Examination Category (Lifeline Infrastructure/Equipment Installation)

Textbook for the Practical Examination

Ver.20220908

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

Chapter 6: Knowledge on Construction Site Work

Chapter 7: Safety during Construction Work

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

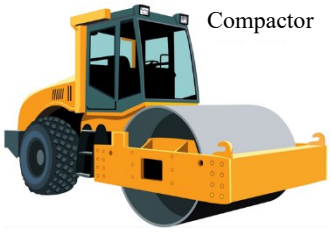
5.1 Tools, machines, materials, and measuring instruments specific to job categories

5.1.1 Construction Machines

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


Hydraulic excavator

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


Compactor

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

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


Tire roller

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


Vibratory roller

[Tractor shovel] (tractor excavator) A machine with a bucket attached to the front of the tractor.

Earth and sand can be scooped up and loaded onto dump trucks using the bucket. In addition to buckets for excavating earth and rocks, the truck can be equipped with a fork for moving obstructing vehicles, etc., and a water gun for firefighting. There are two types of models: the wheel type and the crawler type.

[Wheel 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.

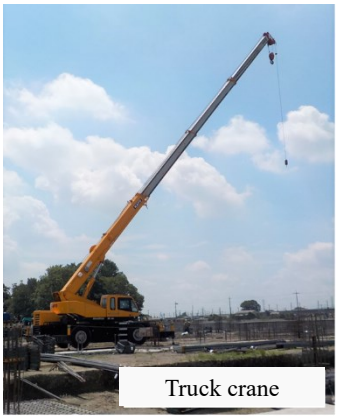
Dump truck

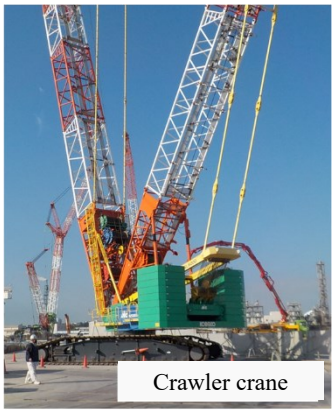
[Crane] A machine that uses power to lift and transport a load horizontally. There are several types of cranes, including tower cranes, truck cranes, and crawler cranes.

[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: mast climbing, where the crane section climbs up a jointed mast, and floor climbing, where the entire pedestal climbs up the building.

[Truck crane] A construction equipment 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.


Truck crane


Crawler crane


Tower crane

5.1.2 Electrical Work

[Kendenki] (voltage tester) A device that checks whether or not an electric charge is present. There are low voltage testers and high voltage testers.


Voltage tester

[Kensoki] (phase tester) A device to check the direction of rotation (phase order) in the 3-phase, 2-wire power supply wiring.

[Tester/multimeter] A device to check the condition of electric circuits, voltages, etc.

[Contester] (outlet tester) A measuring instrument to check the positive/negative and grounding of electrical outlets.

[Clamp meter] A measuring instrument that can measure electric current by simply inserting an electric wire between the clamps of the sensor section.

[Dendo hammer] (electric hammer) A power tool for digging through walls and slabs to clear piping paths.

[Mawashibiki] (drywall hand saw) A saw used to make openings in plasterboard or formwork plywood.

[Bender] A tool used to bend metal pipes.

[Densenkan] (conduit) A metal or synthetic resin tube that can hold electric wires inside.

[Kato densenkan] (flexible conduit) A conduit that can be bent freely.

[Kinzokusei kato densenkan] (metal flexible conduit) A metal conduit that can be easily bent.

Metal conduit

Synthetic resin flexible conduit (PF conduit)

[PF kan] (PF conduit) PF is abbreviation for Plastic Flexible. Synthetic resin flexible conduit without flame resistance.

[CD kan] (CD conduit) CD is abbreviation for Combined Duct. Synthetic resin flexible conduit without flame resistance. It is often used for underground installation in concrete.

[E kan] (E conduit) A steel conduit without threading. The thickness is the external dimension and is expressed as E19, E25, and so on.

[C kan] (C conduit) A thin-walled metal threaded conduit, also called a thin steel conduit. Because it is more impact-resistant and durable than synthetic resin conduit, it is used for exposed indoor piping.

[G kan] (G conduit) A thick-walled metal threaded conduit, also called thick steel conduit. The surface is plated to provide weather resistance.

[Void kan] (cardboard tube) A tube made of paper used to make holes that penetrate slabs, beams, walls, etc.

[Coupling] A connector that connect conduits of the same type. To connecting different types of conduits, combination couplings are used.

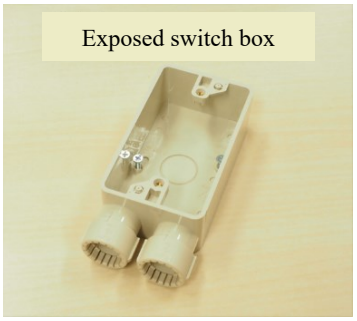
[End cover] A cover used at the point where the cable is pulled out from the ceiling.


End cover

[Stud bar] A fitting used to easily attach a box to the wall or slab using the wall or slab reinforcement.

[Roshutsu box] (exposed box) A box is installed on the wall in a visible manner.

[Roshutsu switch box] (exposed switch box) A box to house wiring fixtures for outlets and switches.


Exposed switch box

[Outlet box] A box used for branching and connecting wires in wiring work.

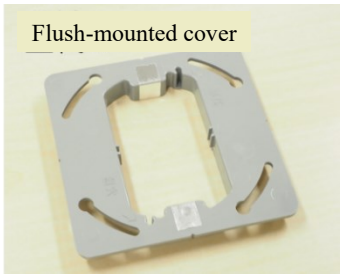
[Radius clamp] (grounding band clamp) An installation fitting for electrically connecting steel outlet boxes and metal pipes.

[Pull box] (junction box) A box used for connecting cables to cables and for branching. Since cables cannot be connected or branched in the conduit, this is done inside the junction box. Boxes are made of metal or plastic.

[Nurishiro cover] (flush-mounted cover) A cover to be installed on boxes that are embedded in concrete.


Outlet box


Junction box


Flush-mounted cover

[Box connector] A member used to connect an outlet box to a metal or PF conduit. It is attached to the box side.


Box connector for threadless conduit


Box connector for PF conduit

[Asshuku tanshi] (compression terminal) A terminal for connecting a wire to a device to another wire. Pressure is applied to the connection to crush the terminal and secure the wire. Various shapes and sizes are available for different applications.

[Asshukuki] (compression tool) A tool used to join compression terminals and wires by applying pressure to the joint.

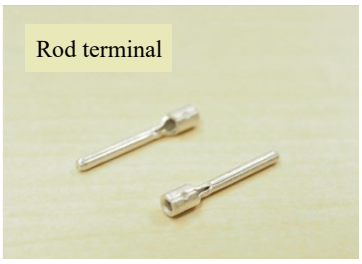
[Acchaku penchi] (crimpers) A tool used to join crimp terminals and wires by applying pressure to the joints of the crimp terminals. Two types are available: one for terminals (with red handles) and one for ring sleeves (with yellow handles).


Crimpers

[Acchaku tanshi] (crimping terminal) A terminal attached to the end of an electric wire for connection. The cable is secured by placing it in the hole of the crimp terminal and crushing the entire crimp terminal to secure the cable. Use the appropriate tool for the crimp terminal.

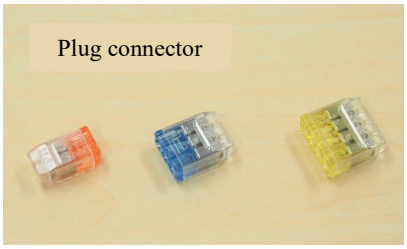
[Ring sleeve] A member used to connect multiple wires. The core wires are inserted into the ring-shaped hole and crimped using a crimping tool for ring sleeves.

[Botanshi] (rod terminal) A crimp terminal with a rod-shaped terminal end.



[T-gata connector] (T-connector) A connector used to crimp the bus bar and branch line when branching a wire from the middle of the bus bar.

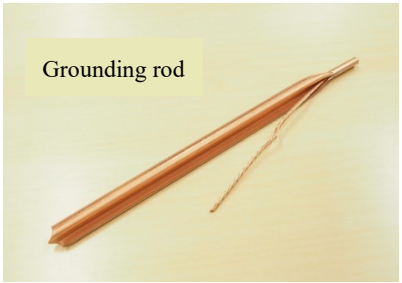
[Sashikomi connector] (plug connector) A member used when connecting wires. Connection can be made simply by inserting the core wire.



[COS] Abbreviation for Change Over Switch. A changeover switch.

[Jiko yuchaku tape] (self-amalgamating tape) A tape that when wrapped around a pipe or other object while being stretched 2 to 3 times, the back and front sides of the tape adhere to each other. It is used for water pipes and water leakage prevention.

[Secchibo] (grounding rod) A rod driven into the ground for grounding. It is commonly made of steel with copper plating. Also called earth rod.



[Lead tanshi] (lead terminal) A member that connects the grounding rod and ground wire.

[Handhole] A block manholes used for electrical and telecommunications wiring.

[Bell mouth] A member is used to prevent damage to the cable when pulling the cable in.

[Yobisen] (fish tape) A wire that is passed through a pipe in advance to make it easier to pass the main line, when pulling an electric wire or cable through the pipe. The main line is connected to the fish tape and pulled through the conduit using the fish tape.

[Cable rack] A ladder-shaped rack used to organize many power lines and other cables together. When the number of cables is small, cable hooks are used.

[Yakumono] (special-shaped part) A specially shaped member used in a specific position or for a specific purpose.

[Tsugite] (joint) A member used to connect two parts. When connecting two cable racks, *jizai tsugite* (universal joint) that can be used to connect cable racks at an angle to each other can be used.

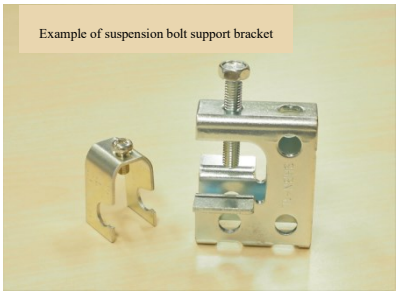
[Earth bond sen] (earth bonding wire) A connection wire used to electrically connect racks when cable racks are connected. There are also fittings called non bond *tsugite* (non-bonded joint) that do not require earth bonding wires.

[Ductor channel] A member for supporting cable racks and conduit pipes. The cross section is U-shaped.

[Raceway] A member with power supply function for attaching lighting and other members. By using suspension bolts, lights can be installed in places such as warehouses where there is no ceiling finish.

[Furetome] (brace) A member that supports the raceway at an angle to prevent it from swaying.

[Tsuri bolt] (suspension bolt) A bolt that attaches to an insert embedded in the slab. For bolts, long *zen neji* bolt (fully threaded bolts) without heads are used.


Example of suspension bolt support bracket

[Tsuri bolt shiji kanagu] (suspension bolt support bracket] A bracket used to hang suspension bolts from various types of steel members and deck plates without drilling holes. Various shapes are available depending on the mounting point.

[Double nut] Two nuts attached to prevent the nuts from loosening due to vibration.

[Saddle] Fittings for attaching conduit pipes directly to walls and ceilings.

[Ban] (electric control panel) A device for supplying electricity to each device by branching the power supply. Inside are breakers and other components. There are *jiritsuban* (freestanding panels) that are placed on the floor and *kabekakeban* (wall-mounted panels) that are mounted on the wall.

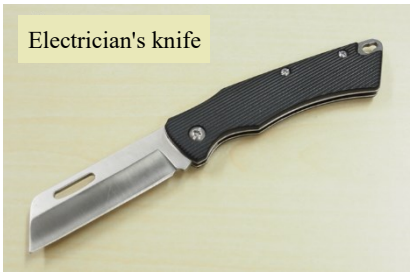
[Channel base] A base that is inserted between the panel and the floor when a freestanding panel is installed.

[Zetsuen densen] (insulated wire) A wire made of copper or other material that conducts electricity and is surrounded by an insulating sheath.

