The 17th Infrastructure Technology Development Award 2015

The Japan Institute of Country-ology and Engineering (JICE) was established as a public interest corporation to promote construction engineering in Japan by conducting cutting-edge research and development activities.

To provide more incentives for construction technology researchers and research institutes to enhance the level of construction engineering more effectively, JICE commenced Infrastructure Technology Development Award with the Coastal Development Institute of Technology (CDIT) under the auspices of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT).

Twenty-five technologies competed for the 17th Infrastructure Technology Development Award. In principle, the technologies had to have been developed within the past five years and applied to the real construction sites in the last three years.

This year, two grand prizes were awarded for the following technologies as a result of examination: "Fluidized Bed Incinerator with Turbocharger (Energy-saving and low environmental load incinerator for sewage sludge)" and "High Durable Concrete with Seawater (Environment-Friendly Concrete with Seawater, Byproducts, and Special Additives) ".

The three excellence prizes were awarded to "Tunnel Enlargement Method for Shield Tunneling with Segments (WJ Segment Method)", "Hybrid tsunami protection wall to enable 'ultra' rapid construction (Minimization of site works and nearby producing materials due to divide wall into pre-casted blocks)", and "Countermeasure against liquefaction and mitigation of global warming by log piling (Log Piling method for Liquefaction mitigation and Carbon stock (LP-LiC))".

One of the grand prizes and two of the excellence prizes were introduced in the previous issue of IDI Quarterly (No. 70).

The other two technologies are introduced in this issue.

For any inquiries/ comments regarding the prizes please contact JICE:
Website: http://www.jice.or.jp/
(Japanese version only)
E-Mail: webmaster@jice.or.jp

High Durable Concrete with Seawater

(Environment-Friendly Concrete with Seawater, Byproducts, and Special Additives)

1. Background of Technology Development

Breakwaters, sea walls, wave dissipating concrete blocks, and pavements located at ports, coastal structures, and factories are often exposed for a long period to severe natural environment such as impact or friction due to abrasion of wave, water flow or traffic load. In such cases, highly durable concrete with high density and strength is required to stand such natural circumstances. Besides, on isolated islands, at offshore or coastal areas, and for restoration works from disasters, to obtain fresh water for mixing concrete becomes a critical issue.

It is generally accepted that concrete mixed with sea water has following material properties: Firstly, the early strength is higher but long term strength gain is slower than ordinary mixture; Secondly, workability is not good enough to cast the concrete due to shorter period of flowability; Thirdly, the sea water causes steel reinforcement to become corroded in a short term.

High durable concrete with seawater was developed so as to solve these problems.

2. Detailed Description of the Technology

For this newly developed concrete, sea water, that is enormous natural resource, and industrial byproducts such as blast-furnace slag, fly ash, silica fume, and special additives are utilized. It is also possible to use concrete debris and steel slag as aggregate.

For the reinforced concrete structure, anticorrosive reinforcement is required to maintain high durability.

3. Advantages of the Technology

[Lengthen Infrastructure Life Time]

The long term strength of concrete mixed with seawater, blast-furnace slag, fly ash, and special additives is increased as shown in Figure 1. Water tightness is also enhanced as shown in Figure 2. The durability of concrete against impact or friction due to abrasion of wave, water flow or traffic load are also expected to be improved. The durability of reinforced concrete is ensured for long term if anticorrosive reinforcement is used as shown in Photo 1.

