It is a vital that D・BOX should be covered with soil or a light-tight sheet whenever they are employed.***

Prof. Hajime MATSUOKA
E-mail:hajime.matsuoka@md.ccnw.ne.jp
URL: http://www.soilbag.com/

Mr. Futoshi NOMOTO
Metry Technical Institute
E-mail:info@metry.jp
URL:http://www.metry.jp/

添付資料_006_アンケート結果まとめ

アンケート結果まとめ

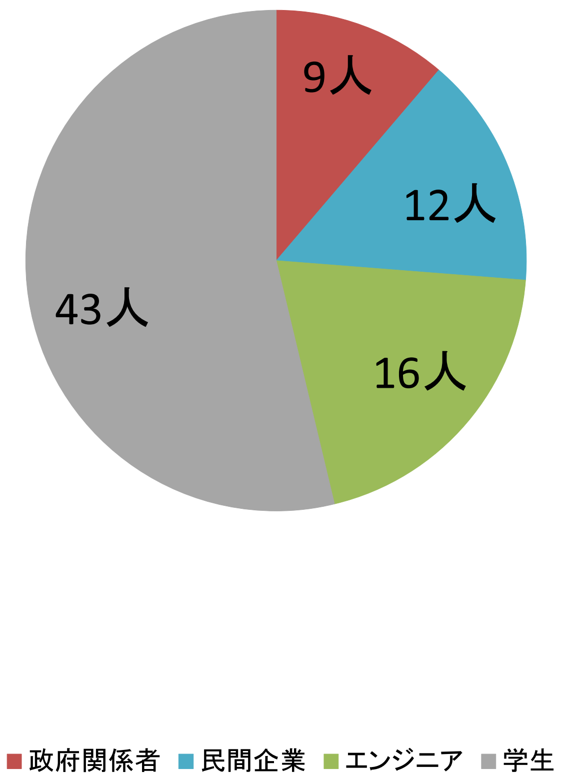
2013年11月5日　D・BOXセミナー（ヤンゴン）

2013年11月12日　D・BOXセミナー（ネピドー）

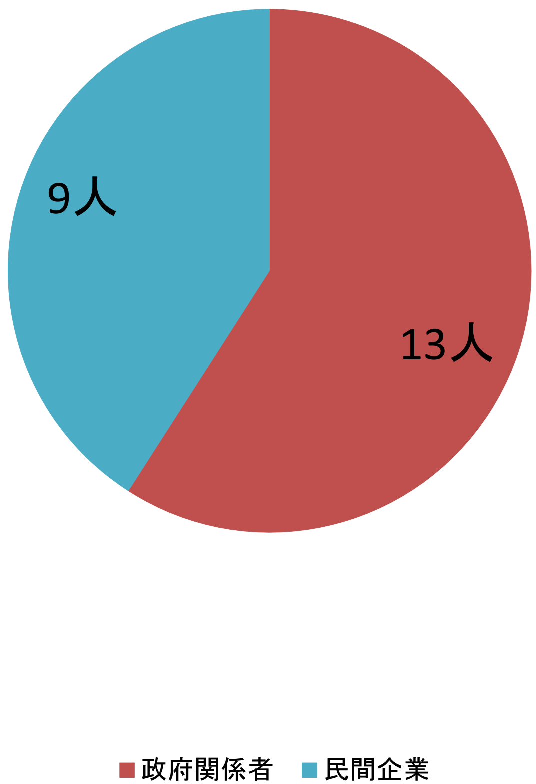
2013年12月7日　D・BOXセミナー（ヤンゴン）

回答者内訳

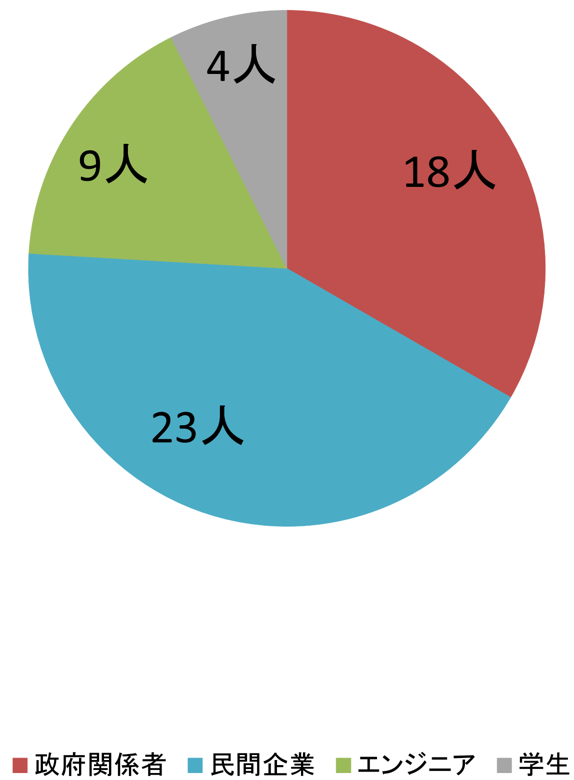
第一回目セミナー



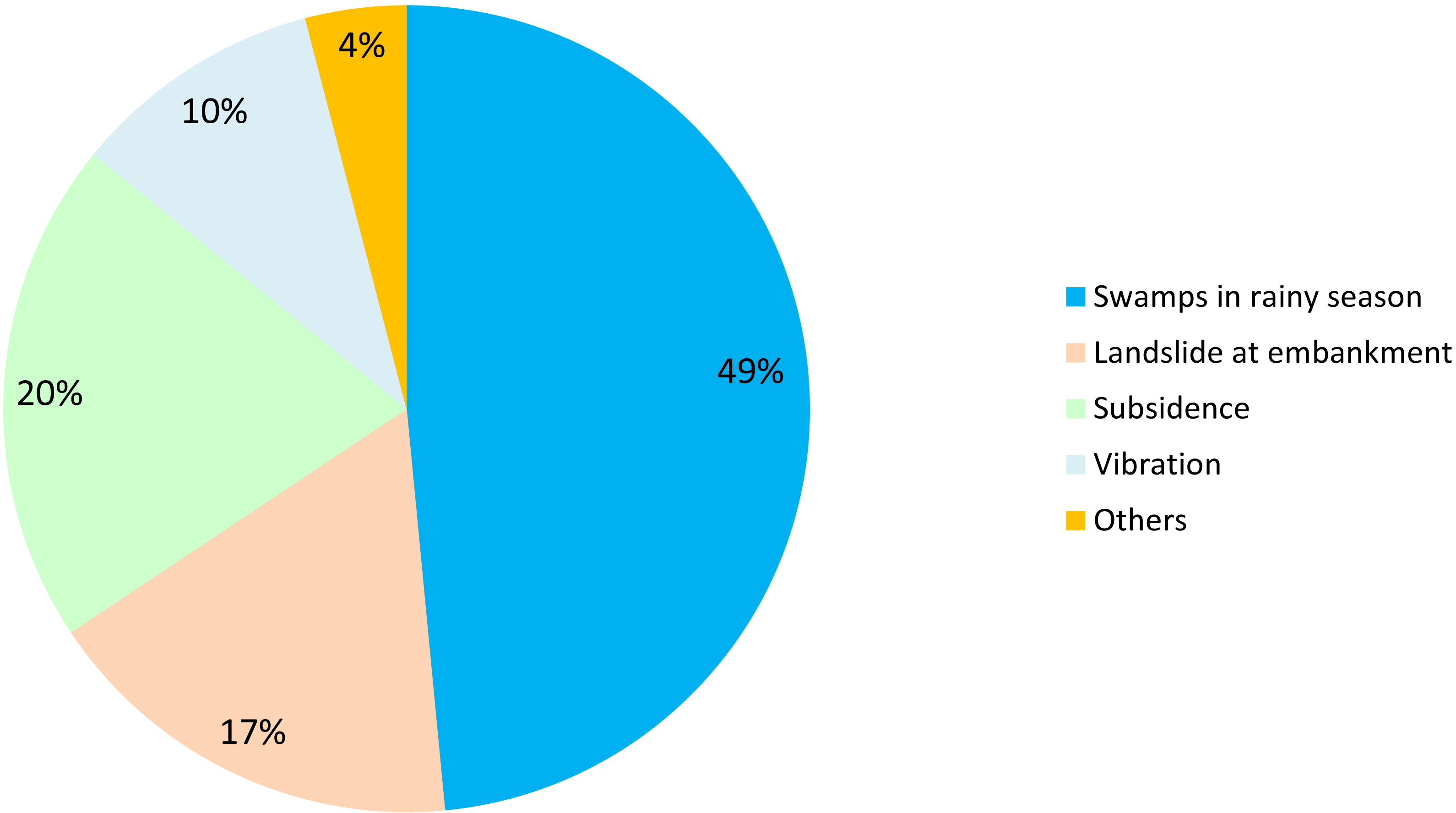
第二回セミナー



第三回目セミナー



軟弱地盤による問題



具体的な場所：　道路、建物の沈下、洪水、雨期の湿地

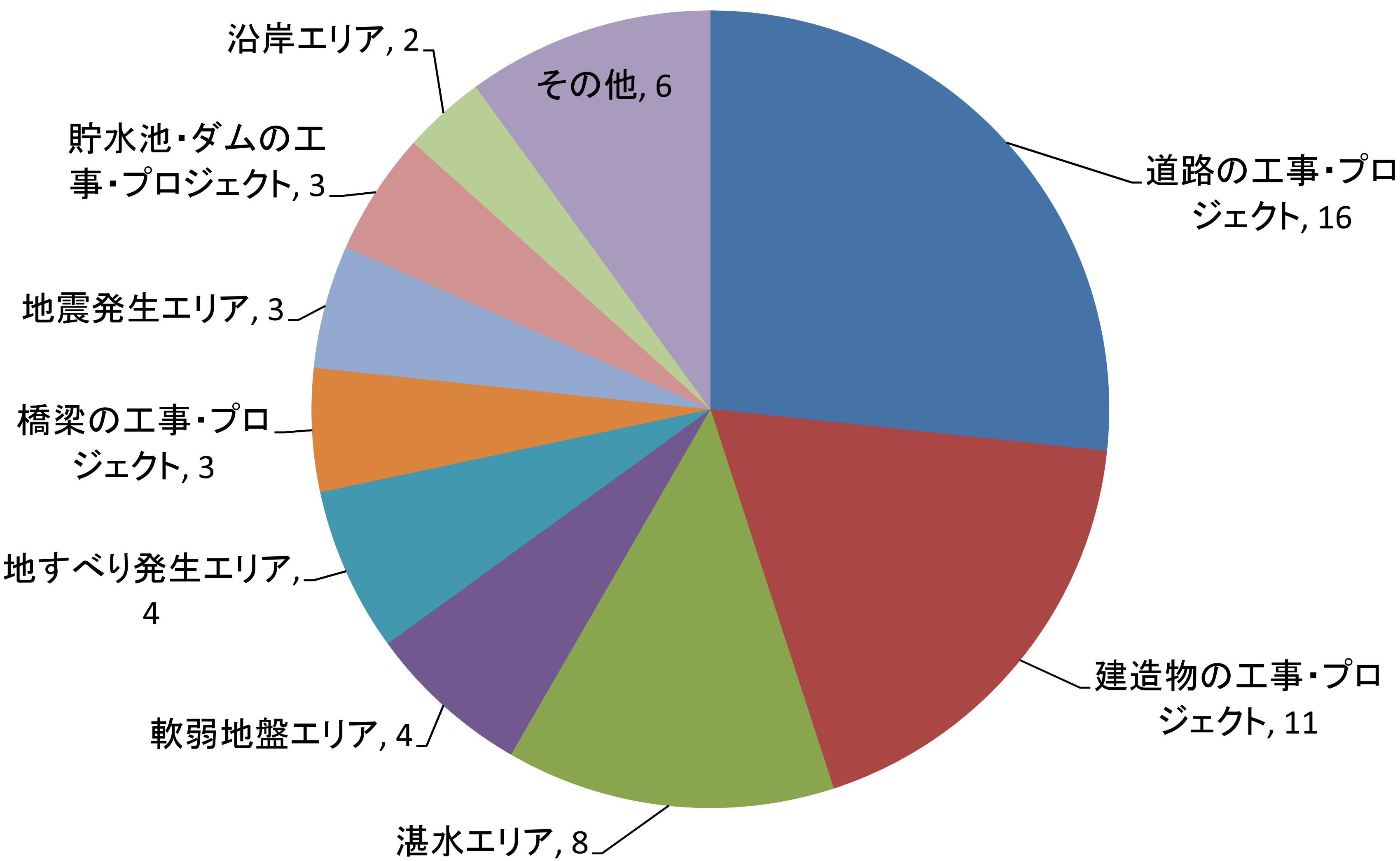
具体的な場所及び問題

場所	主な問題				
	地盤沈下	振動問題	湿地	地すべり	その他
Delta Area, Ayeyarwady	✔	✔	✔	✔	
Roadside area, Ayeyarwady				✔	
Magway	✔				
Shan State near Inle Lake	✔		✔	✔	
Taninthanyi Division				✔	
Yangon	✔		✔	✔	
NayPyiTaw	✔		✔		
South Dagon				✔	
South Dagon Industrial Zone	✔	✔	✔	✔	
Building Construction site			✔		
Waterflow Area (River, Stream, Channel etc.)	✔	✔	✔	✔	
KUN Hydropower Project				✔	
HinTharTa Township			✔		
Paddy field	✔				
KUN HPP in Phyu				✔	
Embankment at Bago and Ineawady Region					✔

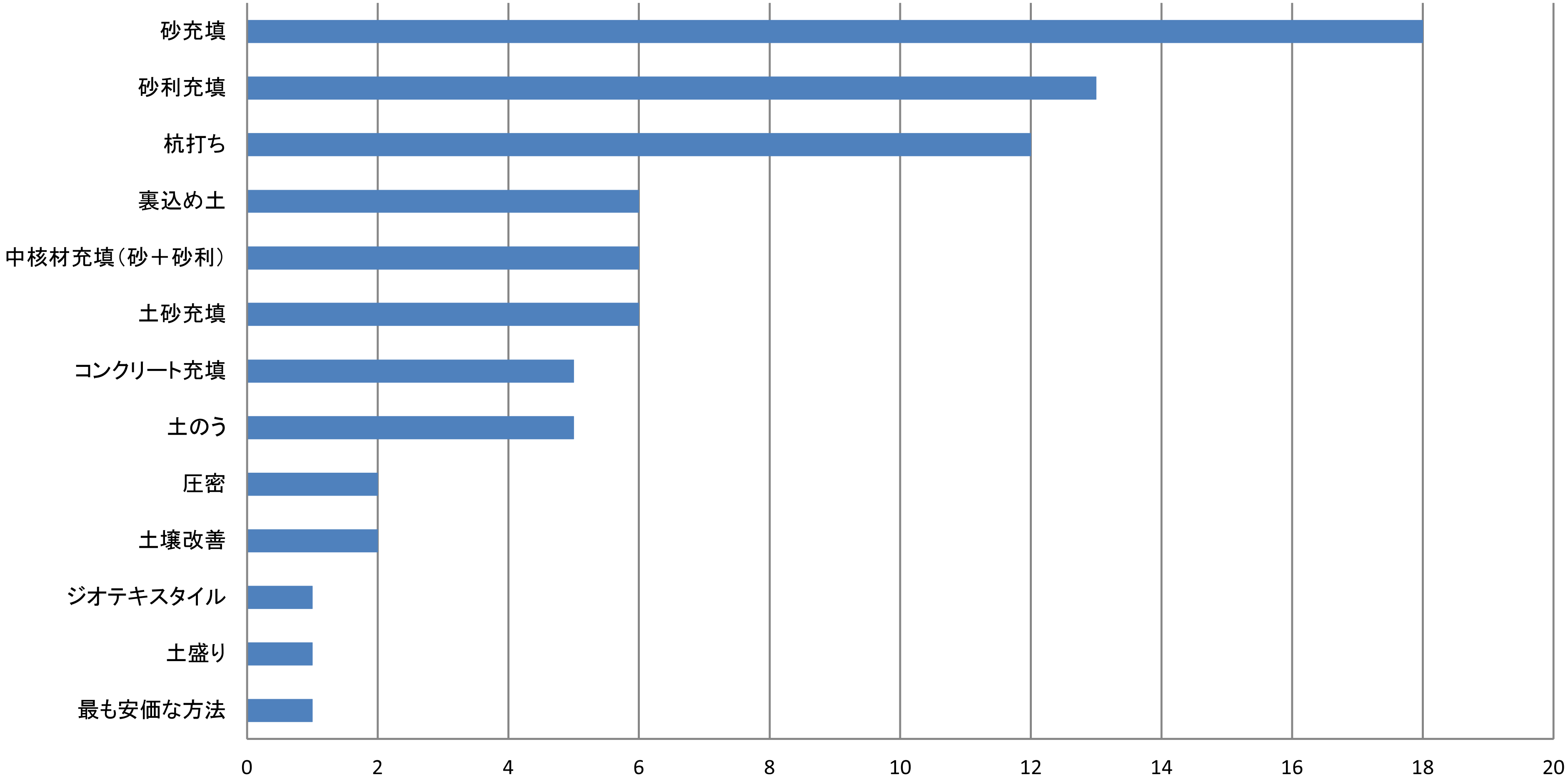
軟弱地盤による問題

主な問題	回答数
修復費用が高い	7
Damage	4
頻度（低）	4
ダメージ（大規模）	2
地盤沈下（道路）	2
地盤沈下（建物）	2
地盤沈下	2
路盤のダメージ	2
水域近辺のダメージ	2
頻度（高）	1
ダメージ（中規模）	1
雨期の山間部における地すべり	1
ダメージ（建物）	1
工事に支障が生じる	1
雨期の洪水によるダメージ	1
掘削に支障が生じる	1

D・BOXを導入したい場所・プロジェクト



従来の軟弱地盤対策



	最も安価な方法	土盛り	ジオテキスタイル	土壌改善	圧密	土のう	コンクリート充填	土砂充填	中核材充填（砂＋砂利）	裏込め土	杭打ち	砂利充填	砂充填
回答数	1	1	1	2	2	5	5	6	6	6	12	13	18

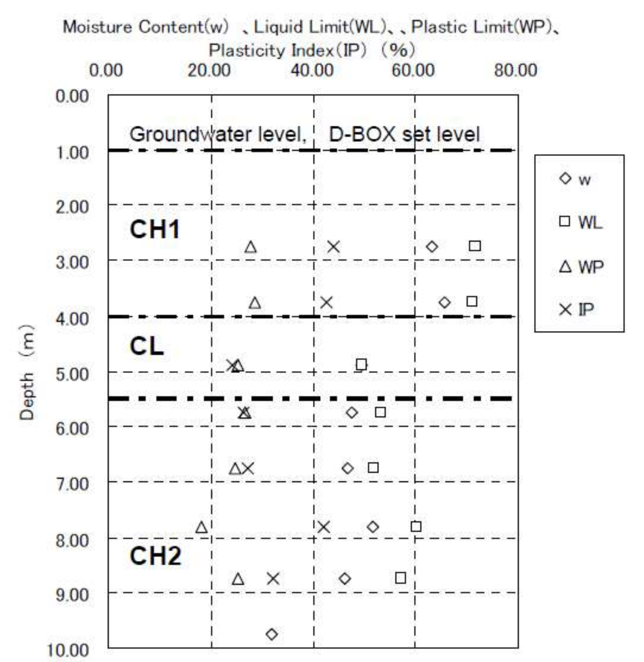
添付資料_007_沈下解析

1.1　沈下解析モデル

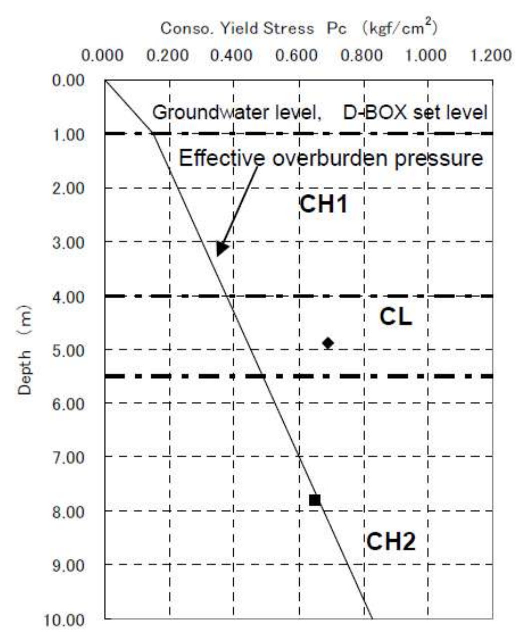
1)　粘土層の物理・圧密モデル

図 1.1.1に示す物理試験結果（含水比、液性限界、塑性限界等）の深度分布図より、粘土層を上位より、CH1（高液性限界粘土）、CL（低液性限界粘土）、CH2（高液性限界粘土）の３つのグループに分類した。粘土層の単位体積重量は 17.5kN/m^3で共通である。

粘土層の圧密試験は、CL（深度 4.5～5.25m： T-1）及び CH2（深度 7.5～8.14m： T-2）で実施した。よって、図 1.1.2に示すように CH1 の圧密モデル（T-0）は、同じ高液性限界粘土の CH2 の圧密試験結果より設定した。なお、CH2 の圧密降伏応力 Pc は有効土被り圧と同程度（正規圧密粘土）であるため、CH1 の圧密降伏応力は、試験を実施している D-BOX 設置面から深度 2m 位置の有効土被り圧（15kN/m^2）した。



(a) 粘土層の物理試験結果



(b) 粘土層の圧密降伏応力

※解析モデルは、D－BOX設置面の標高 96.59mを基準(設置面を GL±0m)とする

※粘土層の単位体積重量は 17.5kN/m^3

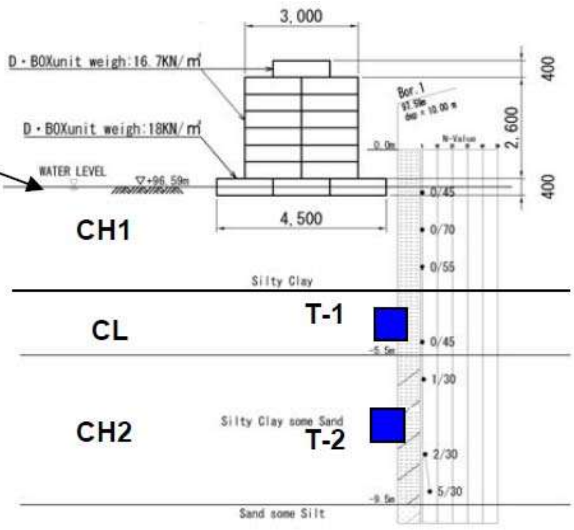
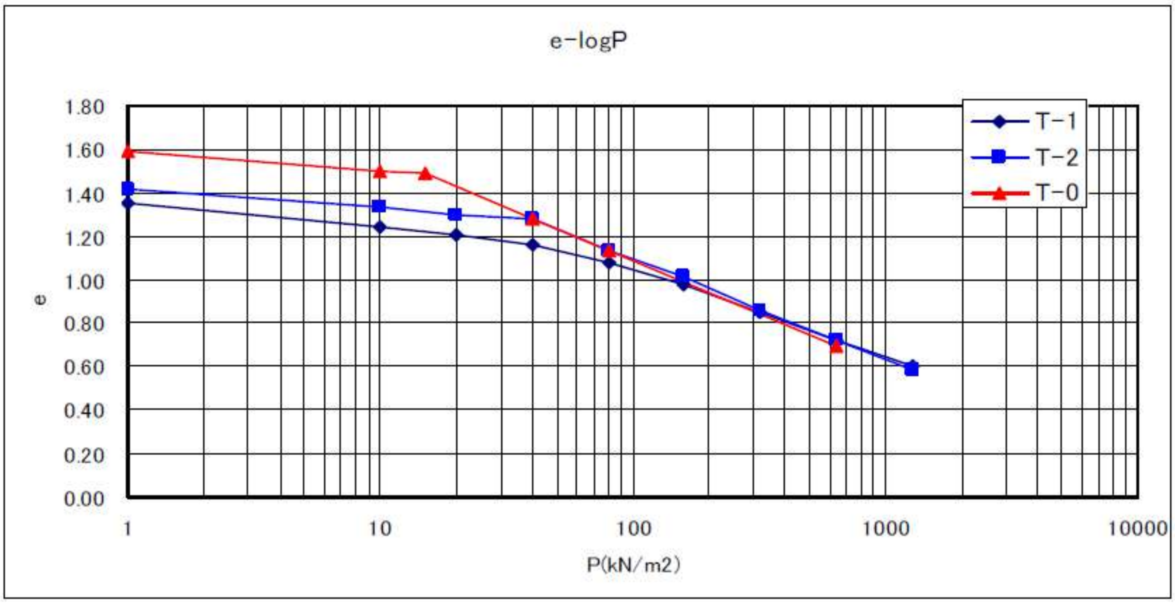
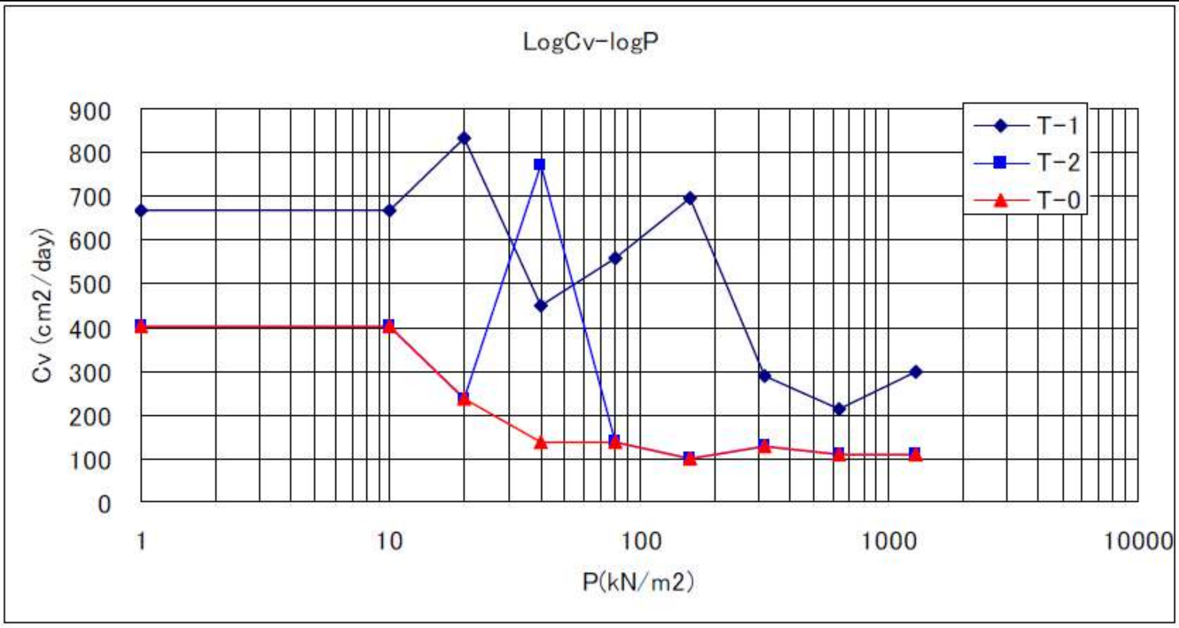


図 1.1.1 粘土層の物理試験結果及び圧密降伏応力

出典; 試験結果を基に調査団作成



(a) 平均鉛直応力 Pc～間隙比 e 間係



(b) 平均鉛直応力 Pc～圧密係数 cv 間係

T-0：CH1 の圧密モデル、T-1：CL の圧密モデル、T-2：CH2 の圧密モデル

図 1.1.2 粘土層の圧密モデル曲線

出典；試験結果を基に調査団作成

2)　　D-BOX の荷重モデル

D-BOX の単位体積重量γt=18 kN/m3、16.7kN/m3 (※1) 及び形状より、図 1.1.3に示すように D-BOX の荷重モデルは 7.2～50.6kN/m2の矩形モデルとし、荷重の 3 次元分散を考慮した。

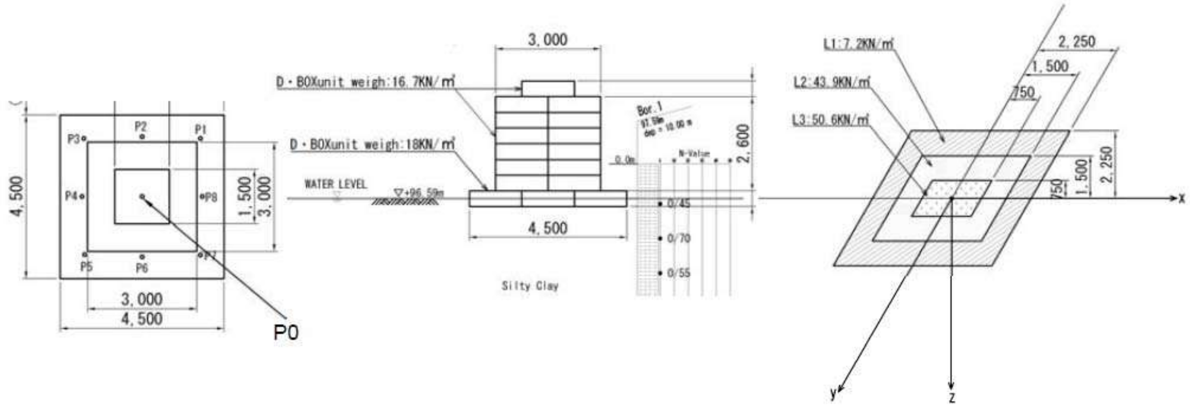


図 1.1.3　D-BOX の荷重モデル（D-BOX の形状を考慮した矩形モデル）

出典; 調査団作成

※1 D・BOX への中詰用現地発生土の重量は下記より 16.7KN/m3 と設定した。

1) 現地での測定

粘土の単位重量の測定結果:現地にて、800ccの容器に発生土の重量を計測した結果

800cc:超軟弱粘土 1.38kg/800cc(17.25 KN/m3)、少し固めの粘土 1.5kg/800cc(18.75 KN/m3)

平均 18KN/m3

2) D・BOX の重量測定(3 個)　平均値　:14.7 KN/m3

3) ボーリング調査結果:17.5 KN/m3

これらの平均値より現地発生土の単位体積重量γ＝16.7 KN/m3　とした。

3)　粘土層の変形係数

スウェーデン式サウンディング試験結果より推定される変形係数 E を表 1.1.1及び表 1.1.2に示す。試験結果の換算 N 値より推定される変形係数 En＝700＊N と、換算粘着力 c より算出される変形係数 Ec＝100＊c は同程度である。

また三軸圧縮試験結果の供試体の「応力～ひずみ関係」を図 1.1.4に示す。図より供試体の破壊ひずみは、概ね 2%程度である。

よって、推定される変形係数 E は、E＝(qu/2)÷1%＝c÷0.01＝100＊c となる。

以上のことより、粘土層の変形は E=100＊c とし、粘着力 c は三軸圧縮試験結果から求まる設計粘着力を用いる（「3）D・BOX の沈下抑制効果」参照）。設定した変形係数 E を表 1.1.3 に示す。

表 1.1.1　スウェーデン式サウンディング試験結果　No.1

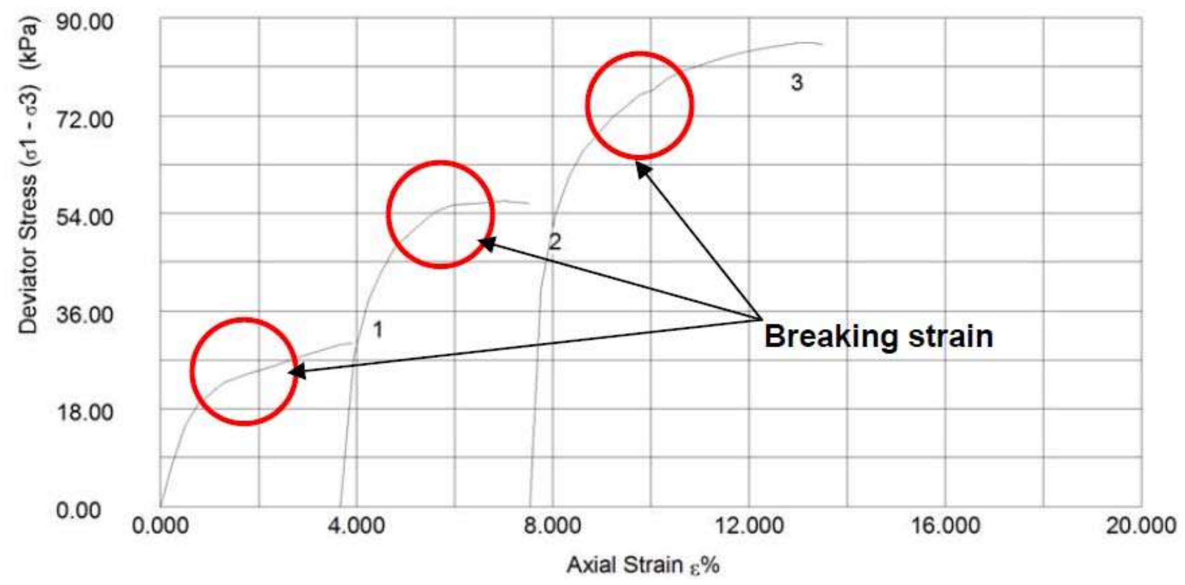
Level 97.59m depth (m)	N	E=700*N (kN/m^2)	ave: En (kN/m^2)	qu (kN/m^2)	c (kN/m^2)	ave: c (kN/m^2)	Ec =100*c (kN/m^2)
0.1	0.15	105		2.25	1.125		
0.16	0.45	315	315.0	6.75	3.375	3.4	337.5
0.18	0.75	525		11.25	5.625		
1.18	1.5	1050		22.5	11.25		
1.33	0.15	105	490.0	2.25	1.125	5.3	525.0
1.93	0.45	315		6.75	3.375		
2.11	0.75	525		11.25	5.625		
2.23	1.5	1050	813.8	22.5	11.25	8.7	871.9
2.31	2.25	1575		33.75	16.875		
3.01	0.15	105		2.25	1.125		
3.05	0.45	315		6.75	3.375		
3.49	0.75	525	630.0	11.25	5.625	6.8	675.0
4.4	1.5	1050		22.5	11.25		
5.04	2.25	1575	1837.5	33.75	16.875	19.7	1968.8
8.45	3	2100		45	22.5		

