Construction Revolution

Efficient construction of robust walls with immensely strong and durable tubular sheet piles

# Tubular Sheet Pile Press-in Method


GIKEN

# Introduction

Tubular sheet piles are tubular piles provided with an interlock, which gives them enormous cross-sectional strength and bending rigidity. Therefore, this type of pile is used widely in ports and rivers (for coastal walls, revetments and breakwaters), urban engineering projects (for retaining walls and cofferdams), bridges (for tubular sheet pile foundations), and many other applications. The Tubular Sheet Pile Press-in Method utilizes the superiority of the press-in principle to insert piles continuously, without causing any structural damage due to noise or vibration, resulting in a strong implant structure.

The tubular sheet pile press-in machine (Tubular Piler) uses a hydraulically-powered static load press-in method, so that piles can be installed precisely, while monitoring the bearing capacity of each individual pile and ensuring there is no damage to the pile or disturbance of the ground. This enables the safe construction of a high-quality continuous wall that can withstand both horizontal and vertical forces in any direction.

Furthermore, by using the "GRB system" so that all of the steps - transporting, pitching and pressing in the piles - are carried out from on top of the installed piles, rapid and compact construction is possible in any location, without the need for temporary structures. The result is a truly exellent balance of the Five Construction Principles "Environmental Protection, Safety, Speed, Economy and Aesthetics".

Using the Tubular Sheet Pile Press-in Method to build an urban river revetment close to a motorway

# Contents

# Overview of Tubular Sheet Pile Press-in Method

## Efficient Construction of Robust Continuous-Pile Walls Using Immensely Strong and Durable Tubular Sheet Piles

The tubular sheet pile is an enormously durable pile which is suited to port construction works, flood and tidal surge protection in river basins, antiseismic strengthening of bridge pillars, bridge foundations (tubular sunken wells), and so on. It can be adapted to different design criteria by altering the pile diameter and thickness, thus enabling efficient and intelligent construction of many various structures for different purposes. The Tubular Piler is compatible with tubular sheet piles with diameters from 500-1,500, and its noise-free and vibration-free process, with no risk of overturning, makes for a safe construction project that is respectful of the environment.

PP150
φ500-φ600

PP260
φ700-φ900

PP300
φ1000-φ1200

PP400
φ1300-φ1500

### Tubular Sheet Pile Press-in Method Creates an Implant Structure of Piles United with the Earth

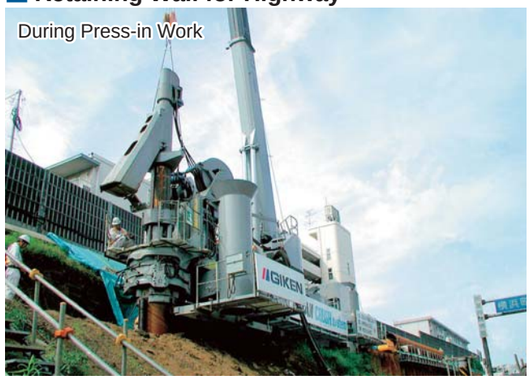
**Revetment**

During Press-in Work

Completed Project

**Retaining Wall for Highway**

During Press-in Work



After Completion of Press-in Work



## Tubular Sheet Pile Press-in Method

No Effect on Water Flow or Neighbouring Area

## Conventional Excavation Method

Water Flow and Water Traffic Cut Off, Oppressive Effect on Surroundings

## Features of Tubular Sheet Pile Press-in Method

### ◇ Creates a Highly Rigid Wall Structure

A secure and solid wall structure can be built by pressing in a continuous sequence of high-quality factory-made tubular sheet piles, which have excellent rigidity.

### ◇ Respectful of the Surrounding Area

By using static load, the press-in method does not create noise, vibration or other nuisances. What is more, the area affected by the press-in work is restricted to the space occupied by the construction system, so the impact on the surroundings can be minimized.

### ◇ Reduces Construction Costs

There is no need for provisional facilities, such as temporary roadways or platforms, which means a straightforward process with minimal equipment, resulting in big cost savings.

### ◇ Excellent Safety With No Risk of Overturning

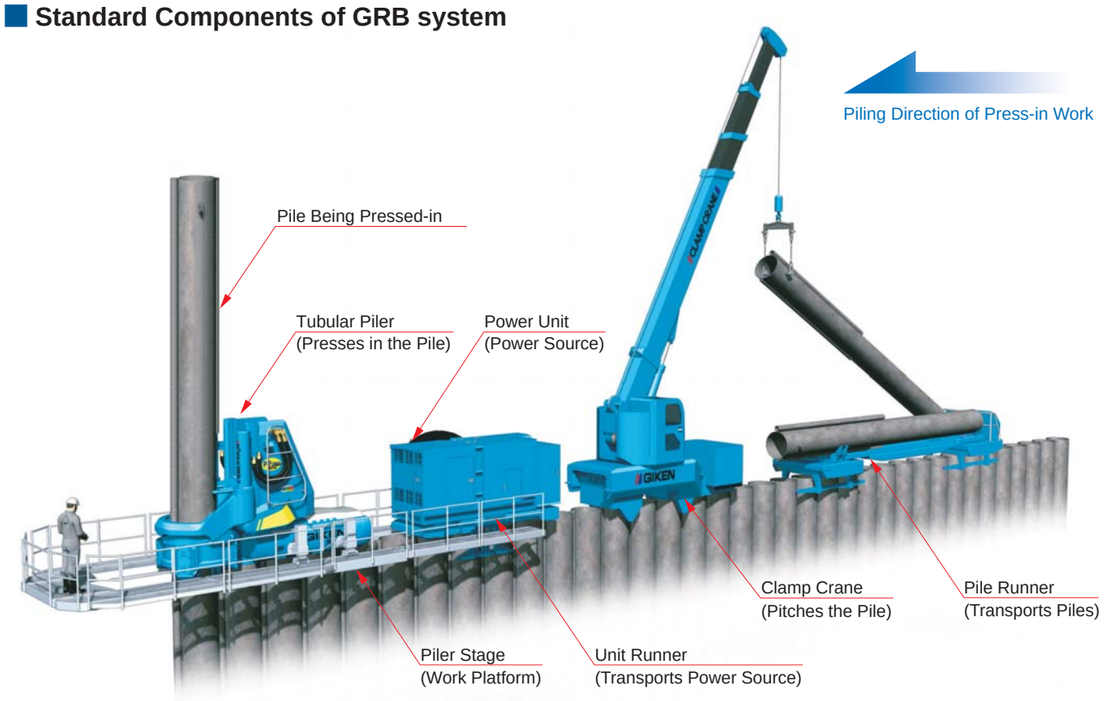
Because the press-in machine grips firmly onto the completed piles, which means there is no risk of overturning.

