

Shovel Loader Auxiliary Textbook
for Driver Technical Training

This supplementary textbook, “Shovel Loader Auxiliary Textbook for Driver Technical Training”, is with the cooperation of the Japan Industrial Safety and Health Association (issued by the Japan Industrial Safety and Health Association on 18 March 2021, first edition fourth printing). This is an excerpt from a bilingual translation created in the Ministry of Health, Labor, and Welfare commissioned in 2021. It was created to enhance the educational effect of foreign workers.

Please note that it is necessary to use this supplementary material combined with the training textbook provided by the registered training institution, not by using it alone when conducting skill training.

March 2022

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Part 1 General Overview

Chapter 1 Shovel Loader etc., overview (Textbook p. 13)

Section 1 Shovel loader etc. definitions and characteristics (Textbook p. 13)

A shovel loader, in principle, is a 2-wheel drive vehicle with a shovel (bucket) attached in front of the vehicle body and used for handling cargo by moving the lift arm up and down (Figure 1-1, Figure 1-2).

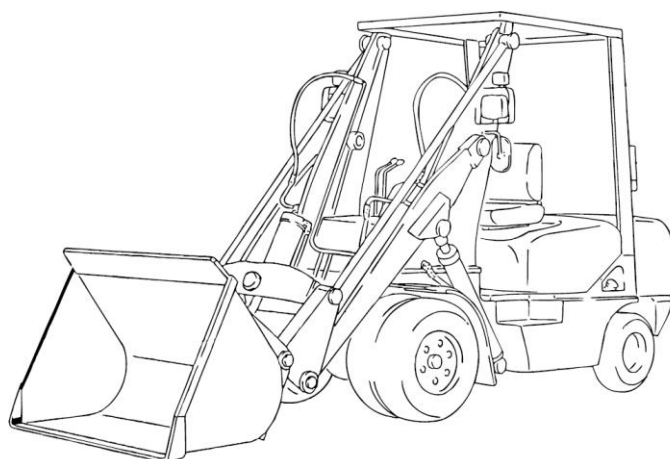


Figure 1-1 Shovel Loader (without reach mechanism)

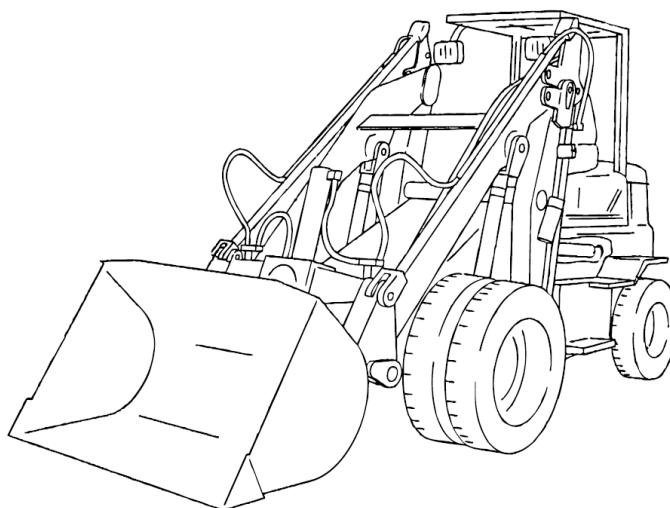


Figure 1-2 Shovel Loader (with reach mechanism)

Fork loader, in principle, is a 2-wheel drive vehicle with a fork attached in front of the vehicle body and used for handling cargo such as lumber by moving the lift arm up and down (Figure 1-3).

Furthermore, the attachment in shovel loader and fork loader can be exchanged to shovel or fork and turn it into shovel loader or fork loader.

Moreover, tractor shovel (the 4-wheel drive crawler type or tire type) is classified as vehicle type construction machine (as listed in the construction machine of Industrial Safety and Health Act Enforcement Ordinance Exhibit Part 7, those that use electric power and are able to travel in unspecified place). Although it is a 4-wheel drive, those that are equipped with a fork without compatibility can also be applied as a fork loader.

Since shovel loader and tractor shovel have different stability standards, drivers who operate different types of vehicles need to pay attention when changing vehicles, especially for vehicle stability and capacity.

The followings are shovel loader characteristics:

- ① Similar to a counterbalance forklift, it has a front-wheel drive and rear-wheel steering system.
- ② Due to body miniaturization, it is effective for small turns.
- ③ Because the drive wheel is a two-wheel, the slip resistance is poor.
- ④ The front area field of vision is poor due to the handling device such as arm and bucket being attached at the front.
- ⑤ The vehicle stability can change based on the load lifting height due to the lifting movement being in an arc shape and not vertical.
- ⑥ It cannot handle or transport work on public roads.

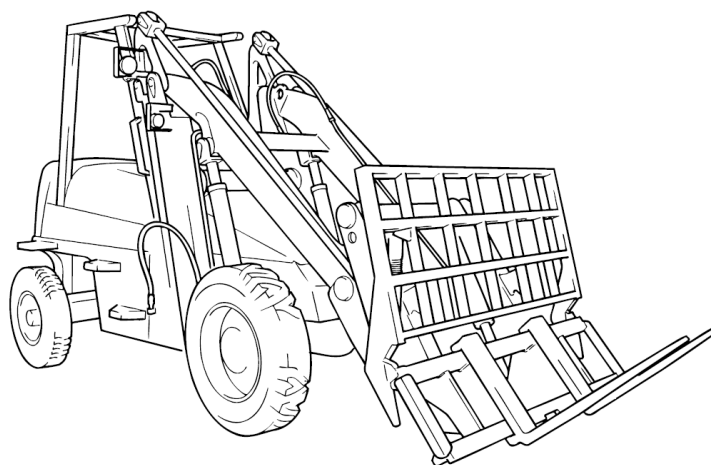
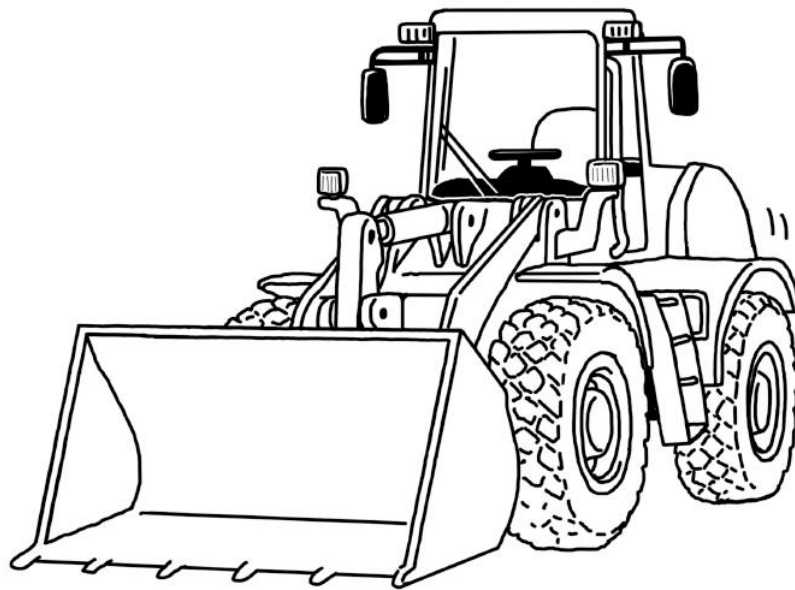


Figure 1-3 Fork Loader

(Since shovel loader and wheel loader are different vehicles, different qualifications are needed to operate them)

Shovel loader characteristic is 2-wheel drive; thus, it is required for the driver to take a “shovel loader driver technical training course” and obtain a certification.

On the other hand, the wheel loader (reference figure) characteristic is a 4-wheel drive. The driver needs to take “a vehicle-type construction machine driver technical training course” to obtain a certification.



Reference Figure Wheel Loader

Section 2 Shovel Loader Types (Textbook p.15)

Section 3 Main Specifications and Dimension (Textbook p.16)

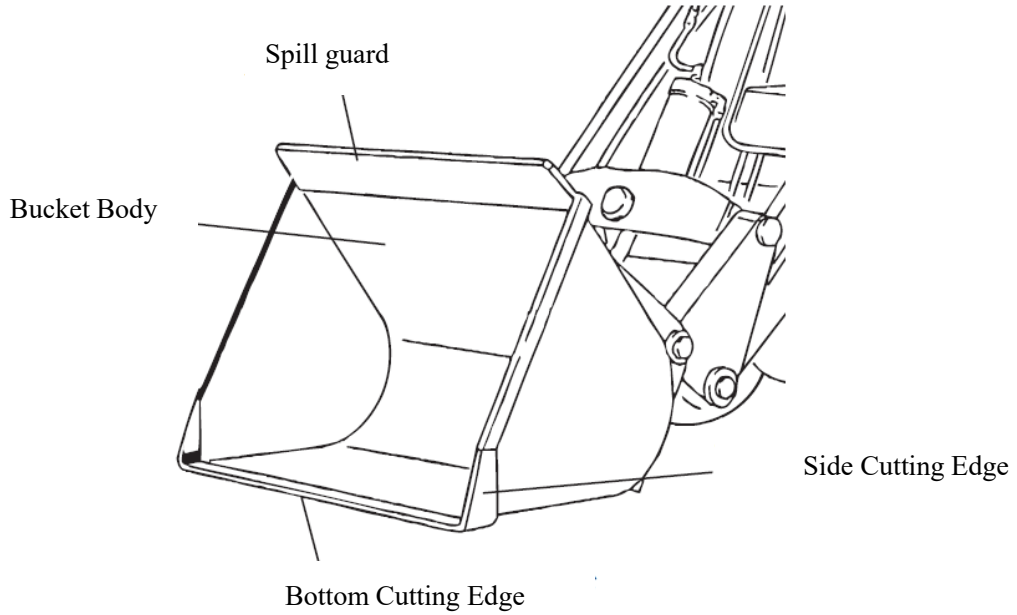


Figure 1-4 Bucket

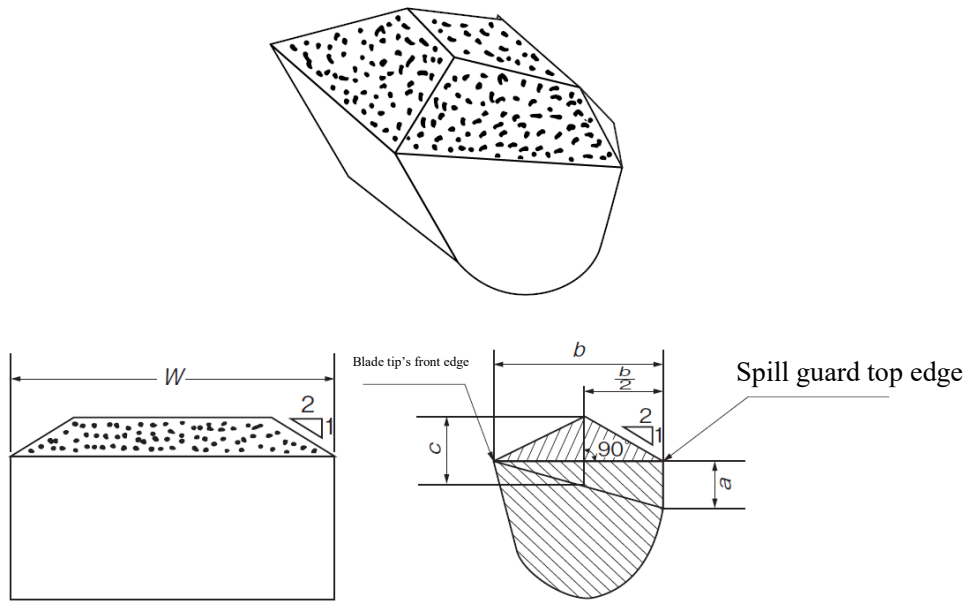


Figure 1-5 I Shape Bucket

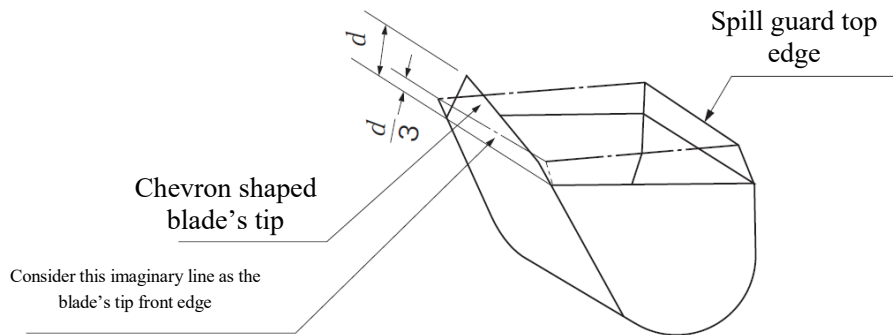
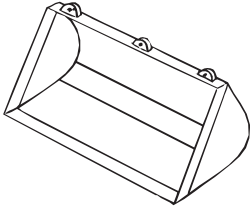
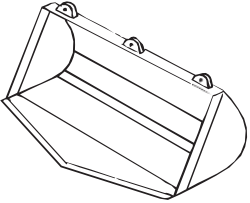
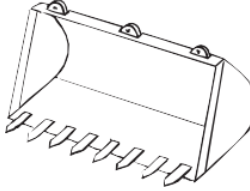
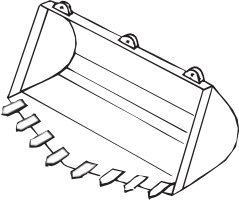


Figure 1-6 II Shape Bucket

Table 1—2 Bucket Types and Characteristics

| Bucket Type | | Structure Characteristics |
|----------------------------|---|---|
| I Shape Standard Bucket |  | <p>This is the most common shape bucket with a straight edge and no claws. Suitable for handling small-sized objects such as sand, gravel, soil, etc.</p> <p style="border-left: 1px solid black; border-right: 1px solid black; padding: 0 10px;">The capacity may be increased with the same shape for handling objects (chips) with a small relative density. (Specific objects)</p> |
| II Shape |  | <p>Similar to the I shape bucket; this type is also suitable for handling small-sized objects. However, in order to increase the scooping ability, the edge is chevron shaped.</p> |
| III Shape |  | <p>The I shape has a straight edge with attached claws, and it is suitable for handling chips with bigger granularity, such as crushed stones.</p> |

| | | |
|----------|---|--|
| IV Shape |  | The II shape has a chevron edge with claws, and it is used to handle chips with big granularity when improving scooping performance is wanted. |
|----------|---|--|

Chapter 2 Shovel Loader Functions (Textbook p.25)

Section 1 Shovel Loader Stability (Textbook p.25)

Section 2 Travel Speed (Textbook p.27)

Section 3 Stopping Distance (Textbook p.27)

Section 4 Elevating Speed (Textbook p.28)

The speed at which the bucket is raised and lowered tends to be higher because it significantly affects the efficiency of cargo handling work.

In the case of lowering, some buckets are equipped with a valve that limits the lowering speed according to the weight of the load, when the operation valve is fully opened.

Section 5 Others (Textbook p.28)

1. Operability

It can be compared to operating an ordinary car but with load handling functions. In addition, the use of operation for forward and backward switching, clutch, brake, lift, and dumping maneuvers are frequently performed; therefore, lately, arrangements of levers, pedals location, and seats (adjustment for lever front and back position) has been made to improve driver operation and comfortability.

2. Field of Vision

Driving a shovel loader while the bucket is in the middle position can obstruct the field of vision and worsen the vehicle stability; thus, the bucket needs to be placed at the bottom when driving it.

Part 2 Knowledge Related to Shovel Loader Drive Device Structure and Handling Method

Chapter 1 Structure (Textbook p. 31)

Section 1 Prime Mover (Textbook p. 31)

1. Engine (Internal combustion engine)

The following is an explanation of the engine structure, operation principle, and characteristics of the shovel loader engine.

(1) Gasoline Engine

A gasoline engine is a device that compresses a mixture of gasoline and air, ignites it, and converts the resulting explosive force into rotational energy.

A. Structure

The main parts of the engine body consist of cylinder, piston, piston rings, connecting rod, crankshaft, flywheel, valves, camshaft, crankcase, carburetor, distributor, and ignition plug. To this, it is equipped with accessories such as an alternator, starter motor, fan, and air cleaner. (Figure 2-1, Figure 2-2).

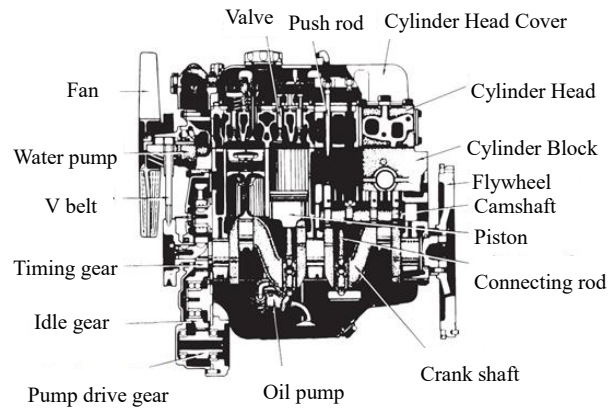


Figure 2-1 Engine Structure

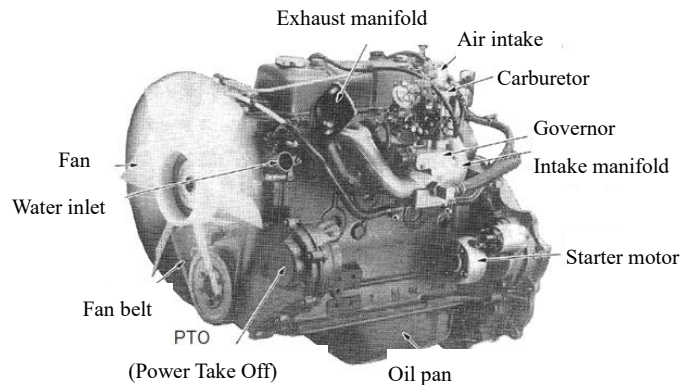


Figure 2-2 Gasoline engine exterior appearance

B. Operation Principle

As the piston goes down inside the cylinder, the atomized gasoline is sucked into the top of the piston along with the air (about 14 parts air to 1 part gasoline by weight ratio) by the atomizing mechanism of the carburetor. Next, the piston rises, and the exhaust valve and intake valve are closed, the gasoline/air mixture gets compressed (around 1/6 to 1/9). When the piston rises, an electric spark is sent into the spark gap of the ignition plug to ignite and explode the gas mixture (the maximum pressure at this time is about 3 MPa), and this pressure pushes the piston down. When the piston is near bottom dead point, the exhaust valve opens, and then as the piston rises, the burnt gas is pushed out through the exhaust valve and through the exhaust manifold, pipes, and muffler.

The up and down movements of the pistons are converted into rotational movements of the crankshaft through the connecting rod and become the power source.

An engine that performs four strokes of: intake, compression, combustion, and exhaust during two rotations of the crankshaft; it is called a four-stroke engine (Figure 2-3). Other than this, there is also a two-stroke engine where one rotation will result in ignition. However, it is usually not applied in shovel loader; hence the explanation will be omitted.

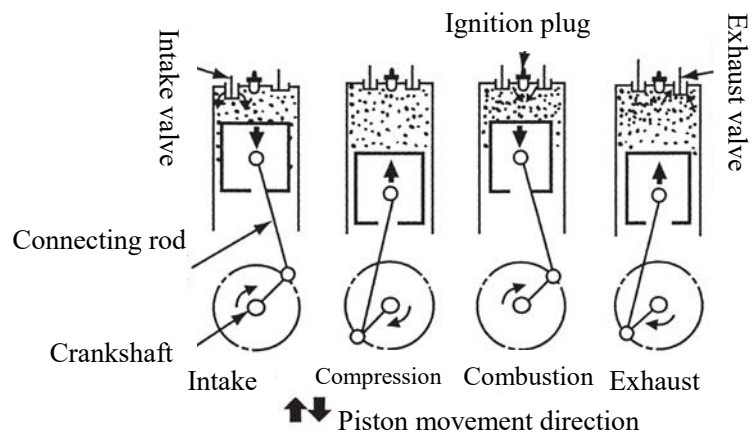


Figure 2-3 Four-stroke Engine Process Illustration

(2) Diesel Engine

A diesel engine is a device that converts the explosive force into rotational energy by compressing air to high pressure and injecting diesel fuel into the air at high pressure, causing the diesel fuel to spontaneously ignite and explode due to the heat of compression of the air.

