Examination Category
(Building Work)
Textbook for
the Practical Examination

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

Chapter 7: Safety during Construction Work

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

This chapter describes the tools, machines, materials, and measuring instruments used in each construction project. Sections 5.1 and 5.2 explain what is specific to each specialty work, by specialty. 5.3 explains what is used in several specialized construction work.

5.1 Frame Construction

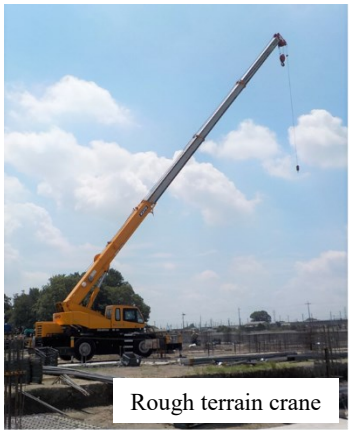
5.1.1 Construction Machines

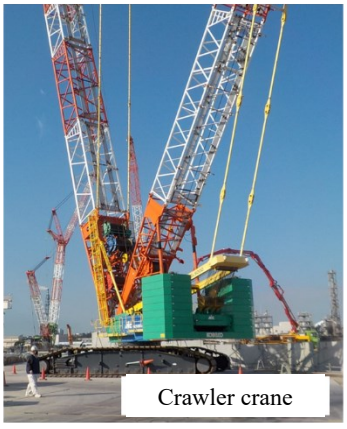
[Crane] A machine that can lift a load using power and transport it horizontally. There are several types of cranes, including tower cranes, truck cranes, and crawler cranes.

[Tower crane] A crane used in the construction of high-rise buildings. The crane section is mounted on a supporting tower called a mast. There are two types of climbing: mast-climbing (mast climbing top crane) in which the crane section climbs up a jointed mast, and floor-climbing (internal tower crane) in which the entire base climbs up the building.

[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

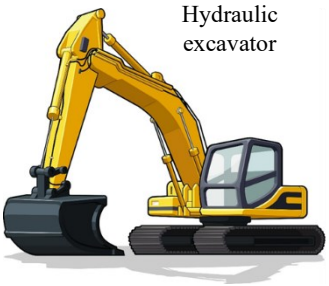

Crawler crane


Tower crane

[Tenjo crane] (overhead crane) A type of crane that moves along rails attached to the ceiling of a factory or other facilities.


Overhead crane

[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

[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

5.1. 2 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.

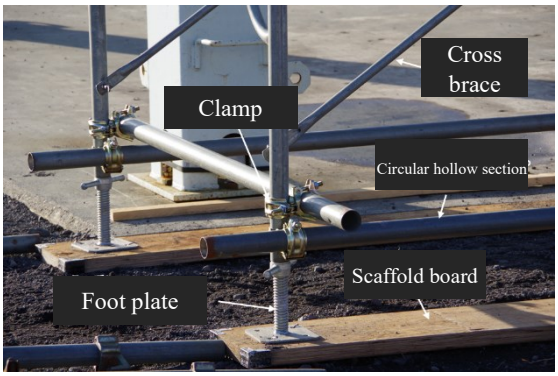
[Joint] A member used to connect circular hollow sections.

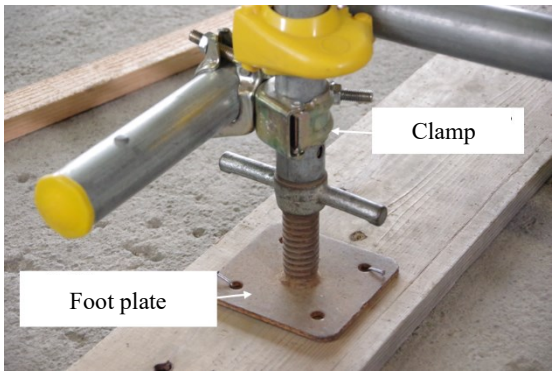
[Kotei base] (foot plate) Base fitting to fix an upright circular hollow section (*tateji* (upright circular hollow section)).

[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 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.

[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.

[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 using only the back and forth 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

5.1.3 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.

[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


Spanner

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.

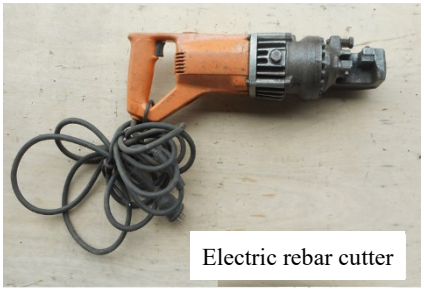
[Combination wrench] A wrench that has an opening and captures and turns bolts and nuts at two points. A combination wrench is a wrench with one spanner end and one box wrench end. The end is angled at 15 degrees to the grip, so the back and front sides can be used alternately to provide a rotating stroke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

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

5.1.4 Steel Reinforcement Work (Rebar Work)

[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.

[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.

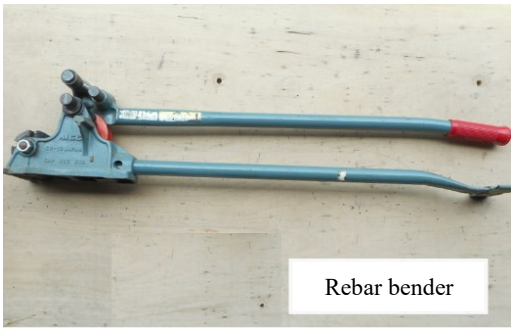

Electric rebar cutter

[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.

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


Rebar bender


Stationary rebar bender

[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.

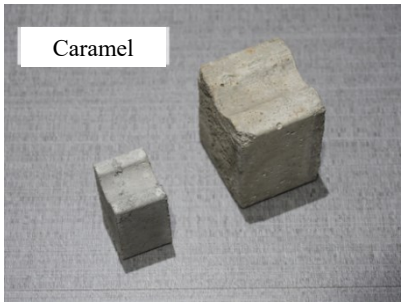
Rebar tier

[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 to secure space for the correct concrete cover thickness in columns, beams, and walls.

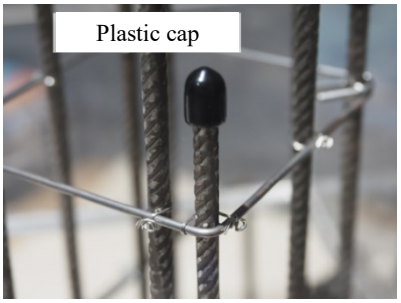
[Caramel] Dice-shaped mortar blocks placed under the floor rebars to secure space for the correct concrete cover thickness of the floor.


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.



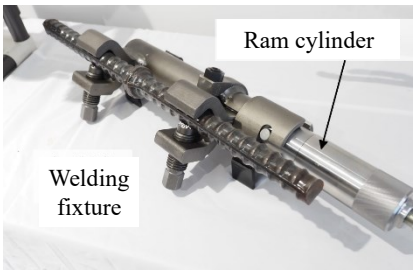
[Orijaku] (folding ruler) A tool for measuring short lengths. It is mainly made of fiberglass or wooden material and has an extended length of one meter. It is useful when working alone or in situations where it is difficult to work because it can be folded. This tool is often used in rebar work.

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

[Hacker] Rebars are tied together to secure them. 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.

[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.

5.1.5 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.

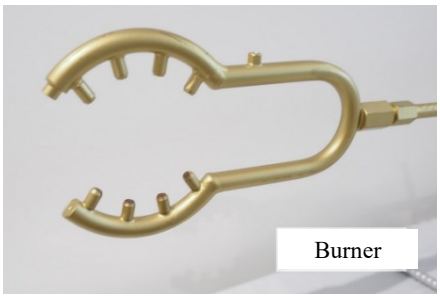
[Dendoshiki kaatsusochi] (electric pressurizer) A hydraulic pump that can set the pressurizing power as desired. Pressurization can be turned on and off with a switch at hand.

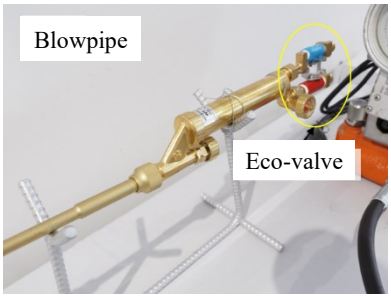
[Jido kaatsusochi] (automatic pressurizer) A machine in which pressurization sequences are programmed to automate pressurization.

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

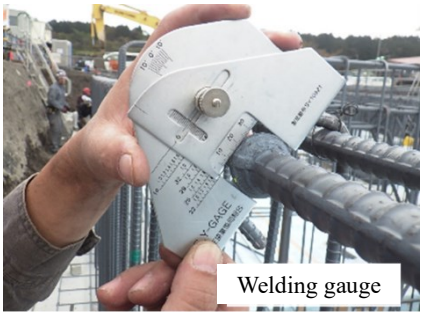
[Suikan] (blowpipe] A heating apparatus for mixing and delivering oxygen and acetylene gas.

[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.





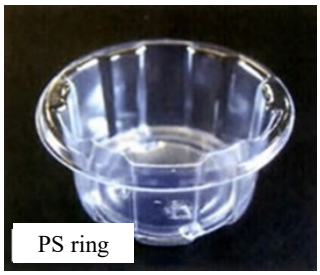
[Gaikan sokuteiyo kigu] (welding gauge) An inspection tool to measure the diameter and width of the bulge of the pressure-weld joint.



[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.

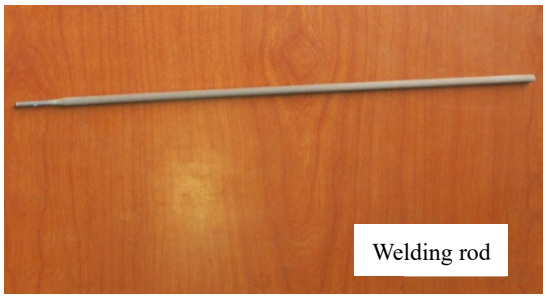
5.1.6 Welding Work

[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.

Shielded arc welding machine

[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.

[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.


Welding rod


Pliers

[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.

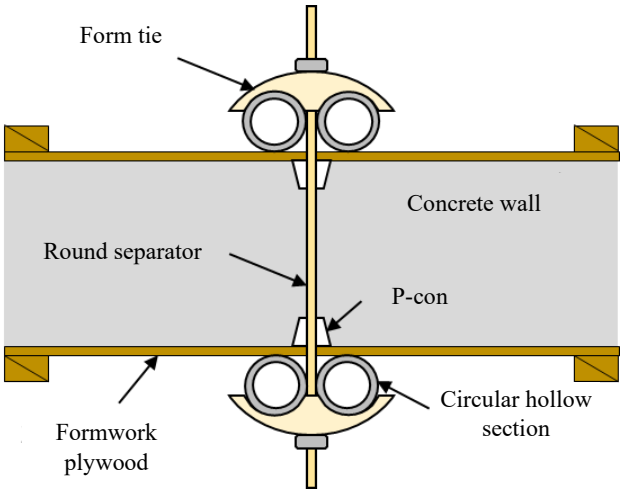
[Spatter fuchaku boshizai] (anti-spatter compound) Spatter is the slag and metal particles scattered during welding. Since they can lower the quality of the weld finish, this compound is used to prevent the spatter from sticking. The compound is applied to the material before welding by brush or spray.