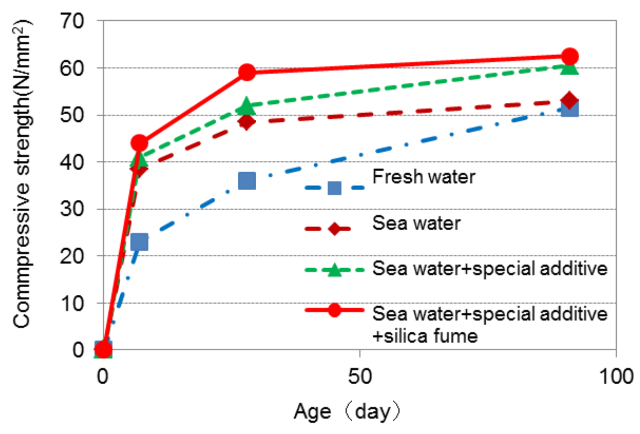


Figure 1 Compressive Strength of Concrete

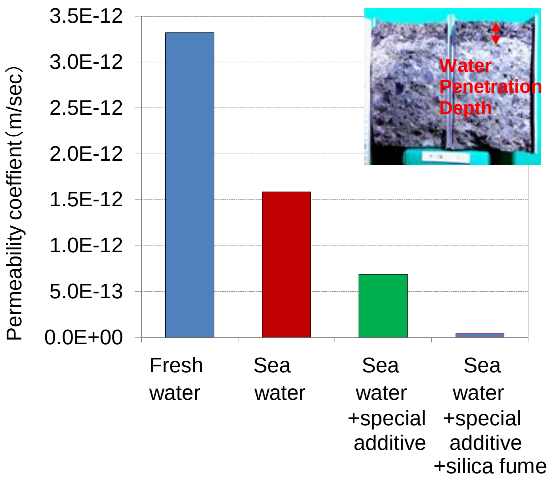
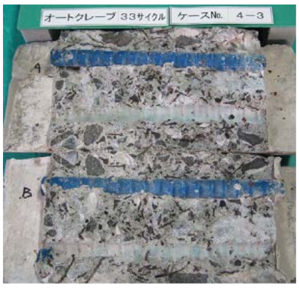
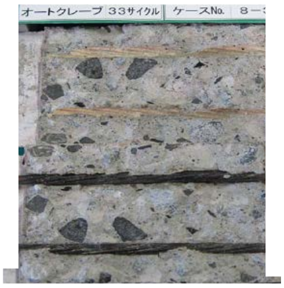


Figure 2 Water tightness Test

(Pressured at 1.0MPa for 48 hours)



Epoxy coated rebar



Carbon fiber rod

Ordinary steel bar

Photo 1 Corrosion of reinforcement after accelerated test

(Equivalent to 100 years' service life)

[Improved Workability]

This concrete can be placed in the same manner as ordinary concrete.

[Reduced Construction Period]

The concrete formwork can be removed earlier than ordinary concrete, and the curing time can be shortened due to early strength developing property.

[Reduced Construction Cost]

Concrete's cost can be reduced if fresh water is not easily available.

[Less Impact for the Environment]

CO_2 emission can be reduced due to the use of seawater and byproducts.

[Reduced Waste Material]

Byproducts, such as concrete debris and steel slag, can be reused as shown in Photo 2, 3 and 4.

Photo 2 Wave dissipating concrete block using sea water

Photo 3 Wave dissipating concrete block using sea water and debris

Photo 4 Pavement using sea water and steel slag

4. Applicability

- Breakwaters, sea walls, wave dissipating concrete blocks, pavements etc. located at ports, coastal structures, and factories.
- This technology is adoptable for reinforced concrete, provided that its anticorrosion property and characteristic are ensured.

5. Installation Record

Restoration work from the Great East Japan Earthquake at Soma port in Fukushima Prefecture, Oct. 2012-Oct. 2013.

Technology developer: Obayashi Corporation

Joint developers: Port and Airport Research Institute, Tokyo Institute of Technology, Tohoku University, JFE Steel Corporation

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Countermeasure against Liquefaction and Mitigation of Global Warming by Log Piling

(Log Piling Method for Liquefaction Mitigation and Carbon Stock (LP–LiC))

1. Background of Technology Development

The background for the development of this technology is as follows:

- Global warming is a serious problem requiring mitigation.
- A huge earthquake is predicted to hit Japan in the near future, and we must prepare countermeasures against liquefaction, which can cause extensive damage even in areas far from the epicenter.
- Forests in Japan are now extremely bountiful. We are now at the stage to utilize them and a technology that can spur demand for wood is desired.

As the IPCC 5th Assessment Report (2013) shows, global warming has become increasingly serious, and reduction of greenhouse gases is a crucial issue. Another urgent issue is advancing national resilience measures against earthquakes expected to hit the Tokyo metropolitan area and the Nankai Trough. Liquefaction due to earthquakes is particularly dangerous, as it occurs over a wide area and so can cause serious damage even far from the epicenter. Low-environmental-impact, low-cost, sustainable measures are therefore necessary. On the other hand, forests in Japan are now extremely bountiful, which allows for the extensive use of wood resources. The Japanese government recently put into place the requirements for the expanded use of wood in civil engineering, the same as in other sectors such as construction and furniture.

2. Detailed Description of the Technology

The log piling method for liquefaction mitigation and carbon stock (LP-LiC) is a method that densifies ground and increases liquefaction resistance by piling logs into the ground (Figs. 1 and 2). The method uses non-processed, non-cut green logs. LP-LiC is a low-vibration and low-noise method (Fig. 3), and it can be performed with small construction machinery (Photo 1) and does not extensively displace ground around the construction site (Fig. 4). Construction is therefore possible in urban areas, narrow sites, and detached houses, where construction in close proximity is required.