A. Structure

The main part of the engine itself can generally be thought of as a gasoline engine with the carburetor, ignition plugs, and other ignition devices removed, and instead equipped with a throttle, injection pump, and injection nozzles, while the auxiliary machine is the same as a gasoline engine (Figure 2-4).

B. Operation Principle

The four strokes of action: intake, compression, combustion, and exhaust, are the same as in a gasoline engine, but while a gasoline engine absorbs a mixture of gasoline and air, while in a diesel engine, only the air is absorbed and compressed (the compression ratio is $1/17 - 1/23$, which is greater than the gasoline engine). The difference is that while the former is ignited and explodes, in the latter, when diesel fuel is injected into the compressed air at a higher pressure (about 20 MPa), the diesel fuel spontaneously ignites and explodes due to the heat of compression of the air.

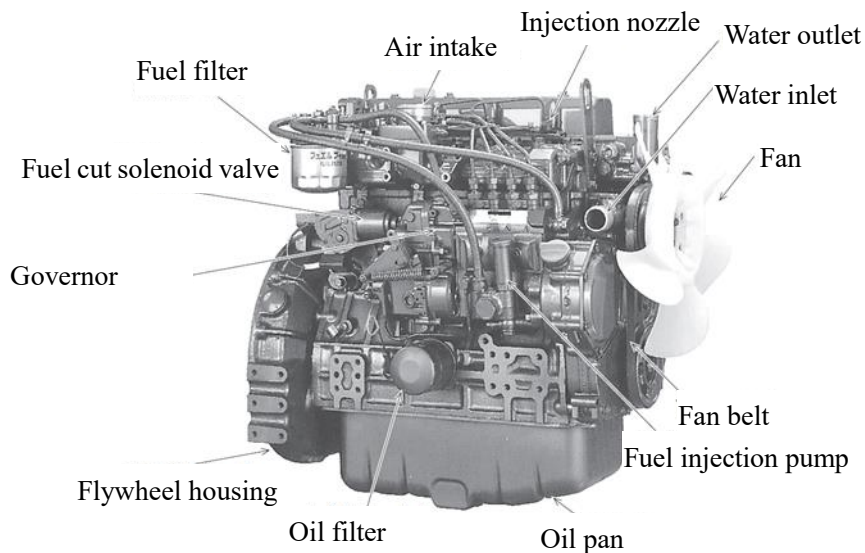


Figure 2-4 Diesel Engine Exterior

Section 2 Power Transmission Device (Textbook p. 42)

Section 3 Travel Gear (Textbook p. 50)

Section 4 Maneuvering Gear (Textbook p. 52)

Unlike ordinary cars, shovel loaders have a big steering angle as explained in “section 3 2. Rear Axle”. In addition, the steering wheel operating force differs considerably between empty and loaded vehicles, and the frequency with which the steering wheel is operated is high, to make the operator control it easier, power steering is applied.

1. Steering Gear

The ball nut type is often used in small excavator loaders. The speed reduction ratio is generally 20 to 25 for the speed reduction device, and the total number of steering wheel revolutions is about 4 to 5 (Figure 2-24).

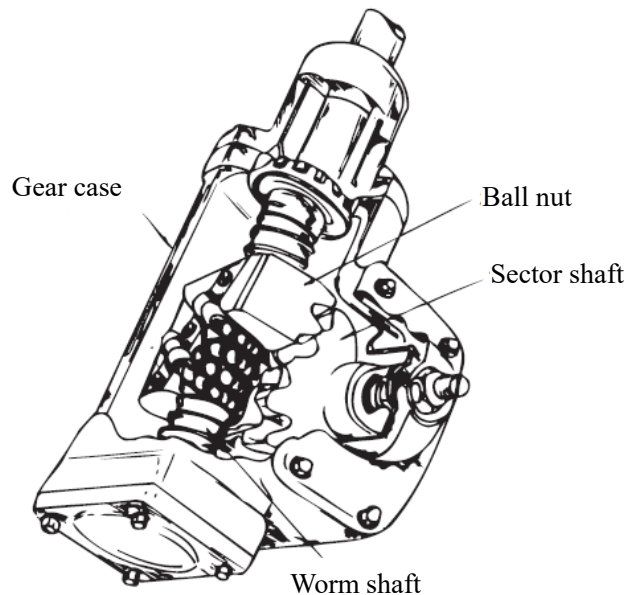


Figure 2-24 Steering Gear
(Ball nut type)

2. Steering Booster Device (power steering)

In order to reduce the steering wheel operating force, it is common to use a steering booster device (power steering) that uses hydraulic pressure for maximum loads of 0.7 tons or more. Shovel loader power steering includes semi-integral type, linkage type, and full hydraulic type (Figure 2-25 ~ Figure 2-27).

(1) Semi Integral Type

The steering deceleration device and valve body are integrated while the cylinder is installed separately.

(2) Linkage Type

The steering deceleration device, valve body and cylinder are separately installed, or valve body and cylinder are integrated.

(3) Full Hydraulic Type

A steering valve with a built-in hydraulic circuit switching valve and metering hydraulic pump that is linked to the rotation of the steering wheel sends oil to the cylinder of the rear axle to steer as much as the steering wheel is turned.

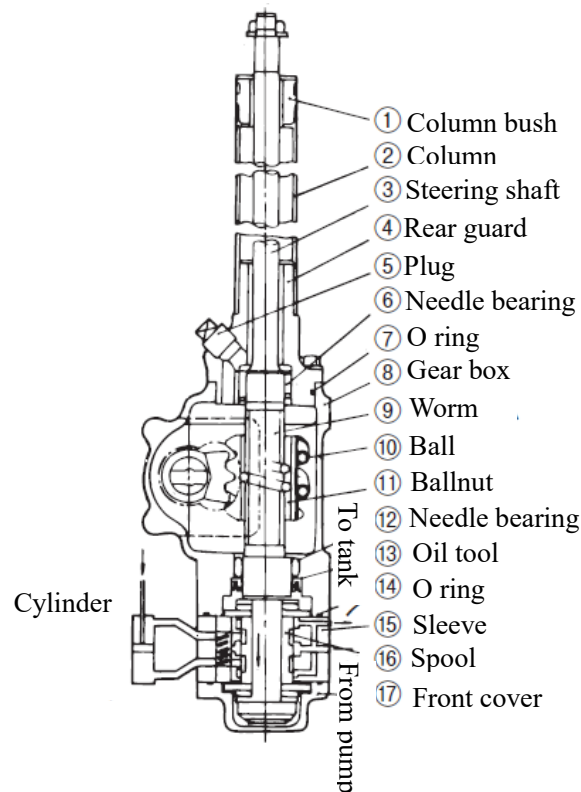


Figure 2-25 Semi Integral Type

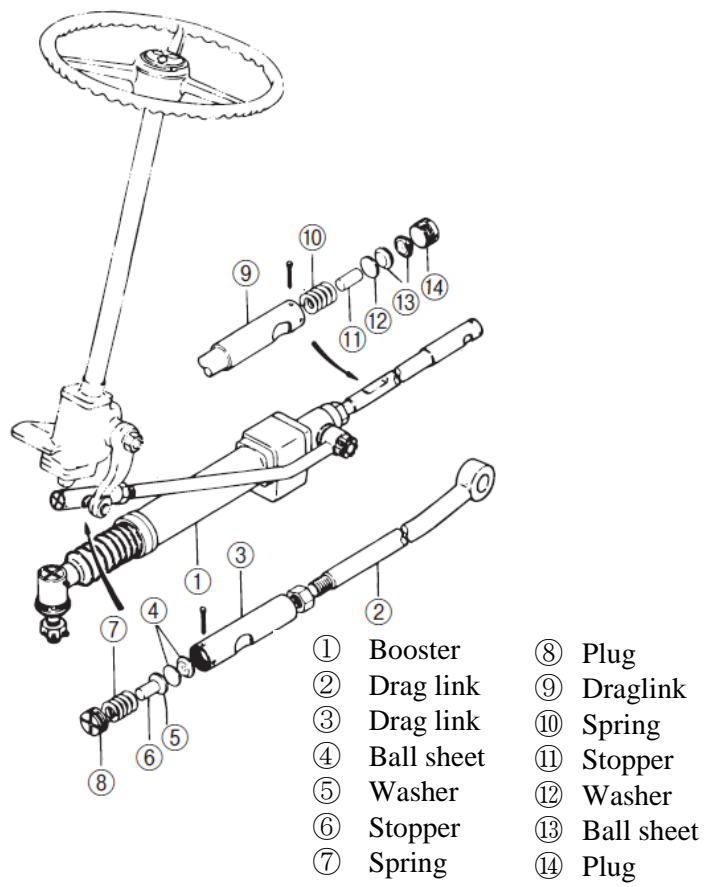


Figure 2-26 Linkage Type

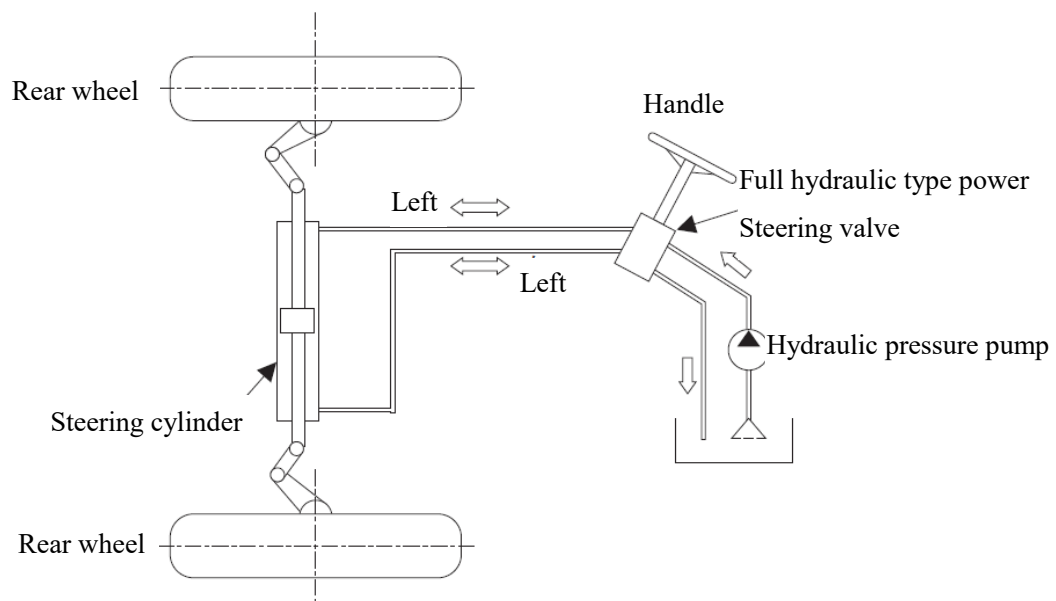


Figure 2-27 Full Hydraulic Pressure Type

3. Steering Link

The steering link connects the steering deceleration device to the rear axle, and consists of a drag link, tie rods, and bell cranks (Figure 2-28).

As shown in Figure 2-28 in the full hydraulic pressure type the steering cylinder functions as an alternative to the bell crank.

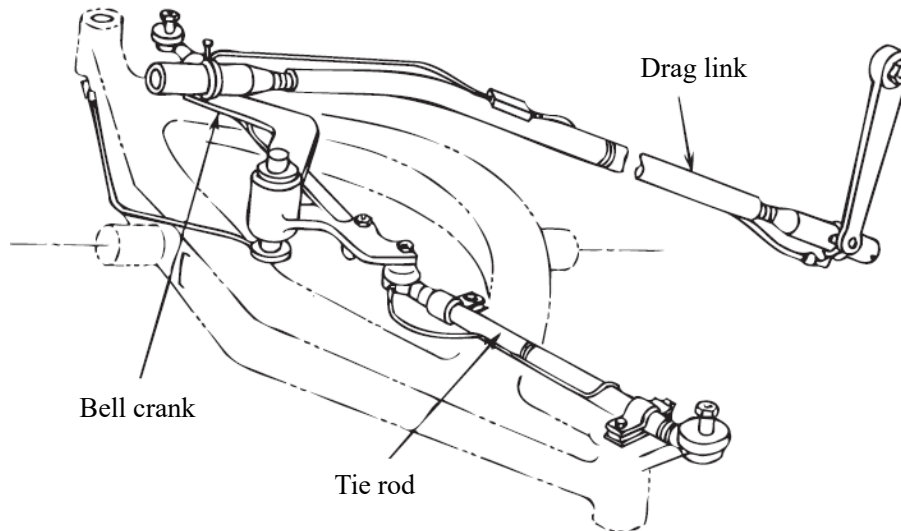


Figure 2-28 Drag Link and Tie Rod

Section 5 Braking Device (Textbook p.56)

Shovel loaders are generally equipped with a hydraulic foot brake acting on the front wheels and a mechanical parking brake acting on the front wheels or output shaft transmission.

The maximum speed of the shovel loader is usually 15 to 30 km / h. Unlike ordinary cars, hydraulic foot brakes are usually installed only on the front wheels and not on the rear wheels, except for special large vehicles, because a large load is applied to the front wheels when loaded.

1. Hydraulic Type Foot Brake

Similar to the ordinary car's foot brake, the tread force of the foot is transmitted to the master cylinder, and the hydraulic pressure generated is sent to the wheel cylinder to expand the brake shoes and apply braking by friction with the brake drum. (Figure 2-29).

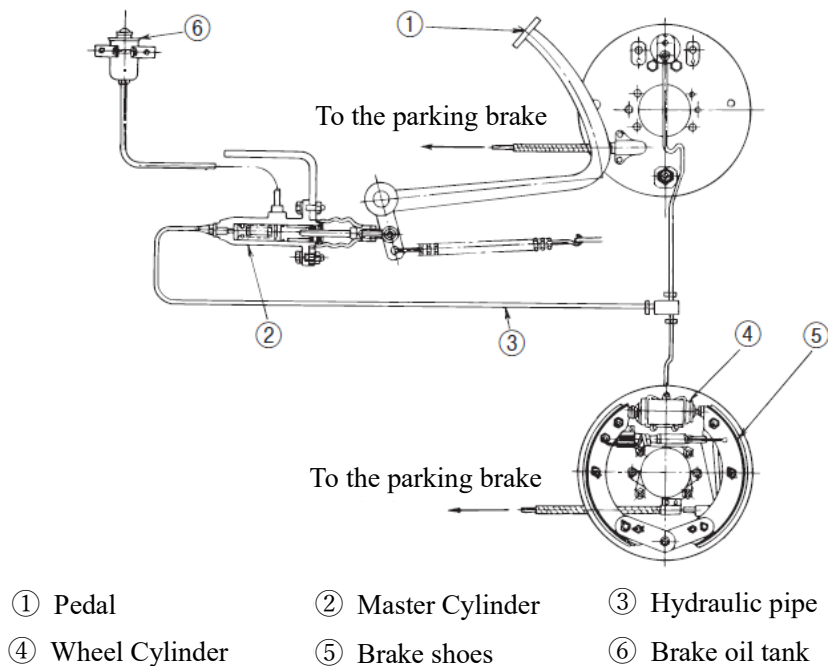


Figure 2-29 Foot Brake (Example of drum type brake without servo)

2. Servo Type Brake

The system shown in Figure 2-29 is sufficient for a small type of shovel loader. However, in larger vehicles, the hydraulic foot brake alone may not provide enough braking force, a booster (servo type) is required to reduce the tread force to apply the brake.

Since servo-type takes and uses energy from the engine in the form of hydraulic pressure, vacuum force, and air pressure, the following precautions are required.

- ① Immediately stop the shovel loader if the engine stops or the hydraulic or air system malfunctions during the operation. Stop the engine in a downward slope or flat area and don't operate it.
- ② Don't move a vehicle with a brake and steering system malfunction by towing it.

There are several types of servos.

(1) Hydraulic Servo

The hydraulic pressure from the hydraulic pump attached to the engine is sent to the wheel cylinder via a brake valve linked to the brake pedal to expand the brake shoes and apply braking.

(2) Vacuum Servo (Figure 2-30)

This type uses a brake booster that uses the differential pressure between the vacuum pressure generated by the vacuum pump or engine intake side and atmospheric pressure to increase the fluid pressure generated in the master cylinder.

(3) Air Servo

This type uses compressed air obtained from the engine with a compressor installed.

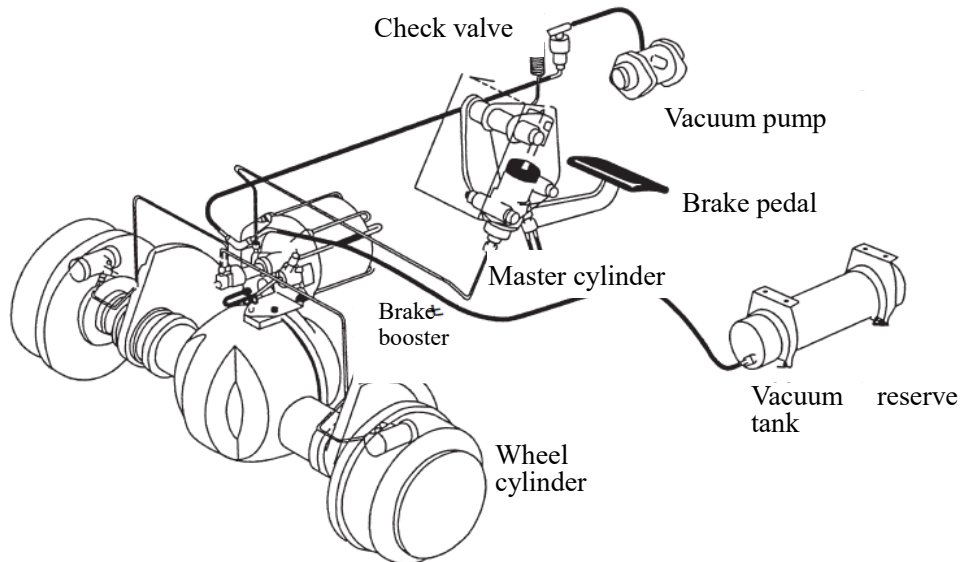


Figure 2-30 Example of Brake Booster (vacuum servo type)

3. Parking Brake

Similar to an ordinary car this part is used when parking or unexpected braking transmitting a hand or other force to a cam via a link which rotates causing the brake shoe to contract and the friction between it and the brake drum to apply braking. (Figure 2-29).

Furthermore, the parking brake lever is equipped with a ratchet or over-lock structure to maintain the braking state even when the hand is released. Figure 2-31 shows the internal expansion type, but there is also an external contraction type.

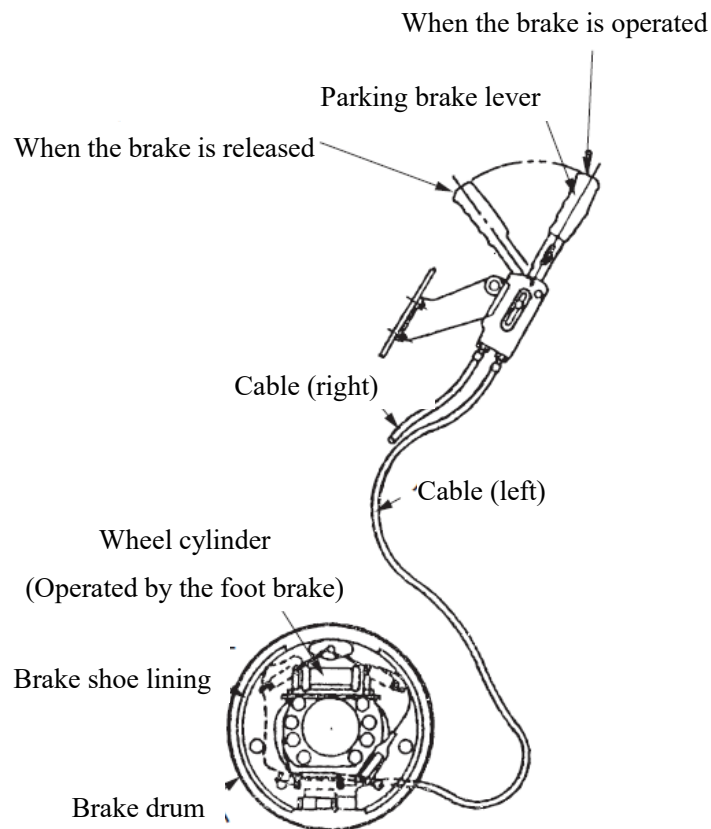


Figure 2-31 Internal Expanding Type Brake (double as parking brake too)

Section 6 Attachment (Textbook p. 59)

Chapter 2 Handling Method (Textbook p. 61)

Section 1 Basic Matters (Textbook p. 61)

Unlike cars, a shovel loader is not only for driving but also for cargo-handling work and has a larger vehicle mass and driving force, and due to the differences in structures and characteristics, many accidents occur because of the driver carelessness. Moreover, the load-handling and transporting work is often performed in a narrow place, the drivers and the guides must pay close attention to the surrounding conditions, especially with pedestrians and highly loaded cargo.