Construction works can be carried out with Environmentally-friendly considerations, lower cost and shorter work duration at any work conditions.

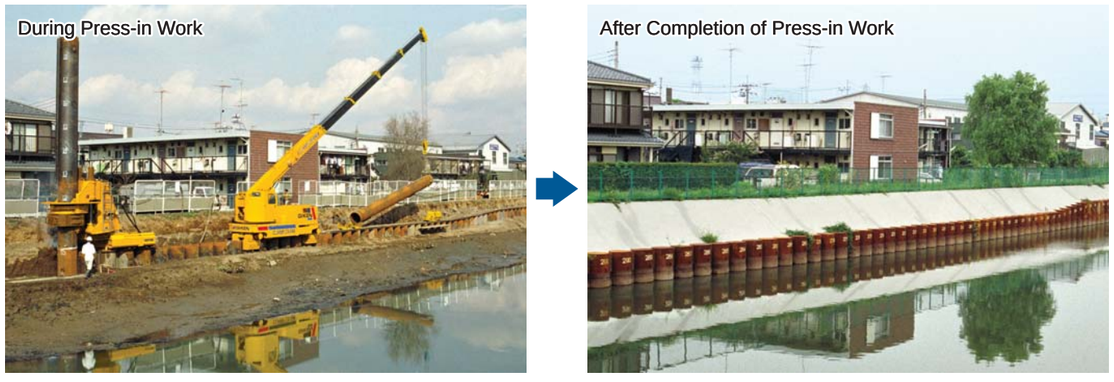
# GRB System for "Temporary Work Less" Construction

The GRB system applies the Press-in Principle which states that a reaction force is obtained from completed piles. In this way, all of the steps of the process, from transporting and pitching the pile, to pressing it in, can be carried out from a position on top of the existing piles.  And since all of the equipment is self-supporting and grips onto the completed piles, then there is no risk of overturning, and the area affected by the works is restricted to the width of the machinery on the piles. Even over water, on sloping or uneven ground, in narrow spaces, or locations with restricted headroom, the GRB system has no need for any temporary structures, like platforms or roadways, and can focus efficiently on the purpose of the project - building the main structure.

## Standard Components of GRB system



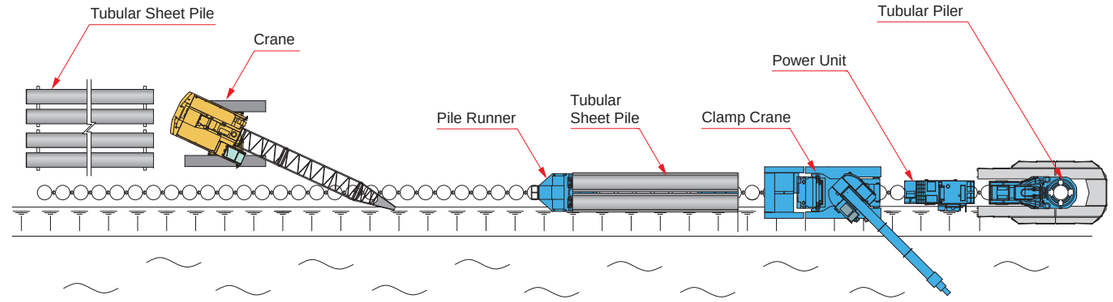

**Without using any temporary structures, a revetment is built with an implant structure of piles that are united with the Earth.**



