Examination Category
(Civil Engineering)
Textbook for
the Practical Examination

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Chapter 5: Knowledge of Tools, Machines, Materials, and Measuring Instruments Used on Construction Sites

Chapter 6: Knowledge on Construction Site Work

Chapter 7: Safety during Construction Work

Chapter 5: Knowledge of Tools, Machines, Materials, and Measuring Instruments Used on Construction Sites

5.1 Tools, machines, materials, and measuring instruments specific to job categories

5.1.1 Construction Machines

[Yuatsu shovel] (hydraulic excavator (backhoe)) A machine that performs digging and loading work using the boom, arm, and bucket, which are operated by hydraulic cylinders, and by rotating the upper unit. By changing attachments, it can be used in various ways as a breaker, a ripper, a crusher, etc.

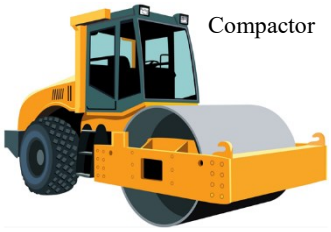

Hydraulic excavator

[Power shovel] A type of hydraulic excavators. A bucket is attached to the end of the arm. The bucket is mounted with the opening upward. Suitable for excavating at a level higher than the machine's position.

[Bulldozer] A machine consisting of a crawler (a metal or rubber belt) type traveling unit equipped with a movable blade (dozer), mainly used for excavation and transportation. There is also a machine called rippable (bulldozer ripper) with a ripper that rakes up earth and rock.


Bulldozer

[Ten'atsuki] (compactor) A machine that compacts by weight. There are several types, depending on the material and shape of rollers and their combination.


Compactor

[Road roller] A compactor with steel rollers. It is used to compact subgrade layers and aggregate base layers in pavement construction.

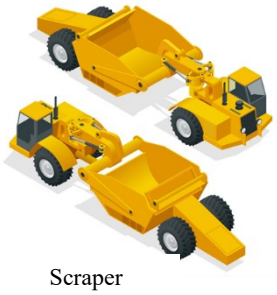
[Tire roller] A compactor with rubber rollers. It is suitable for ordinary soil that is easy to compact and for crushed stones for aggregate base layers of pavements. It is also used for machine-compacting asphalt mixtures.


Tire roller

[Shindo roller] (vibratory roller) A compactor with vibrating steel rollers. The vibration is normally vertical, but those that vibrate horizontally are specifically called *shindo roller* (vibratory rollers). Vibratory rollers have a strong compacting effect, even when they are small in size.

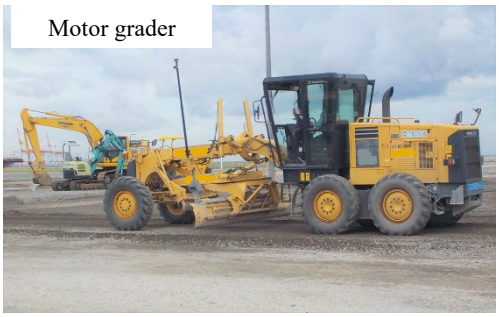

Vibratory roller

[Scraper] A machine that can single-handedly perform a series of operations such as digging, loading, transporting, and spreading soil. The cutting edge at the bottom of the bowl, which fills with soil as it travels, cuts the soil and places the excavated soil into the bowl. Upon arrival at the embankment, the apron is opened, the soil is discharged, and the machine spreads it to a thin layer.


Scraper

[Motor scraper] Self-propelled scraper. It cuts and levels the ground by scraping soil and sand using the blade between the front and rear wheels, and sends the soil to a container above the blade.

[Motor grader] A machine used to flatten and finish the ground surface or aggregate base layer materials such as paving stones. A scarifier and a blade are located between the front and rear tires. The ground is torn up with a scarifier and the ground surface is leveled and compacted with a blade.


Motor grader

[Tractor shovel] (tractor excavator) A machine with a bucket attached to the front of the tractor. Earth and sand can be scooped up and loaded onto dump trucks using the bucket. In addition to buckets for excavating earth and rocks, the truck can be equipped with a fork for moving obstructing vehicles, etc., and a water gun for firefighting. There are two types of models: the wheel type and the crawler type.

Wheel-type tractor excavators and dump trucks

[Wheel loader] A loading and carrying machine that run on wheels, with a large bucket in front of the body. By moving the vehicle forward and operating the bucket and boom, the machine scoops up various materials such as earth, sand, and quarry stones and loads them onto dump trucks or other vehicles. A wheel loader is a tractor excavator that runs on wheels, also called a tire dozer or tire excavator.

Wheel loader

[Dump truck] A vehicle used exclusively for transporting earth, sand, rocks, etc., and is capable of unloading soil (dumping) by tilting the bed of the truck. Often used in combination with hydraulic excavators and wheel loaders.

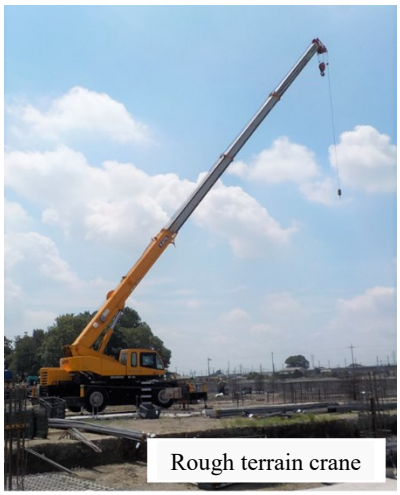
Dump truck

[Sakuganki] (rock drill) A machine used to break up hard rock and bedrock. It is used to drill blasting holes for dynamite and for drilling holes to insert wedges break rocks.

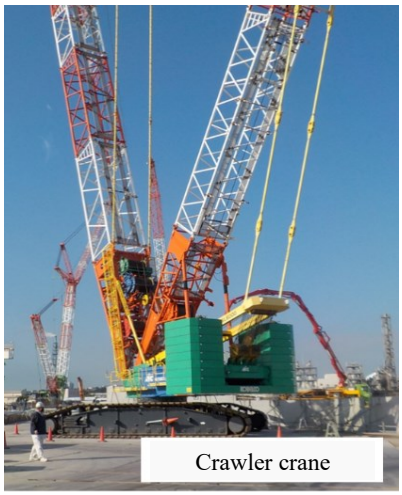
[Crane] A machine that uses power to lift and transport a load horizontally. There are several types of cranes, including tower cranes, truck cranes, and crawler cranes.

[Rough-ter crane] (rough terrain crane) A type of construction machine with a crane mounted on a truck.

[Crawler crane] A crawler-type crane. It can work in a variety of locations, including on snow and unpaved ground.

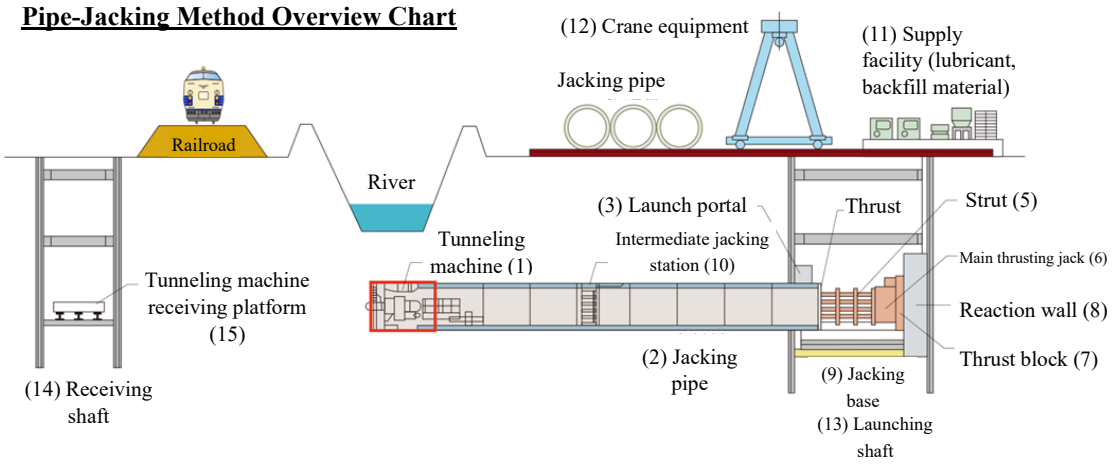


Rough terrain crane



Crawler crane

5.1.2 The Pipe-Jacking Tunneling Method



[(1) Kusshinki] (tunneling machine) A machine that digs soil. There are various types of machines, depending on the type of soil to be dug and the method of transporting the excavated soil.

[(2) Jacking pipe] Pipes used in the pipe-jacking method.

[(3) Hasshin koguchi] (launch portal) The opening where the jacking pipe is pushed out of the launching shaft and into the ground. The launch portal prevents leakage of groundwater and lubricant.

[(4) Oshiwa] (thrust ring) The thrust ring prevents breakage of the jacking pipe by evenly transmitting the force of the main thrusting jack to the jacking pipes.

[(5) Strut] Struts are used to assist the lack of stroke of hydraulic jacks and as auxiliary struts to

transmit the jacking force.

[(6) Moto'oshi yuatsu jack] (main thrusting hydraulic jack) The hydraulic force of the thrusting hydraulic jack pushes the tunneling machine and jacking pipes into the ground.

[(7) Oshikaku] (thrust block) The thrust block distributes the reaction force of the jack and transfers it to the support wall.

[(8) Shiatsuheki] (reaction wall) The reaction wall evenly transmits and supports the reaction force of the main thrusting jack to the ground behind the jack.

[(9) Suishindai] (thrust frame) A thrust frame is a frame used to guide jacking pipes to a specified height and direction.

[(10) Nakaoshi setsubi] (intermediate jacking station) The intermediate jacking station places a hydraulic jack in the middle of the tunnel to compensate for the lack of jacking force of the main thrusting jack.

[(11) Chunyu setsubi] (supply facility) This facility supplies materials (e.g., lubricant and backfill material) necessary for jacking.

[(12) Crane setsubi] (crane facility) This facility lifts jacking pipes and other objects and moves them down the shaft.

[(13) Hasshin tateko] (launching shaft) A shaft used to push the tunneling machine and jacking pipes into the ground. In the launching shaft, equipment such as the main thrusting jack is installed and the jacking pipes are connected.

[(14) Totatsu tateko] (receiving shaft) A shaft used to remove equipment such as tunneling machines after the tunnel is completed.

[(15) Kusshinki ukedai] (tunneling machine receiving platform) This platform is used to push out and retrieve the excavator after it arrives to the destination.

5.1.3 Marine Civil Engineering Work

[Grab shunsetsusen] (grab dredger) A work vessel that grasps sediment from the seafloor by lowering a machine called a grab bucket, which is attached to a crane at the end of the vessel.

[Pump shunsetsusen] (pump dredger) A work vessel that lowers a rotating machine called a cutter head, which is attached to the end of the vessel, to the seabed and digs the seabed while sucking up both the dug sand and soil and sea water.

[Kijukisen] (crane vessel) A work vessel with a crane that lifts, carries, and installs heavy structures such as large blocks and caissons.


Pump dredger


Crane vessel

[Concrete mixer sen] (concrete mixing vessel) A work vessel equipped with machines for mixing concrete materials and pumps for placing the mixed concrete.

[Gattosen] (carrier with grab) A work vessel with a grab bucket for transporting sand and stone materials. It is self-propelled, so it can carry sand and stones to the site, use the vessel's grab bucket to grab the sand and stones and move them or throw them in.

[Dounsen] (sand/gravel carrier) A work vessel used to transport dredged earth and sand or stones for construction materials. Some of them can open the bottom of the boat.

[Hikifune] (tugboat) A work vessel used to move large work vessels that cannot move by themselves by pulling them with wires and ropes.

[Yobyosen] (anchor handling vessel) A work vessel that uses a winch attached to the top of the vessel to hoist the anchors of other work vessels or throw them into the sea.

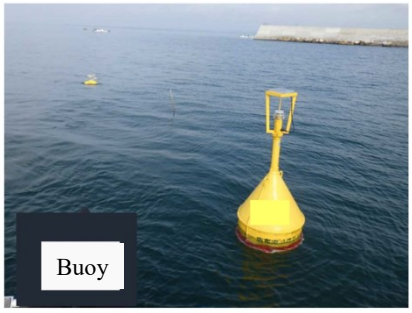

Anchor handling vessel

[Ikari] (anchor) A weight placed on the seabed to secure the ship's position. It has claws, which are inserted into the seafloor to hold the ship in position.

[Sonar] A machine used to measure the shape of the seafloor, which cannot be seen directly.

[Reddo] (sounding line) A measuring tool with a weight at the end of a graduated rope, it is thrown into the sea to easily measure the depth of the sea by reading the marks on the rope.

[Fuhyo] (buoy) Equipment placed around construction sites to notify non-construction vessels of the construction site. Some of them glow at night.


Buoy

[Koyaita] (steel sheet piles) Made of thin sheets of iron. Both sides of a single steel sheet pile have hooks called interlocks that connect the steel sheet piles to each other. They are interlocked to form a wall that keeps the soil from crumbling.

[Kokankui] (steel tube pile) A pile in the shape of a tube made of rounded thin plates of iron. Steel tube piles come in a variety of sizes, ranging from 40-50 cm to over 1 m in diameter.


Wave-dissipating blocks

[Concrete block] Making, installing and assembling small concrete blocks can create a wave-resistant structure. Concrete blocks of various shapes are used in marine engineering works.


Caisson

[Caisson] A large box made of concrete used to build

breakwaters, quays, and other marine structures. Larger ones are more than 20 meters in length, width, and height.

[Suteishi] (uniform riprap) Stones of the same size (30~1,000 kg) and strength for construction. They are piled to create a trapezoid-shape site (foundation mound) on which structures are built.

5.1. 4 Well Drilling Work

[Boring machine] (drilling machine) Machines for digging relatively small-diameter holes in the ground. It is used to dig wells as well as for geological surveys. Excavation is performed by rotational and percussive forces. There are rotary drilling machines, percussion drilling machines, rotary percussion drilling machines, etc.

[Bit] A component used in the rotary *koho* (rotary drilling method) Rotating the bit allows digging through the ground.

[Air hammer] A component used in the air-hammer method. Attached to the end of the drill shaft, it digs through the ground by rotational and percussive forces. There is a hole at the end of the hammer, and air pressure delivered through the drill shaft can blow the dug soil up to above the ground.

[Boring pump] A pump used to pump up groundwater from the boreholes. It is used in combination with boring machines.

5.1.5 Wellpointing

[Wellpoint] A collection pipe fitted with a mesh for filtration. It is attached to the end of a water supply pipe called a riser pipe.

[Casing kan] (casing pipe) The outer pipe in a double-pipe wellpoint, with the riser pipe inside. A vacuum pump is used to create a vacuum inside the casing pipe to forcefully collect pore water around the well.

[Rotary percussion drill] A machine that drills holes in the ground by rotation and percussion. In the wellpointing method, it is used to drill holes for large-diameter wellpoints.

[Water jet] A pump used to create a jet of water to drive riser pipes into the ground. A high-pressure jet of water from a nozzle at the tip is used to drill a hole through which the riser pipe is driven.

5.1. 6 Paving Work

[Asphalt] Material used in paving. It is made from the residue left over from producing gasoline or diesel oil. It hardens at room temperature and becomes liquid at higher temperatures.

[Asphalt finisher] A machine used to spread and level asphalt. It consists of a tractor section with engine, hopper, and screed. There are two types of tractor sections: crawler type and wheel type. A hopper is a cage-like device that holds asphalt. Screed is a device for spreading asphalt. Asphalt from the hopper is sent to the screed by a conveyor belt.

[Concrete cutter] A machine for cutting concrete and asphalt.

[Breaker] (paving breaker) A machine used to break the road surface of paved roads. It is used by attaching it to the tip of a hydraulic excavator or backhoe. It is also used for demolition of concrete structures and rock excavation.

[Distributor] A machine used to spread asphalt emulsifier on roads. A large tank is equipped with asphalt emulsifier, which is sprayed onto the asphalt pavement from the back of the vehicle.

[Hand guide roller] A small hand-pushed road roller.


Hand guide roller

5.1.7 Piling Work

[Earth drill kussakuki] (earth drilling machine) A machine used in the cast-in-situ concrete piling method that drills holes for piles. The ground is excavated by rotating the drilling bucket. Soil

accumulates in the bucket and is discharged to the ground when full. This method is called the earth drill method.

[Zenshukaiten kussakuki] (full slewing excavator) A machine used in the cast-in-situ concrete piling method that grasps a steel tube called a casing (or casing tube) and pushes it into the ground while rotating it 360 degrees. This method is called the all-casing method.

[Hammer grab] This bucket is used to grab up earth and sand in the casing tube and discharge it to the ground. Used in conjunction with a full slewing excavator in the all-casing method.

[Pile driver] A machine for drilling holes to set pre-cast piles. For large machines, there is a three-point pile driver to support the drill section stably.

5.1. 8 Scaffolding Work

[Ashibayo buzai] (scaffolding members) Members used to build scaffolding. The materials used for tube scaffolding, frame scaffolding, and ringlock scaffolding differ from each other.

[Kusabi kinketsushiki ashibayo buzai] (ringlock scaffolding members) *Kusabi kinketsushiki ashiba* (ringlock scaffolding) is a type of scaffolding that uses scaffold members designed to be assembled and disassembled with a single hammer. Basic members include jacks, posts, handrails, scaffold planks with hooks, brackets, cross braces, steel stairs, guardrails, and wall jacks. Basic members are galvanized to resist rust and provide durability.

[Wakugumi ashibayo buzai] (frame scaffold members) *Wakugumi ashiba* (frame scaffold) is a type of scaffolding in which basic members such as jacks, cross braces, and steel scaffold planks with hooks are assembled around portal frames. Basic members include formwork, jacks, cross braces, joint pins, scaffold planks, wall tie anchors, handrails, ledgers, and toe boards.

[Tankan ashibayo buzai] (tube scaffolding members) *Tankan ashiba* (tube scaffolding) is a type of scaffolding that is assembled using clamps to bind circular hollow sections made of 48.6 mm-diameter steel tubes. The scaffold shape can be flexibly changed, allowing it to be used for scaffolding in tight spaces. It is inferior to frame scaffolding in terms of strength and safety, and is mainly used as scaffolding for painting low-rise exterior walls. Basic members include circular hollow sections, foot plates, clamps, circular hollow section brackets, scaffold boards, and joints.


Ringlock scaffolding


Frame scaffolding


Tube scaffolding

[Tankan pipe] (circular hollow section) Tubes for scaffolding made of 48.6 mm-diameter steel tubes.

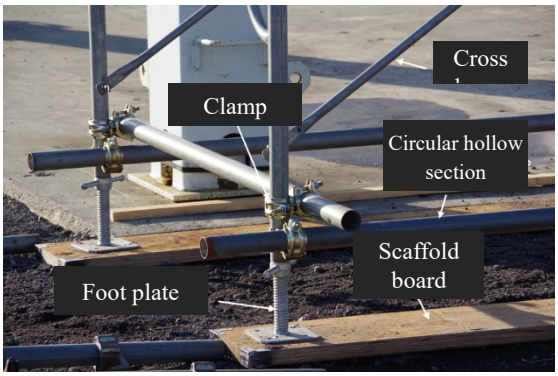
[Joint] A member used to connect circular hollow sections.

