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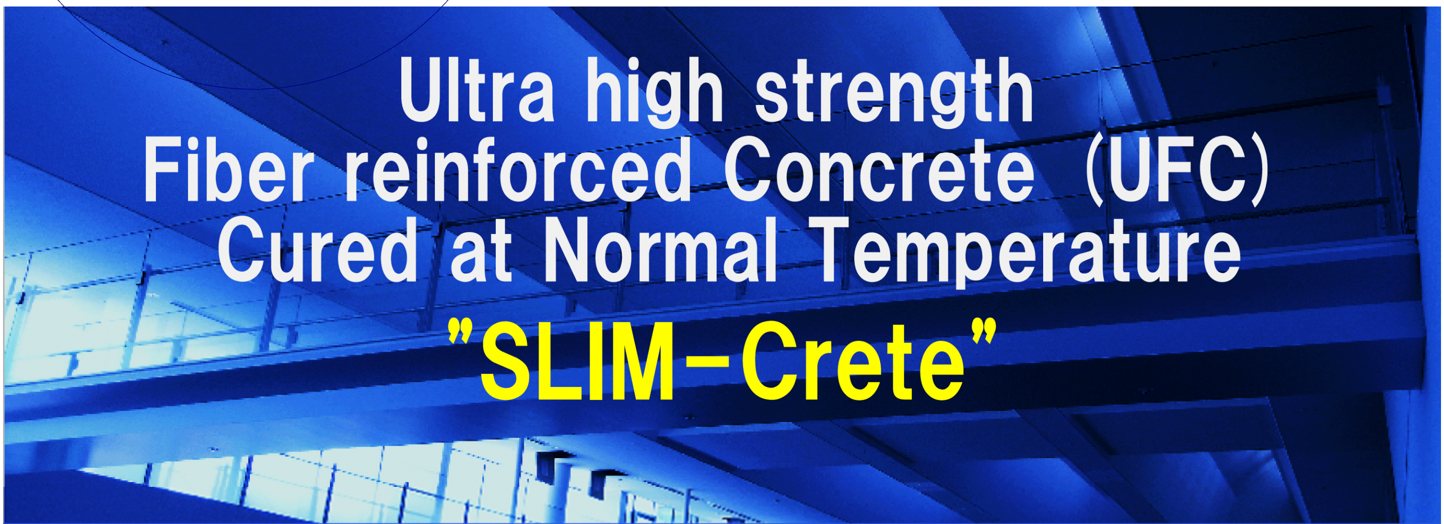

Ultra high strength Fiber reinforced Concrete (UFC) Cured at Normal Temperature "SLIM-Crete"

CONTENTS

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The 18th Infrastructure Technology Development Award 2016

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.

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

Twenty-eight technologies competed for the 18th Infrastructure Technology Development Award.

In principle, the applicants' technologies should have been developed within the past five years and applied to the real sites within the past three years.

As a result of examination, institutes and researchers with the following technologies were awarded 18th prizes.

The grand prize is "Ultra-high-strength Fiber reinforced Concrete (UFC) Cured at Normal Temperature (SLIM-Crete)".

And the two excellence prizes were awarded to "The development of the flap gate type land locks (Seawalls which rises by buoyancy when flooded by the tsunami and storm surges)" and "Short Stroke Seismic Isolation System for Urban Buildings (Development and Application of Passive-Switching Oil Damper)".

The grand prize and two excellence prizes are introduced below.

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

Ultra-high-strength Fiber reinforced Concrete (UFC) Cured at Normal Temperature "SLIM-Crete"

1. Background of Technology Development

Ultra-high-strength Fiber-reinforced Concrete (UFC) has a compressive strength of more than 150N/mm2 and a splitting tensile strength of more than 5 N/mm2. Its durability is assessed at 100 years. However, conventional UFC requires hot steam curing at 90℃, which limits its applicability to factory production. This paper describes a UFC that hardens at normal temperatures, which has been developed for site construction.

Ultra-high-strength mortar

+ Ultra-high-strength steel fiber

Compressive strength : $180 N/mm^2$

Tensile strength : $8.8 N/mm^2$

Figure 1 Constituent materials and strength characteristics

2. Detailed Description of the Technology

The developed UFC uses cement with a lot of alite ingredients and pozzolanic material. UFC produced from mix proportions of these materials possesses high densification, strength and durability.

This UFC can be produced at ready-mixed concrete plants or automotive-type plants, enabling site construction. High-strength steel fiber was added to the high-strength mortar and a compressive strength of more than 180 N/mm2 and a tensile strength of more than 8.8 N/mm2 were achieved (Figure 1).