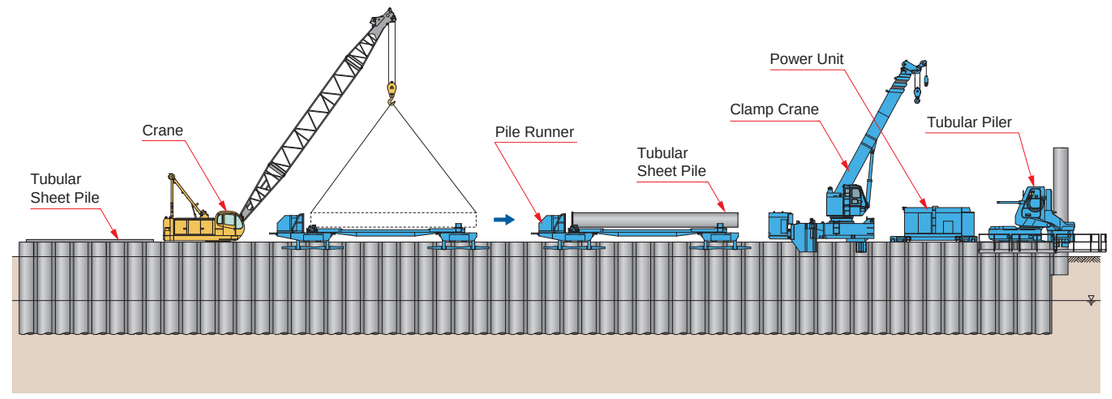

## Standard Machine Layout

### GRB System Working Layout

▼ Plan View

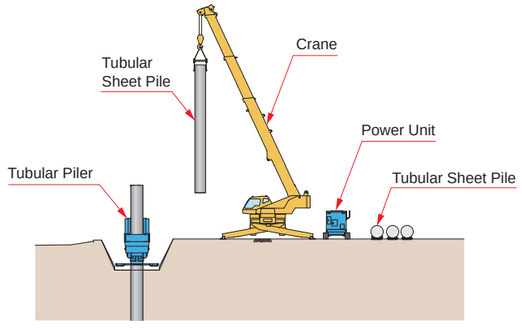



▼ Side View

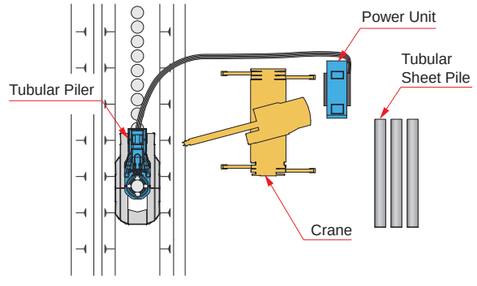



### Standard Procedure (SMP)

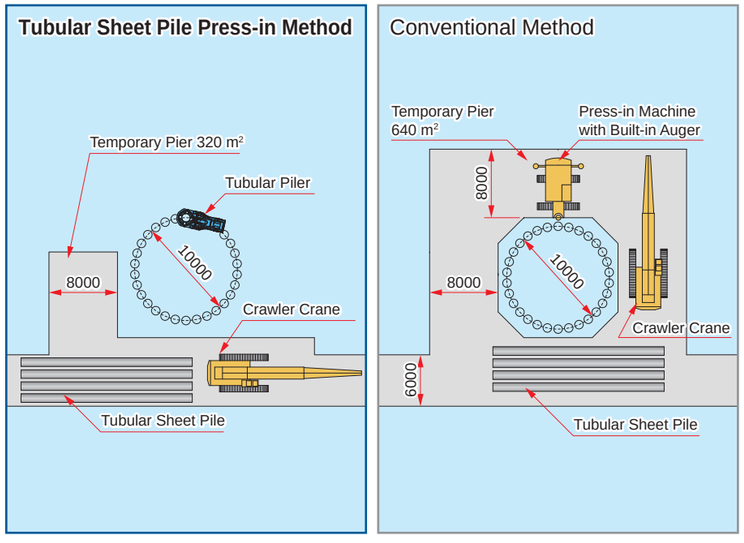
▼ Cross-sectional View




▼ Plan View



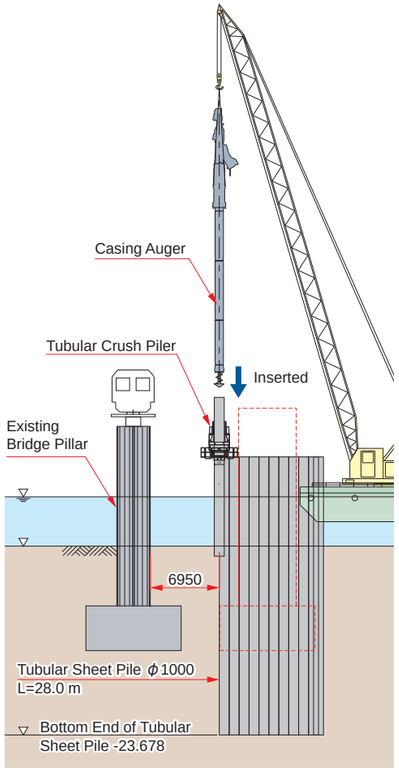
## Sunken Well Foundations Using Tubular Sheet Piles



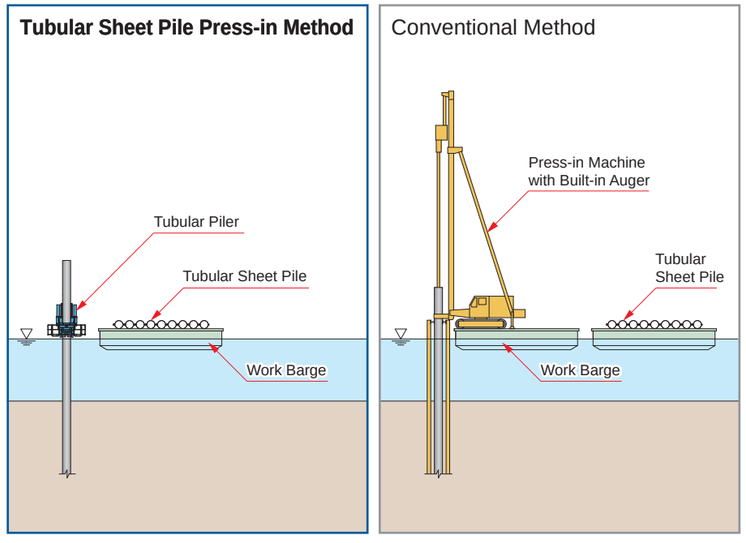

The Tubular Piler grips completed piles and moves by itself along the top of the piles while progressing with the press-in work. This minimizes the requirements for heavy equipment and temporary staging, even in bridge support and sunken well foundation projects, resulting in lower costs and faster completion.

**Reference** Bridge Improvement Project No. 1, Naka River between Mito and Hitachi-Aoyagi Ibaragi Prefecture

1000-dia. tubular sheet piles pressed into hard ground (mudstone layer, STP-N value: 150). No requirement for temporary pier and no disturbance to nearby railway.



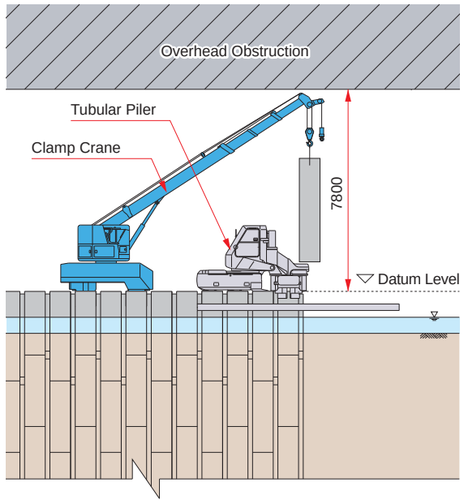

## Coastal / Riverbank Protection



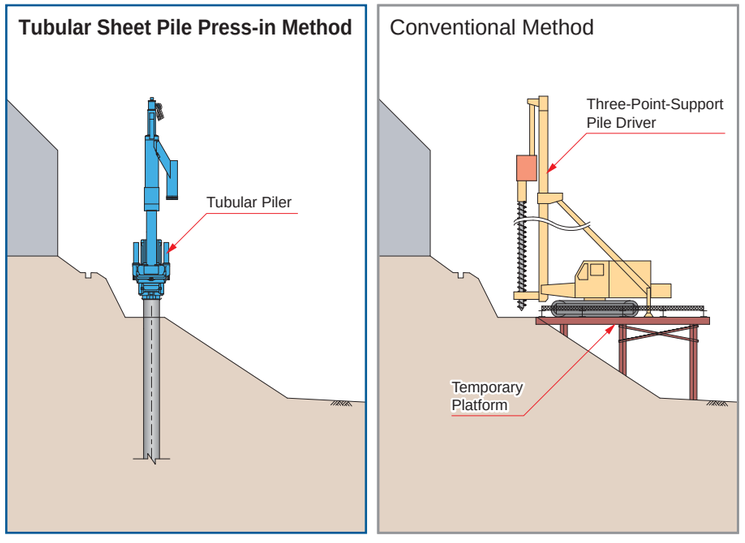

Since there is no need for temporary works and only compact machinery and equipment are required, then the area affected by the project is minimized and the traffic on the river and the bridge is not disturbed at all.

**Reference** Shingashi River Renovation Work Tokyo

With the GRB system, there were no temporary facilities, and work could focus efficiently on building the river revetments. Work completed without affecting traffic, even in sections with restricted headroom.



## Retaining Walls for Highways

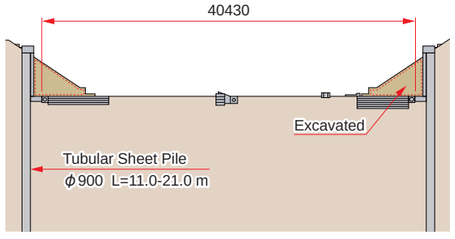



Because the Tubular Piler grips onto installed piles and moves along the top of the piles as the work progresses, it can operate without needing any platform for heavy machinery, even when working on a slope. Using the GRB system also means that the affected area is kept to a minimum, and adjacent activities are not disrupted.