Helmet with a face shield

[Shield-mentsuki helmet] (welding helmet) A helmet with a

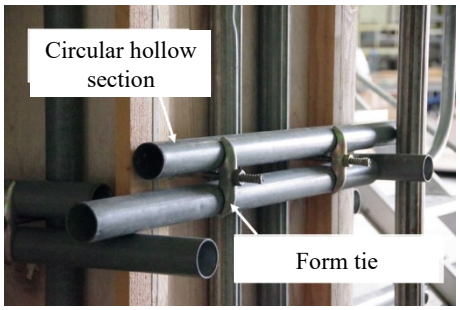
shield attached to it, protecting the entire face. Mainly used for welding work.

5.1.7 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.

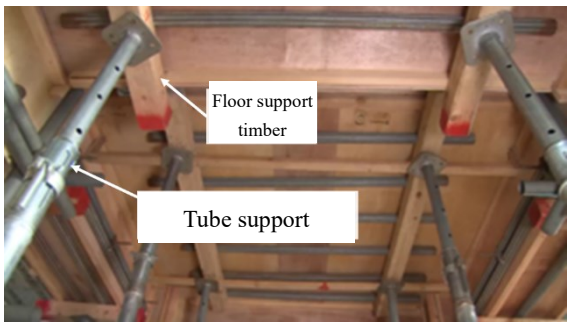
[Sekiita] (formwork plywood) Plywood used to make formwork. Generally, 12 mm thick *conpane* (formwork plywood) is used.

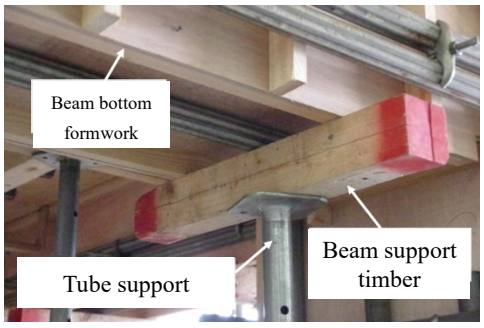
[Panel katawaku] (panel formwork) A panel-shaped formwork made by nailing pieces of batten onto plywood to create a panel. Panel formwork is intended for repeated use.

[Batakaku] (floor support timber) Square timber with a width of 90 mm or 105 mm. It is used to erect tube supports and to support 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] (beam support timber) Square timber often referred to as *tonbo* and used to construct pipe 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*.

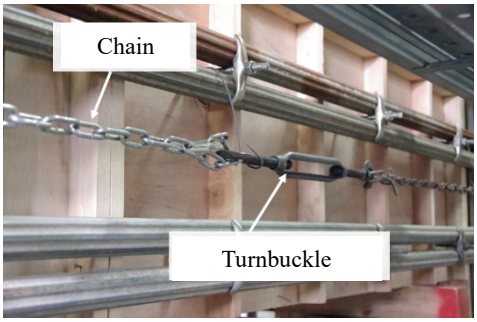
[Mengi] (cornering material) Material used to create corners with concrete.

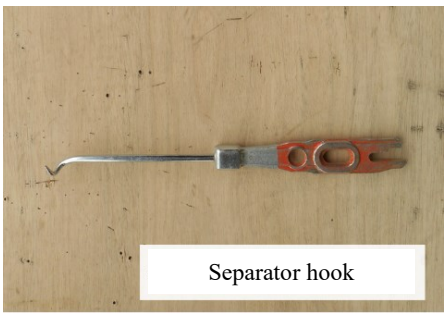
[Mejibo] (grooving rods) Material used to make grooves in the flat surface of concrete.

[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.

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

5.1.8 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.

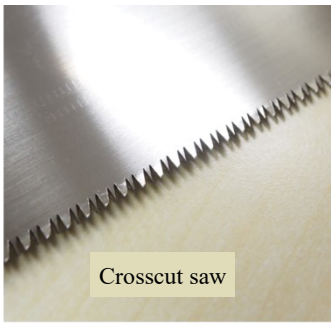
5.1.9 Carpentry Work


Hand saw

[Tenoko] (hand saw) A saw, also called hand saw, that cuts by hand. Some can be folded.

[Tatebiki nokogiri] (rip saw) A saw used to cut along the grain of the wood. On the other hand, a saw used to cut across the grain is called *yokobiki nokogiri* (crosscut saw). Rip saw and crosscut saw have differently shaped teeth.

[Ryoba nokogiri] (double-edged saw) A saw with teeth on both sides. One side is *tatebiki* (rip saw), and the other is *yokobiki* (crosscut saw). Both of these cut on the pull.



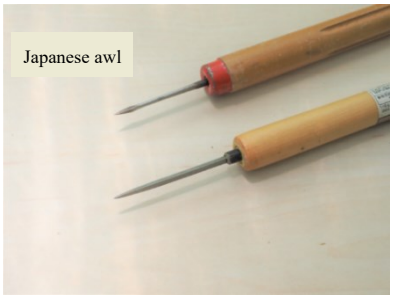
[Dotsuki nokogiri] (backsaw) The opposite side of the blade is reinforced with metal. The blade does not shake while cutting, allowing for a clean cut.

[Genno] (Japanese hammer) A woodworking hammer used for hammering nails and hitting wood chisels. It is slightly bulged to allow the nail head to sink into the wood at the end of the nailing process.

[Nomi] (wood chisel) A tool used for carving trenches or holes in wood. The type with a metal ring attached to the butt of the handle so that it can be struck with a hammer is often used. To maintain sharpness, it is necessary to sharpen the blade with a whetstone.

[Kanna] (hand plane) A tool used to shave and smooth the surface of wood. The blade is attached to a wooden base. To maintain sharpness, it is necessary to sharpen the blade with a whetstone.

[Kiri] (Japanese awl) A tool used to make holes in wood by rotating the blade. The handle is held between the palms of the hands, and the hands are moved to rotate the handle to make a hole. The shape of the tip of the blade differs depending on the purpose. Typical examples include *yotsumegiri*, *mitsumegiri*, *tsubogiri*, and *nezumihakiri*.



[Sujikebiki] (marking gauge) A carpenter's tool used to easily mark accurate lines parallel to the reference.

5.2 Interior and Exterior Construction

5.2.1 Plastering Work

[Mortar] A building material made by mixing cement with water and sand. Unlike concrete, it does not contain gravel. It is used for walls and floors of houses and as an adhesive for stacking bricks and blocks.

[Shikkui] (Japanese plaster) Slaked lime is the main ingredient in this coating material. It is made by kneading slaked lime with glue and *susa* (a plant fiber binding material). Because it is water absorbent and removes moisture, it has long been used as a coating material for the interior walls of

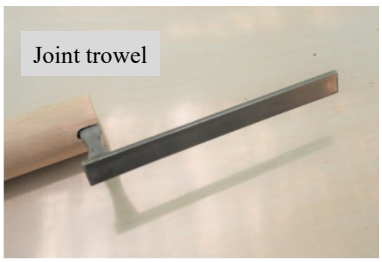
warehouses. It is also airtight.

[Kote] (trowel) A tool used to apply Japanese plaster or concrete to walls, floors, etc. There are many types, depending on usage. Plasterers use dozens of *kote* . Materials include iron, stainless steel, plastic, rubber, and wood. Each type has its own name, and when referring to it, for example, *shiage gote* (finishing trowel) *meji gote* (joint trowel), the term *kote* is modified as *gote*.

[Shiage gote/nakanuri gote] (finishing trowel/middle coat trowel) The trowel tip is pointed. Used for wall coating with Japanese plaster, diatomaceous earth, mortar, etc. A middle-coat trowel is used from the middle coat to rough finishing.

[Yanagiba gote] (willow leaf trowel) The shank is attached to the base of the handle and the heel of the blade. Suitable for working on small parts.

[Meji gote] (joint trowel) Used for finishing decorative joints of tiles, bricks, and blocks. It has a narrow width to match the joints.



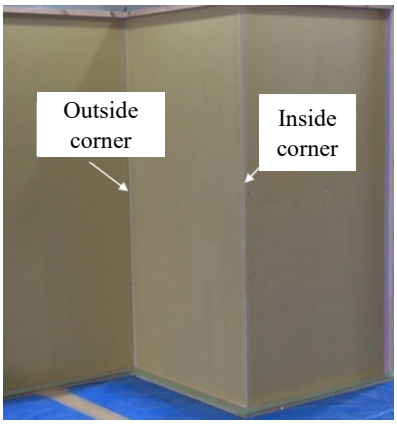
[Kaku gote] (rectangular trowel) The blade is rectangular and heavy. It is mainly used for *osae* (press) finishing.

[Renga gote] (brick trowel) A trowel used for stacking bricks. Shapes are *momo-gata* (peach-shaped) and *fuku-gata* (wider-shaped), and some sizes are used for tiling as well.

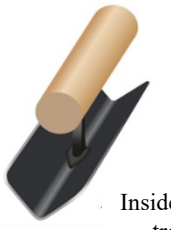
[Block gote] (block trowel) A trowel used for stacking concrete blocks. The tapered end makes it easy to pour mortar into the hole in the block.

[Menbiki gote] (outside corner trowel) Used to finish the outside corner.

[Kiritsuke gote] (inside corner trowel) Used to finish the inside corner.



Outside corner trowel



Inside corner trowel

[Kushime gote] (notched trowel) A part of the blade is notched like a comb. Used to apply adhesive or mortar in tile installation. It is also used to add patterns to diatomaceous earth walls.

[Koteita] (trowel board) A platform on which plastering materials and mortar are placed. It is held in one hand while working.

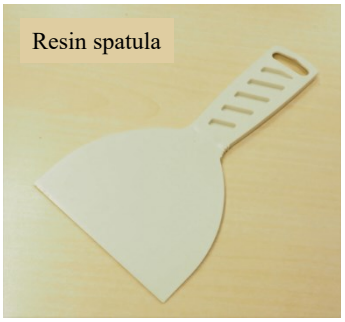
[Chiriboki] (dusting brush) A tool used in plastering work to clean up the *chirigiwa* (the area where the pillar meets the wall).

5.2.2 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.

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

[Hera] (spatula) This tool can be used to mix, apply, and scrape off paint.


Resin spatula

[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.

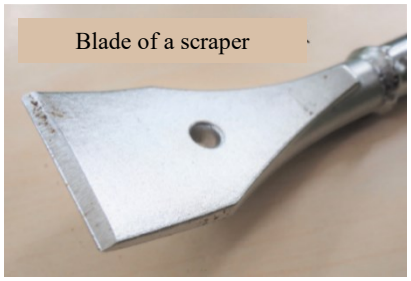
[Kanabera] (metal spatula) Used for various purposes such as mixing putty, leveling and finishing, and pressing sealant.