[Wire stripper] A tool used to strip coated wires of their sheaths.

[Strip gauge] A gauge used to measure the length when stripping the sheath of an electric wire. It is used by attaching it to a wire stripper.

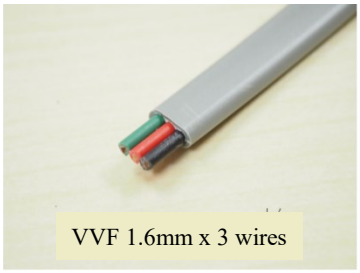
[Denko knife] (electrician's knife) A knife used to peel the sheath of cables during electrical work.



[IV] Abbreviation for Indoor PVC. Vinyl-insulated wires for indoor wiring.

[VVF] Abbreviation for Vinyl insulated Vinyl sheathed Flat-type cable. An electrical wire insulated with flat-shaped vinyl.

[VVR] Abbreviation for Vinyl insulated Vinyl sheathed Round-type cable. An electrical wire insulated with round-shaped vinyl.



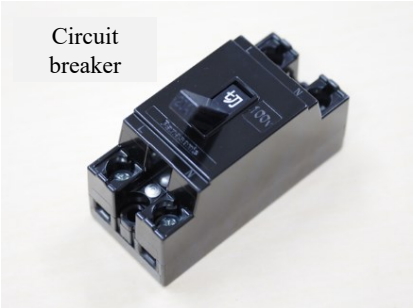
[EM-EEF] VVF cable with a polyethylene cover. Highly flame-resistant.

[VVF stripper] A tool to strip the outer and core insulation of VVF cables.

[CV cable] Abbreviation for Cross-linked polyethylene insulated Vinyl sheath cable. A cable that uses cross-linked polyethylene as the insulator, which is even more flame-resistant than EM-EEF. Used for wiring of electric lights, power equipment, etc.

[CT] Electric wires covered with rubber material. Because of its excellent abrasion and impact resistance, it is used as a portable electric cable.

[VCT] A portable electric cable with a vinyl material for the exterior. It is not only flame-resistant, but also flexible and water-resistant.

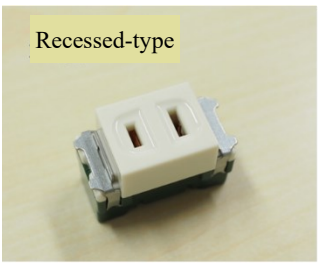


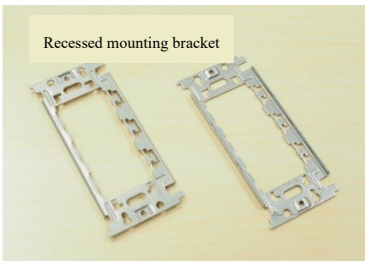
[Kadenryu shadanki] (circuit breaker) A safety device that automatically shuts off the power supply to a device when an excessive current flows through an electric circuit. Also called breaker. Today, no-fuse breakers (NFB) are used for wiring.

[Relay] A switch that can be turned on and off by electricity.

[Thermal Relay] A relay that can interrupt a circuit when the temperature rises. Used to protect electric motors, etc.

[Konsento] (outlet) A socket on a wall, with a single-phase 100 V outlet for general households. There are various types, including recessed and exposed. Recessed types are mounted on a recessed mounting brackets.





5.1.3 Telecommunications Work

[Closure] A box for connecting cable core wires in overhead wiring. It is installed on a utility pole.

[Cable kuridashiki] (cable feeder) A cable feeder that uses pulleys. The cable can be easily pulled out from the cable reel.

[Tsuri sen] (suspension wire) In overhead wiring, this wire is used to prevent tension from being applied to the cable. Also called messenger wire.

[Kinsha] (messenger pulley) A pulley used for pulling a cable to be attached to the messenger wire. Placing the cable on the pulley portion of the wheel attached to the messenger wire makes it easier to pull the cable.

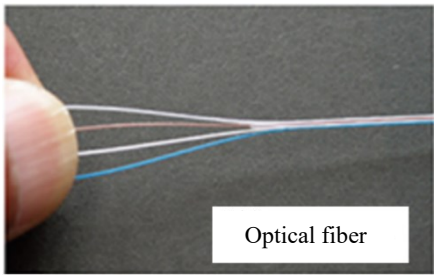
[Chosenki] (tensioner) A device used in combination with a wire grip to apply tension to the messenger wire. By pulling the lever, tension can be applied to the messenger wire.

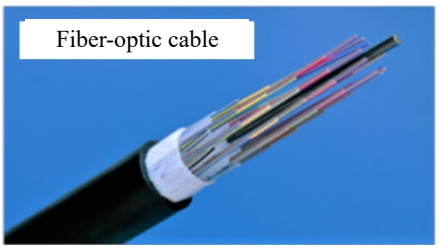
[Kakusenki] (wire grip) A tool for gripping the messenger wire

[Seiryuki] (rectifier) A device that converts alternating current to direct current.

[Chikudenchi] (storage battery) A device that can charge and store electricity.

[Hikari fiber] (optical fiber) Optical fiber is made of two types of quartz glass with different refractive indices. The center part that transmits light is called the core and the surrounding part is called the clad (cladding). It is further surrounded by a nylon membrane. It has the advantages of being thin and light, having high transmission capacity, low loss, and non-inductive, with the disadvantage of being susceptible to scratching, bending, and dirt.

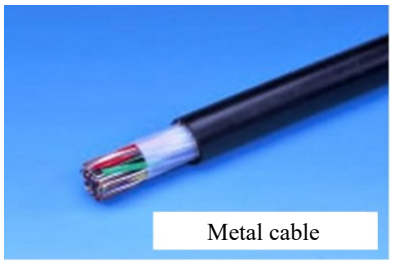

Optical fiber

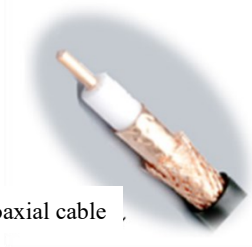

Fiber-optic cable

[Hikari fiber cable] (fiber-optic cable) A cable formed by bundling optical fibers together. There are various types, such as 20-core, 100-core, and 400-core.

[Metal cable] A cable using copper for the core wire. Communication is performed by electrical signals. Includes coaxial cables, twisted pair cables, etc.

[Dojiku cable] (coaxial cable) A cable with a structure in which an insulator is placed around a conductor that transmits signals, and covered with another conductor. Coaxial cable is used for TV antenna cables.


Metal cable


Coaxial cable

[UTP twist pair cable] (UTP twisted pair cable) A cable made by pairing two conductors and twisting them together. It is cheaper and softer than a coaxial cable. These cables are categorized by maximum transfer rate. They can be used for phone calls or for networking, depending on the category.

[Jiko shiji cable] (self-supporting cable) A cable with an integrated support wire for supporting the cable. It can be mounted directly onto the utility pole. It is used for overhead wiring.

[Hikari fiber yuchaku setsuzokuki] (optical fiber fusion splicer) A machine used to melt the tips of two fiber-optic cables to connect them together. This connection method is called *yuchaku setsuzoku* (fusion splicing). Other connection methods include mechanical splicing and connection via connectors.

[Fiber hogo sleeve] (fiber splice protection sleeve) A sleeve used to protect the joint when fusion splicing is performed. It is shrunk by heat to be fastened to the cable. Beware that it must cover the cable before fusion splicing, because it may not be possible to cover the joint after splicing.

[Fiber holder] A device for setting optical fibers in a jacket remover, fiber cutter, or fusion splicer.

[Jacket remover] A tool used to remove the coating of optical fiber.

[Fiber cutter] A tool used to cut fiber-optic cables. When making fusion splices, a special tool is provided to cut the cross-section of the cable perpendicularly.

[Hikari connector] (optical connector) A component for connecting fiber-optic cables. It has the advantage of being easy to insert and remove by hand. Types of connectors include SC connectors, FC connectors, LC connectors, and MU connectors.

SC connector

[Hikari power meter] (optical power meter) A device used to measure the intensity of light used for optical fiber communications.

[Hikari pulse tester] (optical pulse tester) This tester can measure the line length of optical fiber cores and whether there are any abnormalities such as loss or reflectance due to splicing. It is called an OTDR (Optical Time Domein Reflectometer).

[Dojiku cable checker] (coaxial cable checker) A device used to check the continuity of coaxial cables.

[Hub] A device to which wires are connected when configuring a star topology wired LAN network.

[Switching hub] One of the relay devices in a communication network. Normal hubs send the received

data to all devices, but switching hubs check the address and send the received data to only those devices that need to.

[Router] A device that connects multiple different networks. Routers can be used to separate multiple networks.

[LAN tester] A device used to check the eight wires between the modular plugs attached to both ends of a LAN cable to ensure that the wires are not crossed or disconnected.

5.1. 4 Plumbing Work

[Haikan/duct] (pipe/duct) What passes water and gas is called a pipe, and what passes air is called a duct. There are two types of ducts: rectangular ducts, which are rectangular in shape, and circular ducts (also called spiral ducts), which are round in shape.

[Pipe manriki] (pipevise) A tool used to hold pipes in place when cutting or joining pipes.

[Pipe nejikiriki] (pipe threader) A machine used to cut threads in pipes.

[Tube cutter] A tool used to cut thin-walled tubes made ofiron, steel, brass, copper, aluminum, etc.

[Tube bender] A tool used to bend copper tubes.


Pipe cutter

[Pipe cutter] A tool used to cut**pipes**made of steel, brass, copper, wrought iron, and lead. It can cut thicker tubes than tube cutters.

[Pipe wrench] A tool used to join pipes and pipe fittings by tightly gripping and rotating round, difficult-to-grasp pipes. Also called *pairen*.

[Expander] A tool used to expand the ends of copper pipes to connect them. Also called *kakukanki*.

[Flaring tool] A tool used to flare the ends of soft pipes such as copper pipes.

[Mentoriki] (deburring tool) This tool removes burrs from metal and PVC pipes to smooth out the surface.

[Suiatsu shikenki] (water pressure tester) This meter is used for water pressure testing of water supply pipes and hot water pipes. Also called test pump.

[Seal zai] (sealant) Material used to prevent fluid leakage inside a pipe when the pipe is screwed in. There are liquid sealants as well as sealant tapes.

[Enka-vinyl jushiyo secchakuzai] (adhesive for polyvinyl chloride resin) Material used to prevent fluid leakage inside polyvinyl chloride pipes when joining them.

[Haikan'yo tansoko kokan] (carbon steel pipes for piping) This steel pipe is widely used for steam, water, oil, gas and air piping. There are *shirokan* (white pipes, with plating) and *kurokan* (black pipes without plating) depending on whether they are plated or not. Also called gas pipe or SGP.

[Koshitsu poly-enka vinyl kan] (rigid polyvinyl chloride pipe) A pipe made of rigid polyvinyl chloride resin. There are VU *kan* (thin-walled pipes) and VP *kan* (thick-walled pipes). It is gray in color and is also called *enbi* pipe and *enbikan* (PVC pipe). It has the advantages of having a very smooth inner surface, low frictional resistance, light weight, and being easy to process. On the other hand, the disadvantages include being vulnerable to external shocks and heat.

[Taishogekisei koshitsu poly-enka vinyl kan] (impact-resistant rigid polyvinyl chloride pipe) A PVC pipe that is resistant to external impact. It is dark blue in color and is called HIVP *kan* or HI *kan*. Used in locations subject to high external impact, cold climates, etc.

[Tainetsusei koshitsu poly-enka vinyl kan] (heat-resistant rigid polyvinyl chloride pipe) A PVC pipe with improved heat resistance. It is called HT *kan* (HTVP *kan*). It is reddish brown in color and is used for cooling and heating pipes, hot spring pipes, etc.

[Suidoyo koshitsu enka vinyl lining kokan] (rigid polyvinyl chloride-lining steel pipe for water supply) A lined steel pipe for water supply in which the inner surface of the steel pipe is lined with rigid polyvinyl chloride. It has excellent corrosion and chemical resistance. Also called lining *kan* or

VLP.