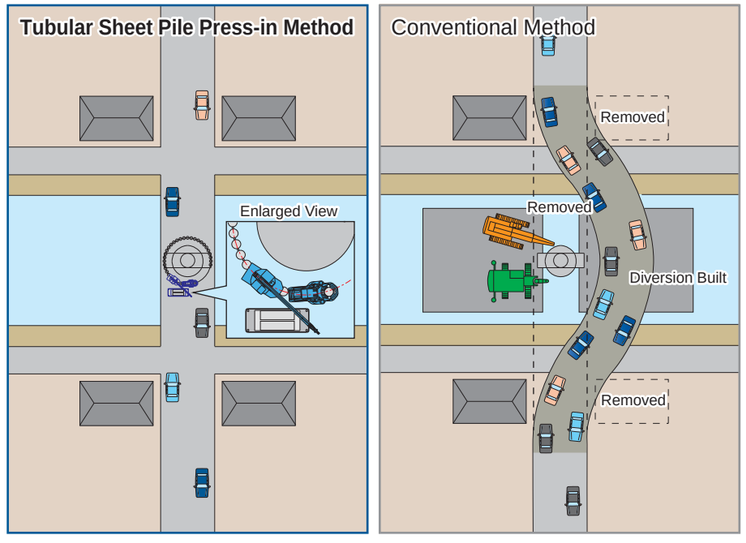
**Reference** Shinsakura-ga-oka Interchange Widening — Kanagawa Prefecture

Despite working alongside a very busy highway, the project was completed without the need for temporary works or banking, and without disrupting normal activities. The mechanism grips tightly onto completed piles, which means that the work procedure is safe, with no risk of toppling.





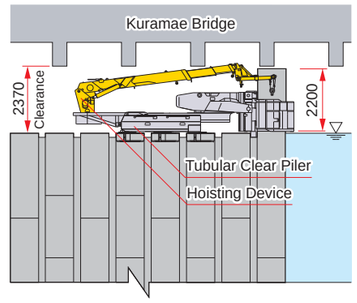

## Reinforcement of Bridge Pillar Foundations

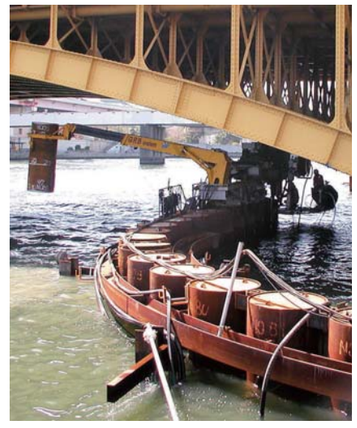



When headroom is restricted, for instance, under a bridge, our compact machinery, plus the principle of gripping the completed piles near the top of the pile, means that the available height can be used to the maximum and work can be completed without needing to remove overhead obstructions. Where height restrictions are especially strict, an excellent option is the Tubular Clear Piler, in which the machine dimensions are compressed to the very minimum.

**Reference** Kuramae Bridge Antiseismic Strengthening and Repair Project — Tokyo

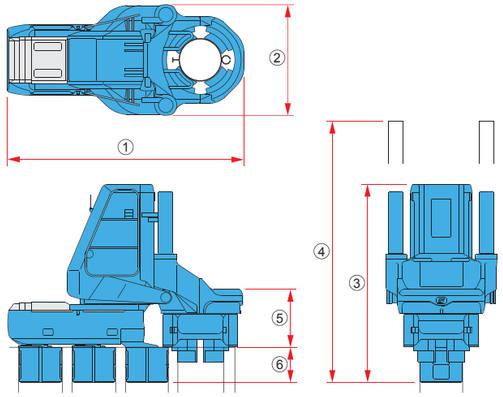
Using the Tubular Clear Piler which is especially designed for working with low headroom by the Overhead Clearance Method, piles could be installed efficiently without disturbing other activities, even when the height was restricted to just 2.37 m.



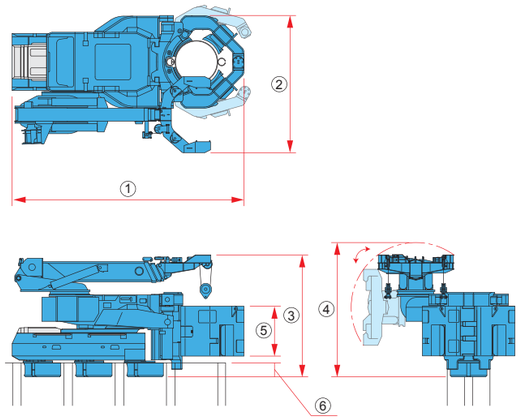



## Tubular Piler

**Vertical Press-in Machines**
(PP150, PP260, PP 200, PP300, PP400)

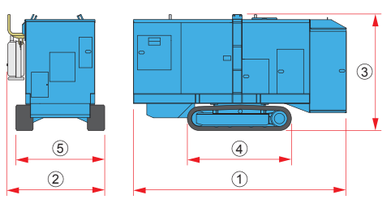



**Low-headroom Press-in Machine** (CLP200)




| Model | PP150 | PP260 | PP200 | PP300 | PP400 | CLP200 |
|---|---|---|---|---|---|---|
| Press-in Force | 1500 kN | 2548 kN | 2000 kN | 3000 kN | 4000 kN | 2000 kN |
| Stroke | 1200 mm | 1300 mm | 1000 mm | 1300 mm | 1000 mm | 700 mm |
| ① Total Length | 3325 mm | 4700 mm | 4935 mm | 5600 mm | 7260 mm | 4790 mm |
| ② Total Width | 1385 mm | 2040 mm | 2000 mm | 2075 mm | 2360 mm | 2890 mm |
| ③ Total Height | 3000 mm | 3640 mm | 3200 mm | 4365 mm | 4145 mm | 2570 mm |
| ④ MAX | 4020 mm | 4800 mm | 4160 mm | 5115 mm | 4595 mm | 2830 mm |
| ⑤ Chuck Height | 935 mm | 1060 mm | 995 mm | 1500 mm | 1475 mm | 1050 mm |
| ⑥ Clamp Length | 400 mm | 650 mm | 500 mm | 800 mm | 565 mm | 300 mm |
| Power Unit | EU200-3P | EU200-3P | EU300D2 | EU300 7K | EU200-3P | EU200-3P |
| Mass | 13850 kg | 28870 kg | 22900 kg | 48700 kg | 66000 kg | 28900 kg |
| Applicable Pile | ϕ500-600 | ϕ700-900 | ϕ800-1000 | ϕ1000-1200 | ϕ1300-1500 | ϕ800-1000 |