[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

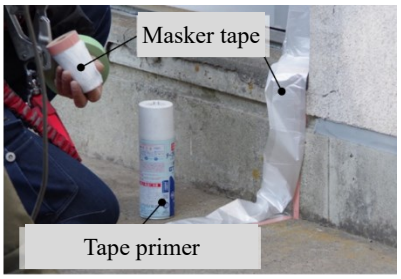
[Kawasuki] (skiving knife) The tool was originally used to skive skins, but because of its sharp blade, it is also used for *keren sagyo* (scraping work) in the painting process.

[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.



5.2.3 Roofing

[Kawarayo hammer] (roof tile hammers) A hammer used not only for hammering nails but also for processing roof tiles. The surface used to hammer nails is square to make it easier to split roof tiles. The other side is pointed.

[Kawara gote] (roof tile trowel) A trowel used for heaping up thatching soil and (*nanban*) plaster.

[Mendo gote] (roof-pointing trowel) A trowel used to apply Japanese plaster to the space (called *mendo*) between *noshigawara* (tiles on the roof ridge) and *shikigawara* (roof tiles).

[Tsurukubi] (crane neck) The shank of this trowel is longer than that of the roof-pointing trowel, like the neck of a crane. Used for plastering work.

[Kawara cutter] (roof tile cutter) A tool used to break tiles by push cutting them and processing

them into the required shapes.

[Niageyo winch] (hoisting winch) A machine used to hoist roofing tiles and other roofing materials up to the roof.

5.2.4 Architectural Sheet Metal Work

[Kananoko] (hacksaw) This saw can cut metal, plastic, plasterboard, bricks, etc. The blade is selected according to the material to be cut. A wood saw cuts on the pull, but a hacksaw cuts on the push.

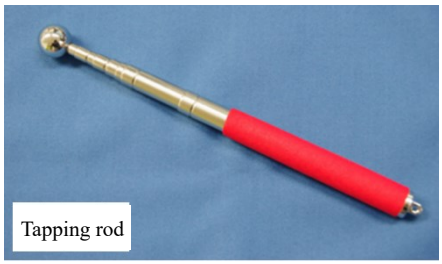
[Bankin basami] (sheet metal scissors) Scissors for cutting thin steel sheets. There are several blade tip shapes available, depending on the application, such as straight blades for easy cutting of straight lines and willow blades for easy cutting of curved lines.

[Yoyu aen mekki kohan] (hot-dip galvanized steel sheet) A galvanized steel sheet widely used for duct work. Also called *aen mekki teppan*.

[Toso yoyu aen mekki kohan] (coated hot-dip galvanized steel sheet) Hot-dip galvanized steel sheet coated with synthetic resin paint and baked. Also called *chakushoku aen teppan* or *color teppan*.

[Stainless kohan] (stainless steel sheet) An alloy steel of iron that contains chromium (11% or more). A thin protective film is formed on the surface, making it resistant to rust and able to maintain its beauty. It is used in kitchens and other places where humidity is high and cleanliness is required.

5.2.5 Tiling Work


Tapping rod

[Dashinbo] (tapping rod) A tool used to check for peeling tiles and floating mortar. The sound produced when the surface of the tile or mortar is tapped is listened to identify the location of the floating. There is also a type of tapping rod that is used by rolling a metal ball attached to the end of the stick.

[Tatakiita] (tile setter) A tool for applying mosaic tiles coated with mortar onto the surface by tapping.

[Shindo kogu] (vibration tool) A power tool used to improve adhesion of tiles. The tiles are set by vibrating the tiles and kneading in the mortar.

[Tile cutter] A pencil-shaped tool used to cut thin tiles. Tiles are cut by scratching the surface and breaking along the scratch. Tile cutters are used to scratch the surface and break the tile by tapping the back of the tile. For cutting thick tiles, tile *setsudanki* (tile cutting machine) is used. The tile cutting machine scratches the surface of tiles by pulling down the lever while pushing the tile forward, and by applying more force to the lever, it breaks the tiles along the scratches.

5.2.6 Interior Finish Work

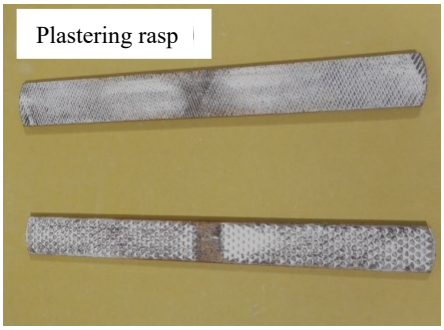

Plaster board

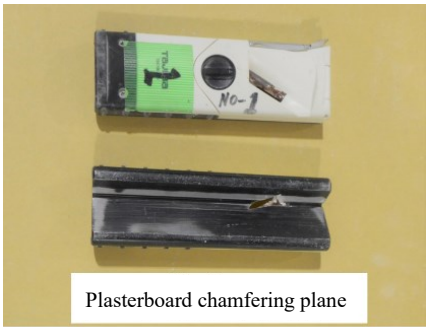
[Sekko board] (plaster board) A construction board material made of gypsum plaster core wrapped with base paper for boards. It is mainly used as a base material for walls. It can be easily cut by grooving it with a cutter and then folding it.

[Board yasuri] (plastering rasp) A tool used to smooth the cut edges of cut plasterboard.

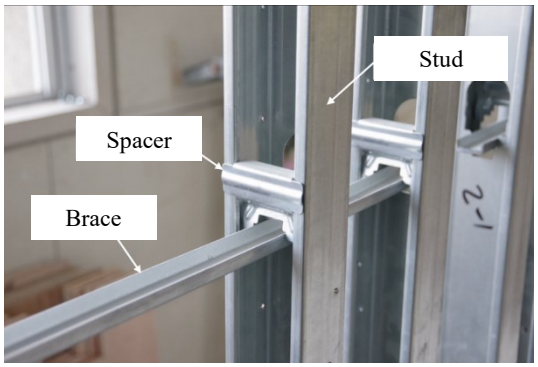
[Board mentori kanna] (plasterboard chamfer plane) A plane used for chamfering (smoothing

corners) of plasterboard.



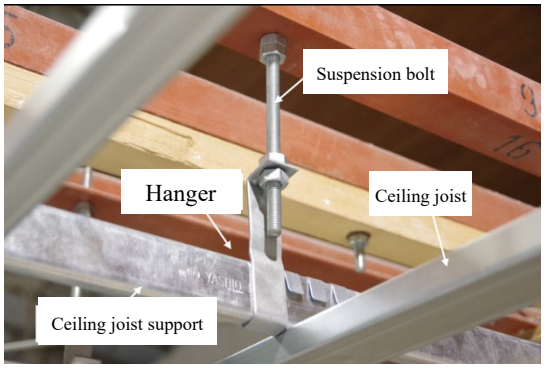


[Stud] Upright columns for partition walls in steel stud framing. It is inserted into the upper and lower runners for installation.



[Spacer] A fitting that is attached to a stud to prevent the stud from being crushed.

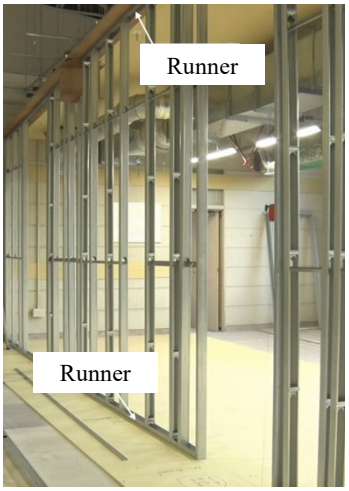
[Furedome] (brace) A member that suppresses the studs from swaying in the wall plane direction.



[Tsuri bolt] (suspension bolt) A fitting for suspending the ceiling base.

[Hanger] Attached to the suspension bolt, this fitting is used to hang the ceiling joist support.

[Nobuchi] (ceiling joist) A member for attaching a ceiling base or a finishing board for a ceiling. A wide ceiling joist is called <u>double *nobuchi*</u>.



[Nobuchiuke] (ceiling joist support) A member used to secure the ceiling joist.

[Nobuchiuke joint] (ceiling joist support joint) A fitting to connect two ceiling joist supports.

[Clip] A fitting used to secure the ceiling joist to the ceiling joist

support.

[Runner] In steel stud framing, this rail is used to erect upright studs as a base for partition walls. The lower side is fixed on the floor slab and the upper side is mounted under the beam or under the slab.

[Joint tape] Tape used to smooth the joints of the plasterboards. Fiber tape and other tapes are used.

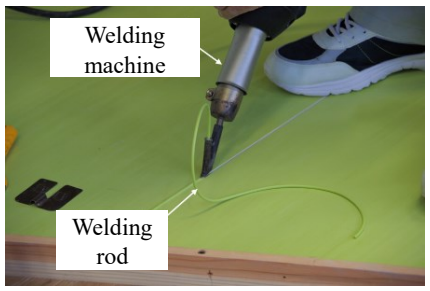
5.2.7 Interior Surface Work

[Senmai toshi] (eyeleteer) Also called *hoshitsuki*. A tool used to make holes in soft objects such as cloth and paper. It can also be used to mark out dimensions or to crease wallpaper, etc.

[Compass] A tool used to draw circles and arcs, and to transfer the same length to another part or material. It has two legs, one with a needle and the other with a pencil or mechanical pencil.

[Divider] Similar to a compass, but has needles on both legs. It is used for the purpose of transferring the same length to another part or material.

[Yosetsuki] (welding machine) A tool used to treat the joints between vinyl floor sheets or vinyl tiles. The welding rod is melted and integrated with the joint.



[Yukazai acchakuyo roller] (roller for pressure bonding flooring material) A roller used to firmly bond flooring material to the substrate using pressure. It is constructed in such a way that it can pressure bond by the weight of the worker.

[Cross roller] A roller used to pressure bond the wallpaper onto the substrate.

[Osae hake] (wall brush) A brush is used to push air out of the wallpaper and to stretch out wrinkles.


Cross roller


Wall brush

5.2.8 Fittings Work

In fittings work, almost the same tools are used as in carpentry work. Also, a screwdriver is used to secure the door to the frame.

5.2.9 Sash Setting Work

[Kusabi] (wedge) Made of hard wood, metal, or rubber, it is thick on one side and thin on the other. Inserting the thin part into a gap and striking it can split wood and other materials. It is also used for positioning when installing sash frames.

5.2.10 Polyurethane Spray Foam Insulation Work

[Dannetsuzai] (insulation) Materials used to block or retain heat.

[Koshitsu urethane foam dannetsuzai] (rigid polyurethane foam insulation) Insulation made by foaming polyurethane into a hard sponge-like state. It has excellent insulation properties because it has trapped gases that do not conduct heat easily.