As explained in section 2, before starting work, the operator must check the effectiveness of brakes, the play of the steering wheel, and tire pressure.

It is necessary to always stop the engine and wipe off any fuel or hydraulic oil leaks when refueling.

Furthermore, it is critical to read and understand the instruction manual that comes with the machine before actually operating it, since each manufacturer and model of shovel loader has its own unique handling precautions.

In addition, if a malfunction of the shovel loader is found, it is necessary to immediately report it to the vehicle supervisor to have it repaired.

Section 2 Instructions Before Starting Work (Textbook p. 62)

To prevent any accidents from happening in the future, it is critical to perform the inspection as shown in table 2-1 before starting work.

The inspection is usually performed in 3 steps.

- ① Before starting the engine,
- ② After starting the engine and while in the car,
- ③ When traveling at slow speed.

Table 2-1 Inspection List Before Starting Work

| Item | Before starting the engine | After starting the engine and while in the vehicle | When traveling at a slow speed |
|-------------------------|--------------------------------------|---|--------------------------------|
| E x t e r i o r | Water or oil leakage | | |
| T i r e | Tire's air pressure, tire damage | | |
| Turn signal and lamp | Stain or damage in the lens and lamp | Every lamp operation | |
| Rearview mirror | Stain, damage | Rear view | |
| Alarm device (horn) | | Is there any sound? | |
| Each indicator | | Each indicator operation | |
| F u e l | | Oil amounts | |
| E n g i n e | | Abnormal noise, exhaust color | |
| C l u t c h | | Pedal play | Clutch disengagement |
| F o o t b r a k e | | Brake pedal engagement | Brake effectiveness |
| P a r k i n g b r a k e | | Lever pull, parking brake effectiveness | |
| S t e e r i n g | | Handle play, looseness | Swing, control |
| Handling device | | Handling device operation, bucket ascending and descending movement, dump arm reach operation | |

Section 3 Periodic Inspections (Textbook p. 63)

The law requires employers to carry out inspections on a regular basis to prevent accidents and improve the vehicles' operating efficiency.

Periodic inspections include every month, every year inspections, and inspection upon resumption of use. When performing periodic inspections, the result must be recorded and stored for 3 years. In addition to the inspection, it is required for inspections to be performed by a person with sufficient ability (a person who has received a certain level of training on the implementation of periodic inspections or a maintenance service provider) in accordance with the "Shovel Loader Periodic Inspection Guideline" published by the Minister of Health, Labor and Welfare (18 December 1985, Inspections Guidelines Public Announcement No.9).

1. Monthly Inspections

Monthly inspection shall be conducted periodically once in a period not exceeding one month to check for abnormalities in braking system, clutch, steering device, cargo handling system, hydraulic system (including safety valve), head guard, etc.

2. Annual Inspection

Annual inspections shall be conducted periodically once in a period not exceeding one year. These are inspections to check for abnormalities in each part of the shovel loader, etc. Furthermore, for shovel loaders with a suspension period that corresponds with the left column of table 2-2, the inspections items in the right column must also be performed when the vehicles restart activities.

Table 2-2 Inspection When Restarting Activities

| Suspension Period | Inspection when restarting activities |
|-----------------------------------|---------------------------------------|
| Over than 1 month, under one year | Corresponds with monthly inspection |
| Over than a year | Corresponds with annual inspection |

Section 4 Guidelines When Starting Operation (Textbook p. 64)

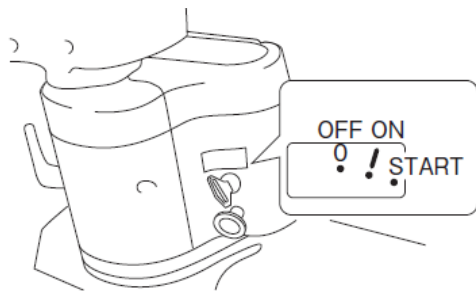
1. Gasoline Engine Type

- ① Make sure the gearshift lever is in the neutral position and the parking brake is pulled.
- ② Insert the engine key into the start switch (Figure 2-33) and turn the key to the ON position.
- ③ Turn the key to the START position and release your hand from the key when the engine starts.
- ④ After the engine starts, let it to warm up for a while.

Since the auto choke is working, the engine number of revolutions will gradually increase, and when the engine is warmed up, the revolutions will automatically decrease.

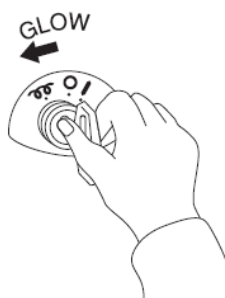
2. Diesel Engine Type

- ① Make sure that the gearshift lever is in the neutral position and the parking brake is pulled.
- ② For diesel models with a preheating system (except direct injection models), the preheating system must be heated, so turn the engine key to the "GLOW" position and turn on the preheating signal lamp (Figure 2-34).
- ③ When heating by the preheating device is completed and the signal lamp turns off, turn the key to the "START" position, and remove your hand from the key when the engine starts. (Check the instruction manual as it may differ slightly depending on the manufacturer).
- ④ Let it to warm up for a while.
- ⑤ Depending on the starter switch structure, there is also a type where the preheat signal lamp will automatically light up when the key is turned to ON (Figure 2-35).



For gasoline engine type, insert the key and turn it to ON position

Figure 2-33 Starting the Gasoline Engine Type



Preheat signal lamp

For diesel engine type (preheat lamp type), turn the key to GLOW position, and turn the preheat signal lamp

Figure 2-34 Starting the Diesel Engine Type (1)



Preheat signal lamp ON position

For diesel engine type (automatic preheat lamp type), there is also a type where the lamp automatically lights up if the key is turned to

Figure 2-35 Starting the Diesel Engine Type (2)

Section 5 Guidelines for Starting and Driving Operation (Textbook p. 66)

1. Before departing

Operate the lift, dump, and reach levers to activate the full stroke of each cylinder two or three times.

Pull the lift lever to lift the bucket 20-30 cm above the ground. Pull the dump lever to move the bucket fully upward.

Pull the reach lever to pull the bucket fully toward to the machine stand side.

2. Clutch Type (Figure 2-36)

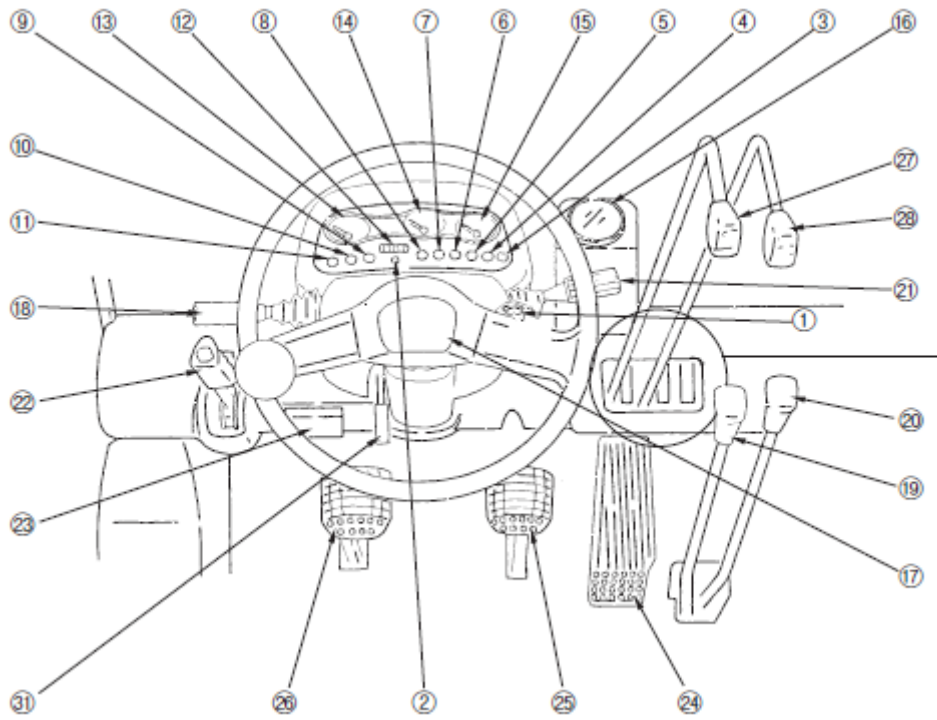
- ① Fully depress the clutch pedal.
- ② Insert the gearshift lever into 1st gear (F-1 for forward, R-1 for reverse).
- ③ Loosen the parking brake (For lever type, push forward. For the stick-type push down while turning).

The shovel loader will move by gradually releasing the foot from the clutch pedal while at the same time depressing the accelerator/gas pedal.

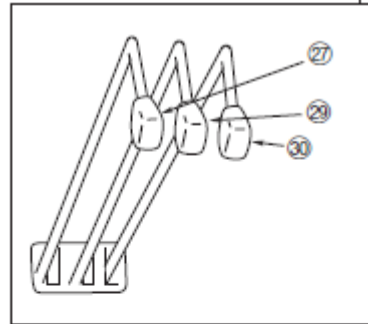
- ④ Depress the accelerator pedal further to accelerate, then release your foot and at the same time, depress the clutch pedal and insert the gearshift lever into 2nd gear.
- ⑤ Depress the accelerator pedal, and at the same time, quickly release the clutch pedal. As described above, it is the same as the clutch type of car.

When moving off, it is necessary to change the degree of pressure to the accelerator pedal when the vehicle is empty and when it is loaded. Please note that if you do not depress the accelerator pedal more than usual when loaded the vehicle may stall.

When started going uphill, the parking brake is released while depressing the accelerator pedal and taking your foot off the clutch pedal.



- ① Start switch
- ② Driving injector (displayed when driving)
- ③ Glow injector (diesel engine type vehicle)
- ④ Sedimeter warning light (diesel engine type vehicle)
- ⑤ Battery liquid amount warning light (optional)
- ⑥ Radiator cooling water quantity warning light
- ⑦ Fuel remaining quantity warning light (optional)
- ⑧ Air cleaner element warning light (optional)
- ⑨ Charge warning light
- ⑩ Engine hydraulic pressure warning light
- ⑪ Brake liquid amount warning light
- ⑫ Hour-meter
- ⑬ Engine water temperature gauge
- ⑭ Torque converter type oil temperature gauge (optional)
- ⑮ Fuel meter
- ⑯ Speedometer (optional)
- ⑰ Horn button
- ⑱ Forward-backward lever (torque converter type vehicle)
- ⑲ Forward-backward lever (clutch type vehicle)
- ⑳ High-low speed (speed switcher) lever (clutch type vehicle)
- ㉑ Combination switch (winker and light switch)



- ㉒ Parking brake lever
- ㉓ Fuse box
- ㉔ Accelerator/gas pedal
- ㉕ Brake pedal
- ㉖ Inching pedal (torque converter type vehicle)
- Clutch pedal (clutch type vehicle)
- ㉗ Lift lever
- ㉘ Dump lever (without reach function)
- ㉙ Reach lever (with reach function)
- ㉚ Dump lever (with reach function)
- ㉛ Tilt handle lock lever

Figure 2-36 Driver Seat (clutch type, torque converter type)

3. Torque Converter Type (Figure 2-36)

- ① Insert the forward-backward lever to forward (backward).
- ② Loosen the parking brake.
- ③ Depress the accelerator pedal to start.

In addition, many of the torque converter models have an inching pedal on the left side. This pedal, when depressed, will neutralize the transmission as well as the brake, making it easier to perform slow speed driving operations such as approaching a dump truck.

4. Driving at a Specified Speed

Speed limit must be specified when driving inside a factory or indoors. Furthermore, it will be safer if the speed is separately decided, for example, 15 km/h when in empty condition and 10 km/h when in loaded condition. When using a shovel loader in a focused manner, these restrictions are necessary, and over-speeding and overtaking must not be done.

5. Turning on the Corner (Figure 2-37)

When changing direction at an intersection or turn, use a turn signal to indicate the direction in which you are turning, and check for safety before turning the wheel.

If there are pedestrians or other vehicles ahead of you trying to turn, stop and wait.

When turning a corner, unlike ordinary cars, the rear wheels are used to steer the car, so when moving forward, it is necessary to pull the car all the way inward to turn.

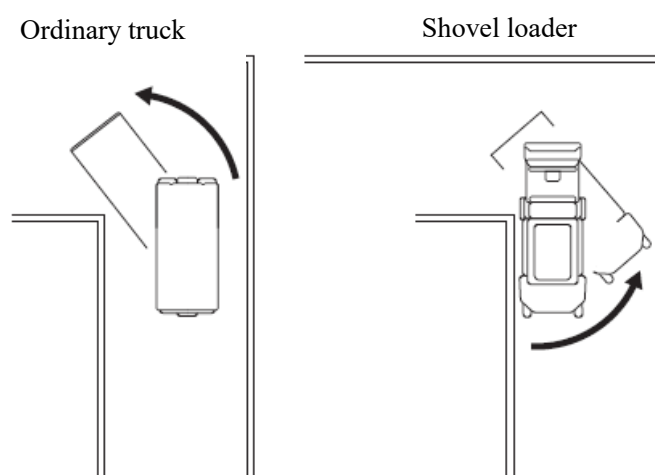


Figure 2-37 Turning at the Corner

6. Backward

Shovel loaders have a higher frequency to use backward movement, unlike cars. The ratio of backward movement to forward movement is about half or 40% (backward) and 60% (forward). When moving backward a vehicle with a reach, pull the arm fully backward, with the bucket facing up lower it to a height of 20-30 cm from the ground, check the load stability, hold to the grips while turning back, and drive carefully.

7. When crossing a corridor or passing through obstacles

Similar to a car, when passing through an area with poor visibility, such as a turn or an entrance/exit of a warehouse or premises, be sure to stop, check for safety on both sides, and then start carefully.

Remove obstacles (for example stone block, timber, depression, salient) as much as possible before passing, or completely avoid them while passing.

If the road conditions are muddy or snowy, it is effective to use double tires on the front wheels since they are the driving wheels. It is also effective to use tire chains.

Section 6 Guidelines for Temporary Stopping, Parking, and End of Driving (Textbook p. 70)

1. Temporary Stopping

(1) Clutch type

- ① Remove foot from the accelerator pedal.
- ② Step on the brake pedal.
- ③ Fully step the clutch pedal all the way down.
- ④ Return the forward-backward and high-low speed (speed switcher) lever to the middle.

(2) Torque converter type

- ① Remove foot from the accelerator pedal.
- ② Step on the brake pedal
- ③ Return the forward-backward lever to neutral position.

2. Parking

- ① Fully pull the parking brake or pull it toward you.
- ② Set the gearshift lever to neutral.
- ③ Lower the bucket to the ground, dump it forward, and keep it on the ground in a horizontal position. (Figure 2-38).

Turn the engine key to the left to stop the engine. Remove the key when leaving the driver's seat.

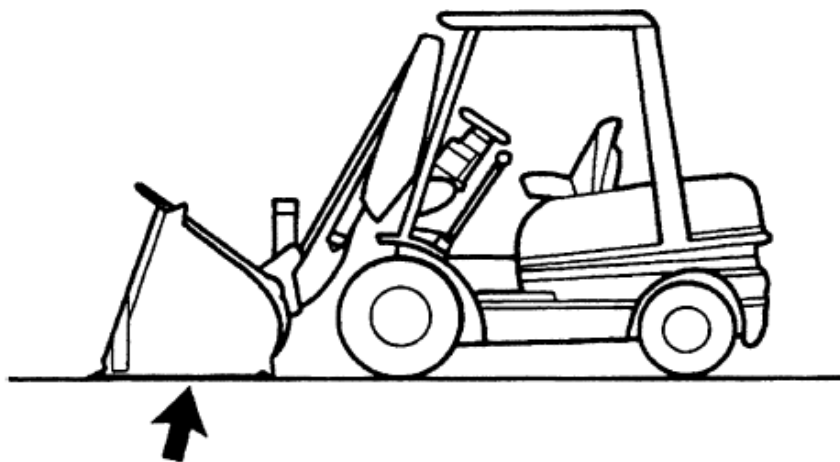


Figure 2-38 Parking Illustration

3. Guidelines for End of Driving

At the end of operation, it is necessary to clean and inspect each part of the vehicle and leave it ready for work at any time.

(1) Cleaning

① Use clothes or brushes to clean the outside of the vehicle. Clean with water when it's too dirty.

② Open the engine hood and wipe off the dusty parts with a rag.

(2) Inspection

① Check the tires for damage.

② Check the exterior of the vehicle for any abnormalities (dents, cracks, etc.)

③ Check the remaining fuel level, refill it.

④ Check if there is any leakage in the hydraulic oil, engine oil, fuel, and cooling water.

⑤ Check if there is any looseness in the hub nut and the piston rod joint of each cylinder.

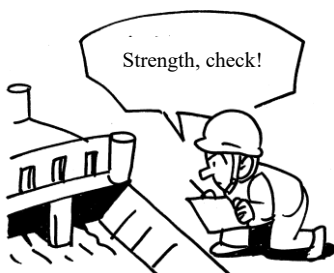
4. Driving Precautions



(1) Do not drive carelessly.
Pay full attention while driving and work carefully. A moment of carelessness can lead to a disaster.



(2) Do not take eyes off the road while driving.
Looking aside while driving can cause a disaster, so pay attention to the direction of travel and pay attention when approaching people working around you.



(3) Check the condition of the road surface and the strength of the bridge in advance.



(4) Do not drive with people on the bucket or on the vehicle. It may cause injury to the person when the vehicle suddenly stops.



- (5) Do not travel with a bucket raised higher than necessary.
(Regardless of whether empty or loaded) lower the bucket and travel in the basic driving position.



- (6) On a slippery surface, avoid high-speed driving, high-speed turning, and sudden braking.



- (7) On steep slopes, do not drive at right angle. The vehicle may slide sideways and fall over.



- (8) Be careful when handling fire. When bringing fire close the vehicle, there is a risk of catching fire.



- (9) ① Be sure to face the vehicle when getting on and off the vehicle. Always hold your body in three position or more by using the handrail and the steps.
- ② Do not jump on or jump off the vehicle.
- ③ Do not get on or get off the vehicle while holding material.
- ④ Do not get caught in the operating device accidentally.



- (10) Be careful of obstacles.
When turning and driving do not collide the vehicle or the bucket with the obstacles.



- (11) Obey the running speed at night.
At night, it is easy to mistake the perspective and height of the ground, so drive at a speed appropriate for the lighting.



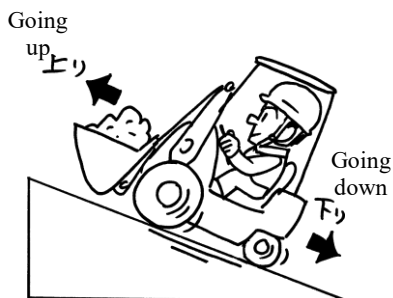
(12) Keep people out of the raised bucket.
Operating the bucket may cause injury.



(13) Fully understand the performance of the vehicle.
Bulk cargo materials are easy to get overload,
so be careful not to overload.



(14) Do not load on one side.
If you load on one side, the left and right sides will be unstable, and the hydraulic system will be overwhelmed.