## Power Unit




| Model | | EU200-3P | EU300D2 | EU300 7K |
|---|---|---|---|---|
| ① Total Length | | 4150 mm | 4315 mm | 4990 mm |
| ② Total Width | | 1705 mm | 2135 mm | 1950 mm |
| ③ Total Height | | 2350 mm | 2550 mm | 2350 mm |
| ④ Crawler Length | | 2100 mm | 2110 mm | 2490 mm |
| ⑤ Crawler Width | | 1600 mm | 1800 mm | 1950 mm |
| Power Source | | Diesel engine | Diesel engine | Diesel engine |
| Rated Output | Power Mode | 147 kW / 1800min$^{-1}$ | 221 kW / 1800min$^{-1}$ | 224 kW / 1800min$^{-1}$ |
| | Eco Mode | — | 177 kW / 1600min$^{-1}$ | — |
| Fuel Tank Capacity | | 350 L | 500 L | 560 L |
| Hydraulic Oil Tank Capacity | | 550 L | 630 L | 900 L |
| Travel Speed | | 1.4 km/h | 1.4 km/h | 1.4 km/h |
| Mass | | 5900 kg | 8000 kg | 9000 kg |

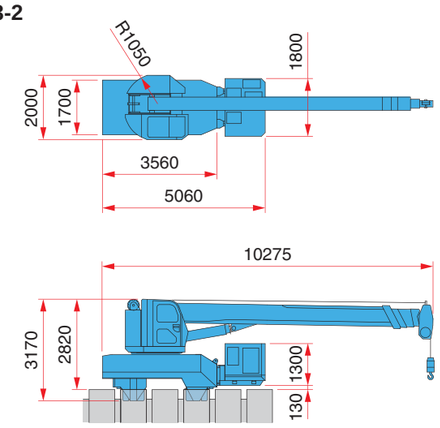
* Product specifications may be changed without prior notice.





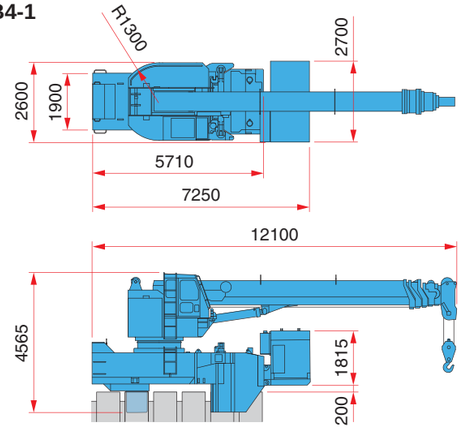
## Tubular Clamp Crane

**CB3-2**




| Model | CB3-2 |
|---|---|
| Crane Power | 10.0 ton × 6.5 m |
| Max. Working Radius | 30.0 m |
| Applicable Pile | Tubular Sheet Pile ϕ700-900 |
| Mass | 18800 kg |

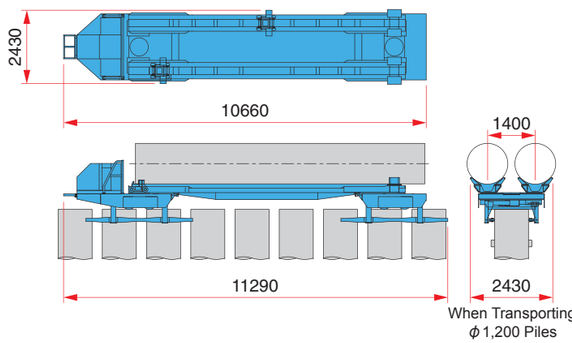
**CB4-1**




| Model | CB4-1 |
|---|---|
| Crane Power | 20.0 ton × 7.0 m |
| Max. Working Radius | 34.0 m |
| Applicable Pile | Tubular Sheet Pile ϕ800-1500 |
| Mass | 46300 kg |

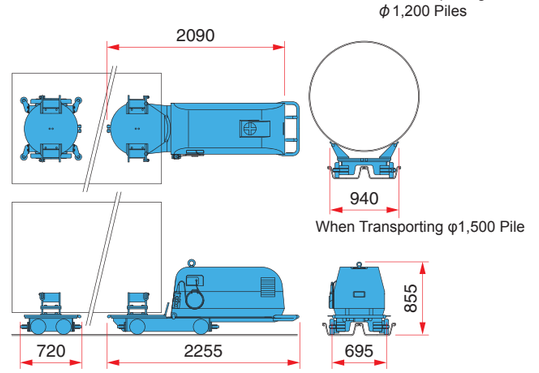
## Pile Runner (For Tubular Sheet Piles and Tubular Piles)

**PR217**




| Model | PR217 |
|---|---|
| Carrying Capacity | 15.0 t |
| Compatible Piles | Tubular Sheet Pile ϕ700-1200 |
| Transporting Rails | N/A |
| Total Mass | 8900 kg |

**TB4**



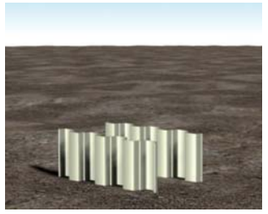

| Model | TB4 |
|---|---|
| Carrying Capacity | 5.0 t |
| Compatible Piles | Tubular Sheet Pile ϕ600-1500 |
| Transporting Rails | Type Ⅱ U Sheet Pile |
| Total Mass | 850 kg |

* Product specifications may be changed without prior notice.