出典；　試験結果を基に調査団作成

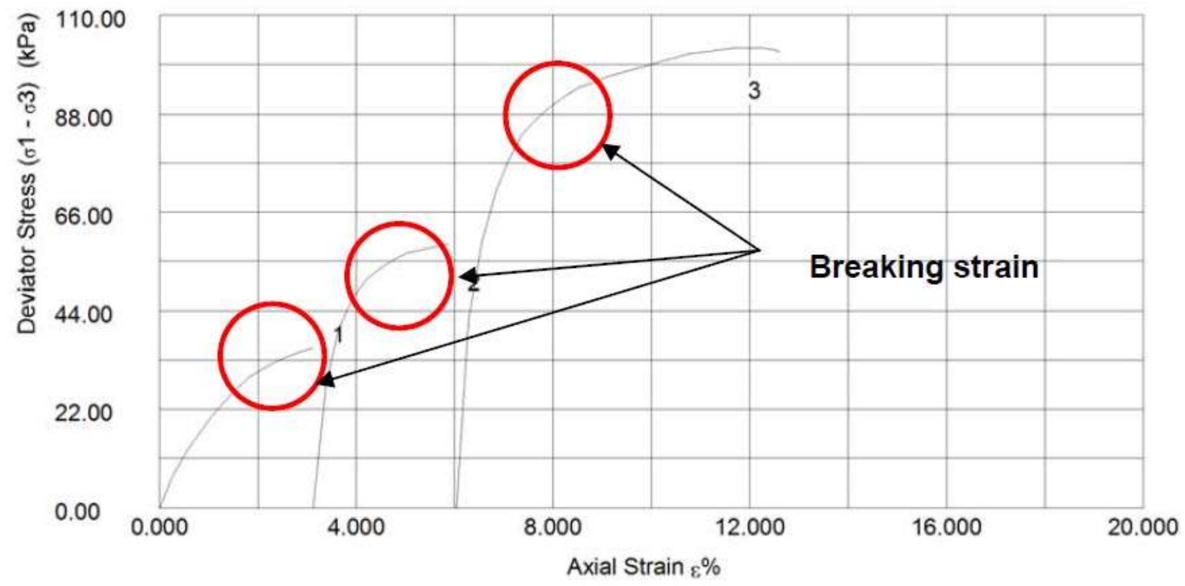
表 1.1.2　スウェーデン式サウンディング試験結果　No.2

Level 96.56m depth (m)	N	E=700*N (kN/m^2)	ave: E (kN/m^2)	qu (kN/m^2)	c (kN/m^2)	ave: c (kN/m^2)	Ec =100*c (kN/m^2)
0.03	0.15	105		2.25	1.125		
0.18	0.45	315		6.75	3.375		
0.26	0.75	525		11.25	5.625		
0.40	1.50	1050	420.0	22.5	11.25	4.5	450.0
	0.15	105		2.25	1.125		
	0.45	315		6.75	3.375		
	0.75	525		11.25	5.625		
1.00	1.50	1050		22.5	11.25		
	0.15	105	498.8	2.25	1.125	5.3	534.4
	0.45	315		6.75	3.375		
2.05	0.75	525		11.25	5.625		
2.80	1.50	1050		22.5	11.25		
3.00	2.25	1575	1225.0	33.75	16.875	13.1	113.1
4.13	1.50	1050		22.5	11.25		
5.42	2.25	1575		33.75	16.875		
5.80	3.00	2100	1837.5	45	22.5	19.7	1968.8
6.20	2.25	1575		33.75	16.875		
8.00	3.00	2100		45	22.5		

出典；　試験結果を基に調査団作成



(a)　軸差応力σ～軸ひずみ 関係：T-1　CL



(b)　軸差応力σ～軸ひずみ 関係：T-2　CH2

図 1.1.4　三軸圧縮試験結果の供試体の「応力～ひずみ関係」

出典; 調査団作成

表 1.1.3　三軸圧縮試験結果より推定される変形係数（E=100＊c）

Level 96.59m depth (m)	UU test c (kN/m^2)	CU test c (kN/m^2)	Design c (kN/m^2)	Design E (kN/m^2)
0～1.0	−	5.3	5.30	530
1.0～2.0	−	7.7	7.70	770
2.0～3.0	10.2		10.20	1,020
3.0～4.0		11.3	11.30	1,130
4.0～6.0	13.3		13.30	1,130
6.0～8.0		18.15	18.15	1,330

※深度 0～3m が CH1、3～4m が CL、4～8m が CH2 に該当する

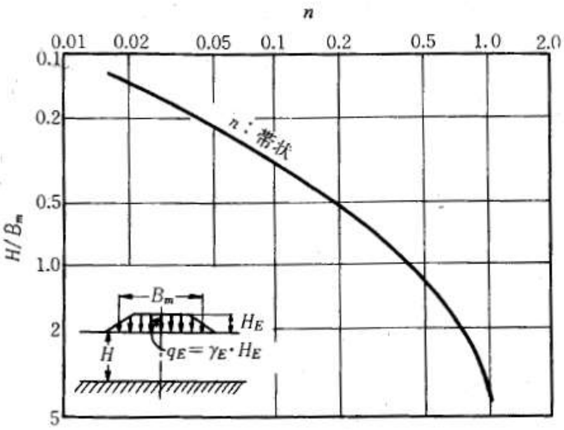
出典；試験結果を基に調査団作成

4)　　**沈下計算式**

(1)　　即時沈下

粘土層の即時沈下量は、図 1.1.5に示される方法で実施する。

S_E＝（q_E・B_m）/E ×n　　式（解 5－2）



解図 5－6　H/B_m と係数 n の値 [2)]

ここに，

S_i：即時沈下量（m）

q_E：盛土荷重　（kN/m²）

B_m：載荷幅（m）

n：**解図 5－6** から求まる係数

E：軟弱層の平均変形係数（kN/m²），$E=\dfrac{1}{\sum H_i}\cdot\left(\sum E_i\cdot H_i\right)$

（この式は対象地盤が複数の土層 i からなる場合の式であり，変形係数 E としては E_{50} を用いることが多い。）

H_i：粘性土層を構成する各層の層厚（m）

E_i：粘性土層を構成する各層の変形係数（kN/m²）

なお，式（解 5－2）で示される即時沈下量 S_i は，即時沈下が非排水条件のせん断変形によって生じるとした値である。

図 1.1.5　粘性土層の即時沈下量の計算方法

出典；「道路土工　軟弱地盤対策工指針(平成 24 年度版)：社団法人　日本道路協会」P123～P124

(2)　圧密沈下

粘土層の圧密沈下量は、図 1.1.6に示される方法で実施する（以下参照）。

$$S_c=\frac{e_0-e_1}{1+e_0}\cdot H \cdots\cdots\cdots\cdots（解5-3）$$

ここに,

S_c：一次圧密沈下量（m）

e_0：圧密層の盛土前の鉛直応力 p_0 での初期間隙比

e_1：圧密層の盛土荷重による圧密後の間隙比で，e-log p 曲線に圧密層中央深度の盛土後の鉛直応力 $p_0+\Delta p$ に対応する間隙比

H：圧密層の層厚（m）

$$t=\frac{(H_0/2)^2}{c_{v0}}\cdot T_v=\frac{D^2}{c_{v0}}\cdot T_v \cdots\cdots\cdots\cdots（解5-8）$$

ここに,

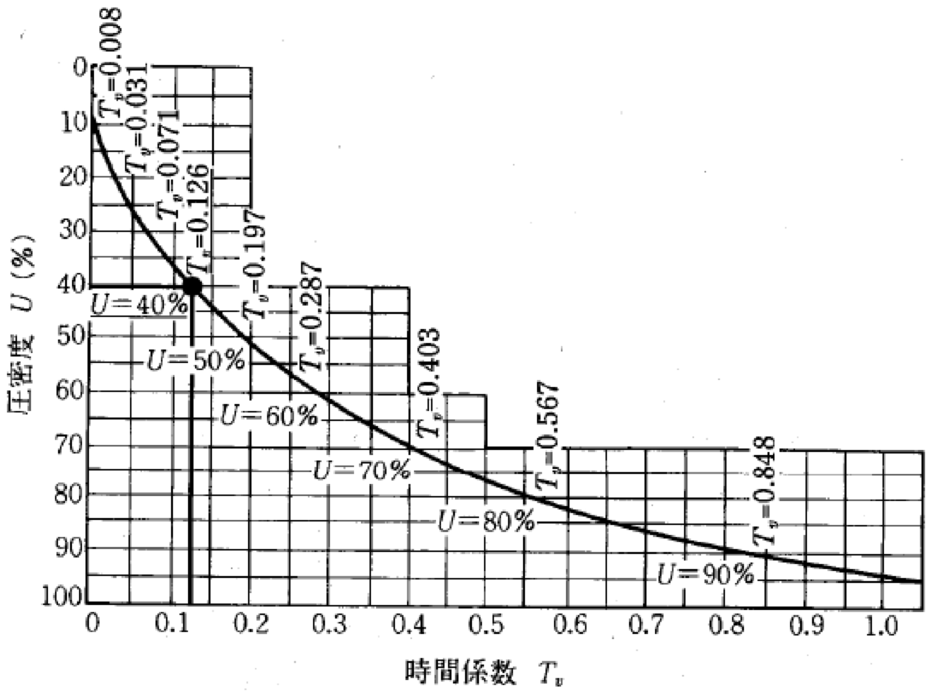
T_v：時間係数で，鉛直有効応力の増分 Δp の瞬間載荷により圧密層で一定値として発生する過剰間隙水圧 Δu_0（$=\Delta p$）の経時的な消散を表し，圧密層全体での平均圧密度 U に応じて，**解図5−8** に示した値を用いることができる。

c_{v0}：圧密層の代表 c_v で，式（解5−7）の例では c_{v3}

圧密層全体での平均圧密度が U_t に達したときの圧密沈下量 S_t は，各圧密層の一次圧密沈下量 S_{cn} を圧密層全体で合算した ΣS_{cn} との間に式（解5−9）の関係があり，時間 t と沈下量 S_t の関係が求められる。 7)

$$S_t=U_t\cdot\sum S_{cn} \cdots\cdots\cdots\cdots（解5-9）$$

以上のように，圧密による沈下速度は，排水が鉛直方向だけに行われるとする一次元圧密を仮定し，層厚換算法によって算定することができる。



解図 5−8 圧密層全体での平均圧密度 U と時間係数 T_v の関係（載荷直後間隙水圧 Δu_0 ＝一定）

図 1.1.6　粘土層の圧密沈下量　計算方法

出典；「道路土工　軟弱地盤対策工指針（平成 24 年度版）：社団法人　日本道路協会」

P125～P130

1.2　　沈下解析結果

P4、P6、P7、P8 地点における 2013 年 11 月 12 日～2013 年 12 月 18 日までの沈下計測結果と P0、P4、P6、P7、P8 地点の沈下解析結果を比較して、図 1.2.2に示す。また、P0、P4、P6、P7、P8 地点の最終予測沈下量を図 1.2.3に示す。

D-BOX の沈下抑制効果がない場合の最終予測沈下量は、23～43cm 程度である。

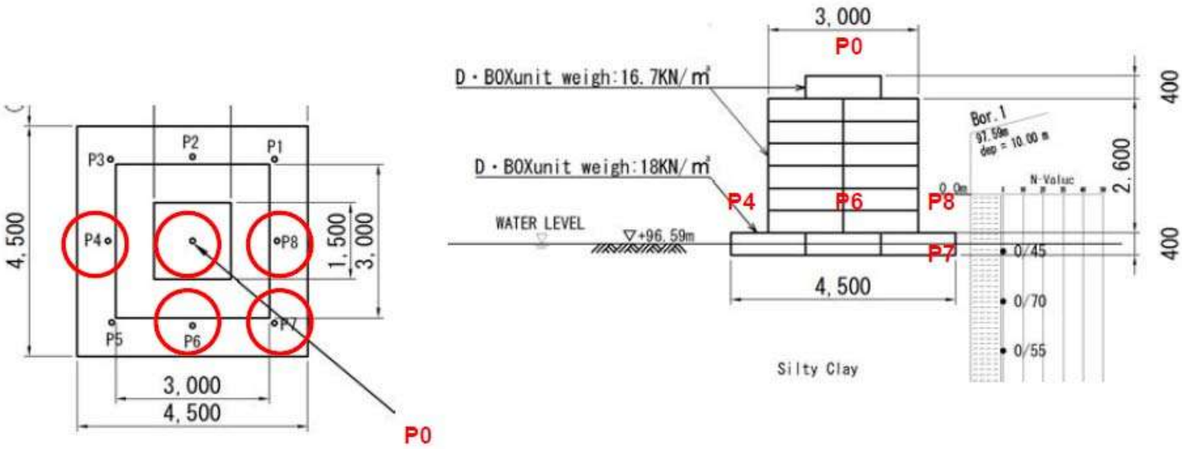
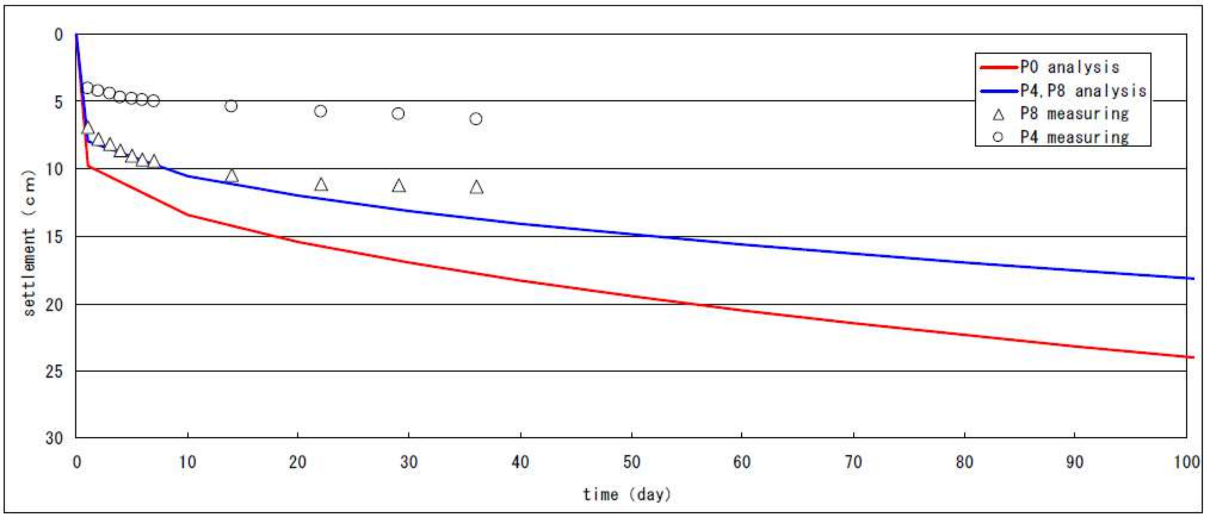


図 1.2.1　沈下測定位置

出典;調査団作成



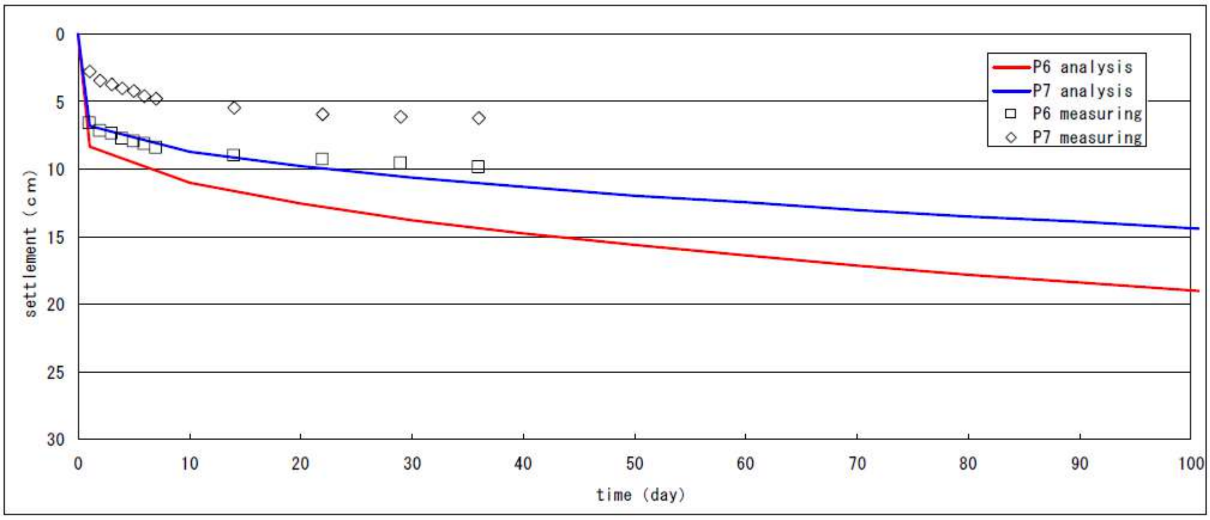
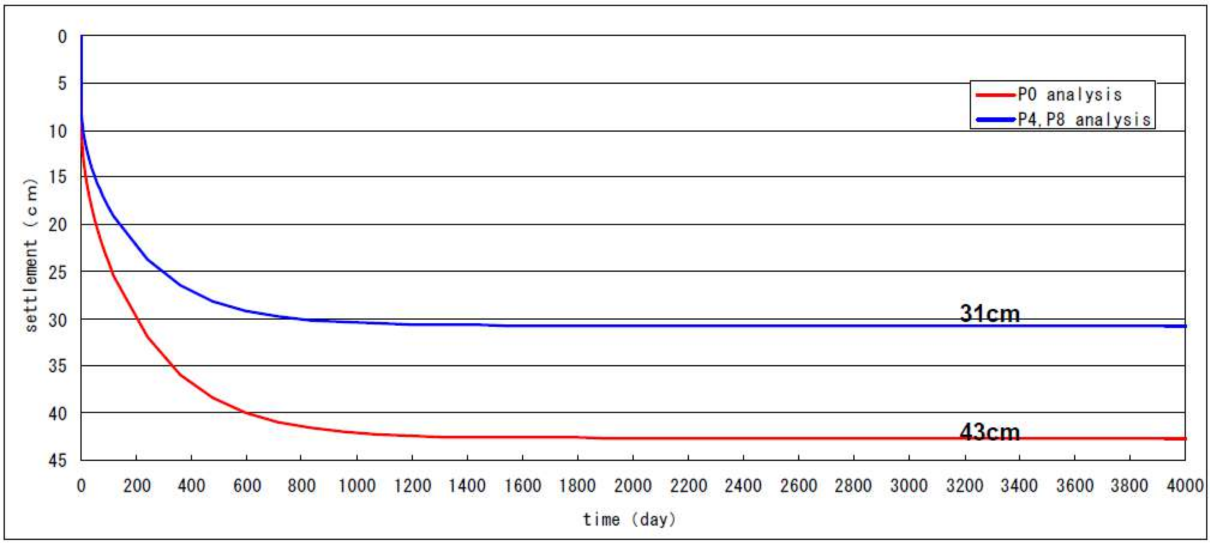


図 1.2.2　P0、P4、P6、P7、P8 地点の沈下解析結果と沈下計測結果の比較

出典;調査団作成



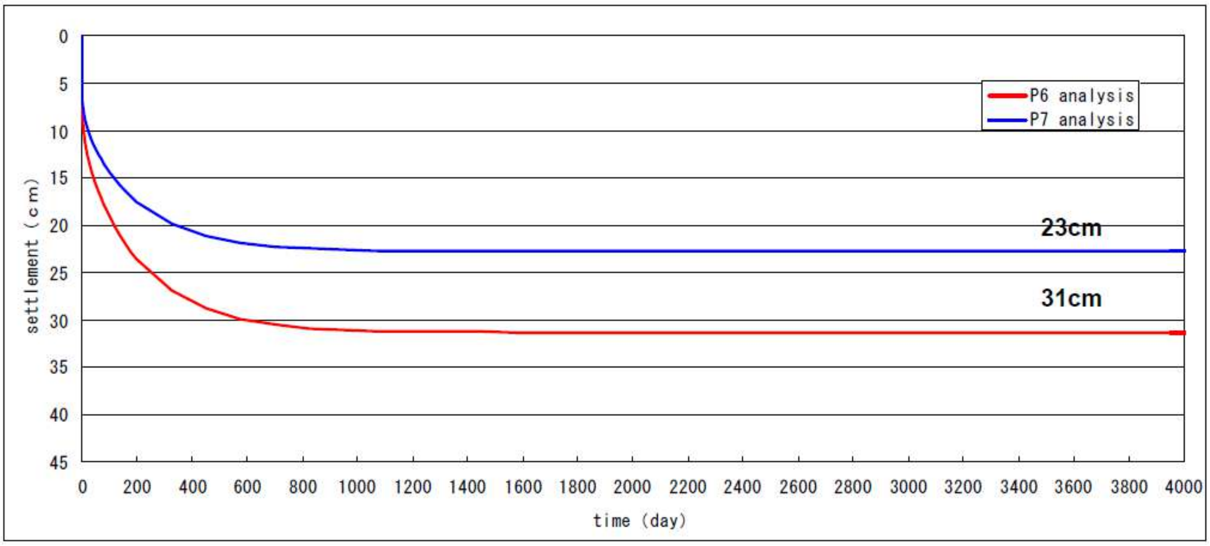


図 1.2.3　P0、P4、P6、P7、P8 地点の最終予測沈下量

出典；調査団作成


図 1.2.4　D・BOX の設置状況写真

出典；調査団撮影

1)　D･BOX の沈下抑制効果

図 1.2.3に示す予測沈下量と計測沈下量の比較より、計測沈下量は予測沈下量より 2 割から 5 割程度小さくなっている。これは最下段の D-BOX の剛性による荷重分散効果等により、沈下が抑制されていると考えられる。ただし、D-BOX の沈下抑制効果については、今後の沈下計測結果も踏まえて評価する必要がある。

1．3　　D・BOX の効果/施工効率確認

1)　　**地盤支持力の検討**

(1)　　地盤支持力検討モデル

A.　　D-BOX（LS150）の極限せん断応力

「土のう」の耐力計算の理論式を参考にして、D-BOX（LS150）の粘着力及び極限せん断応力などを求める。に示すように中詰め材が砂（ϕ=30）の場合、D-BOX（LS150）の粘着力 c は、c=129kN/m²、極限せん断応力 τ_1 は、τ_1=193.5kN/m² となる。

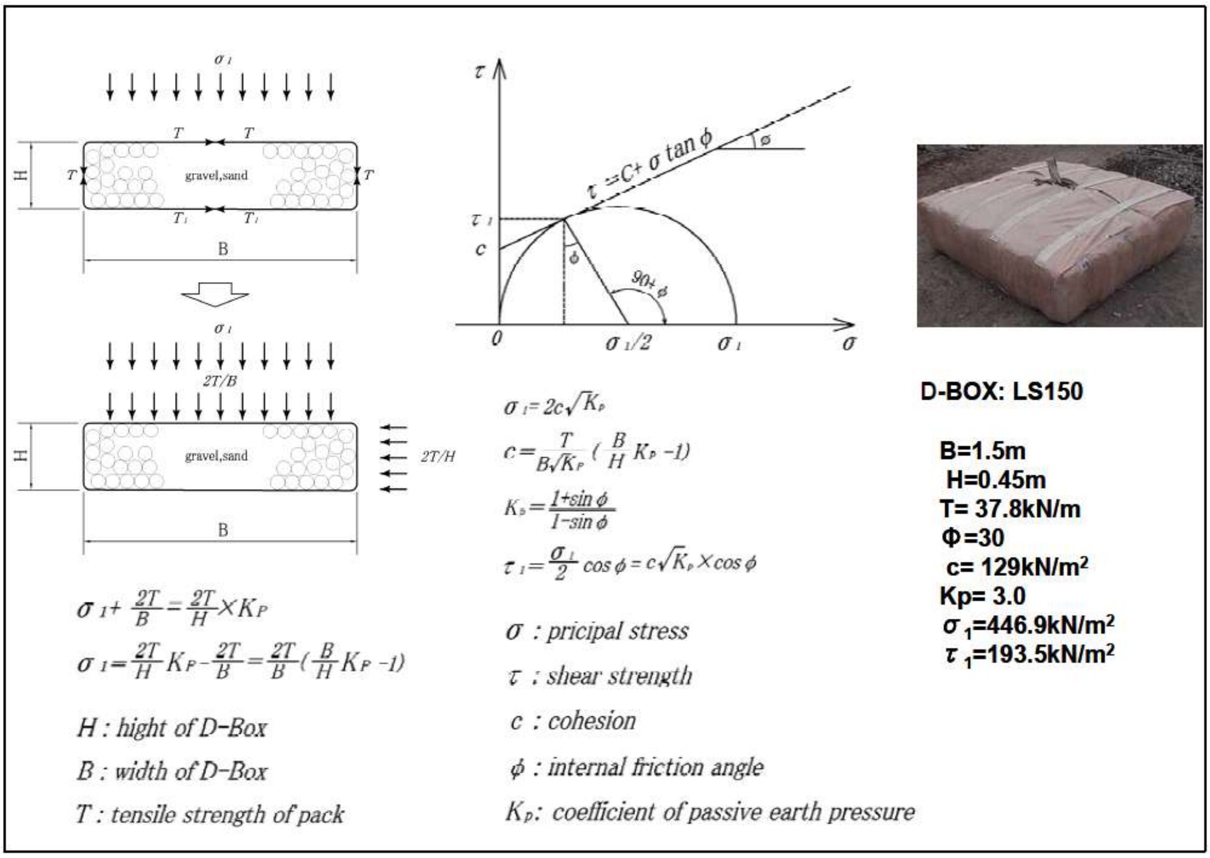


図 1.3.1　D-BOX（LS150）の粘着力及び極限せん断応力の計算結果

出典；　調査団作成

B.　　粘土層の支持力

粘土層の支持力計算は、以下の国土交通省告示第 1113 号、及び建築基礎構造設計指針などに示される計算式を用いる。

・　　極限支持力 Q= 形状係数 1.2（正方形）×支持力係数 5.1×粘着力 c

スウェーデン式サウンディング試験結果からの換算粘着力、及び三軸圧縮試験結果等から求まる粘着力をまとめて表 1.3.1に示す。両者の粘着力は同程度であるため、設計粘着力は三軸圧縮試験結果の粘着力を用いることとした。また設計粘着力より計算した粘土層の極限支持力を表 1.3.2に示す。

表 1.3.1　スウェーデン式サウンディング試験結果からの換算粘着力、原位置せん断試験及び三軸圧縮試験結果（UU・CU 条件）から求まる粘着力、及び設計粘着力

Level 97.59m depth (m)	swedish test 1 c (kN/m^2)	swedish test 2 c (kN/m^2)	site shear test c (kN/m^2)	Level 96.59m depth (m)	UU test c (kN/m^2)	CU test c (kN/m^2)	Design c (kN/m^2)
0～1.0	3.4		1.8	－	－	－	－
1.0～2.0	5.3	4.5	－	0～1.0	－	5.3	5.30
2.0～3.0	8.7	5.3	－	1.0～2.0	－	7.7	7.70
3.0～5.0	6.8	13.1	－	2.0～3.0	10.2		10.20
				3.0～4.0		11.3	11.30
5.0～9.0	19.7	19.7	－	4.0～6.0	13.3		13.30
				6.0～8.0		18.15	18.15

※深度 0～3m が CH1、3～4m が CL、4～8m が CH2 に該当する

出典；調査団作成

表 1.3.2　粘土層の極限支持力

Level 96.59m depth (m)	Design cohesion c (kN/m^2)	Ultimate bearing capacity Q (kN/m^2)
0	4.1	25.09
1	5.3	32.44
2	7.7	47.12
3	10.2	62.42
4	11.3	69.16
6	13.3	81.40
8	18.15	111.08

※CU 試験結果:c=4.1、ϕ=18 より、深度 0m 位置は c=4.1(kN/m^2)

出典；調査団作成

表 1.3.3　スウェーデン式サウンディング試験結果（No.1、No.2）

No.1 地点

Level 97.59m depth (m)	Wsw (kgf)	qu (kN/m^2)	c (kN/m^2)	ave: c (kN/m^2)
0.1	5	2.25	1.125	3.4
0.16	15	6.75	3.375	
0.18	25	11.25	5.625	
1.18	50	22.5	11.25	5.3
1.33	5	2.25	1.125	
1.93	15	6.75	3.375	
2.11	25	11.25	5.625	8.7
2.23	50	22.5	11.25	
2.31	75	33.75	16.875	
3.01	5	2.25	1.125	
3.05	15	6.75	3.375	6.8
3.49	25	11.25	5.625	
4.4	50	22.5	11.25	
5.04	75	33.75	16.875	19.7
8.45	100	45	22.5	

No.2 地点

Level 96.56m depth (m)	Wsw (kgf)	qu (kN/m^2)	c (kN/m^2)	ave: c (kN/m^2)
0.03	5	2.25	1.125	4.5
0.18	15	6.75	3.375	
0.26	25	11.25	5.625	
0.40	50	22.5	11.25	
	5	2.25	1.125	
	15	6.75	3.375	
	25	11.25	5.625	
1.00	50	22.5	11.25	5.3
	5	2.25	1.125	
	15	6.75	3.375	
2.05	25	11.25	5.625	
2.80	50	22.5	11.25	13.1
3.00	75	33.75	16.875	
4.13	50	22.5	11.25	
5.42	75	33.75	16.875	19.7
5.80	100	45	22.5	
6.20	75	33.75	16.875	
8.00	100	45	22.5	

※　qu= Wsw(kgf)×0.45 (kN/m^2)、c=qu÷2 (kN/m^2)

出典；試験結果を基に調査団作成

(2)　地盤の支持力計算式

A.　地中増加応力と粘土層の極限支持力の比較

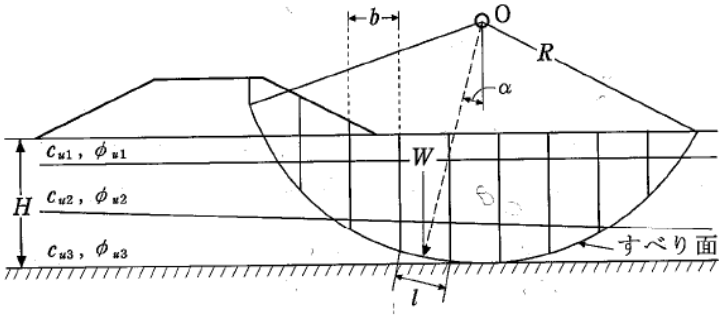
図 1.1.3に示す D-BOX の荷重モデル(D-BOX の形状を考慮した矩形モデル)で求めた粘土層内の地中増加応力⊿p と極限支持力 Q を比較する。

⊿p＞Q の部分がある場合、安定性を確保できているのことが、D-BOX の補強効果（剛性による支持力増加、荷重分散効果など）となる。

B.　　　円弧すべり計算による支持検討

粘土層の支持力検討は、図 1.3.2に示される、円弧すべり計算方法で実施する（以下参照）。

2 段から上位の D-BOX を荷重モデル（図 1.1.3参照）とし、最下段の D-BOX が無いケース（D-BOX 部分を粘土としてモデル化）と、D-BOX があるケースの円弧すべり計算結果の安全率を比較する。安全率の増加分が D-BOX の補強効果となる。また、D-BOX の代わりに砂置換工を実施する場合、安全率 Fs>1.0 となる置換砂の厚さを計算する。



解図 5－14　分割法による安定計算

$$F_s = \frac{\Sigma\{cl + (W - u_0 b)\cos\alpha\tan\phi\}}{\Sigma(W\sin\alpha)} \quad \cdots\cdots\cdots\cdots\cdots\cdots \text{（解 5－15）}$$

ここに,

F_s：安全率

c：土の粘着力（kN/m²）

ϕ：土のせん断抵抗角（°）

l：細片で切られたすべり面の長さ（m）

W：細片の全重量，載荷重を含む（kN/m）

u_0：静水位時における間隙水圧（kN/m²）

b：細片の幅（m）

α：細片のすべり面平均傾斜角（°）

図 1.3.2　円弧すべり計算方法

出典;「道路土工　軟弱地盤対策工指針(平成 24 年度版):社団法人　日本道路協会」

P148～P149

(3)　　地盤支持力検討検討結果

A.　　地中増加応力と粘土層の極限支持力の比較

　P0及びP8位置における粘土層内の増加応力⊿pと極限支持力Qを比較して､図 1.3.3に示す。深度 0m～1.3m の位置まで、増加応力⊿p が極限支持力 Q より大きくなっており、計算上は表層部が局所せん断破壊され、安定性を確保できないこととなる。

　現状は安定性を確保していることから、D-BOX の剛性等による補強効果が発揮されていると考えられる。

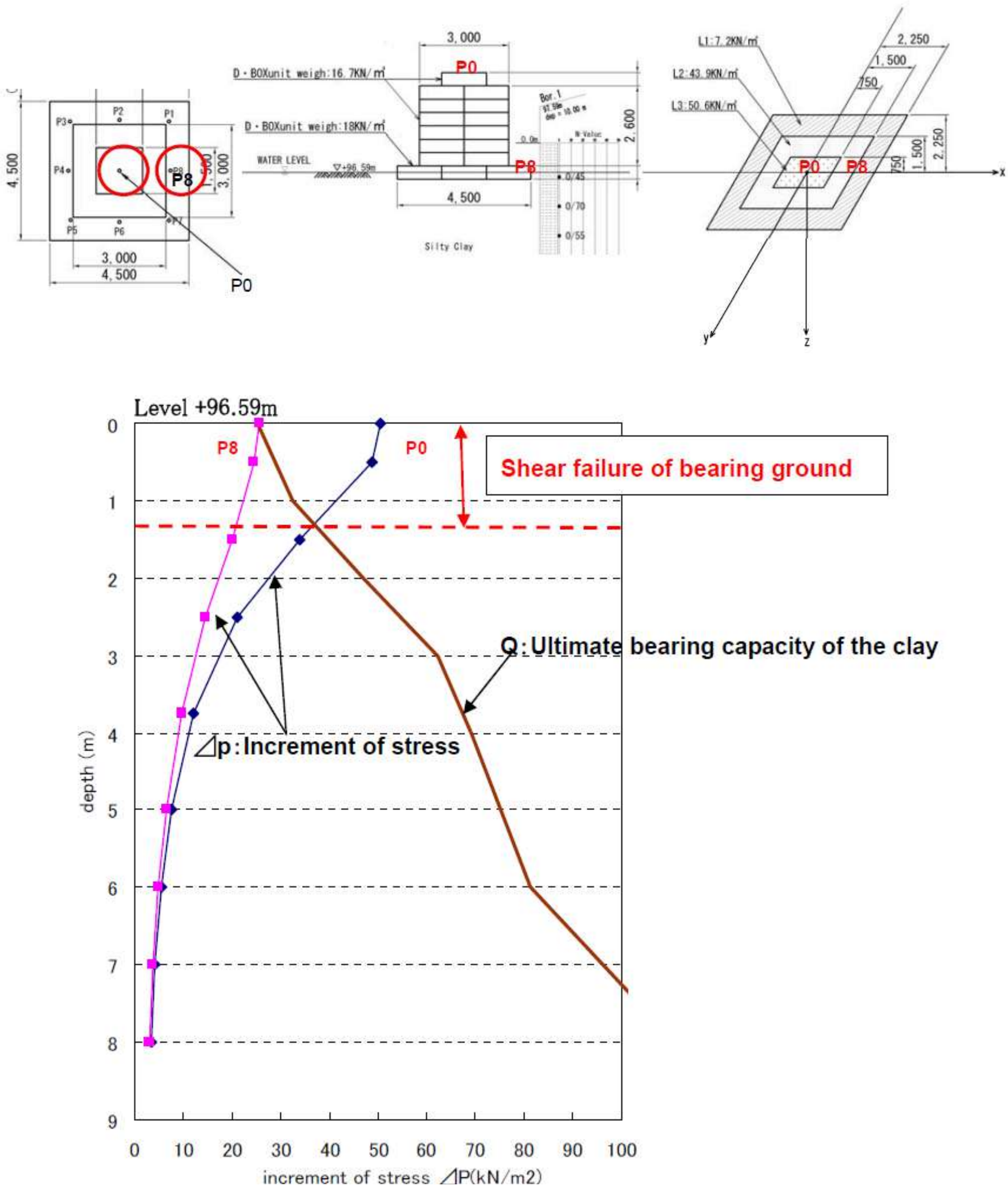


図 1.3.3　P0 及び P8 位置における粘土層内の増加応力⊿p と極限支持力 Q の比較

出典; 調査団作成

B.　　円弧すべり計算による支持検討

最下段の D-BOX が無いケース（D-BOX 部分を粘土（c=5.3kN/m²）としてモデル化）と、D-BOX（τ＝193.5 kN/m²）があるケースの円弧すべり計算結果の安全率を比較した。