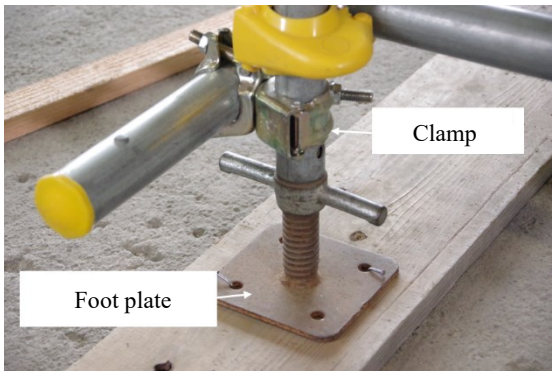
[Kotei base] (foot plate) Base fitting to fix an upright circular hollow section (*tateji* (upright circular hollow section)).

[Clamp] Hardware used to connect circular hollow sections orthogonally or diagonally. There are 90-degree clamps and adjustable clamps.

[Sujikai] (cross brace) A member used to reinforce the structure in order to prevent scaffolding from collapsing due to wind or other factors. It is placed diagonally between the posts.

[Ashibaita] (scaffold board) Boards that serve as working aisles and platforms in scaffolding.





[Nunoita] (scaffold plank with hooks) A member that serves as the working platform of scaffolding. Unlike scaffold boards, it has hooks to secure it to the beams attached to the upright circular hollow section.

[Tankan bracket] (circular hollow section bracket) A member used to support the scaffold board from below. The horizontal portion onto which the scaffold plank with hooks is supported at an angle.

[Habaki] (toe board) Board material attached to the outer edge of the scaffold board. Attached to prevent objects from falling.

[Kabetsunagi] (wall tie anchor) A member to secure scaffolds to walls and other structures to prevent them from collapsing.

[Bo'on panel] (soundproofing panel) A panel attached to scaffolding for soundproofing. Aluminum or stainless steel products also serve to prevent the spread of fire.

[Bo'on sheet] (soundproofing sheet] A sheet put up on scaffolding for soundproofing.

[Anzen block] (safety block) A device used to prevent scaffold workers from falling from heights. The hook of the safety block is hooked to the safety belt.


Safety block

[Bansen] (thick wire) The thick wire used to assemble scaffolding is called *bansen*. To make it stronger than ordinary wire, the iron is treated with heat and then allowed to cool slowly.

[Bansen cutter] (thick wire cutter) A tool used to cut thick wire.


Thick wire


Thick wire cutter

[Chino] A curved tool with a pointed tip. It is used for tying and tightening of thick wires.

[Chino tsuki ryoguchi ratchet wrench] (double-ended ratchet wrench with chino) One end of the grip is pointed, allowing tightening of thick wires, etc. The pointed end is called *shino* (chino). The other end with a hole allows tightening and loosening of bolts. It is used in scaffolding and rebar construction. The size mainly used by steeplejacks is 17 x 21 mm.


Chino


Ratchet wrench with chino

[Ratchet wrench] A wrench that incorporates a

clutch that fixes the direction of rotation in one direction (called *ratchet kiko* (ratchet mechanism)). The ratchet mechanism allows efficient turning of bolts and nuts with just a reciprocating motion of the lever. In steel framing work, a ratchet wrench with a chino, or a pointed form, on one end, is used.


Ratchet wrench with chino

5.1.9 Steel Framing Work

[Borushin] (drift pin) A tool used to align bolt holes in steel section joints by tapping into the bolt holes when they are misaligned.


Spanner

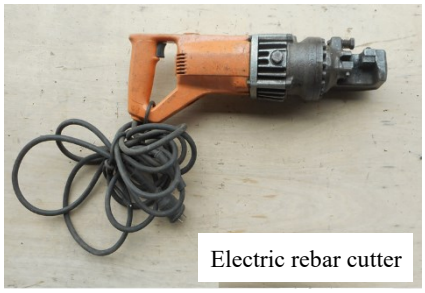
[Wrench, spanner] A tool used to tighten and loosen bolts and nuts by rotating them. In American English, it is called wrench, and in British English, spanner. They both mean the same thing in English, but in Japan, they refer to different tools. The wrench has a hexagonal tip and captures the bolt at six points, while the spanner has an open tip and captures the bolt at two points.

[Megane wrench] (box wrench) A wrench with ends of different diameters on both sides of the grip.

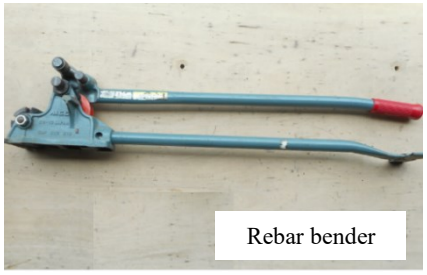
[Combination wrench] A wrench that has an opening and captures and turns bolts and nuts at two points. A combination wrench is a wrench with one spanner end and one box wrench end. The end is angled at 15 degrees to the grip, so the back and front sides can be used alternately to provide a rotating stroke for efficient work.

[Impact wrench] A power tool for turning and tightening hexagonal bolts using the impact from the built-in hammer.

5.1.10 Steel Reinforcement Work (Rebar Work)


Electric rebar cutter

[Tekkin cutter] (rebar cutter) A tool used to cut reinforcing steel bars. There are four types: manual, manual hydraulic, electric hydraulic, and electric circular saw with a tipped blade.


Rebar bender

[Dendo tekkin cutter] (electric rebar cutter) A power tool that uses a hydraulic pump to move the blade and cut the rebar. The rebar is grasped with the tip, and cut by pressing the blade against it.


Stationary rebar bender

[Dendo yuatsushiki tekkin cutter] (electric hydraulic rebar cutter) A portable cutting machine that can cut rebar using electricity and hydraulic pressure.

[Tekkin bender] (rebar bender) A tool used to bend rebar.

[Dendo yuatsushiki tekkin mageki] (electric hydraulic rebar bender) A portable bender that can bend rebar using electricity and hydraulic pressure.

Rebar tier

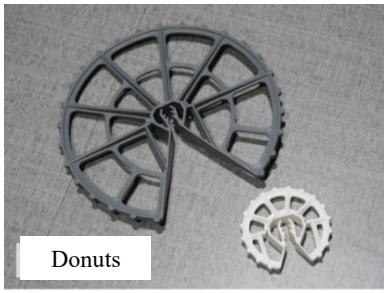
[Teichishiki tekkin mageki] (stationary rebar bender) Stationary-type rebar bender mainly used in rebar processing plants.

[Tekkin kessokuki] (rebar tier) A power tool for tying rebars. Simply insert the arm into where the rebars cross, and pull the trigger to tie them.

[Spacer] A member to secure space (space between the rebar and the formwork) of the rebar. Spacers for the sides are called donuts, and the members that hold the top and bottom of the slab or beam are called bar supports.

[Donut] Donut-shaped spacers fitted to rebars in columns, beams, and walls to secure space for the correct concrete cover thickness.

[Caramel] Dice-shaped mortar blocks placed under the floor reinforcement to secure the concrete cover thickness of the floor reinforcement.


Donuts

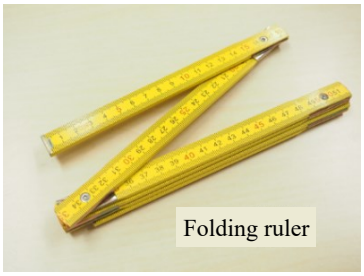

Caramel

[Pura cap] (plastic cap)

Plastic caps placed conspicuously over the tops of the vertical joint bars and the edges of horizontal bars after completion of the rebar placement as a safety measure to prevent injury.


Plastic cap

[Orijaku] (folding ruler) A tool for measuring short lengths. It is mainly made of fiberglass or wooden material and has an extended length of one meter. It is useful when working alone or in situations where it is difficult to work because it can be folded. This tool is often used in rebar work.


Folding ruler

[Kessokusen] (binding wire) A mild steel wire (generally No. 21 in thickness) used to connect rebars.


Binding wire

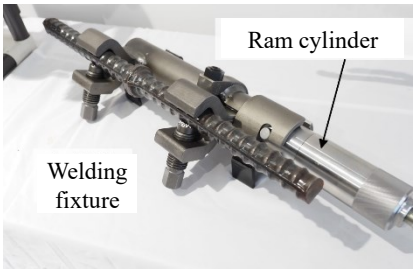
[Hacker] The tying and fixing of reinforcing steel bars together is called *tekkin no kessoku*. The tool used to twist and tighten the binding wire used for tying rebars is called a hacker. It is the most important tool for a rebar worker. There is a hacker case to store the hacker.


Hacker

[Nifuda/efu] (tag) A tag indicating the size, use, position of use, and number of rebar brought in to the site. It is tied to the rebar using a thin wire.

5.1.11 Rebar Splicing Work

[Kaatsuki] (pressure system) The section consisting of a hydraulic power unit, a high-pressure hose, and a ram cylinder, which generates the hydraulic pressure necessary for pressure welding.



[Assetsuki] (welding fixture) The section in which two rebars to be pressure-welded are set. It is driven by hydraulic pressure generated by a pressurizing pump.

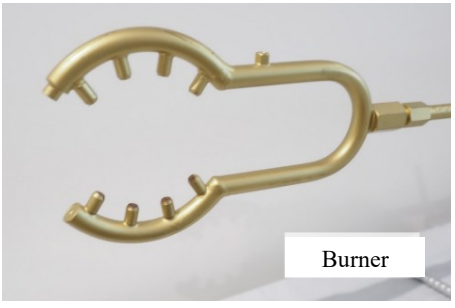
[Ram cylinder] A device used to transfer the hydraulic pressure to the pressure system.

[Koatsu hose] (high-pressure hose) A hose with a flexible bendable structure that can withstand high pressure.

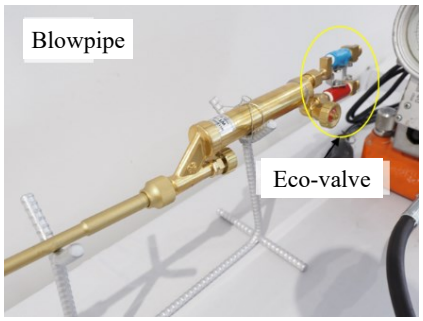
[Dendoshiki kaatsusochi] (electric pressurizer) A hydraulic pump that can set the pressurizing power as desired. Pressurization can be turned on and off with a switch at hand.

[Jido kaatsusochi] (automatic pressurizer) A machine in which pressurization sequences are programmed to automate pressurization.

[Burner] (welding torch) The section that emits flames to heat the pressure-weld joint. There are several different shapes.

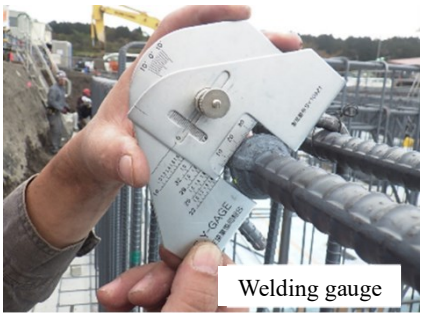


[Suikan] (blowpipe) A heating apparatus for mixing and delivering oxygen and acetylene gas.



[Eco-valve] A valve designed to open and close the oxygen and the acetylene gas flow at the same time. It is used by attaching it to a blowpipe.

[Gaikan sokuteiyo kigu] (welding gauge) An inspection tool to measure the diameter and width of the bulge of the pressure-weld joint.

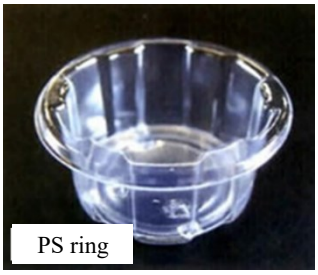


[Cho'onpa tanshoki] (ultrasonic flaw detector) An inspection device that detects internal defects by applying ultrasonic waves to the pressure-weld joint.

[Hippari shikenki] (tensile tester) A machine that performs tensile tests, which pulls pressure-welded rebars, to test the strength.

[Mage shikenki] (bend tester) A machine that performs bend tests to test the strength of pressure-welded rebars.

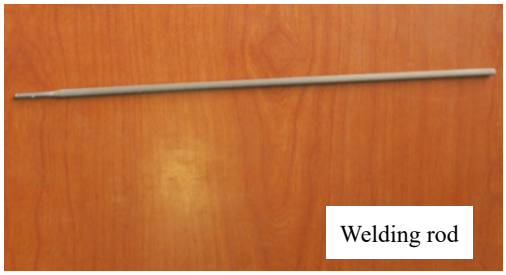
[PS ring] A high molecular weight reducing agent to prevent oxidation of pressure-weld joints. It also makes it less susceptible to wind and rain.



5.1.12 Welding Work

[Hifuku arc yosetsuki] (shielded arc welding machine) A welding machine that uses a welding rod with a metal core covered with a coating material (called "flux"). This type of welding machine is often used at work sites. Welding with a shielded arc welding machine is sometimes called *teyosetsu*

(manual welding) because it is done entirely by hand.


Welding rod

[Yosetsubo] (welding rod) Metal rods used to bond the base metal to be welded. In arc and gas welding, it melts and becomes one with the base metal.


Pliers

[Yattoko] (pliers) A tool made of iron for gripping heated iron and other materials. It consists of two metal rods connected by a hinge. They can be used to grasp objects with strong force using the principle of leverage. They are also used in welding to bend things.

[Sekihitsu] (stone scribe) A tool used to draw *kegaki* (scribe marks) on iron plates, etc. for welding and torch-cutting. *Kegaki* (scribe marks) means to scratch and draw lines on the material.

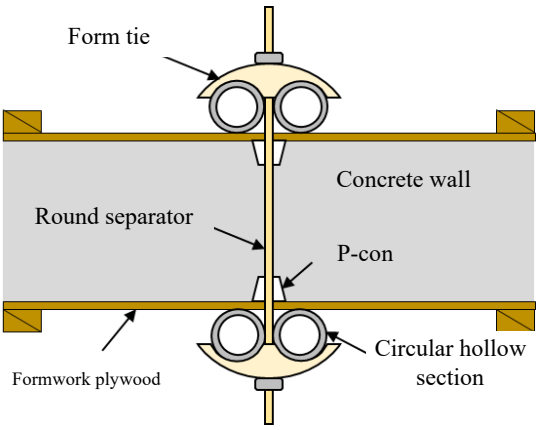
[Spatter fuchaku boshizai] (anti-spatter compound) Spatter is the slag and metal particles scattered during welding. Since they can lower the quality of the weld finish, this compound is used to prevent the spatter from sticking. The compound is applied to the material before welding by brush or spray.


Helmet with a face shield

[Shield-mentsuki helmet] (welding helmet) A helmet with a shield attached to it, protecting the entire face. Mainly used for welding work.

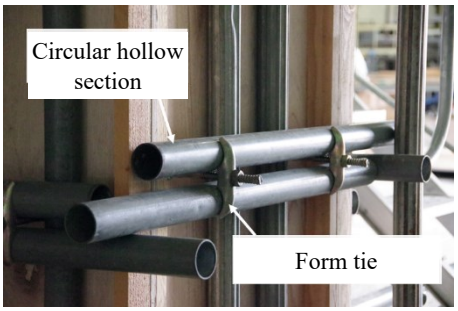
5.1.13 Formwork Carpentry

[Form tie] A tool attached to separators to keep the formwork spacing constant, improve passage, and prevent deformation of the formwork due to lateral pressure from the concrete. It is used to bind the tubes.



[Maru separator] (round separator) A tool commonly called *sepa* or *marusepa* that is placed between formwork facing each other to ensure that the thickness of the concrete will be as indicated in the construction drawings.

[P-con] A plastic part that is attached to an end of a separator. Attached to both ends of the separator, they hold the formwork panel in place.



[Tankan pipe/kokan pipe] (circular hollow section, steel tube) A material used to increase the strength of the formwork. Circular hollow sections are round whereas steel tubes are square-shaped.

[Sangi] (batten) A 25 x 50 mm piece of wood used together with plywood. It is used at joints between panels and to supplement the strength of the formwork.

[Sekiita] (formwork plywood) Plywood used to make formwork. Generally, 12 mm thick *conpane* (formwork plywood) is used.

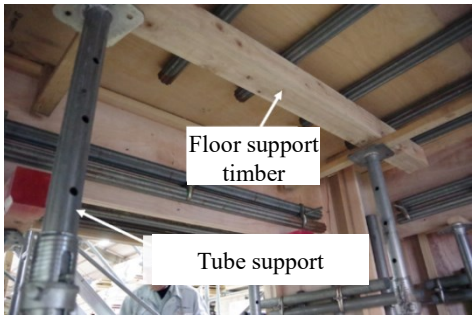
[Panel katawaku] (panel formwork) A panel-shaped formwork made by nailing pieces of batten onto plywood to create a panel. Panel formwork is intended for repeated use.

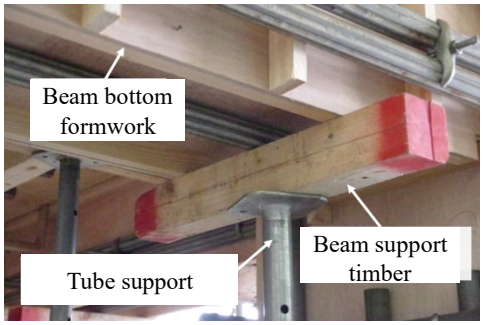
[Batakaku] (floor support timber) Square timber with a width of 90 mm or 105 mm. It is used to

construct pipe supports for receiving the circular hollow sections for the floor framework. It is also used as a platform on which to place heavy objects.

[Pipe support] (tube support) A member used for the bottom plate of beams and as supports for floor formwork. It bears the compressive forces. It is called *sapo*, *sappo*, support, etc. for short.

[Tonbo bata] (square timber) Square timber often referred to as *tonbo* and used to construct tube supports for receiving the circular hollow section (called *neda pipe* (joist tube)) for the beam bottom formwork.





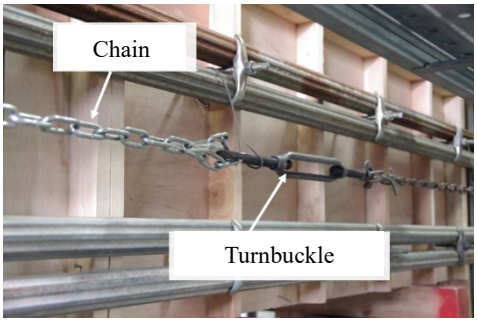
[Kakikomizai] (grooving material) A material attached to the formwork to make grooves in concrete for window frames, etc. It is commonly referred to as *ankozai*.