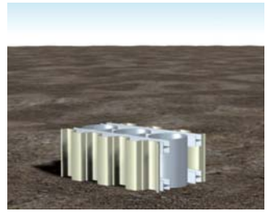
# Standard Press-in Procedure

## Initial Press-in

**1** Press-in Sheet Piles as Reaction Piles

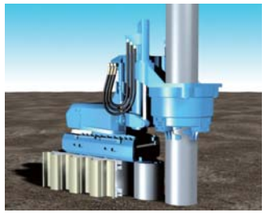


**2** Install Reaction Stand

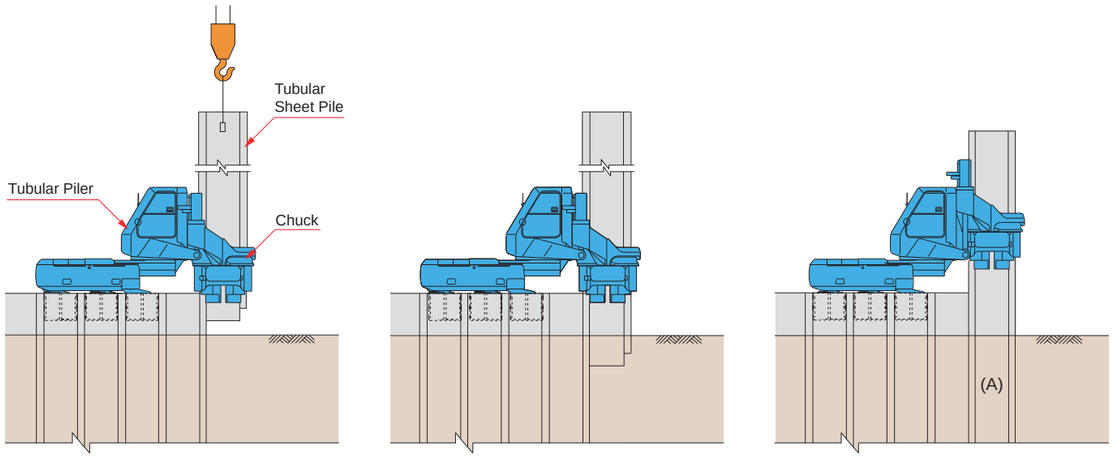


**3** Assemble the three parts of the main body

**4** Press-in from Reaction Stand



## Standard Installation




**1** Pitch the pile and grip with Chuck

**2** Check verticality and alignment, and then start press-in work

**3** Press in pile (A) until bearing capacity is achieved

**4** Open clamp and start self-moving

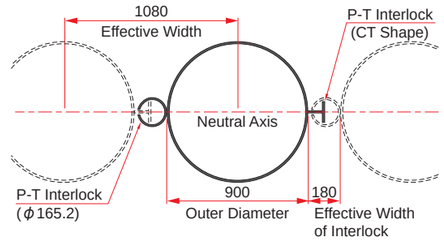
**5** Close clamp and end self-moving

**6** Press in pile (A) to datum level
Pile complete

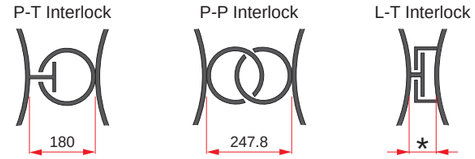
# Design and Technical Data

## Standard Cross-Sections and Interlock Shapes of Tubular Sheet Piles

■ Standard Cross-section (φ900 mm, P-T Interlock)



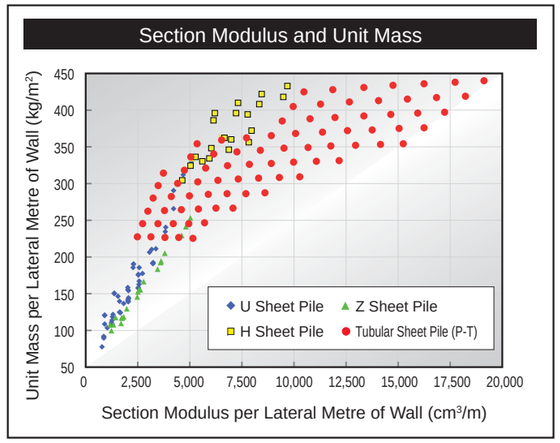

■ Interlock Shapes

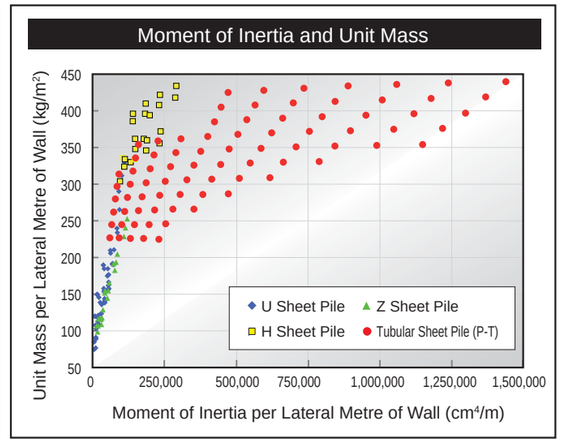



* Depends on pile diameter, etc.

## Cross-Sectional Performance Compared with Other Pile Types

The table below shows typical models of the four main types of pile, distributed by section performance and pile weight. The tubular sheet pile clearly has much higher cross-sectional performance than U and Z sheet piles. Also, when compared with H sheet piles which give similar high cross-sectional performance, the tubular sheet pile involves virtually no increase in pile weight, and therefore is preferable in economic terms.




## Sekisan

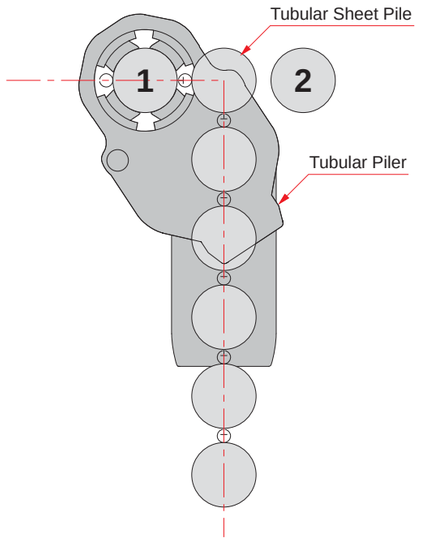
The technical data published by the Japan Press-in Association can be applied to the Tubular Sheet Pile Press-in Method.


Standard technical data can be downloaded from the Association's website.

**http://www.atsunyu.gr.jp**

# Installation Properties

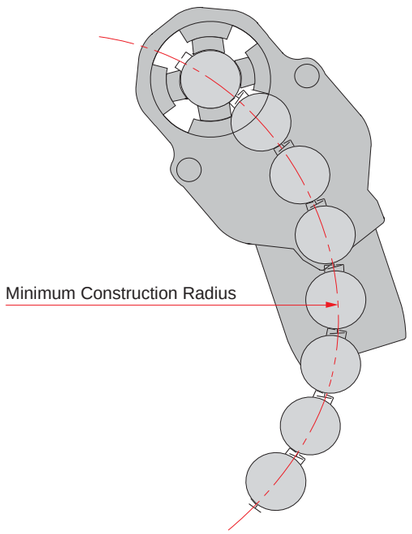
## Corner Installation




The PP150, PP200, PP260, PP300 and PP400 can install tubular sheet piles in the positions 1 and 2 shown left. The CLP 200 is not capable of corner installation, and requires a special approach.

* For details, please contact the Japan Press-in Association.