D-BOX が無いケースの安全率は Fs=0.61、D-BOX があるケースの安全率は Fs=1.79 となり、D-BOX の補強効果によって、安全率が大きく向上している。

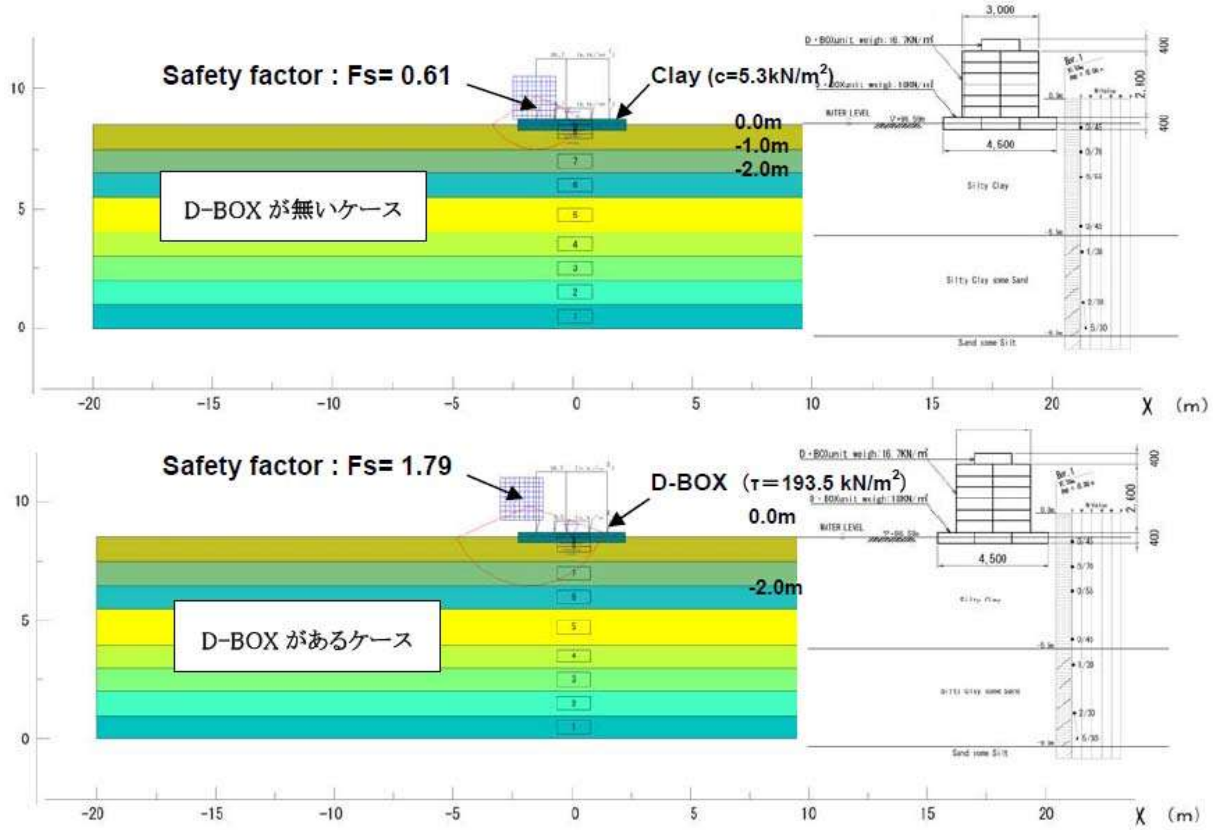


図 1.3.4　最下段の D-BOX が無いケースと D-BOX があるケースの安全率（円弧すべり）の比較

出典；　調査団作成

C.　　砂置換工の検討

D-BOX の代わりに砂置換工を実施する場合において、安全率 Fs>1.0 となる置換砂の厚さを計算した。計算の結果、安全率 Fs>1.0 となる置換砂の厚さは 2m となった（図 1.3.5）

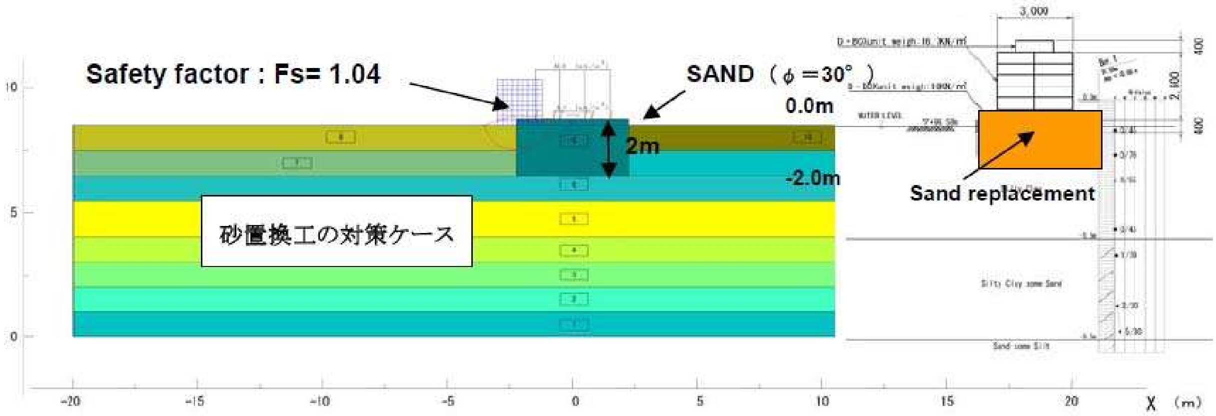


図 1.3.5　D-BOX の代わりに砂置換工を実施する場合における安全率 Fs>1.0 となる置換砂の厚さ

出典;調査団作成

2) 沈下抑制及び補強効果の評価

D-BOX の沈下抑制効果及び補強効果をまとめて、図 1.3.6に示す。

2013 年 11 月 12 日～12 月 18 日までの約 1 ヶ月間の沈下観測結果からは、予測沈下量に対して 2 割～5 割程度の沈下抑制効果を示している。また、地盤の支持力については、増加荷重が表層部の極限支持力を上回り、D-BOX が無い場合は円弧すべり安全率 Fs=0.61 となるが、D-BOX の補強効果（D-BOX 敷設部の支持力増加）により安全率 Fs=1.79 となり、安定性が大きく向上している。

このように D-BOX の大きな剛性（τ ＝193.5 kN/m²）によって、荷重分散による沈下抑制効果、支持力増加による補強効果が発揮されていると評価できる。

ただし、沈下抑制及び補強効果の定量的評価については、今後の沈下計測結果及び追加の土質調査結果（D-BOX 下部の粘土層の物理・強度特性についての変化等を調査）なども踏まえて評価していく必要がある。

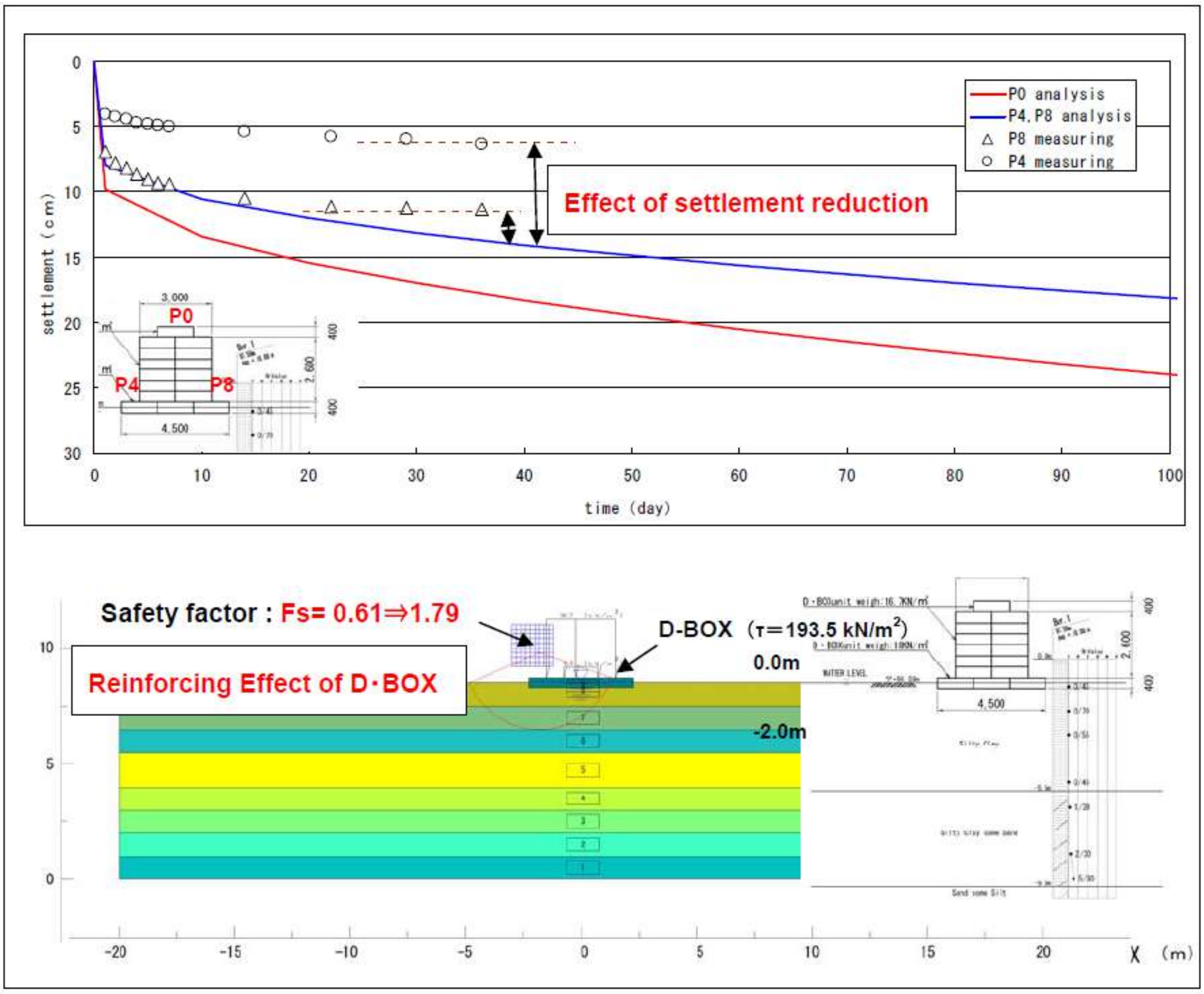


図 1.3.6 D-BOX の沈下抑制及び補強効果（支持力増加）

出典; 調査団作成

添付資料_008_パイロットプロジェクト検討資料

1.1 目的

セミナーおよび事前訪問によるヒアリング時に D・BOX の必要な場所および用途等についてヒアリングを行った結果、エーヤワディ管区等を中心とした軟弱地盤での道路、建物基礎、鉄道などの要望があった。今後の ODA の案件化の中ひとつとして小企業提案型のパイロットプロジェクトの可能性を探るため、より具体的な場所および協力体制について D・BOX の使用を要望している関係機関アンケート調査を実施した。

1.2 アンケート結果

アンケート結果は表-1 に示すとおりであり、鉄道関係（MR）から５候補地、公共事業局（PW）及び救済復興省（RRD）から１候補地が挙げられている。候補地の場所は図-1 に示すようにエーヤワディ管区が大部分を占めている。なお、いずれの候補地においても D・BOX 以外に必要となる材料、重機、作業員は供給するとのことであり、パイロット事業としてはいずれの場所でも対応可能である。但し実施場所の選定においては、パイロット事業での成果が PR でき、今後の需要が期待できるプロジェクトを第一候補とする。

表 1　パイロットプロジェクトの候補地一覧

図1	対象施設	関係機関	窓口	内容	延長	先方の要望	対象場所	備考
①	鉄道レール	鉄道公社 (Myanmar Railway; RW)	U Linn Khine Htay Divisional Engineer Office Hinthada Phone: 098-581820 Email: Linnkhinehtay@gmail.com	･レールの振動による噴泥発生 ･軟弱地盤で雨季にはレールが曲がり通行止めとなる。	広い範囲で発生	不明	Oki shitpin station	図 2
②	鉄道レール	〃	U Zaw Ye Myint Ein Me Executive Engineer Phone: 098-626974 Email: zymyint@gmail.com	･橋梁との取付部の沈下 ･地下水があり常に沈下が発生している。 ･潮位の影響もあり、地盤が常に飽和状態	100m (50m×2)	100m (50m×2)	Chaung Pya Bridge	図 3
③	鉄道レール	〃	Maung Maung Thwin Deputy general manager (Civil) Phone: 095-143680 Email:mgmghwin.mr@gmail.com	･橋との取付部の沈下と法面崩壊	約 4 マイルが洪水区域	100m(50m×2) 橋の両側に設置 法面対策は別途	Sacort village, Pantanaw township 90+520	図 4
④	鉄道レール	〃	Maung Maung Thwin Deputy general manager (Civil) Phone: 095-143680 Email:mgmghwin.mr@gmail.com	･軟弱地盤での沈下	約 2 マイルが洪水区域	100m：湿地帯に設置(人力)	Pantanaw -Sacort	図 5
⑤	道路	公共事業局 (Public Works; PW)	U Kyaw Shane Deputy chief engineer (Planning) Phone: 09-5200284 Email:kyawshane007@gmail.com	･橋梁との取付部の沈下	30m	30m	Kyon Sein Bridge	図 6
⑥	道路、 建物基礎	救済復興局 (Relief and Resettlement; RRD)	U Than Htut Swe Director Phone: 009567404317 Email: thswe.mm@gmail.com	･低地の軟弱地盤上の道路盛土沈下とクラック発生により,Sagaing の事務所への道路が使用できない。 ･倉庫の基礎の沈下	1,150f (345m) +建物基礎	1150f (345m) +建物基礎	Monywa (Sagaing Region)	
⑦	鉄道レール	JICA 技術協力プロジェクト (鉄道関係)	Nobuyuki Komatsu Railway administration and management expart Phone:+95-9-31624963 Email:komatsu@jictransport.co.jp	･雨季の軟弱地盤でのレールの沈下と曲がりによる通行障害	6,000m	30m (試験施工)	Togyaunggale-Dagon 大学	図 7 図 8

出典；調査団作成

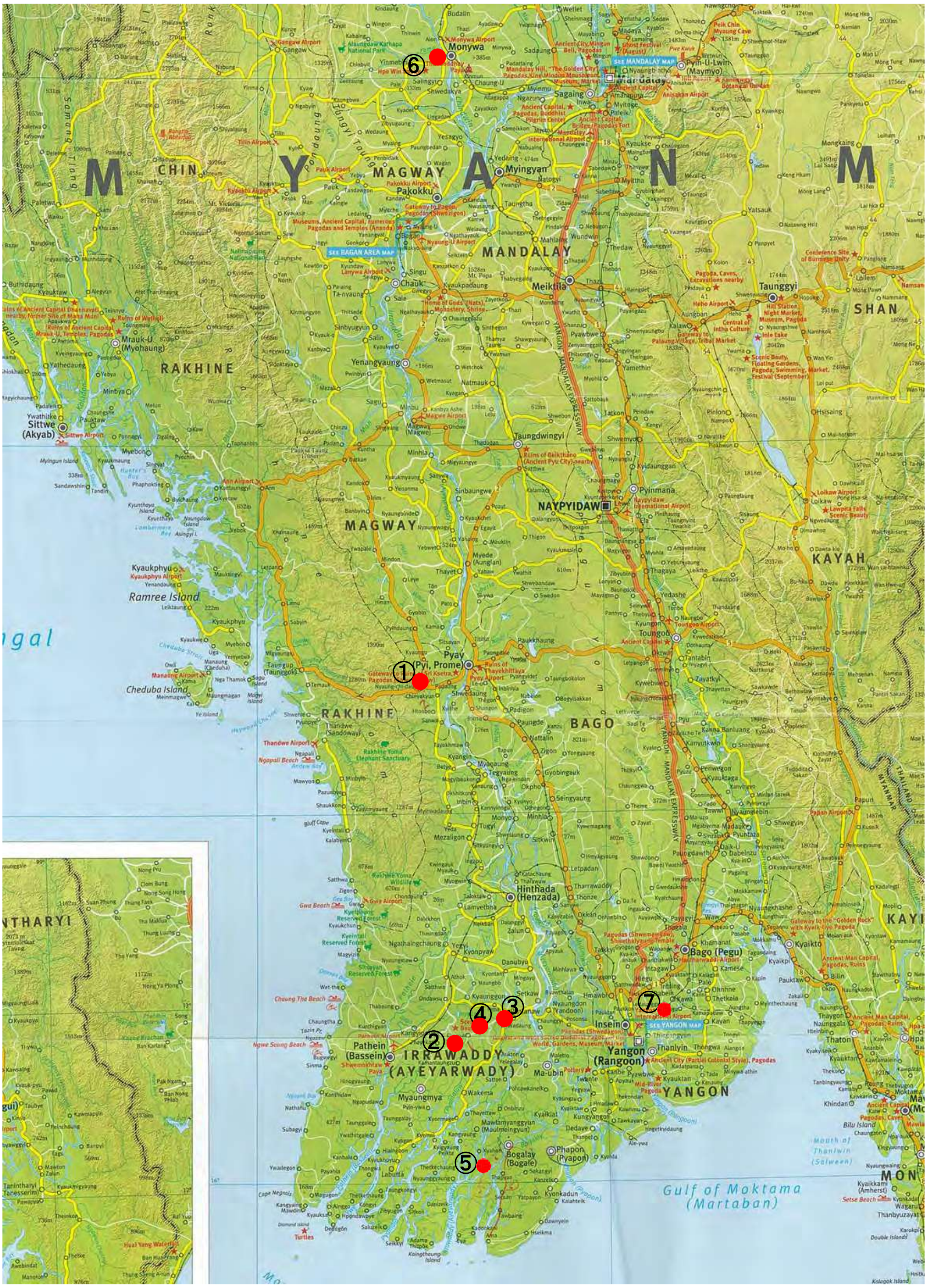


図 1　パイロットプロジェクトの候補地一覧

出典;調査団作成

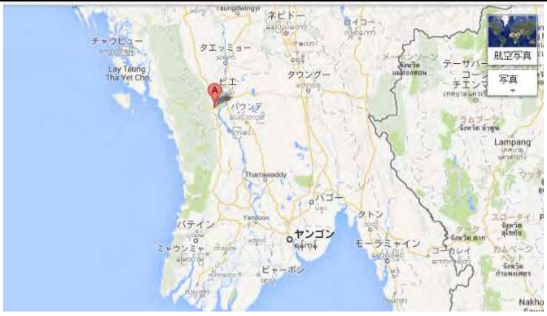


図 2　Oki shitpin station

出典;RW の資料より調査団作成

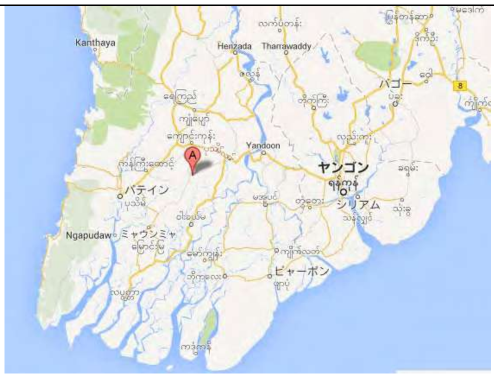
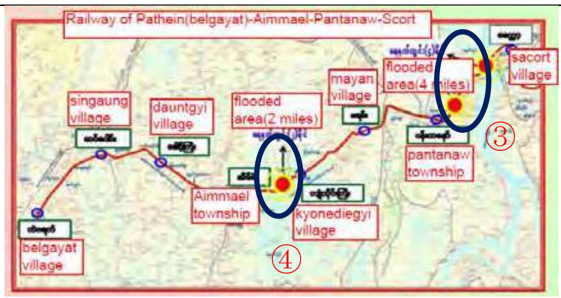


図 3　Chaung Pya Bridge

出典;RW の資料より調査団作成

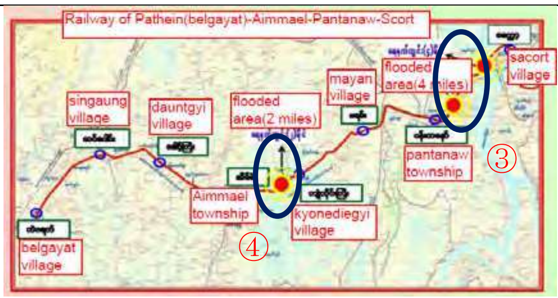


対象位置

Sacort Village-Pantanaw

図 4　　Sacort Village-Pantanaw

出典;RW



対象位置

Pantanaw−Sacort

図 5　Pantanaw-Sacort

出典；RW

図 6　PW.kyon Sein 橋

出典；調査団撮影

図 7　Togyaunggale-Dagon 大学

出典；JICA より入手

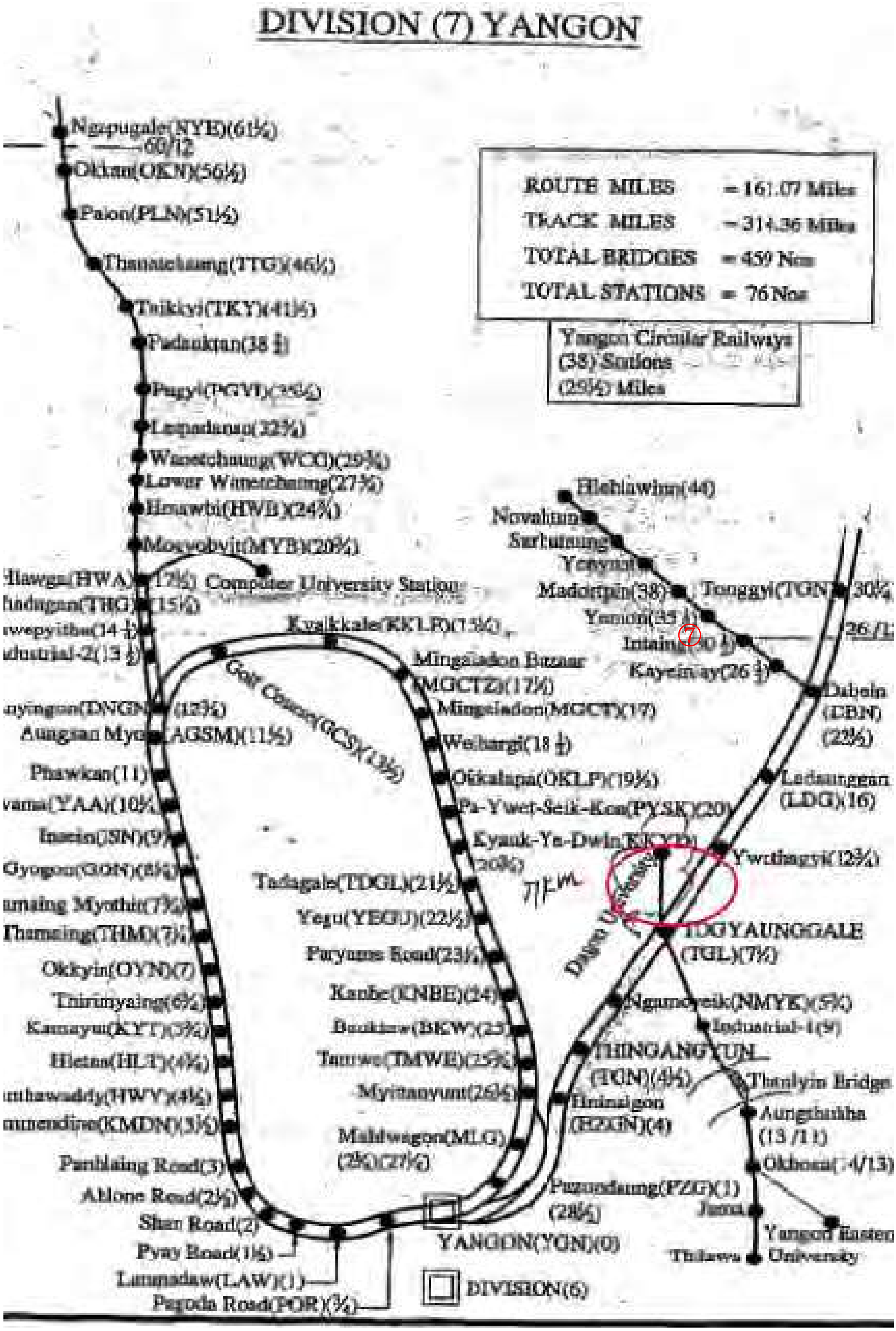


図 8　Tagyaunggale-Dagon 大学の位置図

出典；JICA 鉄道関連技プロより入手資料

1.3　アンケート回答

鉄道公社を始めとするアンケートの回答状況は表 2に示す通りである。港湾公社（MPA）は対象地がなく、ヤンゴン市開発委員会（YCDC）からは回答がなかった。

表 2　アンケート発送先と回答

関係機関	回答の有無	候補地	場所 図	備考
鉄道公社(RW)	○	4か所	①②③④	
公共事業局(PW)	△ 口頭で回答	1か所	⑤	
救済復興局(RRD)	○	1か所	⑥	
JICA 技術協力プロジェクト (RW)	○ (比較の施工)	1か所	⑦	
港湾公社(MPA)	△ 口頭で回答されたが候補地はないとのことであった	—	—	—
ヤンゴン市開発委員会 (YCDC)	×	—	—	—

出典;調査団作成

1.4　調査票とアンケート結果

調査票とアンケート結果及び送付されてきた写真を次項以降に示す。

(1) 調査票-1

パシフィックコンサルタンツ株式会社
〒206-8550 東京都多摩市関戸1丁目7番地5
TEL. 042-372-0111（大代表） FAX 042-372-6360

PACIFIC CONSULTANTS CO., LTD.
7-5, Sekido 1-chome, Tama-shi, Tokyo 206-8550, Japan
TEL.+81-42-372-0111 FAX +81-42-372-6360

November 28, 2013

[Name]
[Title]
[Division]
[Ministry]

Re: Questionnaire for the Pilot Project in 2015

Dear Sir:

We, Metry Technical Institute Co., Ltd., Pacific Consultants Co., Ltd., Oriental Consultants Co., Ltd. and Maeda Technical Industry Co., Ltd. have been assigned as a project team against soft ground by Ministry of Foreign Affairs of Japan. In this project, we conducted the demonstrational construction in Bogaley in Ayawady Region with the D・BOX, advanced countermeasure against soft ground.

We are planning to conduct next D・BOX project in Myanmar; the next project will be the Pilot project for the implementation of the D・BOX business, with the result of the demonstrational construction which has been conducted last November,2013 in Ayawardy. On this purpose, we would like to conduct wide trial and demonstrational construction in Myanmar. Actually, we are planning to apply JICA's Private proposal-based dissemination and demonstration projects.We would like to install the D・BOX at the targeted site(against soft ground) for 1-3 years, evaluate the efficiency of the D・BOX with measuring the situation; and disseminate the D・BOX, technology, method and products, in Myanmar. Based on the results of the Pilot Project, we will compile the D・BOX guideline for Myanmar. Our final goal is to produce the D・BOX at local factories in Myanmar with creating job opportunity, provide reasonable and eco-friendly countermeasure against soft ground, and contribute to Myanmar's safety infrastructure.

As to the targeted site for the Pilot project, we are targeting on the industrial estates in the soft ground area, including the base ground for the buildings; and landfilled ground. We would like to install the D・BOX to those above sites with technical guidance; and

(1) 調査票-2

パシフィックコンサルタンツ株式会社
〒206-8550 東京都多摩市関戸1丁目7番地5
TEL. 042-372-0111(大代表)　FAX 042-372-6360

PACIFIC CONSULTANTS CO., LTD.
7-5, Sekido 1-chome, Tama-shi, Tokyo 206-8550, Japan
TEL.+81-42-372-0111　FAX +81-42-372-6360

implement the Pilot project in Myanmar. Regarding this project, we would like to ask you to provide the site, heavy equipment, workers, gravel, and sand if our proposed Pilot project is adopted by JICA in next year.

We are ready to apply the JICA project in next year; however, we need the targeted site. Thus, we would like to ask you to propose the site for the project. It would be much helpful if you would kindly provide us information with answering the attached questionnaire.

Yours faithfully,

____

Hiroshi Shimada
Project Manager of the D・BOX Project
Pacific Consultants Co., Ltd.
hiroshi.shimada@ss.pacific.co.jp

Attachment: Questionnaire sheet for the target site

(1) 調査票-3

パシフィックコンサルタンツ株式会社
〒206-8550 東京都多摩市関戸1丁目7番地5
TEL. 042-372-0111(大代表) FAX 042-372-6360

PACIFIC CONSULTANTS CO., LTD.
7-5, Sekido 1-chome, Tama-shi, Tokyo 206-8550, Japan
TEL.+81-42-372-0111 FAX +81-42-372-6360

Questionnaire for the targeted site for the next D・BOX project

1. Name of the targeted site:

( )

It would be much helpful if you would provide the copy of google map.

If you would like to propose several sites, please use the copy of this sheet.

2. Situation of the ground at the targeted site:

( )

It would be much helpful if you would provide the pictures at the site.

3. Problems at the targeted site:

( )

4. What kind of support would you provide for the Pilot Project?

☐Heavy equipment ☐Workers ☐Gravel ☐Sand

☐Others

( )

5. With whom we should contact?

Name:		Title:	
Office:			
Phone:		Fax:	
Email:			

Contact person: Mr. Hiroshi SHIMADA (hiroshi.shimada@ss.pacific.co.jp)
Ms. Yuko MATSUDA (yuuko.matsuda@ss.pacific.co.jp)

(2) アンケート回答及び現地写真
図1-① Oki shiptin Stationに関する回答

MYANAM RAILWAYS
CIVIL ENGINEERING DEPARTMENT
NAYPYITAW

Questionnarie for the targeted site for the next D - Box project

1. Name of the targeted site :
   Sake Chan Gone Cutting, Between Kwin Hla and Okshitpin Station.

2. Situation of the ground at the targeted site :
   - Soil and ballast foundation were very weak.
   - the mud under the foundation was compressed due to the vibration of trains.

3. Problems at the targeted site :
   Muddy track cause the derailment of train. Especially in rainy season, the train is stop in operation.

4. What kind of support would you provide for the Pilot Project ?

   ☑ Heavy equipment ☑ Workers ☑ Gravel ☑ Sand

   ☑ Others

5. With whom we should contact ?

Name :	U Linn Khine Htay	Title :	Devisional
Office :	Devisional Engineer Office, Hinthada		
Phone :	098581820	Fax :	04421059
Email :	Linnkhinehtay 09 gamil.com		

図1-① Oki shiptin Station

Imagery ©2013 DigitalGlobe, Landsat, Map data ©2013 Google 2 km

MYANAM RAILWAYS
CIVIL ENGINEERING DEPARTMENT
NAYPYITAW

Questionnarie for the targeted site for the next D - Box project

1. Name of the targeted site :
   Approaches of Chaung Phyar Bridge, Between Einme` - Daung Gyi Station, Yangon - Pathein Rail Line.

2. Situation of the ground at the targeted site :
   This rail line across the deep water firm and tidy affected areas. The soil is satuated even in summer.

3. Problems at the targeted site :
   Unstable and failure of embankment.

4. What kind of support would you provide for the Pilot Project ?

☑ Heavy equipment ☑ Workers ☑ Gravel ☑ Sand

☑ Others

5. With whom we should contact ?

Name :	U Zaw Ye` Myint	Title :	Executive Engineer
Office :	Ein Me		
Phone :	098626974	Fax :	0425689
Email :	zymyint @ gamil.com		

MINISTRY OF RAIL TRANSPORTATION
MYANMA RAILWAYS
CIVIL ENGINEERING DEPARTMENT
NAYPYITAW

図1-③ Chaung Phyar Bridgeに関する回答

No. 19: Pa/2013-14/234
Dated. 17-2-2014

Dear Mr. Hiroshi Shimada,

We are very pleased on your information that the planning of next D-Box project is intended to MR. Although your choice is Pantanau - Sacort Rail line, our MR has already treated with sand piles and blanket on that line.

Our essential requirement is to treat the approaches of Chaung Phyar Bridge, between Einme - Daung Gyi Station, Yangon- Pathein Rail line.