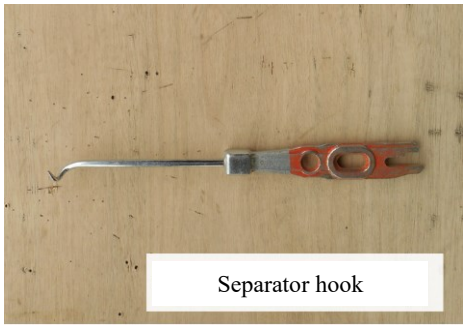
[Mengi] (cornering material) Material used to create corners with concrete.

[Mejibo] (grooving rods) Material used to make grooves in the flat surface of concrete.

[Turnbuckle/chain] Used to prevent collapsing of the formwork and to adjust the verticality (i.e., to accurately level and straighten the columns and beams) by pulling.

[Separator hook] A tool used to guide the separator into the hole drilled in the formwork.





[Form tie mawashi] (form tie spanner) A tool used for tightening and loosening form ties.

[Kariwaku hammer] (formwork hammer) This hammer is used to make the formwork for pouring concrete. It can also pull out nails.

Form tie spanner

Formwork hammer

[Hakurizai] (release agent) An agent applied to the surface of the formwork to facilitate removal.

5.1.14 Concrete Pumping Work

[Agitator] A device that agitates pre-mixed concrete to prevent it from hardening. Trucks equipped with this function are called truck agitator (concrete agitator trucks) or *nama-consha* (ready-mixed concrete trucks).

[Concrete pump] A machine that uses hydraulic or mechanical pressure to feed ready-mixed concrete (concrete made at a factory that has not hardened yet) brought in by concrete agitator trucks into the formwork. There are two types of pumps: *piston shiki* (piston type), which has high pressure and can pump over long distances, and *squeeze shiki* (squeeze type), which has low pressure and limited pumping distance. A device in which a concrete pump is mounted on a vehicle is called a concrete pump truck.

[Hopper] (concrete hopper) A part that receives ready-mixed concrete from a concrete agitator truck. A screen is attached to the concrete hopper to prevent people and foreign objects from falling into the hopper.

[Level sensor sochi] (level sensor device] A device that detects the amount of concrete in the hopper

and automatically operates and stops the machine.

[Kinkyu teishi sochi((emergency stop device) A device used to stop the movement of the concrete pump when a person is about to be or is caught in the agitator.

[Agitator jido teishi sochi] (automatic agitator stop device) A device that automatically stops the movement of the agitator when the hopper screen is opened.

[Doryoku dentatsu sochi (PTO)] (Power Take-Off (PTO)) A device used to take the power from the engine needed by various parts of the concrete pump. Engine power is transmitted to drive the concrete pump truck, operate the outriggers and boom, and power the hydraulic generator.

[Yuatsu kairo] (hydraulic circuit) A device that generates the hydraulic pressure to move the equipment of the concrete pump truck. The hydraulic circuit consists of a hydraulic power unit, a hydraulic control unit, a hydraulic actuation system, and other ancillary equipment.

[Jido kyuyu sochi] (automatic lubricator) A device that sends grease from a grease pump to the bearings of concrete cylinders, S-pipes, and agitators.

[Senjo sochi] (washer) A device used to wash concrete left in various parts of the equipment of concrete pump trucks after pumping operation.

[Boom sochi] (boom) Equipment used to bring the delivery pipe to the location where the concrete is to be placed. Booms can be folding, telescopic, or a combination of these types.

[Senkai sochi] (boom manipulator) A device that moves the boom up and down and swivels it.

[Kadai sochi] (superstructure) A structure for attaching boom and outrigger devices to the vehicle body. It consists of a sub-frame and a boom pedestal.

[Outrigger sochi] (outrigger) A device that extends outward from the body of the vehicle to maintain the stability of the concrete pump truck.

[Yusokan] (delivery pipe) A pipe used to deliver concrete from the concrete pump truck to the location where the concrete is to be placed. It consists of straight pipes, elbow pipes, tapered pipes, a placing hose, etc.

[Cement] Material used to make concrete. It has the property to harden when mixed with water.

[Kotsuzai] (aggregate) Sand or gravel that is mixed with cement when making concrete or mortar.

[Konwazai] (mixing agent) Anything other than cement, water, sand, and gravel that is added to concrete to improve its performance. Includes damping agent, superplasticizer, and hardening accelerator.

[Slump cone] A formwork for conducting a slump shiken (slump test) to check the quality of ready-mixed concrete. After pouring the ready-mixed concrete into the slump cone, the slump cone is removed in order to check the change in height of the ready-mixed concrete. A slump test is always performed prior to placing concrete.

5.2.15 Painting Work

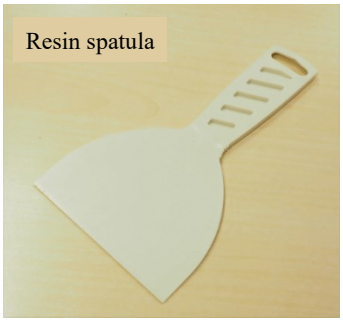
[Hake] (brush) A tool for painting with bristles attached to the end of a wooden or plastic handle. There are various types of brushes, including bristle brush, rubber brush and flat brush, depending on the area to be painted and the type of paint, such as oil-based or water-based.


Brush

[Pate] (putty) A paste-like material used to eliminate unevenness and flatten the surface of a substrate (called *pate shori* (puttying)).

[Spatula] This tool can be used to mix, apply, and scrape off paint.

[Jushibera] (resin spatula) Used for mixing putty, filling putty, spreading adhesives, and pressure bonding masking tapes. There are different types depending on the hardness (bendability), and they are used for different purposes.


Resin spatula

[Kanabera] (metal spatula) Used for various purposes such as

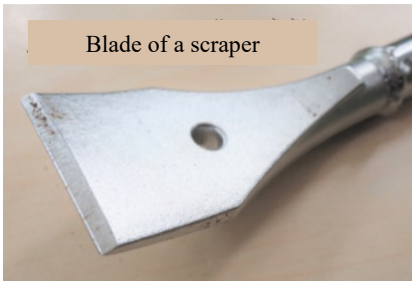
mixing putty, leveling and finishing, and pressing sealant.

[Joban] (mortar board) A thin board to be held with one hand on which mortar or putty is placed. Mortar or putty is kneaded using a spatula on the mortar board.

[Teguwa] (plasterer hoe) A tool used to mix wall materials and carry them to the place where they are to be painted. It is sized so that it can be held and operated with one hand.


Wool roller

[Wool roller] A roller used for efficient painting of wide surfaces. Used in combination with roller handles. Longer bristles allow the paint to soak in better and are suitable for painting large surfaces. The shorter ones leave less hair trails and create a cleaner finish. There are also polyurethane rollers which can be used for water-based and solvent-based paints.


Blade of a scraper

[Scraper] A tool used to remove stuck-on paint and dirt. The process of scraping off rust and other debris from surfaces before painting is called *keren sagyo* (scraping work), and a scraper is used in this process. Larger ones, also called *kerenbo* (scraping sticks), are used not only for the scraping work but also for removing P-tiles from the floor.


Skiving knife

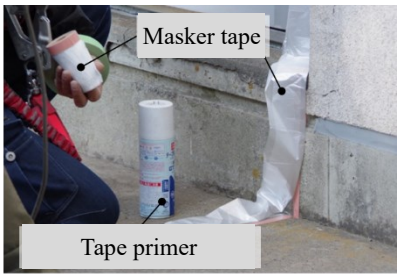
[Kawasuki] (skiving knife) The tool was originally used to skive skins, but because of its sharp blade, it is also used for *keren sagyo* (scraping work) in the painting process.

[Spray gun] A painting tool that uses compressed air from a compressor to spray a fine mist of paint. Depending on the paint supply method, there are gravity, suction, and pressure-feeding types.

[Masking tape] A tape used to protect certain areas from paint. It is applied to the border between the painted area and the area to be protected. It can be easily peeled off. To prevent paint from seeping in through the gaps, press the tape down well with finger so that there are no lifted areas.

[Masker] (masker tape) Adhesive tape with a folded sheet to easily protect a large area. The tape is applied to the protective surface first, and then the sheet is unfolded. Non-slip type is also available.

[Tape primer] A primer used for areas where masking tape is difficult to adhere, such as uneven areas of concrete. Spray-type products are often used.



5.2.16 Landscaping Work

Tools used in landscaping work 1

[Karikomi basami (1)] (trimming shears) Scissors used to cut the leaves and branches to shape the hedges and low garden trees.

[Sentei basami (2)] (anvil shears) Scissors for cutting thick branches.

[Kibasami (3)] (pruning shears) Scissors for cutting thin branches. They are also called *uekibasami*.

[Sentei nokogiri (4)] (pruning saw) A saw used to cut branches that are too thick to be cut with pruning shears.

[Chain saw (5)] A tool that cuts by rotating a chain with many blades. It is used for cutting tree trunks, etc. There are electric and engine types.

[Hedge trimmer (6) (7)] A tool used for trimming. The two blades move in a scraping motion to cut branches and leaves, just like scissors. There are electric and engine types.

[Karibaraiki (8)] (mower) A tool for cutting weeds.

Tools used in landscaping work 2

[Enpi (2)] (pointed spade) A shovel used to cut the lateral roots around the root of a tree.

[Konokiri (11)] (wooden mallet) A small mallet. It is made of hard wood such as oak or zelkova. It is used to lightly drive support logs or other materials into the ground.

[Tsukibo (12)] (poke stick) A stick used to poke the soil when burying tree roots in a hole.

[Takewari (13)] (bamboo machete) This machete is specially designed for vertically splitting and shaving bamboo.

[Kuribari (16)] (needle for bamboo fences) A needle used to tie bamboo to bamboo with *shuro nawa* (palm rope) when making bamboo fences. It is curved like a fishhook and is used by threading the *shuro nawa* through the hole.

[Pin hole (19)] Used to put up level lines by inserting them into the ground.

[Kogai ita (20)] (leveling board) A tool used to beat the soil, sand and prominent soil grains to partially level the ground. It is used to clean up the edges around stones, etc.

See separate sections for the following tools.

[Double sukoppu(1)] [Ken sukoppu (3)] [Makijaku (4)] [Drill (5)] [Bar (6)] [Kanazuchi (7)]

[Suiheiki (8)] [Reki (9)] [Kakeya (10)] [Nokogiri (14)] [Mizuito (15)] [Renga gote (17)] [Meji gote (18)]

5.2 Common Tools, Machines, Materials, and Measuring Instruments

5.2.1 Power Tools

Power tools can be cordless types that use rechargeable batteries or corded types that use AC power.

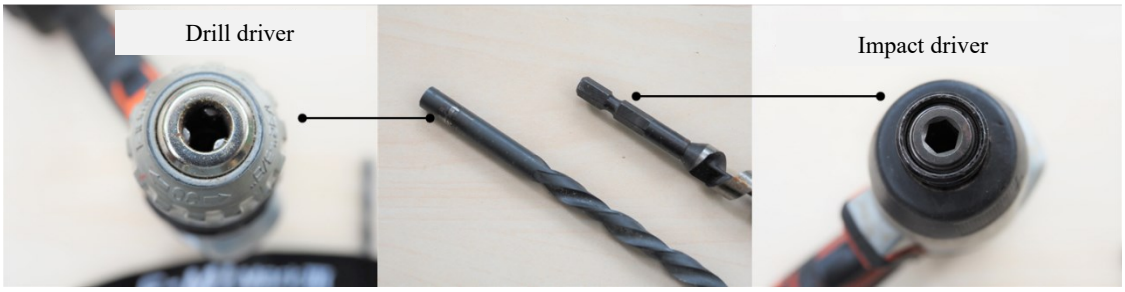
[Drill driver] This electric screwdriver can be used for screwing and drilling by changing the bits. Rotation speed and torque can be adjusted.

[Impact driver] An electric screwdriver that can tighten screws using the impact from the built-in hammer. It has more power than a drill driver. Rotates at a constant rotation speed and torque.

Drill driver

Impact driver

[Bit] A part attached to the tip of an electric screwdriver. Various types of bits for drilling and screws are available. The part where the bit is attached differs between a drill driver and an impact driver.



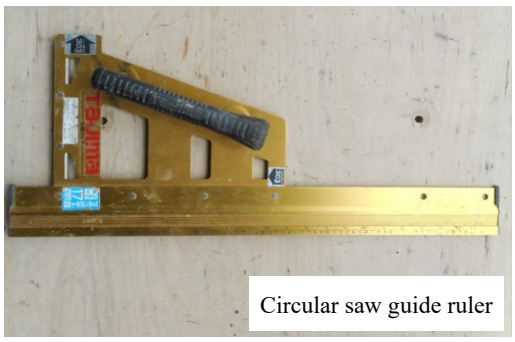
[Disk grinder] (angle grinder) This power tool can cut, grind, and remove paint from metal pipes

and concrete by changing the disc (a round, flat grinding stone for grinding and cutting) attached to the end of the tool. The high speed torque type is suitable for metal cutting, while the low speed torque type is suitable for grinding.

[Sander] This power tool is used to polish flat surfaces by moving sandpaper. There are several types of mechanisms for moving sandpaper, including vibrating, belt, and rotating types.

[Marunoko] (circular saw) A power tool for cutting plywood and other materials in a straight line. Hand-held and fixed types are available. The hand-held type, when it touches the material to be cut, may move in an unexpected direction due to a force (called kickback) that lifts it away from the material. This leads to many accidents, and in some cases, they can be serious, life-threatening accidents. Before use, make sure that the safety cover is working properly.

[Marunoko guide jogi] (circular saw guide ruler) Attached to a circular saw, this ruler is used to cut materials in a straight line.



[Shujin marunoko] (circular saw with dust collection) A circular saw that can cut while collecting

fine dust. Two types are available: one for board cutting and the other for metal cutting. There are two types: one with a dust box to collect dust, and the other with a dust collector to be connected to the circular saw.

[Shujinki] (dust collector) A power tool used to collect dust produced by cutting. It is used when cutting tile and concrete products to prevent cutting debris from flying out into the neighborhood.

[Kosoku setsudanki] (high-speed cutter) An electric tool that cuts metal pipes, rebar, light steel sections, etc. by rotating a grinding stone for cutting. Much like a chip saw cutter, but a chip saw uses a circular saw blade to cut materials. The blades of chip saw cutters wear easily, whereas the blades of high-speed cutters last longer.


High-speed cutter

[Recipro saw] (reciprocating saw) A power tool that cuts materials by moving a long, thin blade back and forth.

[Dendo block cutter] (electric block cutter) A power tool for cutting concrete.

[Kugiuchiki] (nail gun) A tool that uses the force of air pressure compressed by a compressor to drive nails into materials. A compressor is a machine that compresses air.

[Denko drum] (cord reel) A tool for extending an outlet.


Nail gun


Cord reel

5.2.2 Digging/Leveling/Compacting

[Ken sukoppu] (spear head spade) A tool used for digging in the ground by placing the foot on the top of the head. It is also called *kensuko* for short. Do not use as *teko* (lever).

[Kaku sukoppu] (square head spade) A tool used to scoop and carry soil, asphalt, etc. It is similar to a spear head spade, but the blade edge is straight to make it easier to scoop soil and other materials. Also, the top is rounded and does not allow for foot placement. Do not use as *teko* (lever). It is also called *kakusuko* for short.

[Double sukoppu] (double spade) These spades can poke through the ground to dig a deep hole. The dug soil can be grabbed under the surface and pulled out. It is used for digging holes for piles and utility poles.

[Tsuruhashi] (pickaxe) A tool used for excavating hard ground and breaking up asphalt.

[Reki] (rake) A tool used to level soil, spread asphalt, and collect fallen leaves. There are various shapes and materials, depending on the purpose. Rakes for leveling soil have many thin tines, but rakes for asphalt have none.

[Joren] (dredge hoe) A tool used to rake up earth, sand and debris.

[Tako] (manual compactor) A tool used to beat and pack soil and other materials by weight.

[Tamper] A tool with a flat metal plate attached to the end of a long handle. It is used to compact asphalt and other materials by holding the handle and tamping the surface from above.

[Rammer] A machine used to compact the ground. The weight of the rammer and the force of the impactor, which moves up and down, compact the surface. It has strong striking power and is suitable for strong compacting. There are engine- and electric-powered types.

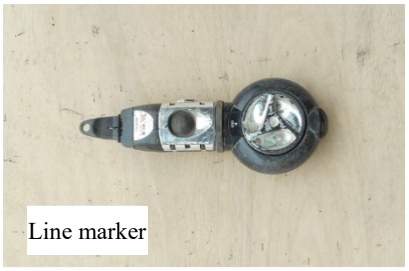

Rammer

[Vibro-compactor] A machine equipped with an engine to compact soil and sand by its own weight and vibration. Used for compacting road aggregate base layers, road subgrade layers, backfill, etc. The machine is pushed and pulled back and forth by hand to compact the surface. Although the impact force is inferior to that of a rammer, a large area can be compacted at once. A similar machine is the plate compactor. A plate compactor is more suitable for flattening due to the larger area of the compacting plate and smaller vibration.

[Vibrator] A machine used to remove air bubbles from concrete and increase the density of the concrete during concrete placement through vibration.

5.2.3 Layout Marking/Marking Tools

[Sumitsubo] (line marker) A tool used for marking long straight lines on the surface of a material.


Line marker

[Sumisashi] (ink pot) The flat part of the ink pot is used for drawing lines, and the round part (*ho*) is used in the same way as a brush.

[Chalk line] Similar to the *sumitsubo* line marker, but draws a line with powdered chalk.

[Laser marker] A machine that emits laser beams onto walls, ceilings, and floors to produce horizontal, vertical, and other reference lines for construction. Laser beams are available in red and green. Green is relatively easier to see in bright locations. Protective goggles for laser work are worn to prevent the laser beam from directly entering your eyes.


Laser marker

[Marker pen, marking chalk] Oil-based pen for architectural use. For example, it is used to allocate the position and pitch (distance between reinforcing bars) where the reinforcing bars are placed.

[Punch] This tool can be used to make small indentations in metal surfaces by tapping with a hammer, or to make round holes in cloth, leather, etc. The center punch is used to mark metal surfaces (this is called marking).


Punch

5.2.4 Measuring/Inspecting

[Level] A leveling device used to determine the height necessary for the work. Mounted on a tripod, the device is manually leveled by balancing the built-in bubble vial. A level with an automatic leveling mechanism is called an auto-level.


Level

[Laser level] An instrument for level surveying by laser and is used to determine the height necessary for the work.

[Transit] An instrument that measures the vertical and horizontal angles based on the viewpoint supporting a small telescope. It is used on a tripod. These days, a digital display type of device called theodolite is often used.


Transit

[Total station] A surveying instrument that combines a light-wave rangefinder and an electronic transit. Look through the telescope and simply align the crosshairs with the target and press the button to simultaneously measure the distance and angle from the reference point. Total stations are used in a wide range of surveying applications, including topographic surveying, construction site location management, initial ground surveying, and fixed point surveying.

[Mizuito] (line level) Thread used to straighten lines and match heights when building foundations or stacking bricks and blocks. It is made of non-stretch material.