[Nejikomishiki katan chutetsusei kudatsugite] (screw-in malleable cast iron pipe fitting) A fitting for connecting threaded pipes. There are elbows, tees, sockets, nipples, etc.

[Neji gauge] (thread gauge) This gauge is used to inspect threads used in connection of pipes, pipe fittings, etc.

[Gas cock] (gas valve) A valve that opens and closes the gas supply pipe. There are end-of-line valves used when connecting gas appliances such as gas stoves and gas water heaters, and mid-line valves used in the middle of piping to open and close gas lines.

[Gas more keihoki] (gas leak alarm) A device that sounds the alarm when there is a gas leak to warn of danger.

[Sekimen cement kan] (asbestos cement pipe) A pipe manufactured by mixing asbestos, cement, and silica sand with water. It has excellent corrosion resistance, is lightweight, easy to fabricate, and inexpensive. On the other hand, it is inferior in strength and impact resistance. Furthermore, the health issues of asbestos inhalation on the human body have been recognized, and it is no longer being produced.

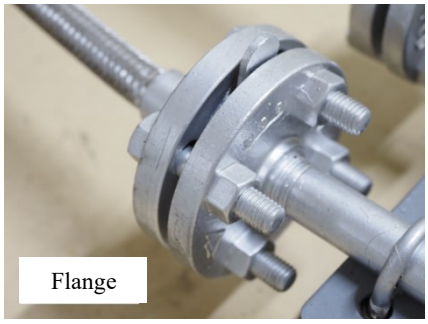
[Ductile chutetsu kan] (ductile iron pipe) A pipe made of spheroidized graphite contained in cast iron that has higher strength and toughness (toughness of the material and resistance to destruction by external forces) than cast iron. It has the disadvantage of being relatively heavy in weight. Until around 1955, when ductile iron pipes were developed, cast iron pipes were the norm.

[Reibaiyo dokan] (copper pipe for refrigerant) A pipe used to pass refrigerant while circulating between the outdoor and indoor units of an air conditioner. Seamless pipes made of copper and copper alloys are used.

[Pump] A machine used to give energy to water in pipes to carry it farther or lift it from low to high places.

[Flange] A ring-shaped device that is attached to the end of a pipe.

[Sleeve] A conduit that is attached to the walls, floors, beams, etc. of a building to carry piping and ducts. It is embedded before concrete is placed.


Flange

[Tsugite] (pipe fitting) A member that splits or bends a pipe. There are elbows that change the direction of flow and tees that make branches.


45 degree elbow


Tee

5.1.5 Freezing and Air Conditioning Apparatus Work

[Air filter] A filter used to remove dust and small debris from the air.

[Fan] A machine used to give energy to the air in the duct to transport the air farther away. There are two types of fans: blowers that send air from the outside into the room, and exhaust fans that discharge air from the room to the outside.

[Reikyaku coil] (cooling coil) Used to cool the air temperature by bringing the air into contact with a tubing through which cold water is passed, and is used for cooling the room.

[Onsui coil] (hot water coil) Used to warm the air temperature by bringing the air into contact with a tubing through which warm water is passed, and used for heating the room.

[Kashitsuki] (humidifier) A device that adds moisture to dry air. Mainly used when heating the room.

5.1.6 Water Supply, Drainage, and Sanitation Facilities Installation

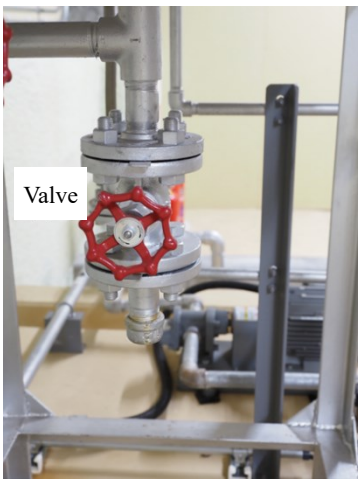
[Eisei setsubi] (sanitation facilities) Short for water supply and drainage sanitary facilities, which

includes water supply facilities, drainage facilities, sanitation fixtures, hot water supply facilities, gas facilities, and fire extinguishing facilities.

[Eisei kigu setsubi] (sanitation facilities) Facilities that produce, store, and discharge cold and hot water, such as faucets, toilet bowls, urinals, wash basins, baths, and sinks.

[Trap] Provided to hold water in a part of the drain pipe to prevent odors and small insects from entering the room.

[Ben/damper] (valve/damper) A device (also called a valve) that stops or adjusts the amount of water in a pipe. What stops or adjusts the amount of air in a duct is called a damper.



5.1.7 Heat/Cold Insulation Work

[Glass wool ho'onzai] (glass wool insulation) Glass (mainly recycled glass) is melted at high temperatures to form thin fibers. It is widely used as an insulator that combines the flexibility of fiber with heat resistance and nonflammability. There are insulation tubes, insulation strips, and insulation panels.

[Rock wool ho'onzai] (rock wool insulation) Basalt and andesite are melted at high temperatures and converted into fiber by centrifugal force. Because it is made from rock, it is more fire-resistant than glass wool material and is used as a firestop sealant of fire partitioning. There are insulation tubes, insulation strips, and insulation panels.

[Polystyrene foam ho'onzai] (polystyrene heat insulation) Polystyrene with added foaming agent (non-fluorocarbon) and flame retardant is foamed by steam heating, dried, and then steam heated again for molding. Available in tubular or plate form. Polystyrene is often used in water supply and drainage pipes because it cannot be used at temperatures above 70°C.

5.1.8 Construction of Fire Fighting Facilities

[Shoka setsubi] (fire extinguishing equipment) Equipment used in the event of a fire to extinguish the fire and guide people to safety.

[Shokaki] (fire extinguisher) A portable device that extinguishes fires in the very early stages of a fire.

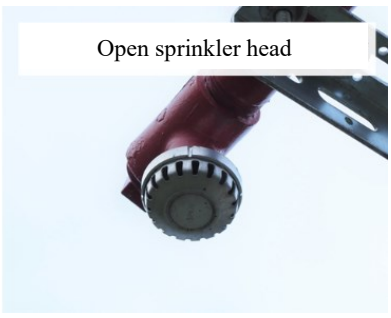
[Okunai shokasen setsubi] (indoor fire hydrant system) A system operated by people for the purpose of fire extinguishing in the initial stage of a fire. There are three types of hydrants: Type 1 hydrant, which is operated by two or more people; Type 1 hydrant with easy operability, which can be operated by one person; and Type 2 hydrant.


Outdoor fire hydrant system

[Okugai shokasen setsubi] (outdoor fire hydrant system) A system installed outdoors to extinguish fires in the initial stages and to prevent the spread of fire to adjacent buildings. It is intended to extinguish fires on the first and second floors of buildings.

[Sprinkler setsubi] (sprinkler system) A system that is attached to fire extinguishing piping and sprays water from the ceiling in the event of fire. Sprinkler heads include closed sprinkler heads, open sprinkler heads, and high-flow sprinkler heads.


Closed sprinkler head


Open sprinkler head

[Mizu funmu shoka setsubi] (water mist fire extinguishing system) A system designed to extinguish fires on roads, parking lots, and places where designated combustible materials are stored

or handled.

[Awa shoka setsubi] (foam fire extinguishing system) A system designed to extinguish oil fires for which water-based fire extinguishing methods are not suitable. This system extinguishes fires through the asphyxiating effect of foam covering the fire surface and the cooling effect of the water that makes up the foam. There are fixed and mobile types.

[Fukassei gas shoka setsubi] (inert gas fire extinguishing system) A system that extinguishes fires by releasing inert gas to dilute the oxygen concentration in the air as well as to cool the air.

[Halogen kabutsu shoka setsubi] (halide fire extinguishing system) A system that uses halide fire extinguishing agents. Halogen elements (fluorine, chlorine, and bromine) stop combustion by inhibiting combustion reactions, cutting off the air supply, and lowering the oxygen concentration in the air. Suitable for oil fires, fires involving energized electrical equipment, computers, books, important works of art, etc.

[Funmatsu shoka setsubi] (powder fire extinguishing system) A system that uses fire extinguishing agents in powder form. In addition to the suppression of combustion reactions by powder fire extinguishing agents, the asphyxiating action makes it suitable for oil fires, fires involving energized electrical equipment, etc.

5.2 Common Tools, Machines, Materials, and Measuring Instruments

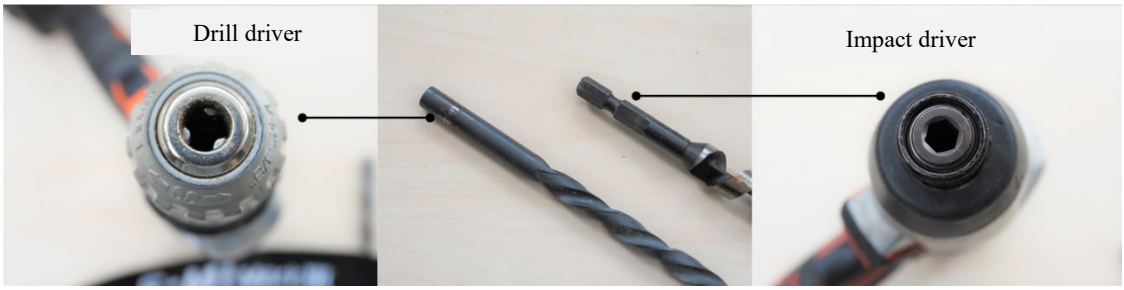
5.2.1 Power Tools

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

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

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

[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.

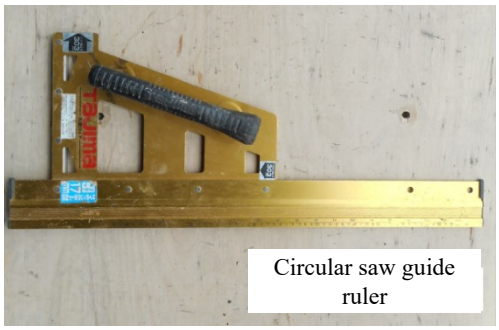
[Sander] This power tool is used to polish flat surfaces by moving sandpaper. There are several types of mechanisms for moving sandpaper, including vibrating, belt, and rotating types.

[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.

Circular saw



Circular saw guide ruler

[Shujin marunoko] (circular saw with dust collection) A circular saw that can cut while collecting fine dust. Two types are available: one for board cutting and the other for metal cutting. There are two types: one with a dust box to collect dust, and the other with a dust collector to be connected to the circular saw.

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

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


High-speed cutter

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

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

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

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


Nail gun


Cord reel

5.2.2 Digging/Leveling/Compacting

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

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

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


Spear head spade


Square head spade


Double spade

[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

[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.

5.2.3 Layout Marking/Marking Tools


Line marker

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

[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

[Laser marker] A machine that emit 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.

[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

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

5.2.4 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.


Plumb bob

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


Carpenter'

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

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

[Convex] (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.


Convex

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

rulers are used.


Aluminum ruler


Stainless steel ruler

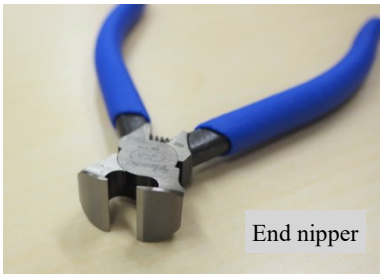

Bamboo ruler

5.2.5 Cutting/Bending/Breaking

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

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

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


End nipper

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

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

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


Box cutter


Masonry chisel


Pliers

5.2.6 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.

[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.

[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.

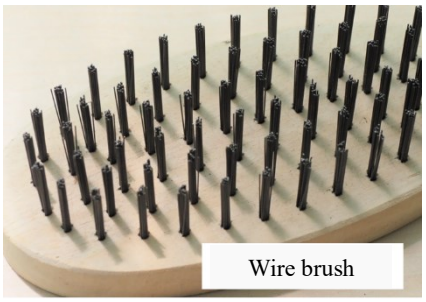
5.2.7 Filing/Polishing/Boring

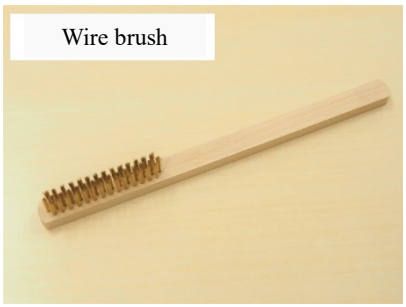
[Toishi] (grindstone) A tool for cutting and polishing metals, rocks, etc. The small rectangular-shaped tools are used to sharpen the blades of *nomi* (wood chisels) and *kanna* (Japanese hand planes).