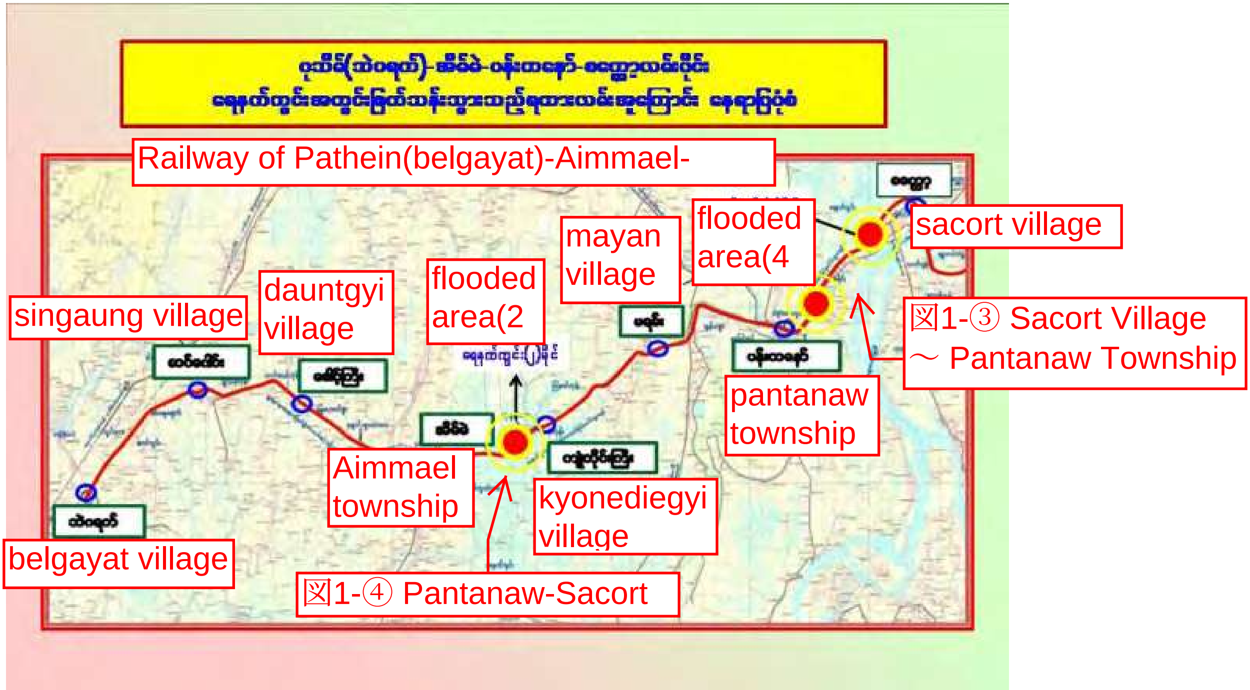
Therefore, Please consider to our requirement and the details factors of that area is following ;

Location	-	Chaung Phyar Village, Einme Township, Irrewaddy Division
Milage	-	16 / 3-4 from Balgayet
Corrdinates	-	Easting - 727368.27 m
		Northing - 1872447.74 m
		Elevation - 1.01 m
		(Azimuth)
Type of Bridge	-	1 / 27.50 m Span , P.C Girder, R.C.C Bored Pile Foundation
Height of Embankment	-	4.34 m

Best Regards Yours,

17/2/14
for General Manager (Civil)
(Maung Maung Thwin)
Deputy General Manager(Civil)


Myaungmya
Myanmar (Burma)
16° 55.666', 95° 7.857'


Railway of Pathein(belgayat)-Aimmael-
sacort village
flooded area(4
mayan village
flooded area(2
dauntgyi village
singaung village
図1-③ Sacort Village ～ Pantanaw Township
pantanaw township
Aimmael township
kyonediegyi village
belgayat village
図1-④ Pantanaw-Sacort

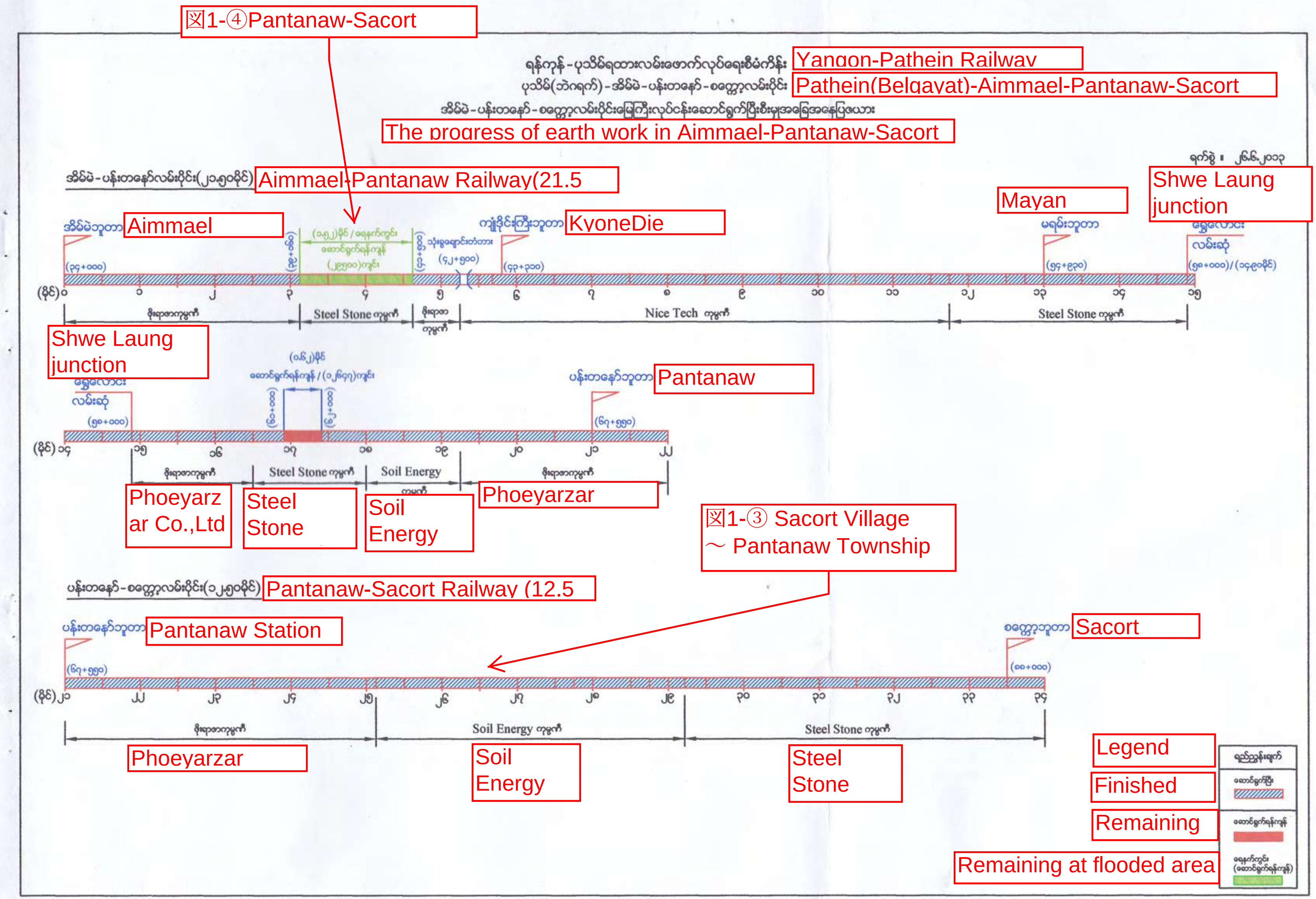


図1-④Pantanaw-Sacort
Yangon-Pathein Railway
Pathein(Belgayat)-Aimmael-Pantanaw-Sacort
The progress of earth work in Aimmael-Pantanaw-Sacort
Aimmael-Pantanaw Railway(21.5
Aimmael
KyoneDie
Mayan
Shwe Laung junction
Steel Stone
Nice Tech
Shwe Laung junction
Pantanaw
Soil Energy
Phoeyarzar Co.,Ltd
Steel Stone
Soil Energy
Phoeyarzar
図1-③ Sacort Village ～ Pantanaw Township
Pantanaw-Sacort Railway (12.5
Pantanaw Station
Sacort
Soil Energy
Steel Stone
Phoeyarzar
Soil Energy
Steel Stone
Legend
Finished
Remaining
Remaining at flooded area

図1-③ Sacort Village ～ Pantanaw Township

Subsidence/Landslide area(about 3 ft) at flooded area between point 90+520 and 90+540

図1-③ Sacort Village ～ Pantanaw Township

図1-③ Sacort Village ～ Pantanaw Township

မိုင်းအမှတ်(၉၀ + ၄၄၀)နှင့်(၉၀ + ၄၅၀)ကြားရေနုတ်တွင်းသောင်ပြန်ရှိသောကြောင့်
အလျား(၁၀ – ၈၀)ခန့်ရထားလမ်းအလယ်အထိပြတ်တောက်နေပုံ

図1-④ Pantanaw-Sacort

The condition of Pantanaw - Sacort Rail road in previous rainy season

ပန်းတနော်-ဆက်ကော့ရထားလမ်းပိုင်း ယခုနှစ်မိုးတွင်းကာလရထားလမ်းကြောင်းအခြေအနေအားမြင်တွေ့ရပုံ

ကိုသော ဝန

အမှတ်(၁)၊ ဝက်င ဘသာလမ်း၊ ဗဟန်းမြို့နယ်

ရန်ကုန်မြို့

Ph. ၀၉၄၃၁၃၆

ဖိလစ်ပိုင်နိုင်ငံသို့ပေးပို့ထောက်ပံ့ခဲ့သည့်ကယ်ဆယ်ရေးပစစည်းများစာရင်း

စဉ်	ကယ်ဆယ်ရေးပစစည်း	စုစုပေါင်း(ထည်)	စုစုပေါင်း(အလေးချိန်)	တန်ဖိုး(US$)
၁	စခောင်	၂၀၀	၈၆.၀၅ kg	၃၉၀
၂	မျက်နှာသုတ်ပဝါ	၁၅၀	၅၃.၉၄ kg	၃၈၂.၅
၃	တီရှပ်	၂၀၀	၅၂.၇၂ kg	၂၁၈
၄	ထွန်းရှူ့ဓါတ်ခဲ းဘူး	၃၀၀၀ဗူး	-	၁၅၀၀
			စုစုပေါင်း	၂၄၉၀.၅

ပြည်ထောင်စုသမ္မတမြန်မာနိုင်ငံတော်အစိုးရ
လူမှုဝန်ထမ်း၊ ကယ်ဆယ်ရေးနှင့် ပြန်လည်နေရာချထားရေးဝန်ကြီးဌာန
ကယ်ဆယ်ရေးနှင့် ပြန်လည်နေရာချထားရေးဦးစီးဌာန

စာအမှတ်၊ /၉(၃) ပထ/ ကဆရ

ရက် စွဲ ၊ ၂၀၁၃ခုနှစ်၊ ဒီဇင်ဘာလ ရက်

အကြောင်းအရာ။ **မေးခွန်းများဖြေကြားပေးရန်အကြောင်းကြားခြင်း**

၁။ တိုင်းဒေသကြီး/ ပြည်နယ်များတွင် တည်ဆောက်ရေးလုပ်ငန်းများ ဆောင်ရွက်ရာ၌ မြေပျော့များတွင် ဆောက်လုပ်သော အဆောက်အဦ၊ လမ်းများ၏ အောက်ခြေ၌ ခိုင်ခံ့စေရန် ဂျပန်နည်းပညာ ဖြင့် ပြုလုပ်ထားသော D-Box ပစ္စည်းများကို Foundation အစား အသုံးပြုနိုင်ဖို့ဖြစ်ပါသည်။ ထိုပစ္စည်း ကို သက်ဆိုင်ရာ တိုင်းဒေသကြီး / ပြည်နယ်များတွင် ဆောက်လုပ်မည့် အဆောက်အဦများ၊ လမ်းများ တွင် အသုံးပြုမည်ဆိုပါက နိုင်ငံတော်အစီအစဉ်(သို့) ဂျပန်နိုင်ငံအစိုးရ အကူအညီဖြင့်ဆောင်ရွက်မည် ဖြစ်ပြီး အောက်ပါမေးခွန်းများအား ဖြေကြားပေးပါရန် လိုအပ်ပါသည်-

၁။ တည်ဆော ောက်မည့် နေရာအမည် (Google Map ပေးနိုင်လျှင် ပိုကော ာင်းပါ သည်။)

၂။ တည်ဆော ောက်မည့် နေရာ၏ မြေအနေအထား(ပုံများပေးလျှင် ပိုကော ာင်းပါသည်။)

၃။ တည်ဆော ောက်မည့် နေရာတွင် တွေ့ရသော ောဖြေသနာများ

၄။ ထိုတည်ဆော ောက်မည့်နေရာအတွက် သက်ဆိုင်ရာဒေသမှ ဘာအထော ောက်အပံ့ပေး မှာလဲ-

☐ လော းလံသော ောပစ္စည်းများ ☐ အလုပ်သမားများ
☐ ကျော ေက် ☐ သဲ

☐ အခြားအရာများ

၅။ ဆက်သွယ်ရမည့် -

အမည်

ရာထူး ရုံး

ဖုန်း ဖက်စ် e-mail

၂။ D-Box နှင့်ပတ်သက်သည့် အချက်အလက်အား သိရှိနိုင်ပါရန်နှင့် မေးခွန်းများ ဖြေကြား နိုင်ပါရန် ပူးတွဲပေးပို့အပ်ပါသည်။

ညွှန်ကြားရေးမှူးချုပ် ( )

(သန်းထွန်းညွှန်ကြားရေးမှူး)

-----------------တိုင်းဒေသကြီး/ ပြည်နယ်ဦးစီးမှူးရုံး

မိတ္တူကို

ရုံးလက်ခံ

မျှော

ပြည်ထောင်စုသမ္မတမြန်မာနိုင်ငံတော်အစိုးရ

လူမှုဝန်ထမ်း၊ ကယ်ဆယ်ရေးနှင့် ပြန်လည်နေရာချထားရေးဝန်ကြီးဌာန

ကယ်ဆယ်ရေးနှင့် ပြန်လည်နေရာချထားရေးဦးစီးဌာန

စာအမှတ်၊ /၁(၁၅) ပထ/ ကဆရ

ရက်စွဲ၊ ၂၀၁၃ခုနှစ်၊ ဒီဇင်ဘာလ ရက်

အကြောင်းအရာ။ **အစည်းအဝေးခန်းမအသုံးပြုခွင့်ပြုနိုင်ပါရန်ညှိနှိုင်းခြင်း**

၁။ မြန်မာနိုင်ငံအတွင်း တည်ဆော ါက်မည့်အဆော ါက်အဦနှင့်လမ်းများတွင်

အသုံးပြုနိုင်သော ါ

D -box နည်းပညာနှင့်ပတ်သက်၍ Japanနိုင်ငံမှနည်းပညာရှင်များသည်

ကယ်ဆယ်ရေးနှင့် ပြန်လည် နေရာချထားရေးဦးစီးဌာနနှင့်(၁၀-၁၂-၂၀၁၃)

နေ့လည် (၂း၃၀)တွင် ခွာ ရွေ ရော်န်ညှိနှိုင်းလာပါသည်။

၂။ သို့ဖြစ်ပါ၍ ကယ်ဆယ်ရေးဦးစီးဌာနမှအစည်းအဝေးခန်းမှာ

မအားလပ်ပါသဖြင့် လူမှုဝန်ထမ်း ဦးစီးဌာနအစည်းအဝေးခန်းမအား နေ့လည်

(၂း၃၀) မှ (၃း၃၀)ထိခေတ္တထုံးစွဲခွင့်ပြုပါရန် ညှိနှိုင်းအပ် ပါသည်။

ညွှန်ကြားရေးမှူးချုပ်(

)

(သန်းထွန်းခွာ ညွှန်ကြားရေးမှူး)

ညွှန်ကြားရေးမှူးချုပ်

လူမှုဝန်ထမ်းဦးစီးဌာန

မိတ္တူကို

ရုံးလက်ခံ

မျှ ၈

The Republic of the Union of Myanmar

Ministry of Social Welfare, Relief and Resettlement

Department of Relief and Resettlement

Letter No. /1(26)supply section/ rrd

Date. December 20 , 2013

Subject; **Replying to use D- Box**

Dear Mr.Hiroshi

Under the Department of Relief and Resettlement, the Sagaing Divisional Office's Road is difficult to use because the foundation of road is muddy, soft and low place. We would like to use D.Box under the road foundation which is 1150 ft long, the warehouse foundation and officer's house foundation by applying JICA supporting.

So we would like to request to come and check in this place to use D-Box in these buildings foundation.

My warmest wishes for your success and good health.

Yours sincerely,

Mr. Than Htut Swe

Director, Department of Relief and Resettlement,

Ministry of Social Welfare, Relief and Resettlement,

Cc;

JICA Myanmar Office

Sagaing Divisional Office

Questionnaire for the targeted site for the next D.BOX project

1. Name of the targeted site:

   Monywa (Sagaing Region)

2. Situation of the ground at the targeted site:

   Soft clay soil

3. Problems at the targeted site:

   Ground becomes lower, the ground is not smooth, cracked ground

4. What kind of support would you provide for the Pilot Project?

   Workers, Gravel, Sand

5. With whom we should contact?

   Name-----Daw Lai Lai Aye

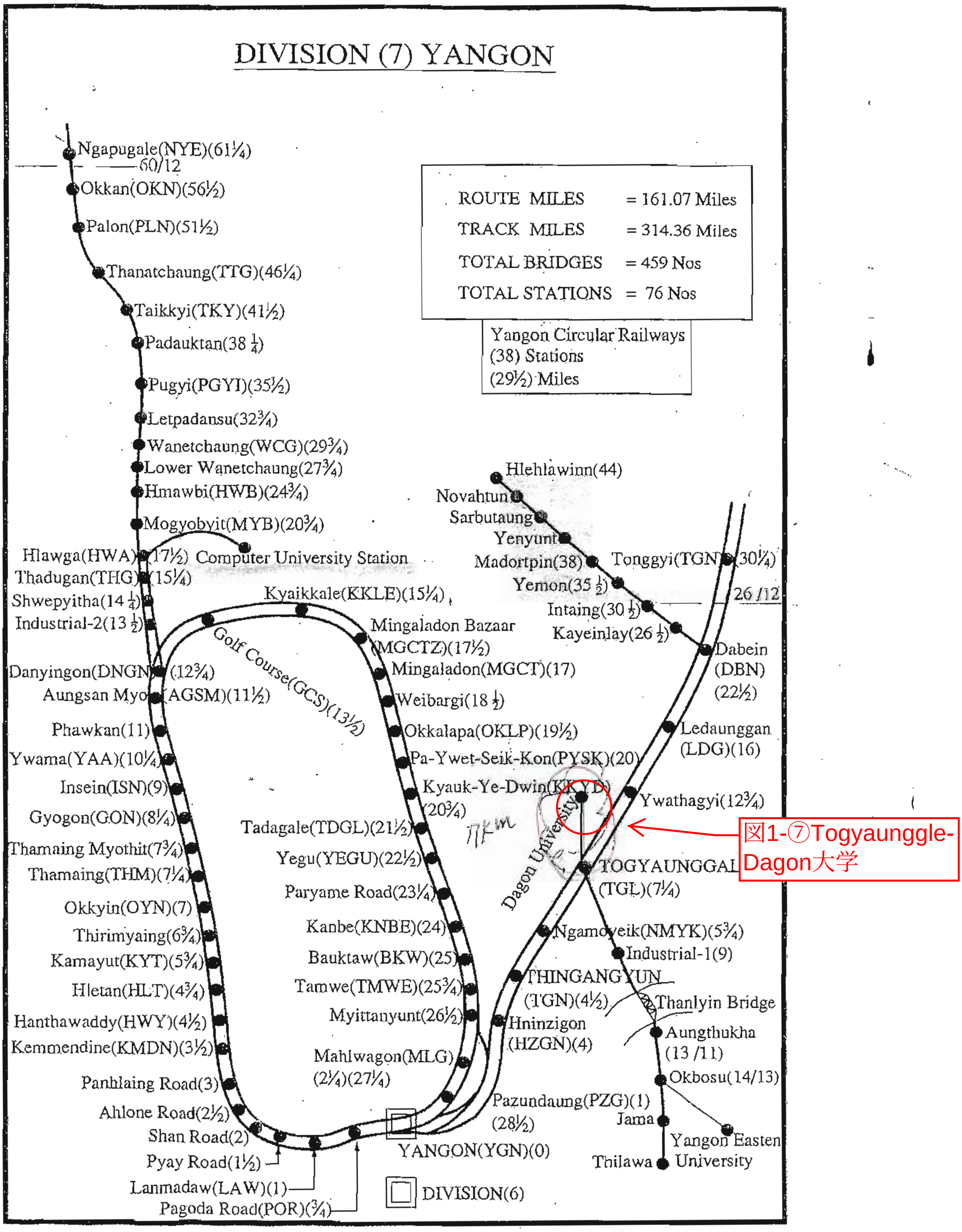
   Title--------Deputy Director

Office-----Sagaing Divisional Office of Relief and Resettlement Department, Nandawan Compound Office, Sagaing Region

Phone----0947093480, 07123221

E-mail-----ayelailaimnta@gmail.com

(4) JICA技プロ関係からの入手資料-1



(4) JICA技プロ関係からの入手資料-2

(4) JICA技プロ関係からの入手資料-6

(4) JICA技プロ関係からの入手資料-8

(4) JICA技プロ関係からの入手資料-9

添付資料_009_ボーリング実施結果

Soil Investigation Report

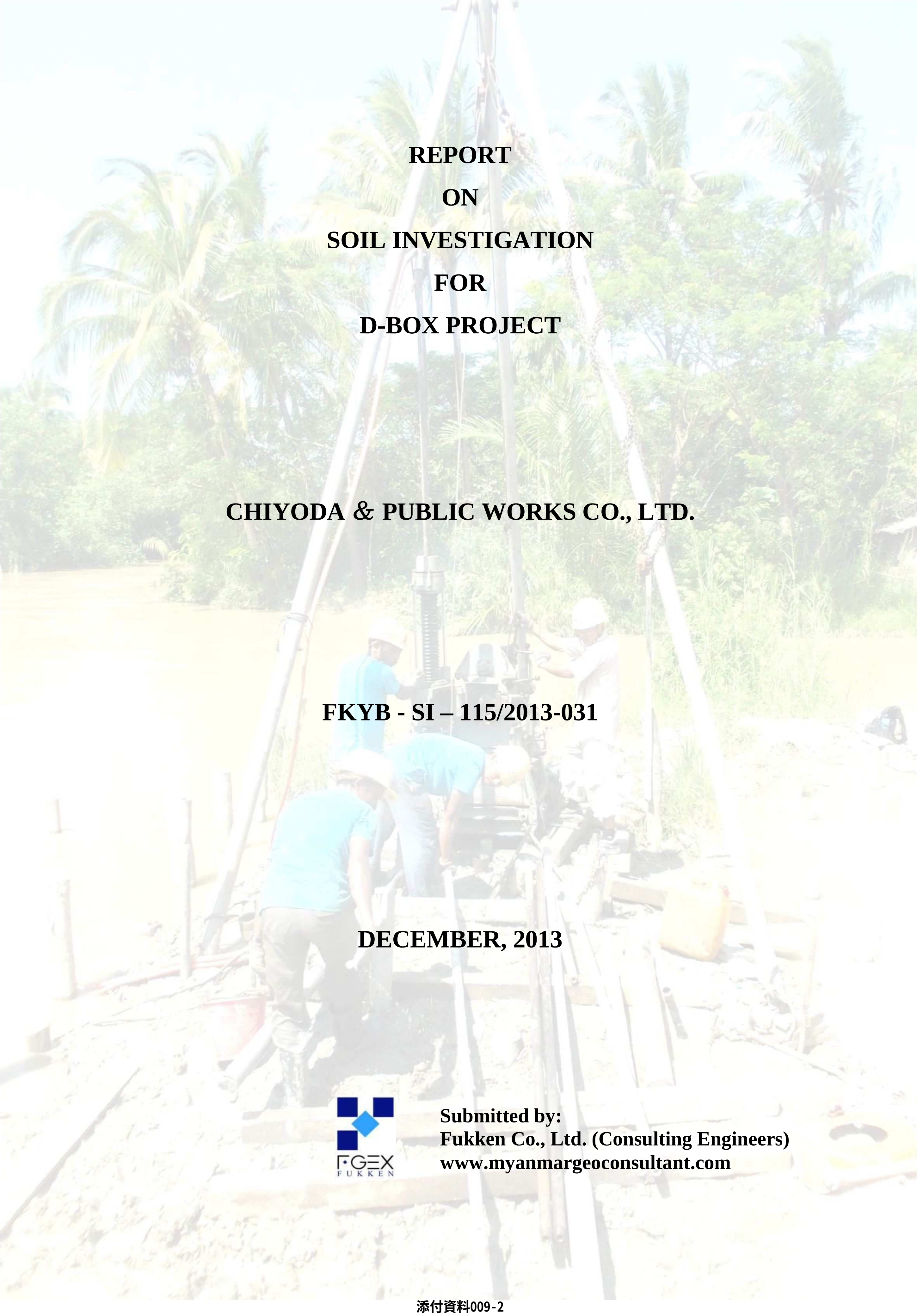
Observed by Pacific Company Ltd.

Data by Fukken Company Ltd.,

Compiled by Chiyoda & Public Works Co., Ltd.

Date: 2014.Jan.22

Chiyoda & Public Work Co., ltd



REPORT
ON
SOIL INVESTIGATION
FOR
D-BOX PROJECT

CHIYODA & PUBLIC WORKS CO., LTD.

FKYB - SI – 115/2013-031

DECEMBER, 2013

Submitted by:
Fukken Co., Ltd. (Consulting Engineers)
www.myanmargeoconsultant.com

REPORT
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REPORT ON SOIL INVESTIGATION FOR D-BOX PROJECT

BOGALAY TOWNSHIP, AYEYARWADDY REGION

UNION OF MYANMAR

1.0 INTRODUCTION

Geotechnical investigations are performed by geotechnical engineers or engineering geologists to obtain information on physical properties and mechanical properties of soil at the designated site by the client.

In this project, the test constructing which of called "D-Box" is planned. D-Box is a type of soil improvement method by consolidation. This method is direct surcharge method by piling up large sandbags called "D-Box" on the soft ground. It can be expected to force the soft ground promote consolidation settlement and to make the strength of the soil increase by constructing D-Box. Our Fukken Co., Ltd was assigned to conduct **one borehole** and **two Swedish sounding tests (hereinafter called as "SW")** to confirm the strength of the original and the improved soil.

1.1 Scope of Work

The scope of investigation work includes four portions; field investigation work about the original soil, field investigation work about the improved soil, laboratory testing and report preparation. The field investigation work about the original soil includes soil rotary boring, Standard Penetration Test (hereinafter called "SPT"), to take undisturbed samples and Swedish sounding (hereinafter called "SW"). The field investigation work about the improved soil includes SW after constructed D-Box. As N_{sw}-value which is got from SW can be converted as N-value, so by carrying SW can be estimated the strength of the original and improved soil. SPT were performed in accordance with ASTM Standard *(American Society of Testing and Materials)*. SW was performed in accordance with JIS *(Japan Industrial Standard)*. The collected disturbed samples and undisturbed sample from the boreholes were analyzed at Fukken's Yangon Branch Laboratory.

1.2 Project Location

Project area is located on Bogalay ~ Ka Don Ka Ni Road, Bogalay Township, Ayeyarwaddy Region. The location of project area is indicated as an aerial photo in Figure – 1.1.

Figure -1.1 Aerial photo of project area

1.3 Equipment Applied in the Project

1.3.1 Boring Equipment

One number of boring equipment TOHO D-1 was applied in field investigation works to study general condition of soil layers under planned area for original condition at the site. The specifications of boring equipment were presented in following table.

Table -1.1 Specification of Boring Equipment

Parts of Equipment	***Particulars***
Brand of Boring machine	TOHO-“D-1”
Boring Type	Rotary
Feeding Type	Hydraulic Feed Type
Drilling Capacity	150m
Spindle Stroke	400mm
Spindle Inner Dia.	43mm
Hoisting Speed	10~59m/min
Weight	476kgf
Oil Pump Discharge Capacity	19 l/min
Oil Pump Working Pressure	45~70kgf/cm^2
Attached Water Pump Type	Toho “BG-3B”
Discharge Capacity	54 l/min
Working Pressure	15 kef/cm^2
Engine	Yanmar Engine 110
Power	11.0 HP
Brand of Boring machine	TOHO-“D-1”
Boring Type	Rotary
Feeding Type	Hydraulic Feed Type

Photo -1.1 TOHO D-1 Drilling Machine

1.3.2 Swedish Sounding Equipment

In this field investigation, Swedish sounding was applied to estimate N-value and compare the strength of the original soil to of the improved soil which is loaded by D-Box. SW equipment is shown in figure-1.2. The specifications of SW equipment are as follows;

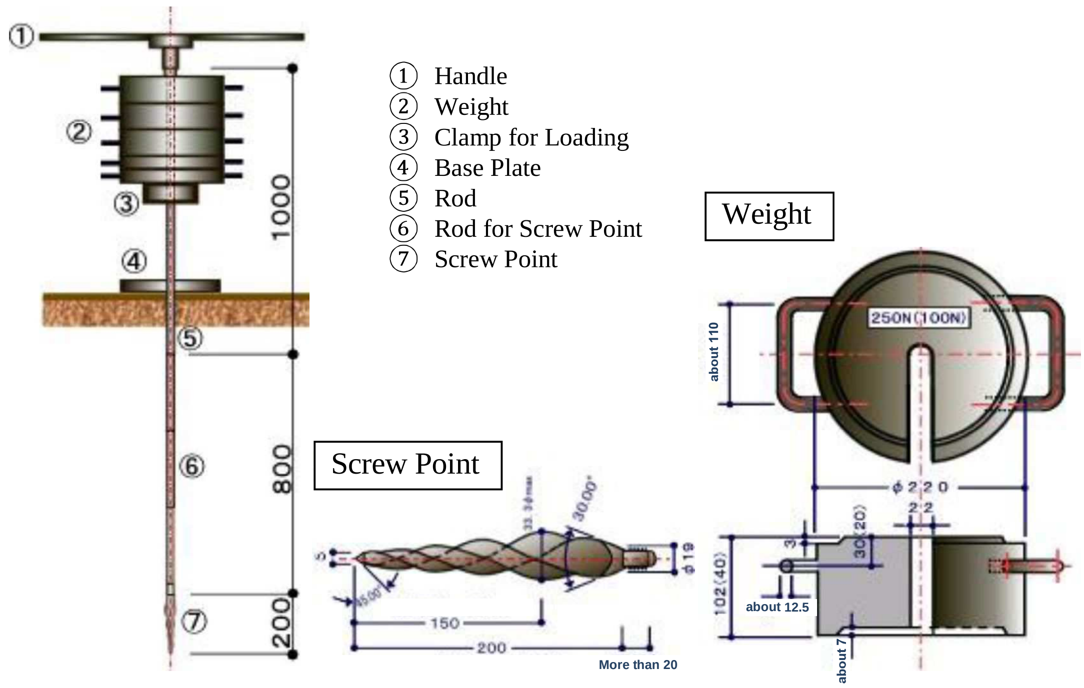


Figure -1.2 Schematic diagram of Swedish sounding equipment

1.4 Project Duration and Personnel

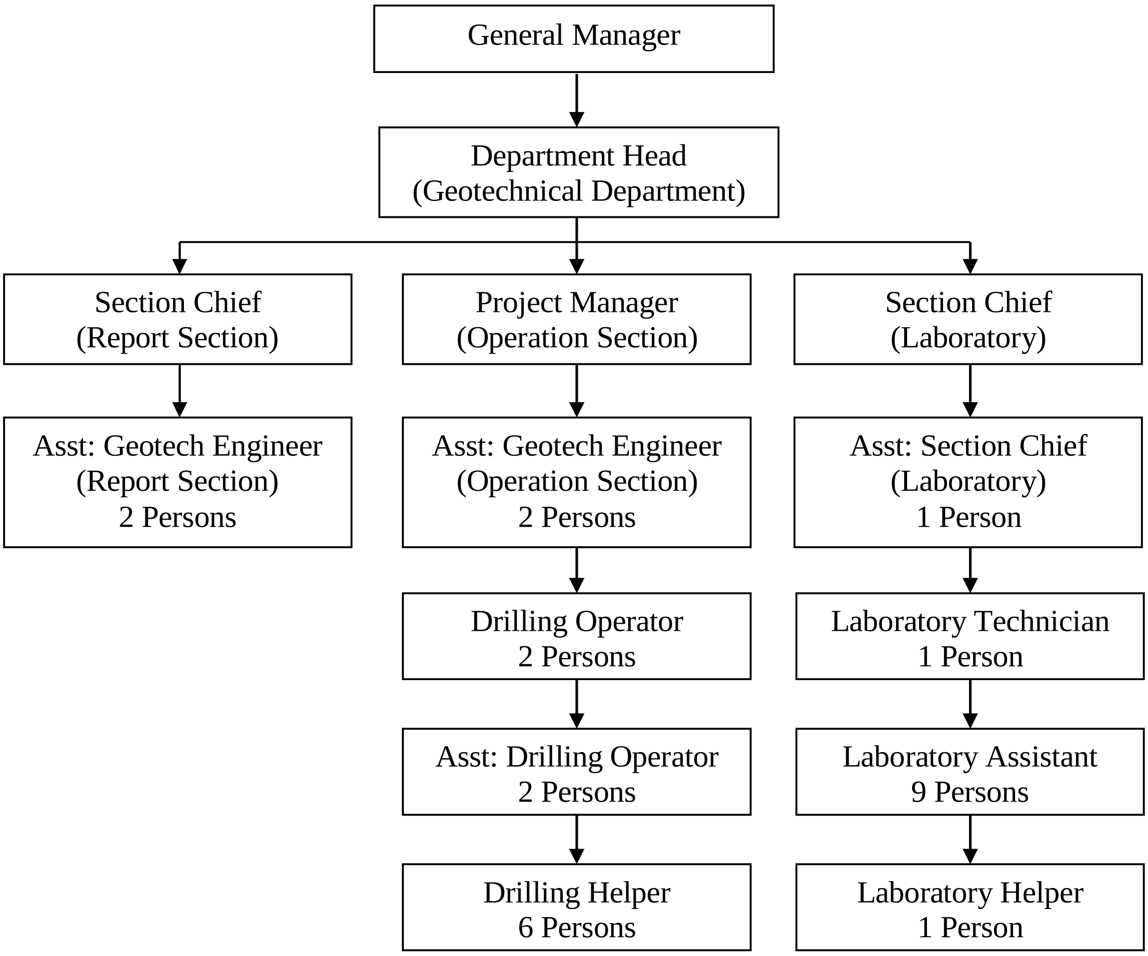
Fukken Co., Ltd conducted field investigation work in project area. The field investigation works was started from 1th November, 2013 and completed a Borehole and Swedish sounding test before constructing D-Box on 2th November, 2013. The laboratory test were carried out after field work and completed on 30th November. Swedish sounding test after constructing D-Box was completed 8th December. The final report shall be submitted on 24th December 2013.

The executed detailed actual working schedule is illustrated in table-1.1, indicating the organization chart of personnel of the operation and their responsibilities, including list of geotechnical engineers, drilling crews for one boring machine, technicians and the entire person involved in this operation.

Table -1.2 Actual Working Schedule of Geotechnical Investigation Work

No.	Description	Octorber-2013					November-2013										'December-2013									
		27	28	29	30	31	1	2	3	4	5	6	7	~	29	30	1	~	7	8	9	~	22	23	24	25
1	Preparation																									
2	Mobilization																									
3	Field Investigation																									
	Boring Work						BH-P-01																			
	Swedish sounding test(1)							SW-01																		
	Swedish sounding test(2)																			SW-02						
4	De-mobilization																									
5	Laboratory Test																									
6	Report Preparation																									
7	Final Report Submission																									

Holiday



Flow Chart -1.1 Organization Chart of Responsible Person

2.0 SITE CHARACTERIZATION

In this chapter, it would be included about the topography, regional geologic setting and geology of the project area, Bogalay Township, Ayeyarwaddy Division.

2.1 Topography

Since the proposed project area is located in the Ayeyarwaddy Delta Region, the topographic feature of the region is regards as relatively flat lying area. The project area is mainly composed of flood plain deposit and marine sediments. As it is located at the delta region, the braided channels are very common. The river and its tributary are meandering, shows old age stage of Ayeyarwaddy River. Flat lying topography with abundant channel is typical features of project area.

2.2 Regional Geological Setting

Refer to the geological map Burma, published by Earth Science and Research Division in 1977, the project area is covered by Younger Alluvial Deposit of Holocene age. The boring results of recent soil investigation confirmed that the project area is covered with the clastic sediments of flood plain deposit of deltaic environment in upper portion and shallow marine deposit of lower portion. Clay and Silt are major unit of both flood plain and marine. According to the geological map, the regional geological setting of the area is described as follow.