Line level

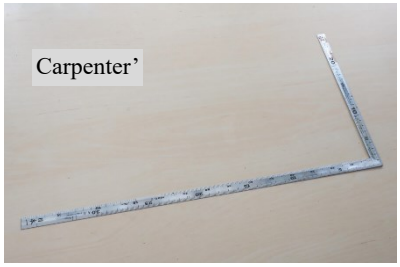
[Suiheiki] (level) A tool used to check whether a construction surface or object is level with the ground. The level is checked by looking at the air bubble in the vial. Some use the needle to check the level, and some are digital levels. Levels with a built-in inclinometer are also used in residential installations.


Level

[Sagefuri] (plumb bob) A weight with a pointed conical tip used to check the verticality of a pillar or other objects. The verticality is checked by hanging it from a plumb bob holder fixed to a post using a thread and checking if the distance between the surface to which the holder is attached and the thread is constant.


Plumb bob

[Sashigane] (carpenter's square) A tool made of stainless steel or other metal, used to measure right angles. It is scaled and can also be used to measure length. The front side is in metric scale, and the back side is 1.414 (√2) times the front side.


Carpenter'

[Ogane] (triangular ruler) A large triangular ruler for measuring right angles. It is made on site using the Pythagorean theorem, the ratio of 3:4:5 . The 3:4:5 is called *sashigo* at the worksite.

[Measure] (tape measure) A tape-like tool for measuring length. Sometimes referred to as *makijaku* (tape measure). Available in steel and vinyl.


Convex

[Convex] (retractable steel measuring tape) A measure with a thin metal tape that measures length. Sometimes abbreviated as *conbe*, the official name is the convex rule.

[Jogi] (ruler) A tool used for measuring length and drawing straight lines. Materials include aluminum, stainless steel, and bamboo. To avoid damaging materials such as fittings, bamboo

rulers are used.


Aluminum ruler


Stainless steel ruler


Bamboo ruler

[Slump kenjaku] (slump scale) An instrument used to measure the slump value (the lowered height after the slump cone is removed) in the slump test.

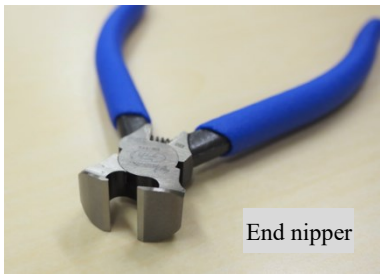

A slump test being conducted

5.2.5 Cutting/Bending/Breaking

[Nokogiri] (saw) A tool with many blades (called *me* (teeth)) on a metal plate, used to cut wood, metal, pipes, etc. It is called *noko* for short.

[Hasami] (scissors) A tool used to cut objects between two blades.

[Kuikiri] (end nipper) A tool used to cut objects between the blades. Used for processing tiles, cutting wires, etc. It can also cut the head of a nail.


End nipper

[Cutter knife] (box cutter) This knife can maintain its sharpness by breaking off the tip of the blade.

[Tagane] (masonry chisel) A stick-shaped tool with a blade on one end that can be used to cut thin metal by tapping it with a hammer. It is also used for *hatsuri sagyo* (breaking), to break concrete and mark measurements of roof tiles. Flat masonry chisel, concrete masonry chisel, carving masonry chisel and others are available depending on use.

[Penchi] (pliers) A tool for bending, cutting, etc. There is a part for gripping with fine grooves to prevent slipping and a part with blades for cutting.


Box cutter


Masonry


Pliers

5.2.6 Tapping/Pulling


Example of a hammer (for ringlock scaffolding)

[Hammer] A tool used to strike things. The material of the striking head can be metal, rubber, or wood, depending on the intended use. Those with a metal head is sometimes called *kanazuchi*.


Rubber hammer

[Rubber hammer] A hammer with a rubber head. It is characterized by its strong striking power without damaging the material. It is used to compact concrete by tapping the formwork and making it vibrate during the concrete placing process.


Wooden hammer

[Kizuchi] (wooden hammer) A hammer with a head made of wood. Although the striking force is weaker than that of a metal hammer, it is less likely to damage the material.

[Kakeya] (large wooden hammer) A large wooden hammer used for driving stakes, etc. *Kakeya* is also used to tap *hozo* (tenon) into *hozo ana* (mortise) in the wooden-frame structure method.


Large wooden hammer

[O-hammer] (large hammer) A hammer with a long handle and a large head. It is used for pile driving and demolition work.


Crowbar

[Bar] (crowbar) A metal tool that can be used as a lever. The L-shaped tip has a groove for removing nails. The tip is inserted under the nail head, and the nail is removed using the principle of leverage. The other side is either a claw or flat like a spatula. In addition to pulling out nails, a large crowbar can be used to lift heavy objects. It can also be inserted into a gap for twisting and prying. A large crowbar is used in the dismantling of the formwork.

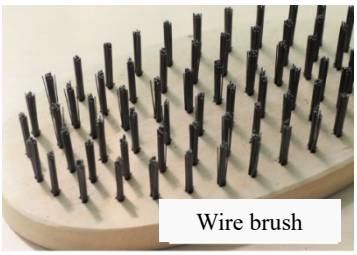
5.2.7 Filing/Polishing/Boring

[Toishi] (grindstone) A tool for cutting and polishing metals, rocks, etc. The small rectangular-shaped tools are used to sharpen the blades of *nomi* (wood chisels) and *kanna* (Japanese hand planes).

[Yasuri] (file) A tool for polishing metal and wood surfaces. There are many types of files for different purposes, such as metal files and wood files. If chips get stuck in the grooves, a wire brush is used to carefully remove the chips.

[Sandpaper] A type of *yasuri* (file) where sand or glass-like grains are applied onto the surface of paper. There are several types of paper, including *taisui* paper (water-resistant paper) that resists water sand *nuno* paper (cloth paper) that has strength. The numbering indicate coarseness. The smaller the number, the coarser the grain, and the larger the number, the finer the grain, resulting in a smoother polished surface.

[Wire brush] A stiff brush made of metal wires. It can be used to remove rust from metal, peel off paint, and clean file grooves.


Wire brush


Wire brush

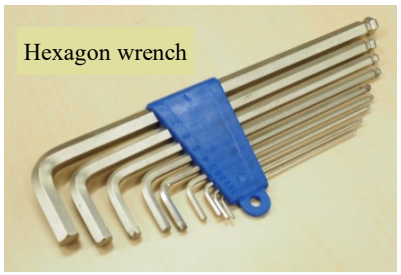
5.2.8 Tightening/Fixing

[Monkey Wrench] A wrench with a mechanism that opens and closes. The width between the upper and lower jaws can be changed to match the diameter of the bolt or nut. The upper jaw is integrated with the grip, so the force should be applied to the upper jaw when turning. Because the tip is open, this tool is classified as spanner, but it uses the word “wrench” as an exception.


Monkey wrench

[Socket wrench] A wrench used for nuts and bolts of various sizes by changing the sockets on the head.

[Box wrench] A wrench in which the socket part for turning nuts and bolts and the handle part are integrated as a single piece. There are L-shaped and T-shaped types.


Hexagon wrench

[Rokkaku wrench] (hexagon wrench) This tool has a hexagonal hole and is used to turn bolts. Also called *rokkaku bo* wrench.

[Driver] (screwdriver) A tool used to turn screws. There is a Phillips-head and a flat-blade screwdriver to fit the grooves on the heads of the screws. It is important to use the correct size to avoid breaking the groove of the screw head (called *nameru* (stripping)). The shape of the grip is also important. For example, the grip of a screwdriver for electrical work is round and large so that the hand can easily wrap around it.


Screwdriver

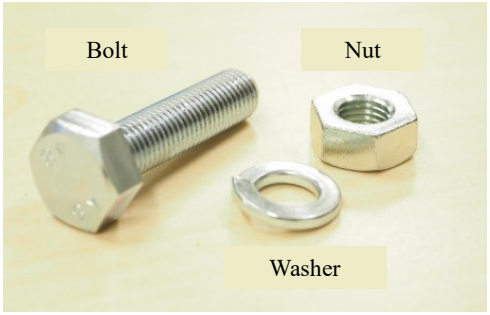
[Kugi] (nail) Something that is hammered in to join members together. Depending on the application, there are various types of nails, such as screw nails, concrete nails, casing nails, and corrugated roofing nails.


Nail

[Neji] (screw) A cylindrical or conical shaped object with a spiral groove that is screwed into a member using a screwdriver to secure it to another member.

[Tapping neji] (self-tapping screw) A screw that threads its own groove into the material as it is being screwed.

[Bolt] A type of screw. A bolt (male thread) and a nut (female thread) are used as a set. A washer may also be used.



5.2.9 Kneading/Mixing

[Hand mixer] A mixer for paint, mortar, and concrete. Ingredients are placed in a mortar box or bucket and mixed with a hand mixer.

[Kakuhanki] (stirring machine) A machine for mixing liquids and construction materials. Also called mixers, various types are used in construction sites.

[Mortar mixer] A machine that mixes cement, water, and sand to make mortar. There are two types of power sources: one that uses a 100 V power source and the other an engine type.

[Concrete mixer] A mixer designed for concrete, with more strength than mortar mixers.


Concrete mixer

[Batch Mixer] A mixer that mixes materials for concrete one batch at a time.

[Torobako] (mortar box) A sturdy box for mixing materials to make concrete or mortar. Also known as *torobune* or *fune*. The ingredients in the mortar box are kneaded using a stirring machine or a kneading shovel.

[Furui] (sieve) A tool with a mesh that can sort materials according to size. Items to be removed are sorted according to the size of the mesh. For example, it can take excavated earth and sand and separate fine soil from gravel.

5.2.10 Curing/Prepping

[Yojoyo poly sheet] (plastic sheet for curing) Polyethylene film in sheet form. It is used for moisture-proofing and waterproofing from the ground when pouring concrete, for curing when painting, and to protect from rain and dust.

[Veneer] (plywood) Thin plywood is laid to protect the floor from scratches.

[Blue sheet] Used to protect walking areas of the floor from paint and dust.

[Hisan boshi net] (anti-scattering net) A mesh-like sheet for scaffolding that covers the entire building. It is also used to prevent construction materials accumulated on site from scattering, and cargo from falling off the rear decks of transport vehicles.

[Suichoku yojo net] (vertical safety net) A net attached to scaffolds at construction sites to prevent materials from flying and falling from scaffolds.

[Suihei yojo net] (horizontal safety net) A net used at construction sites to avoid humans and materials from falling from heights.

5.2.11 Scrubbing

[Brush] A tool with bundles of bristles planted at regular intervals onto the base, used for rubbing to remove dirt. For example, in stonework, a brush wetted with water is used to remove the excess cement slurry from between the stones.

[Sponge] Foam-molded synthetic resin such as polyurethane, wetted with water and used to remove dirt. For example, in stonework, it is used to clean surfaces dirty from cement slurry.

[Wes] (rag) Cloth used to wipe off stains from machine oil and other liquids.

[Bucket] A container with a handle for holding and carrying water. For construction purposes, sturdy

buckets made of galvanized steel sheets are used.

[Hishaku] (ladle) A tool with a handle for ladling water.

5.2.12 Carrying Objects

[Ichirinsha] (wheelbarrow) A tool for carrying items, consisting of a steel bucket with one wheel in the front. Used by holding the handles and pushing. It uses the lever principle with the wheel as the fulcrum, the handles as the effort, and the bucket as the load to make it easier to carry heavy objects. Sometimes called *neko*.


Wheelbarrow

[Daisha] (wheeled platform) A platform with four casters, used to carry objects. Some have handles and some do not. A wheeled platform with brakes is also available.


Wheeled platform

[Sori] (sled) A tool used to move heavy objects such as stones by putting them on top and pulling it.

[Koro] (log) A log used to move heavy objects. Several are placed parallel to each other, an object is placed on top, and the object is moved as the logs roll.

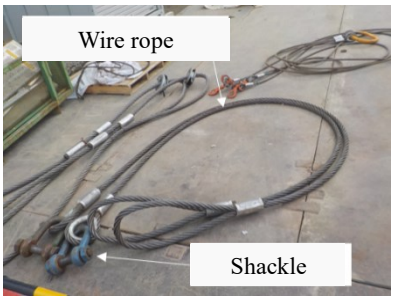
[Forklift] A vehicle equipped with forks that move up and down using hydraulic pressure. Objects placed on the fork are raised to or lowered from high places.


Forklift

5.2.13 Hanging/Lifting/Pulling

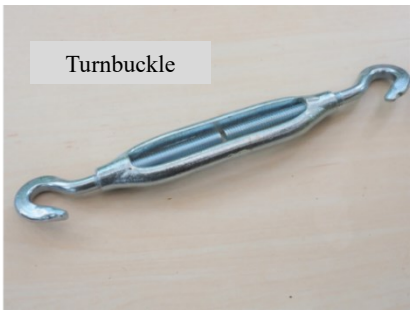
[Winch] A machine that winds up a rope. Also called *makiageki*.

[Wire rope] Several high-tensile-strength steel wires are twisted together to form a strand, and then several strands are twisted together again to form a rope. It has high tensile strength, excellent impact strength, and flexibility for easy handling. Those with processed ends are used for slinging. There are also ropes for anchoring.



[Shackle] A slinging fixture for connecting a wire rope or chain to a suspended load.

[Turnbuckle] A device used to tighten ropes and wires.



[Chain block] A machine that can raise and lower heavy objects by applying the principles of lever and pulley. It is used by attaching it to a tripod, etc.

[Lever hoist] A machine that has the same mechanism as a chain block, but is smaller than a chain block. It is used to secure the load, etc. For example, when a backhoe is loaded onto a truck for transportation, it is also used to secure the backhoe so that it does not move.

[Oyazuna kinchoki] (main rope tensioner) A device that can keep the tautness of the main rope to which the hook of the safety belt is attached. It is used when working at heights, such as scaffolding work.

[Tirfor] A manual winch used for pulling heavy objects. The wire rope passed through the tirfor can be pulled strongly by lever operation. When felling a large tree, pulling the tree with a tirfor can bring it down in the desired direction.

[Jakki] (jack) A device for lifting heavy objects with a small amount of force. The lifting mechanism includes screws, gears, and hydraulic pressure.

[Kirin jakki] (screw jack) A device that can lift heavy objects vertically by using the thrust generated when the screw is turned. It is also used to apply force to the left or right by placing it between two horizontal members in soil retaining structure work.

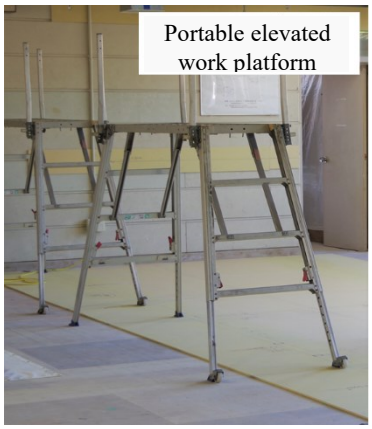
[Lever block] A tool for lifting and securing loads. It is also used to re-align steel frames (to make them vertical).

5.2.14 Work Platforms/Ladders

[Hashigo] (ladder) A tool for climbing to high places. It is climbed by stepping onto the rungs. It should be set at an angle of approximately 75 degrees. If the angle is too steep, there is a risk of falling backwards. Conversely, if the angle is small, there is a risk of the ladder breaking. Also, always work with an assistant to support the ladder.

[Kyatatsu] (stepladder) A tool that is a combination of two ladders. When opened, it can be used as a ladder. When using it as a stepladder, do not sit or stand on the top. Also, do not work while straddling the top with legs on either side, as this may upset

the balance and be potentially dangerous.


Portable elevated work platform

[Kahanshiki sagyodai] (portable elevated work platform) A tool with a platform between two legs that extend and retract. Also known as *nobiuma*. There are handrails on top of the work platform. Leaning outward or pushing against a wall may cause loss of balance and falling.

[Rolling tower] A platform for working at heights. There are casters on all four corners to move it around. There are safety standards for rolling towers under the Industrial Safety and Health Act.

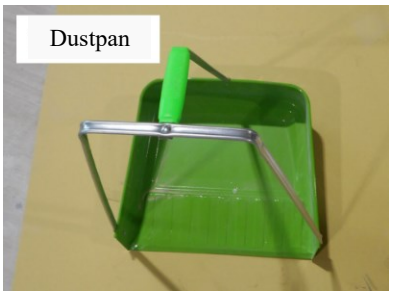
[Kosho sagyosha] (aerial work platform) A vehicle equipped with a device that can raise and lower a man basket to a height of 2 m or more.

5.2.15 Cleaning

[Hoki] (broom) A tool for cleaning by sweeping. Bamboo branches, bundles of plants or synthetic fibers are attached to the end of a stick.

[Chiritori] (dustpan) A tool for collecting dust and debris swept with a broom.


Broom


Dustpan

[Blower] A blower. It is used to collect light objects such as fallen leaves by blowing them with the force of air.

Chapter 6: Knowledge of Construction Site Work

6.1 Matters Common to Construction Sites

Construction sites are home to technicians from many job categories. Although the work they perform may appear to be different from each other, experienced technicians are always aware of certain matters. This realizes high quality and safety. This section describes matters that all technicians should know.

6.1.1 Characteristics of Construction Work

(1) Construction work is on a build-to-order basis.

The term build-to-order refers to the manufacturing of a single product designed from scratch to meet the customer's requirements, rather than the repeated production of the same design in factories, as in the case of automobiles. Construction work is conducted on a build-to-order basis. They are diverse, from large-scale to small-scale projects, and although some may appear to be similar, each individual project has different characteristics and conditions. It is important to have the intention of building-to-order for each customer.

(2) Construction work is subject to location constraints.

The majority of construction work is built in accordance to the unique requirements of the location for each property, which means that a project will never be repeated under the same conditions.

(3) Construction work is subject to nature.

Construction work is often conducted outdoors and subject to uncertain factors, such as topography, seasons, weather and other natural conditions.

(4) Construction work is subject to social constraints.

Construction work is local production, and therefore is subject to social constraints on the site. It is important to manage the site based on safety measures for the surrounding area and environmental preservation measures. Applicable laws and regulations and the surrounding social environment differ

depending on the location of construction, and construction work is expected to conform to these constraints.

(5) Quality is created through safe process.

It is also true in construction work that the quality of the finished structure is created through the entire safe construction process.

6.1.2 Construction Plan

All construction projects have a construction plan. A construction plan is a plan for the construction project based on the terms and conditions of the construction contract, drawings, specifications, site descriptions, and other design documents. The construction plan is prepared considering the following points.

> Planning within various social constraints, such as relevant laws and regulations.

> Comprehensive planning of management methods for quality, construction budget, process, safety, and environmental preservation.

> Planning to efficiently combine construction methods to achieve good quality at minimum cost that is completed within the construction period.

> Planning for accident-free and disaster-free project that considers environmental preservation.

> Planning using the 5Ms of Construction Management. The 5Ms of Construction Management refers to Manpower, Materials, Methods, Machinery, and Money.

> Conducting sufficient preliminary investigation to understand the local/on-site conditions, etc., and planning measures and management methods prior to and during construction.

6.1.3 Construction Management

Construction management is the management necessary for the contractor to complete the

construction target in the prescribed quality in accordance with the construction plan. Construction site work is conducted under the following five management indicators (called QCDSE).