## Curve Installation




Min. Construction Radius by Pile Type Unit: mm

| Model | Interlock / Pile Diameter | L-T | P-T | P-P |
|---|---|---|---|---|
| PP150 | ϕ500 | 3000 | 2700 | 2650 |
| | ϕ600 | 2450 | 2900 | 3050 |
| CLP200 | ϕ800 | — | 7000 | 5000 |
| | ϕ900 | Straight only | 4500 | 4000 |
| | ϕ1000 | | 3400 | 6000 |
| PP260 | ϕ700 | 5000 | 3300 | 3900 |
| | ϕ800 | 4300 | 3000 | 3900 |
| | ϕ900 | 6820 | 3500 | 5000 |
| PP300 | ϕ1000 | 3700 | 2670 | 3700 |
| | ϕ1100 | 5600 | 3650 | 5000 |
| | ϕ1200 | 5825 | 3950 | 5300 |
| PP400 | ϕ1300 | 4000 | 3400 | 3900 |
| | ϕ1400 | 3300 | 3900 | 4300 |
| | ϕ1500 | 3900 | 4500 | 5000 |

* These figures indicate theoretical limits and suitable margins should be allowed when designing actual projects.
These figures are applicable to the use of standard tubular sheet piles.



# Eco-Friendly Design

## Exhaust Gas Cleaning Compliant with "Offroad" Law

The new Power Unit is equipped with a new-generation environmentally friendly engine. The high combustion efficiency, allied with Giken's independent hydraulic control technology, means that exhaust gases are cleaned thoroughly and effectively, and the equipment complies with the "Offroad" Law regulating work vehicle emissions and Level 3 of the Ministry of Land, Infrastructure, Transport and Tourism's exhaust gas measures for construction machinery.


## Biodegradable Oils for Standard Specification

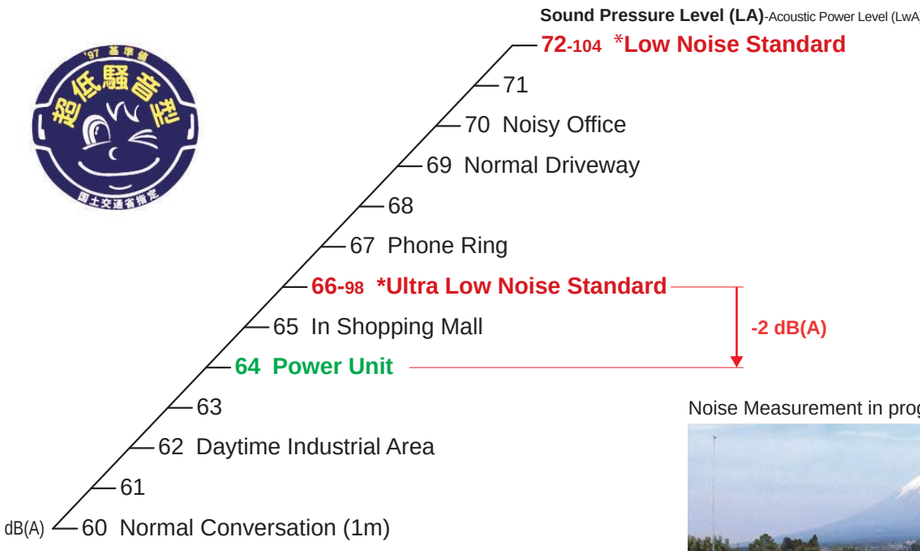
The press-in machinery uses special biodegradable hydraulic oil (Piler Eco Oil) and grease (Piler Eco Grease) developed by Giken in collaboration with oil manufacturers. In the event of any escape into the water or soil, the oil and grease is decomposed by natural bacteria and has no effect on the ecosystem.


Biodegradable Oil Usage Indicator Sticker


The Piler Eco Oil and Piler Eco Grease have been approved with the Eco Mark by the Japan Environment Association.

## Meeting Ultra-Low-Noise Standards

The Power Unit also meets the "ultra-low-noise standards" set by the MLIT.




* The MLIT low-noise standard applicable to the Silent Piler is 104 dB(A) in terms of the acoustic power level of the sound source (LwA), and the ultra-low-noise standard is 98 dB(A). Converted to a noise (sound pressure) level (LA) at 16-m distance, for the purpose of comparison, the low-noise standard is equivalent to 72 dB(A) and the ultra-low-noise standard, 66 dB(A).

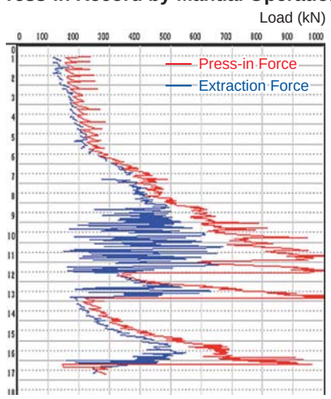
Noise Measurement in progress

# Work Management

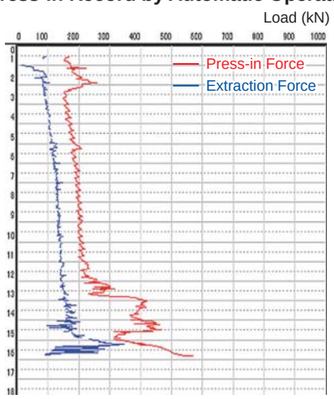
## Automatic Press-in Operation System

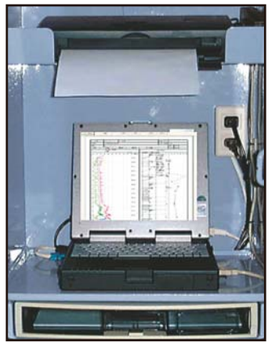
With the Press-in Method, a down-stroke/up-stroke action is applied to the pile being pressed-in in order to eliminate any elements which act to obstruct the penetration of the pile (elements which obstruct the execution of press-in work), so as to achieve a structure of excellent quality after completion. The press-in stroke and extraction stroke, and the maximum press-in force used, etc. are set to optimal values depending on the ground conditions, the pile length, and the construction conditions, and so on. With the Automatic Press-in Operation System, these set conditions are input into the press-in machine and the most efficient press-in operation possible is executed faithfully. Implementing the Automatic Press-in Operation System means that press-in work can proceed in a logical, scientific manner. The charts below show press-in data for manual operation and automatic operation, at the same site.

