AR-assisted Work Management

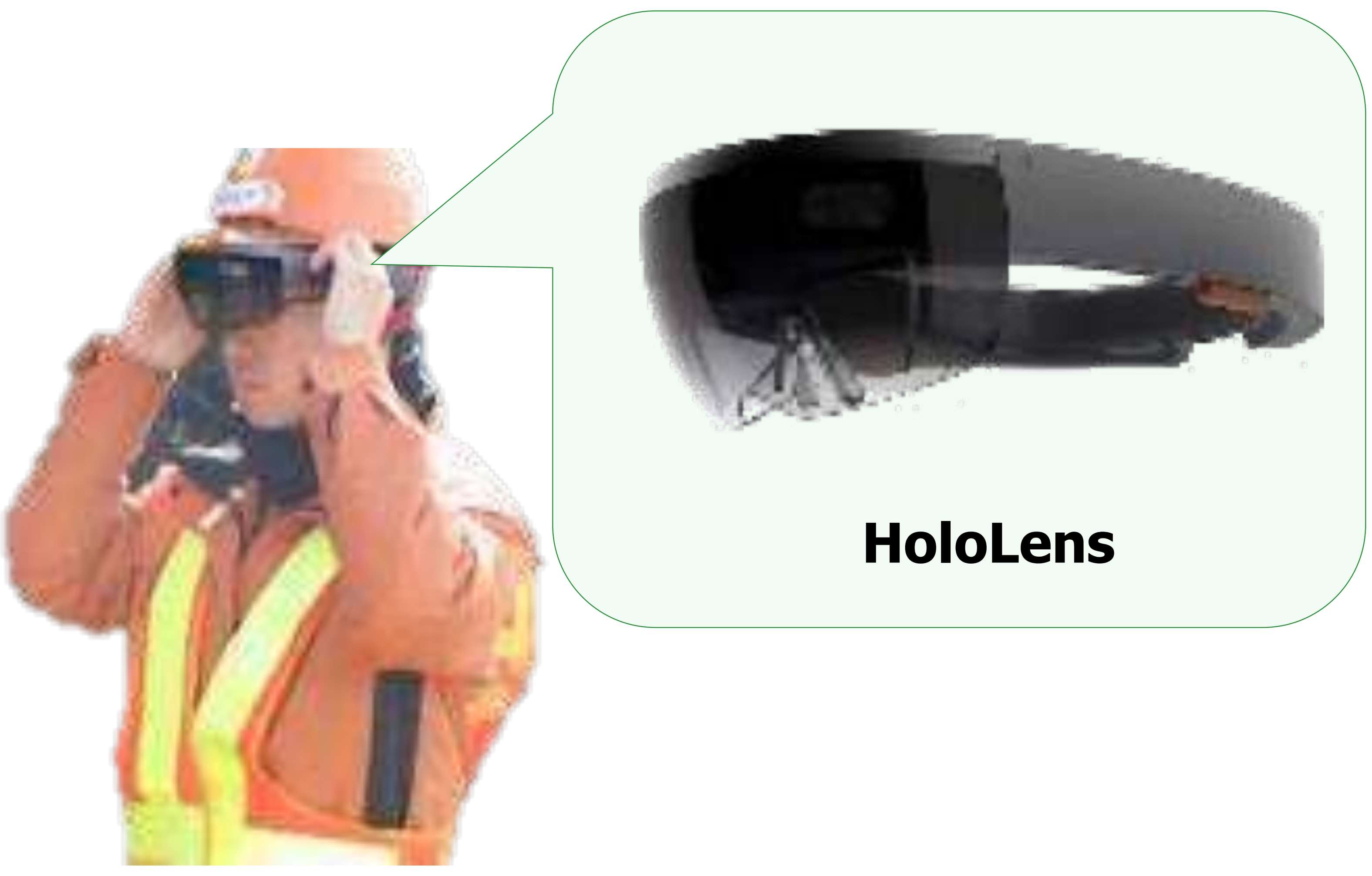
Offers greater efficiency in earthwork quality control operations

إدارة الإنشاءات باستخدام الواقع المعزز (AR)

تحسين رقابة جودة أعمال الحفر الهندسية

■ Overview

Conventionally, earthwork in civil engineering projects has been done depending on on-site physical stake markers. Modern ICT-based earthwork technology *1, which is already widely employed in road construction projects, makes stake markers unnecessary as positions are electronically measured by the power machinery using GNSS signals. However, absence of stake markers makes it difficult to visually confirm on-site that if the earthwork is to be completed exactly as originally planned. Use of AR*2 technology allows projecting the three-dimensional design image over the actual view to facilitate earthwork quality control operation.



Operator using a wearable device
(HoloLens by Microsoft)

*1 ICT-based earthwork: Earthwork technology where all the processes from surveying, design, on-site work, inspection through to delivery are implemented based on three-dimensional electronic data

*2 AR: Augmented Reality

■ Features

●Real-time data sharing

Operators and work supervisor with a wearable device can view three-dimensional models and other electronic data in a safe, real-time manner without using hand-held tablets.

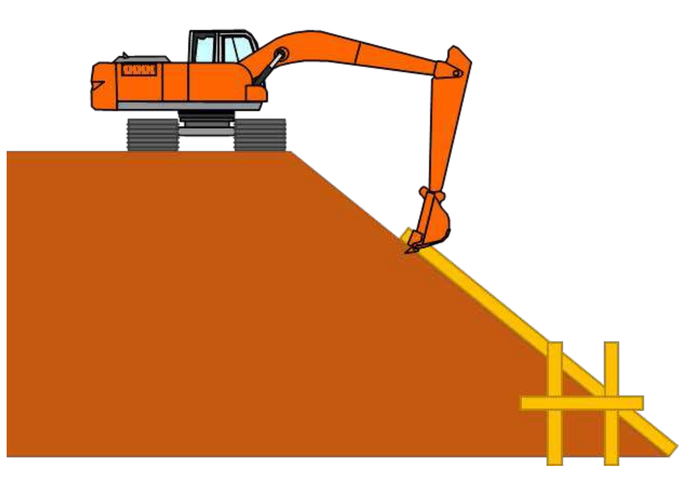
●Efficiency improvement

AR technology is employed to virtually project the design data over the actual view, enabling work management fully without using physical stake markers.

●Productivity improvement

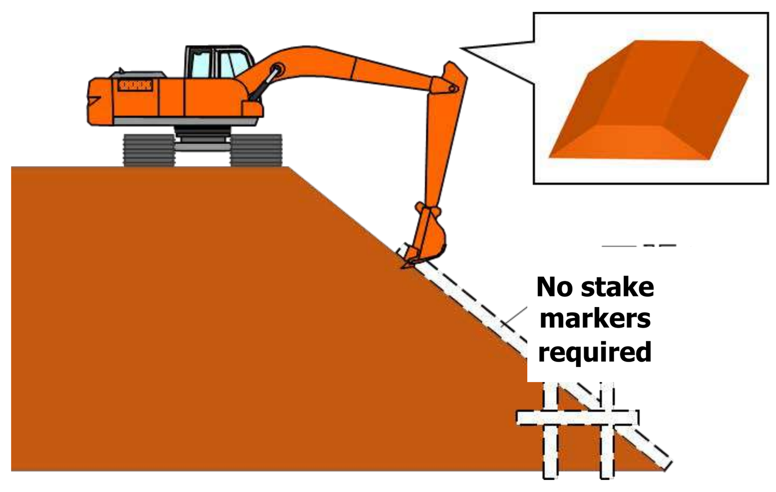
Use of this technology cuts the amount of work hours approximately by half in a U-shaped gutter installation project, greatly improving productivity.

