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Replacement Technology for Road Bridge Decks Using High-Strength Fiber-Reinforced Cementitious Composite Materials (VFC)


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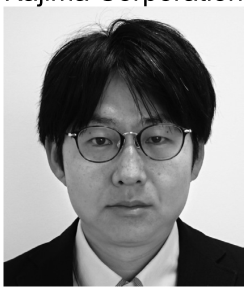
Makoto Muranaka
Central Nippon Expressway Company Limited

Reasons for the Award

Highway bridge decks that have been in service for over 30 years show signs of deterioration due to fatigue from repeated heavy vehicle loads and salt damage from deicing agents, indicating they have reached the time for renewal or repair. In projects where only the deteriorated sections of the deck slab are removed and replaced with new material or thickened, the common approach has been to significantly increase the slab thickness using steel fiber reinforced concrete (SFRC) to enhance load-bearing capacity. However, challenges remain, including the need to reinforce the substructure due to the increased slab weight, adjusting the road surface height associated with thickening, and the risk of re-deterioration in the replaced sections. This has created a demand for the practical application of new materials and construction methods.

The newly developed technology employs Very High Strength Fiber Reinforced Cementitious Composites (VFC) as the replacement material for the deck slab. VFC's superior properties enable efficient enhancement of the deck slab's load-bearing capacity and durability even with a thin construction thickness. This addresses the aforementioned challenges and is expected to reduce both the project cost of renewal work and long-term maintenance expenses. Furthermore, the developed VFC construction system enables safe, precise, and rapid construction even within the narrow work area of a single-lane traffic restriction. This ensures road access during construction and enables early restoration.

This technology was implemented in the large-scale renovation of the Okaya Viaduct on the Nagano Expressway, where its effectiveness was proven. This integrated approach, from pioneering research and development to practical implementation, serves as a valuable reference for engineers involved in developing new materials and construction methods. It is therefore worthy of the Japan Society of Civil Engineers Technical Development Award.

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Development of Manufacturing Technology for High-Durability, Environmentally Considerate Concrete (e-CON) for Cementless Precast Concrete Products



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Reasons for the Award

Sulfate corrosion of concrete causes overflow due to reduced flow capacity, pipe damage, and can even lead to road subsidence, posing a serious societal problem. Improving the sulfate resistance of precast sewer products extends the service life of sewer pipelines used in harsh environments, allows for longer replacement cycles than conventional methods, and effectively alleviates the anxiety caused by frequent traffic disruptions.

Using e-CON as a material for precast products not only confers high sulfate resistance but also enables maintaining strength equivalent to conventional cement concrete products while further improving surface smoothness. Furthermore, e-CON possesses the workability and compactability required for filling molds during product manufacturing, along with the demolding strength directly impacting production costs. Therefore, e-CON can be widely applied to the manufacture of various sewer products, including Hume pipes, and other precast products.

Furthermore, the primary raw materials for the e-CON binder include industrial by-products such as blast furnace slag powder, fly ash, and silica fume. This enables a significant reduction in CO_2 emissions during the manufacturing stage of the e-CON binder compared to conventional cement. e-CON technology ensures high sulfate resistance in sewer pipelines while achieving performance superior to conventional cement concrete products. Furthermore, through CO_2 emission reduction, it is expected to contribute to both extending infrastructure lifespan and preserving the global environment.

For these reasons, this technological development is worthy of the Japan Society of Civil Engineers Technology Development Award.

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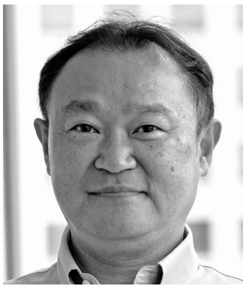
Development of a Deck Thickening Method Using Ultra-High-Performance Fiber-Reinforced Cementitious Composite Material (Stiffcrete®) with Ultra-Rapid Hardening Properties



Takayoshi Tomii
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OBAYASHI CORPORATION


Jyun Honma
OBAYASHI ROAD CORPORATION

Koji Tamaki
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Reasons for the Award

The deterioration of domestic road bridges is a serious problem requiring urgent attention. Within limited budgets, repair and reinforcement methods using materials with high resistance to re-deterioration and excellent long-term durability are sought. Construction methods that minimize impact on users are also crucial.

Traditionally, the surface thickening method using steel fiber reinforced concrete (SFRC) has been applied for deck slab repair and reinforcement of road bridges. However, challenges exist, such as re-deterioration due to insufficient integration with the existing deck slab, and the need for structural verification of the substructure due to road alignment modifications and increased load on the superstructure caused by the thickening.

This technology developed the ultra-rapid hardening UHPFRC “Stiffcrete” as a material suitable for deck surface thickening methods aimed at improving the fatigue durability of existing decks and preventing re-deterioration. It adapts to road gradients and allows for early traffic opening. It also developed a vehicle-mounted dedicated plant and specialized transport machinery/ Stiffcrete's high fluidity ensures reliable filling, achieving integral bonding with the existing deck. Its dense structure provides excellent water and salt barrier properties, allowing the omission of a waterproofing layer.

The development of this technology represents a significant advancement in expanding the application of UHPFRC, which possesses high reliability, proven construction track record, and excellent long-term durability, preventing re-deterioration. This is achieved by verifying and evaluating structural performance, considering not only material properties but also construction methods, and by establishing construction manuals adapted to ambient temperatures for quality control. Furthermore, through the development of this technology and its contribution to Society, it is worthy of the Japan Society of Civil Engineers Technology Development Award.

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Development of Quality Monitoring Methods for Concrete Construction



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Reasons for the Award

The concrete lining of mountain tunnels is poured by installing an arch-shaped movable formwork inside the tunnel and pouring concrete between the tunnel wall and the formwork through inspection windows. This makes it difficult to visually confirm the filling and compaction status. Particularly, the crown section is difficult to inspect visually because the inspection windows are closed and the concrete is poured using the blow-up method. Consequently, even in recent years, quality defects such as voids and insufficient thickness in the crown section of the lining concrete have not been completely eliminated.

Against this background, a long sheet-type sensor capable of monitoring the filling and compaction status across the entire span length (e.g., 10.5m) of the crown section during concrete placement has been developed. This technology offers multi-point monitoring capability. Furthermore, it features integrated detection elements and wiring within the sheet, enabling easy installation and boasting a thickness of just 0.6 mm. Subsequently, to apply this technology not only to lining concrete but also to various parts of other concrete structures, pinpoint types and formwork-mounted types have been developed. Moreover, the filling detection principle has been applied to develop a method for evaluating material segregation in concrete.

This technology facilitates monitoring of the filling and compaction status of the concrete lining crown and is widely utilized, thereby contributing to ensuring the quality and safety of tunnels, which are a public infrastructure. Furthermore, various sensor configurations have been realized to enhance applicability to other concrete structures. As this technology is expected to continue contributing to ensuring the quality and safety of concrete structures, it is worthy of the Japan Society of Civil Engineers Technology Development Award.