(15) Be careful when driving on slopes.
When the vehicle is loaded, drive forward on uphill slopes and backward on downhill slopes.
When the vehicle is empty, drive backward on uphill slopes and forward on downhill slopes.

Volume 3 Structure and Handling Method of Equipment Related to Cargo Handling such as Shovel Loaders.

Chapter 1 Structure (Textbook p.79)

Section 1 Cargo Handling Equipment (Textbook p.79)

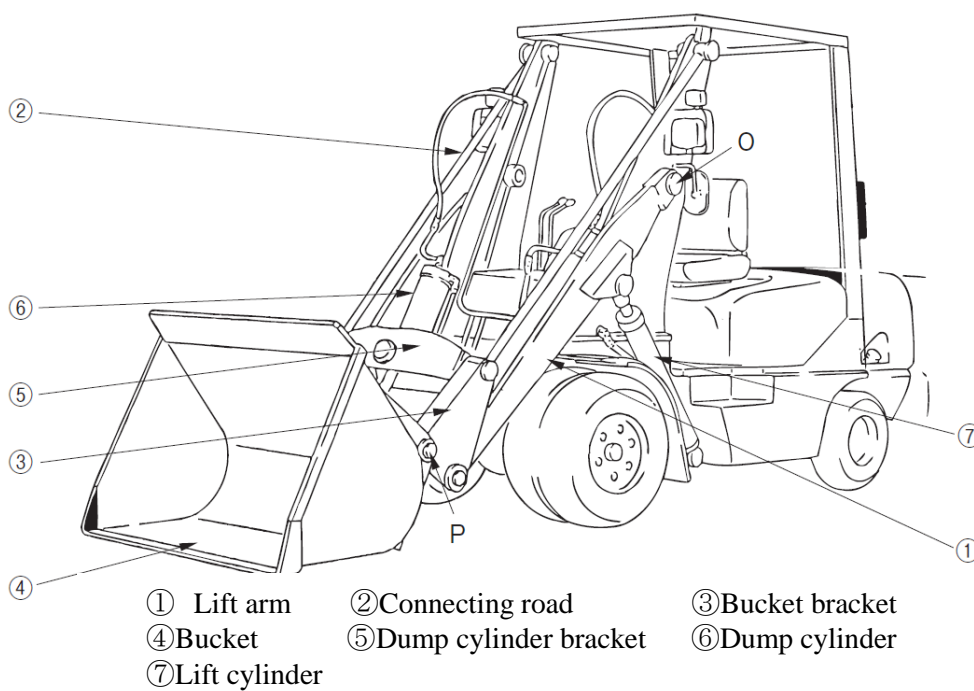
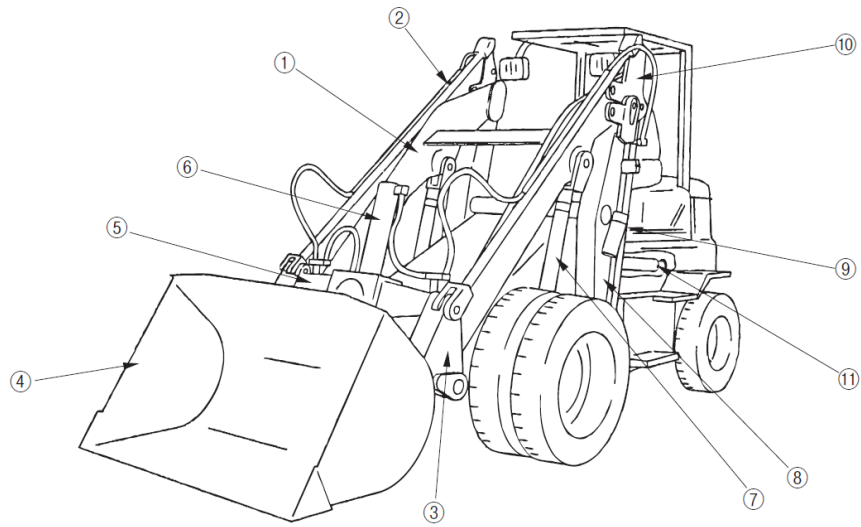


Figure 3-1 Shovel Loader Work Equipment



- ① Lift arm ②Connecting road A ③Bucket bracket ④Bucket
- ⑤Dump cylinder bracket ⑥Dump cylinder ⑦Lift cylinder
- ⑧Reach arm ⑨Connecting road B ⑩ Bell crank ⑪ Reach cylinder

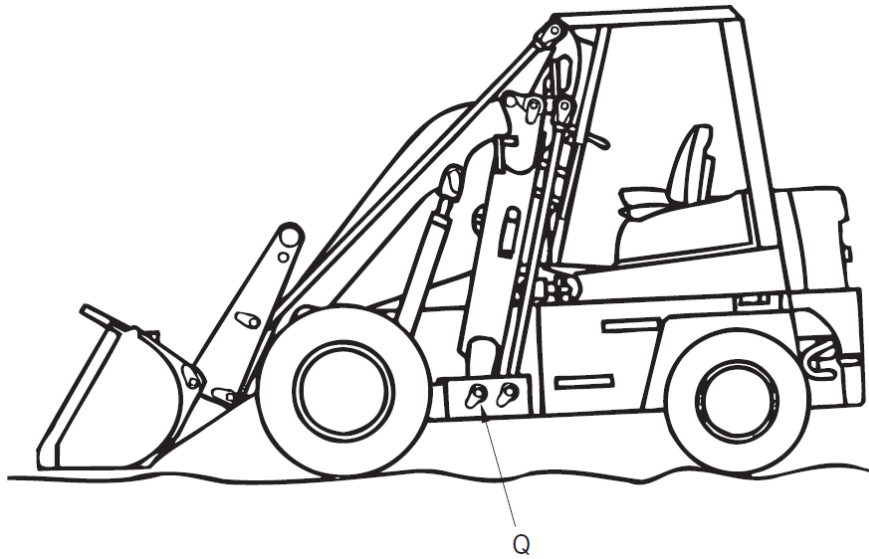


Figure 3-2 Shovel Loader Work Equipment with Reach Mechanism

Section 2 Hydraulic system (Textbook p.82)

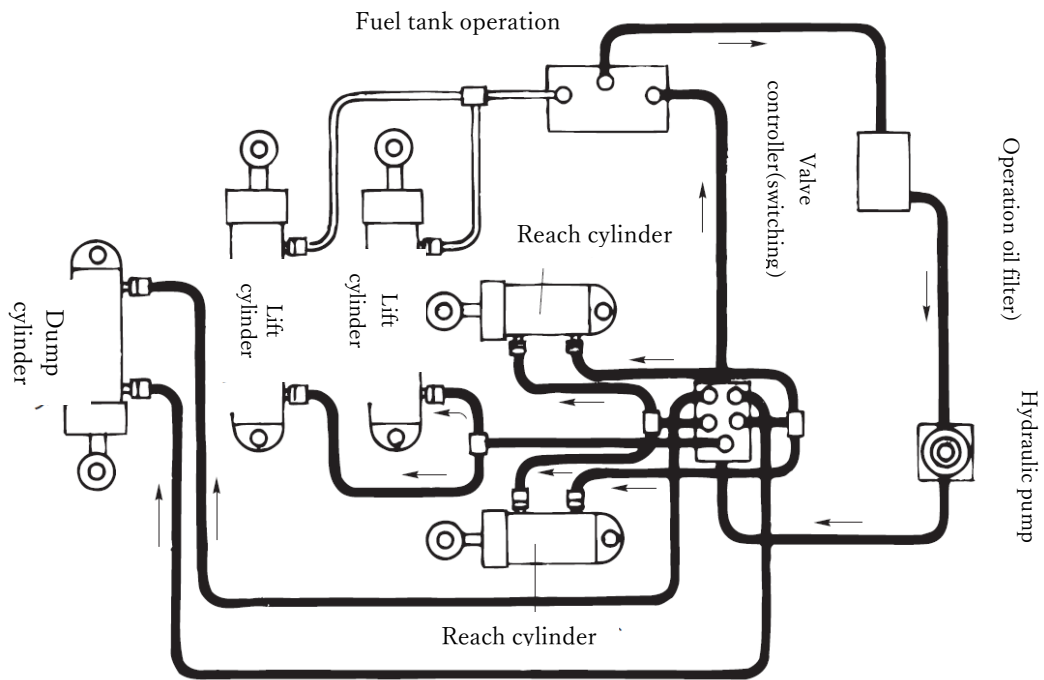


Figure 3-3 Shovel Loader System Diagram

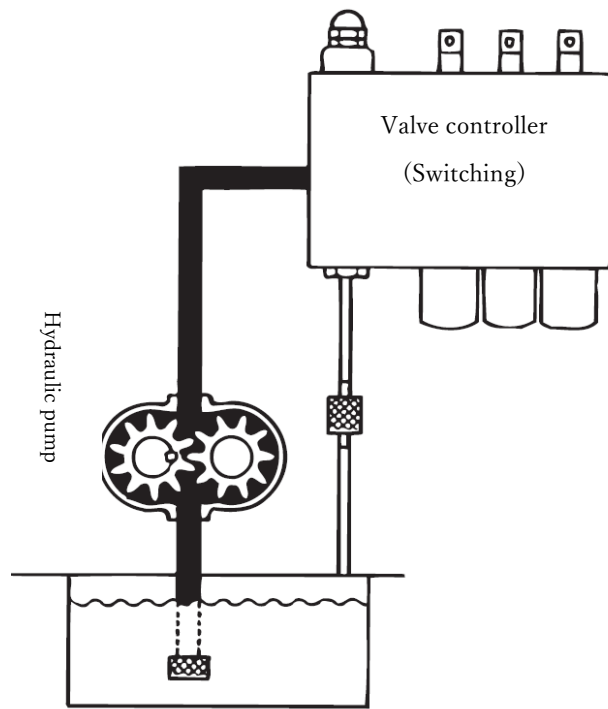


Figure 3-4 Hydraulic Pump

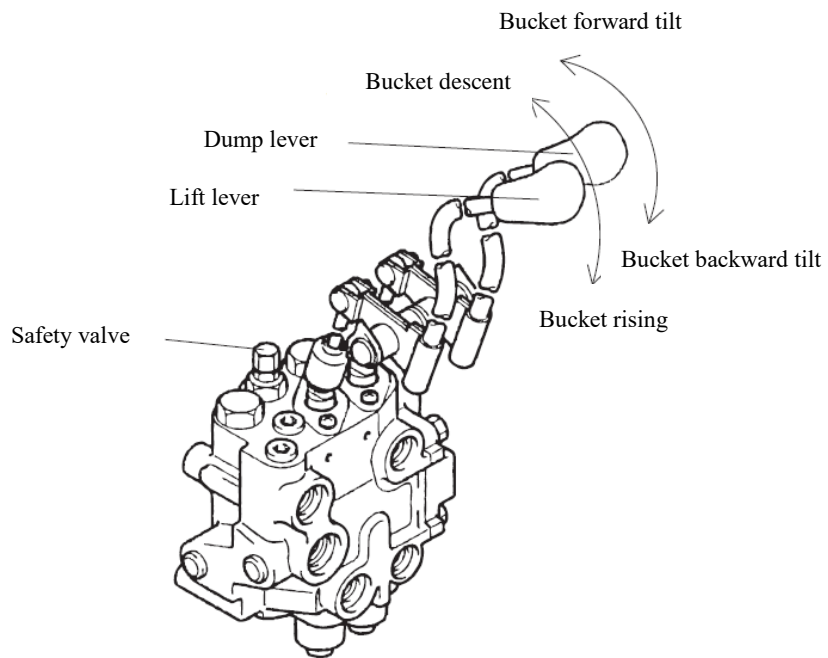


Figure 3-5 Control Valve (Double/standard type)

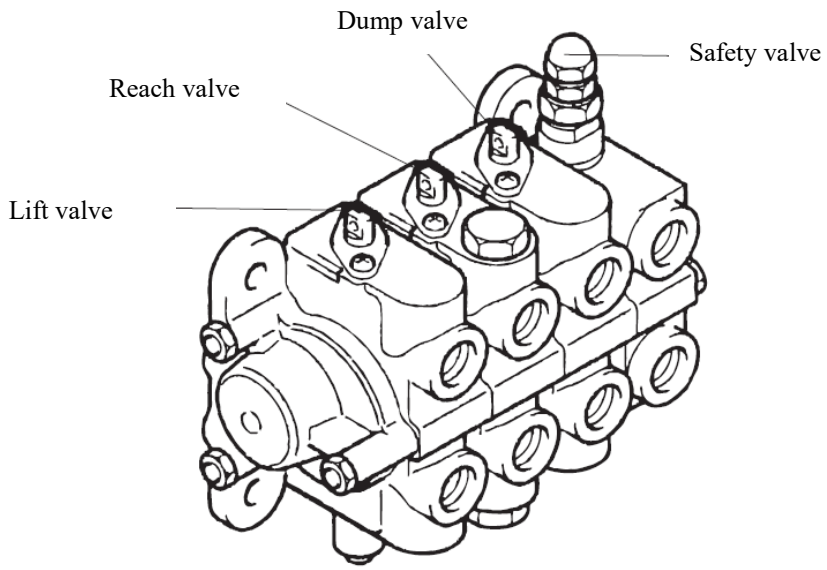


Figure 3-6 Control Valve (Triple, reach type)

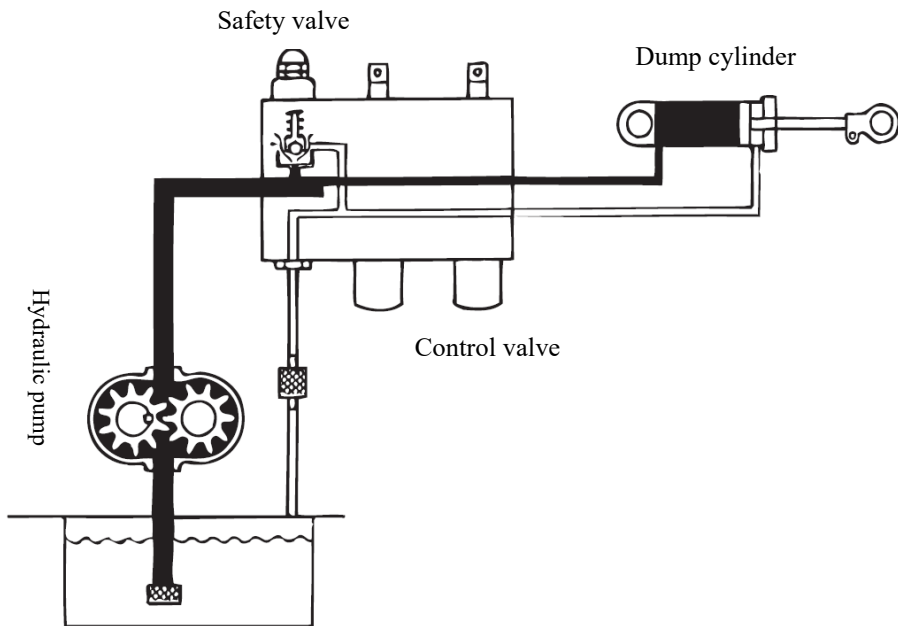


Figure 3-7 Operation of Safety Valve

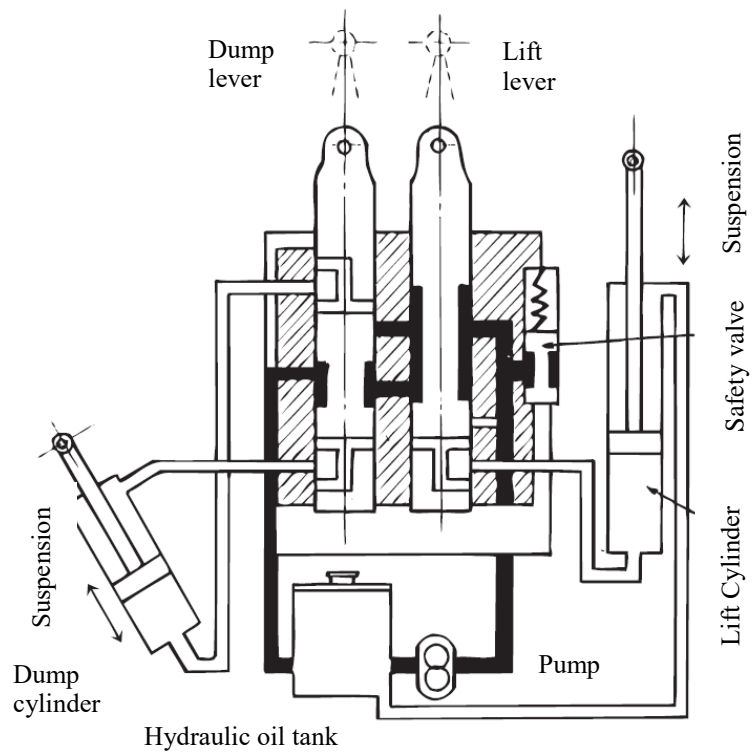


Figure 3-8 Control Valve Operation Diagram in Neutral

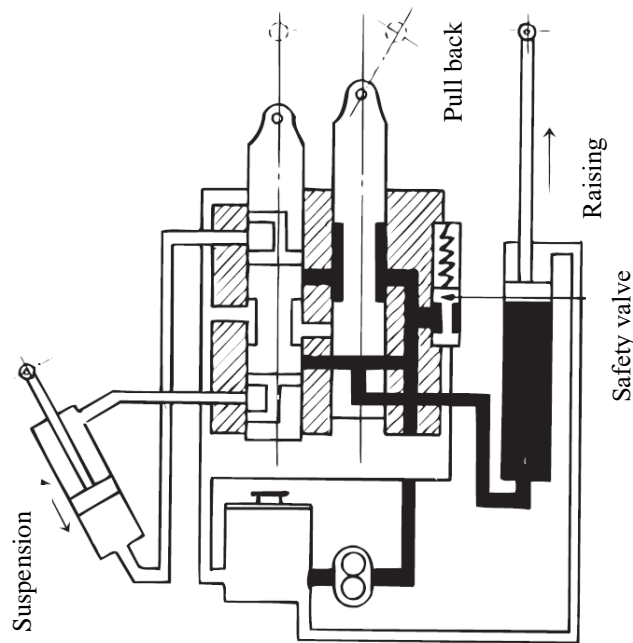


Figure 3-9 Control Valve Operation Diagram When the Lift Raises

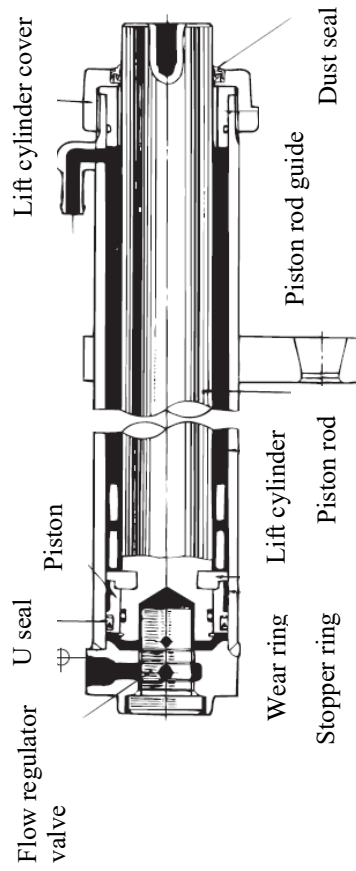


Figure 3-10 Lift Cylinder

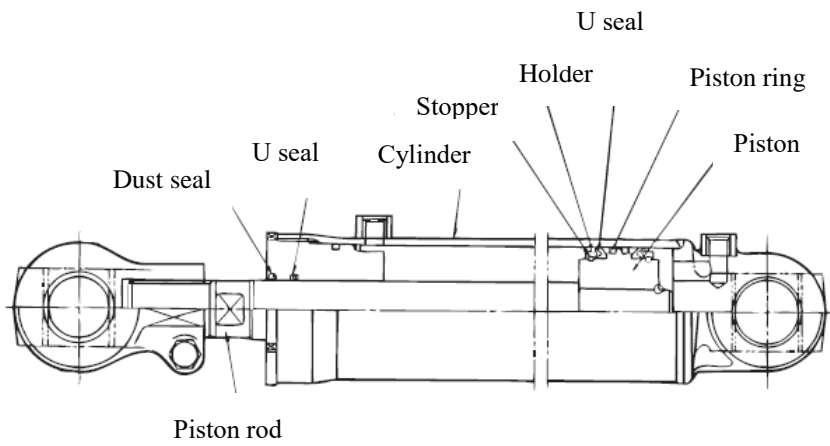


Figure 3-11 Reach and Dump cylinder

Section 3 Headguard (Textbook p.88)