Formation	Age	Lithology
Younger Alluvium	HOLOCENE	Clastic sediments of marine and flood plain deposits
---------------------	Unconformity	
Irrawaddy Formation	MIOCENE-PLIOCENE	Sand, sandstone, silt, subordinated clays and soil
---------------------	Unconformity	
Upper Pegu Group	MIOCEN	Tuffaceous shale, sandstone, limestone of shallow marine origin

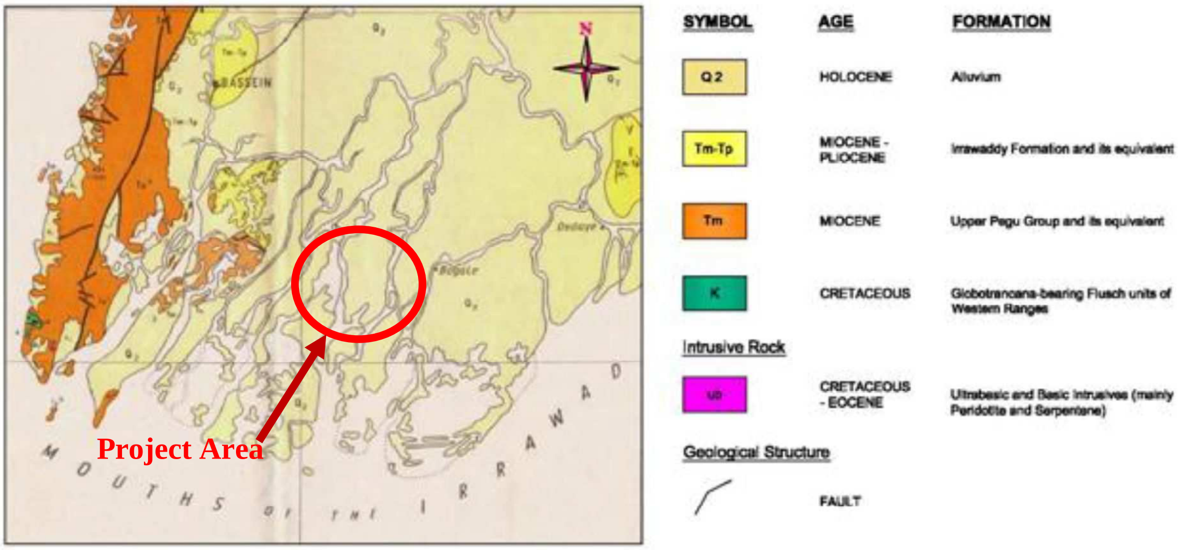


Figure -2.1 Regional Geological Map of Project Area

2.3 Geological Observation from Boreholes

The boring site was geologically formed with younger alluvim (Quaternary to recent). According to the investigation results, the rock outcrop or any evidence of bed rock is not observed throughout the boreholes in project area. By the result of disturbed and undisturbed samples by drill holes, it is showing that it is reflecting the recent Alluvial deposit. Most of soil layers in the project area are mainly Clayey soil layers. Silty SAND layer is observed at the bottom of the investigated hole.

3.0 FIELD INVESTIGATION

3.1 Investigation Works

Investigation works were SPT and taking undisturbed samples with boring work, SW about the original soil (hereinafter called SW(1)) and SW about the improved soil after constructing D-Box (hereinafter called SW(2)) . SPT depth (boring length) and SW(1) depth were 10m. SW(2) depth was 8.0m.

3.2 Boring Works

In boring, rotary direct circulation method is appropriately applied using metal crown bits attached to casings of Ø112mm and metal crown bits of Ø64 mm in diameter setting with single core tube are properly applied depending on soil condition to drilling process. The drilling machines are operated by setting on the stage with maintaining horizontal level of drilling machine and vertical position of drilling direction while drilling on field investigation works. Boring, SPT testing and taking disturbed samples in the point were operated from drilling stage maintaining the stability of boring machine. In the way of direct circulation of drilling fluid, water and betonies slurry was inevitably utilized to control the circulation of the sludge. The schematic diagram of boring equipment is shown in following Figure – 3.1.

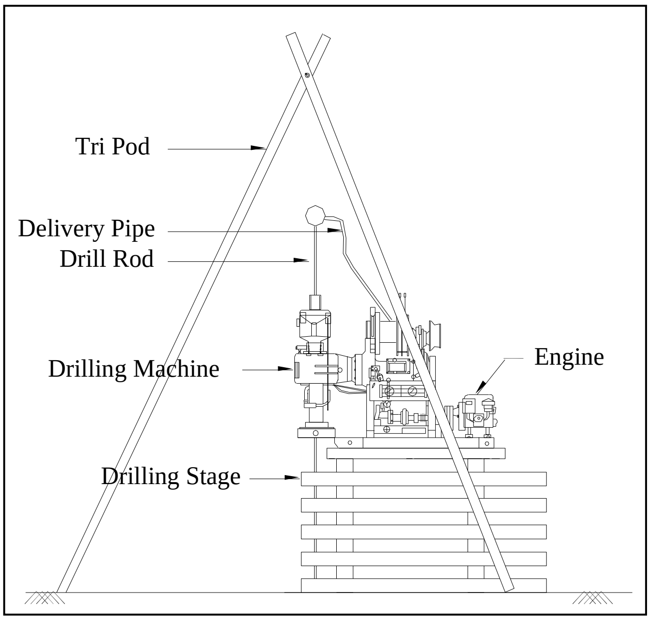


Figure -3.1 Schematic View of Drilling Machine setting

The boring log is shown in Table-3.1. The top layer of surface is Silty CLAY layer to GL-9.80m, and under GL-9.80m Silty SAND layer is checked. Silty CLAY layer has a very homogeneous grain size distribution, wet to moist, medium plasticity, with trace of mica mineral, brownish gray to gray color. Partially thin fine sand is put in Silty CLAY layer from GL-5.50m to GL-6.00m. Silty SAND layer is wet to moist, fine grained and gray.

Silty CLAY layer is shown in photo-3.1. Silty SAND layer is shown in photo-3.2.

Photo -3.1 Silty CLAY

Photo -3.2 Silty SAND

Table -3.1 Boring Log

BORING LOG

BORE HOLE No. **BH-P-01** | Job No. FKYB-2013-031 | Sheet No. 1 OF 1

PROJECT NAME	: Soil Investigation for D-Box Project	BORING EQUIPMENT	: TOHO " D1 "
LOCATION	: Bogalay~Ka Don Ka Ni Road, Bogalay Township, Irrawaddy Region	BORING METHOD	: Rotary Direct Circulation
GROUND LEVEL	: -	ORIENTATION	: Vertical
COORDINATE	: E 746311.000 ; N 1792412.000 DEPTH : 10.00m	GROUND WATER LEVEL	: 0.50m

DATE : 02.11.2013

CLIENT
CHIYODA & PUBLIC WORKS CO., LTD.

ELEVATION (m)	DEPTH GL - (m)	THICKNESS (m)	DIAGRAM	COLOUR	RELATIVE DENSITY (or) CONSISTENCY	SOIL NAME	SOIL DESCRIPTION	DATE & DEPTH (m)	CASING (DEPTH (m) & DIAMETER (mm))	WATER DEPTH (m)
	9.80	9.80		brownish gray to gray	very soft to soft	Silty CLAY	Very soft to soft, brownish gray to gray, wet to moist, medium plasticity, with trace of mica mineral GL-(5.50~6.00)m; thin fine sand layer is observed GL-(9.80~10.0)m; fine grained, silty SAND layer is observed at that depth		4.00 Ø115	
	10.00	0.20		gray	Loose	Silty SAND	Loose, gray, wet to moist, fine grained, Silty SAND	02.11.13 10.00		
							This borehole is terminated at 10.0m, after confirmation			

STANDARD PENETRATION TEST, TEST METHOD (ASTM) — CURVE OF BLOW ●; N-Value (Blows / 30cm) 0 10 20 30 40 50 — SAMPLING

DEPTH GL - (m)	N-Value (Blows / 30cm)	SAMPLE (Type & No.)	DEPTH GL - (m)	TCR (%)	SCR (%)	RQD (%)
1.50	0/45	P-1	1.50 2.00			
2.50	0/70	P-2	2.50 3.00			
3.50	0/55	P-3	3.50 4.00			
4.50		UD T-1	4.50 cm 5.25			
5.50	0/45	P-4	5.50 6.00			
6.50	1/30	P-5	6.50 7.00			
7.50		UD T-2	7.50 cm 8.14			
8.50	2/30	P-6	8.50 9.00			
9.50	5/30	P-7	9.50 10.00			
10.50						
11.50						
12.50						
13.50						
14.50						
15.50						

SCALE (m): 1 – 15

3.3 Standard Penetration Test (SPT)

The standard penetration test was done in accordance with ASTM Standard *(American Society of Testing and Materials).* The test was performed using a spilt barrel sampler (50mm diameter) connected to the end of boring rods. The sampler was driven into the soil by means of a 63.5 kg (140 lbs) hammer falling freely through the height of 76cm onto the anvil attached to the rod. The sampler is driven 450mm into the soil. SPT N value is recorded for each 150mm penetration of the sampling tube. In this case, seating drive of 150mm is first reached and the blow count for the seating drive is not applied because the bottom of the hole may be apart from natural condition at a certain extent. The resistance, N-value, is taken as number of blow for the penetration of test drive of next 300 mm. When 50 blows are reached before the full penetration 300 mm, no other blows are applied but final penetration is recorded. At the conclusion of the test, the retained soil sample is extracted and stored in plastic bag for further analysis. In which, Figure – 3.2 indicates the procedure and apparatus of standard penetration test. N-value is summarized in Figure – 3.3.

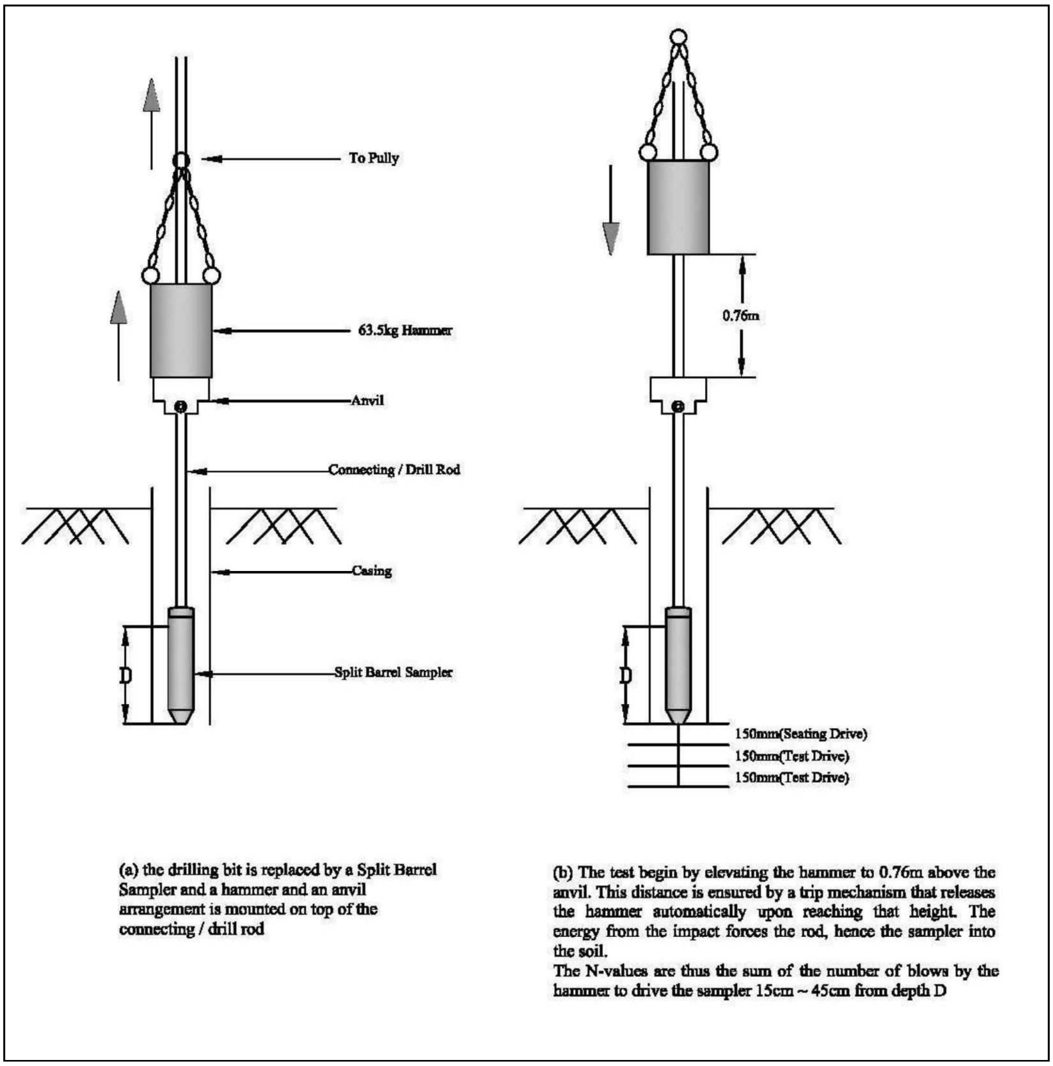


Figure -3.2 Procedure and Apparatus of Standard Penetration Test

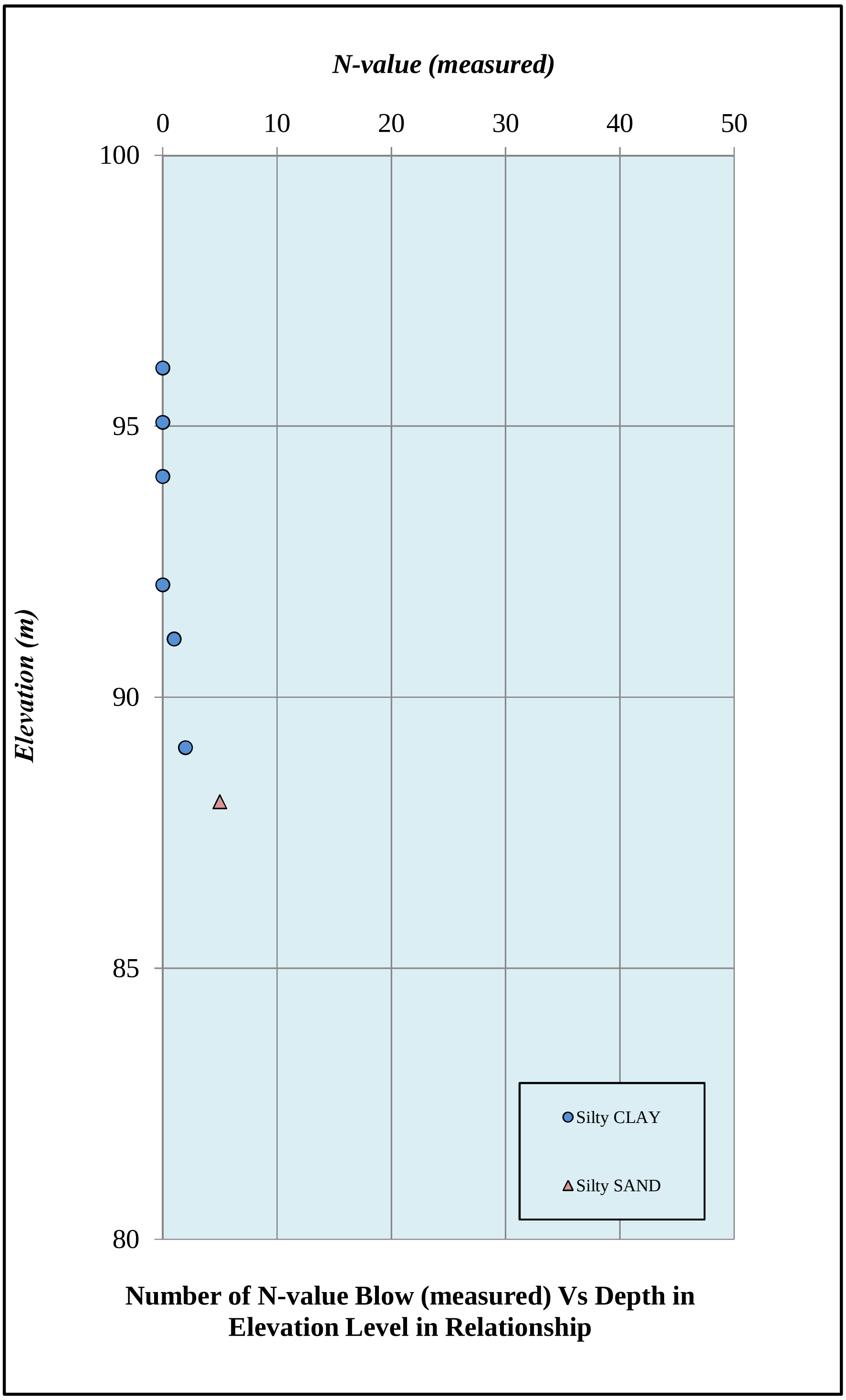


Figure -3.3 Number of N-Value (measured) vs Depth in elevation level relationship

Table -3.2 Comparison for SPT in different standards

Items to be Compared			JIS A 1219 (2013)	ASTM D 1586-84 (1992)	BS 1377 Test 19 (1990)
Testing Equipment	Rod	Length Less than 15m	JIS Rod (Outer diameter 40.5/42mm)	A Rod (Outer Diameter 41.2mm,Inner Diameter 28.5mm)	AW Rod (Outer Diameter 41.3mm, Mass 5.7kg/m)
		Length More than 15m		Recommend to use more rigid rod.	BW Rod or centerizer in every 3 m shall be installed with of AW Rod.
		Bend	-	-	-
	Sampler	Outer Diameter	51mm	50.8±1.3mm	50±0.15mm
		Inner Diameter	35mm	35.0mm	35±0.15mm
		Total Length	810mm	482~812mm (Sampler head is not included)	685mm
		Angle of Shoe edge	19°47′	16~23°	17°15′
		Thickness of Shoe edge	1.15mm	2.54mm	1.6mm
		Drain Hole	4 Hole	Ø9.2mm×2 holes	Ø13.0mm x 4 holes
		Ball Value	-	Hole Ø22.2mm, Ball : Ø25mm	Hole: Ø22.3mm, Ball: Ø25mm
	Hammer	Mass	63.5 kg	63.5±1.0kg	65kg
		Drop	75 cm	76±2.5cm	76cm
	Anvil		-	h:60mm D:75mm	-
Remarks on Testing Borehole	Applicable Diameter of Borehole		65~150mm	65~150mm	-
	Water Level in Borehole		Pay attention not to disturb the soil below the bottom of the hole	Ground water level shall be kept above the water table when the SPT is carried out under water table.	Ground water level shall be kept above the water table when the SPT is carried out under water table.
	Drilling Bit Type			Water jet type bit shall not be used.	Water jet type bit shall not be used.
	Appropriateness for Drilling by Sampler			Sampler with water jet shall not be used for drilling.	-
	Points to note when casing pipes are used			Casing Pipe shall not be below than bottom of hole.	Casing Pipe shall not be below than bottom of hole. Clearance between casing pipe and core tube shall be more than 10% of inner area of casing pipe section.
	Gushed water and water loss			Pump pressure during drilling shall be recorded if water loss is found.	Pay attention on gushing and water loss.
Penetration Test	Penetration	Seating Drive	15cm	15cm	15cm
		Test Drive	30cm	30cm	30cm
		Finishing Drive	0~5cm	-	-
	Maximum blow Counts		50 blows for Test Drive	50 blows for Test Drive	50 times excluding seating drive.
	Record of blow counts	Blow Counts during test Drive	Total penetration for Test Drive. However, in case penetration per blow is less than 2 cm, blow counts every 10 cm. Shall be recorded.	Blow counts in every 15cm penetration including seating drive.	Blows counts in every 7.5cm penetration for test drive.
		In Case 30cm penetration cannot be achieved.	penetration for 50 blow counts	Blow counts equivalent blow counts for last 30cm penetration including seating drive.	Penetration for 50 blow counts in Test blow.
	Way to drop the hammer		Full Automatic or semi automatic drop system	Full Automatic or semi automatic drop system or Cone pulley (Pulley Diameter : 150~200mm, number of wind of rope : Less than 2-1/4)	Recommend the free drop. Pay attention on friction between winch and rope.
Applicable	Soil Types for the Test		All kinds of soils	All kinds of Soils	Mainly for Sandy Soil.
	Application for gravel and sandy gravel layer		-	-	Test shall be done by replacing the shoe to cone with 60° of edge angle.
	Testing Interval in deep		Generally 1.0m interval is adapted but not prescribed in the standard.	-	-

3.4 Swedish Sounding

The Swedish sounding test was done in accordance with JIS *(Japan Industrial Standard)*. Weight is loaded in stages (W_{sw}: 50N, 150N, 250N, 500N, 750N and 1kN). Next, the number of times of the half-rotation in every 25 cm is counted. The number of the half-rotation per 1m (N_{sw}) is calculated by the following formula using this number.

$$N_{sw} = \frac{100}{L} N_a$$

N_{sw}: number of half-rotation per 1m (time/m)
L : penetration length (cm)
N_a : number of half-rotation (time)

The result of SW(1) is shown in figure-3.2. The result of SW(2) is shown in figure-3.3. According to figure-3.2 and figure-3.3, it was proved that the strength of improved soil is partially increasing, but isn't almost increasing than the original soil before constructing D-Box.

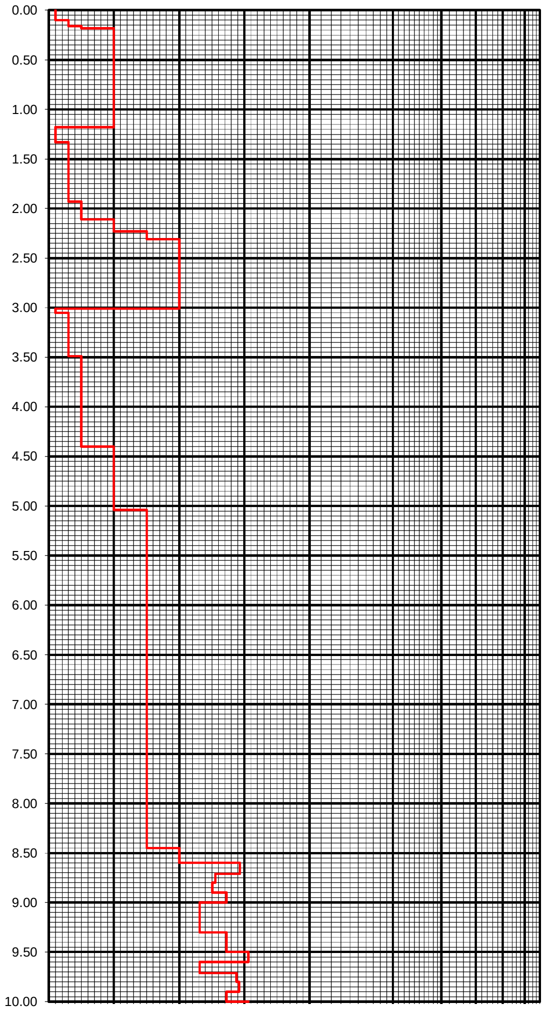


Figure -3.4 Result of SW(1) at original soil

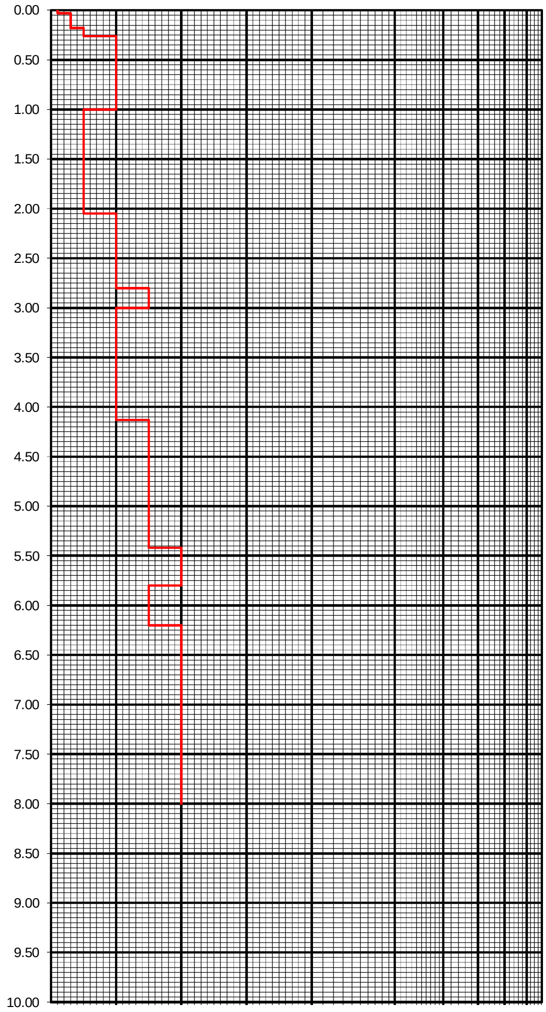


Figure -3.5 Result of SW(2) at improved soil

As for the relation between the result of SW and N-value, the following formulas are proposed.

For gravel, sandy soil : $N=0.002W_{sw}+0.067N_{sw}$

For cohesive soil : $N=0.003W_{sw}+0.050N_{sw}$

N : N-value
W_{sw} : penetrating load at 1kN or less
N_{sw} : number of half-rotation per 1m (time/m)

The results of calculated N-value are shown in Figure-3.6. According to Figure-3.6, N-value which is converted from SW can be almost evaluated as same as N-value with SPT.

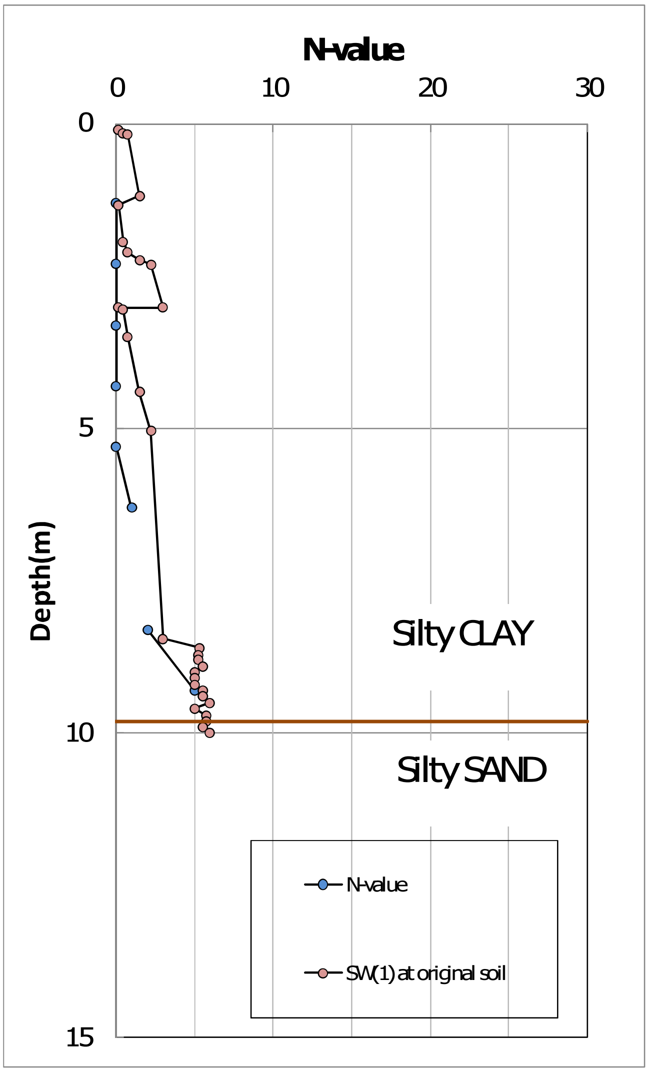


Figure -3.6 Results of calculated N value by SW(1)

Moreover, Figure-3.7 shows comparison of N-value which converted from SW on original soil and improved soil. N-value after constructing D-Box is the approximately same as one before constructing.

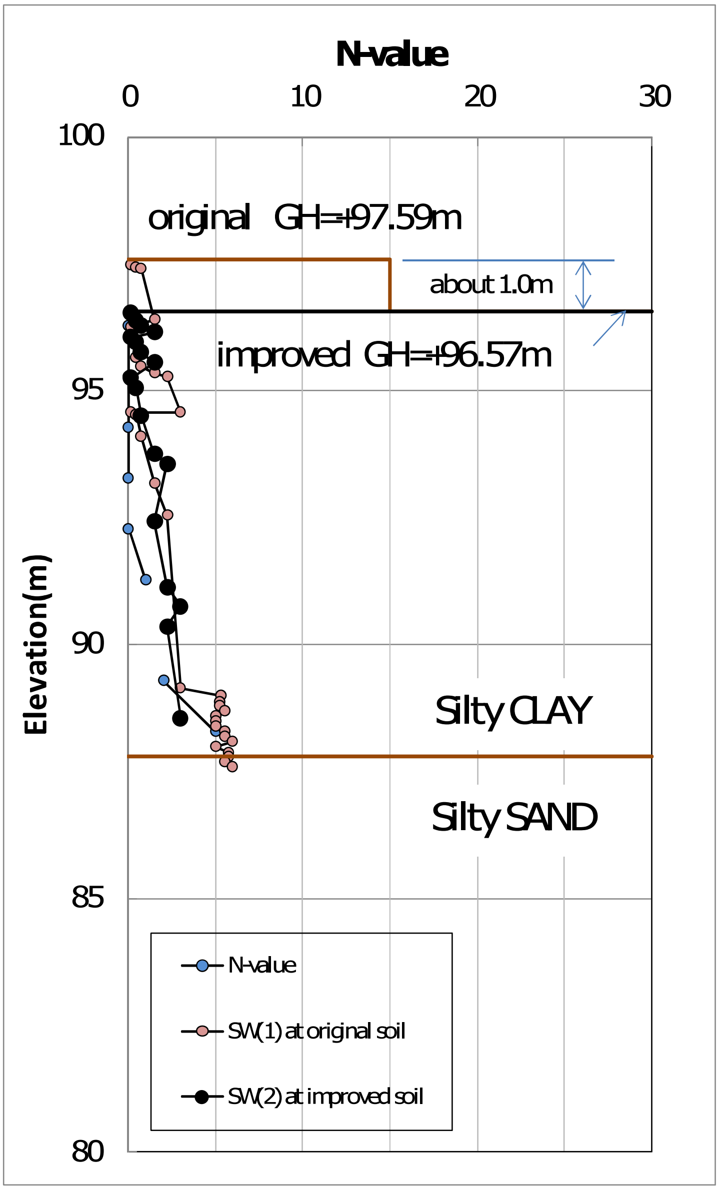


Figure -3.7 Comparison of N-value with SPT ,SW(1) and SW(2)

4.0 LABORATORY TEST

There have been one numbers of investigation borehole and total 7 numbers of disturbed samples and 2 numbers of undisturbed samples were collected in project site and total 6 numbers of disturbed samples and all of undisturbed samples were sent to office laboratory for physical properties and mechanical properties test. The total quantities of laboratory tests carried out in this project are listed in Table-4.1 and detail laboratory results are attached in Appendix-D of this report. The entire tests were carried out in accordance with ASTM Standard.

The physical properties tests include the following items.

- Natural Moisture Content Test
- Specific Gravity Test
- Particle Size Analysis Test
- Atterberg's Limits Test

The engineering properties tests includes-

- Unit Weight test of Soil
- Uncosolidated Undrained Triaxials Compression test [UU]
- Cosolidated Undrained Triaxials Compression test (Measurement of Pore Pressure) [CUB]
- Consolidation test

Summary of list of laboratory tests for each borehole s are illustrated in Table – 4.1.

Table -4.1 Total Quantity of Laboratory Tests

<table>
<tr><th rowspan="3">BH-NO.</th><th colspan="6">Physical Properties Test</th><th colspan="4">Mechanical Property Test</th></tr>
<tr><th rowspan="2">Natural Moisture Content Test</th><th rowspan="2">Specific Gravity Test</th><th colspan="2">Particle Size Analysis Test</th><th colspan="2">Atterberg's Limit Test</th><th rowspan="2">Unit Weight Test of Soil</th><th rowspan="2">Unconsolidated Undrained Triaxial Compression Test</th><th rowspan="2">Consolidated Undrained Triaxial Compression Test (Measurement of Pore Pressure)</th><th rowspan="2">Consolidation Test</th></tr>
<tr><th>Sieve Analysis Test</th><th>Hydrometer Analysis Test</th><th>Liquid Limit Test</th><th>Plastic Limit Test</th></tr>
<tr><td>BH-P-01</td><td>8</td><td>8</td><td>8</td><td>8</td><td>7</td><td>7</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>Total</td><td>8</td><td>8</td><td>8</td><td>8</td><td>7</td><td>7</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
</table>

Table -4.2 Summary of Physical Property Test Results

BH No.	Sample No	Depth	Soil Type	Water Content Wn (%)	Specific Gravity Gs	Grain Size Distribution				Atterberg's Limit		
		GL - (m)				Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI
BH-P-01	P-2	2.75	CH	63.19	2.68	-	0.38	63.43	36.20	71.65	27.78	43.87
	P-3	3.75	CH	65.81	2.67	-	0.15	58.85	41.00	71.15	28.60	42.55
	T-1	4.88	CL	49.61	2.72	-	1.40	66.00	32.60	49.57	25.41	24.16
	P-4	5.75	CH	47.50	2.66	-	1.08	66.93	32.00	53.23	26.80	26.43
	P-5	6.75	CH	46.67	2.66	-	0.97	71.23	27.80	51.90	24.77	27.13
	T-2	7.82	CH	51.69	2.69	-	0.17	67.63	32.20	60.20	18.10	42.10
	P-6	8.75	CH	46.10	2.72	-	0.22	63.58	36.20	57.19	25.16	32.03
	P-7	9.75	SM(or)SC	31.94	2.69	-	73.48	18.32	8.20	-	-	-

Table -4.3 Summary of Engineering Property Test Results

BH No.	Sample No	Depth	Soil Type	Triaxial Compression Test						Consolidation Test			Bulk Density
				Unconsolidated Undrained		Consolidated Undrained (Measurement of Pore Pressure)				*Initial Void Ratio*	*Conso. Yield Stress*	*Compresssion Index*	
		GL - (m)		c_{uu} (kgf/cm²)	ϕ_{uu} (°)	C (kgf/cm²)	ϕ (°)	C' (kgf/cm²)	ϕ' (°)	e_0	P_y (kgf/cm²)	C_c	ρ_t (g/cm³)
BH-P-01	T-1	4.88	CL	0.102	2.00	0.031	33.00	0.041	18.00	1.277	0.690	0.420	1.755
	T-2	7.82	CH	0.133	2.00	0.031	31.00	0.051	16.00	1.346	0.650	0.470	1.742

4.1 Index Property of Soil

Physical property tests and mechanical property testes are done for investigation. The detail laboratory test results are illustrated in Appendix – D.

4.1.1 Natural Moisture Content Test

Natural moisture content tests of (8) numbers have been carried out on soil samples for required two different soil layers at office laboratory in accordance with ASTM Standard. Table-4.4 illustrates the summary of natural moisture content in each soil layers. The photograph of testing natural moisture content is shown in Photo-4.1 and the variation of water content with depth in elevation can be seen in Figure-4.1. The detail laboratory test results are illustrated in Appendix – D.