[Koshitsu urethane foam gen'eki] (rigid polyurethane foam liquid) Rigid polyurethane foam is

made from polyisocyanate and polyol components. Mixing and stirring the two liquids causes a chemical reaction that simultaneously forms polyurethane and foams to create rigid polyurethane foam.

5.2.11 Waterproofing Work

[Torch burner] (blow torch) A tool used in the torch method of asphalt waterproofing. The asphalt waterproofing membrane is attached to the substrate by melting it with a blow torch at a temperature of over 1000°C. It is used by connecting a propane gas hose from a propane gas tank.

[Sealing gun] A tool used to inject sealant in a cartridge into the work area. Sometimes called a caulking gun.

[Tacker] A large stapler-like tool. It is used to fix waterproof sheets, heat insulating materials, and finishing touches for interior materials. Types of tackers include gun tackers, hammer tackers, electric tackers, and air tackers.

[Primer] Material applied to the substrate to improve the adhesion of the waterproof layer to the substrate.

[Asphalt roofing] A waterproofing membrane made by soaking asphalt into the base paper made mainly from natural organic fibers. It has the property of softening at higher temperatures and hardening at lower temperatures. In locations where there is a large temperature difference between summer and winter, it will deteriorate over the years, causing cracks and fissures, resulting in loss of its waterproofing property.

[Kaishitsu asphalt roofing] (modified asphalt roofing) A waterproofing membrane made by mixing asphalt with rubber, synthetic resins, polymers, plastics, etc. to increase durability in order to reduce deterioration caused by temperature changes, which is a disadvantage of asphalt.

[Karyu gomukei sheet] (vulcanized rubber sheet) A waterproofing membrane made from

vulcanized rubber (rubber with the property of expanding and contracting).

[Enbi sheet] (PVC sheet) A waterproofing membrane made of polyvinyl chloride resin. It has excellent resistance to ultraviolet rays, heat, and ozone from sunlight.

5.2.12 Masonry Work

[Block hammer] (brick hammer) A hammer used to break concrete, brick, stone, etc. One side is flat for striking, and the other side is tapered flat and pointed for easy scraping and cutting.

[Koyasuke] (chisel with a perpendicular handle) A type of *nomi* (chisel) used to break stones. One side of the head is a blade. The opposite side of the blade is struck by *setto* (iron mallet) to break stones.

[Setto] (iron mallet) A small iron mallet.


Iron mallet

[Bishan] (bush hammer) An iron mallet used to tap the surface of stone that has been carved with a masonry chisel or other tools to smooth it out. The tapping surface has fine protrusions. At first, hammers with larger protrusions are used to tap the surface, and then gradual switching to hammers with finer protrusions finishes the surface.

[Kanajime] (garden hammer with a metal ring) It is in the shape of a hammer, but has an iron ring attached to the butt of the handle.

5.3 Common Tools, Machines, Materials, and Measuring Instruments

5.3.1 Power Tools

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

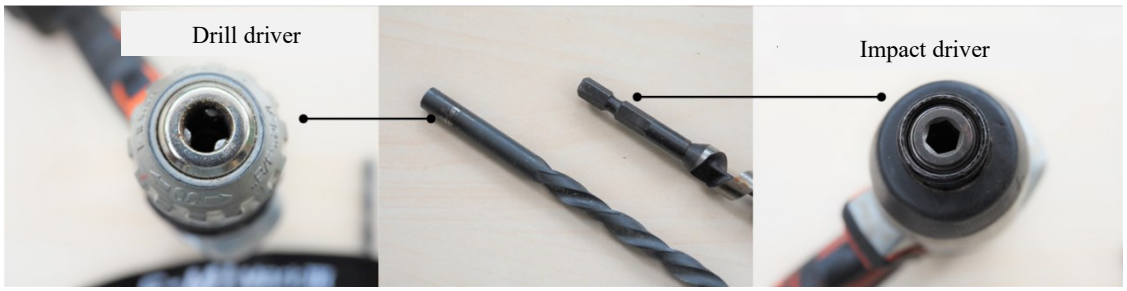
[Drill driver] This electric screwdriver can be used for screwing and drilling by changing the bits. Rotation speed and torque can be adjusted.

[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.

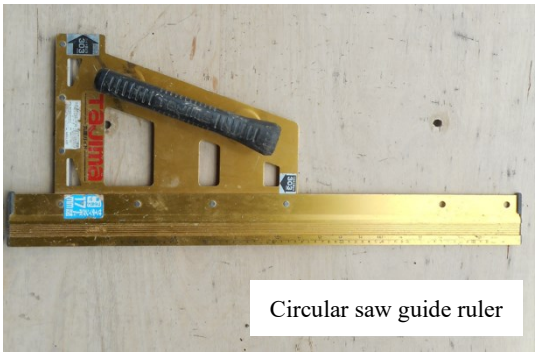


[Disk grinder] (angle grinder) This power tool can cut, grind, and remove paint from metal pipes and concrete by changing the disc (a round, flat grinding stone for grinding and cutting) attached to the end of the tool. The high speed torque type is suitable for metal cutting, while the low speed torque 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. Whereas the blades of chip saw cutters are prone to wear, the blades of high-speed cutters are characterized by their longevity.


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.


Nail gun

[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.


Cord reel

5.3.2 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.

[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.

5.3.3 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


Punch

(this is called marking).

5.3.4 Measuring/Inspecting


Level

[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.

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


Transit

[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.

[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.


Line level

[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.

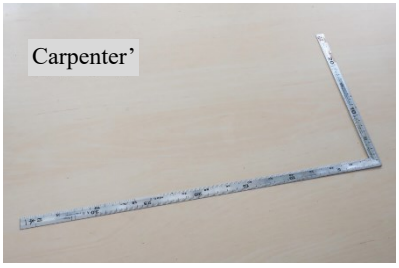

Level

[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.

[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.

[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.



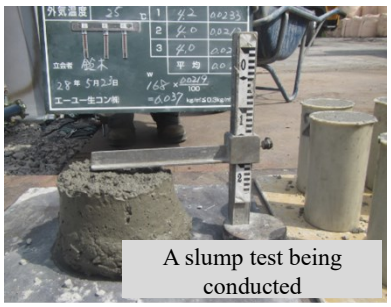
[Ogane] (triangular ruler) A large triangular ruler for measuring right angles. It is made on site using the Pythagorean theorem, the ratio of 3:4:5 . The 3:4:5 is called *sashigo* at the worksite.

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

[Convex] (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.

[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.

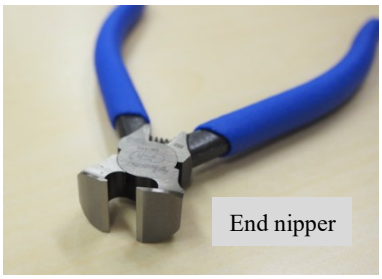

A slump test being conducted

5.3.5 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 chisel


Pliers

5.3.6 Tapping/Pulling

[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*.

Example of a hammer (for ringlock scaffolding)

[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.

Rubber 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.

Wooden hammer

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.

[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.


Crowbar

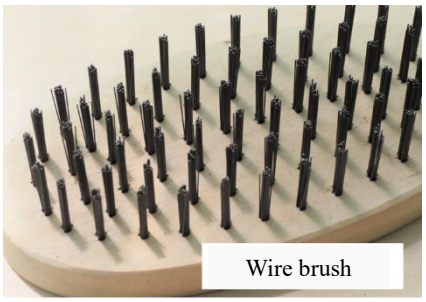
5.3.7 Filing/Polishing/Boring

[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.

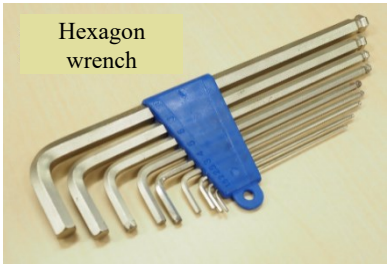


5.3.8 Tightening/Fixing

[Monkey Wrench] A wrench that has 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.

[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.



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

[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

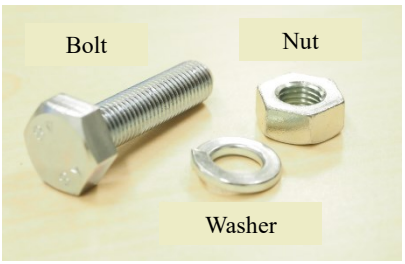
screwdriver for electrical work is round and large so that the hand can easily wrap around it.

[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.

[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.



5.3.9 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.

[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.

5.3.10 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.

5.3.11 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.

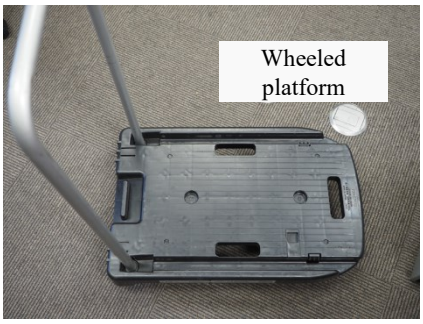
[Wes] (rag) Cloth used to wipe off stains from machine oil and other liquids.

[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.

5.3.12 Carrying Things

[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*.



[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.

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

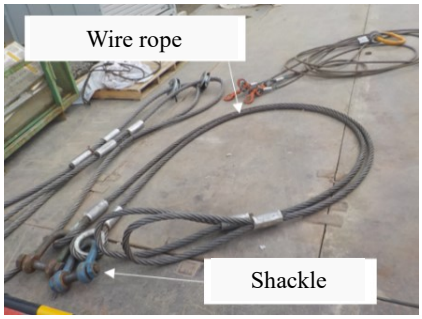
[Koro] (log) A log used to move heavy objects. Several are placed parallel to each other, an object is placed on top, and the object is moved as the logs roll.

[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

5.3.13 Hanging/Lifting/Pulling

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

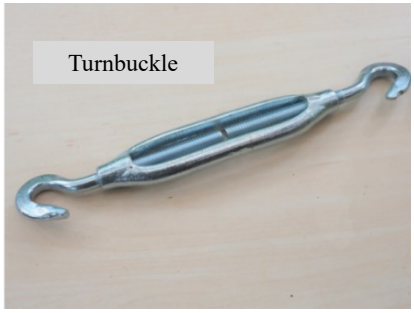

Wire rope
Shackle

[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.

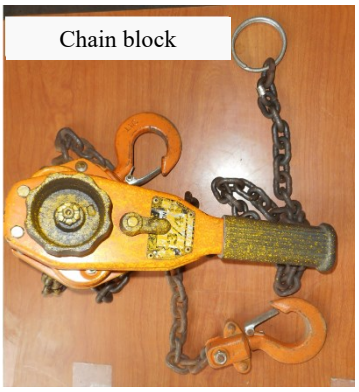
[Shackle] A slinging fixture for connecting a wire rope or chain to a suspended load.

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


Shackle


Turnbuckle

[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).

5.3.14 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.


Stepladder

[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.