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

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

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


Wire brush

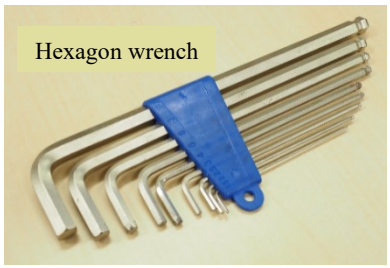

Wire brush

5.2.8 Tightening/Fixing

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

[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.

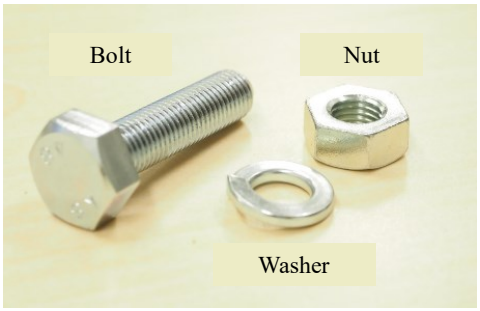
[Driver] (screwdriver) A tool used to turn screws. There is a Phillips-head and a flat-blade screwdriver to fit the grooves on the heads of the screws. It is important to use the correct size to avoid breaking the groove of the screw head (called *nameru* (stripping)). The shape of the grip is also important.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

[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.



5.2.9 Kneading/Mixing

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

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

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

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

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

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

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

5.2.10 Curing/Prepping

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

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

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

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

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

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

5.2.11 Scrubbing

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

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

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

[Bucket] A container with a handle for holding and carrying water. For construction purposes, sturdy buckets made of galvanized steel sheets are used.

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

5.2.12 Carrying Objects

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


Wheelbarrow

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


Wheeled platform

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

[Koro] (log) A log used to move heavy objects. Several are placed parallel to each other, an object is

placed on top, and the object is moved as the logs roll.

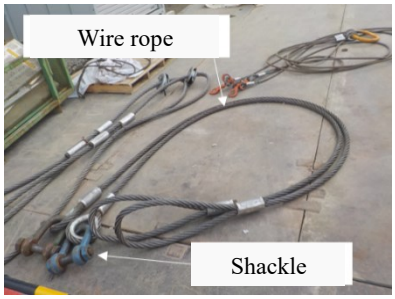
[Forklift] A vehicle equipped with forks that move up and down using hydraulic pressure. Objects placed on the fork are raised to or lowered from high places.


Forklift

5.2.13 Hanging/Lifting/Pulling

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

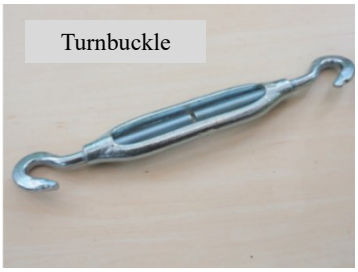
[Wire rope] Several high-tensile-strength steel wires are twisted together to form a strand, and then several strands are twisted together again to form a rope. It has high tensile strength, excellent impact strength, and flexibility for easy handling. Those with processed ends are used for slinging.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



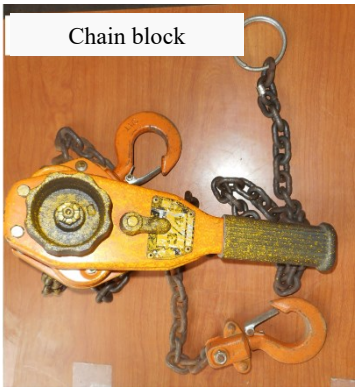
[Shackle] A slinging fixture for connecting a wire rope or chain to a suspended load.

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


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).

5.2.14 Work Platforms/Ladders

[Hashigo] (ladder) A tool for climbing to high places. It is climbed by stepping onto the rungs. It

should be set at an angle of approximately 75 degrees. If the angle is too steep, there is a risk of falling backwards. Conversely, if the angle is small, there is a risk of the ladder breaking. Also, always work with an assistant to support the ladder.


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.

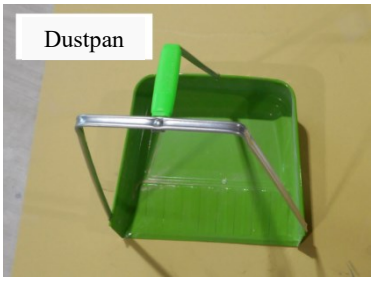
[Rolling tower] A platform for working at heights. There are casters on all four corners to move it around. There are safety standards for rolling towers under the Industrial Safety and Health Act.

[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.

5.2.15 Cleaning

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

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



[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	General interior and exterior fittings, intake and exhaust vents such as ventilation holes, water supply and drainage

installation	sanitary piping, air conditioning and sanitary equipment, and firefighting equipment

6.2 Knowledge regarding Pipe Processing

This section describes basic matters in the processing of carbon steel pipes for piping, rigid polyvinyl chloride pipes, and rigid polyvinyl chloride-lining steel pipes for water supply.

6.2.1 Processing of Carbon Steel Pipes for Piping

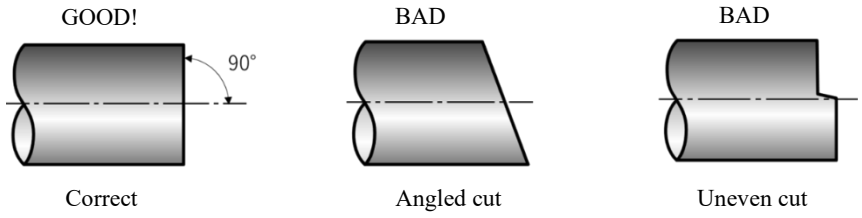
Typical joining methods for carbon steel pipes for piping include screw, welding, and mechanical joining methods.

(1) Screw joining method

This is a common joining method that has been used for a long time. Mainly used for 15A to 100A. A represents the diameter of the pipe and is called A designation. The unit of measurement is in mm. There is also B designation, which uses inches for the unit of measurement. The procedure is as follows.

(1) Pipe cutting

A band saw pipe cutting machine is used to fix the pipe horizontally, and to make a cut that is perpendicular to the pipe axis. If the cut is not made perpendicularly, it may result in angled cuts or uneven cuts. Angled cuts of 1.0 mm or more or uneven cuts can cause water leakage.



Correct and incorrect cutting of steel pipes

(2) Threading (thread cutting)

After the steel pipes are cut, the die head is attached to the pipe threader (with automatic die head)

and the pipes are threaded. Wearing work gloves when threading may cause the hands to get entangled in the threader. Never thread while wearing work gloves. After the threading is completed, the accuracy of the threading is inspected with a thread gauge. Inspections are performed in these instances.

- On a minimum of first three threaded pipes
- When the threaded pipe diameter is changed
- According to the number of threaded pipes (e.g., for 25A, one in every 50 pipes or so)
- When the lot (mainly different manufacturing dates) or the pipe manufacturer of the pipes to be threaded has changed
- When replacing the chaser (cutting tool on the threading head)

(3) Preparation before screwing in

Once the steel pipes are threaded, the screwing-in process begins. Insufficient cleaning and degreasing of screw joints can also cause water leakage, so the following preparatory work is necessary before screwing in.

- Remove shavings, dirt, dust, and other foreign matter on the threads of the steel pipes and fittings with a brush or rag.
- Remove oil, such as threading oil, with a degreasing cleaning agent.
- Wash away water-soluble threading oil with water, wipe with a rag, and dry.
- Never use screws that have rust on the threading.

After the preparatory work is completed, the pipes are screwed in, but before they are screwed in, a sealant is applied to the screw threads. There are two types of sealants: liquid sealant and sealant tape.

(4) When using liquid sealant

Before applying the liquid sealant, thoroughly wipe off any moisture, oil, dust, etc. on the joint surfaces once again. Stir the sealant well before use. Apply the required amount with a brush to the entire threaded portion of the pipe and fitting. Apply carefully and evenly. After using the sealant, remove any sealant from the threads of the sealant can when putting back the cap with brush before

closing it tightly and storing in a cool, dark, well-ventilated place. In case of contact with eyes, rinse with plenty of water and seek medical attention as soon as possible. Contact with skin may cause irritation in some people, so wash off with soap and water.

(5) When using the sealant tape

The sealant tape is wrapped around the side to be screwed in. Since the direction of screwing is clockwise, the sealant tape is also wound clockwise. First, go around once while pressing down on the threads and the sealant tape with your fingers. At this time, there should be about one ridge of the threading still visible. Wrapping without leaving a ridge of threading visible may cause the sealant tape to go inside the piping. The tape should be wound about 6 to 7 times. After wrapping, use your fingers or fingernails to better adhere the tape. Failure to do so will cause the tape to peel off during screwing-in. The sealant tape should be wound so that the tape is pulled from the underside of the reel when brought to the top of the threading. Pulling from the top in this position is wrong. It is correct to leave about one ridge of the threading visible. If the tape completely covers the threading, pieces of the sealant tape will end up in the piping when the joints are screwed in. This can also cause the joint to not fit smoothly.

(6) Screw-in

After the sealant is applied or wrapped, the joints are screwed in. Fix the piping properly onto the bench vise, and first, screw it into the fitting by hand. After it cannot be tightened any further by hand, use a pipe wrench with an appropriate diameter to screw it in further. Be careful not to screw in so hard to the point of destroying the threads. The trick to the screw-in method of pipe joints is to use a pipe wrench to screw in the pipe, leaving about two to two and a half ridges of the threading. Water should be allowed to flow through the piping only after sufficient curing time has elapsed after tightening.

(2) Welding joining method

Welding joining methods for carbon steel pipes for piping include welding and mechanical joining. The welding joining method is often chosen for large-diameter pipes of 100A or more and is a reliable joining method in terms of joint strength, but it requires a high degree of skill. There are two types of welding joining methods: gas welding joining and shielded arc welding joining.

[Gas welding joining method]

There are three methods to weld metals using heat from gases: oxyacetylene welding, oxyhydrogen welding, and air-acetylene welding. The most commonly used of these is the oxyacetylene welding. Gas welding is a welding method often used to weld small diameter pipes.

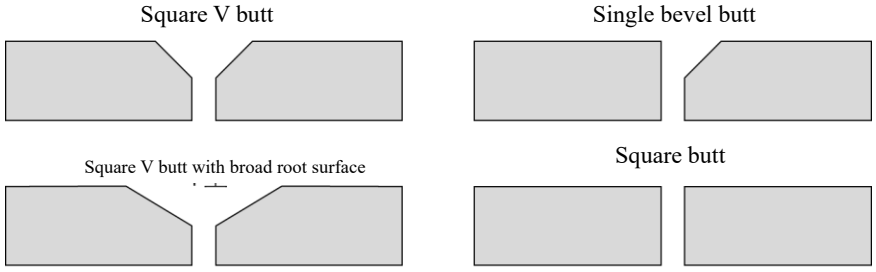
[Shielded arc welding joining method]

The shielded arc welding joining method, along with gas welding joining methods, is widely used in piping work. The shielded arc welding method uses a welding rod coated with a solvent called flux to minimize weld oxidation and other disturbances as much as possible. The combustion of the flux shields the molten metal from air during welding. For either welding method, the process is as follows.

(1) Pipe cutting and processing of the cut

As with the screw-in method of pipe joints, steel pipes are cut perpendicularly to the pipe axis. However, when welding joints, it is necessary to chamfer the pipe ends after cutting to improve the weld quality. Without chamfering, insufficient fusion occurs, affecting weld quality.

There are four typical types of bevels for pipe welding: square V butt, square V butt with broad root surface, single bevel butt, and square butt (also known as *dontsuke kaisaki*).