3. Technological coverage

- This material is needed for structures in general and in particular for structures that require weight saving and thin parts.
- There is a need for structures with high durability to salt water, neutralization, freezing damage, wear, etc.

4. Effect of the technology

- Compressive strengths 7.5 times higher than that of normal concrete and tensile strengths more than 3 times higher can be achieved, which can reduce the cross-section of a structure by about 1/2. Thus, pillars, beams, foundations, piles, etc., can be made smaller and lighter.
- Fluidity of constituents can reduce building costs, making it possible to design a structure with a free shape without the need for rebars, thus reducing construction and labor costs and increasing productivity.
- The durability of the ingredients is extended to 100 years, and maintenance is greatly reduced. Thus, Life-Cycle Cost is about 50% that of conventional reinforced concrete. This also reduces maintenance and management costs.
- Transport of products is unnecessary and special curing equipment and heat energy can be omitted. Equipment costs are reduced, CO2 emissions are reduced by about 50%

compared to those of conventional UFC, and environmental loads are reduced.

5. Expansibility of the technology

This technology can reduce building and maintenance costs. The infrastructure stock can be improved by improving its durability. Future application to bridges and skyscrapers, etc. can be expected because of its light weight.

A new shotcrete application method can be used with this technology, resulting in a new construction technology. This should contribute to increased export of overseas infrastructures of railroads and suspension bridges.

6. Technological application results

This technology was applied to 11 cases of construction so far.

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Photo 1 Example of interior pedestrian overpass