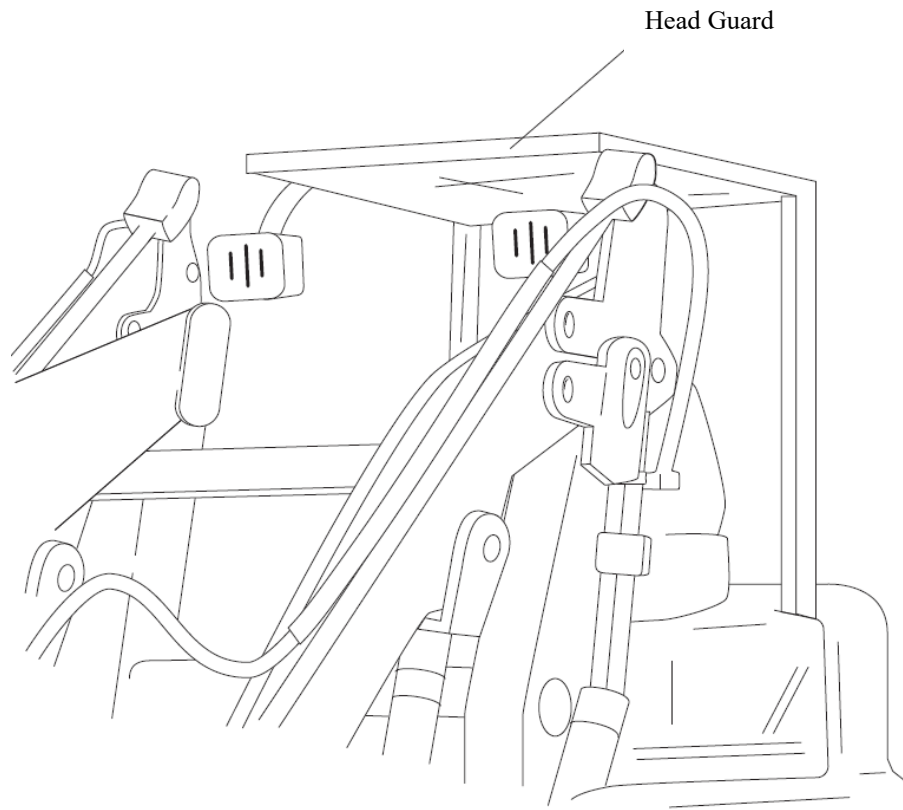
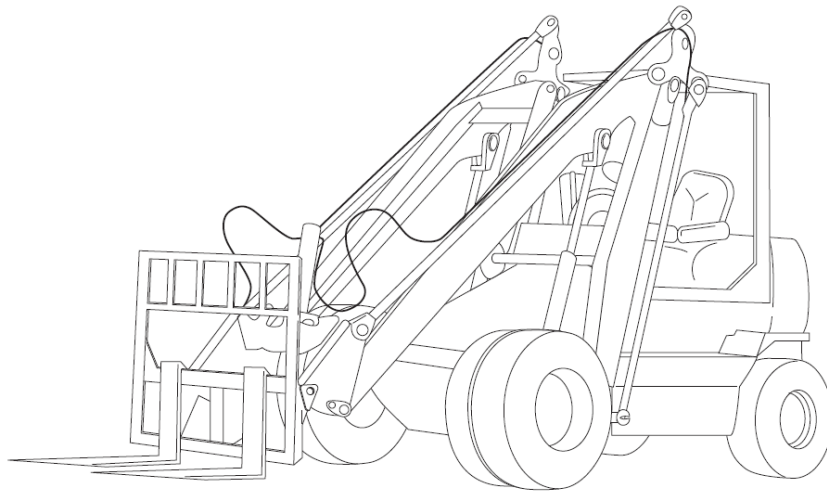


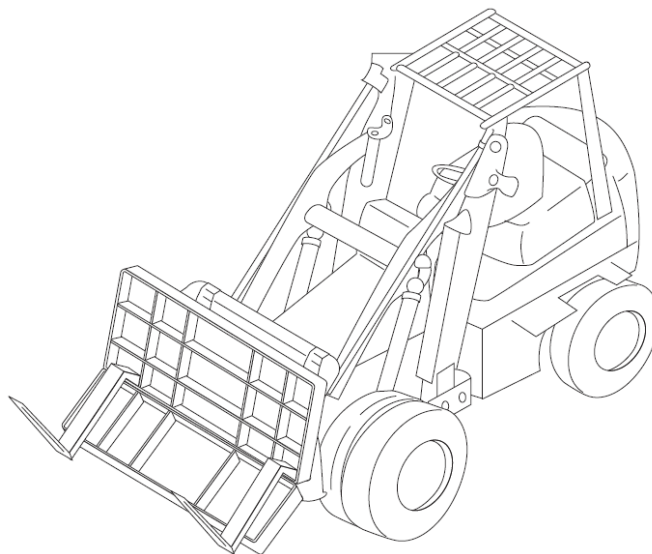
Figure 3-12 Head Guard

Section 4 Fork Loader (Textbook p.89)



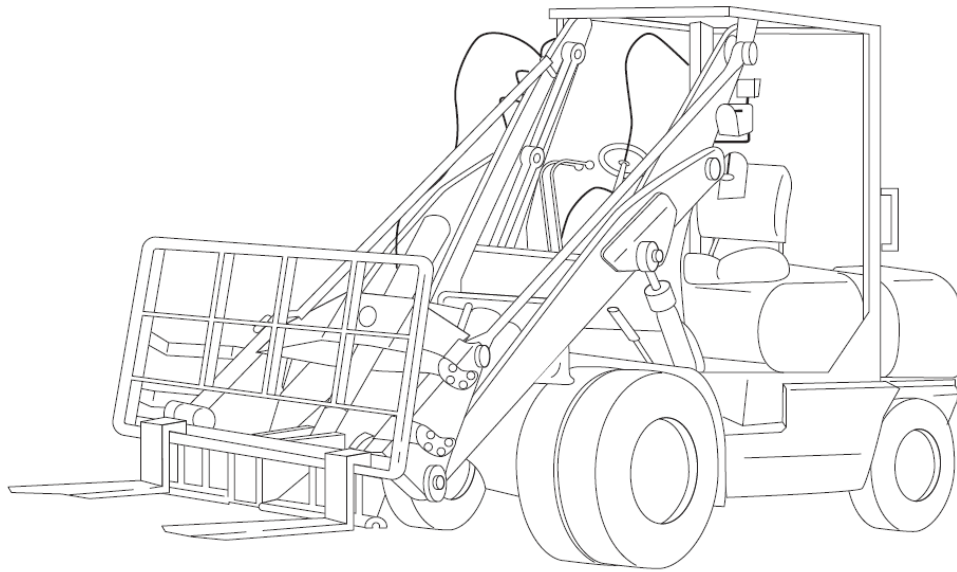
Pallet forks can perform cargo handling operations the same as forklifts.

Figure 3-13 Pallet Fork



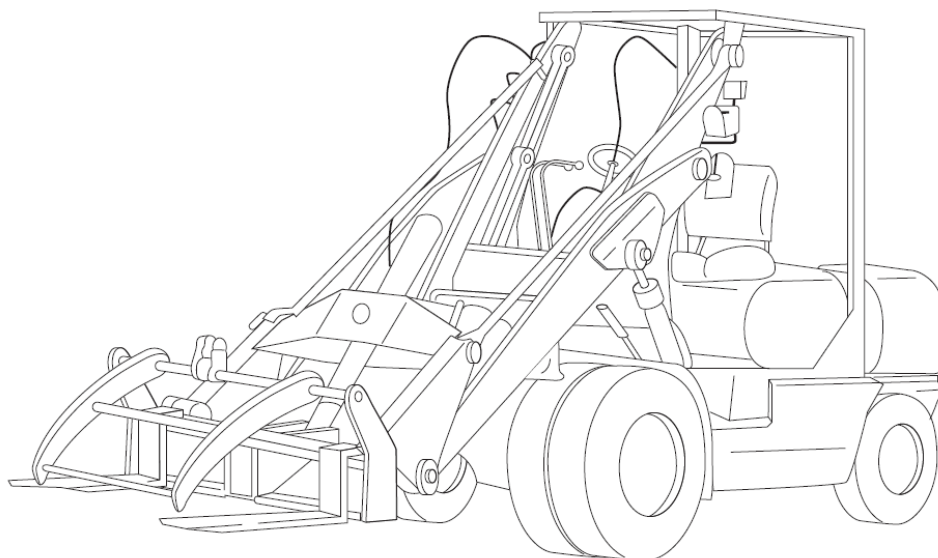
The fork, fork bars and backrest are welded together, and the backrest is tilted forward against the fork. It is suitable for the cargo handling work such as lumber, logs, etc.

Figure 3-14 Sharp Dumping Fork



The fork and backrest are designed to be folded by a hydraulic cylinder. If the fork is used at a right angle to the backrest without folding the fork, normal fork work can be performed making it versatile.

Figure 3-15 Hinged Fork



The load on fork can be hold on the forks from above with a clamp arm, preventing long objects from falling or wobbling.

Figure 3-16 Log Fork

Section 5 Pallet (Textbook p.91)

Chapter 2 Handling Method (Textbook p.98)

Section 1 Load and Vehicle Stability (Textbook p.98)

First, the basic problems of working with the shovel loader, load capacity and vehicle stability, will be briefly explained.

1. Load and Vehicle Stability

① As shown in Figure 3-25, shovel loaders are like a balance between the load on the rear wheels and the weight in front of the front wheels, with the center of the front wheels as the support, when $w \times \ell_2$ exceeds $W \times \ell_1$ it will fall forward. Therefore, the load that can actually be loaded must keep the allowable load that is less than this. If the reach is $\ell'_2 > \ell_2$, because $W \times \ell_1$ is constant, w' it will decrease further. In the case of a vehicle with a reach mechanism, there will be a considerable difference in the load capacity between the minimum reach and the maximum reach. Familiarize yourself with the capabilities of the machine and make no mistakes.

Reference: Example for a vehicle with a maximum load of 2,300 kg

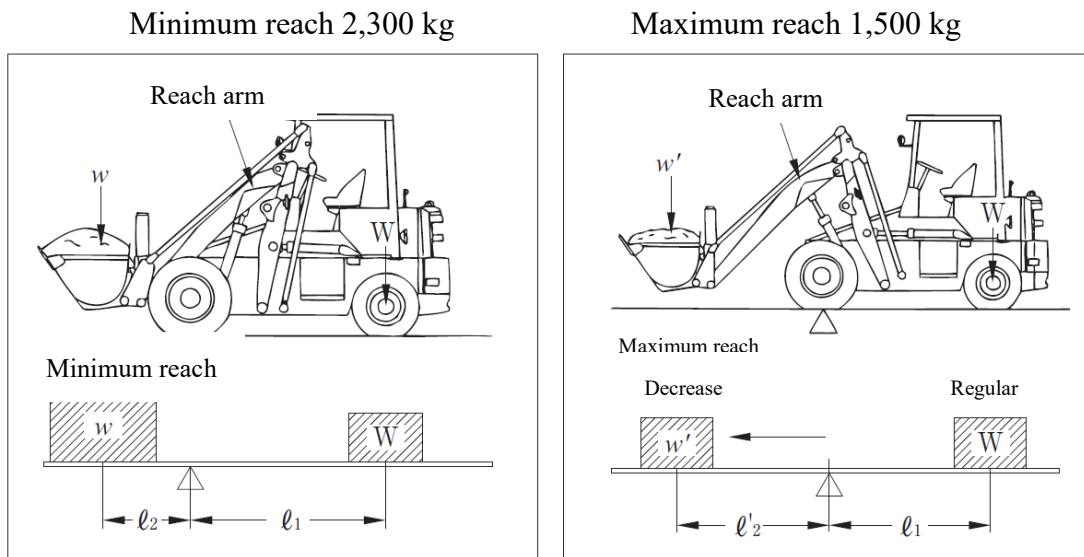


Figure 3-25 Load and Vehicle Stability

② When loading, lower the lift arm as low as possible and pull the bucket toward you as much as possible.

If you drive with the bucket raised high, the risk of tipping over on rough roads or sudden braking increases due to changes in the position of the center of gravity. In addition, driving with the lift arm in horizontal position should be avoided as it obstructs vision and it is dangerous.

- ③ Even when carrying the specified load, as shown in Figure 3-26, if the load is carried eccentrically to the left and right, the stability of the left and right will deteriorate. Also, since it will be overloaded on only one side of the vehicle, as shown in Figure 3-27, the load must be carried so that the center of load (center of gravity) is aligned with the center line of the vehicle.

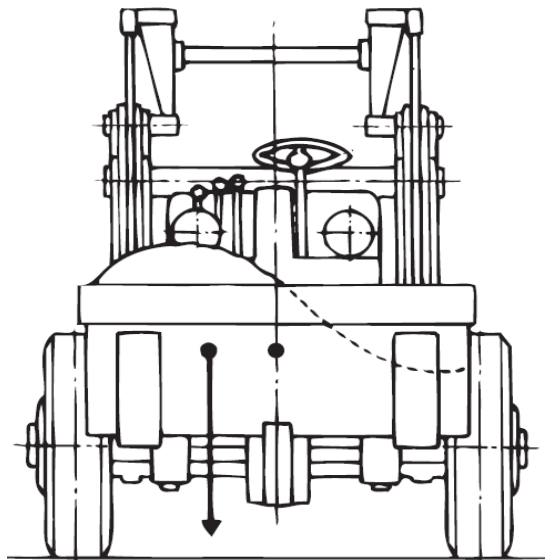


Figure 3-26 Left-right eccentricity

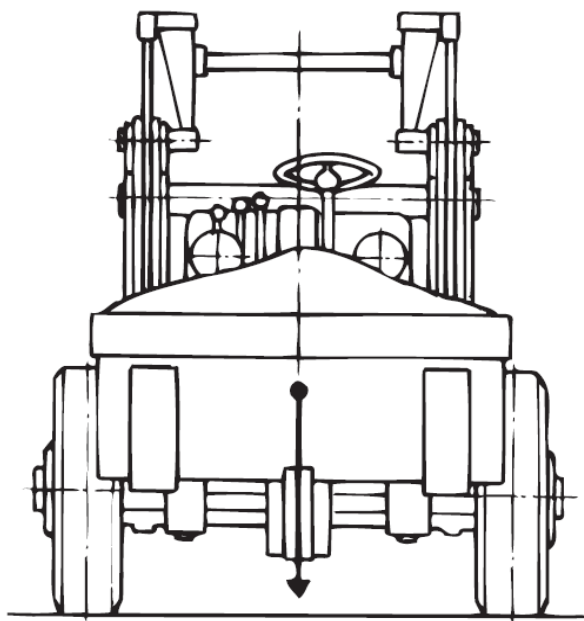


Figure 3-27 The Center of Gravity is Aligned with the Center Line

2. Differences from other Categories of Vehicles

The two-wheel drive "shovel loaders" and "fork loaders" described in this textbook are equipped with buckets and forks similar to those of four-wheel drive tractor shovel loaders (classified as vehicle-type construction machinery). However, the standards of stability are different. When switching from vehicles of such different classifications to drive and operate the "shovel loader" and "fork loader", it is necessary to pay particular attention to stability and vehicle performance.

Section 2 Working Method (Textbook p. 100)

1. Road surface maintenance

In order to improve work efficiency, first do the maintenance of the road surface near the workplace.

If the road surface near the sediment is uneven, the bucket will move up and down along the undulations of the road surface as shown in Figure 3-28, so the sediment will not enter the bucket as expected and the scooping operation efficiency will be significantly reduced.

Therefore, it is necessary to level the road surface near the workplace even if it takes some time and effort before work to improve work efficiency and at the same time to reduce the strain on the various devices of the machine and to reduce malfunctions.

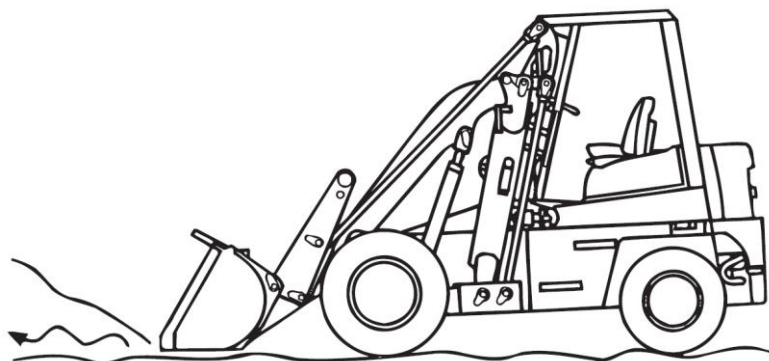


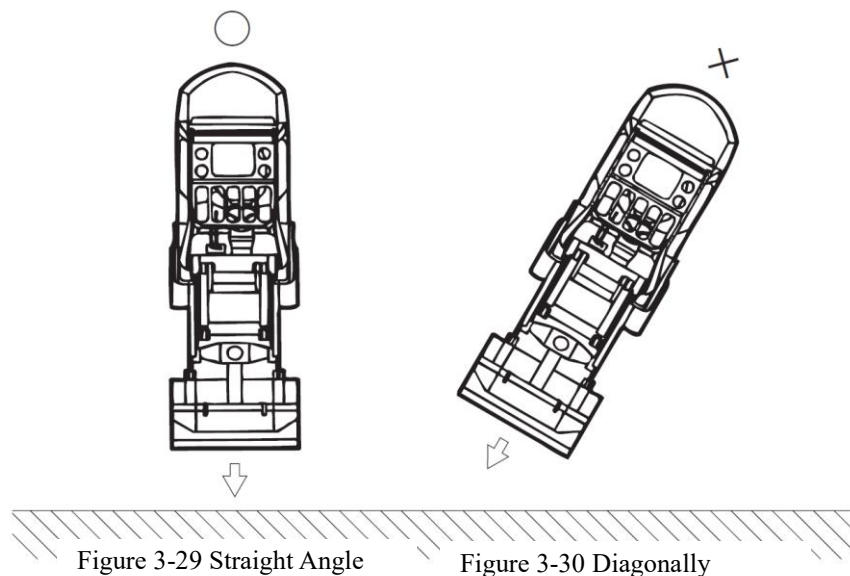
Figure 3-28 Uneven Surface

2. Scooping

① In the case of a shovel loader equipped with a reach mechanism; the reach should be set to the frontmost position. It is easier to operate the reach lever if it is not used during scooping work. However, if the scooping resistance is high and it is better to operate the reach, operate the reach lever.

② The bucket should be horizontal or slightly downward. If the angle of the bucket with respect to the ground is too upward, the load on the front wheels will decrease as the bucket plunges, the tires will slip, making it impossible to exert enough driving force to achieve sufficient scooping. It also causes premature wear of the tire. In such a case, turn the bucket a little further downward so that the weight will be on the front wheels.

③ Point the bucket at a straight angle to the sediment (Figure 3-29) shove it in. If the bucket is shoved into the sediment diagonally as shown in Figure 3-30, an excessive force will be applied to only one side of the bucket, causing malfunction and uneven loading.



④ At the time of plunge, in the case of a clutch car, the car is accelerated by taking a run up distance, plunged into the sediment, and further, by half-clutch operation, moving forward so the engine will not stop. When shoving in, in case of a clutch vehicle, accelerate the vehicle with some help distance, shove in the sediment, and then move forward by operating the semi-clutch to prevent the vehicle from stalling. In the case of a vehicle with a torque converter, there is no need for run up, so when the vehicle reaches the sediment, fully depress the accelerator pedal, and drive forward.