Typical bevels

(2) Temporary welding

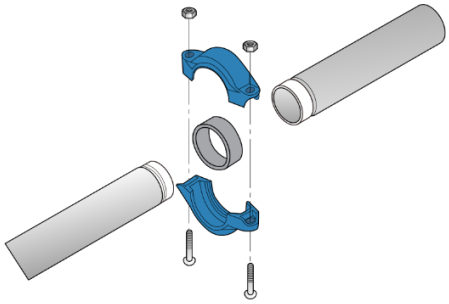
Before the main welding, a temporary welding is conducted to fix the welds in the correct mutual position and to prevent misalignment of the bevel due to distortion of the weld.

(3) Main welding

The work to weld the entire circumference of the piping, performed after temporary welding. Welding operations are performed by welders under a variety of conditions. To consistently achieve good results, it is important to have sufficient experience in welding operations and to avoid creating welding defects.

(3) Mechanical joining method

Also called mechanical joining method. Pipes are joined using housing pipe fittings, bend fittings, coupling fittings and no-hub fittings.



Example of a housing pipe fitting

6.2.2 Processing of Rigid Polyvinyl Chloride Pipes

Rigid PVC pipes are processed in the following steps.

(1) Pipe cutting

Pipes are cut perpendicularly to the pipe axis. If the cut is not straight, it will create parts that are completely inserted and parts that are not quite inserted when gluing, causing water leakage.

(2) Chamfering

Once the pipe is cut, both the inner and outer parts are chamfered with a box cutter so that it can be easily inserted into the fitting. The outer part affects gluing, but also if burrs remain on the inner wall, they can cause plugging. Pipes for water supply and hot water are difficult to insert, so make sure to chamfer them well, especially the outer part.

(3) Marking the insertion depth

To confirm that the pipe is fully inserted into the fitting, mark the depth of insertion on the pipe side. Inadequate insertion will cause the overall length to deviate from the plan, or it may cause leaks.

(4) Applying an adhesive to the pipe and the fitting

Wipe off any moisture or dirt from the surfaces to be coated, and apply the adhesive to both the pipe and the fitting. The following are some things to keep in mind while coating.

> Apply thinly and evenly to the entire surface, starting with the fitting (because the pipe cannot be put down after application)

> Apply evenly only to the portion of the pipe to be inserted

> Apply the coats as quickly as possible

> Adhesive may drip, so protect your work area with rags, etc.

(5) Inserting the pipe into the fitting

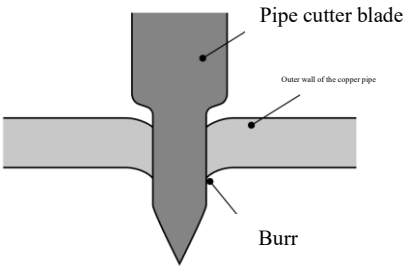
Align the pipe with the mouth of the fitting and insert it all the way in one go, applying force. Once the pipe is inserted up to the mark, continue to apply force inward for about 10 seconds until the adhesive dries.

(6) Wipe off the excess adhesive

Wipe clean any adhesive that is pushed out after insertion. Not doing so will compromise the appearance, and if it drips, it will be difficult to remove later.

6.2.3 Processing of Rigid Polyvinyl-Chloride Lining Steel Pipes for Water Supply

(1) Pipe cutting



Example of burr

Same as with other pipe materials, these pipes are cut perpendicularly to the pipe axis. Care must be taken to never choose a method that creates high temperatures in the cut surface, such as gas cutting with oxyacetylene. In addition, using a manual cutter and threader causes *makure* (burrs) to form, so other pipe cutters such as a band saw or metal saw are used to cut the pipe.

(2) Deburring

After the pipe is cut, deburr the inner wall of the pipe using a deburring reamer for line pipes or a scraper. Do not deburr with a threader reamer. After deburring is completed, chamfer about 1/2 to 2/3 of the PVC pipe wall thickness in order to connect to the pipe-end anticorrosion fitting.

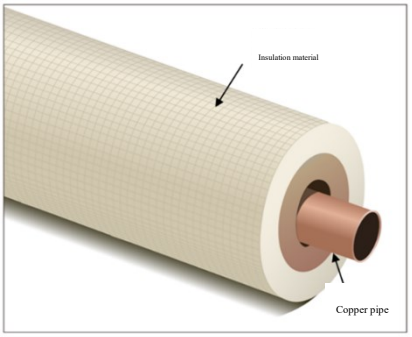
(3) Threading

Threading is done in the same manner as for carbon steel pipes for piping, but if the pipe has an outer resin coating, threading is performed using a jig and tool that will not damage the outer resin coating.

6.3 Freezing and Air Conditioning Apparatus Work

6.3.1 Processing of Coated Copper Pipes for Refrigerant

Between the outdoor and indoor units of an air conditioner, refrigerant, which transfers heat, circulates through pipes. Coated copper pipes for refrigerant are used for this purpose. *Hifuku* means covered by something. Coated copper pipes for refrigerant are bendable and processed copper pipes covered with flame-retardant insulating material (such as polyethylene). If left as is, condensation occurs on copper pipes depending on the outside temperature, and in order to prevent this, they are covered with insulation material. Plumbing for freezing and air conditioning apparatus work requires the following processing and joining of coated copper pipes for refrigerant.



Coated copper pipe for refrigerant

(1) Cutting the insulation material

The insulation material is cut perpendicular to the copper pipe using a box cutter. Be careful not to damage the copper pipe as this may cause gas leaks.

(2) Copper pipe cutting

Set the pipe cutter at a right angle on the copper pipe, and rotate it around the pipe while gradually tightening the hold to cut the pipe without deforming it. Never use a hacksaw or grinder for cutting, because shavings will remain inside the copper pipe.

(3) Deburring

Copper pipe cut with a pipe cutter will have *makuri* (burr) on the inner wall. Smoothing this out allows smoother flaring process. Make sure to use designated tools such as reamers and scrapers for this operation. When deburring, the copper pipe should face downward to prevent shavings and other debris from entering the copper pipe.

(4) Correcting roundness

After deburring, be sure to correct the roundness with a sizing tool for refrigerant pipes or other means. If flaring is performed without a perfect circle, problems such as the center of the pipe being off-center, the fitting not going in during the brazing operation, poor wax coating, etc. may occur.

(5) Bending

Coated copper pipes for refrigerant are bent to site specifications. Bending can be done by hand or by a bender. The three points to keep in mind when bending are: do not let the pipe flatten, buckle, or wrinkle.

[Bending by hand]

Place both thumbs on the inner side of the bend location, and bend it while gradually shifting the thumbs toward the ends of the pipe. The minimum bending radius is six times the outer diameter for copper pipes with an outer diameter of 6.35 to 12.7 mm, and ten times the outer diameter for copper pipes with an outer diameter of 15.88 mm and above. The pipe should be bent a little at a time. Flattening or buckling will occur if the pipe is bent too fast and too much, or below the minimum bending radius.

[Bending by a bender]

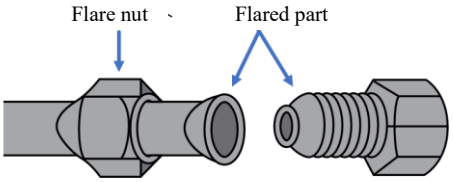
To make the bend radius small and clean, use a bender appropriate for the quality and wall thickness of the copper pipe. The minimum bending radius can be as small as 4 times the outside diameter of the copper pipe. The key is to avoid wrinkles.

6.3.2 Connection of Refrigerant Pipes

Two types of refrigerant pipe connection are flare and brazed connections.

(1) Flare connection

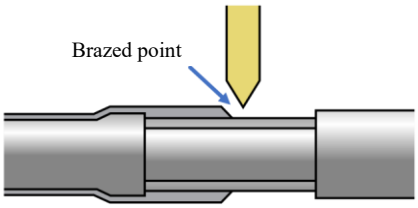
Flaring is a process that widens copper pipes into a trumpet shape. By tightening the flare nut, the flared portion is crimped and acts as a seal.



Flare connection

(2) Brazed connection

This is a method of connecting by melting wax and blending it into the faces to be connected. It is important that there be no oxide film or foreign matter on the surface, and that the proper brazing temperature is ensured. After brazing, the pipe is hot, so cool it with a wet towel and check the appearance for pinholes or poor brazing.



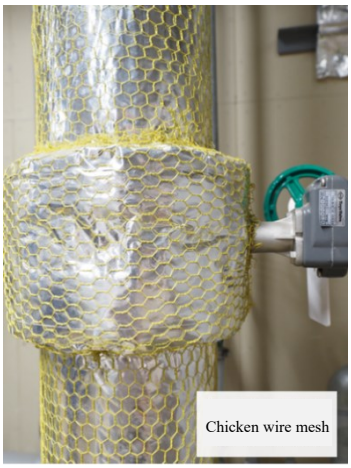
Brazed connection

(3) Connecting the insulation material

The insulation material shrinks by a maximum of about 2% in the longitudinal direction (about 8 cm per 4 m). Since condensation from gaps caused by shrinkage of insulation material may lead to accidents, measures should be taken to prevent gaps. Prepare the connection surfaces on the ends by thoroughly removing dirt, grease, moisture, etc. Once the connection surfaces are prepared, butt the insulation material end faces together so that there are no gaps between them, and wrap insulation tape with the joint at the center line of the tape. Then, adhere the tape thoroughly by hand.

6.4 Heat/Cold Insulation Work

6.4.1 Shapes and Types of Insulation Material



Insulation material is available in various shapes of heat-retention tubes, heat-retention strips, and heat-retention plates. Plates and strips are used for ducts, and tubes are used for piping. Mainly used insulation materials include glass wool (GW), rock wool (RW), and polystyrene foam (PS). In addition, it consists of exterior materials such as colored steel plates and aluminum glass cloth, and auxiliary materials such as steel wire, chicken wire mesh, adhesive tape, and tacks. The method of insulation work depends on the work location.

6.4.2 Example of Heat/Cold Insulation for Piping

(1) Concealed areas such as above the ceiling

Since appearance is a non-issue above the ceiling or inside the pipe shaft, no finishing materials are used. The insulation tube is wrapped in aluminum glass cloth (ALGC) or aluminum craft paper (ALK) and fixed to the pipes.

(2) Piping exposed indoors

For exposed piping indoors, such as in rooms and corridors, pipes are generally covered with synthetic resin covers or lagging materials.

(3) Machine rooms, garages, warehouses, etc.

The insulation tubes are wrapped in aluminum glass cloth (ALGC) or aluminum craft paper (ALK). If iron wire is used for finishing, it should be finished with PVC coated iron wire (PVC coated chicken wire mesh) to prevent the iron wire from rusting. In the case of water supply and drainage piping, polystyrene foam insulation (PS) is used as insulation material.

(4) Piping exposed outdoors

Since high weather resistance is required for outdoor exposed areas, the insulation tube is covered with lagging material made of thin steel sheets processed by sheet metal work. In humid areas, the insulation tube should be moisture-proofed with polyethylene film or similar material.

6.4.3 Example of Heat/Cold Insulation for Ducts

Heat and cold insulation work for ducts is done to prevent heat dissipation from the ducts and to prevent the air in the ducts from being heated by heat from the outside. Wrapping ducts with insulation material can increase the efficiency of heating and cooling, saving energy. In addition, air conditioning ducts without insulation work are prone to condensation. Condensation inside and outside of ducts can cause corrosion and mold. For heat and cold insulation of ducts, insulation panels with coated aluminum and craft paper or insulation panels with aluminum glass cloth are fixed to ducts with tacks, aluminum glass cloth adhesive tape or chicken wire mesh. In outdoor exposed areas, ducts should be covered with a frame made of stainless steel plate or the like, if necessary.