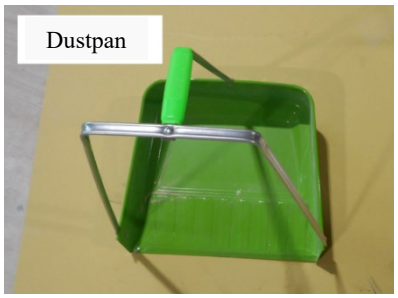
[Rolling tower] A platform for working at heights. There are casters on all four corners to move it around. There are safety standards for rolling towers under the Industrial Safety and Health Act.

[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.

5.3.15 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.



[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 Scaffolding Work

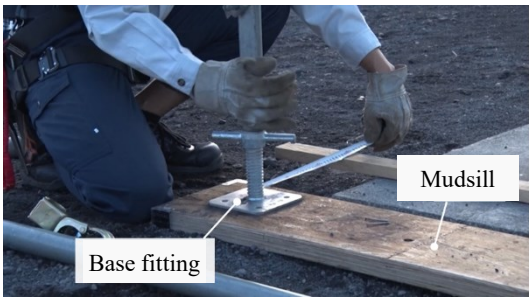
As explained in Chapter 3, there are many different types of scaffolding work. This section describes scaffolding construction. There are several types of scaffolding, including timber scaffolding, tube scaffolding, framed scaffolding, and ringlock scaffolding, but there are some construction tips that 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 sinks, the entire scaffold can crumble. In addition, the ground is made as flat as possible so that there are no gaps between the mudsill and the ground.

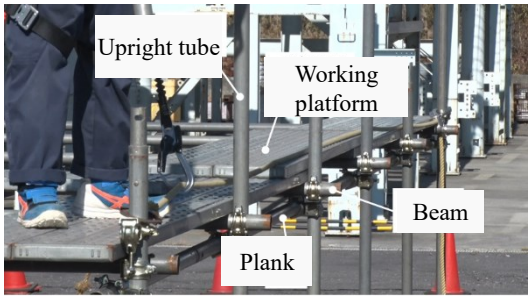
(2) Fixing the legs

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

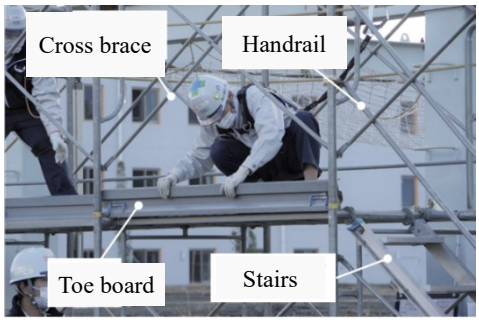
Connect the upright tubes on the front side (the building side) and the rear side (the outside) using braces, and attach the scaffold board (working platform) on top of it.

(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.

6.2.2 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.

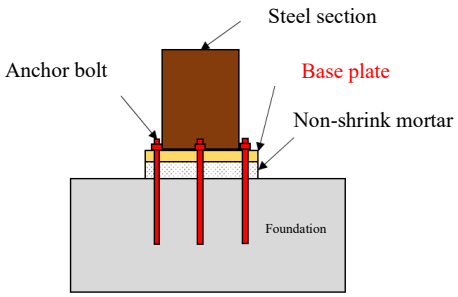
(2) Foundation frame construction

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.


Example of base plate installation

(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.

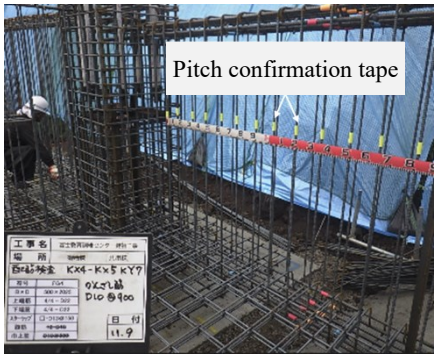
By adding beams, the columns will be pulled and will not be able to maintain their verticality. The frame is pulled with wires to re-align the steel frames, then the nuts are tightened properly, and then the intersection is welded (stud welding).

6.2.3 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.



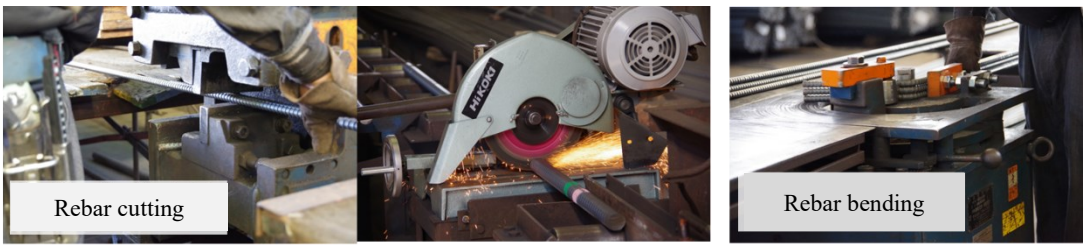
In the case of thin slab rebars, the bars are joined by a

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.

(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 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.

Foundation beam reinforcement

(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

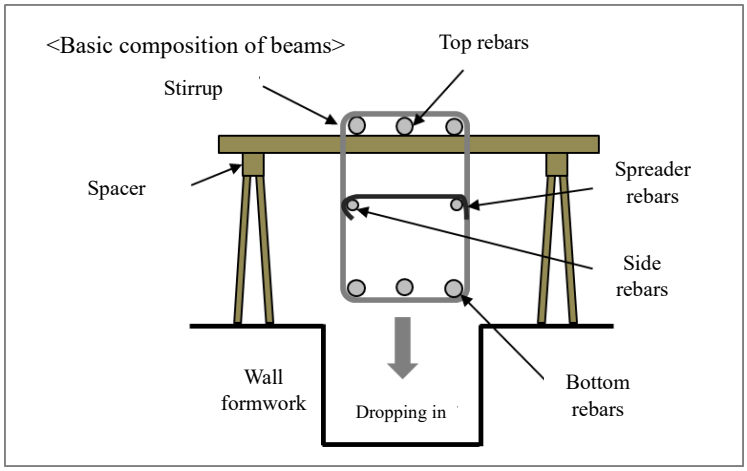
The frame provides the reinforcement for the walls, beams, and slabs.

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

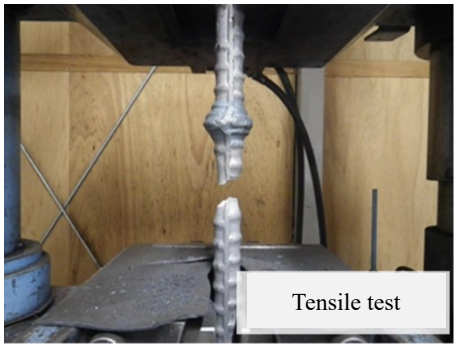
placing reinforcement, placing reinforcement for openings reinforcement, placing spreader rebars, and placing spacer blocks.

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.



6.2.4 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.

(1) Checking rebar butts

Check for bends in the rebar.

(2) Processing of rebar butts

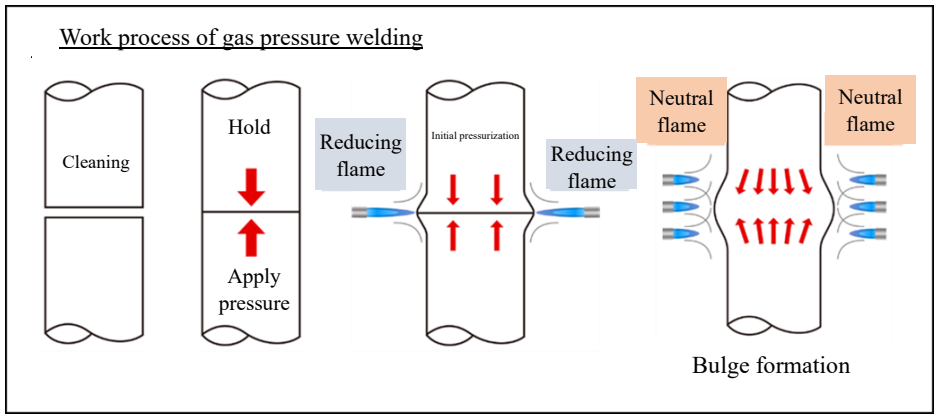
Rebars are cut by push-cutting at steel construction sites, and therefore their butts are unsuitable for pressure welding as they are. Since the cut surface oxidizes over time, the rebar is cut using a cold-cutting, right-angle rebar cutter on the same day that pressure welding is performed.

(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.



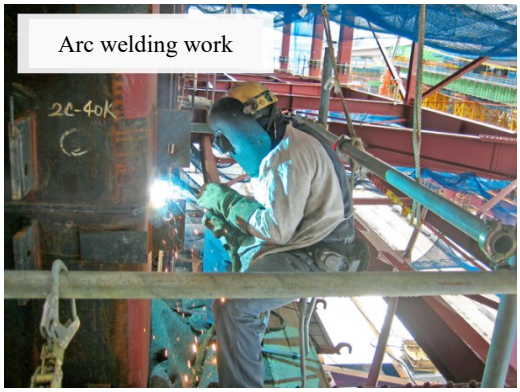
(5) Inspection

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

Examples of bad bulging

6.2.5 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.

6.2.6 Formwork Carpentry


Formwork carpentry

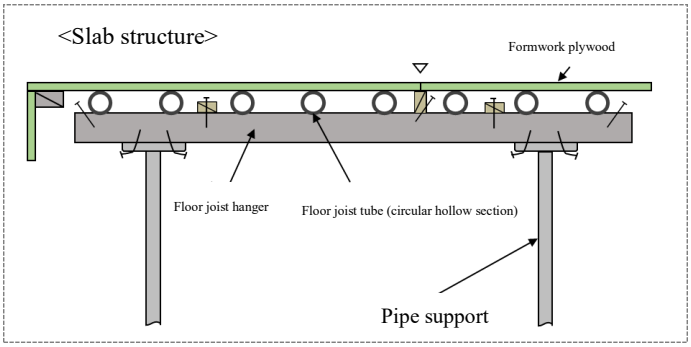
When fresh concrete is poured into a formwork, the formwork is subjected to several times the pressure of the same volume of water. Insufficient reinforcement of the formwork can lead to accidents where the formwork breaks (blow-out) and ready-mixed concrete flows out. In order to prevent blow-outs,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


Tightening form ties

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.

6.2.7 Concrete Pumping Work

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.

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.

Concrete placement by a pump truck

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.

6.2.8 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

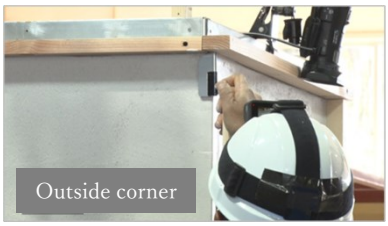
Paint should be applied only where necessary, and therefore, do not forget to cover the areas that do not need to be painted. Cover the floor with a polyethylene sheet, apply masking tape to the border of the area to be painted, and use masker tape to cover large surfaces such as walls. In addition, in exterior

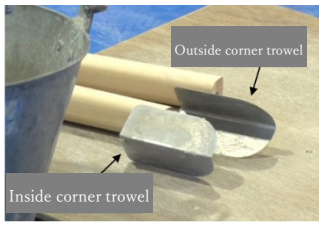

Covering work

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.