- ⑤ When the vehicle stops moving forward, turn the dump angle of the bucket slightly upward or lift it slightly to reduce the shoving in resistance, and the vehicle will move forward again. (Especially if the vehicle stops, by moving it forward, the tire will slip and cause significant damage to the tire, so there is the need to pay attention.) By depressing the accelerator pedal all the way and alternately repeating the operation of raising the lift and dump angle slightly upward, it is possible to sufficiently scoop up the cargo (loose objects) (Figure 3-31).
- ⑥ After scooping and before moving, be sure to pull the reach lever to check if the bucket is at the most front.

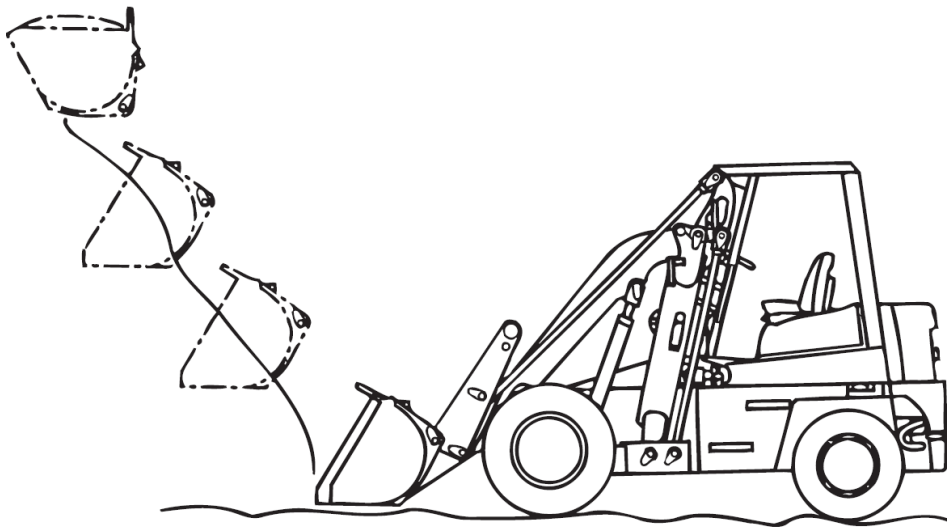


Figure 3-31 Scooping

3. Transportation Work

- ① When driving a loaded vehicle, the load on the rear wheels is reduced compared to when the vehicle is empty, so the speed must be carefully monitored.
- ② If driving with the bucket raised, the vehicle will be unstable, and it is very dangerous because it obstructs the view ahead. Therefore, lower the lift as low as possible and pull the bucket to drive.
- ③ Always drive carefully to ensure that there is a sufficient gap between you and any obstacles above you.
- ④ When turning around a corner, the front wheels can be used to steer in an ordinary car, however, the rear wheels of shovel loaders are steered so that if they are not turned all the way inward as shown in Figure 3-32, the rear of the vehicle will swing widely and the rear of the vehicle will hit the outer wall. When turning, slow down the speed and avoid making a rapid turn.
- ⑤ When the vehicle is loaded, do not drive with cargo held high. (If it is unavoidable, be especially careful and drive slowly).

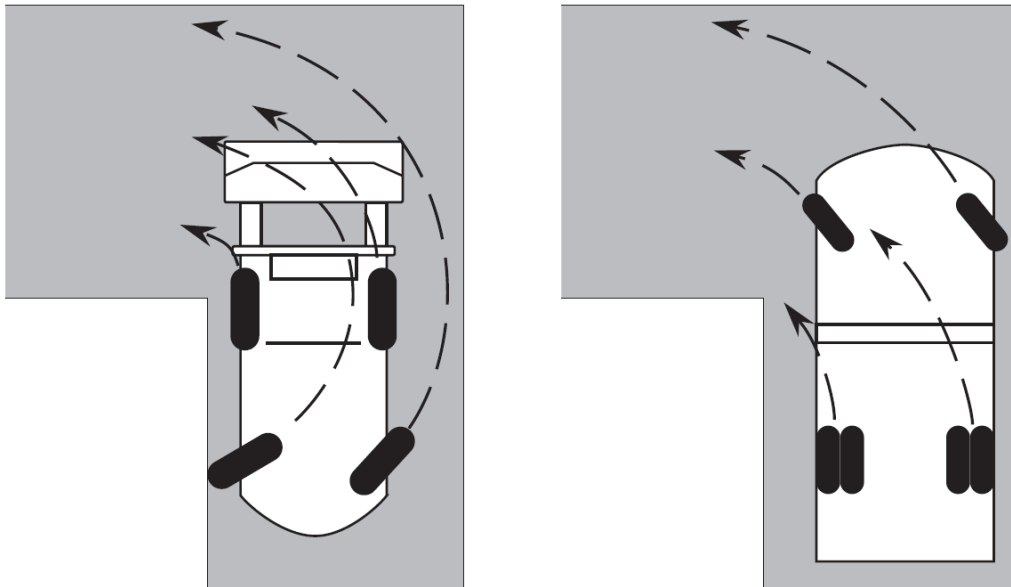


Figure 3-32 How to Turn Around Corners

4. Loading Work

① When loading the contents of a bucket into a truck or freight car, first lift it as much as necessary, gently move the car body forward, and then stop the vehicle at the loading position before dumping. In this case, for the shovel loader equipped with a reach mechanism, perform each operation as necessary. If you move forward or backward while lifting or reaching, the front-rear stability of the vehicle may become unstable and the loader may fall forward, so it must be done carefully. In particular, do not stop suddenly while lifting or reaching.

When dumping high-moisture particles, if you dump gently, the load will remain attached to the corners of the bucket, so dump it with great force.

② When dumping the contents of the bucket to a truck or freight car, carefully consider the position of the bucket in relation to the loading platform of the truck or freight car. When the bucket is facing up as shown in Figure 3-33, even if the position where the contents fall seems to be right, when dumping downwards sometimes it will fall in a position slightly behind, so the load will spill from the loading platform etc.

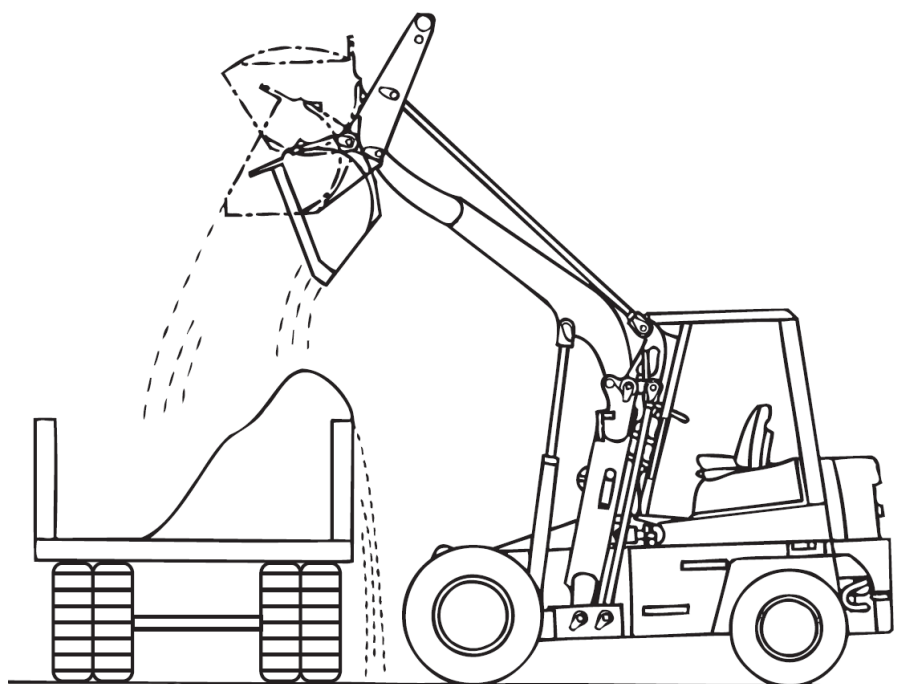


Figure 3-33 When Dumping

③ There are various ways to do load on a truck with a shovel loader as shown in Figure 3-34, (a) is the most common method, but depending on the environmental conditions, (b), (c), and (d) work methods are used.

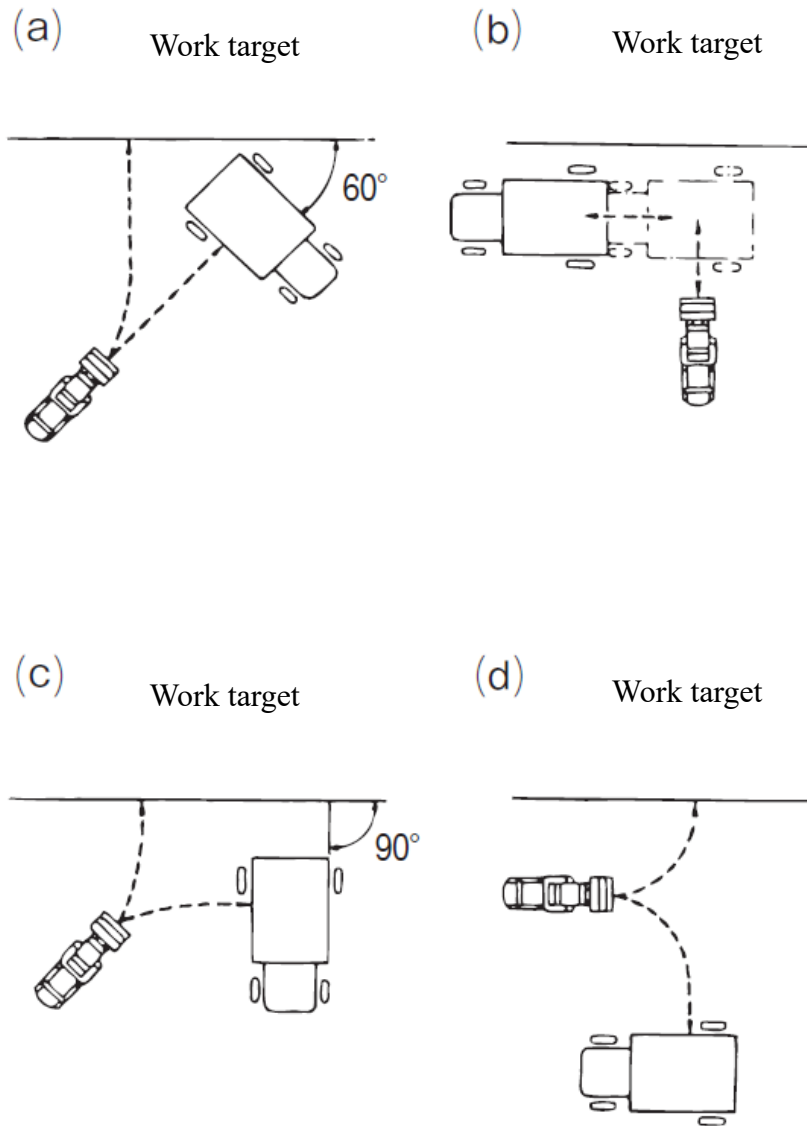


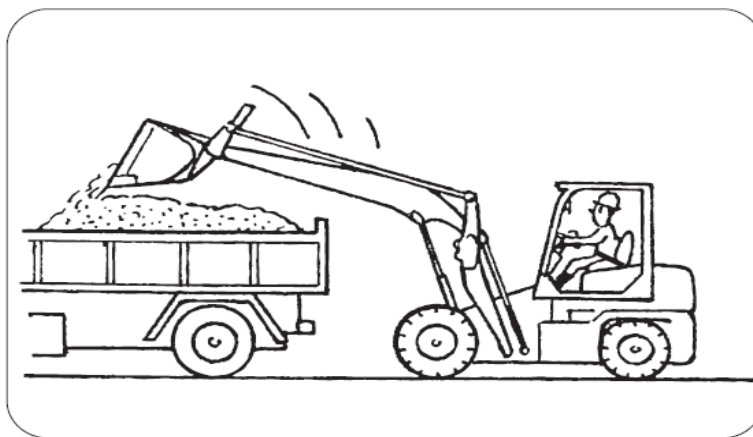
Figure 3-34 How to Load Things

5. Characteristics of Shovel Loaders with Reach Mechanism

Shovel loaders equipped with a reach mechanism have the following characteristics during loading work (Figure 3-35).

- ① Since the amount of reach is further when the reach is extended (reach out), it is possible to load or to scoop area in the back of the truck bed by working from one direction, or the possible work range is expanded.
- ② When the bucket (or fork) is reached out and raised to the maximum height, the dumping clearance (bucket height at the time of discharge) is larger than that at the time of reach work (reach-in), and the work range is expanded greatly.

Shovel Loader with Reach Mechanism



Shovel Loader Without Reach Mechanism

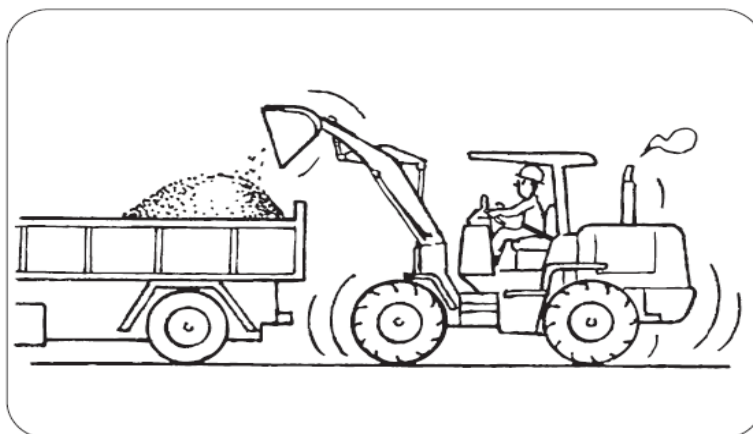


Figure 3-35 Shovel Loaders with and Without Reach Mechanism

6. Handling Precautions

- ① If you carry a load hanging from a bucket, fork, or arm, the load will swing back and forth, left, and right, losing stability causing a disaster, so you should not do such an act.
- ② If you push trucks, freight cars, etc., with the tips of the bucket and fork, the place you hit may be unstable and come off. If it comes off, the vehicle will run in an unexpected direction and may cause harm to surrounding objects, so you should not do such an act.
- ③ If you attach a wire on the tip of the bucket, fork, or arm to pull a truck, freight car, etc., the towed object may be heavy or caught, and it may fall, so you should not do such an act.
- ④ When two vehicles are shared trying to do a pairing work, and if you do not balance each other, an unbalanced load will collapse, which may cause a fall and harm the surrounding objects, so you should not do such an act.

Volume 4 Knowledge of Mechanics Necessary for Driving Shovel Loaders Etc.

Chapter 1 Force (Textbook p. 111)

Section 1 Force (Textbook p. 111)

Section 2 Moment of Force (Textbook p. 115)

When tightening the nut with a wrench, it is better to hold it near the end of the handle of the wrench so that even with the same force applied, the strength will be enough to tighten it. Also, the force is maximized when the direction in which the force is applied is perpendicular to the wrench.

When using a lever to raise an object, it is better to use a long pry bar to bring the support as close as possible to the object, and make the handle longer to raise it, so that more force can be applied. (Figure 4-8). This is because there is a relation between the point of action when the force is applied to the wrench, the length of the handle, and the length of the pry bar at hand in this case.

Now, if one direction of force is AP in Figure 4-9, a vertical line OA is drawn from a certain point O and its length is ℓ , the force P tries to give a rotational motion to the point O. The work to be done is expressed by the product $P\ell$ of the force P and the length ℓ . This multiplied force $P\ell$ is called the force moment of the force P with respect to the point O.

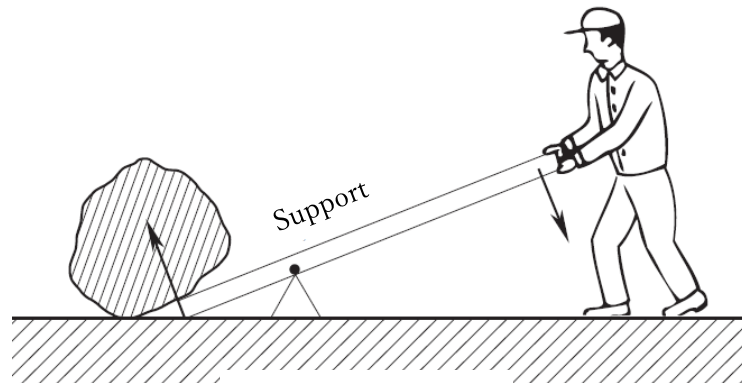


Figure 4-8 Lever

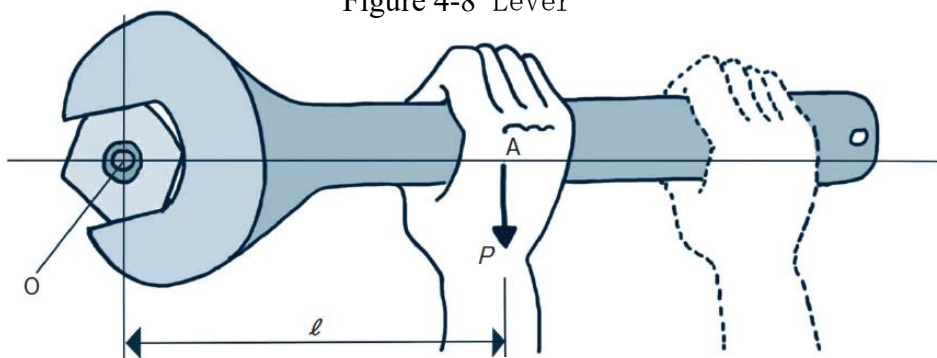


Figure 4-9 Moment of Force

“Moment” is the product of force and distance, and its unit is expressed by N m, kN m, etc.

Consider this moment for shovel loaders and fork loaders (Figure 4-10).

Now, it is assumed that the shovel loader and the fork loader have a load with a mass of W kg in a bucket and a fork. If the mass of the shovel loader and the fork loader itself is W kg, it can be considered that the mass depends on the center of gravity (or the center of mass) G of the shovel loader and the fork loader. If the distance to the front wheels is ℓ_1 m, the moment of the shovel loader and fork loader itself with respect to the front wheels is $9.8W\ell_1$ N m (Note). On the other hand, if the vertical line is drawn from the center of gravity of the load and the horizontal distance to the front wheels is calculated as ℓ_2 m, the moment of the load with respect to the front wheels is $9.8w\ell_2$ N m.

Therefore, in order to prevent the shovel loader and fork loader from tipping forward, it is necessary to have the following equality:

$$W\ell_1 > w\ell_2 \text{ or } W\ell_1 / w\ell_2 > 1$$

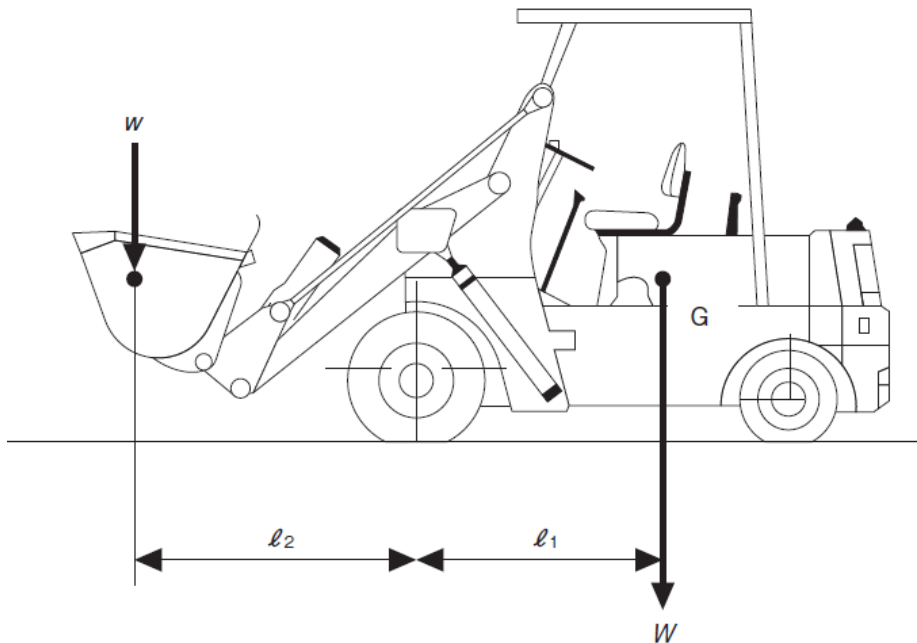


Figure 4-10 Moment Acting on Shovel Loader

(Note) 9.8 is the acceleration of gravity (m/s^2), which is a coefficient for converting the mass (kg) of an object into a load (N).