Installation with a wearable device



《Conventional earthwork》

- Place stake markers
- Work by referring to the marker positions
- Check the completed shape according to the markers



《ICT-assisted earthwork》

- Create a three-dimensional design data
- Work according to the monitor display
- Check the completed shape using AR

Difference between
conventional and ICT-assisted earthwork

AR image overlay with a wearable device

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Worker Safety Control System "Envital"

For centralized worker health management

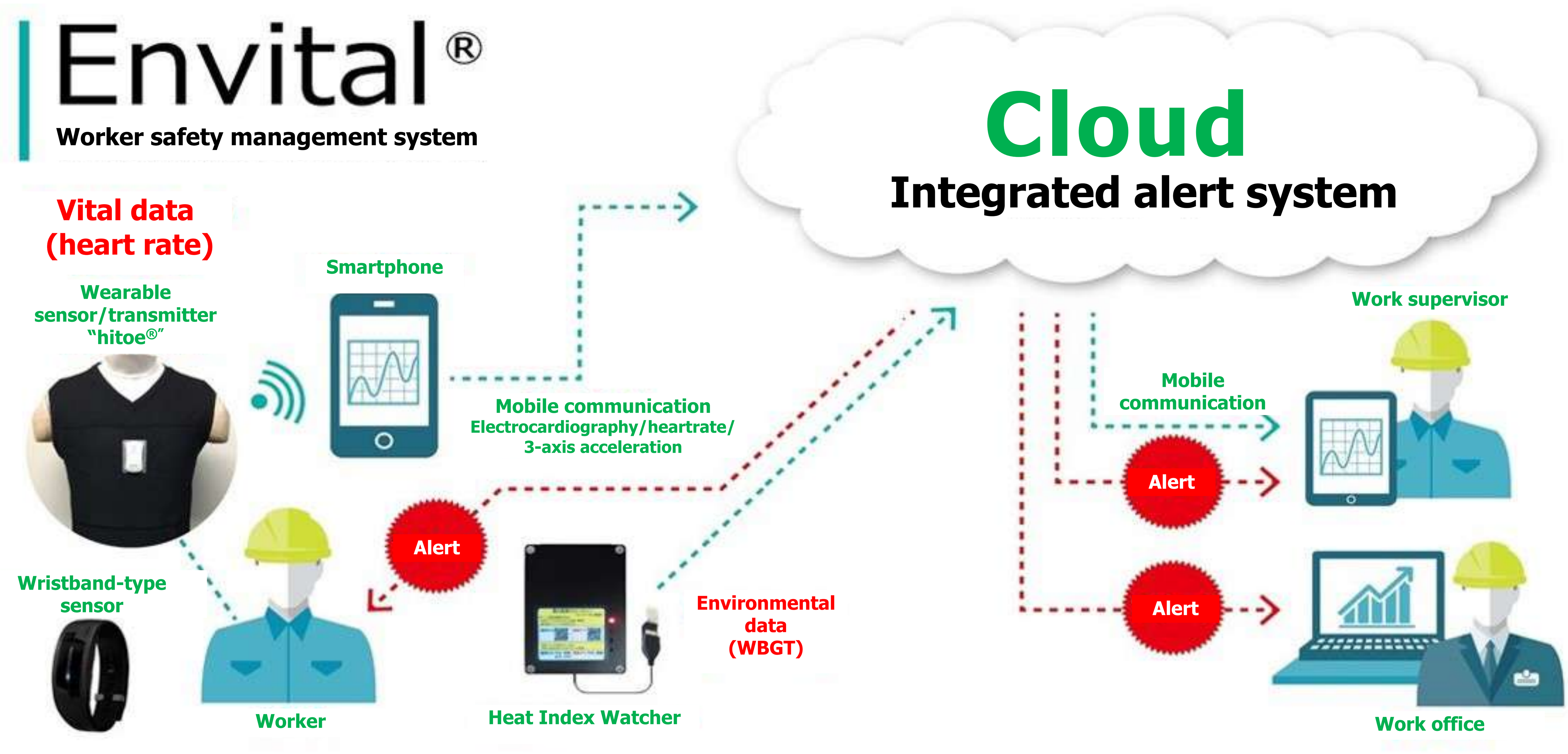
"Envital" نظام إدارة السلامة الخاص بالعمال

الإدارة المركزية لحالة العمال الصحية

■ Overview

Traditionally, worker health management against heatstroke has depended on taking WBGT*1 measurements and reminding the workers to take liquid and salt frequently and to rest regularly, but the tendency to heatstroke differs greatly from person to person and also depending on the work content and location of work being done. Envital is a centralized worker health management system that uses a combination of vital sensors and environmental sensors to measure each worker's heart rate and obtain the environmental heat index in a real time manner for individualized monitoring of each worker's condition.

*1 Wet Bulb Globe Temperature: A heat index proposed in US in 1954 for heatstroke prevention



■ Features

●Individualized worker risk level monitoring

The heart rate from the wearable sensor and the WBGT measurement obtained from the Heat Index Watcher™*2 are uploaded to the cloud to monitor each worker's heatstroke risk level.

●Cloud-assisted centralized management

The controller can monitor and manage all the workers' data single-handed. Analysis of the collected data allows precise determination of the heatstroke risk level, triggering an e-mail alert message to be sent to the controller whenever necessary.

●Compatibility with multiple platforms

The system is compatible with a wide range of web-based platforms including mobile devices and PCs.

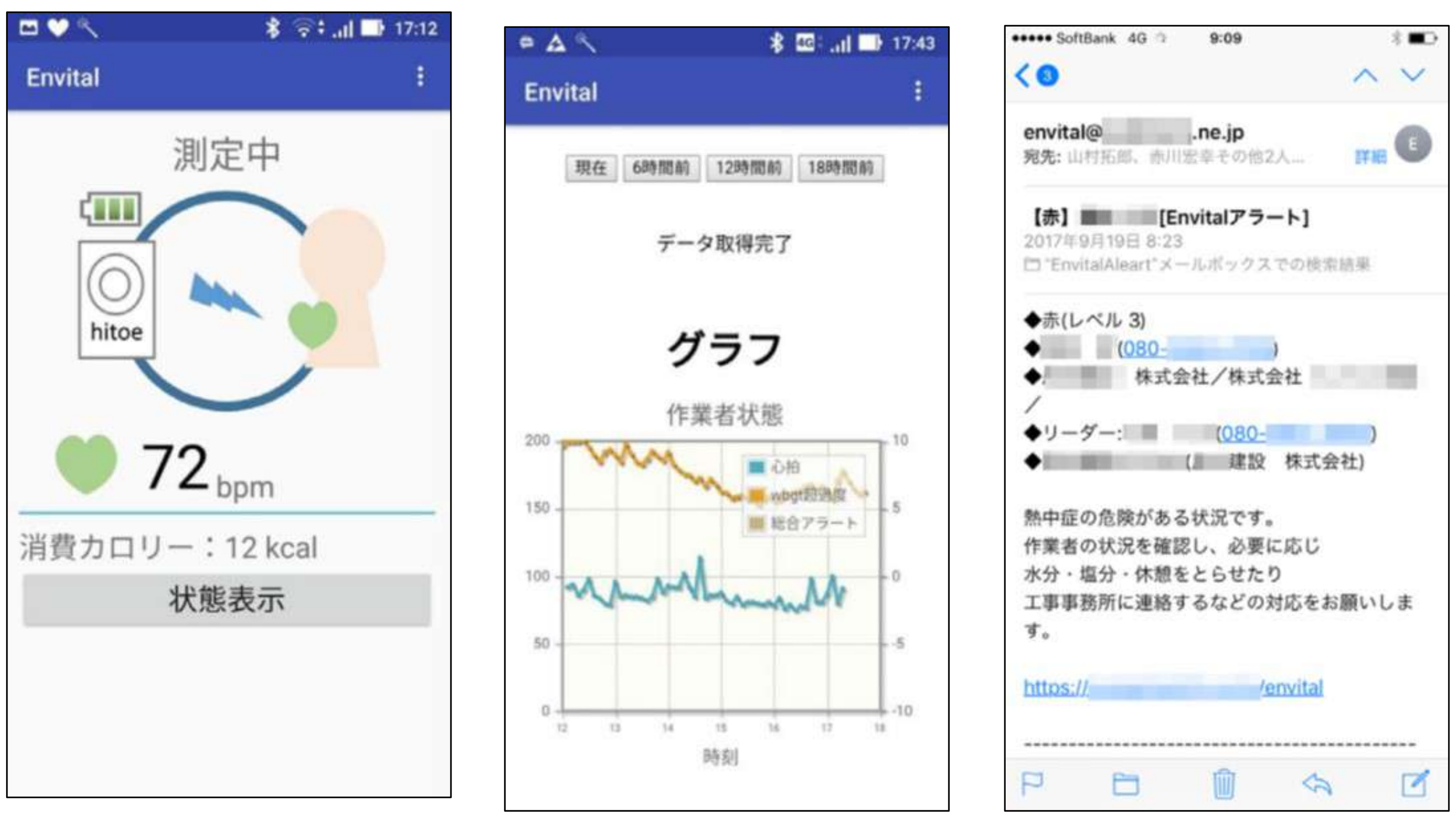
*2 Heat Index Watcher™: :A WBGT monitoring device originally developed by Obayashi. A proprietary wireless communication network allows centralized data monitoring and management.