Photo -4.1 Natural Moisture Content Test

Table -4.4 Summary of Natural Water Content of Test Results

No.	Soil Type	Natural Water Content (%)	
		Range	Average
1	Silty CLAY	46.1～65.8	52.9
2	Silty SAND	31.9	31.9

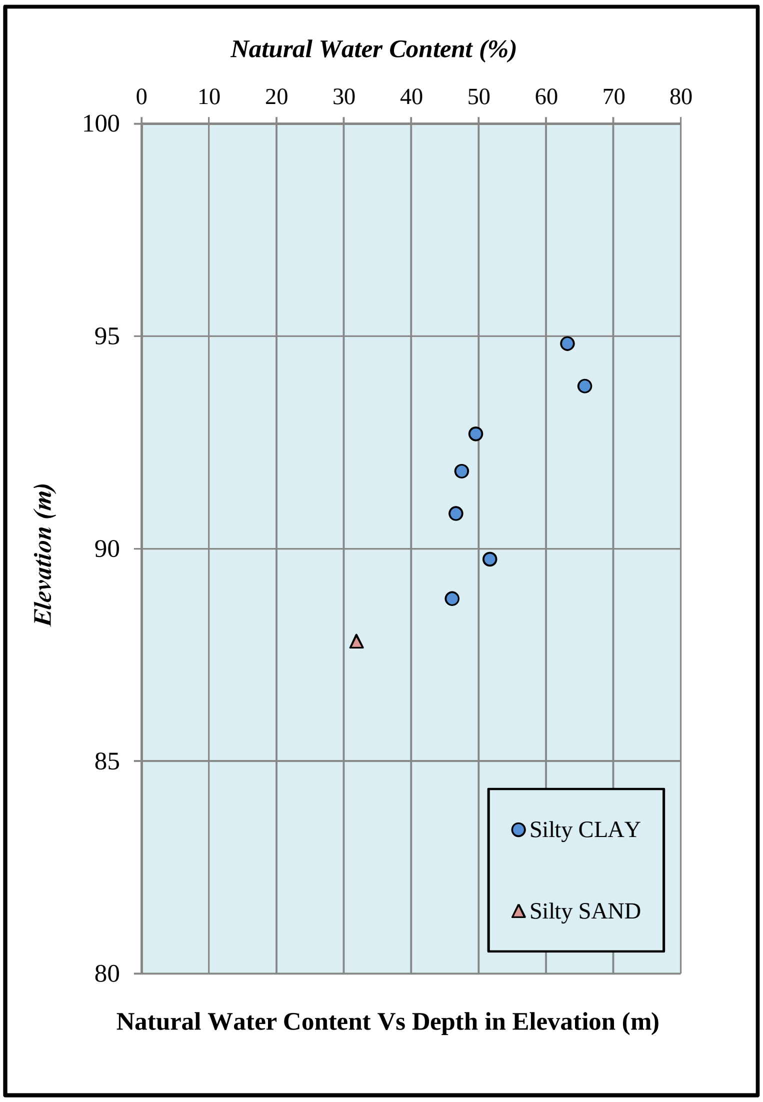


Figure -4.1 Natural Water Content vs Depth in Elevation (m)

4.1.2 Specific Gravity Test

The specific gravity tests in this project were carried out in accordance with ASTM Standard at office laboratory. There have been (8) numbers of specific gravity tests. Table-4.5 illustrates the summary of specific gravity for each soil layers. The photograph of testing specific gravity is shown in Photo-4.2 and the relationship between specific gravity and depth in elevation of each soil layer is shown in Figure-4.2. The detail test results were described in Appendix-D.

Photo -4.2 Specific Gravity Test

Table -4.5 Summary of Specific Gravity Test Results

No.	Soil Type	Specific Gravity	
		Range	Average
1	Silty CLAY	2.657～2.716	2.683
2	Silty SAND	2.691	2.691

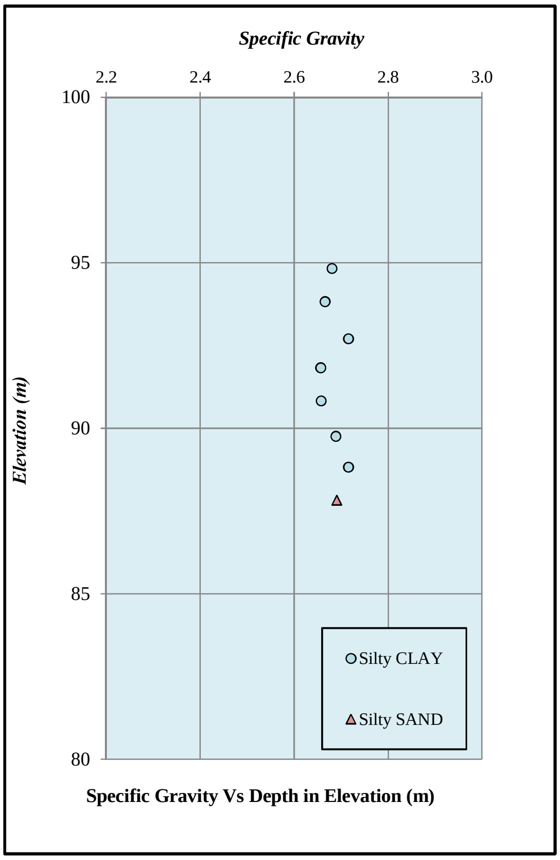


Figure -4.2 Specific Gravity vs. Depth in Elevation (m)

4.1.3 Atterberg's Limit Test

The Atterberg's Limit tests were made on (7) numbers for liquid limit tests and same numbers for plastic limit tests of specimens from disturbed and undisturbed samples by ASTM Standard at office laboratory. The summary of Atterberg's Limit Test result is shown in Table - 4.6. Figure-4.3 to 4.5 illustrate the Plastic Limit, Liquid Limit and Plasticity Index versus depth in elevation and Figure-4.6 shows condition of soil in project area by ranges in plasticity chart. The values of "LL", "PL" and "PI" in Silty SAND layer couldn't be obtained. The photograph of testing is shown in Photo-4.3. The details of test results were shown in Appendix – D.

Photo -4.3 Atterberg's Limit Test

Table -4.6 Summary of Atterberg's Limit Test Result

Soil Type		Liquid Limit (LL)%	Plastic Limit (PL)%	Plasticity Index (PI)
Silty CLAY	Range	49.6～71.7	18.1～28.6	24.2～43.9
	Average	59.3	25.2	34.0
Silty CLAY	Range	-	-	-
	Average	-	-	-

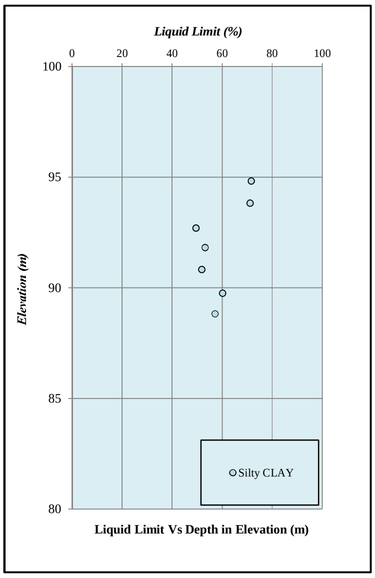


Figure -4.3 Liquid Limit vs Depth in Elevation (m)

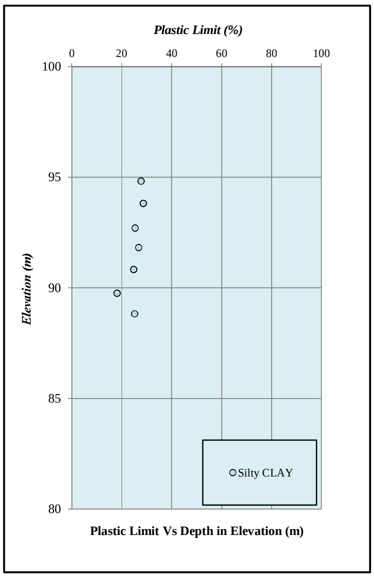


Figure -4.4 Plastic Limit vs Depth in Elevation (m)

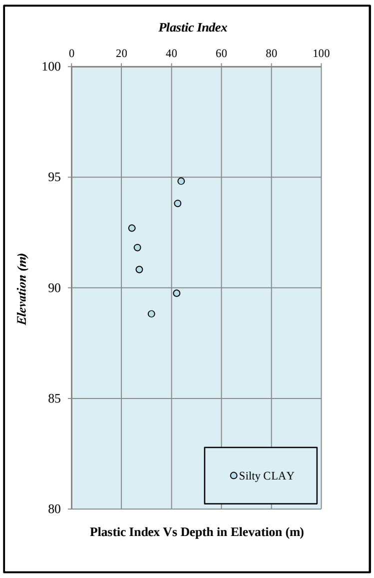


Figure -4.5 Plasticity Index vs Depth in Elevation (m)

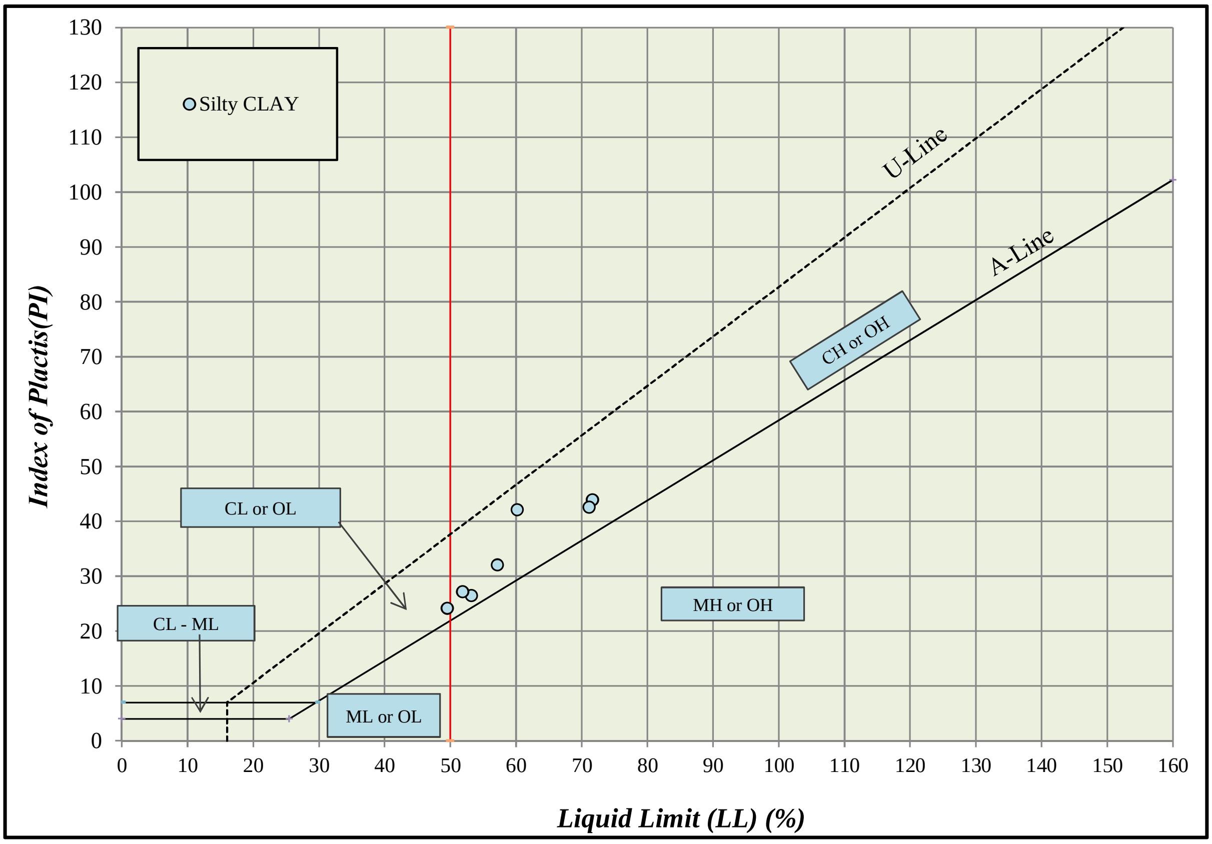


Figure -4.6 Condition of Atterberg's Limit Test Results

4.1.4 Grain Size Analysis Test

Soil classifications or grain size distribution test were done by ASTM Standard. In this project, (8) numbers of sieve analysis tests including (8) numbers of hydrometer tests were carried out in laboratory of Fukken Co., Ltd. Grain size analysis testing and hydrometer testing are shown in Photo- 4.4 and 4.5. Figure-4.7 is illustrated the grain size distribution of each soil layer versus depth in elevation. The detail of Grain Size Analysis Test results were shown in Appendix-D.

Photo -4.4 Grain Size Distribution Test

Photo -4.5 Hydrometer Test

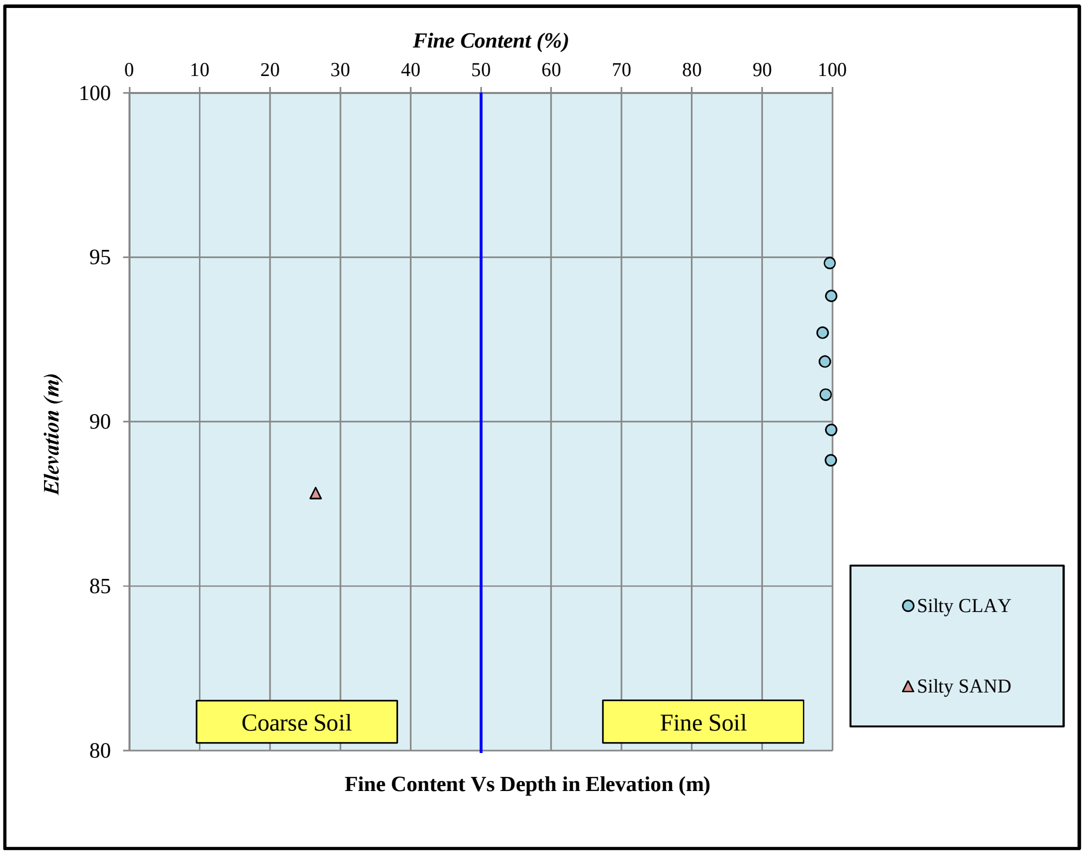


Figure -4.7 Fine Content vs Depth in Elevation (m)

4.2 Mechanical Properties of Soil

In order to obtain the mechanical properties of Silty CLAY layer, (2) numbers of undisturbed soil samples were sent to laboratory in this project. Table-4.7 shows each constants from the items of tests. Hereinafter acceleration due to gravity "g" is assumed as [9.8].

Table -4.7 The items of tests and the constants of soil

No.	Test Name	Mechanical property	The constant of soil by test
1	Unit Weight Test	---	γ_t(kN/m^3), γ_d(kN/m^3), γ_{sat}(kN/m^3), e_0, Sr(%), etc.
2	Unconsolidated Undrained Triaxial Compression Test	Shear strength property	C_{uu}(kN/m^2), ϕ_{uu}(°), E_{50}(kN/m^2), etc.
3	Unconsolidated Undrained Triaxial Compression Test		C'(kN/m^2), ϕ'(°), C(kN/m^2), ϕ (°) , etc.
4	Consolidation Test	Consolidation property	e_0, Cc, P_y(kN/m^2), etc.

4.2.1 Unit Weight Test

Total (2) numbers of undisturbed sample from the project area were carried out for unit weigt test at office laboratory in accordance with *British Standard*. Summary of unit weigt test results are described in Table – 4.8. The relationship between the unit weight "γ_t", the saturated unit weight "γ_{sat}" and the dry unit weight "γ_d" vs depth in elevation is presented in Figure-4.8.

According to Table-4.8 and Figure-4.8, "γ_{sat}" value is about the same as "γ_t" one. This means that the dgree of saturation of Silty CLAY layer is nearly 100%. So there are no difference in Silty CLAY layer of up and down in each value of "γ_t", "γ_{sat}" and "γ_d" ,as Silty CLAY layer is almost homogeneous.

Table -4.8 Summary of Unit Weight Test Result

BH-No.	Sample No.	Depth (m)	γ_t (kN/m^3)	γ_{sat} (kN/m^3)	γ_d (kN/m^3)	e	Sr (%)
BH-P-01	T-1	4.50～5.25	17.20	17.26	11.50	1.363	98.9
	T-2	7.50～8.14	17.07	17.07	11.25	1.389	100.1
Average			17.14	17.17	11.38	1.376	---

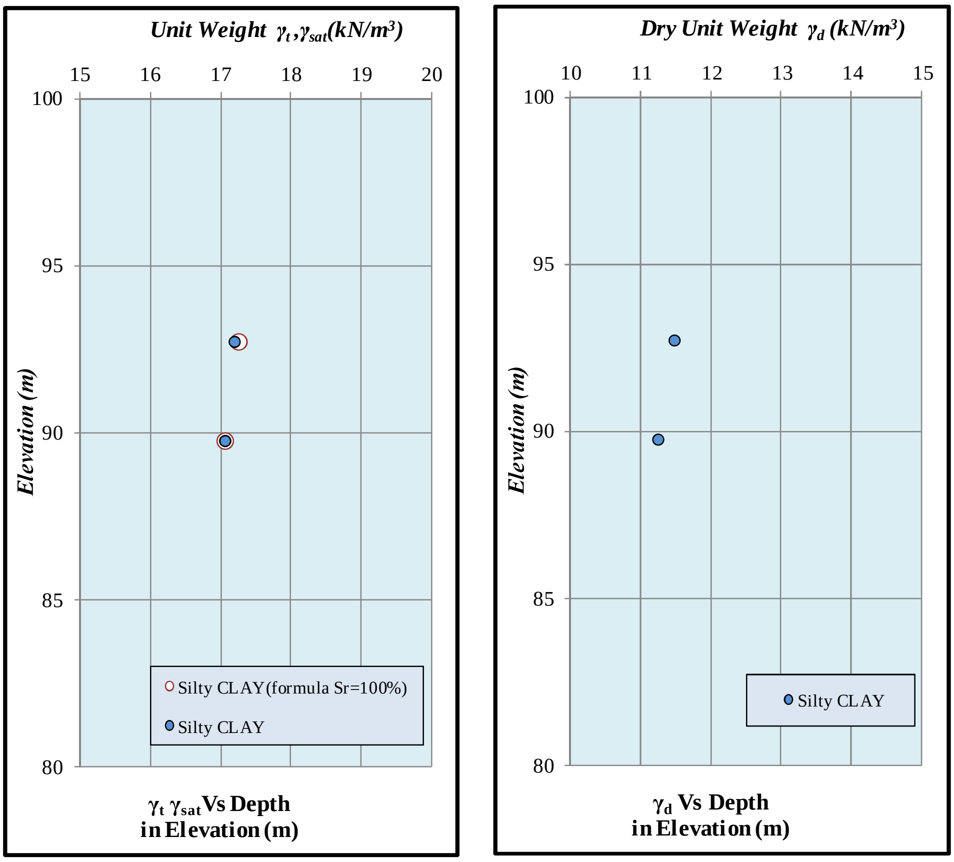


Figure -4.8 γ_t,γ_{sat},γ_d vs Depth in Elevation (m)

4.2.2 Uncosolidated Undrained Triaxial Compression Test

Total (2) numbers of undisturbed sample were carried out for unconsolidated undrained triaxial compression test at office laboratory in accordance with *British Standard*. Summary of unconsolidated undrained triaxial compression test results are described in Table-4.9.

The relationship between the undrained shear strength of clay vs depth in elevation is presented in Figure-4.9 to 4.10. According to Table-4.9 and Figure-4.9 to 4.10, it is proved that there are no difference of the undrained shear strength ”c_{uu}” and “ ϕ_{uu}” in depth direction. In ” E_{50}” which is a sort of modulus of deformation, it can be assumed that E_{50} which of the upper part of Silty CLAY layer is about three times as large as the lower part of one.

Table -4.9 Summary of Unconsolidation Undrained Triaxial Compressive Test Results

NO.	Sample No.	Depth(m)	Corr.Stress/2 $(\sigma_1-\sigma_3)/2$ (kN/m^2)	Strain at 50% ε_{50} (%)	E_{50} (kN/m^2)	C_{uu} (kN/m^2)	φ_{UU} (°)
BH-P-01	T-1	4.50～5.25	11.74	0.9	1276	10	2
	T-2	7.50～8.14	16.26	0.4	4064	13	3

Photo -4.6 Unconsolidated Undrained Compressive Strength Test Equipment

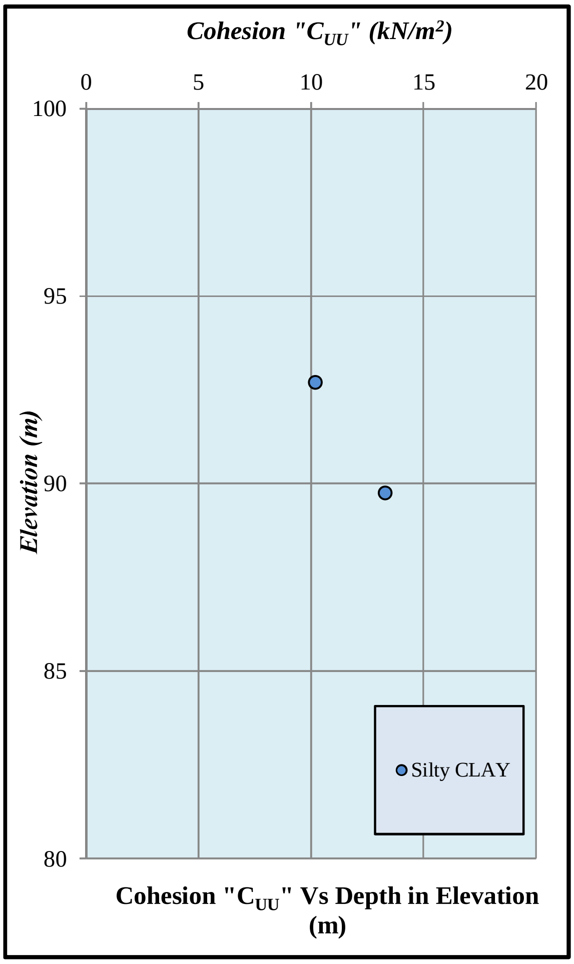


Figure -4.9 C_{uu} vs Depth in Elevation (m)

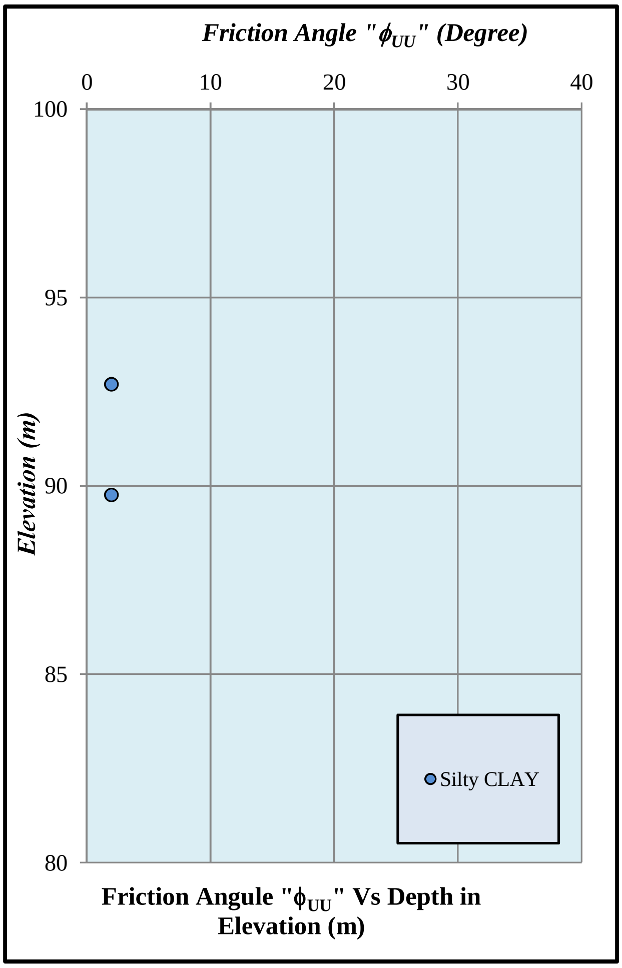


Figure -4.10 ϕ_{uu} vs Depth in Elevation (m)

4.2.3 Cosolidated Undrained Triaxial Compression Test (Measurement of Pore Pressure)

Total (2) numbers of undisturbed sample were carried out for unconsolidated undrained triaxial compression test at office laboratory in accordance with *British Standard*. Summary of consolidated undrained triaxial compression test (measurement of pore pressure) results are described in Table-4.10. The relationship between the total and effective shear strength of clay vs depth in elevation is presented in Figure-4.11 to 4.14. According to Table-4.10 and Figure-4.11 to4.14, it is proved that there are no difference of the undrained shear strength ”c’, ϕ ’” and “c, ϕ ” in depth direction.

Table -4.10 Summary of Consolidated Undrained Triaxial Compressive Test

(Measurement of Pore Pressure) Results

NO.	Sample No.	Depth(m)	Effective Stress		Total Stress		Rate of strength increase
			C' (kN/m^2)	φ' (°)	C_{cu} (kN/m^2)	φ_{cu} (°)	C_{cu}/P
BH-P-01	T-1	4.50～5.25	3.0	33	4.0	18	0.447
	T-2	7.50～8.14	3.0	31	5.0	16	0.381

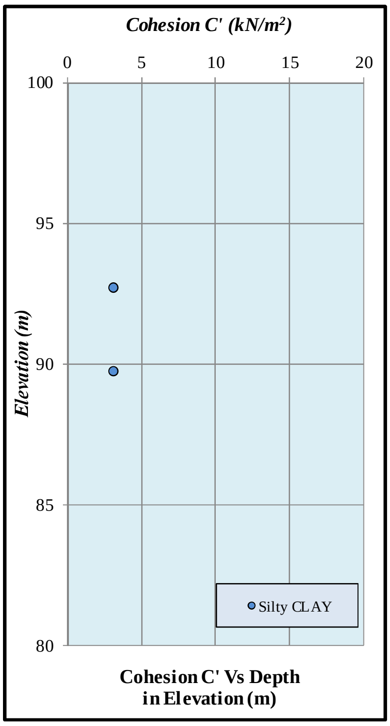


Figure -4.11 Effective Stress "C'" vs Depth in Elevation (m)

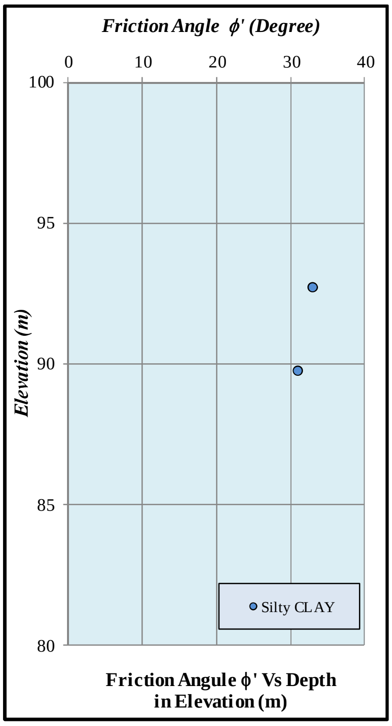


Figure -4.12 Effective Stress " ϕ '" vs Depth in Elevation (m)

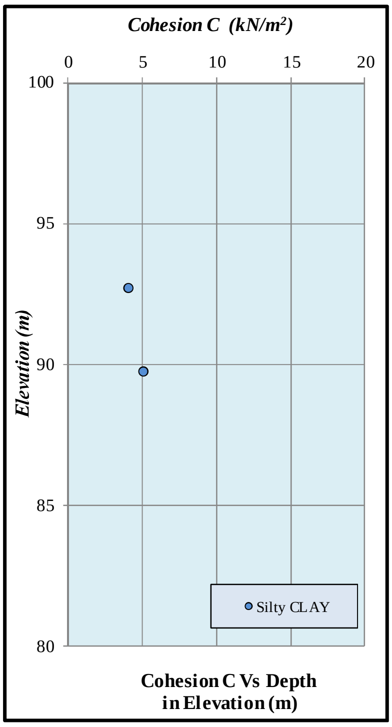


Figure -4.13 Total Stress "C_{cu}" vs Depth in Elevation (m)

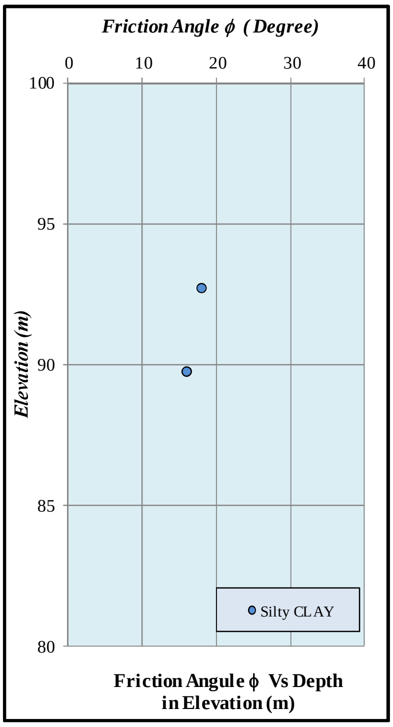


Figure -4.14 Total Stress " ϕ_{cu}" vs Depth in Elevation (m)

4.2.4 Cosolidation Test

Total (2) numbers of undisturbed sample were carried out for unconsolidated undrained triaxial compression test at office laboratory in accordance with *ASTM Standard*. Summary of consolidation test results are described in Table-4.11. The relationship between void Ratio "e_0" and Compression Index "C_c" vs depth in elevation is presented in Figure-4.15 to 4.16. According to Table-4.11 and Figure -4.15 to 4.16, it is proved that there are no difference of the consolidation property "e_0" and "C_c" in depth direction.

Table -4.11 Summary of Consolidation Test

NO.	Sample No.	Depth(m)	e_0	P_Y (kN/m²)	C_c	overconsolidation region c_v (cm²/day)	overconsolidation region m_v (kN/m²)	normally consolidation region c_v (kN/m²)	normally consolidation region m_v (°)	σ_v' (kN/m²)	OCR $=P_Y/\sigma_v'$
BH-P-01	T-1	4.50～5.25	1.28	67.6	0.42	650	1.0E-03	410	$0.022P^{(-0.76)}$	41.6	1.6
	T-2	7.50～8.14	1.35	63.7	0.47	470	8.0E-04	120	$0.059P^{(-0.90)}$	63.7	1.0

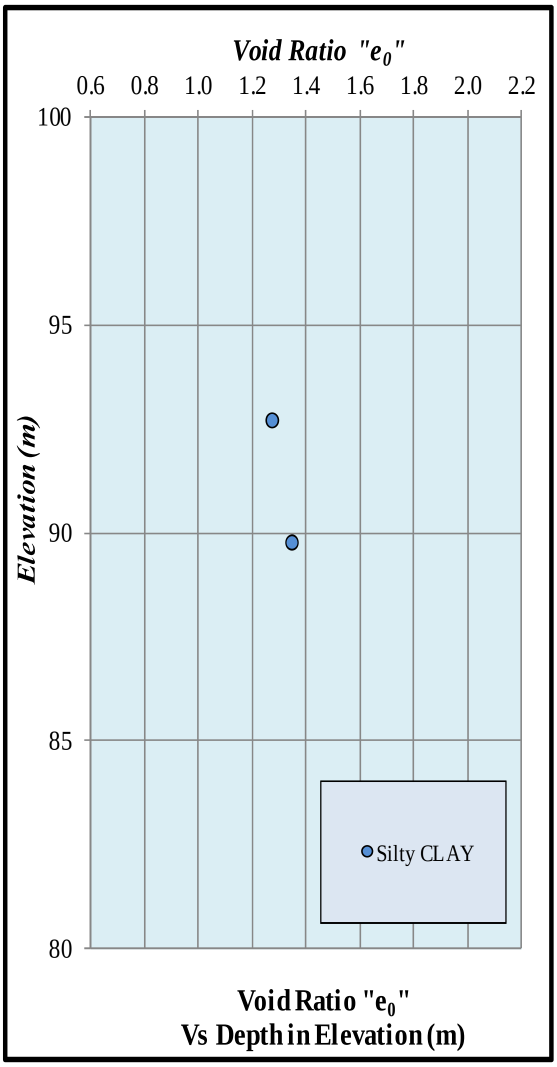


Figure -4.15 e_0 vs Depth in Elevation (m)

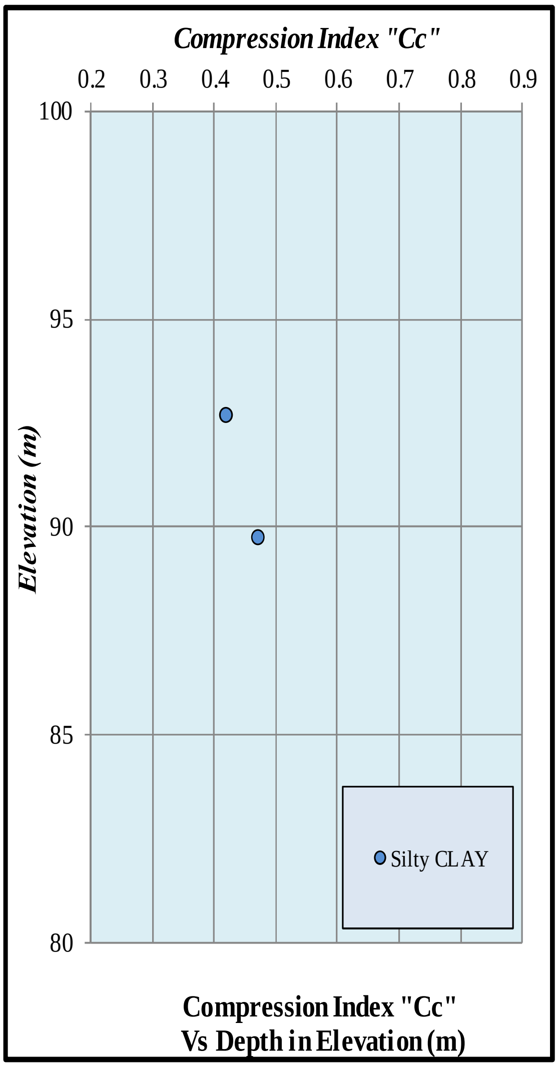


Figure -4.16 C_c vs Depth in Elevation (m)

The relationship between effective overburden pressure “ σ_v’ ” and Consolidation yield stress “P_y” vs depth in elevation is presented in Figure-4.17. According to Table-4.11 and Figure-4.17, it is proved that Consolidation yield stress “P_y” is over effective overburden pressure “ σ_v’ ”. From these results of consolidation test, it can be assumed that Silty CLAY layer is now in normally consolidated region to some overconsolidation region. The “e-logP Curve” is illustrated in Figure-4.18.