[Quality]

This is management to produce a finished structure that fully satisfies the quality required by the client. Quality inspections, quality tests of materials and various construction tests as stipulated in the quality control plan are performed to control the ensure prescribed dimensions and shapes.

[Cost]

Cost is money that can be spent on site. The cost of materials, labor, and field expenses related to the construction project are managed so that they do not exceed the construction budget.

[Delivery]

Companies coordinate with the prime contractor and other contractors in order to ensure that their construction work can be performed efficiently, and manage the construction process to avoid delays in the actual work so as to ensure completion within the construction period.

[Safety]

Necessary management is conducted to prevent accidents such as people and objects falling, and to prevent work-related illnesses such as pneumoconiosis and heat strokes. In addition, risk prediction training in the daily cycle of safety in construction, patrols during work, safe process meetings, 5S promotion activities, and other activities are conducted with the goal of achieving zero accidents and zero occupational injury.

[Environment]

This is management to minimize the impact of construction on the environment, including noise, vibration, and water pollution. The standards set by laws and ordinances must be observed.

6.1.4 Pre-Construction Preparations

（1） Main considerations for the construction procedure manual

In order to ensure high quality in construction work for the day, it is necessary to check and correctly understand the construction details.

> Review and understand the terms of the construction contract.

> Review and understand the contents of the contracted construction (terms and conditions of the estimate) and the scope of work.

> Review and understand the blueprints and construction drawings.

> Review and understand the site construction conditions and site rules.

> Review and understand the work schedule with other contractors and connections with constructions before and after the project.

> Confirm the construction procedures, allocate workers, and prepare materials and equipment.

> Confirm possession and carrying of the Career Up Card and licenses required for the work.

> Identify and understand safety issues.

(2) Pre-work inspection

When working on a construction site, workers use a variety of tools and machinery. Common accidents for workers occur when handling tools and equipment. Be sure to conduct the following as pre-work inspection.

> Pre-work inspection of the machinery

- Confirm that machinery capable of conducting the intended work are in place, inspected, and maintained.

> Checking of equipment, tools, and instruments

- Confirm that the equipment, tools, and instruments to be used are inspected and maintained.

> Confirmation of work procedures

- Confirm that the workflow is realistically feasible.

- Confirm that individual work sharing and collaborative work are assigned in a compatible

manner, and that the work assignment is correct.

> Confirmation of safety

- Confirm that health and safety protective equipment and safety devices, etc. are being used correctly.

- Confirm whether emergency responses are appropriate.

6.1.5 Layout Marking (Marking Out)

Sumidashi (sumitsuke) (layout marking (marking out)) refers to marking the location and height of the structure or component to be constructed on the construction site. In the entire construction process from beginning to completion, this is the very first step. It is the most important work that requires quality (accuracy). Precise reference marking and reference level, axis line as per blueprints, etc. are marked for correct positioning. For layout marking, a tool called a *sumitsubo* (line marker) is used, but nowadays a laser illuminator is used to emit a laser beam to mark along the laser. The laser makes it easy to check for level and right angles. The following are the three main types of layout marking and marking out work.

Layout marking and marking out work	Layout marking and marking out locations
Layout marking	Reference and parent markings for positioning, height (reference level/GL), axis line, etc.
Marking out for member fabrication	Cutting and processing dimensions of reinforcing bars, formwork, piping, wiring, and other components; processing dimensions of wooden workpieces; and scribe marks on sheet-metal
Marking positioning of processed parts, equipment, hardware, etc. for installation	General interior and exterior fittings, intake and exhaust vents such as ventilation holes, water supply and drainage sanitary piping, air conditioning and sanitary equipment, and firefighting equipment

6.2 Construction Knowledge of Each Specialty Work

This section provides an overview of each specialty work and the key points to keep in mind to avoid accidents and compromising quality. For unfamiliar terms, see Chapters 4 and 5.

6.2.1 Earthwork

(1) Excavation work by hand

First, check the excavation site. For example, unstable stones on the untouched ground can fall and cause accidents, so check to see if there are any. Also check for cracks, water content, the presence of springs, and changes in freezing conditions. After heavy rain or earthquakes, these factors are inspected again because the conditions may have changed. Also, use lighting when working in dark areas.

Digging into the lowest part of a near-vertical face is called *sukashibori* (undercutting). Undercutting should never be done because of the danger of collapsing.

A pickaxe is a tool used for excavation. The pickaxe is a dangerous tool because it has a pointed tip. Before use, make sure the handle is securely fastened to the head. Also, taking big swings can be very dangerous because you could hit someone behind you. When two or more people are excavating, make sure to work at a distance. Instead of staying apart vertically, stay apart in the horizontal direction. Instead of taking big swings, use the pickaxe's own weight for excavation.

(2) Backfilling, compaction, and machine compaction work

It is important that during backfill, the soil is sufficiently compacted. Remove any material left over from the previous work in the area to be backfilled. Water, if present, should also be removed before the work is done. For backfilling, use materials that have been predetermined. Backfilling is done by a depth of 30 cm or less at a time, using a hand roller or other compaction machine to repeatedly compact the soil.

A rammer is used for compaction of ditches and other narrow areas. When machine-compacting a

large surface, a tool called a plate is used, which compacts by vibrating a plate with a large surface. A rammer is a tool used to compact the ground with the weight of the equipment and the impact caused by the up-and-down movement of the ram plate. Always operate the rammer with the rammer in front, slowly pushing to move it forward. Its impact is very heavy, so be careful not to hit your own feet. Also, when using a rammer with a power cable, pay attention to the cable routing.

(3) Embankment and cutting soil by hand

First, the slope and finished thickness of the slope are determined by surveying and marking with stakes or other means as reference for the work location. If there are tree roots or water in the area to be embanked or cut, remove them beforehand. To prevent accidents, do not place heavy objects on top of the slope (the edge of the plane above the slope). Also, pay attention to soil falling down from the slope of the cut soil while working. Check the shape of the embankment and cut soil daily.

(4) Handling water

Handling water is an especially important task in earthwork. If it rains, leave a smooth surface after the work is done to prevent soil from being washed away by the rain. It is also necessary to take measures to prevent rainwater from seeping in by covering it with a sheet or other means. In addition, make sure that the construction surface is sloped for drainage, and create a drainage path. If facing a road, install drainage pipes.

(5) Slope protection work


Spraying a sloped surface

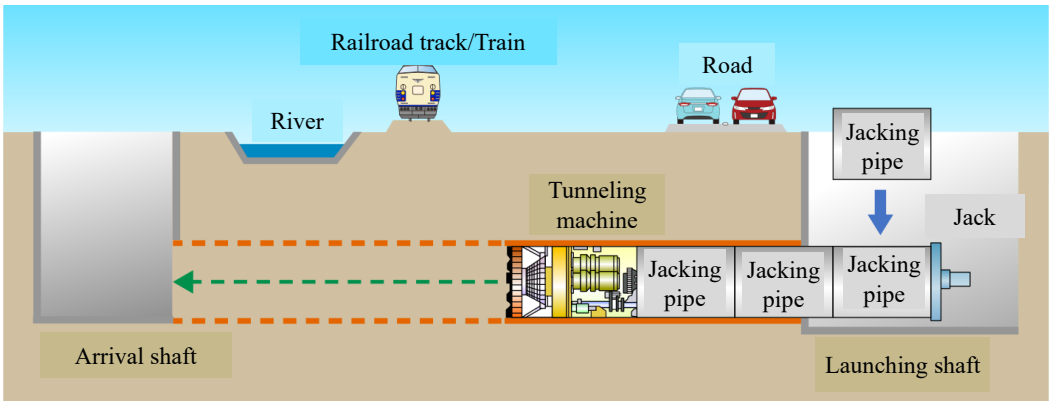
When spraying mortar on to prevent the slope from collapse, spray from top to bottom. The spraying work should be carried out perpendicularly to the construction surface, and with even thickness. The top of the slope is sprayed along the natural ground to prevent rainwater infiltration. When spraying on bedrock, remove unstable rocks, muddy soil, and debris beforehand. If the sprayed surface is earth or

sand, care should be taken to prevent the pressure of spraying from scattering the earth or sand.

When spraying seeds, soil, and other materials, use specialized machines and make sure to achieve an even thickness. Turf delivered to the site should be placed as soon as possible. Watering on sunny days should be done in the morning or evening, avoiding midday.

6.2.2 The Pipe-Jacking Tunneling Method

There are various methods of tunnel construction, depending on the geological characteristics of the site to be excavated. This section describes the pipe-jacking method of tunneling, where tunneling machines are used to excavate underground and construct a tunnel.



(1) In pipe jacking, a shaft is first constructed at the starting point of the tunnel to serve as the tunneling base and a connection to the ground level. The shaft is used to transport materials required for tunnel construction down, and send excavated earth up to the ground. Heavy materials and equipment are carried in and out from within and the top of the shaft.

(2) After the shaft is constructed, the jack to push the jacking pipes into the ground and other temporary equipment are installed, and the tunneling machine is brought into the shaft.

(3) When the tunneling machine is ready, it is launched from the launching shaft (starting point side) and the tunnel excavation begins. In the pipe-jacking tunneling, factory-made pipes are connected to

the tunneling machine and pushed into the ground with the jack installed in the shaft. Excavation is continued by repeating this process until the arrival shaft is reached (end of the tunnel).

(4) Once the tunneling machine has reached the arrival shaft, the tunneling machine, the jack, and other temporary equipment are dismantled and removed. If manholes or other structures are designed into the shaft, they are usually constructed after this step.

Matters to be considered in the pipe-jacking tunneling method are as follows.

> Inside the tunnel, be aware of the possibility of oxygen depletion and toxic gases. Carbon monoxide and carbon dioxide are colorless and odorless, so their presence or absence and concentration must be measured using a detector. Toxic gas measurements must be taken at the beginning of each work shift to ensure safety. In addition, ventilation must be provided in the shaft and inside the tunnel.

> Pipe-jacking tunneling is often used for sewer and water piping construction with small pipe diameters, often 0.2 to 3 m in diameter. In addition to the various temporary equipment required for pipe-jacking tunneling, excavated earth and sand are carried out through the shafts. Take care to avoid being caught-between, hit by flying/falling objects and falling from heights.

6.2.3 Marine Civil Engineering Work

At marine civil engineering worksites, many different types of work vessels gather to work. This is called a fleet. The fleet leader, who organizes the fleet, gives instructions to each work vessel to perform the work. In addition, each work vessel will be directed by a person called the captain or deck officer.

Fleet (breakwater construction)

(1) Preparation of the construction site

Place a buoy to mark the construction site on the sea. This prevents other vessels from coming in during construction.

The work vessels used for construction are moved from the work vessel's base port (the port where the vessels are anchored when not working) to the construction site using a tugboat.

At construction sites, anchors at the four corners of the work vessel are lowered and secured using an anchor handling vessel to prevent the work vessel from being moved from the construction site due to waves or wind.

(2) Work performed on/by work vessels

The work vessels perform various types of construction work such as dredging, breakwater construction, and quay wall construction. The following tasks will be performed on the work vessel or at the site at sea

[Tamagake sagyo] (slinging) Attaching and detaching wires to loads when lifting them with a crane. In marine civil engineering work, crane vessels are used to load and unload concrete blocks, stones, and other materials.


Slinging

[Crane sagyo] (crane operation) Crane operation involves lifting heavy objects, moving them from place to place, and lowering them to a different location. The cranes on the work vessels are used for dredging, dumping in uniform riprap, and installing blocks.


Crane operation (dumping in uniform riprap)

[Winch sagyo] (winch operation) A winch is a machine that can wind up and send out wires. When moving or securing the work vessel, the winch of the anchor handling vessel is operated. Also, in breakwater construction, caissons are installed by winch operation.


Winch operation

(3) Safety of marine civil engineering work

Marine civil engineering work cannot be performed when there are large waves, as the work vessels will be greatly disturbed. When doing construction, it is always necessary to know the weather and wave forecast.

Marine civil engineering works are performed near the sea, on the sea, and on working vessels. When working, there is a danger of slipping and falling or falling into the water. Also, work vessels are very narrow and have various machines on them, making it very easy for workers to bump into or trip over them, which is very dangerous.


Example of a life vest

> When working on the sea, always wear a life vest. When worn correctly, life jackets are designed so that when a person falls overboard, his or her mouth will be maintained above water.

> The ropes on work vessels are dangerous. Do not place your foot among the ropes on the deck, or step on them. If the boat moves and the rope suddenly shifts, the rope can wrap around your leg and cause injuries.

> Boarding and disembarking the work vessel can result in falling into the sea. Do not jump on or off. Climbing to the wharf from a small boat should be done where there are stairs or ladders installed, or use a portable ladder.


Example of using an installed ladder

> When carrying cargo between vessels, a wide *ayumiita* (gangplank) is set up. Only one side of the gangplank is secured to the boat.

> When mooring a work vessel, the eye (the looped part at the end of the rope) is hung on a short post called a bollard, and when doing so, always use an auxiliary rope to prevent fingers from being caught in.

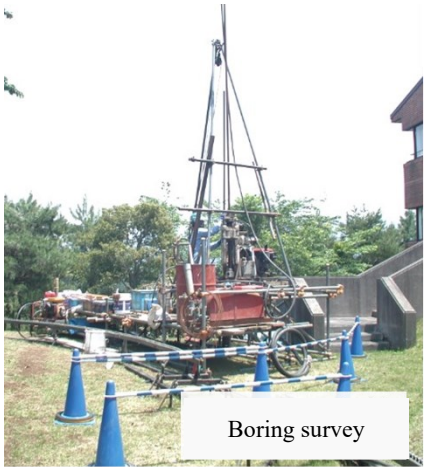
> When moving around on a work vessel, only pass through designated areas and do not enter restricted areas. Comply with the signs on the working vessel.

> Always keep the work vessel deck organized and tidy. Also, wipe up any oil spills, as they can cause slipping and falling.


Mooring operation with auxiliary rope

6.2.4 Well Drilling Work

Small wells are for general household use, and water is pumped manually. Medium-scale wells are installed at evacuation sites, etc., and water is pumped up using an emergency generator. Wells used for drinking water must allow drawing water of good quality.


Boring survey

(1) Preparatory temporary structure

Determine the scope of construction and clear the site. After clearing the site, the drilling machine is assembled.

(2) Drilling

A boring machine is used to drill straight through to the water-bearing stratum (called *taisuiso* (aquifer)), making sure not to collapse the stratum. Use the appropriate drilling equipment to excavate in the shortest time possible, according to the strata. The drilled hole is filled with drilling mud mad of melted clay to prevent collapsing and to keep the digging debris afloat. Digging debris is removed by a device called a bailer. The drilling and removal process is repeated until the aquifer is reached.

(3) Selection of the aquifer

Once the planned depth is reached, the resistance of the stratum is checked using a method called *denki kenso* (electrical logging), in which an electric current is passed through the hole to determine if the layer is suitable as a water source. Resistance is lower in clay layers, and higher in sand and gravel layers with good groundwater flow. Once the aquifer is determined, a device called a screen is installed to extract groundwater at this location.

(4) Gravel filling

Connect and insert the casing pipes into the hole. The area between the drilled surface and the casing is filled with sorted gravel or silica sand. This is to control sand, secure the screen and casing, and prevent collapsing of the borehole wall. The depth of the fill, the size of the gravel grains to be used for filling, and other factors are important, affecting the quality of the finished well.

(5) Finishing

Muddy water in the well is pumped out to allow groundwater to flow out.

(6) Water shielding

Water from the ground surface or aquifers of poor water quality is prevented from entering the well.

(7) Pump installation

A pumping test to determine the amount of water to be pumped and a water quality test to determine the quality of the water to be pumped are conducted, and the pump is installed.

6.2.5 Wellpointing Work


Wellpointing work

When the ground is being excavated for building foundation work, if groundwater flows into the excavation, earth and sand will flow out of the sides of the excavated area and interfere with the construction work. Wellpointing is performed to lower the groundwater level in close proximity to the stratum in which construction is taking place to create a strong foundation. Pumping will continue until the necessary construction is completed. Once the foundation work is complete and pumping is stopped, groundwater will return to the level natural to the local environment prior to construction. The wellpointing method is suitable for pumping up water at a depth of 2 m to 7 m. For greater depths, the deep-well method is used.

(1) Investigation and determination of construction details

Investigate how far the groundwater level should be lowered. Based on the results of the survey, a projection of the drainage volume is made to determine the spacing and number of wellpoints to be installed.

(2) Preliminary jetting

Using a jetting pipe, a hole is jetted to the required depth using pressure water from a jet pump attached to the pipe.

(3) Installing wellpoints

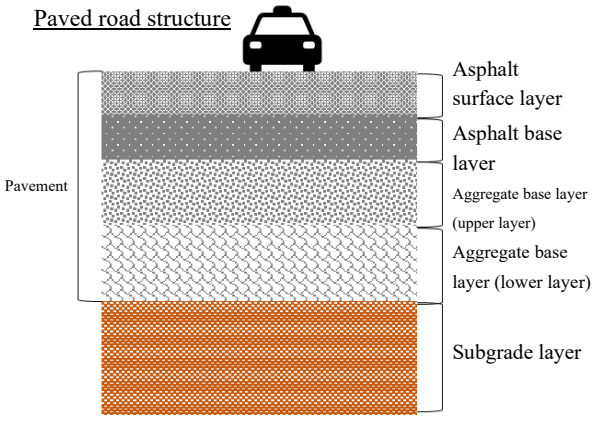
A wellpoint is attached to the end of a riser pipe, and inserted into the previously jetted hole. This process is repeated at pre-determined intervals.

(4) Connection to the header pipe and installation of the vacuum pump

Connect multiple wellpoints to a header pipe. The header pipe connects to a vacuum pump for pumping out water.

6.2.6 Paving Work

If a road to be worked on already exists, it is subject to general vehicular and human traffic and requires safety measures as specified for traffic safety facilities, such as the placement of flaggers, safety cones, security fences, and road construction signs. A paved road is composed of four layers. The construction will be divided into four processes, one for each layer.



(1) Subgrade layer work

The lowest level of the road is called *rosho* (subgrade layer). When thick, it can be about 1 m deep. A backhoe or bulldozer is used to dig into the ground. Because different operations are performed simultaneously over a short distance, such as excavating with a backhoe, loading excavated soil onto a dump truck, compacting with a hand roller, spreading and compacting gravel with a bulldozer, and compacting with a road roller, be mindful of avoiding accidents including collisions with heavy equipment, entanglement, and being crushed.

(2) Aggregate base layer construction

The aggregate base layer is the middle layer of a paved road, divided into upper and lower layers. Crushed stone or other materials are placed over the subgrade layer to disperse loads and impacts. Although not seen at worksites, a machine called jaw crusher is used to crush stones into small pieces, which is brought in and used. Crushed stones are scooped up from dump trucks with a backhoe or excavator buckets and spread on the subgrade layer. Workers leveling crushed stones with rakes are often working at the same time, so care must be taken to avoid accidents.