6.2.9 Plastering Work

Plastering is work in which knowledge and skill have a particular impact on the finished product. Plastering requires a high level of skill to ensure that there are no imperfections when it comes to the flat finish. Plastering in general housing is also expected to contribute to the design, so it is a creative job that requires not only technical skills but also a sense of style. The main tools used in plastering are *kote* (trowels) and *koteita* (trowel boards), and many different trowels are used depending on the area to be painted and the finishing method.

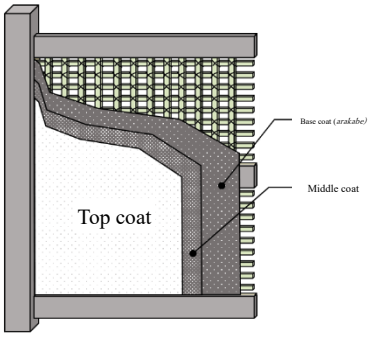




For example, the photo above shows the finishing of the middle coat on the outside corner and the inside corner. To press-finish, *kiritsuke gote* (inside corner trowel) is used for the outside corner and *menbiki gote* (outside corner trowel) is used for the inside corner.

More than the surface coat that is visible as the finished product, the difference in technical skill is apparent in whether or not the base coat can be painted delicately and flatly. The base coat quality directly affects the finish coat.

There are several types of base coats. For example, the photo on the right shows the painting process of traditional *Kyo-kabe/Juraku-kabe* clay walls. First, the wall is constructed of woven bamboo, onto which clay is applied in the following order: base coat (*arakabe*), middle coat, and top coat. A more recent method is to apply a base coat on gypsum board or lath board, followed by a middle coat.



Process of *Kyo-kabe/Juraku-kabe* walls

6.2.10 Carpentry Work

Carpentry work constructs wooden buildings. What is important in carpentry work is to know the properties of wood and to master the use of tools. Wood is not a homogeneous material and has disadvantages such as being prone to cracking and deformation. A worker unfamiliar with the properties of wood can easily split the material during processing. For processing and assembly, electric tools are used these days, but in general, tools that have been handed down from generation to generation are also used. In particular, cutting tools such as *nomi* (wood chisels) and *kanna* (planes) must be maintained by the workers in order to keep them sharp.

The traditional construction method is the *jikugumi koho* (Japanese timber framing) which combines horizontal members such as foundations, beams, and girders with vertical members such as columns. The diagonal members, called *sujikai* (cross braces), provide strength to the building as a whole. Lumber is joined together by a combination of processed members called *tsugite* (splices) and *shikuchi* (joints). Splices and joints are intricately carved using wood chisels and *kanazuchi* (hammers), but recently, machine-made parts with high-precision cutting are also being used to assemble on site. In recent years, the spliced/joined parts are reinforced with hardware to provide strength. After the concrete foundation is completed, the Japanese timber framing is carried out according to steps (1) through (12) shown below. During the construction process, many craftsmen

are involved, including those in plumbing, electrical, interior finishing, sheet metal, and roofing, so it is important to work closely with them.

(1) Laying the foundation

On top of the foundation, a base for the columns is installed.

(2) Installation of the through column, hanger columns, outer floor beams, and beams,

A through column is a single-piece column that passes though the first- and the second-stories. It serves to support the outer floor beams (called *dosashi*) on the second and third floors. Hanger columns are columns that are specific to each floor.

(3) Temporary brace

Members are mounted at an angle to keep the columns vertical and prevent deformation of the timber framing. This is called *sujikai* (cross brace).

(4) Installation of the second-story hanger columns, girders, and beams

The second-story hanger columns are erected on top of the first-story outer floor beams, and girders and beams are attached. A girder is a member orthogonal to a beam.

(5) Vertical roof strut

Vertical members that support the roof (called *koyatsuka*) are attached.

(6) The purlin and the ridgepole

The purlin (the member that receives the rafters) and the ridgepole (the uppermost member of the timber frame) are attached.

(7) Installation of rafters

Rafters to support sheathing and roofing materials are attached.

(8) Installation of sheathing

Sheathing is attached to the rafters. Sheathing is a component that serves as a base for roofing materials.

(9) Completion of the framework

Construction up to this point completes the framework (*joto*). It is sometimes referred to as *muneage*, *tatemae*, or *tatemai*.

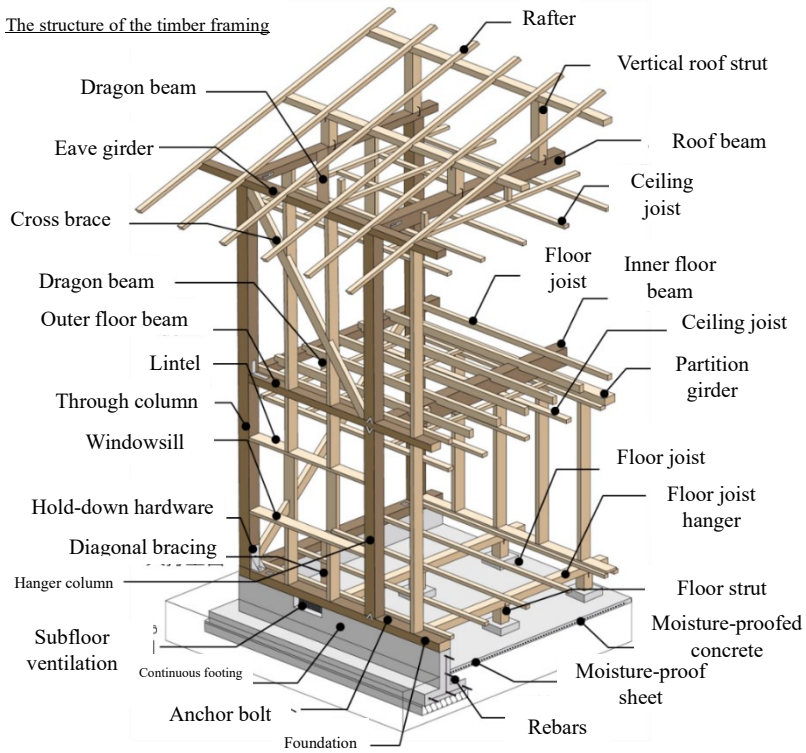
(10) Installation of the cross brace

Install the cross brace and remove the temporary brace.

(11) Installation of wall studs and hold-down hardware

Wall studs (*ma-bashira*) are attached between the columns to serve as the wall base material. In addition, reinforcement members called hold-down hardware are installed to prevent the columns from being pulled out from the foundation and beams.

After the above construction is completed, roofing, interior, exterior, fittings, equipment, and electrical work will be performed.



In addition to timber framing, there is also the 2x4 method, also called *wakugumikabe koho*. Panels for walls and floors are made using 2 x 4-inch members and plywood, and panels are joined to each other using special hardware. Compared to conventional Japanese timber framing, traditional tools are used in very few situations, construction is easier, and can be erected in a shorter construction period.

2x4 method

6.2.11 Roofing Work

Material for roofing include clay tiles, cement/concrete tiles, slates, corrugated sheets, galvanized steel, copper sheets, and asphalt shingles. Clay tiles are used for Japanese houses, shrines, and temples. Clay tiles have the advantages of long service life, heat insulation, soundproofing, and do not require painting, but their disadvantage is that they are a bit heavier, so consideration must be given to the earthquake resistance of the building itself.

The purpose of a roof is shield and protect a building from rain and snow. Therefore, the most important point in roofing work is waterproofing. The entire roof is waterproofed with sheet materials such as asphalt roofing. Large flat areas of a roof rarely leak if the substrate is properly waterproofed, but leaks are more likely to occur where flat surfaces are joined with another flat surface or a wall. Such areas use special roof tiles and sheet metal fabricated components called *mizukiri* (flashing). In the case of tile roofs, for waterproofing, the tile joints are filled with a material called *nanban shikkui* (nanban plaster) using *kote* (trowel).

Rainwater that travels down the roof will go around the edges of the roof and damage the building, so it is necessary to do *amajimai* (rain-proofing) work. Rain-proofing is a structure that directs rainwater into gutters and down to the ground.

Japan lies long from north to south and the climate differs by location, so roofs suited to each region

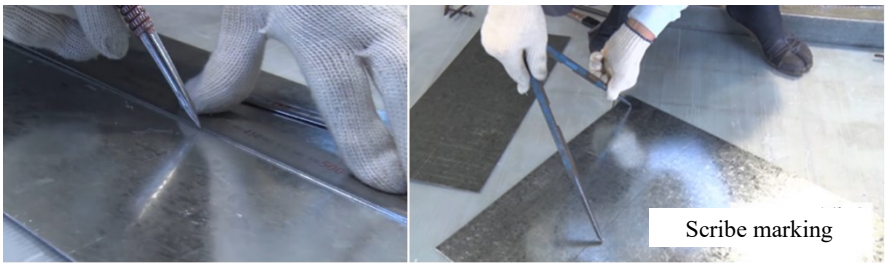
are constructed. For example, in regions with heavy snowfall, a metal fitting called *yukidome* (snow guard) is installed on the roof. Without snow guards to prevent snow on the roof from falling down, snow can fall and break the eaves. Okinawa buildings use uniquely shaped tiles to protect buildings from objects blown into the air by typhoons. It is also important to know that the shape of the roof and roofing materials vary depending on the location where the work is to be done.

6.2.12 Architectural Sheet Metal Work

Architectural sheet metal work involves cutting, bending, punching, welding, and otherwise processing thin metal sheets to create components that meet the intended use and install them. This work is needed in a wide range of areas, including plumbing and roofing. The basic operations required to process steel plates are scribe marking, cutting, bending, and welding. When making products with complex shapes, a technique called hammering is required. This is a task that requires high skill and therefore it will be omitted here.

(1) Scribe marking

Scribe marking is done in a single step as much as possible, using scribing needles, dividers, and metal rulers. When making several of the same item, gauges are made for efficiency.



(2) Cutting

The sheet metal is cut carefully, lifting the part to be retained by hand so that the scissors can easily enter. Keep the eyes on the scribe lines and continue to cut along the scribe lines. Cut edges are smoothed with a metal file.

(3) Bending

Using *kage tagane* (wide chisel) and a hammer, the sheet metal is tapped from the back side along the scribe line. This way, the surface can be bent slightly in the desired direction. Next, using an anvil or the corner of a platform called surface plate as dollies, the piece is gradually bent to the required angle by tapping it with a hammer.