**Press-in Record by Manual Operation**




**Press-in Record by Automatic Operation**



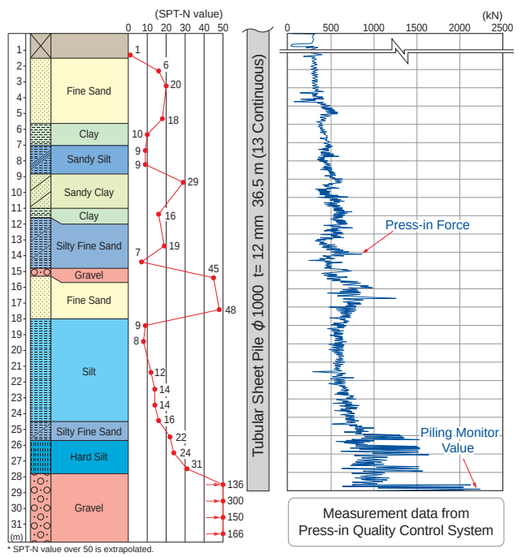
The Power Unit is connected to a PC and the state of press-in work is captured in real time.

## Press-in Quality Control System

### Scientific analysis of the state of press-in work, using Press-in Monitoring Data for each pile

Data about the press-in work, such as the press-in force and press-in speed, is measured and collected in real time, enabling scientific management of the state of the work. By linking this data to a borehole diagram, it is possible to make reliable decisions about optimal press-in work settings for different types of ground, and countermeasures for obstacles, etc.

Antiseismic Strengthening of Bridge Pillars




* SPT-N value over 50 is extrapolated.

Measurement data from Press-in Quality Control System

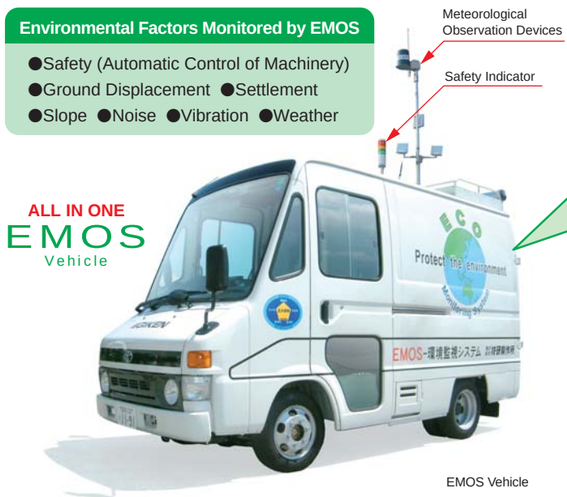
## EMOS Eco Monitoring System

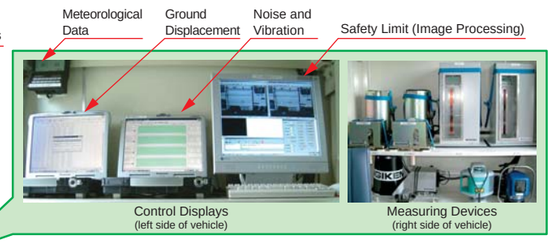
### Monitoring the behaviour of the machinery during construction and the accomplishment of reliable safety within regulatory standards

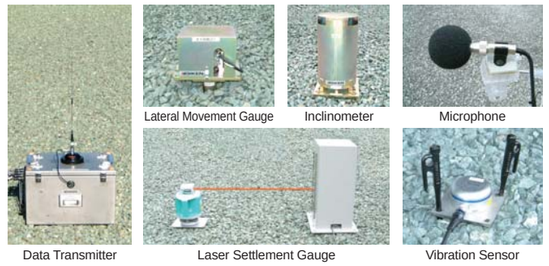
EMOS: The Eco Monitoring System (EMOS) is an immensely flexible environmental monitoring set-up with all the necessary measuring equipment mounted in a single custom-designed vehicle. The technical data provided by EMOS gives a scientific demonstration of the superiority of the construction method and the safety and reliability of the procedure, which can be shown to clients, local residents and other interested parties.

**Environmental Factors Monitored by EMOS**

- Safety (Automatic Control of Machinery)
- Ground Displacement
- Settlement
- Slope
- Noise
- Vibration
- Weather

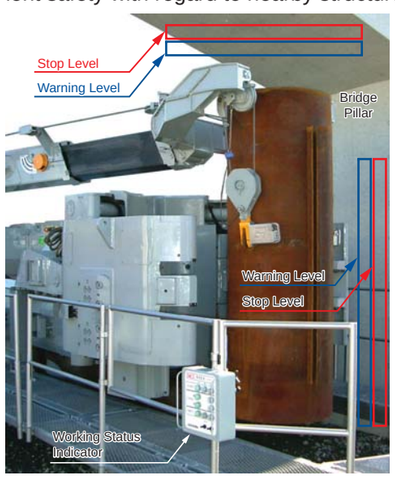



### Construction machinery stopped automatically by image data processing (Systematic Control of Safety)

EMOS uses camera monitoring equipment and image processing to automatically control the operations of the construction machines, so that work is carried out within the established safe area. This safety control system enables fast and cost-effective work that makes maximum use of the space inside the clearance limits, while ensuring excellent safety with regard to nearby structures, cables, and railway and road traffic.



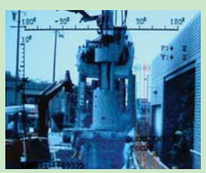

Monitoring Camera

Safety Monitor

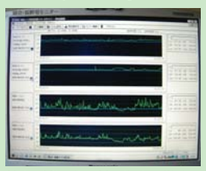
Working Status Indicator

- A warning level and stop level can be set in each of four areas
- A warning or automatic stop is implemented, depending on the effect on existing structures
- An image is recorded on the management computer whenever there is an abnormality in the warning and stop level detection

EMOS Measurement in action



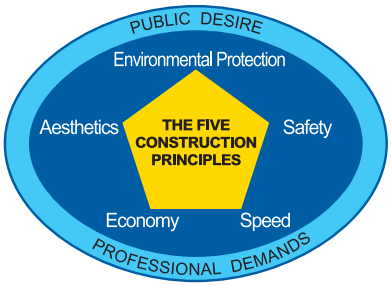
Safety Monitoring Status



Noise/Vibration Monitoring Status

Explaining how it works

# THE FIVE CONSTRUCTION PRINCIPLES




If we analyse all the parties involved in any construction work, we can categorise them into three main groups: the client, the contractor and the general public. The ideal situation is when all three parties are in agreement and satisfied with the successful outcome of the construction work. Problems arise when one of the parties becomes a victim of imbalance in this relationship. The conventional construction methods based upon principles that "more is paid for less efficient work" are no longer appropriate to present-day society. Universally acceptable construction methods must embody the Five Construction Principles.

| | |
|---|---|
| Environmental Protection | Construction work should be environmentally friendly and free from pollution. |
| Safety | Construction work has to be carried out in safety and comfort with a method implementing the highest safety criteria. |
| Speed | Construction work should be completed in the shortest possible period of time. |
| Economy | Construction work must be done rationally with an inventive mind to overcome all constraints at the lowest cost. |
| Aesthetics | Construction work must proceed smoothly and the finished product should portray cultural and artistic flavour. |

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