(3) Asphalt base layer construction

The asphalt base layer is the layer above the aggregate base layer. The heated asphalt is spread and

leveled with an asphalt finisher. The asphalt finisher is a machine that discharges asphalt in the hopper from the back. The edges of the road are leveled by hand using a tool called *tonbo* (asphalt rake). The spread asphalt is compacted with a macadam roller or other machinery, and further compacted with a tire roller. By using two different machines, it is possible to compact not only the surface but also the interior.

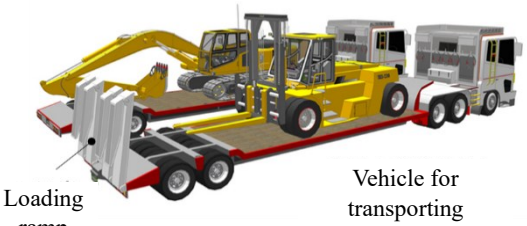
(4) Asphalt surface layer construction

The asphalt is spread using the same method as for the base layer construction. The asphalt used in this process differs in nature from the asphalt used in the base layer construction, having high water resistance and non-slip properties.

6.2.7 Mechanical Earthwork

Mechanical earthwork is earthwork performed using construction machinery. If multiple machines or workers will be working on the same construction site, make sure there are no other vehicles or people around before commencing work. When getting in and out of vehicles, be sure to turn off the engine and lock the safety lever. In addition, during machine cutting operations, the direction of the machine's undercarriage should be oriented at a right angle to the cutting edge as a general rule.

When transporting machinery to the construction site, a vehicle dedicated to machine transfer is used. A ramp called *tohan yogu* (loading ramp) is installed on the transfer vehicle for loading and unloading. The ramp should be securely attached to the loading bed with a slope of 15 degrees or less. Since tipping over a machine can cause a fatal accidents, the surrounding area must also be kept off-limits.



Because mechanical earthwork often generates noise and vibration, measures such as using *teishindogata kensetsu kikai* (low-vibration construction machinery) that have been designated as low-

vibration/noise construction machinery according to the regulations of the Ministry of Land, Infrastructure, Transport and Tourism, are taken.

In order for the construction work to be carried out as planned, machines must function properly without malfunctioning. At the end of the day's work, park in a safe place, and lower buckets and other attachments to the ground. Once the safety lever is in the locked position, allow the machine engine to idle for about five minutes while stepping off the machine and check for oil leaks, coolant leaks, etc.. Abnormalities are to be reported to the person in charge of maintenance, and the results of daily maintenance are recorded in the inspection chart. Even though inspections are performed after work is completed, it is required by the Occupational Health and Safety Law that brakes and clutches be inspected before commencing work.

6.2.8 Piling Work

(1) Preliminary investigation of underground objects and facilities

Before piling work begins, a survey of the buried objects is required. For example, if there are buried gas, water, or power lines in the area where the holes are to be dug, it could cause a major accident. Presence of large rocks and hard bedrock requires specific methods of excavation and machines. If important archaeological sites or cultural assets are buried, archaeological excavation and other research will be required.

(2) Geotechnical survey

In addition to investigating underground objects and facilities, a geotechnical survey of soil quality, soil strength, and groundwater level is also required. A boring machine is used to dig deep holes and collect soil samples for investigation and determination.

(3) Safety precautions

Foundation construction involves the use of large machinery, which can pose a variety of hazards. Most accidents are caused by errors in work procedures, unstable machine locations, falling machines

or materials due to loss of balance, slipping/tripping or falling into openings due to careless stepping or backward movements, or being caught-between by entering an area that is off-limits. To avoid accidents, it is important to check above and around, pay attention to moving machinery, and alert other workers.

- Danger of falling objects

Incorrect procedure when using a pile driver, such as removing the wire before inserting the pin, could result in the screw detaching from the joint and falling off. Also, when using a vibro hammer to drive in or pull out H-beams or sheet piles, the H-beams or sheet piles could fall.

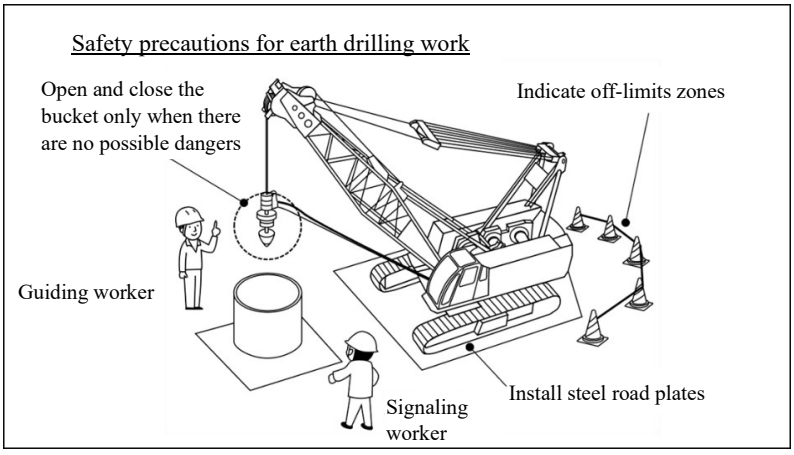
- Danger of being caught-between

When a pile driver or crane is in motion, if the machine is operated incorrectly or if a worker enters an off-limits area, there is a risk of being caught between the suspended H-beams, sheet piles, the leader, etc. and other surrounding objects.

- Danger of tipping over

Depending on the location of large machines, they may lose their balance and tip over.

- Danger of falling from heights



Although foundation work is not performed at height, and thus there is little risk of falling from heights, falling into excavated holes due to inattentive backward movement and falling from machinery such as when performing joint work on a pile driver leader are possible accidents. In

addition to wearing non-slip shoes, it is important to receive work instructions from the work supervisor.

6.2.9 Scaffolding Work

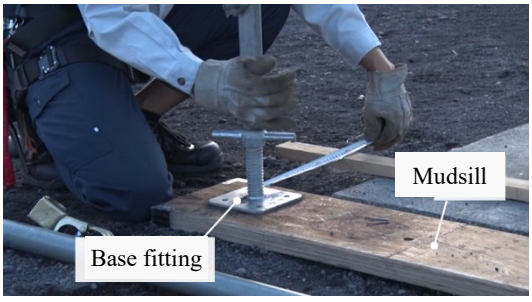
As explained in Chapter 3, there are many different types of scaffolding work. This section describes scaffolding construction. There are several types of scaffolding, including timber scaffolding, tube scaffolding, framed scaffolding, and ringlock scaffolding, but there are some construction tips that are common to all types of scaffolding work. It is to make sure that the footing is secure, then assemble it so that it is vertical and level, and diagonally brace it to keep it straight. To prevent the entire scaffold from collapsing, when there is a building, it is secured to the building with *kabetsunagi* (wall tie anchors). When there is no building, it is braced with circular hollow sections or other means.

(1) Foundation of scaffolding

The ground on which the scaffolding is erected is compacted for strength. If even one upright tube sinking can cause the entire scaffold to collapse. In addition, the ground is made as flat as possible so that there are no gaps between the mudsill and the ground.

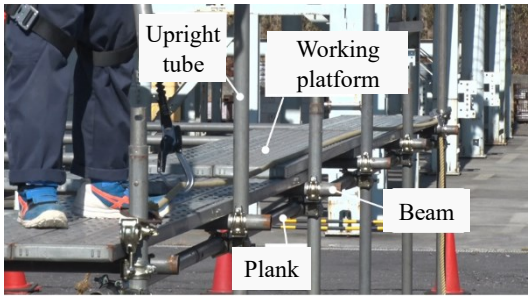
(2) Fixing the legs

The base fitting is nailed to the mudsill laid on the ground.



(3) Installation of upright tubes and planks

Upright tubes are erected vertically, and planks should be attached perpendicular to the upright tubes. The footings of the upright tubes are connected to each other by horizontal members to secure them.



(4) Installation of beams and working platform

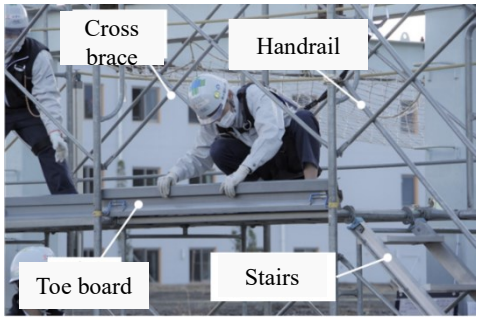
Connect the upright tubes on the front side (the building side) and the rear side (the outside) using braces, and attach the scaffold board (working platform) on top of it.

(5) Installation of stairs, handrails, middle and lower ledgers, and toe board.

Install handrails for workers, middle and lower ledgers for fall prevention, and toe boards to prevent tools and other items from falling. Handrails are also installed for stairs.

(6) Installation of cross braces

Install large cross braces to keep the entire scaffold vertical and level.



(7) Installation of wall tie anchors

To prevent the entire scaffold from collapsing, it is secured to the side of the building with wall tie anchors. If there is no building, diagonal supports (*yarazu*) are installed using circular hollow sections or similar members.

6.2.10 Steel Framing Work

In steel framing work, steel sections are assembled to complete the framework of a building. It is performed in the order of steel section fabrication, foundation frame construction, and steel section erection.

(1) Steel section processing

The steel sections are fabricated in the factory. A construction plan is drawn, and the steel sections

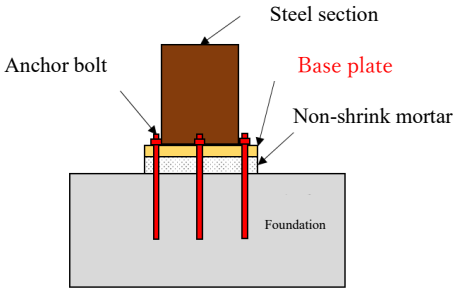
are cut accordingly. The cut steel sections are assembled and welded, and the welds are inspected by ultrasonic testing. After inspection, they are coated with rust-proofing paint and transported to the construction site.

(2) Foundation frame construction

Anchor bolts are secured to the nonstructural concrete with anchor bolt stands or other means. This is followed by the placement of the underground beams and foundation reinforcement, foundation formwork, and foundation concrete pouring.

(3) Steel frame erection

Steel columns and anchor bolts fixed to the foundation are joined to each other by a member called a base plate. Foundation work in steel construction is just as important as that in scaffolding construction. For example, foundation heights may vary slightly, which, if not adjusted, will affect the accuracy of the overall building finish. Check the height of the foundation and match the base plate height of all columns using non-shrink mortar or layers of thin steel plates. After making sure the mortar has set, check the orientation and bolt the columns in place.



Fixing steel frames with base plates

There are two methods of fastening the upright members to the beam: bracketed and non-bracketed. In the bracketed method, the beam is divided into three sections, and the two ends of the beams and the columns that cross those ends are bracketed together by welding or other means at the factory. The non-bracketed method is a construction method in which columns and beams are joined directly on site.

The intersection of columns and beams are bolted and then welded. If the holes for the bolts do not

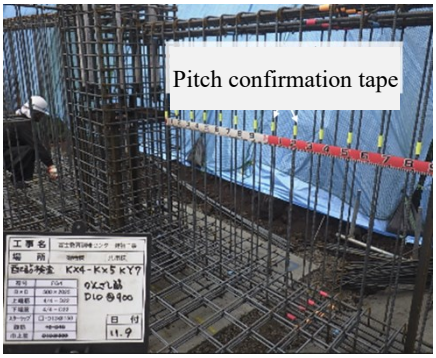
match, a tool called a drift pin is used to align them before securing the bolts. At this stage, the nut is temporarily fixed.

By adding beams, the columns will be pulled and will not be able to maintain their verticality. The frame is pulled with wires to re-align the steel frames, then the nuts are tightened properly, and then the intersection is welded (stud welding).

6.2.11 Steel Reinforcement Work (Rebar Work)

Concrete is resistant to compressive forces but weak against tensile forces. Because of its tensile strength, rebar can be placed in concrete to compensate for the weakness of concrete.

Rebar can oxidize and rust. Concrete is alkaline, which protects the rebar from rust, but over time it will become more and more neutral. If neutralization progresses to the rebar, the rebar will rust. Therefore, when placing the reinforcement, it is important to ensure a certain distance from the surface of the concrete, or *kaburi* (concrete cover thickness).



In order to maintain strength, it is necessary to use rebar of a specified thickness and to distribute the rebar with proper spacing between the rebars. Tape is wrapped around the rebar to make it easier to check the pitch.

In the case of thin slab rebars, the bars are joined by a method called rebar lapping. This joint method gains strength from the concrete's adhesion to the rebar, but because the strength of the concrete affects the strength of the joint, make sure to secure a sufficient length of overlap and secure the bars with binding wires.

Rebar work is involved throughout the entire construction in a typical RC structure building. In particular, it is closely related to formwork carpentry, and the processes need to be coordinated with

each other. In addition, meetings with electric technicians will be necessary for piping and wiring work for electricity and equipment, and with plumbing technicians for water supply and drainage. Rebar work is performed in the following order: rebar fabrication, foundation reinforcement, and floor slab reinforcement.

(1) Rebar processing

Construction drawings are based on structural drawings calculated by a structural design specialist. From the construction drawings, the required shapes and sizes of rebar and the required number of each are calculated, and a reinforcement detailing is created. Rebar is cut, bent, or otherwise processed according to the reinforcement detailing. In addition, bar tags are created based on the reinforcement detailing. Bar tags are attached to the fabricated rebars and are used for sorting and receipt inspection at the time of delivery.

Rebar cutting


Rebar bending

(2) Foundation reinforcement

Rebar delivered from the processing plant is inspected upon receipt and organized for ease of retrieval in subsequent operations. The foundation reinforcement work begins by layout marking the exact location of the foundation onto the nonstructural concrete. After layout marking is complete, embedded beam bearing brackets are lined up to keep the main beam bars of the foundation at a level height, and secured with nails or anchors for nonstructural concrete. Spacer blocks are used to lift the base reinforcement to ensure cover thickness. After the base reinforcement, the column reinforcement is placed. A column consists of a

Foundation beam reinforcement

main rebar placed perpendicular to the ground and hoop rebars surrounding the main rebar. Hoop rebars are installed to reinforce against shear and to prevent the main bar from shifting due to shaking caused by earthquakes and other shocks. Once the column rebar and hoop rebars are bound, spacers are installed to secure the cover thickness. After the column rebars, the beam rebars are placed. After all the foundation reinforcement is completed, the formwork is erected and the foundation concrete is poured.

(3) Reinforcement of *doma* (ground under the house)

Typically, pipe burial and backfilling are performed prior to *doma* reinforcement. *Doma* reinforcement is placed in the following order: main rebar placement, distribution rebar placement, and installation of spacers. After completing the *doma* reinforcement, the *doma* concrete will be poured.

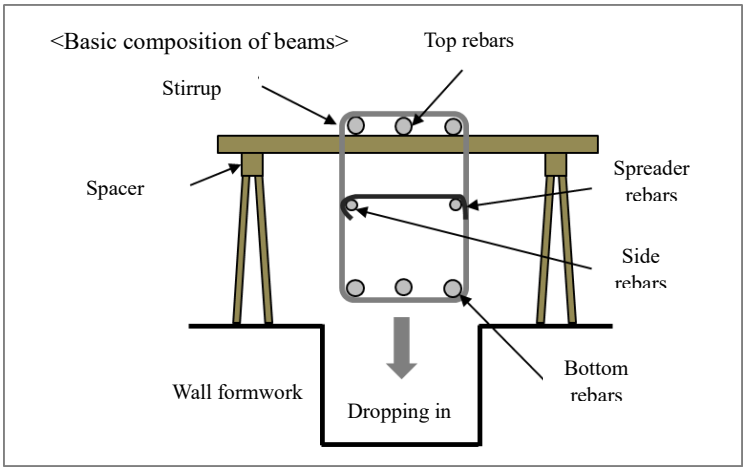
(4) Frame reinforcement

The frame provides the reinforcement for the walls, beams, and slabs.

Wall reinforcement is placed in the following steps: checking the cover thickness, checking the internal/external relationship of longitudinal and transverse reinforcement, allocating the pitch and placing reinforcement, placing reinforcement for openings reinforcement, placing spreader rebars, and placing spacer blocks.

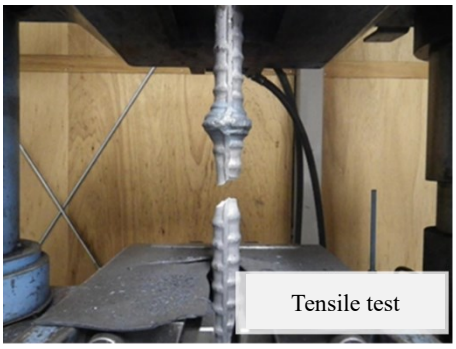
Beam reinforcement is placed in the following order: placement of bottom rebars, temporary placement of hoops at the ends, placement of top rebars, placement of bottom and top rebars of small beams, pressure welding, placement of stirrups and tying to top rebars, placement of side and spreader rebars, dropping into the formwork, and placement of spacers.

The slab shall be doubly reinforced with bottom and top reinforcement consisting of main rebars and distribution rebars.



6.2.12 Rebar Splicing Work

There are several types of rebar splicing methods, but no matter which method is used, the spliced joint must have strength equal to or greater than that of the base rebar. For example, the splice cannot be detected when viewing a cross-section of a perfectly executed gas pressure welded splice, and when a tensile or bending test is performed, the splice does not break, but instead the base rebar does. The following steps are used to check the process while performing pressure welding.


Tensile test

(1) Checking rebar butts

Check for bends in the rebar.

(2) Processing of rebar butts

Rebars are cut by push-cutting at steel construction sites, and therefore their butts are unsuitable for pressure welding as they are. Since the cut surface oxidizes over time, the rebar is cut using a cold-cutting, right-angle rebar cutter on the same day that pressure welding is performed.

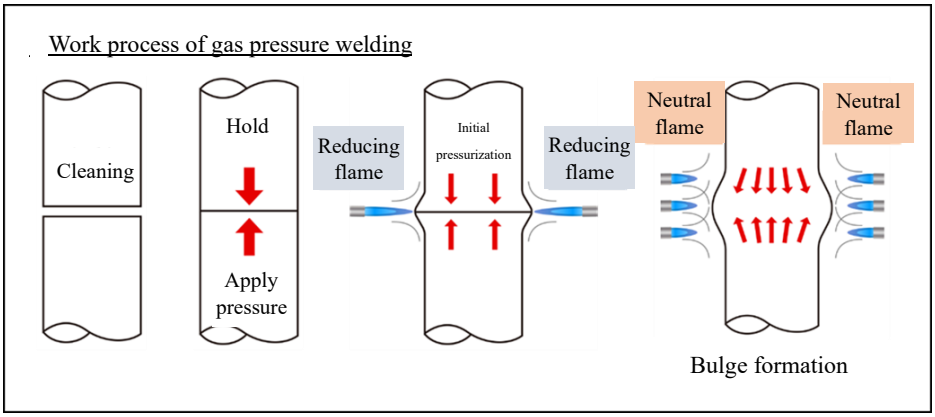
(3) Mounting onto the welding fixture

Make sure the welding faces of the rebars are clean before setting them to the welding fixture using

bolts. Because high pressure is exerted onto the rebar during the pressure welding process, the bolts should be securely fastened so that they do not loosen during the course of the work. When fixing, check the size of the gap between the butts to be pressure welded.