(4) Welding

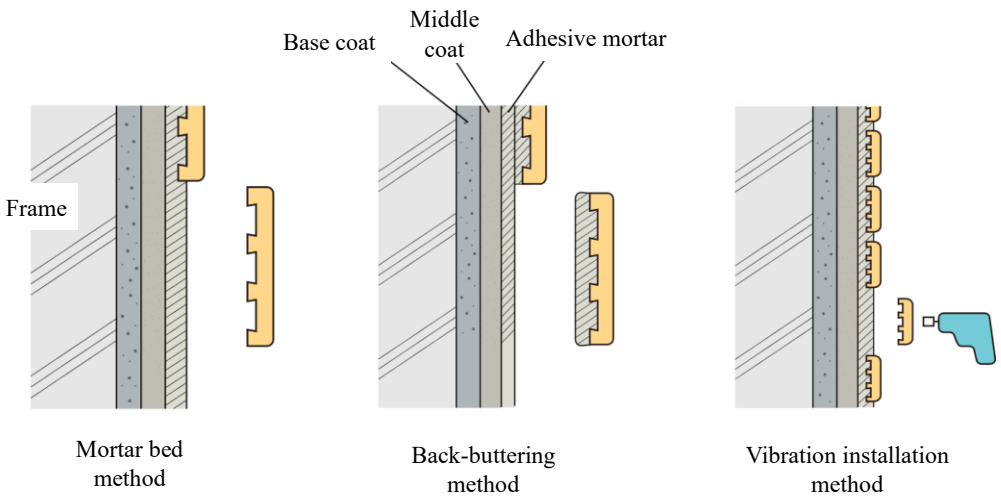
The welding method most commonly used in sheet metal welding is the fusion welding method, in which a filler metal (welding rod or wire) is melted to make the joint. Secure overlapping parts using clamps. Next, temporarily attach the joints at a 10 mm pitch. The key to this welding is to melt the welding rod while maintaining a set distance between the parts and the fire. This work requires concentration and is therefore performed in a comfortable position.

6.2.13 Tiling Work

When tiles come off, it is called *hakuri* (debonding). Also, tiles can detach and fall off, or *hakuraku*. Tiles from high places debonding and detaching can lead to life-threatening accidents. In tiling work, the most important thing is to ensure that the tiles do not debond or detach.

In a method known as *acchaku-bari* (mortar bed method), the substrate is coated with adhesive mortar, and tiles are pressed onto the mortar. The tiles have grooves on the back side called *uraashi*. The tile is wiggled as it is pushed into place so the mortar goes into these grooves, and then tapping them in with *kizuchi* (wooden hammer), *tatakidai* (tapping board), etc. A certain amount of time (open time) must be allowed between the application of the adhesive mortar and the installation of the tiles. Failure to take proper open time can cause debonding and detaching.

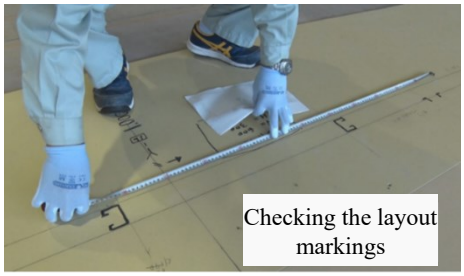
Because of the difficulties in taking this open time, *kairyo acchaku-bari* (the back-buttering method) was invented. Mortar is applied to the substrate and the back of the tile, and the tile is pressed against the substrate. Another idea was to apply adhesive mortar to the substrate surface, and then use a tile vibrator for tiling. It is called *micchaku-bari koho* (the vibration installation method). This method can also be used to finish the joints by pressing down the mortar rising up from the joints with *meji gote* (joint trowel). Another method is to use flexible tile adhesive instead of mortar. When adhesive is used, it begins to harden about 30 minutes after application. Be systematic in determining the area to be tiled and positioning them before the adhesive hardens.



6.2.14 Interior Finish Work

Interior work is largely divided into steel stud framing, drywalling, and ceiling and floor finishes. This section describes steel stud framing and drywalling. Both tasks may be done by one person, and it is important to make sure to prepare tools, process and count materials, etc., so as not to interrupt the flow of the work.

(1) Steel stud framing


Checking the layout markings

Steel stud frames are divided into two categories: partition frames, which are walls, and ceiling frames. Both are installed according to the layout markings. Even if there already are layout markings, do not begin work; always check the layout markings for walls, doors/windows, fittings, equipment doors, etc. with the construction drawing.

To make the construction process more efficient, check the number of materials to be used and arrange them in such a way that they can be easily picked out according to the work procedure. Scaffolding should be erected for ceiling work to make the work easier. There are places inside the wall where pipes for electrical outlets, gas, water, etc. run. These are the jobs of other contractors, but it is important to consider the interfacing when working so they do not clash with the studs, which reduces rework.


Material preparation

(2) Drywalling

Gypsum board for drywalling can be easily cut by making a shallow cut with a box cutter and then applying force. Gypsum boards can be bent to some extent, so it can be fixed to gently curved surfaces as it is, while gently conforming it to the substrate. If the radius is small, use a box cutter to make evenly spaced cuts in the board surface base paper, which is then folded to the front side and secured

with self-drilling tapping screws.

6.2.15 Interior Surface Work


Applying putty

Corner taping the outside corner

Interior surface work involves finishing the walls, floors, and ceilings of a building's interior.

(1) Wallpapering the walls and the ceiling

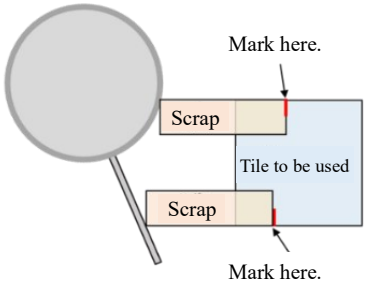
The most common problem with wallpapering is the visibility of the substrate condition on the wallpaper, resulting in a poor finish. For gypsum drywalls, the joints where the boards butt together must be smoothed out. Use fiber tape on the joints, apply putty, and polish to make the joints smooth and flush with the board surface. For the outside corner, use a corner tape, apply putty, and then polished.

In the case of concrete/mortar walls, if the substrate is not treated, it will result in poor adhesion, causing the wallpaper to lift and peel. Apply the base coat sealer, putty the surface with a water-based seal putty or similar, and sand it smooth.

Wallpaper is applied while removing air with a brush. Corners are well pressed down with a corner spatula, and adhered while wiping off excess glue with a sponge.

(2) Finishing the floor

There are many types of floor finishing materials, including wood, vinyl, carpet, and tile materials. The difficult part of using any finishing material is processing the material to fit the intricately shaped corners. For example, use scrap material with the same length as the tiles to mark the position of the cuts, or if there are round columns, use a divider to transfer the shape of the columns to the material.



Marking out a round column

6.2.16 Fittings Work

Fittings work is the installation of wooden or metal fittings. Installed fittings must have specified levels of wind pressure resistance, air tightness, water tightness, and earthquake resistance. Especially in Japan, where earthquakes are common, ensure that fixtures do not become dislodged or unable to open and close due to earthquakes. This section describes the installation of wooden fittings.

Wooden fittings include *kamachi-do* (framed doors), flush-*do* (flush doors), *fusuma* (opaque sliding panel), and *tobusuma* (wooden sliding panel), which are processed and assembled by fixture craftsmen. When fittings are installed as sliding doors, *kamoi* (door lintel) and *shikii* (threshold) with grooves cut for the sliding doors are installed at the doorway. Alternatively, door wheels are attached to the bottom of the fixture and a rail is attached to the threshold. When fittings are installed as swing-open doors, hinges are used.

(1) *Kamachi-do*

The frame called *kamachi* is assembled, and a board called *kagami-ita* is inserted between the frames. The inside of the *kamachi* can also be divided by vertical and horizontal planks called *kumiko*. Glass is also sometimes used instead of *kagami-ita*. The design could be modified to match both Japanese and Western-style architecture.

(2) Flush-*do*

A door with a framework sandwiched with finishing panels. Flush doors are often used for interior doors. Thick boards are used to give it a sense of heaviness when used for entrance doors.

(3) *Fusuma*

A wooden frame to which paper is pasted, with added rim and pull handles. It is used to separate a Japanese-style room from another Japanese-style room.

(4) *Tobusuma*

Fittings used to separate a Japanese-style room from a Western-style room. The Japanese-style room side is in *fusuma* style, and the Western-style room side is covered with decorative veneer, etc.

6.2.17 Sash Setting Work

Sashes are fittings made of aluminum and glass. It is more airtight than wooden fittings. In the case of a wooden structure, a frame is made on the building side for the sash to be installed so that the sash frame will fit properly. For concrete walls, the opening is larger than the sash frame, so the installation work proceeds as follows.

(1) Checking the installation position

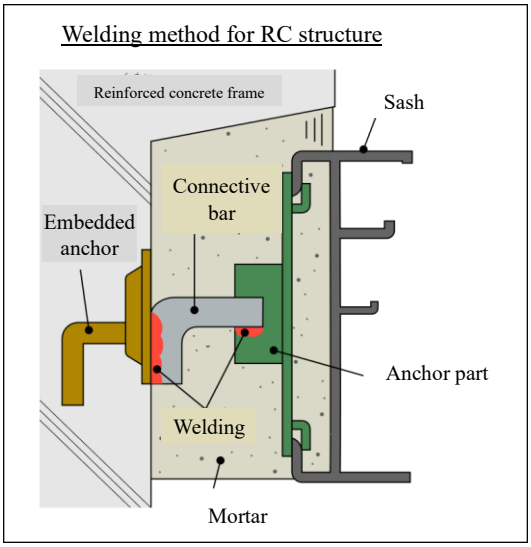
Check the installation position by looking at the reference mark drawn in advance on the area to be installed.

(2) Temporarily fix with wedges

Temporarily fix the frame using *kusabi* (wedges). Using multiple wedges, the height and in/out are measured and fine-tuned to determine the position. A check for distortion is also conducted at this point.

(3) Weld the rebar and sash anchors

Rebars are embedded in the concrete walls to weld the sashes in place. This rebar and the weldable anchor on the sash side are welded together by electric welding.



(4) Fill in the gaps

Fill the gap between the sash frame and the concrete wall with mortar.

(5) Glass installation

Install the glass and adjust the movement.

6.2.18 Polyurethane Spray Foam Work

When foaming rigid polyurethane foam, it is important to control the temperature and pressure of the solution.

Types of individual liquid and solvents	Handling precautions
Polyisocyanate component	Store at around 20°C, as high temperatures will alter the composition and low temperatures will cause solidification and precipitation. It reacts with water to produce carbon dioxide, so never contaminate it with water. Containers that have been contaminated with water should not be closed, as they may burst. Do not use open flame to heat storage containers.
Polyol component	Store at around 20°C. It is usable for the period of around three months. Always close the container properly, because the foam ratio changes when the component is contaminated with water. Since the container may have internal pressure, open it gradually to

	release the pressure. Do not use open flame to heat storage containers.
Cleaning solvent	Because of its flammability and anesthetic properties, be careful of vapor emissions and handle in a wide open area. Open flames are strictly prohibited.