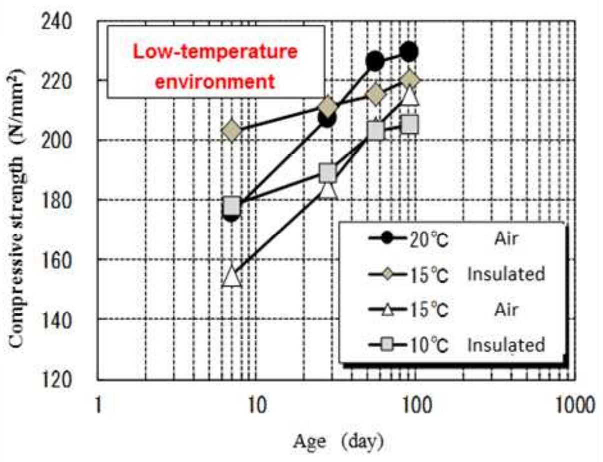


Figure 2 Curing condition and strength

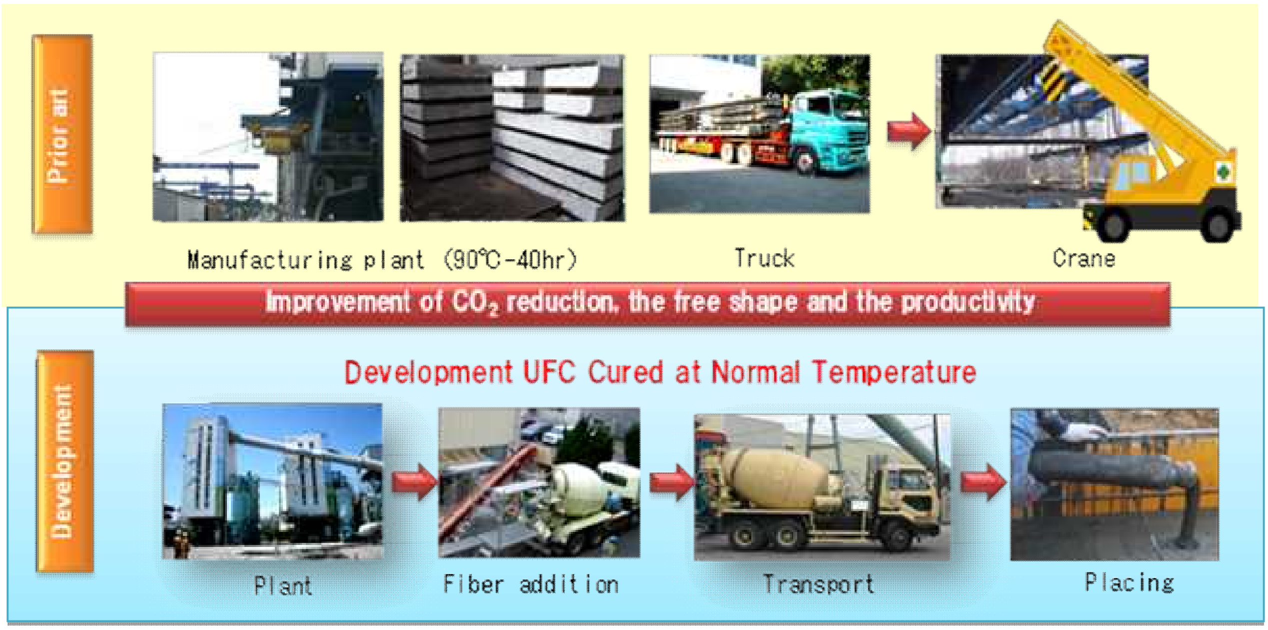


Figure 3 Comparison of a construction processes

The development of the flap gate type land locks

(Seawalls which rises by buoyancy when flooded by the tsunami and storm surges)

1. Background of Technology Development

We have already developed a flap-gate type of breakwater for tsunamis and surge waters since 2003. Taking advantage of it, we have started a flap-gate type of land lock since 2009. The 2011 Great East Japan Earthquake caused many of the casualties from fire corps volunteers who tried to operate and close gates against tsunami.

As a countermeasure, normally closed type and/or the remote operation type of gates are effective. But the normally closed type, which open/close gates each time of passage, imposes a burden on a daily operation. On the other hand, the remote operation type which has a remote control system, is required the burden of tremendous maintenance over the long term.

In our technology, the gate closes the opening automatically by using the buoyancy due to flooding.

If the gate opens absolutely at the time of flooding without the remote control system and in normal time there is no traffic obstruction, those aforementioned problems will be solved.

We made the analysis of the interference caused at the time of gate standing, and the evaluation of hydraulic model experiments. Furthermore, we drafted the risk avoidance methods including maintenance method. Then finally, our technology has been put to practical use with sufficient reliability.

2. Detailed Description of the Technology

Construction example of this technology shows in Photo 1, showing the operation mechanism in Figure 1.

Gate that has been installed on the seawall opening, to automatically close the opening by turning standing with the buoyancy and the aid by counterweights.

In this technology, we could have both a strength and lightness to the passing vehicle by placing a filler material inside the Gate leaf. And by using the counterweights as a braking force at the end of rising and the assist force at the start of rising, we had made it possible to improve the response characteristic in a very simple mechanism.

(See Figure 2).

Tokushima Prefecture Hiwasa Port (April, 2014)

MUYA port coast Kuwashima Seto district (October, 2015)

Photo1 Installation Record

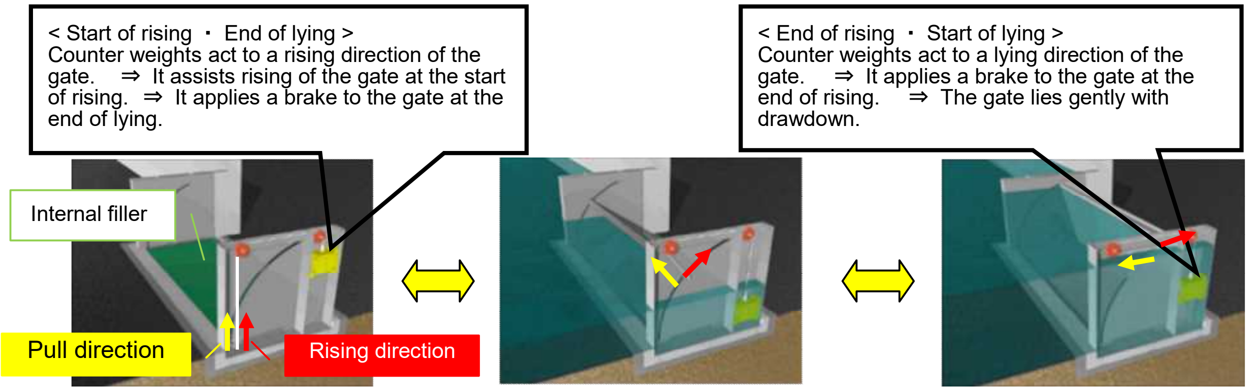
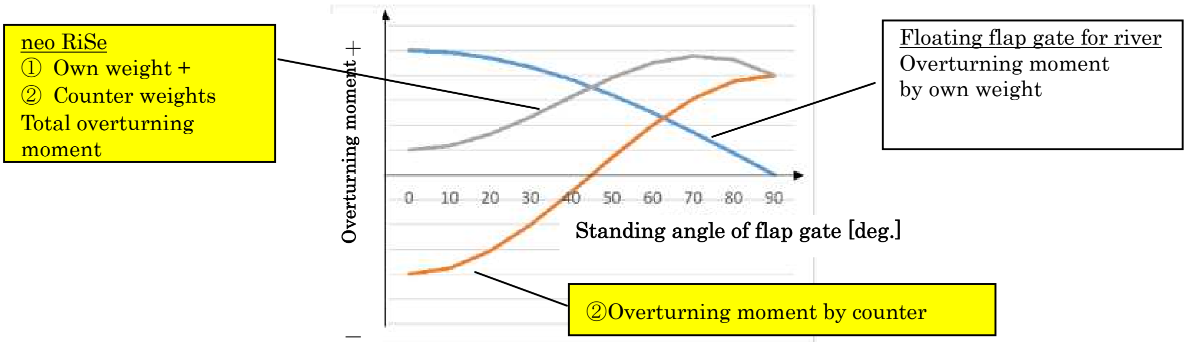