(4) Heating and pressurizing

First, the part where the rebars are butted together is heated with a burner, and the heated portion is gradually expanded to the left and right. The approximate range to be heated is about twice the diameter of the rebar. Simultaneously with heating, pressure is applied to press the butts together. The butts will gradually bulge out, and the work is finished when they reach a predetermined size.



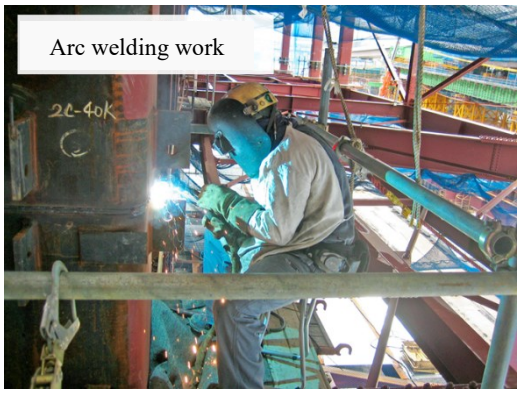
(5) Inspection

The size, length, shaft misalignment, bending, cracks and dents on the exterior, and bulkiness of the bulge are all inspected.

Examples of bad bulging

6.2.13 Welding Work

Arc welding is a necessary technique in many areas of construction work. If the current is too low, proper welding cannot be performed. If the current is too high, the member will melt and create a hole. Proper and constant distance should be maintained between the welding rod and the material to be welded, without getting too close. A proper weld will produce a weld scar that looks like a line of shells. Welding is an easy task for anyone to do once the basics are mastered, but it is important to take precautions against physical effects and accidents.


Arc welding work

Arc welding uses electrical power to weld metals together, so avoiding electric shocks is the priority. Even more important is the prevention of effects on people. Inhalation of fumes from welding (metal vapors cool and solidify in the air and become individual particles floating in the air, which appear like smoke) can cause symptoms such as headaches, fever, chills, muscle aches, thirst, and fatigue. Dust masks should be worn to prevent fume inhalation. Also, wear light-shielding glasses or welding face shield to protect your eyes from harmful rays. The welded area is polished with a grinder, at which time metal dust adheres to gloves and hands. Avoid rubbing your eyes polishing, as rubbing your eyes can damage them.

6.2.14 Formwork Carpentry

When fresh concrete is poured into a formwork, the formwork is subjected to several times the pressure of the same volume of water. Insufficient reinforcement of the formwork can lead to accidents where the formwork breaks (blow-out) and ready-mixed

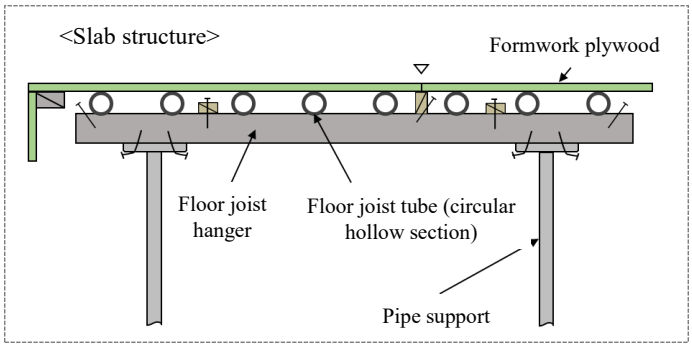

Formwork carpentry

concrete flows out. In order to prevent blow-outs, the formwork must be adequately reinforced to withstand the pressure of the concrete. Also, since placing concrete from height may result in a blow-out, a detailed discussion is held with the concrete pumping contractor regarding the concrete placement method.

The formwork should be erected in the correct position, vertically and leveled, and should be assembled so that it can withstand loads, lateral pressure, vibrations, impacts, etc., without significant deformation or damage.

Wall formwork should be made from materials such as separators, form ties, and P-Con to ensure that there are no misalignments or errors. Form ties can also be tightened through circular hollow sections to make them stronger.

The slab is supported vertically from below because the weight of the concrete will be applied directly in the vertical direction. The materials used are, from the bottom, pipe supports called shoring, floor joist hanger, and floor joist, on top of which formwork plywood (also called *sekiita* in formwork carpentry) is attached.



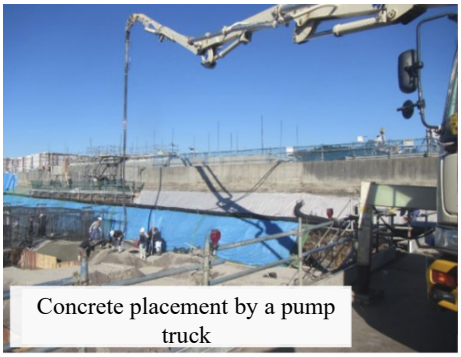
A sufficient number of pipe supports are required to support the slab. To prevent the shoring from sliding, the footings are connected in two horizontal directions by pipes called *negarami*. If the pipe support is longer, horizontal joints are installed using every 2 m or less in height using circular hollow

sections. Finally, the chain, turnbuckle, and support are used to push and pull while checking the verticality and the axis line as adjustments are made.

6.2.15 Concrete Pumping Work


Acceptance inspection

Concrete pumping work involves pouring ready-mixed concrete delivered by truck agitators into formwork using pump trucks. The ready-mixed concrete brought in undergoes acceptance inspection (slump value, air content, and chloride content) based on the ready-mixed concrete delivery note, and a test piece for compressive strength inspection is prepared at the same time.


Concrete placement by a pump truck

An important thing to do before starting the pouring work with the pump truck is to prepare the ground to put out the outriggers that secure the pump truck so that it will not fall over. To prevent the outriggers from sinking into the ground due to vibration, the outriggers' jacks are supported by the receiving wood on solid ground, and on softer grounds, the pump truck is installed by laying a steel plate and then opening the outriggers to their maximum width. In addition, tire stops should be securely inserted. On sloping terrain, adjust the outriggers' jacks so that the horizontal angle is within 3 degrees both front to back and left to right.

During construction, care must be taken to avoid contact with or cutting power lines due to boom movement. In the case of high-voltage wires, even without direct contact, the spark discharge may cause electricity to flow and cause electric shocks. Check and observe the safety clearance distance (distance away from the wire).

It is also important to inspect the delivery pipes and check connections. If a delivery pipe ruptures, ready-mixed concrete will flow out, leading to an accident. It should be inspected on a daily basis by

tapping (checking the sound when tapped) or ultrasonic thickness gauge. Pipes are to be handled carefully to avoid damage during loading and unloading.

Before placing the ready-mixed concrete, a primer is sent through the delivery pipe first to make the inner wall more slippery. This primer is discarded, because when cast into the formwork, it compromises the strength and quality of the concrete. About 1.5 times the amount of the primer, including the primer, is not placed in the formwork, but instead discarded.

6.2.16 Painting Work

There are many different types of painting work. The important thing common to all types is to make sure that the paint adheres well to the painted surface. If the work is not done properly, problems such as the paint film cracking or peeling and loss of luster will occur after one to three years.

Painting is basically divided into three processes: primer, middle coat, and top coat. It is important that appropriate amount of time is passed between each step of the process in order to let the paint dry, which is called the process interval period. The time between painting processes must be at least as long as specified for each coating, and the coating must be allowed to dry thoroughly before moving on to the next painting process. Process interval periods vary depending on a variety of conditions, including temperature, insolation and humidity, and the worker must be able to assess the situation in proceeding with the work. Construction should not be performed when the humidity is 85% or higher, such as during rainy weather.

Before starting priming, make sure the painted surface is free of debris. This process is called *keren* (scraping). If the exterior walls are to be painted, dust and dirt should be removed by high-pressure washing or other methods, and cracked areas (cracks) should be repaired.

The primer coat is applied to improve adhesion between the substrate and the middle-coating material. Sealer, primer, filler, and other priming materials are chosen for different purposes.

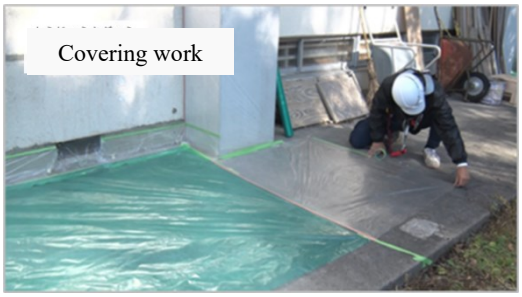
The middle coat smooths out surfaces that have become uneven due to scratches or cracks in order

to achieve an even finish. It can also reinforce and enhance adhesion of the topcoat material.

The top coat is the final stage of the painting process, and its finish demonstrates performance in weather and stain resistance as well as design for aesthetic purposes. The performance of the painting work is determined by three layers of paint (primer, middle coat, and top coat), but is generally evaluated based on the performance of the top coat paint. In spray painting, the surface usually receives two coats.


Spray painting

Paint should be applied only where necessary, and therefore, do not forget to cover the areas that do not need to be painted. Cover the floor with a polyethylene sheet, apply masking tape to the border of the area to be painted, and use masker tape to cover large surfaces such as walls. In addition, in exterior wall painting, paint can splatter onto cars, etc., causing problems. The entire building should be covered, and automobiles and other vehicles within the area where paint is likely to splatter are also covered with sheets.


Covering work

6.2.17 Landscaping Work

Landscaping is the designing of space through placement of natural stones, trees, plants, and flowers. Landscape architects, sometimes called *niwashi* (gardener), create gardens and residential yards based on traditional Japanese landscaping culture. In recent years, landscaping techniques have also been required for the greening of building rooftops, wall surfaces, and artificial grounds. Landscape architects are required to have not only knowledge and skills in planting, diagnostic for plants and planting substrates, and transplanting, but also artistic and design capabilities. In particular, pruning

trees in the garden affect the finished landscape, and therefore must be discussed in detail with the client in order to avoid complaints. It is also important to know that different trees have different pruning timing. Pruning at the wrong time can cause the plant to die or not bloom.

Landscaping requires a lot of work at heights. Working on an unstable ladder or stepladder can cause falling accidents. Choose a stepladder location for stability without wobbling, and take measures to prevent it from falling over, such as by tying and securing the stepladder to the trunk of a tree. Working on top of a branch can result in a falling accident when the branch breaks. If the height exceeds 2 m, use a safety belt.

Crane trucks are used to move plants and garden stones, and drag shovels are sometimes used for excavation work. Take ample care to prevent the machinery from tipping over. There have been accidents such as being entangled in self-propelled mowers, being trapped under a falling tree when felling trees with a chainsaw, and receiving direct hits to the head.

Pruning

6.2.18 Demolition Work

Demolition work is performed on structures of all sizes. There are two methods of building demolition: block *kaitai koho* (floor-by-floor demolition) and *happa kaitai koho* (blast demolition). Here, the floor-by-floor demolition will be explained. Demolition will begin only after confirming that all lifeline infrastructure (electricity, telephone, fiber optic cable, cable TV, gas, water, sewage, etc.) are shut off. For example, demolition with active gas, water, and sewage lines can lead to major

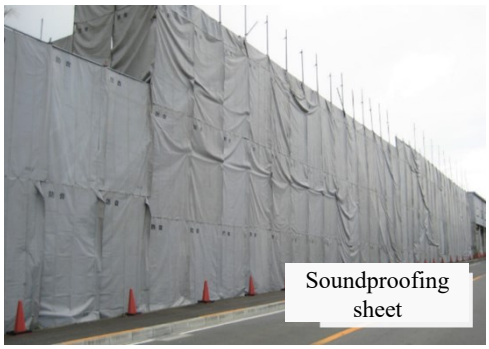
accidents. The demolition work will proceed in the following steps.

(1) Demolition of exterior areas

Remove items from around the building to make the work easier. It is necessary to confirm what is to be demolished, as there may be items on the property that are not subject to demolition.

(2) Installation of scaffolding and soundproofing panels

Install scaffolding for the demolition workers. The entire surface is covered with soundproofing panels, soundproofing sheets, etc. to prevent noise and scattering of dust from demolition.



(3) Demolition of the building interior

Remove fittings, plaster boats, sashes, and various equipment by hand. At this time, separate recyclable material. In order to utilize resources through recycling and to curb illegal dumping of waste, the Construction Material Recycling Act establishes standards and penalties for demolition of buildings with a floor area of 80 m^2 or more.

(4) Drilling holes in floors on each floor

Drill holes in the floor to allow the demolished walls and structural debris to be dropped down.

(5) Installation of support for heavy machinery

Walls and columns are dismantled by hoisting heavy equipment upward. Provide supports to withstand the weight of heavy equipment.

(6) Demolition of walls and structure, excavation and demolition of the foundation

Because digging up foundations is an underground construction process, vibration is inevitably generated. It is important to choose the right time of day to conduct this work.

(7) Disposal of waste, removal of debris from the ground surface, land clearing, and street cleaning

Recyclable materials are taken to a disposal site, and the ground is cleared of debris. The surrounding streets dirtied by the work are also cleaned and restored to their original condition.

The above is a method of demolishing from the top, but there is also a method of demolishing from the first floor while supporting the severed columns with jacks. Not only does it eliminate the need for support installation work in (5), it also allows for efficient removal and sorting of demolition materials.

Chapter 7: Safety during Construction Work

7.1 Fatalities in Construction Work

A variety of industrial accidents occur at construction sites. Table 7-1 shows the number of fatal industrial accidents in the construction industry in 2021 by major accident type, based on the data released by the Ministry of Health, Labour and Welfare. Among the various types of industrial accidents that occur, fall from heights, accidents involving construction machinery and cranes, and crumbling/collapsing are the three major accidents in the construction industry, accounting for 40-70% of all accidents. Most of the struck-by and caught-in/between/entanglement cases in the table below are accidents involving construction machinery and cranes.

The most common of the three major disasters is fall from heights, occurring while working in high places. Aside from the three major disasters, the most common type of accident is traffic accidents that occur while traveling on public roads. Chapter 7 describes the types and causes of accidents that occur on civil engineering construction sites, as well as countermeasures and how to be mentally prepared.

	Fall from heights	Slipping/tripping/falling/tipping over	Crashing	Flying/falling	Crumbling/Collapsing	Struck-By	Caught-In/Between/Entanglement	Drowning	Contact with hot/cold objects	Exposure to hazardous substances, etc.	Electric shock	Traffic accident (road)	Traffic accident (other)	Total
Civil engineering work	19	5	1	4	13	11	15	9	4	3	2	10	1	102
Tunnel construction	0	0	0	0	1	0	0	1	0	0	0	1	0	3
Bridge Construction	1	0	0	0	2	0	1	2	0	0	0	0	0	6
Road Construction	3	0	1	1	2	1	2	0	1	0	0	5	0	17
River engineering work	1	3	0	0	1	1	1	2	0	1	0	0	0	10
Erosion-control work	2	0	0	0	0	1	0	0	0	0	0	1	0	4
Harbour/coastal	0	1	0	0	0	0	1	2	0	1	0	0	1	6
Other civil engineering	9	0	0	2	4	8	8	2	3	1	2	1	0	44
Building work	71	0	0	5	15	7	6	0	6	5	2	9	0	139
Steel frame and reinforced concrete houses	23	0	0	3	5	2	0	0	3	4	0	5	0	48
Wooden-frame house construction	12	0	0	0	1	1	0	0	0	0	1	1	0	19
Building equipment installation	8	0	0	0	2	0	0	0	0	0	1	2	0	16
Other building work	28	0	0	2	7	4	6	0	3	1	0	1	0	56
Other constructions	20	0	0	1	3	1	6	1	1	1	4	6	0	47
Telecommunications work	4	0	0	0	1	0	2	0	1	0	2	2	0	13
Machinery and equipment installation	4	0	0	0	1	0	0	0	0	0	0	0	0	6
Other constructions	12	0	0	1	1	1	4	1	0	1	2	4	0	28
Construction industry subtotal	110	5	1	10	31	19	27	10	11	9	8	25	1	288

Table 7-1 Fatal Industrial Accidents in the Construction Industry in 2021 by Major Accident Type
(Compiled from the Ministry of Health, Labour and Welfare's Workplace Safety Website)

7.1.1 Fatalities and Injuries in Construction

Table 7-2 shows the number of fatal accidents involving foreign workers in all industries in FY2020 and FY2021, as compiled by the Ministry of Health, Labour and Welfare. Table 7-3 shows that the construction industry has the highest numbers.

Accident Type	Number of fatalities	
	FY 2020	FY 2021
Fall from heights	5	5
Slipping/tripping/falling/tipping over	2	0
Crashing	1	0
Flying/falling	1	2
Crumbling/Collapsing	3	3
Struck-By	4	2
Caught-In/Between/Entanglement	2	3
Exposure to hazardous substances	2	0
Electric shock	2	1
Fire	0	1
Traffic accident (road)	7	4
Drowning	0	1
Other	1	2
Total	30	24

←Table 7-2 Occurrence of Fatal Accidents of Foreign Workers in All Industries

Industry Type	Number of fatalities	
	FY 2020	FY 2021
Manufacturing industry	3	8
Construction industry	17	10
Other	10	6
Total	30	24

Table 7-3 Number of fatalities by industry

[Tsuiraku/tenraku] (fall from heights) These are industrial accidents caused by falling from high places, falling down shafts during construction, or falling down a hole during excavation.

[Tento] (slipping/tripping/falling/tipping over) Industrial accidents caused by tripping over objects or losing one's balance and falling.

[Gekitotsu] (crashing) Industrial accidents caused by a violent collision with something.

[Hirai/rakka] (flying/falling) Industrial accidents caused by loads being lifted by a crane falling, or tools or materials falling from a high place.

[Hokai/tokai] (crumbling/collapsing) These are industrial accidents that occur when a scaffold crumbles or a building under demolition collapses.

[Gekitotsusare] (struck-by) Industrial accidents caused by being struck by heavy machinery that is running, by a circling bucket, etc.

[Hasamare/makikomare] (caught-in/between/entanglement) Industrial accidents caused by being

caught or entangled in machinery.

[Yugaibutsu tono sesshoku] (exposure to hazardous substances) Industrial accidents that occur when hazardous substances, such as chemicals, come into contact with the human body.

[Kanden] (electric shock) Industrial accidents caused by electric current flowing through the body, for example, by cutting an energized wire or touching a leaking device.

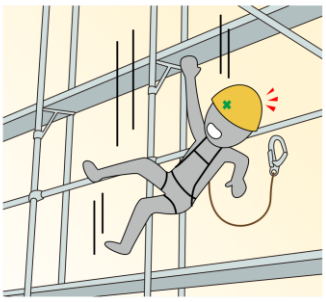
[Kasai] (fire) Industrial accidents caused by being caught in a fire started by a variety of factors.

[Kotsu jiko (doro)] (traffic accident (road)) Industrial accidents that occur while commuting to and from construction sites, and industrial accidents that occur when a worker is involved in a general automobile accident during construction work next to a road.