Management screen (server)

■ Implementation records

The system was implemented in 23 work sites covering a total of 462 workers, only one of whom was diagnosed with heatstroke. (This single failure case was a result of negligence to follow the system implementation rules).

Control screen (terminal device)



Heart rate monitor | Condition indicator | Alert message

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GCP-less UAV

For greater UAV measurement efficiency in earthwork projects

طائرات مسيرة بدون نقاط مراقبة أرضية

تحسين عمليات قياس أعمال الحفر الهندسية التي تقوم بها الطائرات المسيرة

■ Overview

UAV-assisted photograph measurement in earthwork projects has been an extremely time-consuming work as numerous GCPs[*1] have to be installed on the ground.

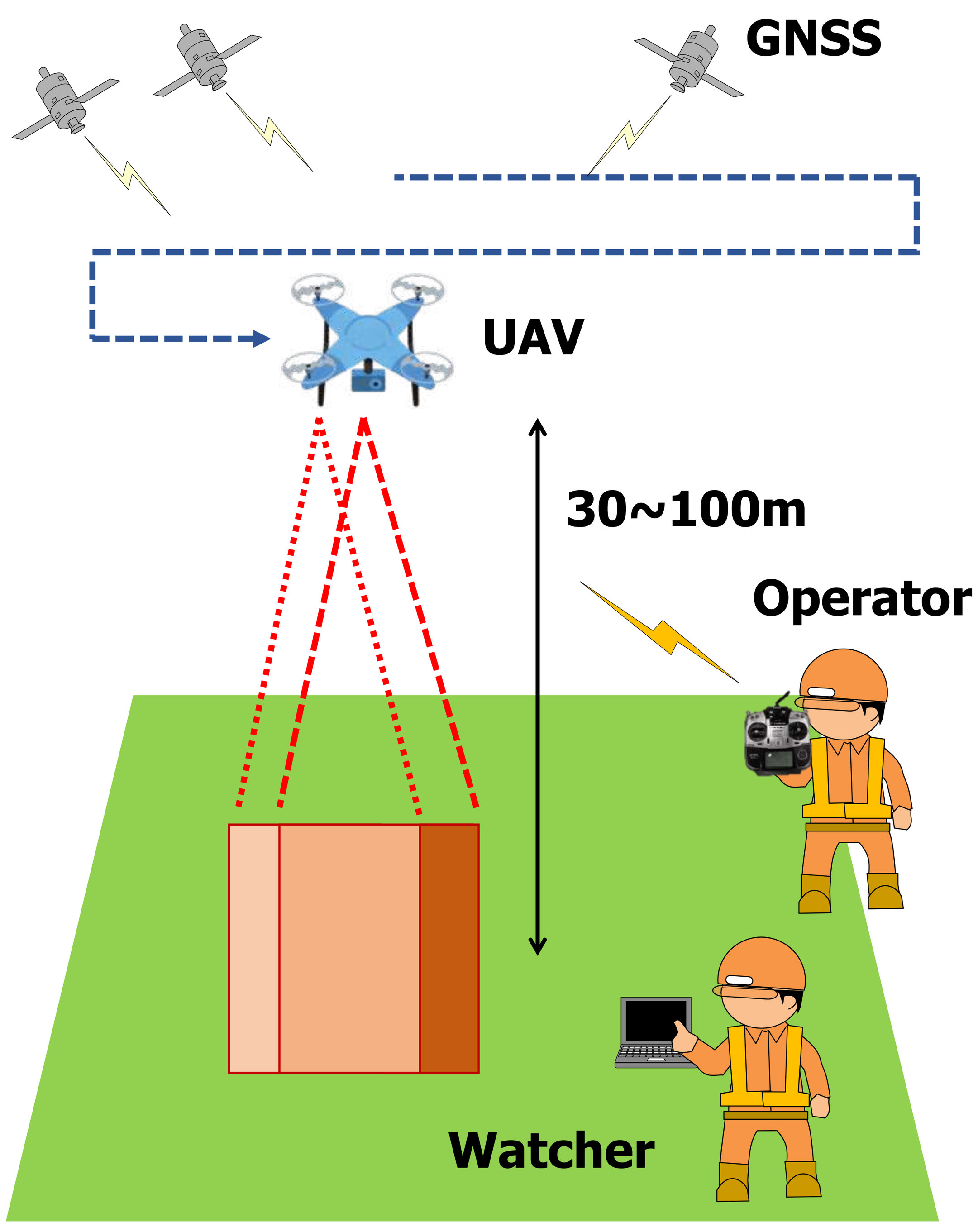
Our "GCP-less UAV" is a UAV[*2] technology that employs high-precision positioning data to enable photograph measurement operation to be completed without using ground GCPs.

The system mainly comprises a general-purpose UAV and a PPK[*3] processing system and is ideal for speedy geometrical measurements of fills and cuts in road construction projects.

*1 GCP: Ground Control Point
GCPs are reference points to be used for coordinate correction as part of UAV-assisted photograph measurement operation.
To adequately evaluate a completed earthwork geometry, one GCP needs to be placed every 100 m.

*2 UAV: Unmanned Aerial Vehicles

*3 PPK: Post Processing Kinematics
PPK technology implements correction from the reference point after independent positioning
Data processing requires the use of the "KLAUPPK" program supplied by Geolink Japan Co., Ltd.



Overview of GCP-less UAV

■ Features

● Excellent measurement accuracy

Photograph measurement accuracy using the GCP-less UAV system is assured to be the actual measured position ±50 mm or finer[*4] at a validation point. The system sufficiently offers measurement accuracy required for successful UAV-based management of finish shape.

● Productivity improvement

Unlike the conventional UAV-assisted photograph measurement using GCPs, the GCP-less UAV technology does not need the installation and measurement of ground control points and thus realizes 30% improvement in productivity.

● Greater safety

Elimination of on-site GCP installation and measurement tasks contributes to greater worker safety.

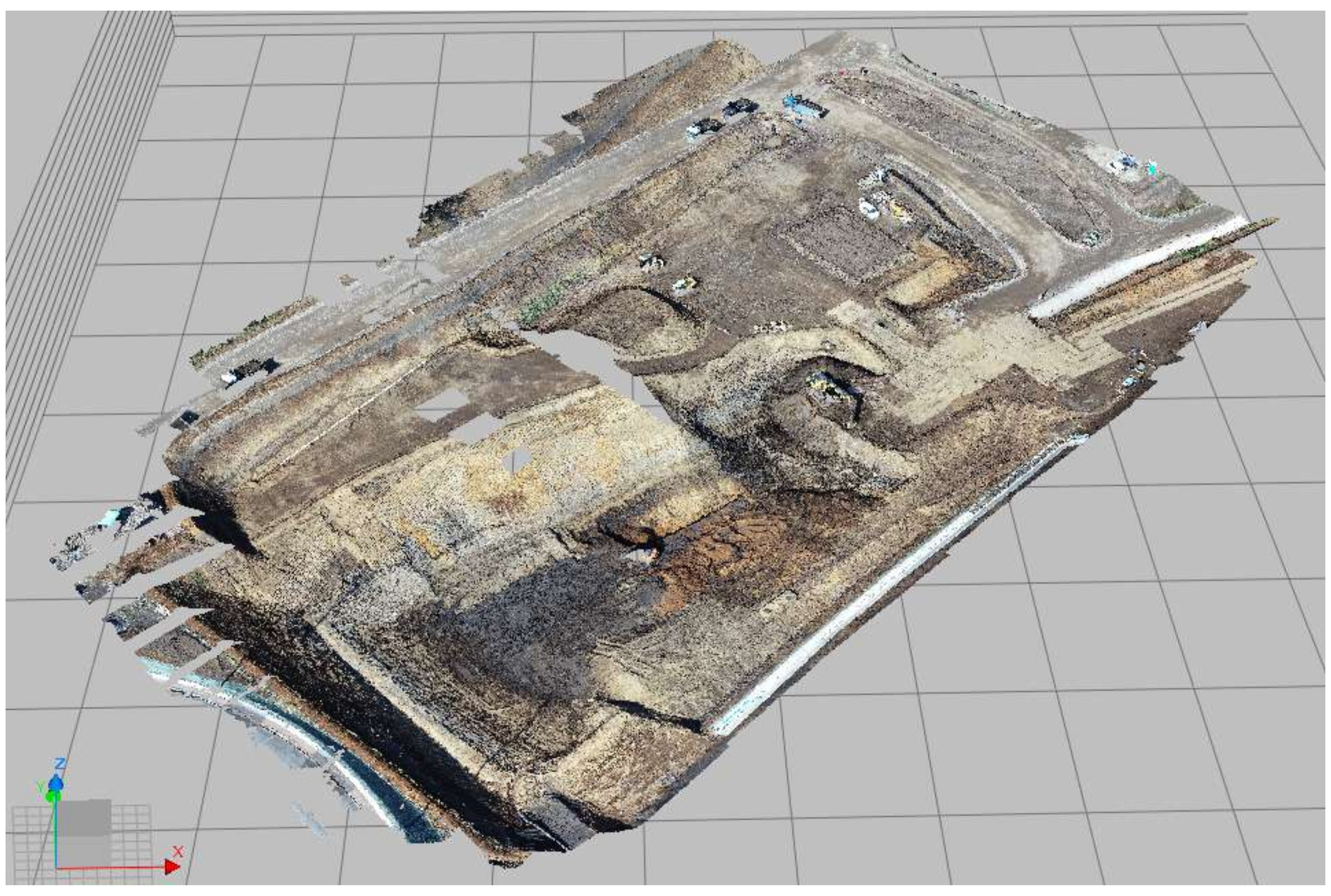
*4 The Ministry of Land, Infrastructure, Transport and Tourism specifies, in its "Aerial Photograph-based (Unmanned Aircraft-assisted) Surveying for finish Shape Management" (Earthwork version), establish that the UAV-assisted photograph measurement accuracy should be ±50 mm or less.