Figure1 Rising assist device by counter weights



3. Advantages of the technology

The key feature of this technology is shown below.

・Without that the operator is at risk, and operational errors and operation forget, risk by the operation delay can be avoided.

・We do not have to close the gates before the tsunami. Therefor the opening can be used as escape route until the tsunami comes.

・Maintenance is easy as compared to the remote operation system, and we can reduce maintenance burden significantly.

4. Applicability

・Applying place: Seawalls opening and river embankment opening (land locks as a tsunami and storm surge protection)

・Size: Width 1.25m - 15.0m , Height 0.5 m - 4.0m (The following shows the production results. Also applicable to larger size)

5. Installation Record

2014 MUYA port coast Kuwashima Seto district levee improvement work (Part 2), such as all 34 Gate (April 1, 2016)

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Short Stroke Seismic Isolation System for Urban Buildings

(Development and Application of Passive-Switching Oil Damper)

1. Background of Technology Development

Since the Great East Japan Earthquake, from the point of view of building functional maintenance and business continuity after the earthquake, the needs of the seismic isolation building is increasing more and more. However, in dense urban areas, from the constraint of the narrow site environment, the adoption of seismic isolation system that requires a gap distance between building and retaining walls of about 600mm~700mm is often difficult, so the development of a technology for suppressing the isolation story displacement has been strongly desired. In a conventional seismic isolation system, it is possible in principle to suppress the seismic isolation story displacement by increasing the damper amount of seismic isolation story, but the damping force will become excessive and the seismic isolation effect will not be obtained sufficiently for the high-frequency small and medium-sized earthquake, so the adoption of the seismic isolation building have not proceed in dense urban areas.

2. Detailed Description of the Technology

As a short stroke seismic isolation system for urban buildings, the authors have solved the above problems by developing "Passive-Switching Oil Damper (certification number MVBR-0498, MVBR-0565)", in which the damping force is switched from the lower to the higher when the damper displacement exceeds the designated level. In other words, for the high-frequency small and medium-sized earthquakes, this system demonstrates a sufficient seismic isolation effect to contribute to business continuity by having an appropriate lower damping force, while for a larger earthquake, it suppress the seismic isolation story displacement by switching to the higher damping force to prevent the collision of the retaining wall and ensure the safety of the building. This damper operates reliably at the time of the earthquake because of the simple mechanism that does not require a supply of energy such as electricity.

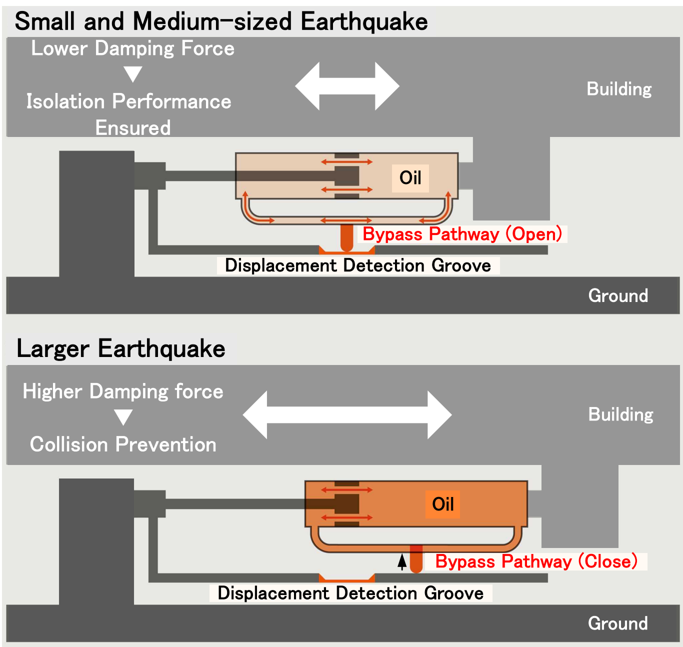

Fig.1 Mechanism of Passive-Switching Oil Damper

3. Advantages of the Technology

While maintaining the seismic isolation effect against small and medium-sized earthquakes, Passive-Switching Oil Damper enables to avoid a collision with a small gap distance between buiding and retaining walls than conventional systems by switching to a larger damping force in a large earthquake. Accordingly, in dense urban areas which have given up the adoption of seismic isolation system, this system enhance the business continuity after the earthquake while effectively utilizing narrow sites.