Spray foaming machines are used for spraying work. The foaming machine is designed to achieve a certain mixing ratio of the two liquid components. If the foaming machine fails and the ratio of the polyisocyanate component becomes excessive, the foam becomes dense and brittle. Excess polyol content results in low density and softness. Rigid polyurethane foam is self-adhesive, so it can strongly adhere to the target surface to create a thermal insulation layer without the use of adhesives. However, if there is moisture or oil on the target surface, adhesion strength will be significantly reduced. Spraying at low temperatures also reduces adhesion. During spraying, the thickness is checked every 4 to 5 m using an urethane-*atsu sokuteiki* (polyurethane foam thickness gauge).

Polyurethane spray foam work

6.2.19 Waterproofing Work

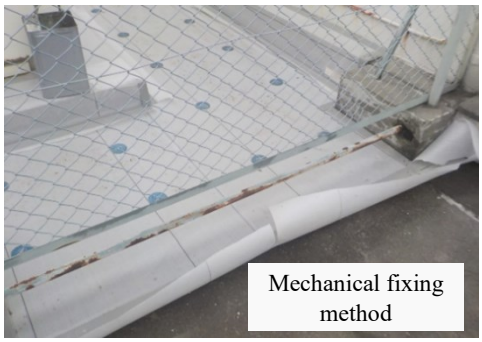
In waterproofing work, it is important to select the right materials, substrate, delivery method, and finish according to the construction site. There are several waterproofing methods, depending on the materials used. This section describes sheet *bosui* (sheet waterproofing).

Sheet waterproofing uses PVC or rubber sheets as the waterproofing layer. It is characterized by its ability to efficiently waterproof large areas. There are two types of methods: secchaku koho (the adhesion method), which uses a special adhesive, and kikaiteki kotei koho (the mechanical fixing method), in which the sheet is fixed to the waterproofed area by a machine. For both methods, the spots to watch out for are the drain (drain opening) and the inner corners of where the flat area meets a raised surrounding.


Adhesion method (asphalt sheet waterproofing)

In the *secchaku koho* (the adhesion method), a special adhesive is applied to the substrate and the sheet is fixed by adhesion. It is important to keep the substrate clean and free of debris, because dirty substrate causes improper adhesion, causing accidents such as the sheet peeling off and being blown away by strong winds. Insert sealant in the overlapping areas of the sheets, and press the entire area well.

Kikaiteki kotei koho (the mechanical fixing method) is a method of fixing sheets using fixing discs. Since it is less affected by the substrate, the construction period can be shortened, especially in renovation projects. On a flat surface (flat area), lay out the insulating sheet and fix it using kotei disc (fixing disc). Then, spread the PVC sheet over it and join the overlapping parts with a welding agent. Areas that have not fully bonded are fused together with a hot air blower.


Mechanical fixing method

Then, using a special machine called an induction heater, heat is applied to the mounting portion of the fixing discs to integrate them with the insulation sheet. Finally, the joints of the PVC sheets are treated with a liquid seal as secondary waterproofing.

6.2.20 Masonry Work


Masonry work in a public bathhouse

Masonry work includes the processing of stones, building structures using stonework, and installing stones onto structures. Specifically, the construction methods used and the skills required differ depending on the building's exterior walls, interior walls, floors, bathrooms, entrances, gardens, etc. For example, in exterior wall construction, there are two types of methods: *shisshiki koho* (the wet-set method), in which marble, granite, and other stone materials are placed with mortar, etc., and *kanshiki koho* (dry masonry), in which the stone materials are fixed to bolt anchors and other hardware attached to the frame. The wet-set method is more prone to post-installation defects and requires the use of appropriate adhesives.

The use of natural stones for crazy paving for entrances requires a sense of combining various shapes of stones, and the processing of crazy paving stones requires a skilled craftsman.


Masonry work with crazy paving stones

When handling heavy stones, take precautions to avoid accidents during transportation and possible falling of stones. When processing stones with a grinder, handle the grinder with care and wear protective goggles and masks to protect against dispersed dust.

6.2.21 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.


Soundproofing sheet

(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 that occur 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 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 .1Numbers of Fatalities 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.

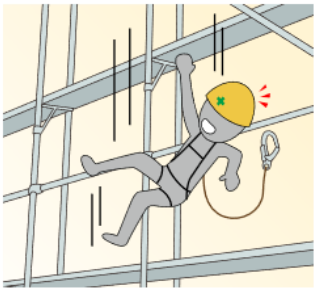
[Kotsu jiko (doro)] (traffic accident (road)) Industrial accidents that occur while commuting to and from construction sites, and industrial accidents that occur when a worker is involved in a general automobile accident during construction work next to a road.

[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

The most common type of fatal accidents at construction sites is death by falling from heights. In particular, accidents tend to occur more frequently during work on scaffolding and during the assembly and disassembly of scaffolding. In addition, falls from slippery slate roofs occur in roofing work, and falls from high trees occur in landscaping work. When working at heights, be sure to wear and use full-harness fall protection gear. Scaffolds should be equipped with middle and lower ledgers at predetermined positions for fall prevention. Also, do not pass through areas other than the designated work passageways. Opening should be covered with a fall prevention net. Tripping and falling accidents also occur. Do not place unnecessary items in the passageways.

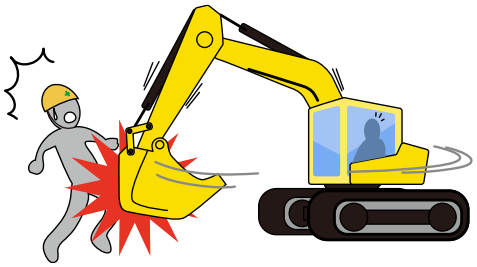


(2) Collapsing

Accidents occur due to collapsing of scaffolding and buildings under construction. Both collapses are of large, heavy objects and can lead to major accidents. Preparing a stable scaffold foundation is fundamental. There should be no gap between the mudsill and the ground, and the base fittings should also be firmly nailed to the mudsill.

Even if the foundation is well constructed, it can collapse due to strong winds. Curing sheets and soundproofing panels covering the scaffolding can sway and flap by strong winds, which pull on the scaffolding and cause it to collapse. In some cases, strong earthquakes are the cause of collapsing. This is caused by human factors, as in inadequate construction by not securing wall tie anchors properly, using fewer materials (called *mabiku* (thinning-out)), and other corner-cutting. In the event of high winds, collapse can be prevented by removing some or all of the sheeting, adequately reinforcing wall tie anchors, and periodically inspecting for loosened fasteners and other loose parts.

(3) Struck-By/Caught-In/Between

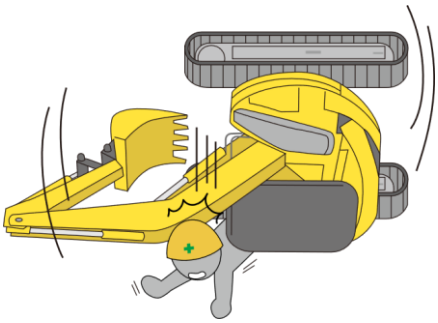


The most common accidents involving construction machinery are caused by backhoes and cranes. Backhoes have caused accidents such as collision between the circling arm/bucket and a person, or a person getting caught between the bucket and an object.

An accident also occurred when a flagger of another vehicle failed to notice a dump truck backing up and got caught-between. 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.



Tipping over accidents can also occur with large cranes. In addition to tipping over caused by lifting objects beyond the crane's capacity, tipping over can also occur due to improper use of outriggers to support the vehicle body.

(4) Flying/falling

Flying and falling accidents are caused by flying or falling objects. 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.

7.1.3 Work with A High Number of Fatalities

(1) Building construction

On construction sites, there is a lot of work that involves coming and going on scaffold planks at high elevations. In construction work, wearing full-harness fall protection gear is required when working in areas exceeding a height of 5 m. However, accidents have occurred when the gear is worn but

not used. In addition, buildings under construction have many openings, and accidents involving falling through these openings also occur.

(2) Housing construction

Although the number of fatal accidents in wooden-frame construction is smaller than in building construction, nonfatal injuries are very common. In 2021, for example, there were 845 falls from heights and 168 slipping/tripping/falling/tipping over. Death by falling from heights does not always occur by falling from high places; it can also occur by falling from lower elevations. Carpentry work involves working on top of beams. Falling from beams have resulted in fatal accidents. Scaffolding can be erected around the building, but it is difficult to erect solid scaffolding for carpentry work, which is often done in confined spaces. When working in such areas, it is important to wear a helmet, and wear and use a safety belt.

Another falling hazard to watch out for is losing balance and falling from stepladders and ladders. The following must be observed.

> Do not work on the top of a stepladder.

> Do not work astride a stepladder.

> Do not climb up and down stepladders or ladders while holding objects with both hands.

> Do not climb up or down a ladder without the top or bottom end of the ladder secured. Before use, check the condition of the anti-slip caps on the bottom legs.

If space is available, use stepladders with handrails, rolling towers, portable work platforms, and aerial work platforms, which pose less of a fall hazard than stepladders and ladders.

The number of fatalities and injuries, known as *kire/kosure* (being cut/scraped), is also significant, at 284 in 2021. The most common cause is due to misuse of *marunoko* (circular saw). For example, in the picture on the right shows a worker with gloves, but a circular saw should never be operated with

Example of a dangerous way to use a circular saw

gloves on. Gloves may get entangled in the spinning blade. Also, when the wood to be cut is not properly secured, it could kick back and cause accidents.

(3) Traffic accident (road)

Fatalities resulting from automobile accidents are a common occurrence in the construction industry as a whole. 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.

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.

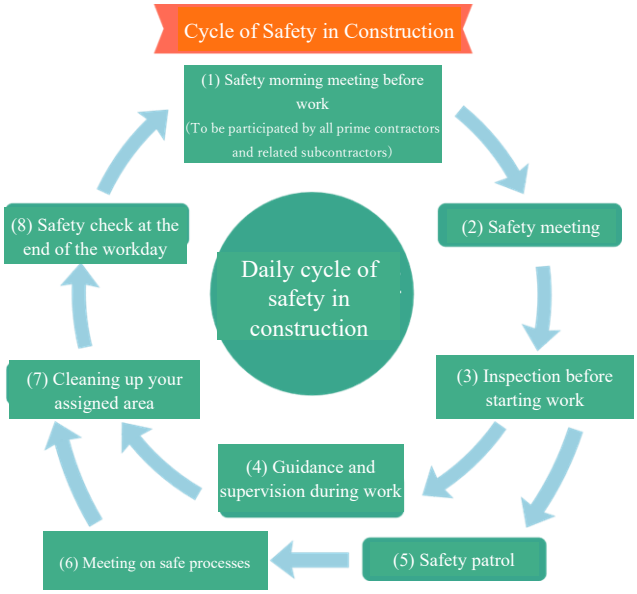
b. Facilitate cooperation between the prime contractor and other related subcontractors.

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!”