Measurement operation using the GCP-less UAV system

■ Application example

・Finish shape measurement in earthwork project

Aircraft for GCP-less UAV



Result of photograph measurement by GCP-less UAV

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Steel Pipe-and-Concrete Hybrid Structure

For speedy installation of bridge piers

أسلوب مختلط يجمع بين أنابيب الصلب والخرسانة

البناء السريع لركائز الجسور

① Suitable for building high bridge piers: Hybrid Slipform Method

■ Overview

The Hybrid Slipform Method is a frame construction technique designed for making steel-pipe-and-concrete composite bridge piers. A highly rigid steel pipe structure is stood up first to support the operational counterforce, and then the integrated formwork/scaffold unit is moved up and down along the structure with a stabilized mechanism to construct the pier.

The Hybrid Slipform Method helps reduce workload in various pier construction tasks (steel reinforcement assembly, formwork handling, scaffold preparation) and greatly reduces the overall construction work time.

<<Recommended use>>

・30m or higher bridge piers, especially those located in mountainous or other difficult-to-work areas

Steel-pipe-and-concrete composite bridge pier

■ Features

● **Manpower saving**

・The rigid truss-structure formwork unit does not require a separator and therefore can be automatically lifted and lowered by a jack system.

・Steel PC strands, used in place of tie hoops, are mechanically installed by a self-travelling winder into a continuous spiral shape, significantly reducing steel reinforcement assembly workload.

・Elimination of intermediate tie hoops further reduces manpower requirement.

● **Speedy Construction**

・The favorable characteristics of steel pipes and PC strands enable the work time to be reduced by 20% compared to that of an ordinary elevated formwork system.

・Steel pipes and reinforcements are assembled in one operation through to the highest level, followed by a series of single-lift-per-day concrete casting operations (single lift height of 1.8 to 2.4 m).

Steel pipe and reinforcement assembly completed

Slipform system in operation

■ Installation records

Successfully employed for highway bridge pier construction projects, etc. (pier height of 30 m to 80 m)

② Suitable for low bridge piers: Hybrid Honeycomb Method

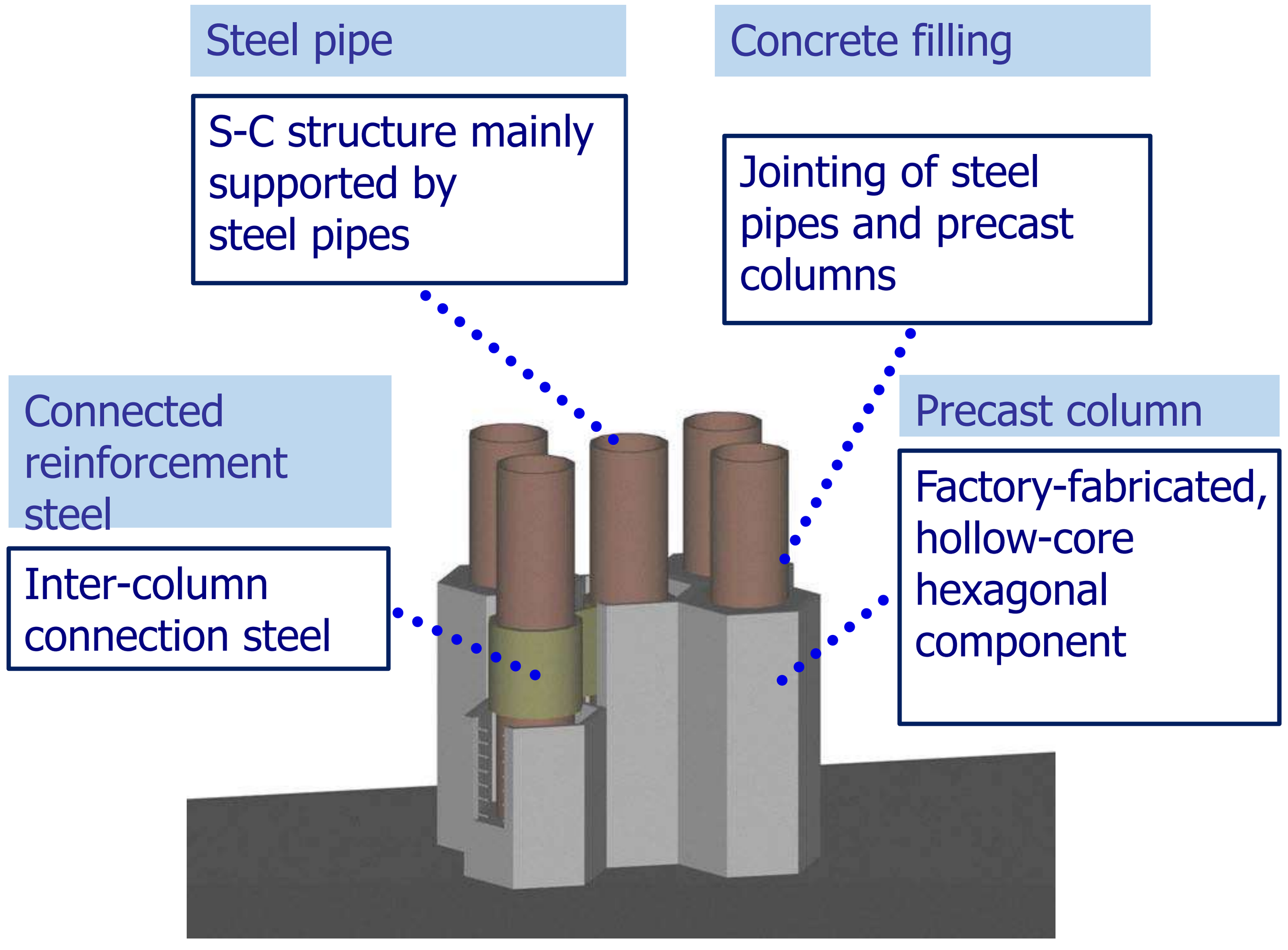
■ Overview

The steel-pipe-and-concrete composite pier system consists of hollow-core hexagonal precast column components and steel pipes, which are integrated to form individual column units. Use of precast concrete components in bridge pier construction traditionally involved operational concerns such as those concerning jointing between components and lift-up weight. The present process solves these concerns by inserting and stacking hollow precast column components around each steel pipe and jointing them in the height direction at a regular interval.

The system offers bridge pier weight reduction, durability improvement and speedy installation.

<<Recommended use>>

・Relatively low bridge piers of overhead bridges in urban areas



Structural concept drawing

■ Features

● **Greater durability and earthquake resistance**

・Use of steel pipes improves shear strength and toughness.