As logs do not biodeteriorate below groundwater level (Fig. 5), the carbon absorbed during growth can be semi-permanently stocked in the ground. The method therefore mitigates global warming by construction work, a particular characteristic not seen in other methods (Fig. 6). While log heads are generally set below the groundwater level, to ensure prevention of biodeterioration, we partially process log heads in consideration of possible groundwater fluctuations. By combining modern and traditional techniques for using logs as stated above, we have established a modern and reliable design and construction method. Through creating below-ground forests using this method, we are simultaneously stocking carbon, mitigating earthquake disaster due to liquefaction, and mitigating global warming for the first time.

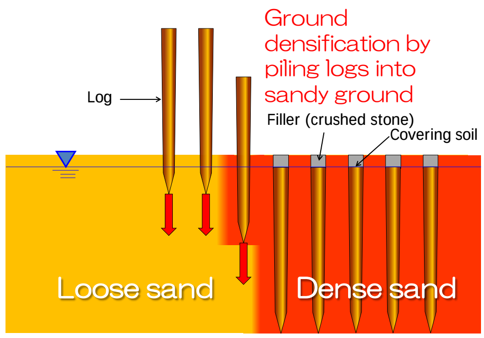


Figure1 Principle of LP-LiC liquefaction countermeasures

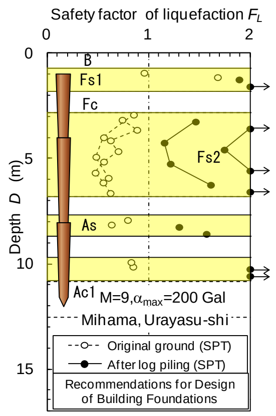
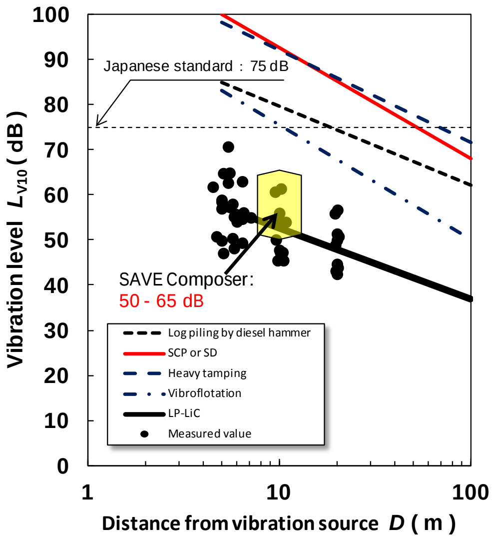
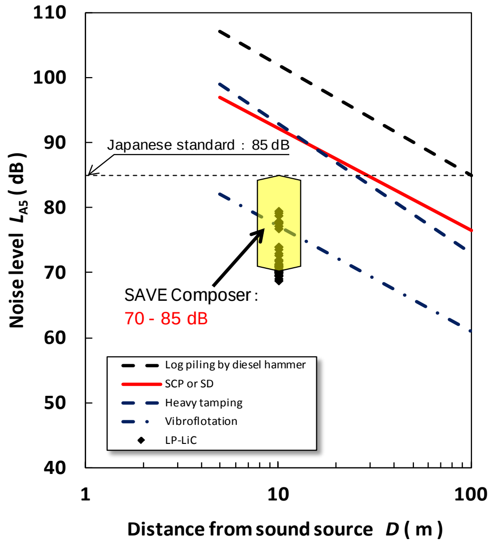