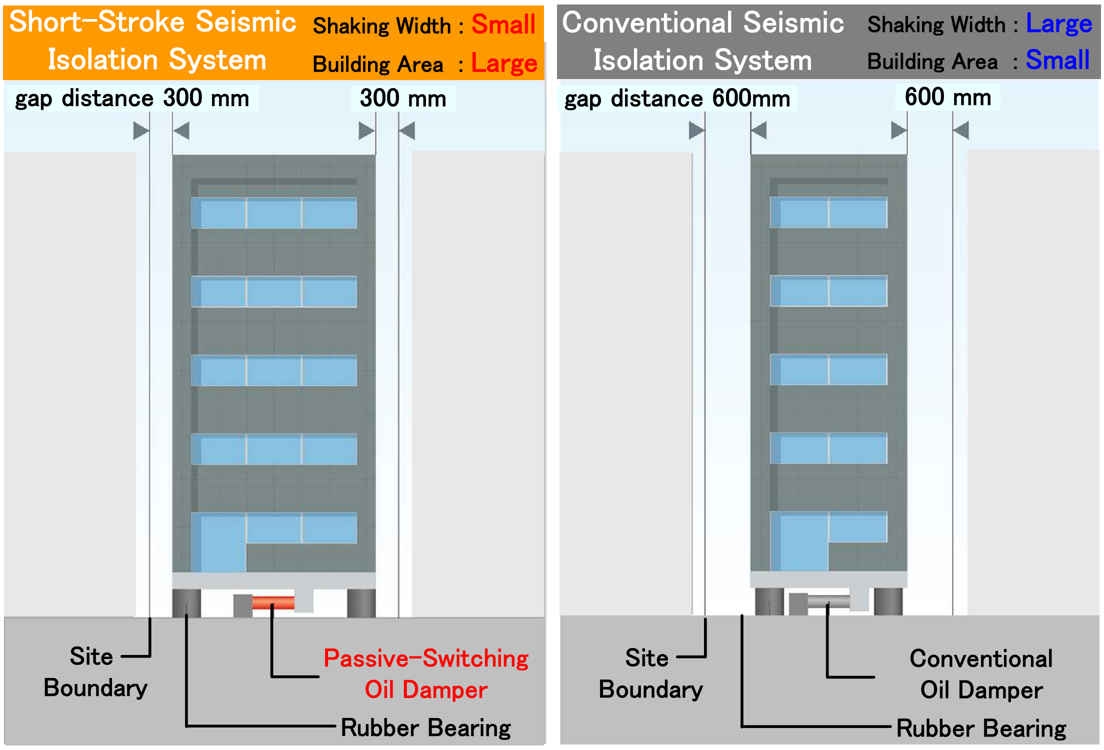

Fig.2 Comparison of Short-stroke Seismic Isolation system and Conventional Seismic Isolation system

4. Applicability

Available to all of the seismic isolated building including new construction, seismic isolation renovation of existing buildings (except for small detached houses).

5. Social Significance and Future Possibilities of the Technology

Passive-Switching Oil Damper is expected to contribute significantly to the spread of seismic isolation building in dense urban areas, accordingly, the effect of improving the disaster prevention and the safety of the city is also expected. This damper is a high potential technology developable to general new construction and existing seismic isolation buildings as a safety improvement technology against the ground motion exceeding the conventional design level.

6. Installation Record

Shinjuku Ward Office main government building, seismic isolation renovation, April 2014 – November 2015. Applied to 2 others.

(a) Building Appearance

(b) Passive-Switching Oil Damper

Fig.3 Applied building [Shinjuku Ward Office Main Government Building]

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Infrastructure Development Institute (IDI)-Japan is a general incorporated association operating under the guidance of Ministry of Land, Infrastructure, Transport and Tourism of Japanese Government.
IDI provides consulting services for mobilizing International Assistance to developing countries, promoting international exchange of information and human resources, and supporting globalization of project implementation systems targeting both developed and developing countries in the field of infrastructure.

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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