・External protection by factory-fabricated precast column components

● **Quality improvement**

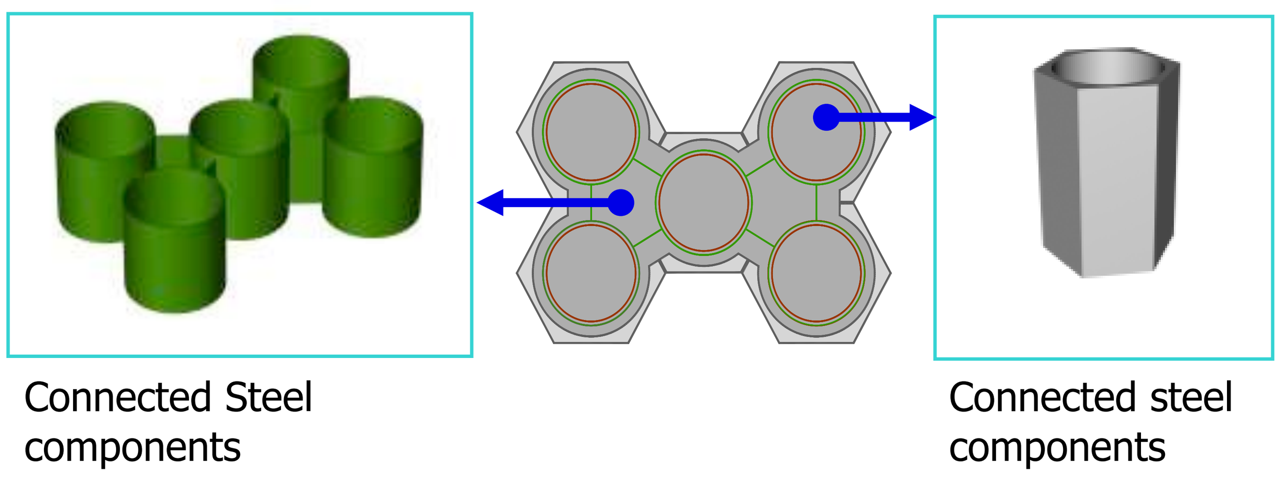
・Easily installable and therefore not prone to work errors

● **Lightweight**

・The nearly shell-shaped cross section contributes to weight reduction

● **Manpower saving and speedy construction**

・Significant manpower saving in steel reinforcement assembly and formwork handling



Steel-composite honeycomb structure

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Deck Slab Replacement Technology
Slim Fastener

For speedy jointing of precast bridge deck slab components

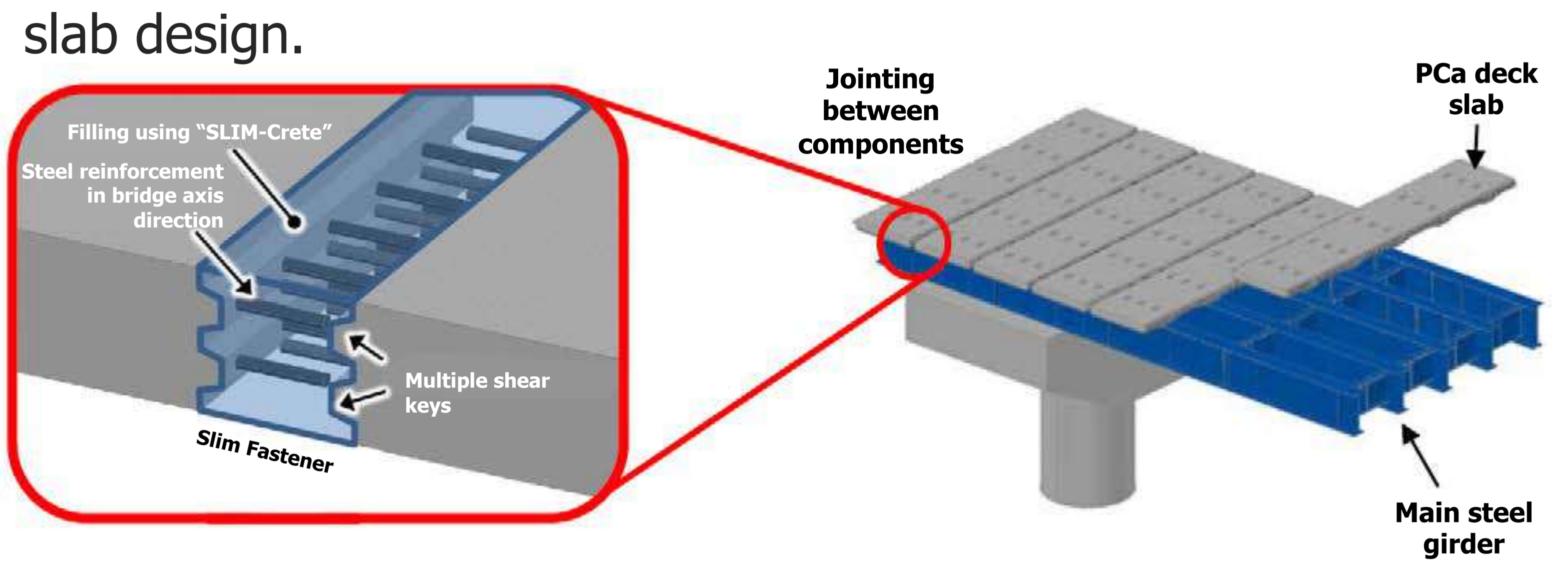
تكنولوجيا استبدال ألواح الأرضيات باستخدام أجزاء الربط الضيقة

التوصيل السريع لألواح أرضيات الجسور المسبقة الصب

■ Overview

This technique allows speedy jointing between precast deck slab components in a bridge structure and is ideal for replacing the deck slab on old bridges. Our originally-developed mortar, "SLIM-Crete,"* reduces the jointing width to approximately half that of conventional jointing technique and also eliminates the need for on-site steel reinforcement assembly work, which significantly shortens the overall work time.

Another advantage is that absence of steel reinforcement joints and other obstructing features makes the structure free from deck slab thickness restriction, allowing greater flexibility and economy in deck slab design.



Slim Fastener concept

Precast deck slab jointing

Conventional jointing method (W≈400 mm)

Slim Fastener（W≈200 mm）

*UHPFRC (SLIM-Crete) with Compressive Strength of 180 MPa by Ambient Temperature Curing

Its main ingredients include cement-based special powder and ultra-high-strength steel fiber.

The product achieves a compression strength of 180 MPa greater can be achieved without special curing and is suitable for both cast-in-place and onsite precast installation. With the superb fluidity, the product self-fills the tightest corners of the formwork (post-cast compaction is unnecessary).

The product is designed for more than 100 years of durability against neutralization and salt damages and is about eight times as wear-resistant as an ordinary concrete mix.

<<Recommended applications>>

・Jointing between precast deck slab of bridges (for installation of new floor base or replacement of existing ones)

■ Features

● Work time reduction

・The shortened jointing width of approximately 200 mm and the elimination of transverse steel reinforcement greatly reduce the overall work time.

● Lower maintenance and management cost

・The joint cross section consisting of multiple shear keys increases the shear strength and adhesion of the joint, effectively reducing gap-opening and cracking risks and consequently alleviating maintenance and management workload.

SLIM-Crete application

■ Installation record

Road bridge deck slab replacement project:

・Existing deck slab was removed and a new deck slab was installed and jointed over a section of approximately 150 m. The overall work time was about 30% shorter than that by a conventional construction method (conventional 20 days ⇒ shortened to 14 days).

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Image Analysis-based Automatic Crack Detection