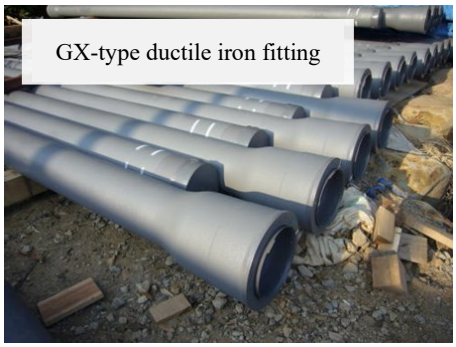

Insulated ducts

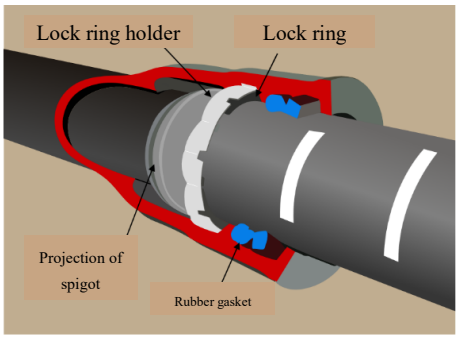
6.5 Lifeline Infrastructure Plumbing Work

6.5.1 Waterworks—Ductile Iron Pipe Installation

Japan experiences frequent earthquakes. Therefore, ductile iron pipes, which can protect pipes against earthquake damage, are used. There are various types of ductile iron pipes, but GX-type ductile iron fittings are used relatively frequently in Japan.

GX-type ductile iron fitting is an earthquake-resistant fitting. This fitting has a large expansion and contraction capability and a function to prevent the pipe from slipping out. The fitting expands, contracts, and flexes in response to large ground movements during earthquakes. Even when stretched to its limit, the anti-detachment function of the fitting will maintain the function of the piping.





Cross-sectional view of GX-type ductile iron fitting

The distance between the pipes will be the dimension for possible expansion and contraction. In the event of further elongation, the lock ring and the projection of the spigot inside the fitting will catch and prevent the pipe from slipping out. Ductile iron pipes are joined as follows.

(1) Pipe installation

Gently lower the suspended pipe with the manufacturer's mark on the top side.

(2) Pipe cleaning

Remove any foreign matter from the groove of the socket, the area approximately 30 cm from the spigot edge, and the socket circumference. In addition, wipe off any water from the surface where the rubber gasket is to be attached. **(3) Checking the lock ring and lock ring holder**

The lock ring and lock ring holder are pre-set. Check visually and by touch to see if they are properly located in the specified groove of the socket. If an abnormality is identified, such as not being properly placed in groove, use lock ring pliers to squeeze the split parts and so that it fits correctly in the groove above the lock ring holder.

(4) Setting the rubber gasket

Be sure to check that the rubber gasket is labeled for GX type and of the correct nominal diameter. Clean the rubber ring and place it inside the socket with the angled portion facing forward. Then,

attach it in place while pressing it by hand or a plastic hammer to ensure that there are no gaps. After installation, tap the rubber gasket with a plastic hammer to let it settle into the inside of the socket. Further, feel the inner surface of the rubber gasket with fingers to confirm that there are no lifted parts.

(5) Applying lubricant

Use the lubricant specifically made for ductile iron pipe fittings. Apply the lubricant evenly to the tapered inner surface of the rubber gasket and the outer surface of the spigot, from the white line hear the pipe end to the end of the pipe. Lubricant should not be applied to the inner surface of the socket before setting the rubber gasket.

(6) Inserting the spigot

Suspend the pipes by a crane, etc., and lightly place the spigot at the mouth of the socket. At this time, make sure that no stones, pieces of wood, or other foreign objects stick to the rubber gasket or the spigot. Also, make sure that the angle of the two pipes are 2 degrees or less. Operate the lever hoist and slowly insert the spigot into the socket. Of the two white lines marked on the outside surface of the spigot, align the end of the socket within the width of the white line closer to the socket.

(7) Checking the rubber gasket position

Check the rubber gasket position using a special check gauge. A special check gauge is used to measure the amount of penetration over the entire circumference of the gap between the socket and the spigot to confirm that everything is within the acceptable range. If the entire circumference is within the acceptable range, the amount of penetration is measured for eight points of the circumference and noted on the check sheet. The check sheet is a quality control document for ductile iron pipe joining. Write down the entire joining operation.

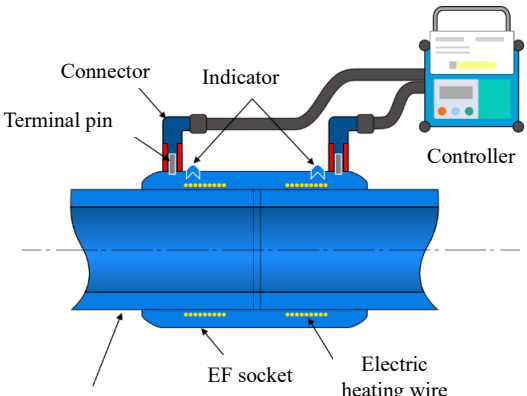
(8) Procedure to bend piping

Straight pipe fittings can be bent to the allowable bending angle after joining. After verifying that the joint is correct, bend the fitting slowly, within the allowable bending angle. Instead of bending one fitting to the allowable bending angle, bend several fittings until the desired angle is reached.

6.5.2 Waterworks and Gas—EF Connection

Polyethylene pipes for water and gas distribution are lightweight, flexible, corrosion resistant, and hygienic pipes used for water and gas piping. In addition, this pipe material demonstrates durability during emergencies such as earthquakes and land subsidence. Pipe material and fittings are blue for water and yellow for gas.

In joining polyethylene pipes, there are two methods: electrofusion (EF) joining and mechanical joining. EF joining is a joining method in which the electric heating wire is heated to melt and fuse the inner wall of the pipe fitting and the resin on the outer wall of the pipe into a single piece. After setting a pipe (spigot) into a pipe fitting (socket) with an electric heating wire embedded in the face to be joined, the controller energizes the wires to heat them.



EF connection of polyethylene pipes

EF joining is performed in the following steps.

(1) Pipe cutting

Cut the pipe so that the end of the pipe is perpendicular to the pipe axis. The allowable limit for diagonal cutting of pipe is within 5 mm, regardless of the nominal diameter. Cutting tools that use high-speed grinding wheels should not be used because their heat may deform the cut surface.

(2) Preparing the EF socket

Inspect the pipe for damage, then wipe off any soil or dirt from the pipe with paper towels or a clean rag. Measure from the end of the pipe and draw a marker line at the specified insertion length.

(3) Scrape

Using a scraper, scrape the surface of the pipe from the end of the pipe to the marker line.

(4) Cleaning of fusion surface

Clean the entire scraped surface of the pipe and the inner wall of the EF socket with a paper towel soaked in ethanol or acetone.

(5) Marking

Insert the scraped and cleaned pipe into the socket and mark the pipe along the circumference of the socket end.

(6) Inserting and joining the pipes and the fitting

Insert both pipes into the EF socket to the marked line. Then, use clamps to secure the pipes to the EF socket.

(7) Preparing for fusion

Connect the controller power plug into an electrical outlet. Turn on the switch. Then, connect the output cable to the terminals of the fitting. Use the barcode reader attached to the controller to read the fusion data.


Preparation for EF fusion

(8) Fusion

Press the start button on the controller to start energizing. Energization stops automatically.

(9) Inspection

Check that the EF socket indicators, both left and right, are pushed up. Confirm the controller display that it has finished the process successfully. Then, remove the output cables and attach the caps.

(10) Cooling

After fusion is completed, leave the product for a predetermined amount of time to cool. Remove the clamps after completely cooled. Use the check sheet to note the check items for each fusion point.

6.5.3 Precautions in Telecommunications Work

(1) Underground conduit

Where expansion or contraction of the conduit is anticipated, use fittings that expand and contract, or other means to make connections.

(2) Cabling

Route the cable so that there is extra length of cable at the handhole near the cable pull-in and pull-out ports.

(3) Optical cable underground wiring

At the handhole, secure enough length of optical cables at both the connection and pull-through sections to prevent disconnection caused by cable kinks when the cables are moved during a disaster or similar events.

6.5.4 Precautions for Underground Piping Work

(1) Damaging or cutting existing underground pipes during excavation

During underground piping work, care must be taken to avoid damaging or cutting existing underground pipes. Accidents involving damaging or cutting underground pipes, such as water, sewer, gas, communication, and electric conduit pipes, disrupt the lives of residents not only at the construction site but also over a wider area. Accidents involving damaging or cutting underground pipes can be caused by the following.

> Failure to follow instructions

> No/inadequate exploratory survey

> The location of the underground pipe differed from the drawing

> Insufficient confirmation of ledgers, etc. before commencing work

> There was no entry in the road ledger

> Failure to check the shape of piping bends, risers, etc.

> It was an underground pipe in a shallow area

> Failure to mark buried objects on the road

> Other

It is important to exchange information among the respective contractors to accurately determine the location of existing underground structures. Prior to the start of construction, a thorough exploratory survey will be conducted. During excavation, a steel pipe and cable detector will be used to detect the location of existing underground pipes and conduits. If a backhoe or other machine is used for excavation, excavation should be done by hand within 50 cm around the existing underground pipes. Looking at accidents by type, more than half are caused by backhoes, but note that there are also cutting accidents during excavation by hand. To prevent accidents, Underground Object Identification Sheets as shown in the table below will be placed between underground objects and the ground surface.

Color legend for Underground Object Identification Sheets

Type of buried equipment	Color legend	Type of buried equipment	Color legend
Communication cable	Red	Sewer pipes	Brown
High-voltage and low-voltage power lines	Orange	Gas pipes	Green
Water pipes	Blue	-	-

(2) Disasters related to manholes

Many disasters related to work in manholes are caused by anoxia and sulfide poisoning. Persons who can enter manholes are those who have completed Class I and Class II skill training courses for oxygen deficient danger operations supervisors or special education for work at the place of an oxygen-deficient danger. Measure oxygen and hydrogen sulfide concentrations, and ventilate the work area so that the oxygen concentration is at least 18% and the hydrogen


Inside a manhole

sulfide concentration is less than 10 ppm. If ventilation is not possible, workers must wear air-purifying respirators and a monitor must be assigned. Falling accidents from ladders also occur due to lack of oxygen. In areas where there is a possibility of oxygen deficiency, even if the height is less than 2 meters, fall arrest devices should be worn. Because construction and work related to manholes often take place on busy roads, accidents with passing vehicles can also occur. Enclosures (manhole shields) and other security facilities will be installed around manholes, and flaggers will be posted around the manholes.

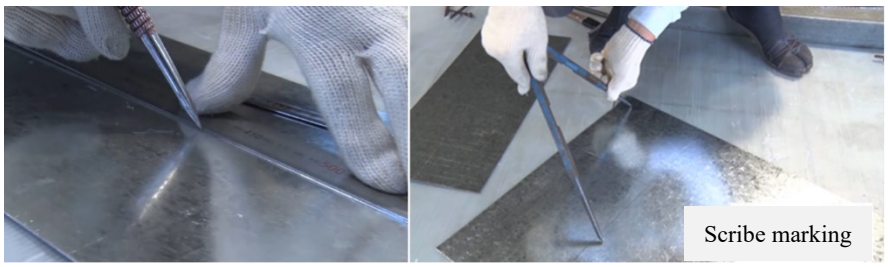
6.6 Architectural Sheet Metal Work

6.6.1 Sheet Metal Processing

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.

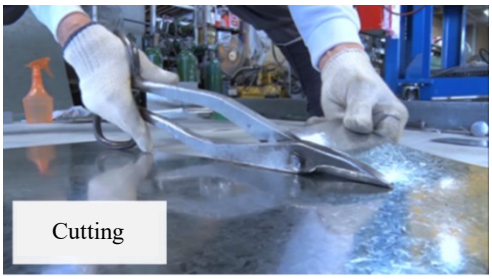
(1) Scribe marking

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.



Scribe marking

(2) Cutting


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


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.

Using the corner of a platform called surface plate as a dolly, 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.