That is, the shovel loader and the fork loader cannot be operated unless $w\ell_2$ is always smaller than $W\ell_1$.

Furthermore, when the shovel loader and fork loader are moving forward on a downhill, the ratio of the lengths of $\ell_1 : \ell_2$ changes depending on the height of the center of gravity, so the moment value will change, and it will become easy to fall. This will be further explained in Chapter 2, Section 3.2.

Section 3 Force Balance (Textbook p.117)

2. Balance of Parallel Forces

When carrying a load with a balance bar, if the weight of both loads is equal, the load is centered on the balance bar, but if the weight of the loads is different, bring the heavier load closer to the shoulder. This is a way to balance the moment.

An object with an axis of rotation is said to be balanced if the sum of all positive moments equals the sum of all negative moments, meaning that the algebraic sum of the moments of all forces acting on the object is equal to 0.

In Figure 4-12, consider the moment of force around the shoulder. Now, if the weight of the load is P_1 , P_2 , respectively, and the horizontal distance between the point where the load is lowered and the shoulder is a , b respectively,

the moment on the left side is $M_1 = -P_1 \times a$

the moment on the right side is $M_2 = P_2 \times b$

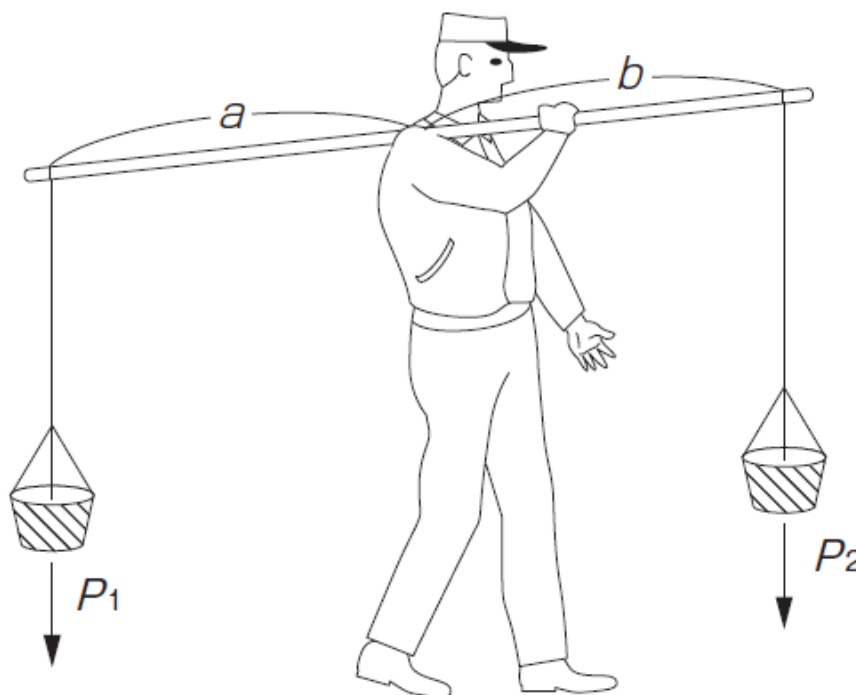


Figure 4-12 Balance with a Balance Bar

Chapter 2 Mass, Weight and Center of Gravity (Textbook p.121)

Section 1 Mass and Weight (Textbook p.121)

1. Mass

When the same object is held on the earth and on the moon, the weight felt by the hand is different, but the amount of the object does not change. The amount of the object itself that does not change even if the place changes is called “mass”.

The unit of mass is expressed in kilograms (kg), tons (t), etc. Table 4-1 shows the approximate values of mass per unit volume of various materials.

Using this table, if the object is homogeneous and its volume V is known, the mass W can be known by the following formula (Table 4-2).

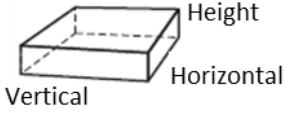
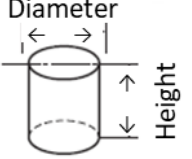
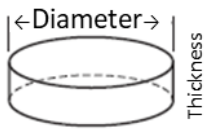
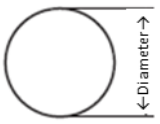
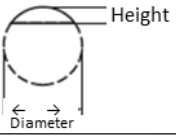
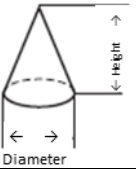
$$\text{Mass } W(t) = \text{per } 1 \text{ m}^3 \text{ Mass} \times \text{Volume } V(\text{m}^3)$$

Table 4-1 Unit Volume Mass Table of Various Objects

| Type | Mass per $\text{m}^3(\text{t})$ | Type | Mass per $\text{m}^3(\text{t})$ | Type | Mass per $\text{m}^3(\text{t})$ |
|-----------|------------------------------------|-------------|------------------------------------|------------------------|------------------------------------|
| Lead | 11.4 | Concrete | 2.3 | Japanese evergreen oak | 0.9 |
| Copper | 8.9 | Brick | 2.2 | Japanese zelkova | 0.7 |
| Steel | 7.8 | Soil | 2.0 | Beech | 0.7 |
| Tin | 7.3 | Pebble | 1.7 | Chestnut | 0.6 |
| Cast iron | 7.2 | Sand | 1.8 | Japanese red pine | 0.5 |
| Zinc | 7.1 | Coal lump | 0.8 | Larch | 0.5 |
| Pig iron | 7.0 | Coal powder | 1.0 | Cedar | 0.4 |
| Aluminum | 2.7 | Cork | 0.5 | Japanese cypress | 0.4 |
| Clay | 2.6 | Water | 1.0 | Paulownia | 0.3 |

(Note) The mass of wood is air-dry mass, coal and cork have apparent unit mass.

Table 4-2 Volume Calculation Formulas

| Shape of the object | | Volume approximation formula |
|---------------------|---|---|
| Name | Shape | |
| Rectangular |  | Vertical × horizontal × height |
| Cylinder |  | (Diameter) ² × height × 0.8 |
| Disk |  | (Diameter) ² × thickness × 0.8 |
| Ball |  | (Diameter) ³ × 0.5 |
| Missing ball |  | (Height) ² × (Diameter × 3 - height) × 0.5 |
| Cone |  | (Diameter) ² × height × 0.3 |

2. Weight

The weight felt when holding an object is the gravitational force of the earth pulling the object towards the center of the earth. The weight of the object felt in the hand is the velocity of the gravity of the Earth acting on the object towards the center of the Earth, and its unit is displayed in Newton (N) and Kilonewton (kN).

The weight of an object with a mass of 1 kg under the acceleration of gravity (9.8 m/s²) is

$$1 \text{ (kg)} \times 9.8 \text{ (m/s}^2\text{)} = 9.8 \text{ N}$$

For example, the weight of an object with a mass of W kg becomes 9.8 W N.

3. Load

“Load” is a term that originally means force. Therefore, the unit of load is expressed in Newton (N) and Kilonewton (kN). For example, “tensile load”, “impact load”, etc. indicate a force, and the units are expressed in Newton (N) and kilonewton (kN).

However, it should be noted that the term “○○ load” may be used even if it expresses mass such as “rated load” or “lifting load” in laws and regulations.

4. Specific Gravity

The ratio of the mass of an object to the mass of pure water at 4°C, in the same volume as the object, is called the specific gravity of the object.

Since the mass of pure water at 4°C is 1 kg for 1 ℓ and 1t for 1 m³, the unit volume mass table in Table 4-1 shows how many times the mass of pure water is compared to water if the volume is the same.

Section 2 Center of Gravity (Textbook p.124)

1. Center of Gravity or Center of Mass

The point where the gravitational force acting on each part of an object apparently gathers and acts on it is called the “center of gravity (or center of mass)” of the object.

For example, A uniform bar has its center of gravity at the center of the bar, and a disk of a certain thickness has its center of gravity at the center of the circle, so if a force equal to the weight of the bar or disk is applied to support it, the bar or disk will stabilize horizontally.

Also, when an object is suspended in the air, its center of gravity is on a vertical line drawn from the point where it was suspended, and the object comes to stand still. Therefore, the center of gravity of an object can be determined by the point of intersection of the vertical lines when the object is suspended at different points (Figure 4-15).

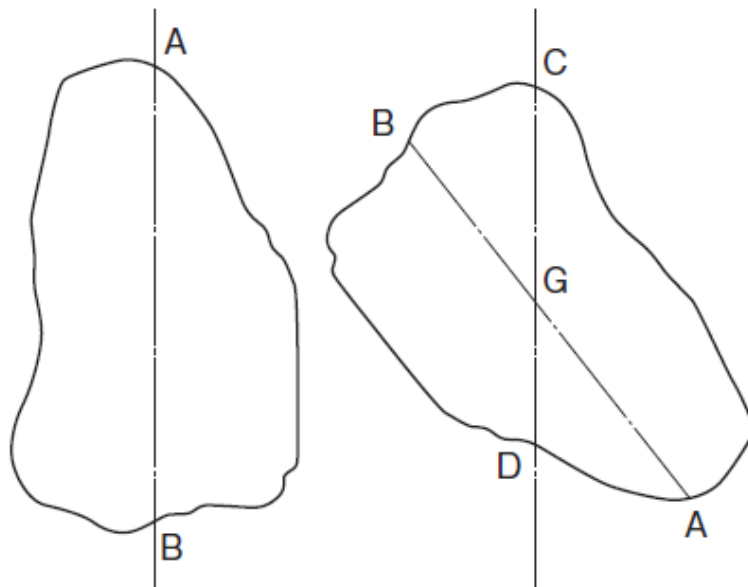


Figure 4-15 How to Find the Center of Gravity

Section 3 Stability of Objects (Sitting) (Textbook p.125)

When a stationary object is tilted a little and the object tries to return to its original position, the object is “stable” (it stays still), and when the tilt becomes larger, it is said to be “unstable” (doesn’t stay still). In addition, it is said to be “neutral” when it stands still without tilting.

1. Conditions of Stability

As shown in Figure 4-16, when the object is tilted slightly with point A as the support, the center of gravity (or mass center) of the object shifts from G_1 to G_2 . At this time, the mass W of the object with respect to the point A and the moment $W\ell_2$ corresponding to the horizontal distance ℓ_2 with respect to the point A of the center of gravity act on the object. In Figure (A), this moment acts to try to return the object to its original position, so that the object is stable, and in Figure (B), it acts to tilt the object more and more, and the object becomes unstable. When an object is tilted slightly, it is stable when a moment is generated on the side that stabilizes it, and unstable when a moment is generated on the side that causes it to fall (tipping).

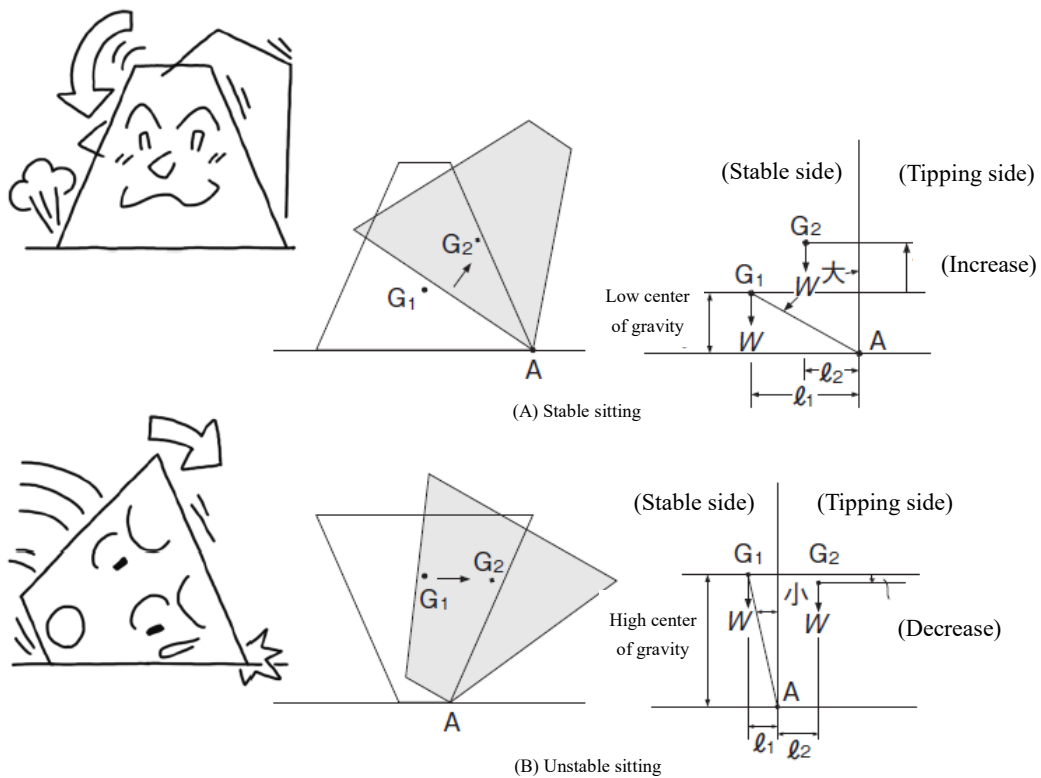


Figure 4-16 Object Stability

Chapter 3 Motion of Objects (Textbook p.130)

Section 1 Speed (Textbook p.130)

Section 2 Acceleration (Textbook p.131)

Section 3 Inertia (Textbook p.131)

When a stopped train suddenly departs, the person standing inside is likely to fall in the direction opposite to the direction in which the train travels, and when the running train suddenly stops, the person standing inside will fall in the direction of travel. We have experienced many other similar examples.

This is because an object has the property of trying to remain stationary forever unless a force acts on it from the outside, and this is called inertia.

To put it the other way around, force is necessary to move a stationary object or change the speed or direction of motion of a moving object, and the greater the change in speed, the greater the force required for this. When suddenly pulling up a load or suddenly stopping a moving object, a very large force is required. This is the reason why the wire rope breaks under the impact load.

Section 4 Centrifugal Force (Textbook p.132)

When you hold one end of a thin string that holds a weight and make it do a circular motion, the hand is pulled in the direction of the weight. As you turn the weight faster, the stronger your hand feels being pulled. If the hand is released from the string, the weight will fly in the tangent line direction from the position when the hand was released and will not make a circular motion.

In this way, for an object to make a circular motion, a force on the object must act (in the above example, the force of the hand pulling the weight through the string). The force causes this object to make a circular motion called the centripetal force. The centripetal force is expressed by the following equation.

$$F = \frac{m \cdot v^2}{r} = m \cdot r \cdot \omega^2$$

(F : Centripetal force, m : mass, r : radius, v : peripheral velocity, ω : angular velocity)

The force that is equal in magnitude to the centripetal force but opposite in direction is called the centrifugal force (the force that pulls the hand in the above example).

In the operation of a shovel loader etc. excessive speed on a curve may lead to an accident such as a fall due to centrifugal force.

Especially when the road surface is wet with rain, the coefficient of friction of the road surface decreases, so there is a danger of skidding on a curve.

Section 5 Friction (Textbook p.133)

1. Static Frictional Force

When an object placed on the ground is pulled along the ground, resistance appears between the ground and the object in an attempt to obstruct the movement of the object. The stronger the tension, the greater the resistance, and when the pulling force exceeds a certain limit, the object finally starts to move. This indicates that there is a phenomenon of friction between a stationary object and the ground, and the resistance acting on the contact surface in this case is called the static friction force. The static frictional force has no relation with the size of the contact surface.

As shown in Figure 4-20, the static frictional force F becomes maximum at the moment when the force P is applied to the object and the object starts to move. The frictional force at this time is called the maximum static frictional force, and the ratio of the normal force W acting on the contact surface of the object to the maximum static frictional force is called the static friction coefficient.

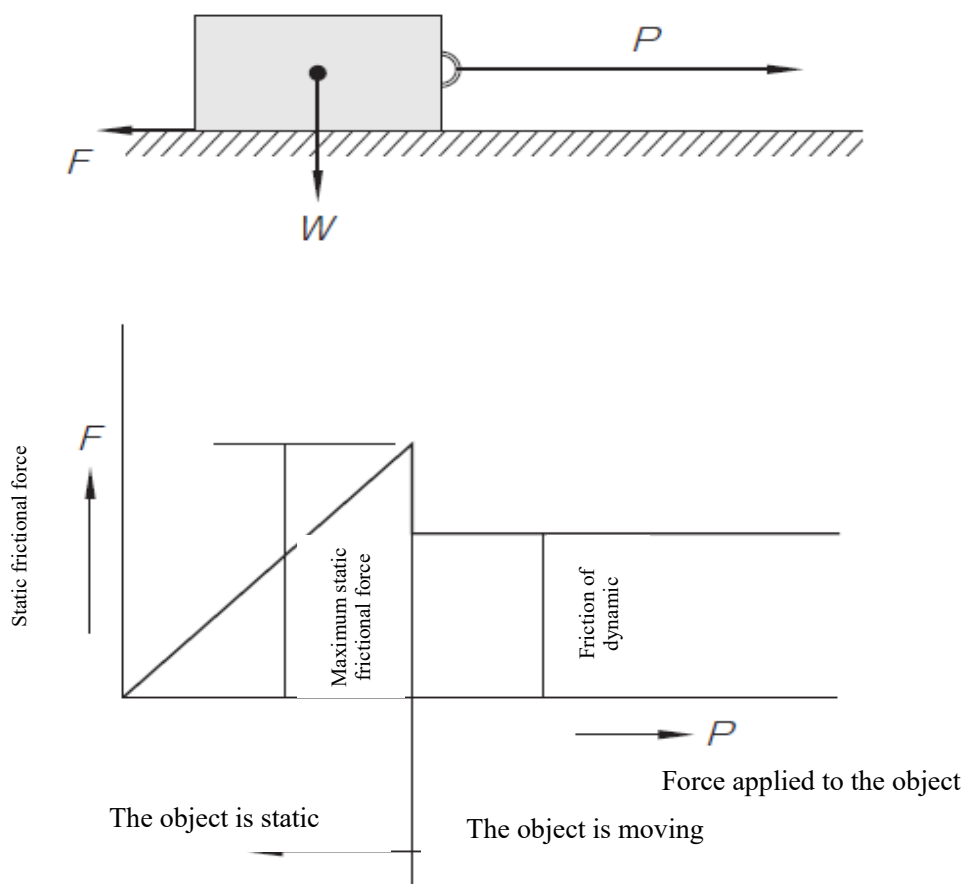


Figure 4-20 Maximum Static Frictional Force and Dynamic Friction

2. Dynamic Friction

The frictional force acting after an object starts moving is called the frictional force of motion, and its value is smaller than the maximum static frictional force.

The magnitude of the frictional force is not related to the area of contact surface, it is proportional to the vertical force acting on the contact surface of the object. Therefore,

$$F = k \times W$$

Here, F : frictional force

W : vertical force acting on the contact surface of the object

K : Sstatic friction coefficient

The value of the static friction coefficient is determined by the type of 2 objects in contact and the condition of the contact surface.

3. Rolling Friction

The same phenomenon of friction appears when an object is rolled without sliding along the contact surface. This is called rolling friction. For example, rolling a barrel or drum can make it easier to move than when dragging them, but it does not roll forever because there is the rolling friction. The rolling friction force is very small (about 1/10) compared to the friction force of motion, as can be seen from the examples of barrels and drums. This is why rollers are used to move heavy loads easily, wheels are attached to shovel loaders, and roller bearings and ball bearings are used for bearings.

Chapter 4 Load, stress, and material strength (Textbook p. 135)

Section 1 Load (Textbook p. 135)

Section 2 Stress (Textbook p. 138)

Section 3 Material Strength (Textbook p. 138)

Volume 5 Related laws and regulations

Chapter 1 Before learning related laws and regulations (Textbook p. 145)

Section 1 Importance of learning related laws and regulations - Related laws and regulations are a collection of know-how for preventing occupational accidents -

Section 2 What you need to know to learn related laws and regulations

Section 3 How to learn from Chapter 2 onwards

There are several laws related to worker safety and health, including the Industrial Safety and Health Act. In particular, the Industrial Safety and Health Act stipulates matters that must be observed for the purpose of ensuring the safety and health of workers and promoting the formation of a comfortable working environment. Specific matters associated with the enforcement of the law are indicated in government ordinances, ministerial ordinances, notifications, etc.