AI-assisted speedy infrastructure inspection

تكنولوجيا الكشف التلقائي عن التشققات عن طريق تحليل الصور

فحص البنية التحتية السريع باستخدام الذكاء الاصطناعي

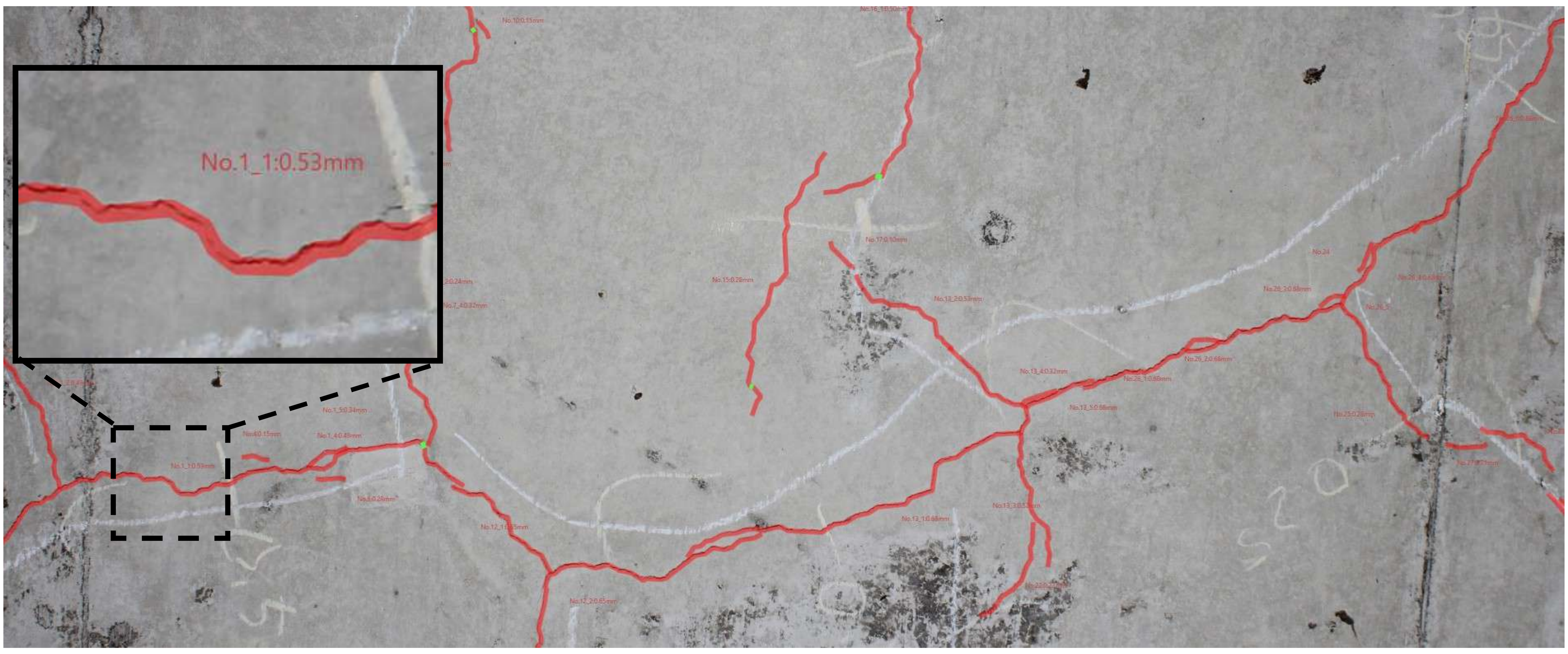
■ Overview

Images of a concrete structure recorded by a special high-performance camera are processed by an AI-assisted image analysis system to automatically and speedily detect concrete surface cracks, accurately determining the width and length of each crack.

The system is designed to allow the recorded data to be easily stored and managed, contributing to manpower reduction in concrete structure maintenance and management operations.

<<Recommended applications>>
Concrete structures (box culverts, bridges, tunnel lining, etc.)

Crack detection example



■ Features

● Automatic conversion into electronic data

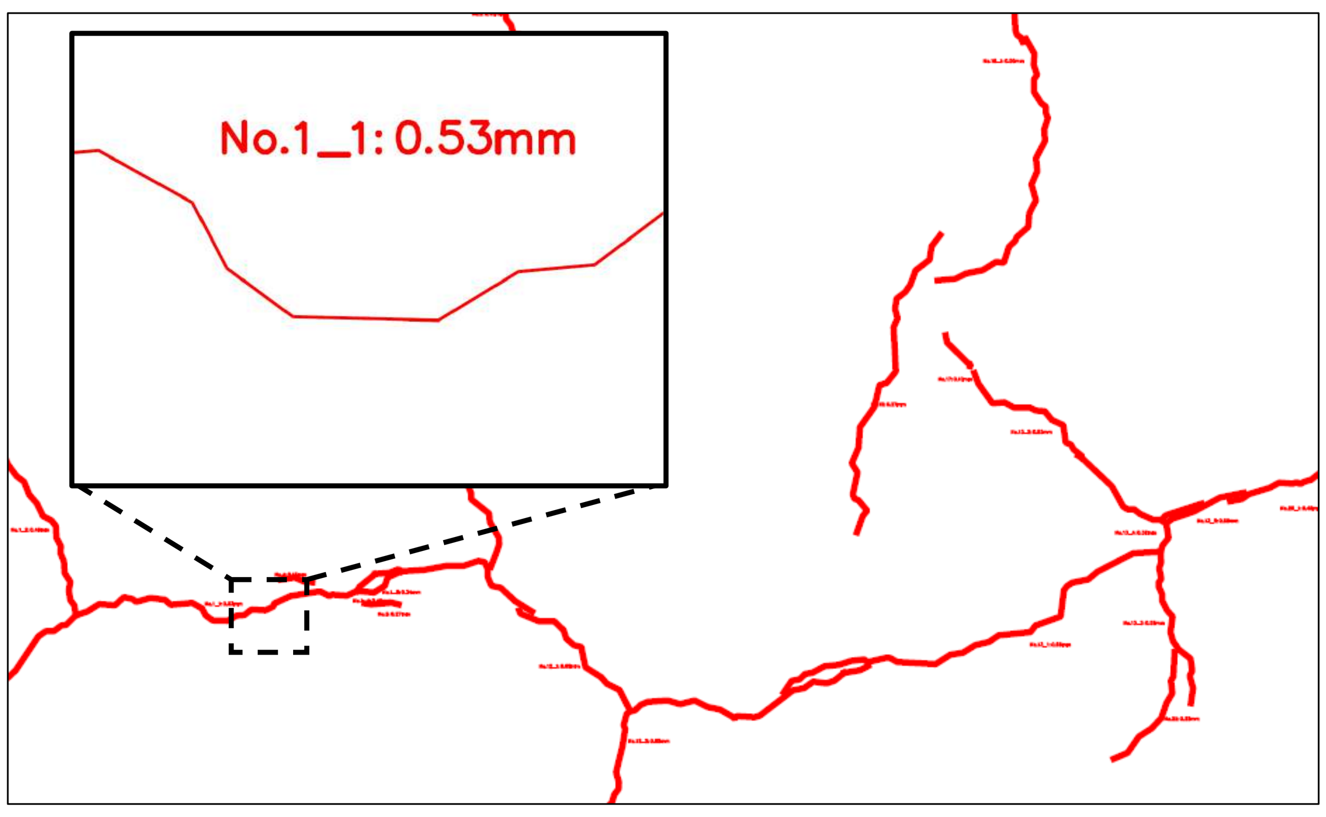
- Automatically detects concrete surface cracks from recorded images and determines the crack position, width and length.
- The crack detection result can be stored as a CAD data (DXF format).
- Multiple photographs can be automatically stitched to create an expanded image.

● Greater inspection operation efficiency

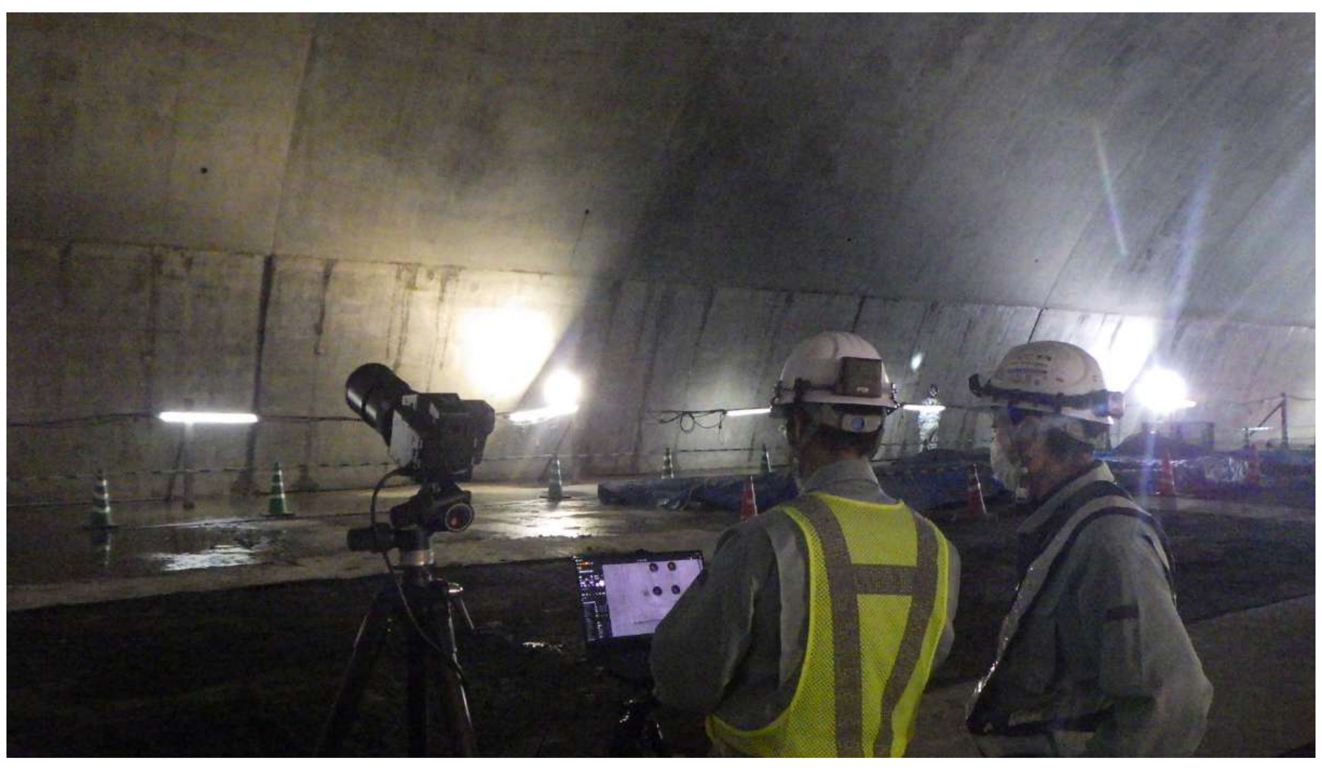
- On-site work involves crack photographing only.
- No large-scape equipment such as an inspection scaffold or aerial platform is required, which potentially reduces inspection cost.
- Use of a special high-performance camera enables photographs to be taken over a long distance (approx. 50 m).
- The required number of shots can be reduced to about 1/6 of that by a common SLR camera (20 million pixels), further reducing labor cost.
- The system is designed to facilitate comparison with past inspection results.