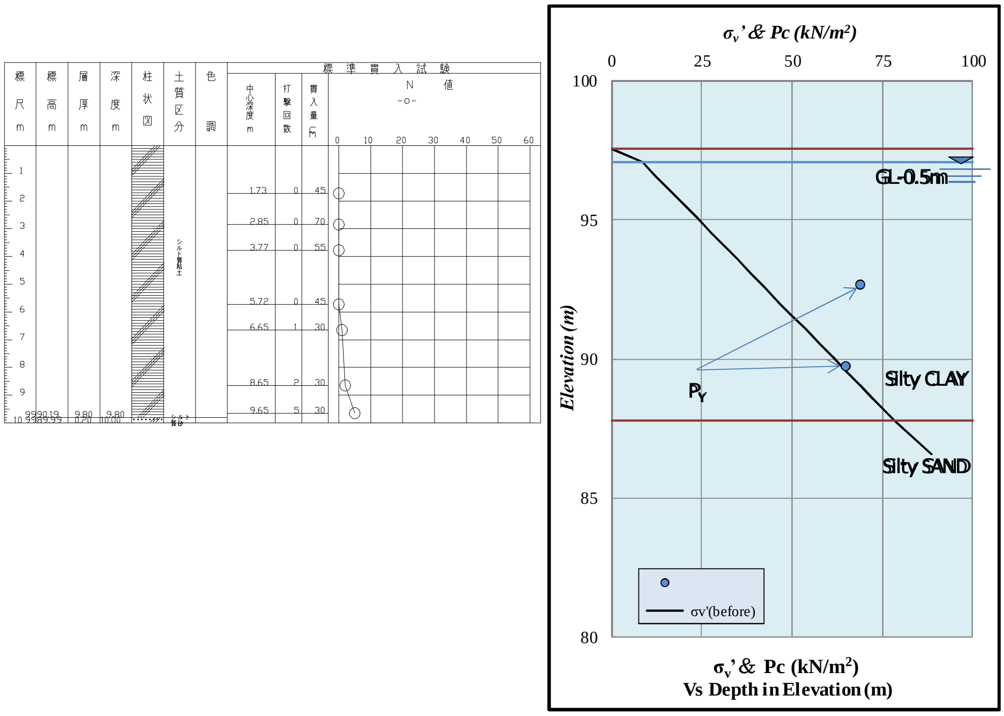


Figure -4.17 σ_v’ and P_Y vs Depth in Elevation (m)

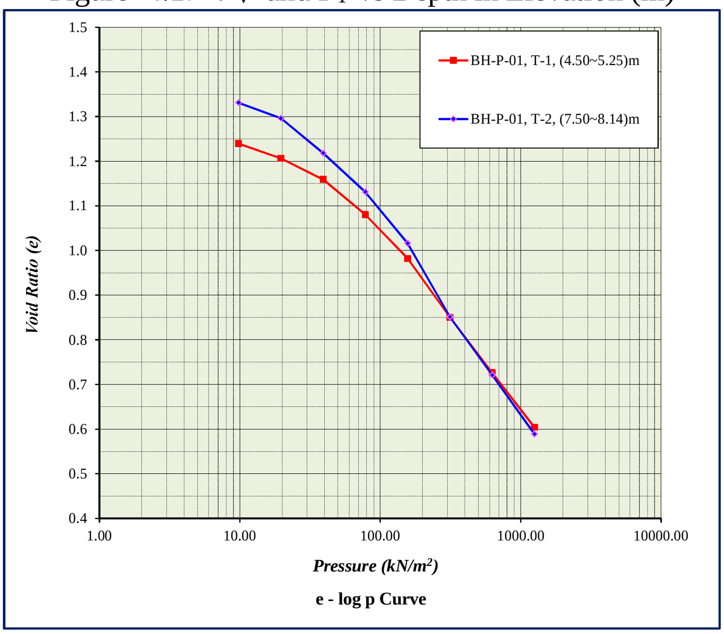


Figure -4.18 e-logP Curve

The "C_V-logP Curve" is illustrated in Figure-4.19 and the "mv-logP Curve" is illustrated in Figure-4.20. According to Figure-4.19 and Figure-4.20, it is proved that "Cv" and "m_V" in overconsolidated region are over "Cv" and "m_V" in normally consolidated region.

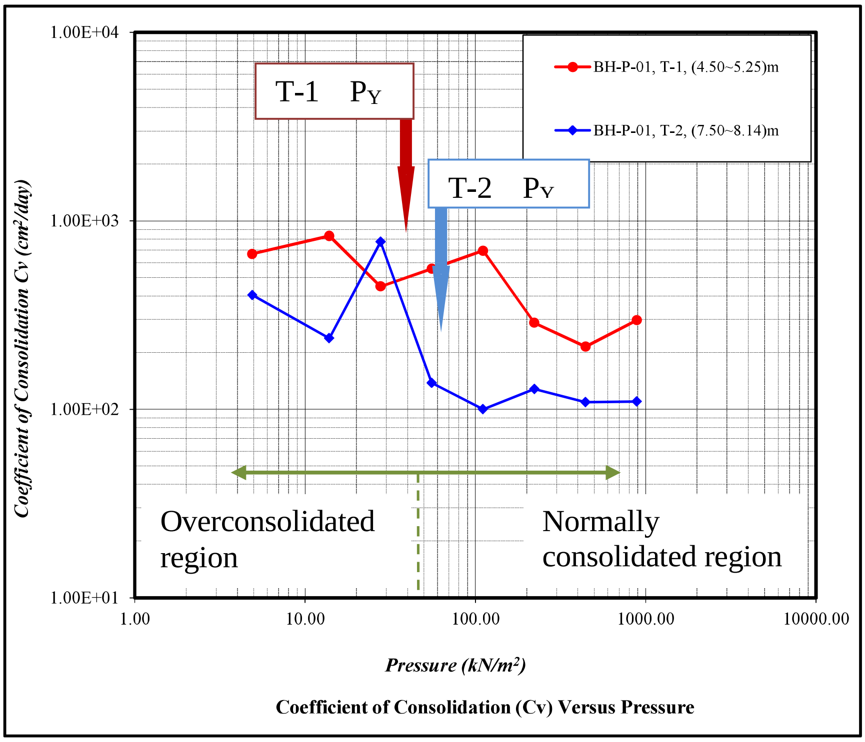


Figure -4.19 C_V-logP Curve

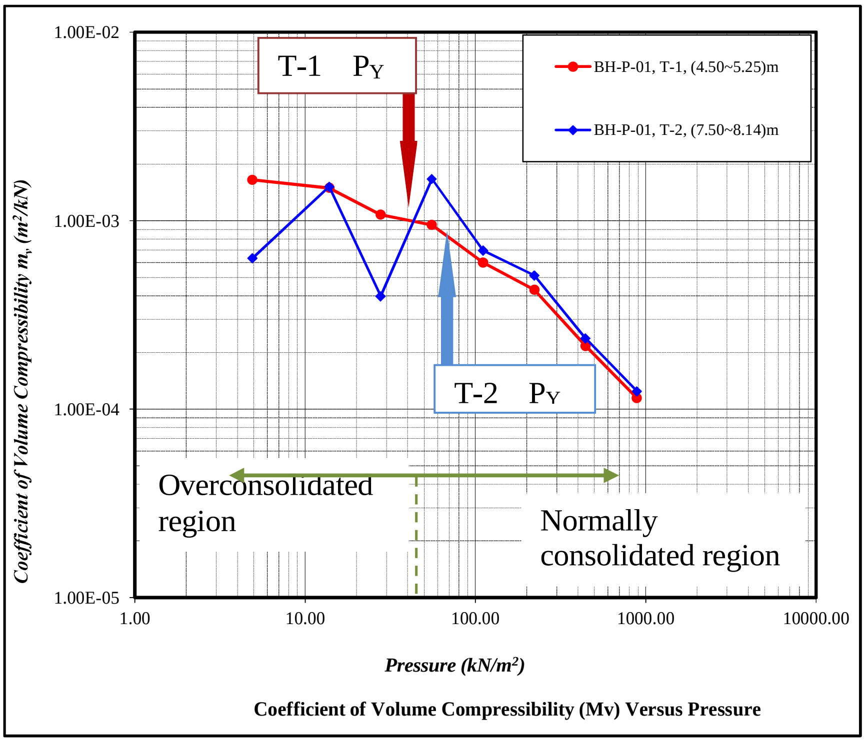


Figure -4.20 m_V-logP Curve

5.0 GEOTECHENICAL ASSESSMENT

5.1 Site conditions

As for the result of drilling work at one point in this site, cohesive soil layer is covered from the surface to GL-9.8m with topsoil and Silty CLAY. Although the thin layer with fine sand of about 0.5m lies inside Silty CLAY layer from GL-5.5m to GL-6.0m, Silty CLAY layer is very soft and very homogeneous without coarse soil. From below Silty CLAY layer, incohesive soil layer is piled with Silty SAND layer. This layer is very loose with fine grained. As the lower end of Silty SAND layer wasn't confirmed in this investigation, the thickness of this layer is unknown. In this area, the stratification of ground is a simple. It can be assumed that Silty CLAY layer is in normally consolidated. This means that it can cause the consolidation settlement, when anything will be loaded on the ground. The boring log is shown in Table-5.1.

Table -5.1 boring log in the site

BORING LOG

BORE HOLE No.	BH-P-01	Job No.	FKYB-2013-031
		Sheet No.	1 OF 1
PROJECT NAME	Soil Investigation for D-Box Project	BORING EQUIPMENT	TOHO " D1 "
LOCATION	Bogalay~Ka Don Ka Ni Road, Bogalay Township, Irrawaddy Region	BORING METHOD	Rotary Direct Circulation
GROUND LEVEL	-	ORIENTATION	Vertical
COORDINATE	E 746311.000 ; N 1792412.000	GROUND WATER LEVEL	0.50m
DEPTH	10.00m	DATE	02.11.2013
CLIENT	CHIYODA & PUBLIC WORKS CO., LTD.		

ELEVATION (m)	DEPTH GL - (m)	THICKNESS (m)	COLOUR	RELATIVE DENSITY (or) CONSISTENCY	SOIL NAME	SOIL DESCRIPTION	DATE & DEPTH (m)	CASING (DEPTH (m) & DIAMETER (mm))	WATER DEPTH (m)
	9.80	9.80	brownish gray to gray	very soft to soft	Silty CLAY	Very soft to soft, brownish gray to gray, wet to moist, medium plasticity, with trace of mica mineral GL-(5.50~6.00)m; thin fine sand layer is observed GL-(9.80~10.0)m; fine grained, silty SAND layer is observed at that depth		4.00 / Ø115	0.50
	10.00	0.20	gray	Loose	Silty SAND	Loose, gray, wet to moist, fine grained, Silty SAND	02.11.13 / 10.00		
						This borehole is terminated at 10.0m, after confirmation			

STANDARD PENETRATION TEST TEST METHOD (ASTM) / SAMPLING

DEPTH GL - (m)	N-Value (Blows / 30cm)	SAMPLE (Type & No.)	DEPTH GL - (m)	TCR (%)	SCR (%)	RQD (%)
1.50	0/45	P-1	1.50 – 2.00			
2.50	0/70	P-2	2.50 – 3.00			
3.50	0/55	P-3	3.50 – 4.00			
4.50		UD T-1	4.50 – 5.25			
5.50	0/45	P-4	5.50 – 6.00			
6.50	1/30	P-5	6.50 – 7.00			
7.50		UD T-2	7.50 – 8.14			
8.50	2/30	P-6	8.50 – 9.00			
9.50	5/30	P-7	9.50 – 10.00			
10.50						
11.50						
12.50						

5.2 Soil Parameters

The geotechnical parameters can be directly evaluated from many ways such as field in-situ testing, laboratory testing and so on. Some of the design parameters cannot be evaluated directly neither from field tests nor laboratory tests due to the unfavorable of nature of deposit or investigation methods. However, some parameters would be derived from the other instrumental testing of past events and physical properties obtained from field and laboratory tests. For evaluating the stability or consolidation of ground, the shear strength parameters and property of consolidation are significant. The geotechnical design parameters required for stability and consolidation analysis are listed as below-

γ_t Wet unit weight of soil (kN/m^3)
γ_d Dry unit weight of soil (kN/m^3)
γ_{sat} Saturated unit weight of soil (kN/m^3)
γ' Effective unit weight of soil below water table (kN/m^3)

C_{uu} Cohesion of soil (kN/m^2) [use for short term stability problem]
$Ø_{uu}$ Friction angle of soil (angle of internal friction in degree) [use for short term stability problem]
C Total Cohesion of soil (kN/m^2) [use for long term stability problem]
Ø Total Friction angle of soil (angle of internal friction in degree) [use for long term stability problem]
C' Effective Cohesion of soil (kN/m^2) [use for long term stability problem]
Ø' Effective Friction angle of soil (angle of internal friction in degree) [use for long term stability problem]
Property of Consolidation Py, Cc, e-logP Curve, C_v-logP Curve, etc.

a) Wet Unit Weight of Soil(γ_t)

The unsaturated soil defines as the soil located above the water table. The wet unit weight of soil can be evaluated directly from the soil test.

b) Saturated Unit Weight of Soil (γ_{sat})

The saturated soil defines as the soil located below the water table. The saturated unit weight of soil can be evaluated directly from the field density test or equation.-

$$\gamma_{sat} = (G_s\gamma_w + e\gamma_w) / (1 + e)$$

Where- γ_{sat} = saturated unit weight of soil (kN/m^3)
γ_w = saturated unit weight of water (kN/m^3)
G_s = specific gravity of soil
e = void ratio of soil ($e = wG_s$ for saturated clayey soil)

The G_s and w can be resulted from laboratory tests of collected "Disturbed Samples".
For those soils, which cannot be referred from above equation, the void ratio is referred from-

Table -5.2 Typical Void Ratio

Type of soil	Void ration (e)
Loose uniform sand	0.8
Dense uniform sand	0.45
Loose angular-grained silty sand	0.65
Dense angular-grained silty sand	0.4
Stiff clay	0.6
Soft clay	0.9-1.4
Loess	0.9
Soft organic clay	2.5-3.2
Glacial till	0.3

Source from Principles of Foundation Engineering (Braja M. Das) (Seven Edition)

c) Dry Unit Weight of Soil (γ_d)

The dry soil defines as the soil located above the water table. The dry unit weight of soil can be evaluated from the field density test. However, field density test cannot be carried out. Hence the unit weight of dry soil can be derived from the unit weight of saturated soil using the following equation-

$$\gamma_d = \gamma_{sat} / (1+w/100)$$

Where - γ_d = unit weight of dry soil (kN/m^3)
γ_{sat} = unit weigh of saturated soil (kN/m^3)
w = natural moisture content (%)

The natural moisture content (w) can be resulted from the laboratory tests (of collected Disturbed Samples).

d) Effective Unit Weight of Soil (γ')

The effective unit weight of soil under water table can be evaluated from the equation-

$$\gamma' = \gamma_{sat} - \gamma_w$$

Where- γ' = effective unit weight of soil (kN/m^3)
γ_{sat} = saturated unit weight of soil (kN/m^3)
γ_w = unit weight of water (kN/m^3)

The unit weight of water in SI unit is 9.8 kN/m^3 (or) 10 kN/m^3.

In this report, the unit of soil can also be referred from the recommended design parameters by *Japan Highway Cooperation (J.H.C)*, see Table-5.3.

Table -5.3 Recommended Soil Parameter by J.H.C

Soil Type		Condition of Soil	Bulk Density γt (tf/m^3)	Internal Friction Angle φ (°)	Cohesion Cu (tf/m^2)	Remarks (Soil Name)
Fill Material	Gravel Gravelly Sand	Compacted one.	2.0	40	0	(GW), (GP)
	Sand	Compacted one. Well graded one.	2.0	35	0	(SW), (SP)
		Compacted one. Poor graded one.	1.9	30	0	
	Silty Sand Clayey Sand	Compacted one.	1.9	25	Less than 3	(SM), (SC)
	Silt, Clay	Compacted one.	1.8	15	Less than 5	(ML), (CL) (MH), (CH)
	Kanto Loam	Compacted one.	1.4	20	Less than 1	(VH)
Natural Ground	Gravel	Dense or Well graded one.	2.0	40	0	(GW), (GP)
		Not dense and Poorly graded one.	1.8	35	0	
	Gravelly Sand	Dense one.	2.1	40	0	(GW), (GP)
		Not dense one.	1.9	35	0	
	Sand	Dense or Well graded one.	2.0	35	0	(SW), (SP)
		Not dense and Poorly graded one.	1.8	30	0	
	Silty Sand Clayey Sand	Dense one.	1.9	30	Less than 3	(SM), (SC)
		Not dense one.	1.7	25	0	
	Sandy Silt Sandy Clay	Stiff one.	1.8	25	Less than 5	(ML), (CL)
		Firm one.	1.7	20	Less than 3	
		Soft one.	1.6	15	Less than 1.5	
	Silt Clay	Stiff one.	1.7	20	Less than 5	(CH), (MH), (ML)
		Firm one.	1.6	15	Less than 3	
		Soft one.	1.4	10	Less than 1.5	
	Kanto Loam	---	1.4	5	Less than 3	(VH)

e) Cohesion (C_u)

The cohesive strength also known as undrained shear strength of cohesive soil, is normally evaluated from the unconfined compression test or triaxial compression test [Undrained Unconsolidated, hereinafter called as UU]. The relationship between "C_u" and "q_u" can be evaluated from -

$$C_u = q_u / 2$$

Where- C_u = cohesive strength (kN/m^2)

q_u = unconfined compressive strength (kN/m^2)

For some soil, as the undisturbed sample cannot be easily collected, the cohesive strength can be reliably derived from SPT N-value, or referred from previous experiences; i.e. from Table-5.4. In case of cohesive strength derived from SPT N value the following equation is used-

$$C_u = 20N/3 \ (kN/m^2)$$

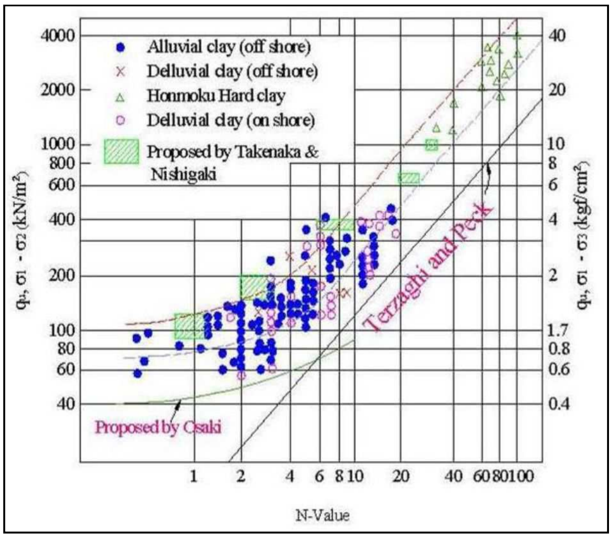
Alternatively the relation of SPT N-value and unconfined compressive strength (q_u) is illustrated in Graph-5.1.

f) Friction Angle (φ_u)

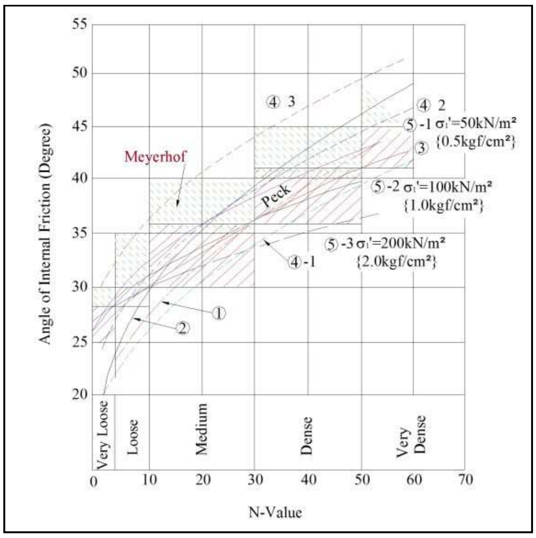
The friction angle of the granular soil can be directly evaluated from the SPT N-value. The friction angle of granular soils is evaluated from their average SPT N-value, in accordance with Graph-5.2. The friction angle of such deposits can be also evaluated from equation and the recommended design parameters by *Japan Highway Cooperation (J.H.C)*(See Table-5.3). In case of granular soil, the friction angle of soil can be derived from following equation.

$$\varnothing = \sqrt{20N} + 15 \text{............(From Osaki, 1979)}$$

The friction angle for cohesive soil can be also determined from triaxial compression test [UU].



Graph -5.1 Empirical Relation of N-Value and Unconfined Compressive Strength for Clay



Graph -5.2 Empirical Relations between N-value and Friction Angle for Sand

g) Cohesion (C,C') and Friction Angle (φ, φ')

When the short term will be examined, cohesive strength and frictive strength also known as drained-consolidated shear strength of cohesive soil, is normally evaluated from the triaxial compression test [drained consolidated hereinafter called as CU]. When this test is carried out with measurement of pore pressure, the effective stress of soil can be evaluated. In this case, the test neme is called as [CU(measurement of pore pressure), hereinafter called as CUB] .

h) Modulus of Elasticity of Soil and Rock (E)

The modulus of elasticity of soil can be derived from the SPT N-value. In general, the modulus of elasticity of soil can be evaluated by multiplying SPT N-value. The modulus of elasticity of soil for granular soil is evaluated from the following equation -

$$\mathbf{E = 70N\ (tf/m^2) = 700N\ (kN/m^2)\ (for\ Sand\ and\ Gravel)}$$

However the modulus of elasticity of cohesive soil can be derived from modulos of deformation(undrained cohesive strength test; unconfined compression test or triaxial compression test(UU)).

i) Poisson's Ratio (υ')

The poisson's ratio is the ratio of axial strain versus lateral strain. In this report poisson's ratio of the soil can be estimated from experts' options described in following Table-5.4.

Table -5.4 Typical Values of Poisson's Ratio

No	Type of Soil	υ'
1	Saturated clay	0.4 ~ 0.5
2	Unsaturated or sandy clay	0.2 ~ 0.4
3	Sand: ø = 40˚	0.2
4	Sand: ø = 20˚	0.5

j) Property of Consolidation (P_y, Cc, e-logP Curve, C_v-logP Curve, Cu/P ,etc.)

In this project, it is important to obtain the property of consolidation on Silty CLAY layer. So it was carried out the consolidation test and triaxial compression test [CUB]. The property of consolidation can be estimated from consolidation test. And the rate of strength increase "Cu/P" can be acquired by triaxial compression test [CUB] test.

Table-5.5 shows soil parameters extract from several correlations and proposed formulas. Finally, the recommended geotechnical design parameters are indicated as shown in Table-5.6. Table-5.7 shows the property of consolidation about Silty CLAY layer. The design curve is indicated in Figure-5.1, Figure -5.2 and Figure -5.3.

Table -5.5 Soil Parameters for Geotechnical Analysis from several formulas

No.	Soil Name	N-Value (Average)	Cohesion (Cu) kN/m^2			Effective Cohesion	Friction angle (degree)			Effective friction Angle	Unit weight (kN/m^3)				Modulus of Elasticity (kN/m^2)	Poission's Ratio
											γ_{sat}	γ'	γ_{sat}	γ'		
		N	SPT	Lab	JHC	by Lab	SPT	Lab	JHC	by Lab	by Lab		by JHC			
1	Silty CLAY	0	0	12	<50	3	0	17	15	32	17	7	14	4	2,600	0.4
2	Silty SAND	5	0	NA	0	NA	25	NA	30	NA	NA	NA	18	8	3,500	0.5

Table -5.6 Recommended Geotechnical Design Parameter for Geotechnical Analysis

No.	Soil Name	N-Value	Cohesion	Friction angle	Effective Cohesion	Effective Friction Angle	Soil Unit weight		Modulus of Elasticity (kN/m^2)	Poission's Ratio
		(Average)	C	ϕ	C'	ϕ'	kN/m^3			
		N	kN/m^2	(degree)	kN/m^2	(degree)	γ_{sat}	γ'		
1	Silty CLAY	0	10	0	0	30	17	7	2,600	0.4
2	Silty SAND	5	0	25	-	-	18	8	3,500	0.5

Table -5.7 Recommended Geotechnical Design Parameter for Consolidation Analysis

e-logP Curve	Cc	Overconsolidated Region		Normally consolidated Region		Cu/P
		C_v (cm^2/day)	m_v (kN/m^2)	C_v (cm^2/day)	m_v (kN/m^2)	
Figure-5.3	0.45	400	1.0E-03	100	$0.036P^{\wedge(-0.83)}$	0.4

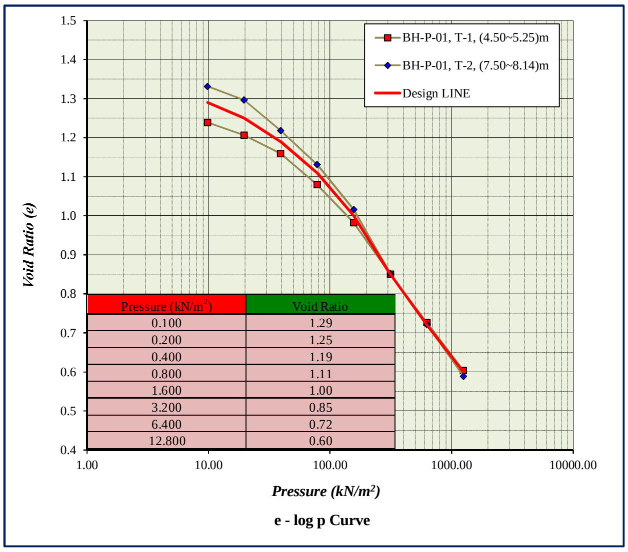


Figure -5.1 Designed e-logP Curve

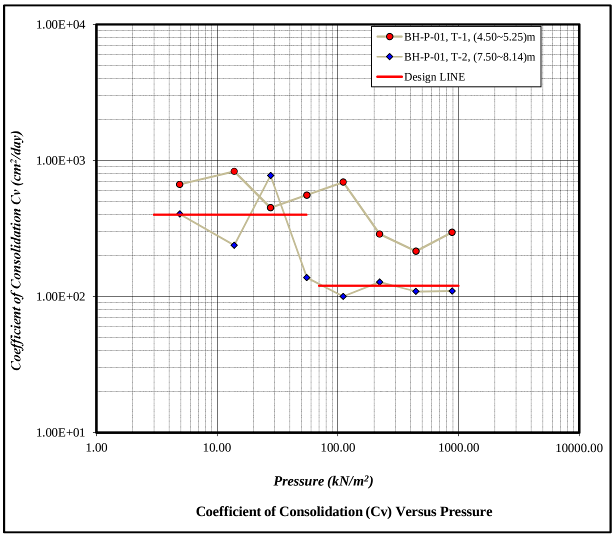


Figure -5.2 Designed C_v-logP Curve

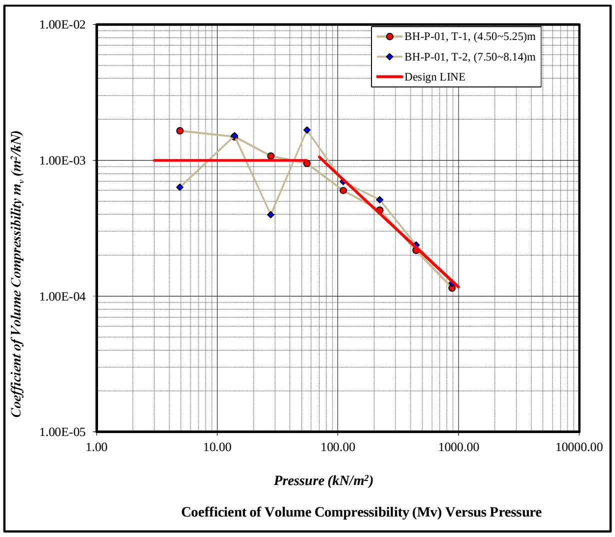


Figure -5.3 Designed m_v-logP Curve

<u>Remark</u>

Above geotechnical design parameter shows average ones based on investigation results.

6.0 SUMMARY OF SOIL INVESTIGATION

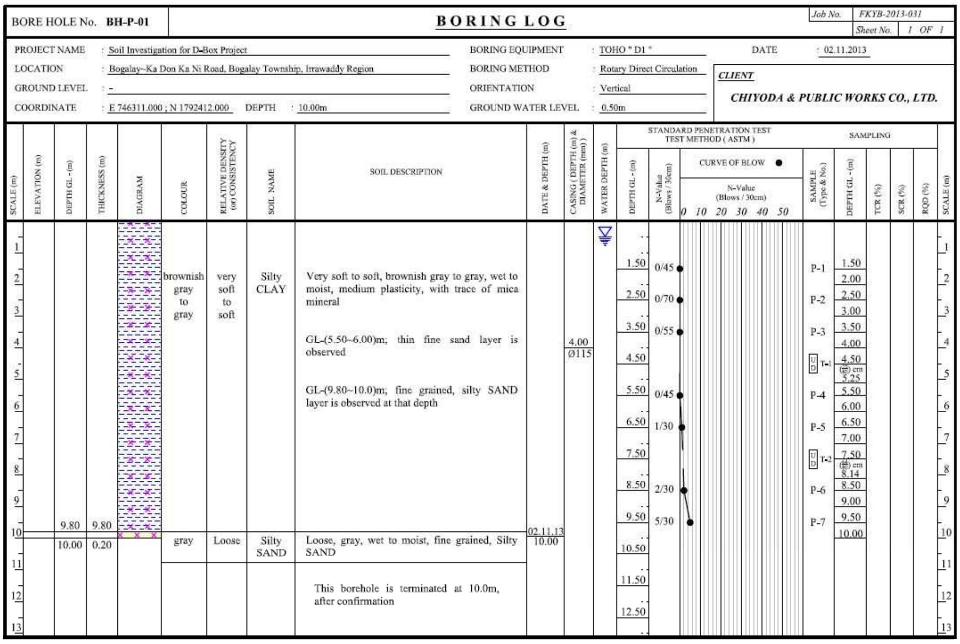
6.1 General

In this investigation before constructed D-Box, it was conducted drilling work of 1 point and Swedish sounding test of 1 point. It was carried out to check the stratification with standard penetration test (hereinafter called as SPT) and to collect the undisturbed samples which of represented stratum at this site. The collected samples were sent to laboratory to obtain the consolidation and strength property on the original soil. Swedish sounding test was carried out to compare the converted N-value with N-value from SPT. At one month after constructed D-Box, Swedish sounding was carried out to check the strength of soil which was progressing to consolidate and to compare with the original strength of soil.

6.2 Site Condition of original

As for the result of drilling work at one point in this site, cohesive soil layer is covered from the surface to GL-9.8m with topsoil and Silty CLAY. Although the thin layer with fine sand of about 0.5m lies inside Silty CLAY layer from GL-5.5m to GL-6.0m, Silty CLAY layer is very soft and very homogeneous without coarse soil. From below Silty CLAY layer, incohesive soil layer is piled with Silty SAND layer. This layer is very loose with fine grained. As the lower end of Silty SAND layer wasn't confirmed in this investigation, the thickness of this layer is unknown. In this area, the stratification of ground is a simple. It can be assumed that Silty CLAY layer is in normally consolidated. This means that it can cause the consolidation settlement, when anything will be loaded on the ground. The boring log is shown in Table-6.1.

Table -6.1 boring log in the site



BORE HOLE No. **BH-P-01** — **BORING LOG** — Job No. FKYB-2013-031 — Sheet No. 1 OF 1

PROJECT NAME : Soil Investigation for D-Box Project
LOCATION : Bogalay~Ka Don Ka Ni Road, Bogalay Township, Irrawaddy Region
GROUND LEVEL : -
COORDINATE : E 746311.000 ; N 1792412.000 DEPTH : 10.00m
BORING EQUIPMENT : TOHO " D1 "
BORING METHOD : Rotary Direct Circulation
ORIENTATION : Vertical
GROUND WATER LEVEL : 0.50m
DATE : 02.11.2013
CLIENT: CHIYODA & PUBLIC WORKS CO., LTD.

DEPTH GL - (m)	THICKNESS (m)	COLOUR	RELATIVE DENSITY (or) CONSISTENCY	SOIL NAME	SOIL DESCRIPTION	DATE & DEPTH (m)	CASING (DEPTH (m) & DIAMETER (mm))
9.80	9.80	brownish gray to gray	very soft to soft	Silty CLAY	Very soft to soft, brownish gray to gray, wet to moist, medium plasticity, with trace of mica mineral GL-(5.50~6.00)m; thin fine sand layer is observed GL-(9.80~10.0)m; fine grained, silty SAND layer is observed at that depth		4.00 Ø115
10.00	0.20	gray	Loose	Silty SAND	Loose, gray, wet to moist, fine grained, Silty SAND	02.11.13 10.00	
					This borehole is terminated at 10.0m, after confirmation		

STANDARD PENETRATION TEST — TEST METHOD (ASTM); SAMPLING

DEPTH GL - (m)	N-Value (Blows / 30cm)	SAMPLE (Type & No.)	DEPTH GL - (m)
1.50	0/45	P-1	1.50 – 2.00
2.50	0/70	P-2	2.50 – 3.00
3.50	0/55	P-3	3.50 – 4.00
4.50		UD T-1	4.50 – 5.25
5.50	0/45	P-4	5.50 – 6.00
6.50	1/30	P-5	6.50 – 7.00
7.50		UD T-2	7.50 – 8.14
8.50	2/30	P-6	8.50 – 9.00
9.50	5/30	P-7	9.50 – 10.00
10.50			
11.50			
12.50			

6.3 The study results on effect of soil improvement

The comparison of original with improvement ground is indicated in Figure-6.1. It can be proved that the strength of soil wasn't increasing for one month after constructed D-Box.