6.6.2 Duct Connection Method

(1) Connection of square ducts

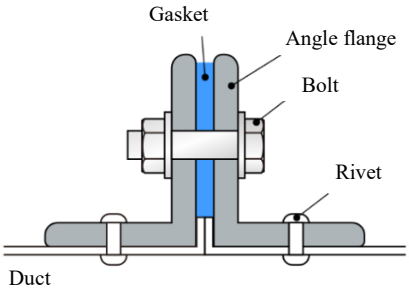
Angle flange and slip-on flange methods are available for connecting square ducts.

[Angled flange method]

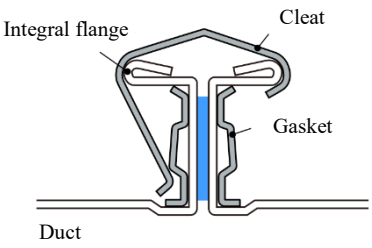
Because of its superior connection strength and airtightness, it is often used for smoke exhaust ducts, etc. However, it is not often used for other duct connections because of the labor-intensive installation process.

[Integral flange method]

A portion of the duct is bent to make a flange (integral flange), the integral flanges are joined together, and the four corners of the duct are secured with special clips. Compared to the angle flange method, this method requires less work to make flanges and is easier to install, and this is why it is often used for ducts other than smoke exhaust.



Angle flange method



Integral flange method

[Slip-on flange method]

A pre-made flange is inserted into the duct and spot-welded, then tightened with bolts and nuts at the four corners, and the flange is held together with special hardware called cleats. This method is more efficient to manufacture than the angle flange method, and is easy to install, requiring only bolts at the four corners. It is stronger than the integral flange method and can be considered an intermediate method between the integral flange method and the angle flange method.

(2) Connection of round ducts

Connection methods for spiral ducts and other round ducts include the flange method and the nipple connection method.

[Flange method]

A flange collar is inserted into the spiral duct, and the flanges are fixed to each other with bolts and nuts. Plate flanges are used for small ducts with diameters of 75 to 100 mm, while angle flanges are used for ducts with diameters of 200 mm or more. This method is suitable for connections that require high strength.

[Nipple connection method]

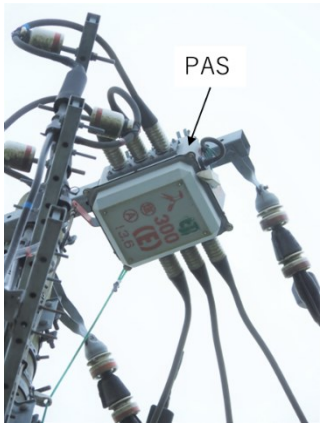
A spiral duct is connected by inserting a special fitting called a nipple into the duct, securing it at two or three points with steel plate screws (self-drilling screws), and wrapping duct tape around it from the outside. This connection method is relatively easy and widely used. When fixing ducts and nipples with steel plate screws, do not drive the screws directly under the ducts so as to prevent water leakage in case water flows into the ducts.

6.7. Electrical Work

The scope of work for electrical work technicians is broad and includes piping, wiring, installation of fixtures, and installation of electrical equipment. This work characteristically uses many different types of tools and equipment. Be careful to avoid electric shock and leakage current while working.

6.7.1 Precautions in Working with High-Voltage Substations

6600V electricity drawn from the power company, etc. is supplied to cubicles installed on the premises, in the basement or on the roof of the building via PAS (Pole Air Switch, a high-voltage air-insulated switch) installed on the poles (in the case of overhead wiring). In cubicles, the received 6600V is converted to 100V or 200V. Inside, there are disconnectors and circuit breakers to shut off electricity. To prevent industrial accidents when working with high-voltage substations, it is fundamental to open the PAS and work while de-energized, including cubicles. When a disconnector or circuit breaker is opened, electricity is still flowing to the primary side of the open section. It is very dangerous to work with an active wire (energized) on the primary side, as it may cause a direct electric shock or an electric shock accident due to electrical discharge.



6.7.2 Short-Circuit, Ground Fault and Leakage Current

A short circuit (also called a short) is when two or more wires from two- or three-phase circuit come in contact with each other, bypassing the load. Short-circuit occurs when the wire is cut while live. Also, wiring errors and metal parts of tools such as screwdrivers may cause short circuits.

A ground fault is when the electric current flows to the ground. The power line must be insulated from the ground. A ground fault occurs when the grounding is done with the wrong polarity.

Leakage current occurs when the current, flowing through the intended circuit, also flows to where it should not. This can cause electric shocks to people, fires, etc. If a building or apartment building is equipped with an earth leakage circuit breaker or ground-fault alarm, leakage current can cause the electric circuit to be interrupted or set off an alarm. Make sure to exercise caution during renovation projects.

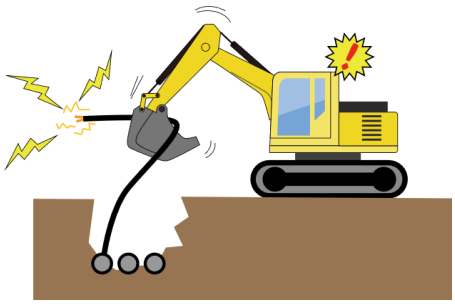
6.7.3 Precautions in Crimping Wires

Poor crimping of wires can lead to accidents caused by heat or sparks. Using a crimping tool, firmly crimp the center of the sleeve of the crimp terminal. Also, make sure to use crimp terminals that are compatible with the wire thickness. Note that not only the wire but also the crimp terminal itself has an ampacity rating.

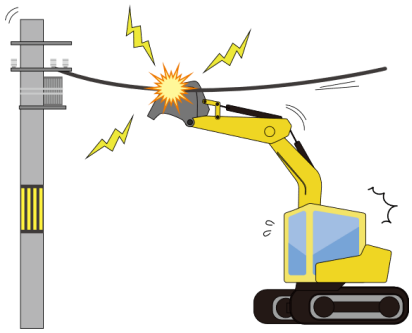
6.7.4 Damage to or Disconnection of Existing Underground Pipes and Overhead Wiring

(1) Cutting of existing underground pipes during excavation of a cable trench

A cable trench is a facility for housing above-ground utility poles and overhead power lines in an underground space. This work is done to improve landscaping and make the roads easier to navigate. Preliminary investigation and temporary work is required for the construction of the cable trench because of the possibility of accidental cutting of existing lifeline infrastructure such as water, sewer, gas, communication, and electrical conduit pipes. For precautions in construction, refer to 6.5.4 Precautions for Underground Piping Work.



(2) Accidental cutting of overhead wires



There are examples of accidents involving cutting of overhead wiring by construction machinery boom movements, raising the dump truck bed, and when loading and unloading construction machinery from construction machinery hauling vehicles. You may be asked by other contractors to install cable covers to protect overhead cables.

6.7.5 Precautions for Road Use

When working on the road, pay attention to relevant laws and regulations. General precautions are as follows.

> The person in charge of the work will carry a road use permit. In addition, the conditions of the permit (working hours, working conditions, etc.) should be observed.

> Security facilities are set up at the construction site to prohibit the entry of people who are not involved in the construction.

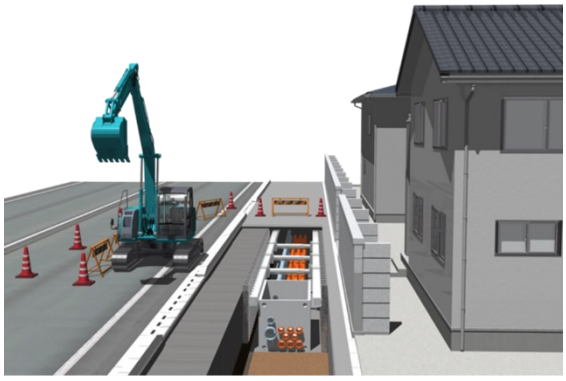
> Traffic control personnel will be positioned to ensure that the flow of traffic is not impeded.

> Measures will be taken to ensure safe passage for pedestrians.

> Efforts will be made to minimize noise, vibration, and other impacts on nearby residents.

> When workers leave the site, excavated surfaces should not be left as they are; they must be backfilled or covered. If holes are to remain as they are, security fences will be installed.

> When temporarily placing objects on the road, secure them or install security facilities around them to prevent them from being scattered or moved.



Construction work to eliminate utility poles

> Caution lights should be placed to indicate the width and height of the installation site at night.

6.8 Telecommunications Work

6.8.1 Types of Telecommunications Facilities

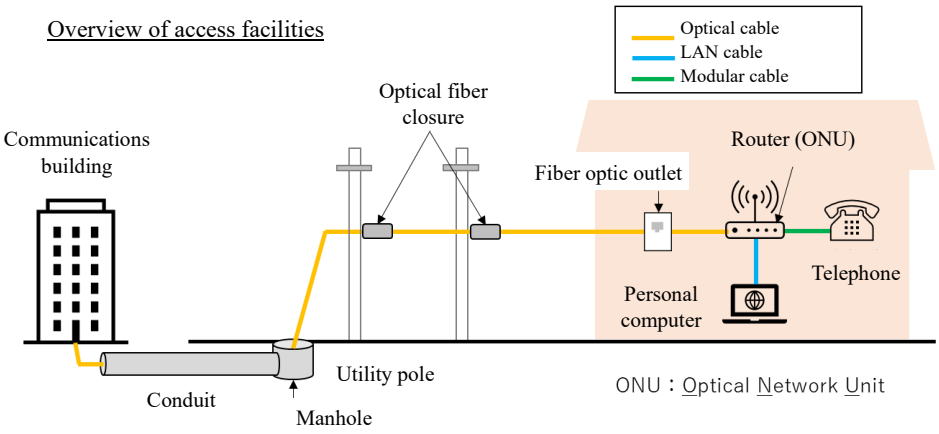
Telecommunications facilities are divided into wired communications facilities, wireless communications facilities, telecommunications civil engineering facilities, switching transmission facilities, and power facilities for communications. This section describes wired communication facilities and telecommunication civil engineering facilities.

(1) Wired communications facilities

A network of wired transmission lines to provide telecommunications services is called access *setsubi* (access facilities).

Access facilities are divided into outdoor and indoor, and outdoor facilities are further divided into overhead and underground. Overhead facilities are facilities attached to utility poles. The following facilities are installed.

Overview of access facilities



[Hikari fiber cable] (fiber-optic cable) These cables pass optical signals.

[Metal cable] Cable used in communication equipment. Fiber-optic cables communicate using optical signals, while metal cables communicate using electrical signals.

[Closure] A box-shaped device installed at the splices or branching points of fiber-optic or metal

cables. Closures may be color-coded with gray for fiber-optics and black for metal cables.

[Hikikomisen] (service cable) This is the cable that draws communication lines into homes.

There is required ground clearance for overhead facilities to ensure safety. When it is over a road, a minimum of 5 meters must be maintained.

***Procedure for erecting poles**

The poles are erected according to the following procedure.

1) Identify the location where the pole will be erected.

2) Check for buried objects by hand-digging or using a probe stick.

3) Excavate by hand and a pole-setting truck.

4) Erect the pole.

5) Backfill.

(2) Telecommunications civil engineering facilities

Telecommunication civil engineering facilities include conduits, manholes, handholes, cable tunnels, joint trenches, and cable trenches.

[Kanro] (conduit) This conduit connects manholes, handholes, cable tunnels, and riser poles. As a general rule, this refers to a pipe that has been drawn in and laid so that one section of cables can be pulled in or out without excavation.

[Manhole] A structure to provide underground access from above ground for cable pull-in, pull-out, and connection work.

[Handhole] A small manhole provided at the junction of underground piping. Cable maintenance is performed without people going inside.

[Todo] (cable tunnel) A tunnel to house various cables for telecommunications.

[Kyodoko] (joint trench) An underground structure in the form of *todo* (cable tunnel) where two or

more facilities such as telecommunications, electricity, gas, water, and sewage are accommodated.

[C.C.BOX] (cable trench) U-shaped structure to house communication and power cables as well as power supplies for information transmission, broadcasting, road management, etc. It is set up under roads, and the U-shaped ditch is covered.