● Enables inspection in dark places

- Images can be recorded with existing work light only even in dark places such as the inside of a tunnel.



Example of image analysis result output (DXF format)



Photographing concrete tunnel lining

■ Application records

Have been successfully applied to concrete tunnel lining inspection.

＊Image analysis requires the use of "Infrastructure Photo Analysis Cloud Service" supplied by Fujifilm Corporation.

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High Durable Concrete with Seawater

Useful for post-disaster restoration or infrastructure projects on a remote island or in other locations where freshwater is hard to come

خرسانة ذات متانة عالية مخلوطة بماء البحر

للاستخدام في إنشاءات الجزر النائية ومناطق التعافي من الكوارث والمناطق التي يصعب تأمين الماء العذب فيها

■ Overview

This product is designed to be mixed with seawater and uses industrial byproducts (blast furnace slags, fly ash, etc.) and special additives so that strength starts to develop in early stages and will be sustained over a long period of time.

The unique product composition also contributes to quality enhancement such as greater durability and water blocking effect. Furthermore, unwashed sea sand can be mixed into the product.

With the use of non-corrosive reinforcement, the product can be used for making steel-reinforced concrete structures.

Manufacturing and installation processes are identical to those of common freshwater-mixed concrete product.

This is **a first-of-the-world technology developed in and originating from Japan.**

Wave-dissipating block fabrication as part of post-disaster restoration effort
(Soma Port, Fukushima Prefecture)

<<Recommended applications>>

- Structural construction on remote islands or dry climate areas where freshwater is hard to come by
- Construction work after a natural disaster or in other situations where freshwater is hard to come by
- Structures to be build around rivers, ports and along pavements where both initial and long-term strength is critical
- Structures such as those in a radioactive industrial waste facility where superior water blocking functionality is required Wave-dissipating block fabrication as part of post-disaster restoration effort

■ Features

● Greater strength

- When blast furnace cement is used, the compression strength is approximately 60% better than that of freshwater-mixed concrete.
- Strength starts to develop in early stages.

● Greater water blocking effect

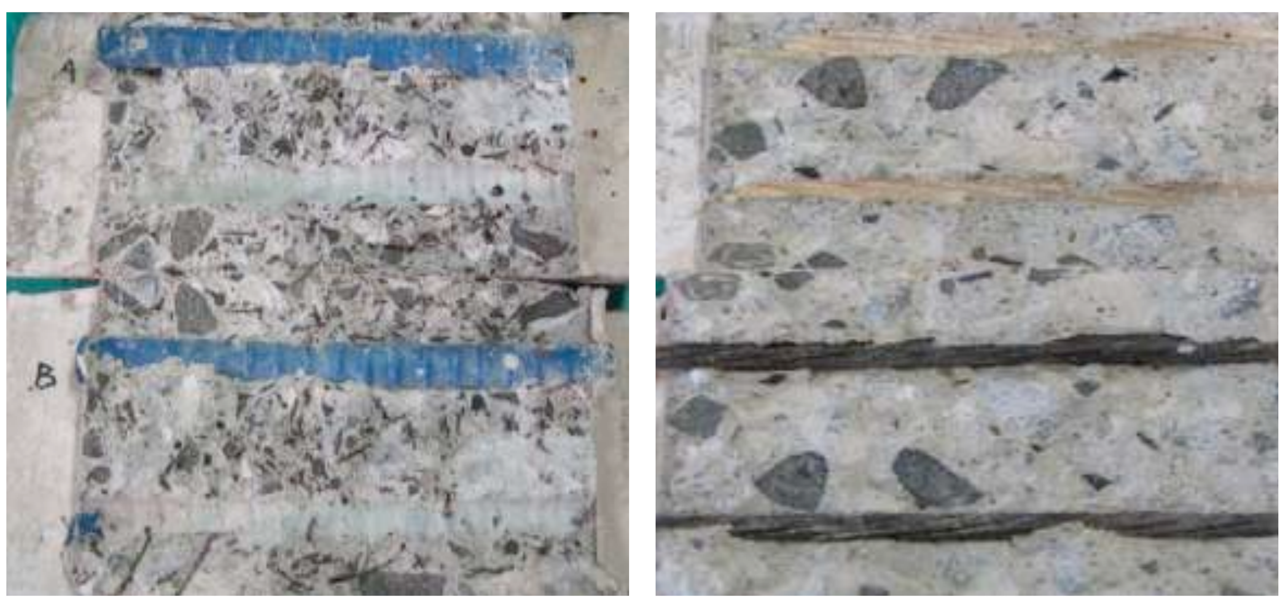
- Use of seawater causes the microstructure to be denser than with freshwater mixing, decreasing the water permeation coefficient to approximately 1/70 of freshwater-mixed product and thus achieving greater water blocking effect.

Freshwater-mixed **Seawater-mixed**

Water permeation test result
(water pressure 1.0 MPa for 48 hrs)

● Steel reinforcement corrosion control

- Use of non-corrosive reinforcement component enables the structure to be designed in the same way as common steel-reinforced concrete.
- With the use of epoxy resin-coated reinforcement, a design service life of 100 years is assured.
- With the use of stainless steel or carbon fiber rod reinforcement, a design service life of over 100 years is assured.



Epoxy-coated steel reinforcement : No corrosion detected

Carbon fiber rod reinforcement: No corrosion detected

Accelerated corrosion test result with different reinforcement materials
(No corrosion detected after an accelerated corrosion stress equivalent to a natural exposure of 100 years is applied)

● Cost reduction

- Use of locally procurable ingredients (seawater and sea sand) makes material cost reduction possible.

● CO_2 emission reduction

- Use of industrial byproducts and locally procured material can reduce CO2 emission in the manufacturing process by 50%.

■ Application records

Pavement using blast furnace slags

Prepacked concrete block using concrete debris

Revetment block for seaport protection

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Next-generation Automatic Quality Inspection System

BIM-assisted speedy steel reinforcement inspection

نظام الجيل القادم لفحص الجودة التلقائي

تسريع عمليات فحص تسليح الأبنية باستخدام نمذجة معلومات البناء (BIM)

■ Overview

All concrete structure construction works require the inspection of steel reinforcement, we must make sure that that numerous reinforcement bars are assembled in correct quantity and spacing (pitch) and that the diameter, length and material type of each bar is as instructed in the design drawing. However, it is difficult to clearly indicate the arrangement of all reinforcement bars on two-dimensional design drawings. It therefore used to take long experience to be able to conduct drawing-based steel reinforcement inspection.

This solution is an automatic quality control assistance system assisted with image recognition technology, three-dimensional data capability, BIM and mixed reality.