Figure2 Effects of LP-LiC

Photo1 Installation by small construction machinery at a narrow site



(a)Vibration level



(b) Noise level

Figure 3. Vibration/noise level by LP-LiC

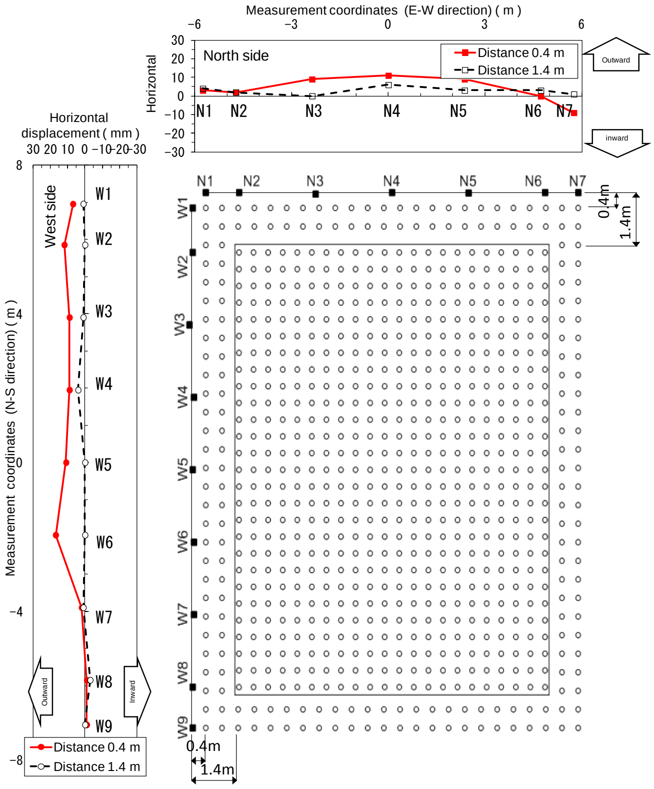


Figure 4. Displacement in surrounding construction site by LP-LiC

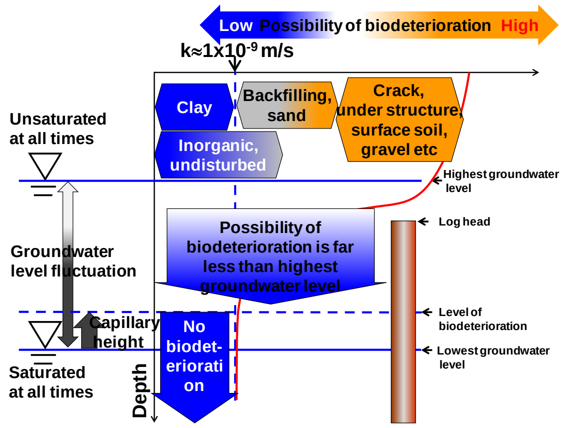


Figure 5. Possibility of wood biodeterioration in the ground

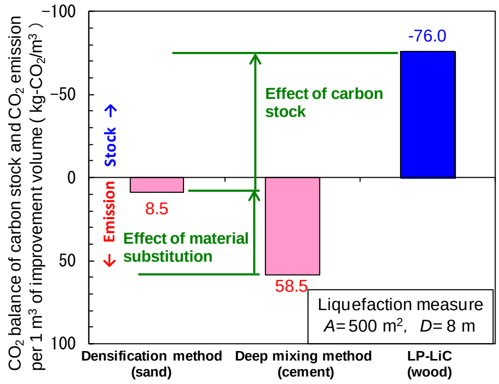


Figure 6. Comparison between improvement methods for CO_2 balance of carbon stock and CO_2 emission

3. Advantages of the Technology

[Liquefaction mitigation]
This method is based on a highly reliable principle of ground densification and can certainly improve liquefaction resistance.

[Carbon stock]
Increased use of LP-LiC as a liquefaction countermeasure results in increased carbon stock.

[Effects on the surrounding area]
This method can be used in narrow areas because of its low vibration, low noise, and low displacement characteristics.

[Indirect effects]
This method extensively uses domestic wood resources that are now going unused, contributing to forest regeneration. It can recharge water resources and prevent landslides in mountainous areas in addition to liquefaction prevention in coastal areas.

4. Applicability

Target: Liquefaction prevention measures for surrounding buildings, detached houses, embankments (for roads, railways, residential land, and river and coastal conservation), parking lots, parks, sporting grounds, etc.

Applicable ground: SPT N value ≤ 20, sandy soil, fine fraction content ≤ 50%, maximum improvement depth ≤ 12 m

Log tree species: Basically any tree species can be used (cedar, cypress, larch, etc.).

Log specifications: Log top diameter: $0.13 \leq D_t < 0.18$ m; log length: ≤ 6 m; number of joints: ≤ 2

5. Installation Record

One-story public hall in Urayasu City (Sept–Nov 2013) and 10 other cases.

Technology developer: Tobishima Corporation

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IDI has been publishing the free quarterly journal "IDI Quarterly" since1996 for the purpose of introducing information relating to public works and construction technologies developed in Japan to foreign countries. We have distributed the journal to administration officials in more than 90 countries around the world by e-mail.

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