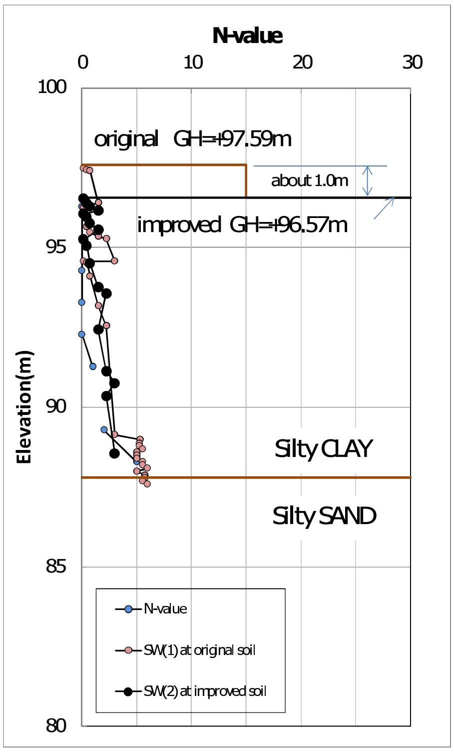


Figure -6.1 Comparison of original ground vs improved ground by Swedish sounding test

It could be expected that it can be proceeded to consolidate when it would be loaded from consolidation test result. After consolidation phenomenon is observed, the strength of soil can be higher than original soil. But the result is against that in this investigation. There is few reasons which the strength of soil was same as one of original soil. It can be considered as following-

- The increasing load was small

When D-Box was constructed, the increasing stress in ground can be assumed by "Boston-Code Method". The formula of "Boston-Code Method" is indicated as following-

$$\sigma_z = \frac{B^2}{\left(B + 2Z\tan 30^\circ\right)^2} q$$

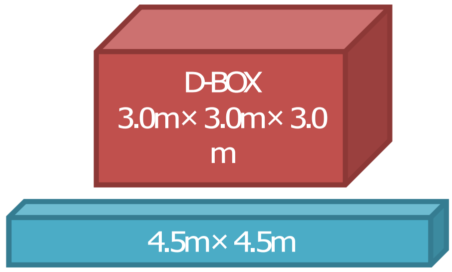
B : width (m)
z : depth (m)
q : load (kN/m^2)

D-Box unit weight : 17 kN/m^3 (Assumed)

D-Box height : 3m

D-Box width of foundation plate : 4.5m × 4.5m

q= (17×3×3×3) / (4.5×4.5) =22.7 ≒ 23 kN/m^2



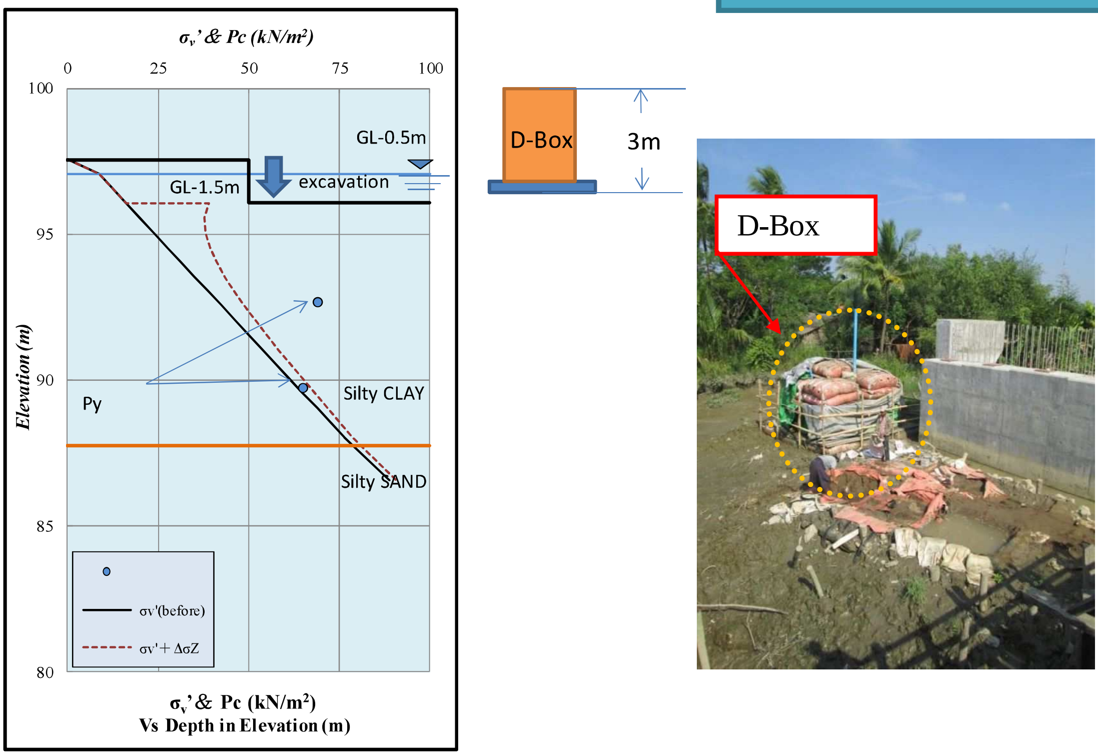


Figure -6.2 The stress condition of loading "D-Box"

According to Figure-6.2 which of red line indicates the stress condition, increasing load wasn't got to the consolidation yield stress "P_y" of original soil.

Appendix – A Boring Logs

BORE HOLE No. BH-P-01	BORING LOG	Job No.	FKYB-2013-031
		Sheet No.	1 OF 1

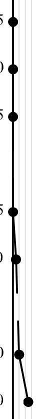
PROJECT NAME	: Soil Investigation for D-Box Project	BORING EQUIPMENT	: TOHO " D1 "	DATE	: 02.11.2013
LOCATION	: Bogalay~Ka Don Ka Ni Road, Bogalay Township, Ayeyarwaddy Region	BORING METHOD	: Rotary Direct Circulation	CLIENT	
GROUND LEVEL	: + 97.590m	ORIENTATION	: Vertical	CHIYODA & PUBLIC WORKS CO., LTD.	
COORDINATE	: E 746311.000 ; N 1792412.000 DEPTH : 10.00m	GROUND WATER LEVEL	: 0.50m		

ELEVATION (m)	DEPTH GL - (m)	THICKNESS (m)	COLOUR	RELATIVE DENSITY (or) CONSISTENCY	SOIL NAME	SOIL DESCRIPTION	DATE & DEPTH (m)	CASING (DEPTH (m) & DIAMETER (mm))	WATER DEPTH (m)
87.79	9.80	9.80	brownish gray to gray	very soft to soft	Silty CLAY	Very soft to soft, brownish gray to gray, wet to moist, medium plasticity, with trace of mica mineral GL-(5.50~6.00)m; thin fine sand layer is observed		4.00 Ø115	0.50
87.59	10.00	0.20	gray	Loose	Silty SAND	Loose, gray, wet to moist, fine grained, Silty SAND	02.11.13 10.00		
						This borehole is terminated at 10.0m, after confirmation			

STANDARD PENETRATION TEST
TEST METHOD (ASTM)

DEPTH GL - (m)	N-Value (Blows / 30cm)
1.50	0/45
2.50	0/70
3.50	0/55
4.50	
5.50	0/45
6.50	1/30
7.50	
8.50	2/30
9.50	5/30
10.50	
11.50	
12.50	
13.50	
14.50	
15.50	
16.50	
17.50	
18.50	
19.50	
20.50	
21.50	
22.50	
23.50	
24.50	
25.50	
26.50	
27.50	
28.50	
29.50	
30.50	

CURVE OF BLOW ●
N-Value (Blows / 30cm)
0 10 20 30 40 50



SAMPLING

SAMPLE (Type & No.)	DEPTH GL - (m)	TCR (%)	SCR (%)	RQD (%)
P-1	1.50 - 2.00			
P-2	2.50 - 3.00			
P-3	3.50 - 4.00			
UD T-1	4.50 - 5.25 (75/80) cm			
P-4	5.50 - 6.00			
P-5	6.50 - 7.00			
UD T-2	7.50 - 8.14 (64/80) cm			
P-6	8.50 - 9.00			
P-7	9.50 - 10.00			

NOTES

Relative density description		Consistency description	
Relative density	SPT N-Value (meas)	Consistency	SPT N-Value (meas)
Very loose	0 - 4	Very soft	under 2
Loose	4 - 10	Soft	2 - 4
Medium dense	10 - 30	Firm	5 - 8
Dense	30 - 50	Stiff	9 - 15
Very dense	over 50	Very stiff	16 - 30
		Hard	over 30

Sample key

- P-1 Disturbed sample (SPT sample)
- UD T-1 Undisturbed Sample (Piston sampler)
- UD D-1 Undisturbed Sample (Denison sampler)
- Rock core sample (Single core tube)
- Rock core sample (Double core tube)
- Rock core sample (Core lost)
- W-1 Water sample

RQD (%)	Term
0 - 25	Very poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Planner structure

Term	Spacing (mm)
Very thick	> 2000
Thick	600 - 2000
Medium	200 - 600
Thin	60 - 200
Very thin	20 - 60
Thickly laminated	6 - 20
Thinly laminated	< 6

Discontinuities

Term	Spacing (mm)
Very widely spaced	> 2000
Widely spaced	600 - 2000
Medium spaced	200 - 600
Closely spaced	60 - 200
Very closely spaced	20 - 60
Extremely closely spaced	< 20

Remarks

FUKKEN CO., LTD.
Consulting Engineers
(Yangon Branch)
FGEX FUKKEN
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www.myanmargeoconsultant.com

Revision No.	Rev: 00
Revision Date	10.12.2013

Appendix – B Swedish Sounding Result (1)

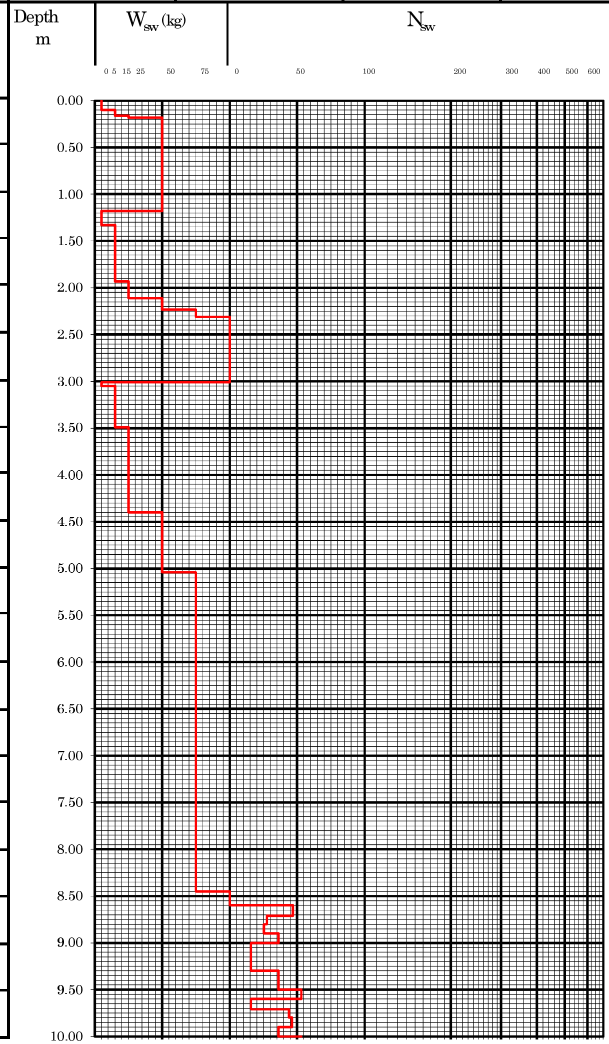
SWEDISH LOAD SOUNDING TEST

Location	Soil Investigation for D. Box Project	Date	02.11.2013
Point No.	SW-1	Operator	M.T.K
Elevation	97.590m	Weather	
Water Level	-		

0 (kg)	*N_a*	*Depth* (m)	*L* (cm)	*N_{sw}*	N value from sewdish sounding
5.0		0.10	10.0	0.0	0.15
15.0		0.16	6.0	0.0	0.45
25.0		0.18	2.0	0.0	0.75
50.0		1.18	100.0	0.0	1.50
5.0		1.33	15.0	0.0	0.15
15.0		1.93	60.0	0.0	0.45
25.0		2.11	18.0	0.0	0.75
50.0		2.23	12.0	0.0	1.50
75.0		2.31	8.0	0.0	2.25
100.0		3.01	70.0	0.0	3.00
5.0		3.01	0.0	0.0	0.15
15.0		3.05	4.0	0.0	0.45
25.0		3.49	44.0	0.0	0.75
50.0		4.40	91.0	0.0	1.50
75.0		5.04	64.0	0.0	2.25
100.0		8.45	341.0	0.0	3.00
100.0	7.0	8.60	15.0	46.7	5.33
100.0	5.0	8.71	11.0	45.5	5.27
100.0	4.0	8.80	9.0	44.4	5.22
100.0	5.0	8.90	10.0	50.0	5.50
100.0	4.0	9.00	10.0	40.0	5.00
100.0	4.0	9.10	10.0	40.0	5.00
100.0	4.0	9.20	10.0	40.0	5.00
100.0	5.0	9.30	10.0	50.0	5.50
100.0	5.0	9.40	10.0	50.0	5.50
100.0	6.0	9.50	10.0	60.0	6.00
100.0	4.0	9.60	10.0	40.0	5.00
100.0	6.0	9.71	11.0	54.5	5.73
100.0	5.0	9.80	9.0	55.6	5.78
100.0	5.0	9.90	10.0	50.0	5.50
100.0	6.0	10.00	10.0	60.0	6.00

BORING LOG (POST HOLE AUGER METHOD)

Scale	Depth (m)	Thickness (m)	Soil Name	Description	SPT N value	N value from swedish sounding	Depth GL- (m)	Scale
0.50								0.50
1.00						1.50		1.00
1.50					0			1.50
2.00						0.75		2.00
2.50					0			2.50
3.00						3.00		3.00
3.50					0			3.50
4.00						1.00		4.00
4.50								4.50
5.00			CLAY	Very soft to firm, CLAY		2.25		5.00
5.50					0			5.50
6.00						0.00		6.00
6.50					1			6.50
7.00						0.00		7.00
7.50								7.50
8.00						3.00		8.00
8.50					2			8.50
9.00						5.00		9.00
9.50					5			9.50
10.0	10.0	10.0				6.00		



Remark: $N_{sw}=(100/L)*N_a$
N_{sw}:Nos. of half rotation per meter
N_a:Nos.of half rotation for each length

N-value of SPT is calculated from Swedish Load Sounding test
$N=0.02W_{sw}$ (kgf)$+0.067N_{sw}$ (For Sandy Soil)
$N=0.03W_{sw}$ (kgf)$+0.050N_{sw}$ (For Clayey Soil)
W_{sw}:Weight(kg)

q_u=0.0045*Wsw+0.0075*Nsw
q_u=Unconfined compressive strength (kgf/cm^2)
DS-Disturbed Sample

Appendix – C Swedish Sounding Result (2)

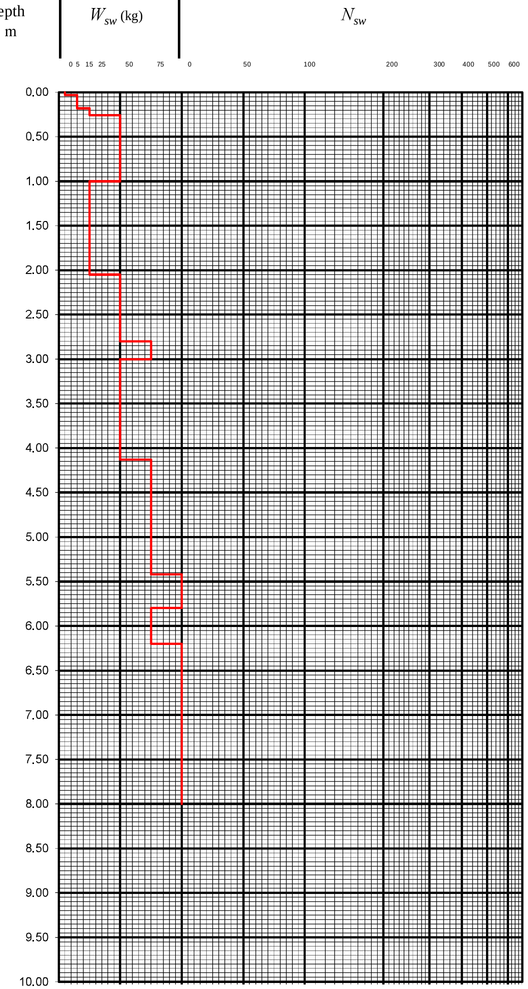
SWEDISH LOAD SOUNDING TEST

Location	Soil Investigation for D. Box Project	Date	08.12.2013
Point No.	SW-2	Elevation	96.562m
Operator	P.P.A	Weather	
Water Level	-		

0 (kg)	N_a	$Depth$ (m)	L (cm)	N_{sw}	N value from sewdish sounding
5.0		0.03	3.0	0.0	0.15
15.0		0.18	15.0	0.0	0.45
25.0		0.26	8.0	0.0	0.75
50.0		0.40	14.0	0.0	1.50
5.0					0.15
15.0					0.45
25.0					0.75
50.0		1.00	60.0	0.0	1.50
5.0					0.15
15.0					0.45
25.0		2.05	105.0	0.0	0.75
50.0		2.80	75.0	0.0	1.50
75.0		3.00	20.0	0.0	2.25
50.0		4.13	113.0	0.0	1.50
75.0		5.42	129.0	0.0	2.25
100.0		5.80	38.0	0.0	3.00
75.0		6.20	40.0	0.0	2.25
100.0		8.00	180.0	0.0	3.00

BORING LOG (POST HOLE AUGER METHOD)

Scale	Depth (m)	Thickness (m)	Soil Name	Description	SPT N value	N value from swedish sounding	Depth GL- (m)	Scale
0.50								0.50
1.00						1.50		1.00
1.50								1.50
2.00						0.75		2.00
2.50								2.50
3.00						2.25		3.00
3.50								3.50
4.00			CLAY	Very soft to soft, CLAY		1.50		4.00
4.50								4.50
5.00						2.00		5.00
5.50								5.50
6.00						2.25		6.00
6.50								6.50
7.00								7.00
7.50								7.50
8.00	8.00	8.00				3.00		8.00
8.50								8.50
9.00								9.00
9.50								9.50
10.0								



Remark: $N_{sw} = (100/L)*N_a$
N_{sw}:Nos. of half rotation per meter
N_a:Nos.of half rotation for each length

N-value of SPT is calculated from Swedish Load Sounding test
N=0.02W_{sw} (kgf)+0.067N_{sw} (For Sandy Soil)
N=0.03W_{sw} (kgf)+0.050N_{sw} (For Clayey Soil)
W_{sw}:Weight(kg)

q_u=0.0045*Wsw+0.0075*Nsw
q_u=Unconfined compressive strength (kgf/cm^2)
DS-Disturbed Sample

Appendix – D Laboratory Test Results
(Detailed Test Result：See in attached CD)

SUMMARY OF SOIL TEST RESULTS

Project Name : Soil Investigation for D-Box Project

Borehole No. BH-P-01 | Location : Bogalay Township, Ayeyarwaddy Region

Sample No.				P-2	P-3	T-1	P-4	P-5
Depth (m)				2.50 ~ 3.00	3.50 ~ 4.00	4.50 ~ 5.25	5.50 ~ 6.00	6.50 ~ 7.00
Moisture Content		w	%	63.19	65.81	49.61	47.50	46.67
Bulk Density		ρ_t	g/cm^3	-	-	1.755	-	-
Atterberg's Limit	Liquid Limit	WL	%	71.65	71.15	49.57	53.23	51.90
	Plastic Limit	WP	%	27.78	28.60	25.41	26.80	24.77
	Plasticity Index	IP	%	43.87	42.55	24.16	26.43	27.13
Grain Size Analysis	Gravel, (76.20 ~ 4.75) mm		%	-	-	-	-	-
	Sand, (4.75 ~ 0.075) mm		%	0.38	0.15	1.40	1.08	0.97
	Silt, (0.075 ~ 0.005) mm		%	63.43	58.85	66.00	66.93	71.23
	Clay, (< 0.005 mm)		%	36.20	41.00	32.60	32.00	27.80
Specific Gravity of Soil		Gs (20˚C)		2.681	2.666	2.716	2.657	2.658
Unconfined Compression	Unconfined Compressive Strength	q_u	kgf/cm^2	-	-	-	-	-
				-	-	-	-	-
	Failure Strain	ε_f	%	-	-	-	-	-
				-	-	-	-	-
Direct Shear Test	Cohesion	C_{UU}	kgf/cm^2	-	-	-	-	-
	Phi Angle	ϕ_{UU}	Degree	-	-	-	-	-
Unconsolidated Undrained Triaxial Compression Test	Cohesion	C_{UU}	kgf/cm^2	-	-	0.102	-	-
	Phi Angle	ϕ_{UU}	Degree	-	-	2.00	-	-
Consolidated Undrained Triaxial Compression Test (Measurement of Pore Pressure)	Cohesion	C'	kgf/cm^2	-	-	0.031	-	-
	Phi Angle	ϕ'	Degree	-	-	33.00	-	-
	Cohesion	C	kgf/cm^2	-	-	0.041	-	-
	Phi Angle	ϕ	Degree	-	-	18.00	-	-
Consolidation	Initial Void Ratio	e_0		-	-	1.277	-	-
	Conso. Yield Stress	P_y	kgf/cm^2	-	-	0.690	-	-
	Compression Index	C_c		-	-	0.420	-	-
Soil Classification (ASTM D 2487 - 06)		Group Symbol		CH	CH	CL	CH	CH
		Group Name		Fat clay	Fat clay	Lean clay	Fat clay	Fat clay

NOTE

Data used for reference are shown by red color.

SUMMARY OF SOIL TEST RESULTS

Project Name : Soil Investigation for D-Box Project								
Borehole No. BH-P-01	Location : Bogalay Township, Ayeyarwaddy Region							
Sample No.				T-2	P-6	P-7		
Depth (m)				7.50 ~ 8.14	8.50 ~ 9.00	9.50 ~ 10.00	~	~
Moisture Content		w	%	51.69	46.10	31.94		
Bulk Density		ρ_t	g/cm^3	1.742	-	-		
Atterberg's Limit	Liquid Limit	WL	%	60.20	57.19	-		
	Plastic Limit	WP	%	18.10	25.16	-		
	Plasticity Index	IP	%	42.10	32.03	-		
Grain Size Analysis	Gravel, (76.20 ~ 4.75) mm		%	-	-	-		
	Sand, (4.75 ~ 0.075) mm		%	0.17	0.22	73.48		
	Silt, (0.075 ~ 0.005) mm		%	67.63	63.58	18.32		
	Clay, (< 0.005 mm)		%	32.20	36.20	8.20		
Specific Gravity of Soil		Gs (20˚C)		2.689	2.716	2.691		
Unconfined Compression	Unconfined Compressive Strength	q_u	kgf/cm^2	-	-	-		
				-	-	-		
	Failure Strain	ε_f	%	-	-	-		
				-	-	-		
Direct Shear Test	Cohesion	C_{UU}	kgf/cm^2	-	-	-		
	Phi Angle	ϕ_{UU}	Degree	-	-	-		
Unconsolidated Undrained Triaxial Compression Test	Cohesion	C_{UU}	kgf/cm^2	0.133	-	-		
	Phi Angle	ϕ_{UU}	Degree	2.00	-	-		
Consolidated Undrained Triaxial Compression Test (Measurement of Pore Pressure)	Cohesion	C'	kgf/cm^2	0.031	-	-		
	Phi Angle	ϕ'	Degree	31.00	-	-		
	Cohesion	C	kgf/cm^2	0.051	-	-		
	Phi Angle	ϕ	Degree	16.00	-	-		
Consolidation	Initial Void Ratio	e_0		1.346	-	-		
	Conso. Yield Stress	P_y	kgf/cm^2	0.650	-	-		
	Compression Index	C_c		0.470	-	-		
Soil Classification (ASTM D 2487 - 06)		Group Symbol		CH	CH	SM (or) SC		
		Group Name		Fat clay	Fat clay	Silty sand (or) Clayey sand		

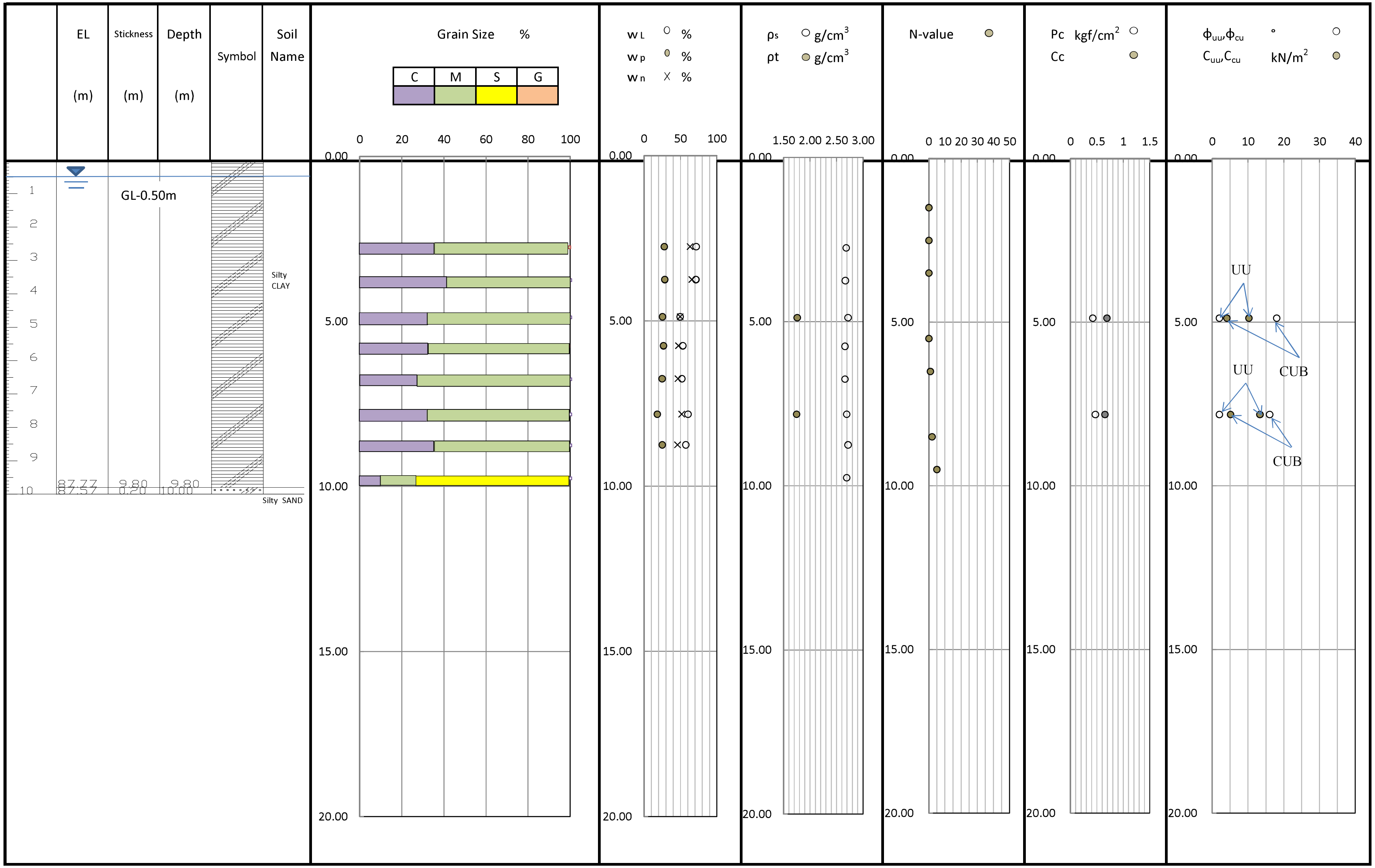
NOTE

Data used for reference are shown by red color.

Appendix – E Soil Property Chart

Soil Property Chart

Project Name : Soil Investigation for D-Box Project **BH-No. :** BH-P-01 **E.L. :** 97.57 **Date :** 4. Dec. 2013



※ Water table was measured after cleaning the hole

Appendix – F Daily Records for Boring Works

BORE HOLE No. BH-P-01 — BORING LOG RECORD

Job No. FKYB-2013-031
Sheet No. 1 Of 2
Date 2.11.13

Project Name : SOIL INVESTIGATION FOR D-BOX PROJECT
Location : Bogalay Township, Ayeyarwaddy Region
Ground Level : +97.590m
Coordinate : E 746311.000 ; N 1792412.000
Method for SPT : ASTM

Boring Equipment : TOHO -"D1"
Boring Method : Rotary (Direct Circulation)
Orientation : Vertical
Ground Water Level : 0.50m
Casing Diameter : Ø 115mm

Client
CHIYODA & PUBLIC WORKS CO., LTD.

Date & Time	Casing No.	Casing Length (m)	Total Casing Length (m)	Depth of Casing (m)	Description of Drilling Work	Soil Sample Depth (m)	Type	No.	Total Blows	Length (m)	Soil Description	SPT Blows per 15 cm	SPT Blows per 15 cm	SPT Blows per 15 cm	N Value	Remarks
2.11.13																
8:00	-	-	-	-	Arrive at site & preparation for											
					drilling work											
9:10	1	1	1	1	Install casing Ø-115mm	0.0 ~ 1.0										
9:20					Drilling with TC bit	0.0 ~ 1.5										
9:30					SPT at GL- 1.5 m	1.5 ~ 2.0	SPT	P-1	0	0.37	Silty CLAY, gray, moist to wet, medium	0	0	0	0/45	
											plasticity, very soft					
9:35	1	1	2	2	Install casing Ø-115mm	1.0 ~ 2.0										
9:40					Drilling with TC bit	1.5 ~ 2.5										
9:50					SPT at GL- 2.5 m	2.5 ~ 3.0	SPT	P-2	0	0.36	Silty CLAY, gray, moist to wet, medium	0	0	0/40	0/70	
											plasticity, very soft					
9:55	1	1	3	3	Install casing Ø-115mm	2.0 ~ 3.0										
10:05					Drilling with TC bit	2.5 ~ 3.5										
10:15					SPT at GL- 3.5 m	3.5 ~ 4.0	SPT	P-3	0	0.32	Silty CLAY, gray, moist to wet, medium to high	0	0	0/25	0/55	
											plasticity, very soft					
10:20	1	1	4	4	Install casing Ø-115mm	3.0 ~ 4.0										
10:30					Drilling with TC bit	3.5 ~ 4.5										
10:40					UD at GL- 4.5 m	4.5 ~ 5.3	UD	T-1	-	-	Recovery ratio = 75/80cm	-	-	-	-	
10:50	-	-	4	4	Drilling with TC bit	5.3 ~ 5.5										
11:05					SPT at GL- 5.5 m	5.5 ~ 6.0	SPT	P-4	0	0.38	Silty CLAY, gray, moist to wet, medium	0	0	0	0/45	
											plasticity, trace of fine sand and mica, very soft					

Ground Water Observation

Date & Time	Depth of Casing	Depth of BH	Depth of Water
2.11.13 8:00	GL- Nil	GL- Nil	GL- Nil
2.11.13 13:00	GL- 3.0m	GL- 9.5m	GL- Full

Note
Undisturbed Sample (UD - T : Thin wall sampler, D : Denison sampler)
Standard Penetration Test Sample (SPT : P)
Water Sample (W)

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BORE HOLE No. BH-P-01	**BORING LOG RECORD**	*Job No.*	FKYB-2013-031
		Sheet No.	2 *Of* 2

Project Name	: SOIL INVESTIGATION FOR D-BOX PROJECT	Boring Equipment	: TOHO -"D1"	Date	2.11.13
Location	: Bogalay Township, Ayeyarwaddy Region	Boring Method	: Rotary (Direct Circulation)		
Ground Level	: +97.590m	Orientation	: Vertical	*Client*	
Coordinate	: E 746311.000 ; N 1792412.000	Ground Water Level	: 0.50m	***CHIYODA & PUBLIC WORKS CO., LTD.***	
Method for SPT	: ASTM	Casing Diameter	: Ø 115mm		

Date & Time	Casing No.	Casing Length (m)	Total Casing Length (m)	Depth of Casing (m)	Description of Drilling Work	Soil Sample Depth (m)	Type	No.	Total Blows	Length (m)	Soil Description	SPT Blows per 15 cm	Blows per 15 cm	Blows per 15 cm	*N* Value	Remarks
2.11.13																
11:10	-	-	4	4	Drilling with TC bit	5.5 ~ 6.5										
11:20					SPT at GL- 6.5 m	6.5 ~ 7.0	SPT	P-5	1	0.39	Silty CLAY, with trace of mica and fine sand,	0	1	0	1/30	
											gray, moist, medium plasticity, very soft					
11:25	-	-	4	4	Drilling with TC bit	6.5 ~ 7.5										
11:35					UD at GL- 7.5 m	7.5 ~ 8.3	UD	T-2	-	-	Recovery ratio = 64/80cm	-	-	-	-	
11:40	-	-	4	4	Drilling with TC bit	7.5 ~ 8.5										
11:55					SPT at GL- 8.5 m	8.5 ~ 9.0	SPT	P-6	2	0.38	Silty CLAY, with trace of mica and fine sand,	0	1	1	2/30	
											gray, moist, medium plasticity, soft					
12:10	-	-	4	4	Drilling with TC bit	8.5 ~ 9.5										
12:30					SPT at GL- 9.5 m	9.5 ~ 10.0	SPT	P-7	5	0.41	Silty CLAY based by Silty SAND, gray, moist,	0	1	4	5/30	
											medium plastic clay, soft clay					
					This borehole is terminated at											
					9.50 m; after confirmation											
13:00	-	-	-	-	Drilling crews go back home											

Ground Water Observation	Date & Time	Depth of Casing	Depth of BH	Depth of Water
	2.11.13 8:00	GL- Nil	GL- Nil	GL- Nil
	2.11.13 13:00	GL- 3.0m	GL- 9.5m	GL- Full

Note
Undisturbed Sample (UD - T : Thin wall sampler, D : Denison sampler)
Standard Penetration Test Sample (SPT : P)
Water Sample (W)

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Appendix – G Site Photographs

SOIL INVESTIGATION FOR D-BOX PROJECT

BH-P-01

Before commencement of drilling work

Drilling Condition

Standard Penetration Test

S.P.T Sample

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SOIL INVESTIGATION FOR D-BOX PROJECT

BH-P-01

Piston Undisturbed Sampling

Piston Undisturbed Sample

Drilling & Left Length (A)

Drilling & Left Length (B)

FGEX FUKKEN *Fukken Co.,Ltd (Myanmar Branch),www.myanmargeoconsultant.com*

SOIL INVESTIGATION FOR D-BOX PROJECT

BH-P-01

Water Sampling

Water Sample

Panoramic View

After completion of drilling work

Soil Investigation for D-Box Project

SW-1

Before commencement of test work

Test Condition

Panoramic View

After commencement of test work

Soil Investigation for D-Box Project

SW-2

Before commencement of test work

Test Condition

Panoramic View

After commencement of test work