Comparison of the three-dimensional image shown on a tablet and the actually-assembled reinforcement immediately makes it clear if the steel reinforcement is assembled exactly to the design drawing, minimizing human error risks and significantly reducing inspection time.

Wearable system device in use

■ Features

● Precision positioning

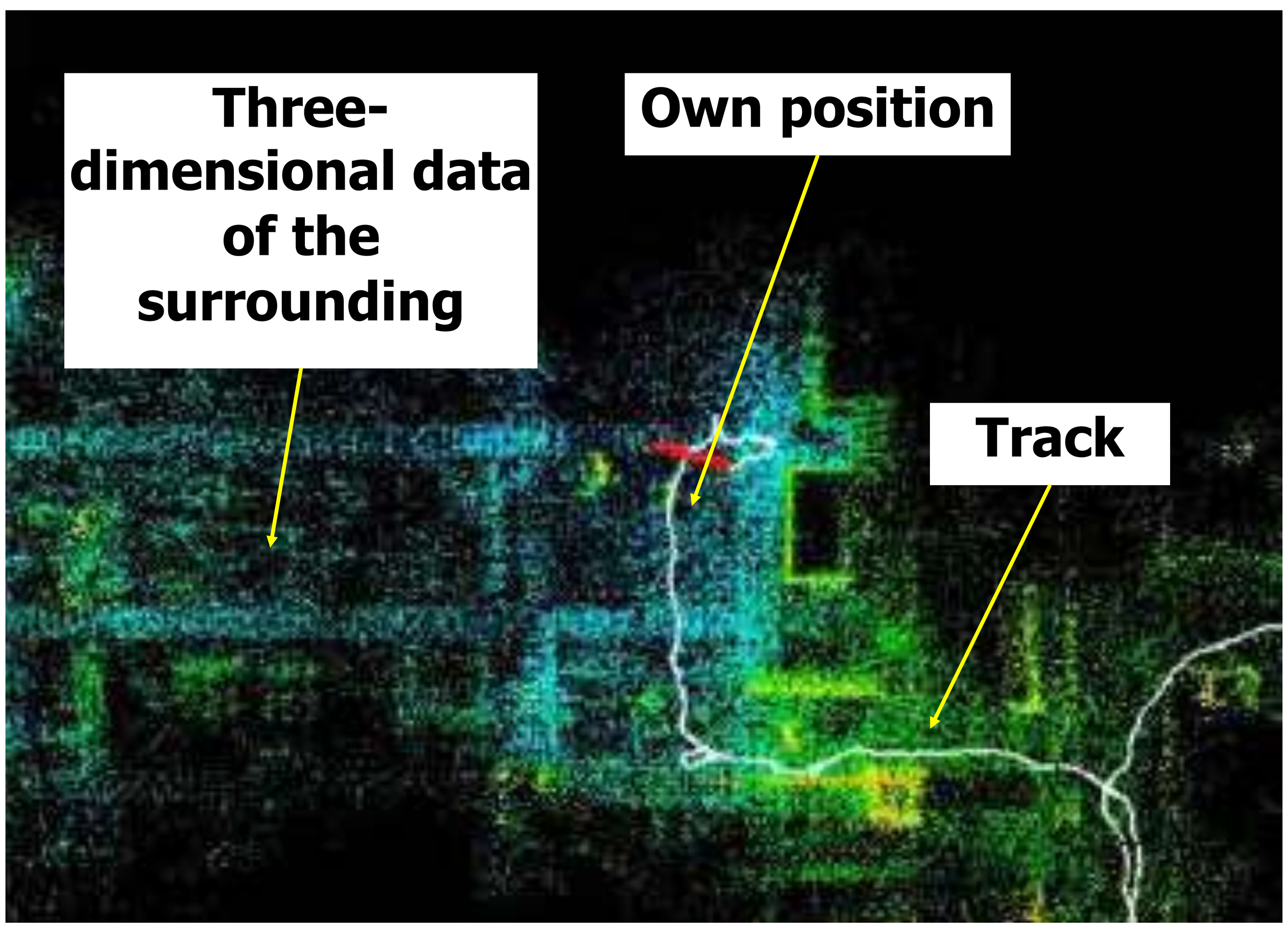
Use of composite sensor capability enables precision indoor positioning without the use of GPS or Wi-Fi

● Automatic measurement

Number of reinforcement bars, diameter and spacing can be automatically obtained from real-time three-dimensional data

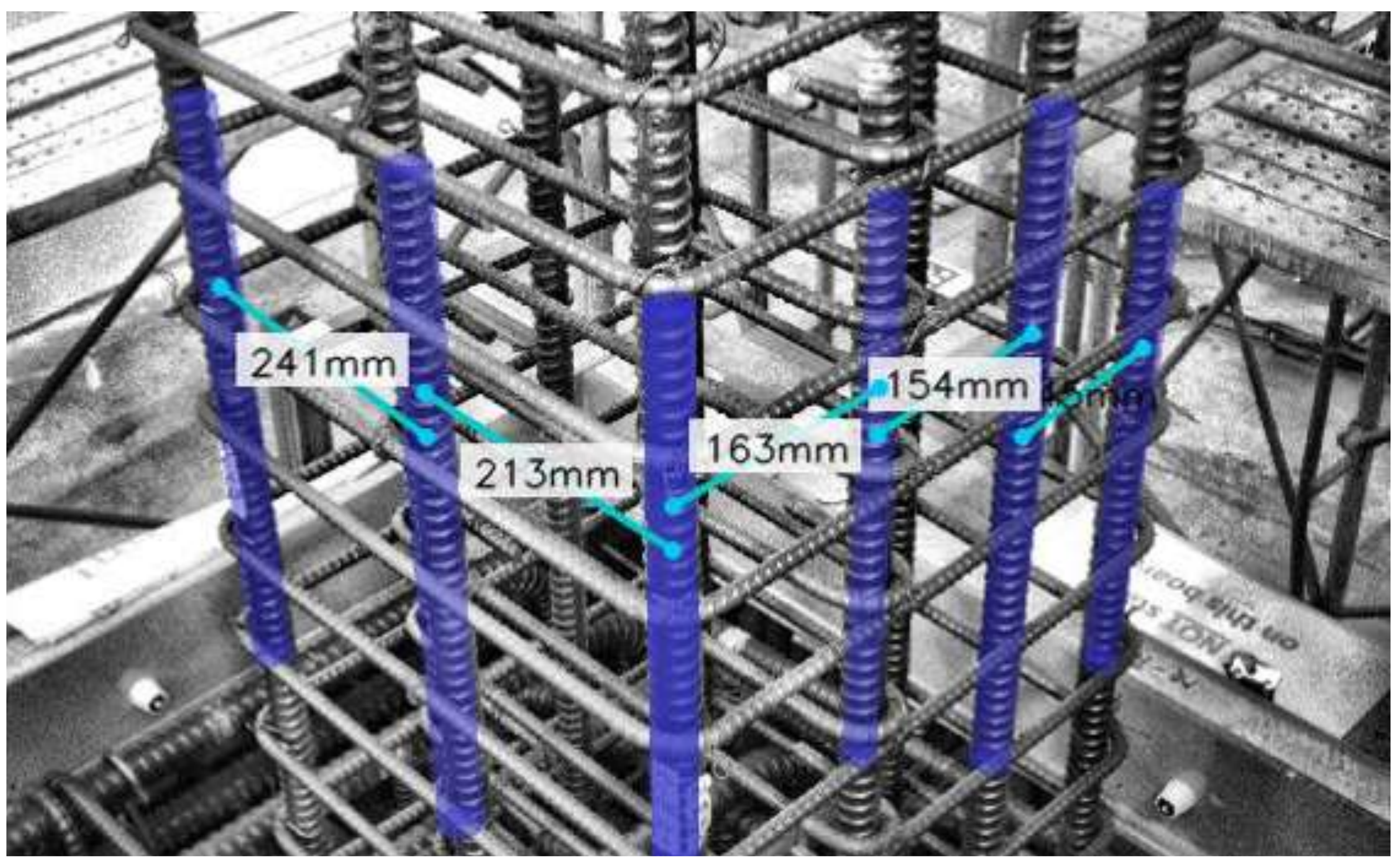
● Productivity improvement

BIM model comparison based on three-dimensional measurement result can expedite the steel reinforcement inspection operation, cutting the overall inspection time approximately by half.



Indoor positioning result

Checking the overlaid image of BIM model and actually-assembled reinforcement bars on a tablet



Measuring spacing between reinforcement bars

■ Application records

This system can be used for inspection in various reinforced concrete structures.

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