[Obore] (drowning) Industrial accidents that occur by falling into water in places where water is a part of the work, such as oceans, rivers, and sewerage works.

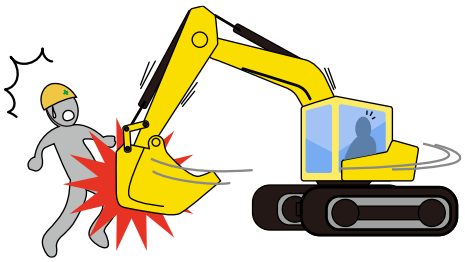
7.1.2 Types of Fatal Accidents

(1) Fall from heights



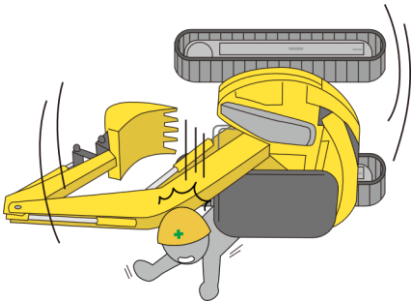
Fatalities from falling from heights do not always occur in crashes from extreme heights, but can also occur in lower places, such as falling from the back of a dump truck. There have also been accidents of falling into excavated holes. Since falling often occurs due to loss of balance or slipping, full-harness fall protection gear should be worn properly at high altitudes. Also, be sure to use them, accidents have occurred when the gear is worn but not used.

(2) Struck-By/Caught-Between



Civil engineering work is prone to heavy equipment disasters because the work often involves the use of large construction machinery. Accidents involving being run over or caught-between by construction machinery, as well as tipping over and falling of construction machinery, are common. Backhoes have caused accidents such as collision between the circling arm/bucket and a person, or a person getting caught between the bucket and an object.

An accident also occurred when a flagger of another vehicle failed to notice a dump truck backing up and got caught-between. In addition, accidents have also occurred, such as a dump truck flicking up the mudsill laid out on the site's loading ramp and hitting a flagger.



A backhoe tipping can result in fatal accidents when someone is crushed by it. In addition, backhoe tipping accidents are more likely to occur when loading and unloading backhoes onto and off trucks, etc.

Falling and tipping over of construction machinery can also occur while traveling on a ramp or by falling off the shoulder of a road. Paths for construction machinery should be wide enough to prevent the shoulder from crumbling. Tipping over can also occur when trying to lift heavy objects with a backhoe. Construction machinery, including but not limited to backhoes, should not be used for purposes other than those for which they were originally intended.

(3) Traffic accident (road)

Fatalities from traffic accidents, not limited to construction work, are also common in construction, equipment, and lifeline infrastructure projects. Many traffic accidents occur while commuting to construction

sites, and some traffic accidents occur when construction vehicles are traveling on public roads. Accidents include being hit by another vehicle while loading or unloading goods on a public road, or a dump truck carrying a load of surplus soil driving too fast and overturning on a curve.

(4) Flying/falling

A flying/falling accident occurs when a person is hit by a flying or falling object. For example, being struck by the object carried by a crane or becoming trapped under a falling suspended load. Insufficient slinging, moving suspended loads, etc. can cause accidents. The important thing is not to ever go below suspended loads. Accidents have also occurred due to falling tools and components to be installed.

(5) Collapsing/Crumbling

Because civil engineering work involves dealing with nature, accidents due to landslides and falling trees have occurred. Accidents can occur especially in excavation work, where the soil wall can collapse.

7.1.3 Work with A High Number of Fatalities

(1) Characteristics of and accidents in road construction

Paving work

The photo on the right is of road paving work. Behind a line of several construction machinery moving forward, several workers are leveling asphalt. Road construction accidents include collision with rollers and being hit by dump trucks backing up. Accidents also occur during paved road repair work by colliding with backhoe arms and buckets. Road construction is characterized by construction machinery and people working in close proximity. Flaggers are assigned to ensure the safety of the workers by signaling with

the operators of the construction machinery, but the workers themselves must also be constantly aware of the safety situation of their surroundings.

(2) River engineering work


River engineering work

The most common accidents that tend to occur in river engineering work are those related to construction machinery and vehicles. At these construction sites, accidents such as backhoes tipping over from slopes or people being run over by moving vehicles can occur. Large blocks are often used, and accidents can occur during lifting and moving operations of crane-type backhoes.

(3) Bridge construction


Bridge construction

Bridge construction often involves working at heights. As a result, accidents due to falling from heights and being hit by flying/falling objects are more likely to occur. As a result, accidents due to falling from heights and being hit by flying/falling objects are more likely to occur. Accidents also occur when a worker's foot is caught on a circular hollow section temporarily fixed at the upper part of a bridge, causing the formwork to come loose and fall down. Such an accident was caused by an attempt to climb up using a passageway other than the one provided. The general rule in fall prevention is to wear and reliably use the full-harness fall protection gear. Falling can also be caused by tripping and losing one's balance. In addition to watching your step, it is also important not to place unnecessary objects in the passageways.

(4) Tunnel construction

As discussed in Chapter 3 Section 3.1.1, there are a variety of tunneling methods that can be used depending on geological and environmental conditions. The geology, construction machinery used, and temporary facilities necessary differ by method, so there are some differences in safety considerations, but there are also many similarities. In tunnels, excavated soil is removed and materials are transported by railway equipment and dump trucks in a narrow, dark environment, and many vehicles drive through the tunnel as workers work. As a result, many accidents involving heavy machinery occur. Although the geology differs, fragile geology such as sandy earth and weathered rocks are also excavated, which can lead to collapses of strata disturbed by the excavation work, resulting in rockfall accidents. In tunnel excavation, it is important to carefully observe the geological conditions near the tunnel face and plan excavation work suitable for the geological conditions.

This section describes matters to be considered when conducting the pipe-jacking tunneling method.

> Inside the tunnel, be aware of the possibility of oxygen depletion and toxic gases. Carbon monoxide and carbon dioxide are colorless, odorless, and difficult to predict from where they will originate. Therefore, their presence or absence and concentration should be measured using a detector. Toxic gas measurements must be taken prior to the beginning of each work shift to ensure safety. Recently, many tunnel construction sites install automatic measuring devices to continuously take measurements 24 hours a day.

> If flammable gases are likely to be generated, fire is strictly prohibited.

> Pipe-jacking tunneling construction is often used for small-diameter sewer and water pipeline construction, often with a diameter of 0.8 to 3 meters. In addition to the various temporary equipment required for pipe-jacking tunneling, excavated earth and sand are carried out through the shafts. Take care to avoid being caught-between, hit by flying/falling objects and falling from heights. Measures such as prohibiting entry into the shaft during excavated soil removal are necessary.

7.2 Safety Activities at Construction Sites

Construction sites are home to technicians from many job categories. Although the work performed may seem different, experienced technicians are always mindful of some common matters. This realizes high quality and safety. 7.2 describes common safety activities that all technicians should know.

7.2.1 Cycle of Safety in Construction

By continuing the cycle of safety in construction, we can make worksites less prone to industrial accidents. The cycle of safety in construction is to achieve the following aims.

a. Integrate construction procedures and safety.

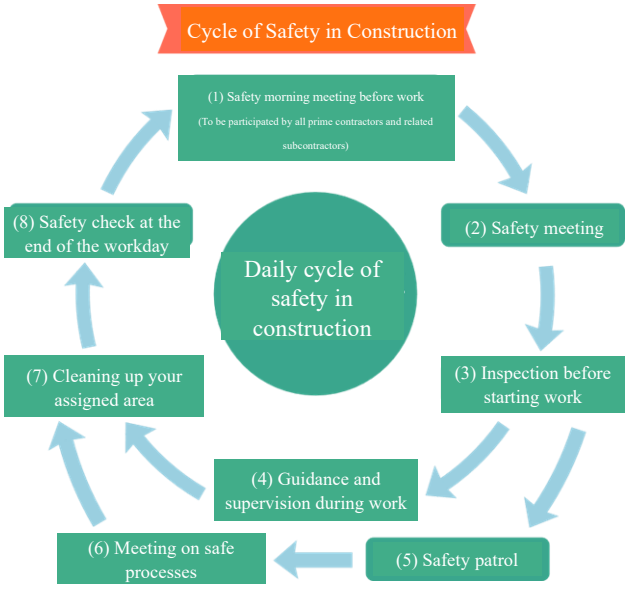
b. Facilitate cooperation between the prime contractor and other related subcontractors.

c. Make safety and health activities a habit.

d. Be inventive in taking preemptive safety measures.

e. Inform everyone of construction and safety requirements.

Various safety activities should be incorporated into daily operations at construction sites. To prevent industrial accidents, it is important to set up and continue the daily cycle of safety in construction.



(1) Safety morning meeting before work

All prime contractors and related subcontractors participate in the meeting, which includes a presentation on the results of the safety patrol conducted on the previous day by the worksite managers, instructions regarding work safety for the day's work, and radio calisthenics.

(2) Safety meeting

Discussions will be led by the foremen, by job category. The training includes reviewing the results of the previous day's work process, hazard prediction (KY) activities related to today's work process, and newcomer education.

(3) Inspection before starting work

Before starting work, safety inspections are conducted, including inspections of the machines and tools used, checking the work content, etc.

(4) Guidance and supervision during work

Site supervisors (foreman, operations supervisor, etc.) provide guidance and supervision to workers.

(5) Safety patrol

Safety patrols are conducted by the worksite manager and subcontractors, and instructions and

guidance are given to each foreman, etc.

(6) Meeting on safe processes

The prime contractor and each specialty contractor will communicate and coordinate with each other regarding work on the following day, and discuss work methods, etc.

(7) Cleaning up your assigned area

Every worker is to organize, tidy, clean, and sanitize the area he/she worked in.

(8) Safety check at the end of the workday

The prime contractor and the person in charge of specialty contractor will confirm measures to prevent fire, theft, public disaster, etc.

7.2.2 Safety and Health Education for Newcomers

Safety and health education for newcomers is provided when a business hires new workers. The implementation of safety and health education for newcomers is required by the Ordinance on Industrial Safety and Health.

[1] Matters related to danger or harmful effect of machines, etc., or raw materials, etc., and those related to methods of handling thereof

[2] Matters related to performance of safety devices, harmful substance control devices, or personal protective equipment and matters related to methods of handling thereof

[3] Matters related to operation procedures

[4] Matters related to inspection at the time of commencement of work

[5] Matters related to the causes and prevention of diseases which workers are susceptible regarding the work

[6] Matters related to keeping the workplace in order and maintenance of its sanitary conditions

[7] Matters related to emergency measures and evacuation at the time of an accident

[8] Beyond what is set forth in each of the preceding item, matters necessary for maintaining safety

and health related to the work

7.2.3 Newcomer education

A worker who newly enters a construction site is called a newcomer. Nearly half of all construction site fatalities occur within one week of newly entering a site. For this reason, the Ministry of Health, Labour and Welfare has mandated newcomer education. The Guidelines for Construction Site Safety Management by Master Employer defines the implementation standards as follows.

[Implementation of newcomer education]

In case of newly assigning any employees to work at a construction site, the related subcontractors shall instruct their foremen, etc., to inform such workers of the following matters based on the characteristics of said construction site before they commence work at the site, and shall report the results to the master employer.

[1] Conditions concerning locations where work is conducted by a mixed workforce that consists of both the master employer's employees and the related subcontractors' employees

[2] Locations that pose a danger to workers (dangerous and harmful places and no-entry zones)

[3] Relationship between work processes conducted at mixed work sites

[4] Evacuation methods

[5] Command structure

[6] Contents of the work involved and industrial accident prevention measures

[7] Rules on safety and health

[8] Plans that prescribe the basic policy and goals of safety and health management at the construction site and other basic industrial accident prevention measures

The above will be implemented as follows.

(1) Before work on the day the contractor first enters the site to begin work

The person in charge from the construction company (builder), the foreman, and the health and

safety officer will conduct the training.

(2) Before work on the day a newcomer is added to the contractor's workforce

The foreman and the health and safety officer will conduct the training.

The training will take place in a conference or meeting room in the field office for about 30 minutes.

7.2.4 Safety Gear for Work

The photo below shows the safety gear for work. Full harness fall protection gear (1), helmet (2), hooks (3), and safety shoes (4) are the basic gear.

[Full-Harness gata tsuiraku boshiyo kigu] (full-harness fall protection gear) The full-harness fall protection gear prevents falls. From January 2, 2022, it is mandatory to wear it if the height of the working platform exceeds 6.75 m. However, in the construction industry where falling accidents occur frequently, the use of full-harness fall protection gear is required even when working at heights exceeding 5 m. However, falling accidents do occur for those wearing but not using the gear, so be sure to use it.

In addition, the following protective and safety equipment is used depending on the task.

[Hogo megane] (protective eyewear) These glasses are designed to protect the eyes from metal and wood dust, sparks, heat, smoke (including toxic gases), lasers and other harmful rays generated at construction sites and material processing sites. Select the best eyewear for your purpose.

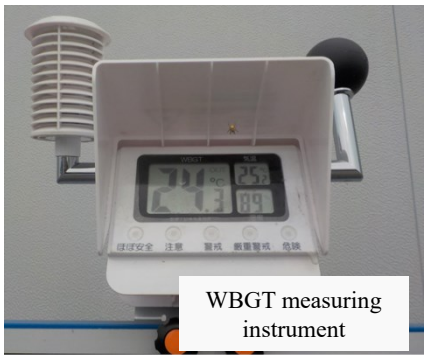
[Hogo mask] (protective mask) A mask used to protect against dust and other debris. There are disposable masks and those with replaceable filters. The Ministry of Health, Labour and Welfare (MHLW) sets the standard for masks. For example, inhaling dust from arc welding and rock cutting operations over a long period of time can cause lung dysfunction (pneumoconiosis), so the use of protective masks is mandatory.

[Tebukuro] (gloves) Used to protect hands when performing machine/hand cut processing, painting work, various types of installation work, and work involving chemical substances. However, gloves (work gloves) should not be used when using rotating blades such as circular saws, drilling machines, chamfering machines, pipe threading machines, etc., because gloves (work gloves) can get entangled in rotating blades and result in accidents.

[Shield-mentsuki helmet] (welding helmet) A helmet with a shield attached to it, protecting the entire face. Mainly used for welding work.

7.2.5 Prevention of Heat Strokes

Summer in Japan has many *manatsubi* (hot day) with temperatures exceeding 30°C and *moshobi* (extremely hot day) with temperatures exceeding 35°C. Work performed in hot temperatures can cause the workers to have heat strokes. Heat stroke can cause dizziness and fainting, muscle pain and stiffness, profuse sweating, headache, mood discomfort, nausea, vomiting, fatigue, a sinking feeling, impaired consciousness, convulsions, impaired limb movement, high body temperature, and other symptoms that not only make it impossible to continue working but can also cause death. The Japan Meteorological Agency calculates and provides information on the predicted value of the Web Bulb Globe Temperature (WBGT) in each region. To reduce WBGT values, site managers install large fans, shading nets, dry mist systems, rest areas, air conditioning equipment, water supply equipment, refrigerators, ice machines, drinking watervending machines, etc. On extremely hot days, work start and end times may be moved up. Workers should try to rest in a cool place, such as an air-conditioned rest area, during allotted break times, and to drink water and consume salt before and after work. Also, wear breathable work clothes, safety vests that absorb heat easily, etc.



WBGT measuring instrument

7.2.6 Marks Calling Attention to Work Safety

Marks with a green cross on a white background can be seen at various locations on the construction site. This mark is called *midorijuji* (green cross) and is a symbol of safety and health. It is often designed together with the words *anzen daiichi* (safety first) because safety is the first and most important thing on a construction site. Helmets and *kyukyubako* (first aid kit) containing medicine and tools for first aid in case of injuries are also marked with the green cross. Sometimes the safety and health flag, combining the green cross with *shirojuji* (white cross) which represents *eisei* (health), is

used.

Example of the green cross

Examples of the safety and health flag

7.2.7 Understanding Human Error

Mistakes caused by humans are called human errors. Human errors occur because we are human. This includes not only mistakes caused by carelessness, but also those caused by *tenuki* (cutting corners), skipping procedures that should have not been skipped. To avoid getting involved in or causing accidents on construction sites, it is important to be conscious of possible human errors. In addition, human errors not only cause accidents involving people, but also affect the quality of the completed construction as well as cause delays in the process. It is said that there are 12 different causes of human error.

(1) Cognitive errors

It is a human error caused by assumptions. For example, the assumption that “such and such instructions will be given in this situation” can lead to misreading the actual instructions and cues given.

(2) Lack of attention

It is a human error caused by lack of attention. Concentrating on one particular task can reduce attention to one's surroundings and lead to accidents. For example, there are cases where a person is so focused on the work in front of him that he fails to notice the hole behind him and falls in.

(3) Attention lapse and diminished awareness

Attention lapse and diminished awareness can occur especially when engaged in simple and repetitive tasks. When simple tasks are repeatedly performed, workers stop thinking about those tasks but instead perform them unconsciously.

(4) Inadequate experience/knowledge

It is a human error caused by lack of experience and ignorance. This can result in improper use of tools, incorrect understanding of the work process, or inability to anticipate accidents that may be associated with the work. KY activities before commencing work are an opportunity for seasoned technicians to share their experience in predicting hazards. Workers can learn what to look out for, even when engaging in the task for the first time.

(5) Complacency

Humans tend to gain confidence through familiarity and, as a result, tend to be less careful or skip steps compared to when they were beginners at that task. Accidents are more likely to occur when workers become complacent and relaxed. No matter how familiar you are with the work, be sure to practice safe conduct, inspect tools before you work, check your safety equipment, and wear and check the fit of your safety gear.

(6) Group errors

It is a human error that occurs in groups. For example, when it seems that meeting the construction deadline is unlikely, it is easy to for the overall atmosphere to lean towards condoning unsafe conduct. While it is important to meet construction deadlines, the safety of people is of primary concern. In addition, if accidents occur due to unsafe conduct, they can cause delays in the construction schedule.

(7) Shortcuts and omissions

This is a human error caused by omitting necessary actions and procedures out of the desire to work efficiently.

(8) Communication errors

This is a human error that occurs because the instructions are not clearly conveyed. Working without

understanding the instructions can lead to accidents and construction delays.

(9) Behavior based on situational instinct

It is an action that we unintentionally take when we are in a certain situation. Especially when people are focus on one point, they become oblivious to their surroundings. For example, when a person is about to fall from a stepladder, he/she would throw his/her tools in order to hang onto the stepladder. An accident occurs if those tools hit another worker.

(10) Panic

Sudden surprises or panic can easily lead to spontaneous unsafe behavior or giving inappropriate directions.

(11) Decline in physical and mental functions

What was possible when younger may no longer be possible due to aging. In particular, reduced function in the legs and hips and vision impairment are difficult to notice because they occur gradually. It is important to be aware of this so that you do not try uncomfortable actions or postures.

(12) Fatigue

Accumulated fatigue reduces alertness, and this can lead to accidents. It is important to take good care of your health on a daily basis, including proper sleep and nutrition.

“Have a safe day!”