6.8.2 Installation of Underground Conduits

(1) Soil cover thickness and slope of the conduit

The soil cover thickness of a conduit is the distance from the surface of the road to the top of the conduit. The Order for Enforcement of the Road Act stipulates that, as a general rule, the thickness should not be less than 0.8 m under roads and 0.6 m under sidewalks. The slope of a conduit is the slope of the conduit between manholes. The slope is set so that water and sediment can flow inside the conduit without stagnation.

(2) Clearance distance from underground facilities managed by other agencies

The standard clearance distances between conduits and electric, gas, water, and sewage lines are determined as shown in the table below.

	Track (JR, private railway)	Powerline	Water, gas, others
Horizontal distance when parallel	1.0 m or more	Low/high voltage: more than 0.3 m Extra-high voltage: exceeding 0.6 m	0.3 m
Vertical distance when crossing	1.5 m or more		0.15 m

When telecommunication conduits and underground facilities managed by other agencies intersect in close proximity, they should be constructed according to the above table, with the necessary protection methods, after requesting the attendance of the respective managers and obtaining their approval.

(3) Various tests after conduit installation

After conduit installation, the following two tests are performed.

[Mandrel tsuka shiken] (mandrel test) A test to inspect whether the conduits are completely connected. It is conducted by passing through a stick called a mandrel. In conduits longer than 150 m, a mandrel with a diameter of 600 mm is passed through. If the 600 mm mandrel cannot pass through a conduit shorter than 150 m, a mandrel with a diameter of 300 mm is passed through the conduit.

[Kimitsu shiken] (airtightness test) The pressure in the conduit is set to 49 kPa and left for 3 minutes to confirm that the pressure drop is less than 1.96 kPa.

6.8.3 Precautions during Work

See separate sections for more information.

- Precautions for excavation work → 6.5.4
- Precautions for work on manholes, cable tunnels, etc. → 6.5.4
- Precautions for road use → 6.7.5

6.9 Furnace Installation

Furnace construction refers to the construction of the inside of the incinerators, annealing furnaces, cremation furnaces, melting furnaces, electric furnaces, etc., where high temperatures are generated, using refractories. Different types of furnaces require different construction methods and techniques. For example, if refractory bricks are used as the refractory material, bricklaying techniques are required. The bricks used in the furnace are refractory bricks and refractory insulating bricks. The mortar used to bond the bricks is also different from ordinary mortar; mortar made for refractory insulating bricks. There are two types of mortar for refractory insulating bricks: heat setting refractory mortar (bakes and hardens at high temperatures) and dry air setting refractory mortar (hardens in air

at room temperature).

The work proceeds in the following order: layout marking, temporary enclosure erection, and brickwork. Laying refractory bricks (brickwork) requires the highest level of skill among furnace materials. When laying bricks, there are six things that must be observed.

> Use materials correctly.

> Make sure the dimensions are accurate.

> Apply enough mortar and make the joints uniform.

> When laying bricks to create a flat wall, make sure to stagger them.

> Do not use small bricks broken into 1/4 or less of the normal length.

> Brickwork should always be based on level and perpendicular references.

6.10 Fire Fighting Equipment Installation

Part of the fire pump equipment

Firefighting facilities are not operated in normal times; it is mostly used only during emergency situations. For water-based hydrants, it is sometimes necessary to operate the pump to deliver water even when there is no water in the piping on the discharge side of the pump. For this purpose, unlike pumps for water supply facilities, etc., a pump primer, overflow piping to prevent water temperature increase, and performance test equipment are installed.

(1) Installation of a pump primer

If there is no water in the pump itself or if there is an air pocket, the pump will not be able to pump water even if it is operated. If the water source is lower than the pump, install a pump primer to prevent this.

(2) Installation of overflow piping to prevent water temperature increase

If the pump is operated when the pump discharge is closed, the pump continues to just rotate. If left to rotate, the pump will overheat and stop. To prevent this, an overflow piping to prevent water temperature increase is installed.

(3) Installation of performance test equipment

Performance test equipment is installed to determine if the pumps are capable of performing as specified.

(4) Material used for piping

Piping may also be subject to high temperatures from flames when there is no water in the pipe. Metal pipes lined on the inner wall should not be used because the lining material may melt and harden, making it impossible to deliver water.

Chapter 7: Safety during Construction Work

7.1 Fatalities in Construction Work

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

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

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

Table 7-1 Fatal Industrial Accidents in the Construction Industry in 2021 by Major Accident Type

(Compiled from the Ministry of Health, Labour and Welfare's Workplace Safety Website)

7 .1 .1 Numbers 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) 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 handled, such as oceans, rivers, and sewerage works.

7.1.2 Types of Fatal Accidents

(1) Fall from heights

To ensure safety when working at heights on steel towers, there is an *idoyo* rope (safety lanyard) that connects to the full-harness fall protection gear. Falling accidents are more likely to occur when a safety lanyard in use is removed and replaced with another safety lanyard. Keylock-type lanyards and full-harness fall protection gear are designed so that the lanyard currently in use cannot be removed until the next lanyard is inserted.

Overhead wiring uses aerial work platforms that provide a stable working platform, but leaning over the railing can cause loss of balance and falling. Also, if there is no emergency stop device or operation lever available on the working platform, a caught-between accident may occur.

Fatalities from falling from heights include falling into excavated holes. Falling can occur due to loss of balance, slipping, etc.

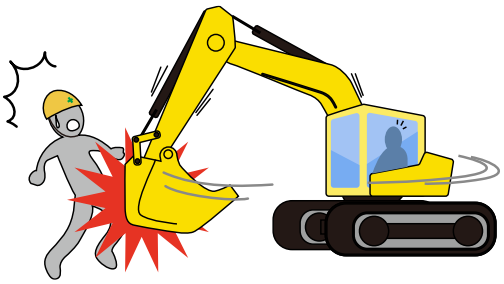
(2) Traffic accidents (road)

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.

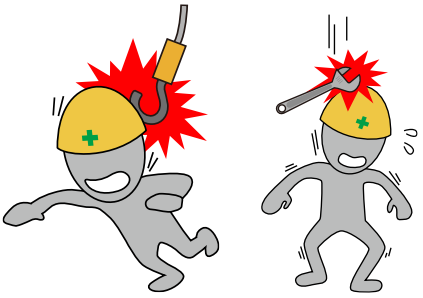
When working on public roads, such as in pipe laying, it is easy for accidents involving ordinary vehicles to occur. For example, if an ordinary vehicle snags a cable during overhead wiring work on a utility pole, it may pull the worker down to the ground. To prevent passing vehicles from entering the worksite, security equipment such as enclosures, fences, and guards will be provided and flaggers will be posted. It is also important that workers do not work outside the scope of the worksite.

(3) Struck-By/Caught-Between

In work performed on public roads, such as pipe laying, be careful of backhoe accidents. These are accidents such as collision between the circling bucket and a person, or a person getting caught between the bucket and an object. In addition, backhoe tipping accidents are more likely to occur when loading and unloading backhoes onto and off trucks, etc. A backhoe tipping can result in fatal accidents when someone is crushed by it.



(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 place yourself under the suspended load. Accidents have also occurred due to falling tools and components to be installed.

(5) Crumbling/Collapsing

In electrical work, accidents include temporary poles breaking and collapsing, or poles on trucks tumbling down and trapping people underneath.

(6) Electric shock

An electric shock is a strong shock that occurs when electricity passes through a person's body. By touching a wire or device that has voltage running through it, electricity flows through the body and into the ground. Electric shock can also be caused by other mistakes such as touching leaky equipment or short-circuiting an electrical circuit. To prevent electric shocks, do the following.

> Work with protective equipment such as antistatic protective gear, rubber gloves to prevent electrical hazards, insulating clothing, and rubber boots to prevent electrical hazards. Even when wearing protective equipment, parts of the body not covered by the equipment may come in contact. Choose proper protective equipment, and consider working under de-energized conditions whenever possible.

> When energized, non-electrical workers may receive an electric shock. Inform people who are not involved in the work, and take steps to prohibit entry to the worksite.

> Unintentionally touching something may cause an electric shock. Ensure that work is performed under de-energized conditions.

> Electric shock accidents can also occur by falsely believing that the worksite is de-energized. In addition to thoroughly notifying all concerned parties, also test for electrical current before work is

performed in order to confirm de-energization.

(7) Oxygen deficiency in manholes

Fatalities from oxygen deficiency and anoxia due to sulfide poisoning have occurred when working inside manholes. In situations where oxygen deficiency occurs, fatal accidents have also occurred to rescuers entering the site without using an air respirator. Refer to 6.5.4 Precautions for Underground Piping Work for more information on disasters related to manholes.

7.1.3 Characteristics of Lifeline Infrastructure/Facility Installation Work with a High Number of Fatalities

(1) Characteristics of and accidents in electrical work

Because electrical equipment installation deals with electricity, a fatal accident called electrocution can occur. Replacement of high-voltage lines and overhead wiring work is performed at heights, and therefore there is also a risk of falling accidents.

An electric shock accident can occur when cutting wires with a cable cutter. Such an accident is the result of failure to check for de-energization, failure to use protective gear to prevent electric shock, etc.

Falling accidents occur when working at heights, such as installing cables on utility poles. Whenever possible, prepare a stable working platform, such as an aerial working platform.

Work on an aerial working platform

(2) Machinery installation

When installing large machines, accidents can occur when the machine tips over and traps people underneath.

(3) Water and sewage works

In water and sewer works, excavation work involves digging trenches in the ground to pass pipes.

There are several accidents associated with this excavation work. For example, there have been accidents in which the people inside the excavated hole were buried alive when the excavated soil collapsed. If the depth of excavation is more than 1.5 m, as a general rule, steel sheet piles are used for soil retaining. Falling accidents can also occur due to tripping over pavement ridges, sinking around shuttering boards, cables, hoses, etc.

Because excavation work involves the use of backhoes, accidents related to backhoes are also likely to occur. Examples include contact accidents caused by circling booms or being run over when backing up. A full-time flagger is assigned to communicate with the backhoe operator in order to ensure the safety of those working in the trench. The backhoe itself is also at risk of tipping over or falling into a ditch.

Sewer manhole construction

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.

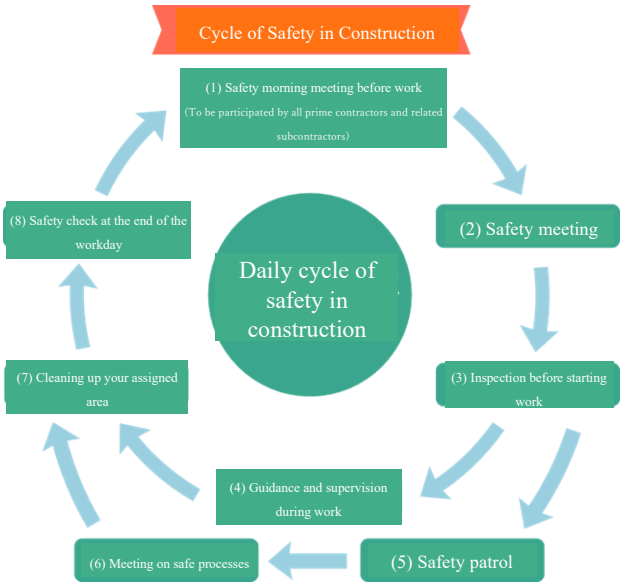
b. Facilitate cooperation between the prime contractor and other related subcontractors.

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.

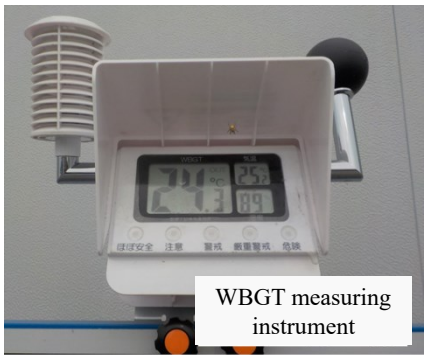
[Hogo mask] (protective mask) A mask used to protect against dust and other debris. There are disposable masks and those with replaceable filters. The Ministry of Health, Labour and Welfare (MHLW) sets the standard for masks. For example, inhaling dust from arc welding and rock cutting operations over 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!”