The legal system for worker safety and health is as follows.

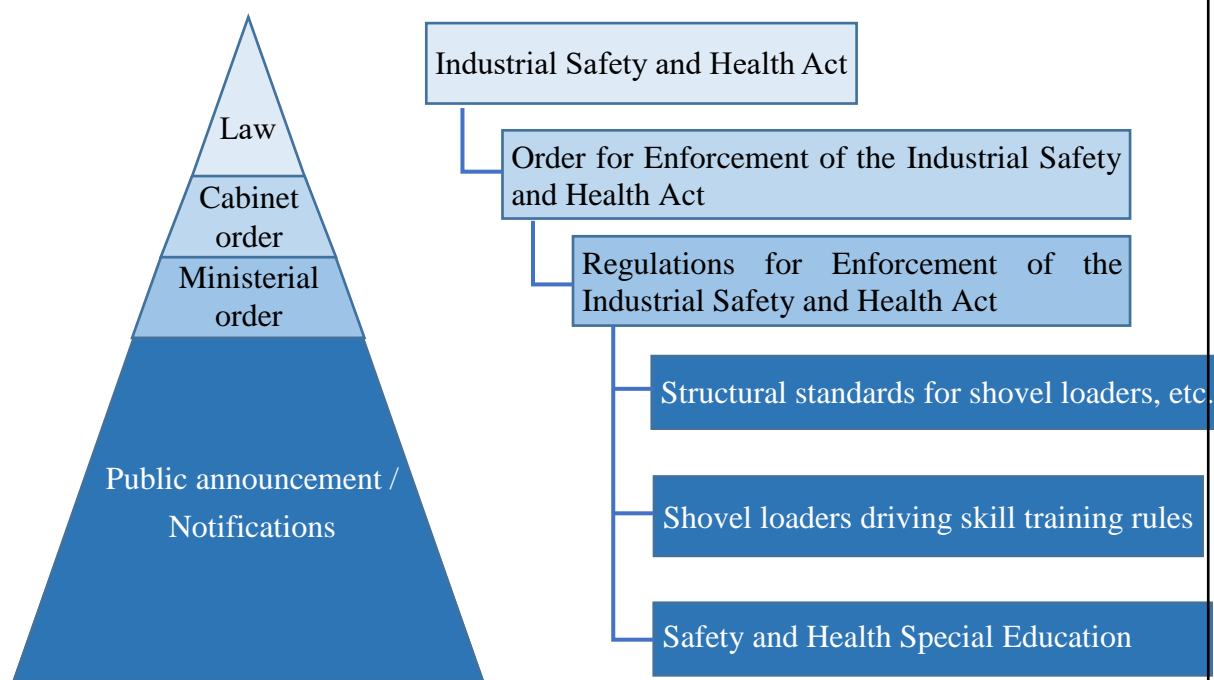


Figure 5-1 Driving Skills Legal System for Shovel Loaders etc.

(Reference) Ministry of Health, Labor and Welfare Risk assessment manual in the building maintenance industry

Chapter 2 Overview of the Industrial Safety and Health Act (Textbook p. 148)

Chapter 3 Industrial Safety and Health Act (Extract) (Textbook p. 154)

Law No. 57 of 1972

Law No. 41 Final Amendment 2017

Chapter 1 General provisions

(Purpose)

Article 1 This law, in combination with the Labor Standards Law (Law No. 49 of 1945), takes measures to establish hazard prevention standards for the prevention of occupational accidents, clarify the responsibility system, and promote voluntary activities. By promoting comprehensive and systematic measures to prevent such problems, the purpose is to ensure the safety and health of workers in the workplace and to promote the formation of a comfortable working environment.

(Definitions)

Article 2 In this Act, the meanings of the terms set forth in the following items are as prescribed in those items:

- 1 “industrial injury” means a worker being injured, contracting a disease, or dying due to a construction, equipment, raw material, gas, vapor, dust, or the like that is connected with the worker’s employment, or as a result of a worker’s work activities or other duties
- 2 “worker” means a worker as prescribed in Article 9 of the Labor Standards Act (excluding a person who is employed at an undertaking or office at which only cohabitating relatives are employed, and excluding domestic servants)
- 3 “employer” means a person that is engaged in an undertaking and that employs a worker or worker.

2~4 of 3 (Omitted)

((Responsibilities of the Employer)

Article 3 Not only must an employer comply with the minimum standards for preventing industrial injuries provided for in this Act, but it must also work to ensure the safety and health of workers in the workplace through the creation of a comfortable work environment and the improvement of working conditions. Furthermore, an employer must work to cooperate with government-implemented policies for preventing industrial injuries.

②, ③ (Omitted)

Article 4 In addition to observing the necessary particulars to prevent industrial injuries, a worker must also endeavor to cooperate with measures to prevent industrial injuries that the employer and related parties implement.

(Periodical Inspections)

Article 45 An employer, pursuant to Order of the Ministry of Health, Labor and Welfare, must conduct inspections periodically and keep the records of the results on boilers and machinery or other such equipment that is specified by Cabinet Order.

- ② If undertaking any inspection under the provisions of the preceding paragraph for machinery or other such equipment specified by Cabinet Order as referred to in that paragraph, that is specified by Order of the Ministry of Health, Labor and Welfare (hereinafter referred to as a “specified inspection”), an employer must have this implemented by a worker it employs who constitutes a person with the qualifications specified by Order of the Ministry of Health, Labor and Welfare or by a person registered as prescribed in Article 54-3, paragraph (1) to carry out specified inspections of the relevant machinery or other such equipment at the request of other persons (hereinafter referred to as a “registered inspection agency”)
- ③ The Minister of Health, Labor and Welfare must release the necessary guidelines for inspections to ensure the appropriate and effective implementation of inspections as referred to the provisions of paragraph (1).
- ④ Having released guidelines for inspections as referred to in the preceding paragraph, and on finding that it is necessary to do so, the Minister of Health, Labor and Welfare may provide the necessary guidance on those guidelines for inspections to employers, registered inspection agencies, and associations thereof.

(Restrictions on Work)

Article 61 An employer must not assign a person to the operation of a crane, or any other operations specified by Cabinet Order unless the person has obtained a license for those operations from the Director of the Prefectural Labour Bureau, has completed a skill training course for those operations conducted by a person registered by the Director of the Prefectural Labour Bureau, or has other qualifications specified by Order of the Ministry of Health, Labour and Welfare.

- ② A person other than one that may engage in the relevant operations pursuant to the provisions of the preceding paragraph must not engage in those operations.
- ③ A person that may engage in the relevant operations pursuant to the provisions of paragraph (1) must, at the time of the engagement in these operations, carry the license for those operations or other document evidencing the person’s qualifications.
- ④ (Omitted)

Chapter 4 Industrial Safety and Health Act Enforcement Ordinance (Excerpt)
(Textbook p.164)

(Operations Pertaining to Restriction on Engagement)

Article 20 <Operations Pertaining to Restriction on Engagement>

The operations defined by the Cabinet Order set forth in paragraph (1) of Article 61 of the Act shall be as follows:

1~12 (Omitted)

13 Work driving a shovel loader or fork loader with a maximum load (meaning the maximum load that can be applied according to the structure and material of the shovel loader or fork loader) of 1 ton or more (excluding driving on the road).

14~16 (Omitted)

Chapter 5 Ordinance on Industrial Safety and Health (Extract) (Textbook p. 167)

Volume 1 General rules

(Reissuance of skill training completion certificate, etc.)

Article 82 A person who has received a skill training course completion certificate and been actually engaging or intends to engage in the work pertaining to the said skill training shall, in the case of loss or damage of the certificate excluding a case prescribed by paragraph (3) below, submit an application document for the reissuance of the skill training course completion certificate (Form No.18) to the registered training institution that issued the certificate, and thereby reacquire the skill training course completion certificate.

- ② A person prescribed by the preceding paragraph shall, when having changed the name or, submit an application document for change of the skill training course completion certificate (Form No.18) to the registered training institution that issued the certificate, and thereby revise the certificate excluding a case prescribed by paragraph (3).
- ③ The person prescribed by preceding paragraph shall, in the case that the registered training institution from which the certificate issued has discontinued the training service (including the case the said registration has been cancelled become invalid) and prescribed in the proviso of paragraph (1) of Article 24 of the Ordinance on Registered Inspection Agency, etc. (Ordinance of the Ministry of Labor No.44 of 1972), and when having lost or damaged the said certificate or changed the permanent address or the name, shall submit an application document for the reissuance of the skill training course completion certificate (Form No.18) to the institution designated by the Minister of Health, Labor and Welfare as prescribed in the proviso of the same paragraph, and thereby acquire a document that certifies completion of the relevant skill training course.
- ④ In the case of the preceding paragraph, the organization designated by the Minister of Health, Labor and Welfare provided the skill training when the person who applied for the delivery of the document of the same paragraph has completed the skill training other than the skill training prescribed in the same paragraph. Upon receiving the information regarding the completion of the skill training of the person from the registered training institution, the person may be delivered to the person by stating that the skill training has been completed in the document of the same paragraph.

Part 2 Safety Standards

Chapter 1-2 Material handling and transportation machines, etc.

Section 1 Vehicle-based material handling and transportation machines, etc.

Subsection 1 General Provisions

(Definition)

Article 151-2 In this Ministerial Ordinance, the term of “vehicle-based material handling machinery, etc.” refers to any of the following items.

- 1 (Abbreviation)
- 2 Shovel loader
- 3 Fork loader
- 4~7 (Abbreviation)

(Work plan)

Article 151-3 The employer shall carry out any work using vehicle-based material handling and transportation machines, etc. (excluding the work of traveling on roads using rough terrain transport vehicles or freight vehicles. The same shall apply to Article 151-7.) The employer shall establish in advance a work plan that is adapted to the size and topography of the place related to the work, the type and capacity of the vehicle-based material handling machine, etc., and the type and shape of the load, etc., and shall carry out the work in accordance with the work plan.

- ② The work plan set forth in the preceding paragraph must indicate the operation route of the vehicle-based material handling machine, etc. and the work method by the vehicle-based material handling machine, etc.
- ③ When the employer has established the work plan set forth in paragraph 1, the employer shall inform the relevant workers of the matters indicated by the provisions of the preceding paragraph.

Explanation

1. In this article, in order to ensure the safety of work when working with vehicle-based material handling machines, etc., the work method, etc. shall be examined in advance and a work plan shall be established.
2. The "work" in “when working with a vehicle-based material handling machine, etc.” in paragraph 1 includes not only loading of cargo using a boom lift, etc., but also traveling within the premises.
3. The "etc." in "type and shape of load" in Paragraph 1 includes the weight of the load, the harmfulness of the load, etc.
4. The "work method" in paragraph 2 shall include the time required for the work.
5. “Dissemination to related workers” in Paragraph 3 might be disseminated orally, but if it is difficult to inform the public orally due to the complexity of the content, it should be done by distributing documents, posting notices, etc.

(Showa 53.2.10 Basic No.78)

(Conductor of work)

Article 151-4 When carrying out work using a vehicle-based material handling machine, etc., the employer shall appoint a conductor for the work and have that person conduct the work in accordance with the work plan set forth in paragraph 1 of the preceding article.

Explanation

The work commander in this article does not need to be appointed when performing independent work. In addition, if a work conductor, etc. has been appointed and these persons can also perform work command, it is permissible to also serve as the work commander in this article. It should be noted that the work command is appointed for each employer when the cargo is delivered to different employers or when the work of different employers is under the work supervisors. In this case, work coordination should be made between each work commander.

(Showa 53.2.10 Basic No.78)

(Speed Limit)

Article 151-5 When an employer performs work using a vehicle-based material handling machine, etc. (excluding those with a maximum speed of 10 km /h or less), in advance, it is necessary to determine an appropriate speed limit for vehicle-based material handling machines, etc. according to the topography of the place where the work is to be carried out, the condition of the ground, etc., and perform the work in accordance with such speed limit.

② The operator of the vehicle-based material handling and transporting machine, etc. in the preceding paragraph shall not drive the vehicle-based material handling and transporting machine, etc. beyond the speed limit in the same paragraph.

Explanation

The "speed limit" in Paragraph 1 stipulates what is considered appropriate at the discretion of the employer, but the stipulated speed limit shall be bound by both the employer and the worker. The "speed limit" should be determined by vehicle type and location as necessary.

(Showa 53.2.10 Basic No. 78)

(Prevention of falls, etc.)

Article 151-6 When working with a vehicle-based material handling machine, etc., the employer shall prevent the danger of workers due to the falling or overturning of the vehicle-based material handling machine, etc. It is necessary to take necessary measures such as maintaining the necessary width for the operation route, preventing uneven subsidence of the ground, and preventing the collapse of the road shoulder.

- ② When the employer works using a vehicle-based material handling machine, etc. on a road shoulder, slope, etc., if there is a risk that the worker may be in danger due to the falling or overturning of the vehicle-based material handling machine, etc., a guide must be assigned to direct the vehicle-based material handling machine, etc.
- ③ The operator of the vehicle-based material handling machine, etc. set forth in the preceding paragraph shall follow the guidance given by the guide set forth in the same paragraph.

Explanation

1. The "etc." in paragraph 1 "maintaining the required width, preventing uneven subsidence of the ground, preventing the collapse of the shoulder, etc." shall include the installation of guardrails, etc.
2. In the case where guardrails are properly installed so that there is no risk of falls, tumbles, etc., the placement of guides under paragraph 2 shall not be required.

(Showa 53.2.10 Basic No. 78)

(Prevention of contact)

Article 151-7 When an employer works using a vehicle-based material handling machine, etc., there is a risk of danger to the workers from contact with the vehicle-based material handling machine, etc. in operation or its load. the employer shall not allow workers to enter the area. However, this shall not apply when a guide is assigned, and the vehicle-based material handling machine is directed by the guide.

- ② The operator of a vehicle load handling and transportation machine, etc. set forth in the preceding paragraph shall follow the guidance given by the inductor referred to in the provision of the same paragraph.

Explanation

The "places where danger may occur" in paragraph 1 includes not only the traveling range of the machine but also the moving range of the bucket and other load handling equipment of the shovel loader, and the protruding part of the lumber of the fork loader.

(Showa 53.2.10 Basic No. 78)

(Sign)

Article 151-8 When an employer has a guide for a vehicle-based material handling machinery, etc., the employer shall establish certain signals and have the inductor must give such signals.

- ② The operator of the vehicle-based material handling machine, etc. in the preceding paragraph must follow the signal in the same paragraph.

(Prohibition of Entry)

Article 151-9 Regarding the vehicle-based material handling machinery, etc. (excluding those that are structurally equipped with a device to prevent the fork, shovel, arm, etc. from dropping unexpectedly). The employer shall not allow workers to enter under a shovel, arm, etc. or a load supported by them. However, when performing repairs, inspections, etc., have workers engaged in the work use safety columns, safety blocks, etc. in order to prevent the danger of workers due to the sudden drop of forks, shovels, arms, etc.

- ② Workers who perform the work referred to in the provision of the preceding paragraph shall use the safety poles, safety blocks, etc. referred to in the provision of the same paragraph.

Explanation

1. The "etc." in "arm, etc." in paragraph 1 shall include the loading platform of the dump truck.
2. The "safety posts, safety blocks, etc." referred to in paragraph 1 shall be strong enough to securely support hoists, shovels, arms, etc. The "etc." in "safety blocks, etc." shall include girders, etc.

(Showa 53.2.10 Basic No. 78)

(Loading of the load)

Article 151-10 When loading a load on a vehicle-based material handling machine, etc., the employer shall comply with the following provisions.

- 1 Loading shall be carried out so as not to cause unbalanced loads.

2 (Abbreviation)

Explanation

1. The first is to prevent accidents such as tipping over due to unbalanced loads when loading.
2. The first item, "loading so that unbalanced load does not occur," means, for example, for truck loaders, to prevent unbalanced lumber from being caught in the mouth, and to prevent the load from becoming uneven when loading the load. However, it is not necessary to take measures such as inspecting the inside when loading the container on a truck.

(Showa 53.2.10 Basic No. 78)

(Measures when leaving the driving position)

Article 151-11 When a driver of a vehicle-based material handling machine, etc. leaves the driving position, the employer shall have the driver take the following measures.

- 1 Loading and unloading equipment, such as forks and shovels, must be placed in the lowest position.
 - 2 Take measures to prevent the escape of vehicle-based material handling machinery, etc., such as stopping the prime mover and ensuring that the brakes are applied to maintain the machine at a standstill.
- ② The driver set forth in the preceding paragraph shall take the measures listed in each item of the same paragraph when leaving the operating position of the vehicle-based material handling machine, etc.

Explanation

1. The "lowest descent position" of "placing the cargo handling device in the lowest descent position" in paragraph 1, item 1 shall be the lowest position that can be structurally lowered.
2. The "etc." in paragraph 1, item 2, "ensuring that the brakes are applied, etc." shall include stopping with a wedge or stopper.

(Showa 53.2.10 Basic No. 78)

(Transfer of vehicle-based material handling and transportation machines, etc.)
Article 151-12 In event that the employer uses road boards, embankments, etc. when loading and unloading freight vehicles by self-propelled or towed to transport vehicle-based cargo handling and transportation machines, etc. In such cases, in order to prevent the danger of the vehicle-based material handling machine, etc. from tipping over or falling, the operators shall comply with the following provisions.

- 1 Loading and unloading should be done in a flat and solid place.
- 2 When using a road board, use a road board with sufficient length, width, and strength, and attach it securely with an appropriate gradient.
- 3 When using embankments, temporary stands, etc., ensure sufficient width and strength, and an appropriate gradient.

Explanation

This article shall have the same purpose as the case of transfer of vehicle-type construction machinery in article 161.

(Showa 53.2.10 Basic No. 78)

(Note) The interpretation of Article 161 is as follows.

1. The "etc." in "Freight vehicles, etc." shall include trailers.
2. The second item, "sufficient", should be determined according to the weight and size of the vehicle-based construction machinery to be loaded and unloaded. In addition, "appropriate gradient" means a gradient within a safe range in consideration of the performance such as climbing force of the machine.
3. The strength of the embankment referred to in No. 3 shall be ensured by taking measures such as placing hard logs on the embankment and sufficiently consolidating the embankment.

(Showa 47.9.18 Basic No. 601-1)

(Restrictions on boarding)

Article 151-13 When working with material handling machines, etc. (excluding rough terrain vehicles and freight vehicles), the employer must not place the workers in places other than the passenger seats. However, this shall not apply when measures are taken to prevent danger to workers from falling

Explanation

1. This article shall be provided for all transportation of vehicle-based material handling machinery, etc. for the same purpose as the provisions of article 42 of the Industrial Safety and Health Regulations (hereinafter referred to as the "former Safety and Health Regulations") before the revision regarding forklifts.
2. "Measures to prevent danger" shall mean the provision of covers, enclosures, etc. to prevent workers from falling from high places such as straddle carriers and moving vehicle-based material handling machines.

(Showa 53.2.10 Basic No. 78)

(Restrictions on uses other than the principal use)

Article 151-14 The employer shall not use a vehicle-based material handling machine, etc. for any purpose other than the main purpose of the vehicle-based material handling machine, etc., such as lifting loads and raising and lowering workers. However, this shall not apply when there is no risk of causing danger to workers.

Explanation

1. This article is intended to prevent not only crashes but also dangers such as being pinched and caught.
2. The phrase "when there is no risk of danger" means that when there is no risk of the forklift, etc. falling over, the handrail or frame of sufficient height is provided around the valet, etc., and measures such as fixing the valet, etc. to the fork or having workers use the lifeline are taken.

(Showa 53.2.10 Basic No. 78)

(Repairs, etc.)

Article 151-15 When an employer repairs a vehicle-based material handling machine, etc., or installs or removes an attachment, the employer shall appoint a person to direct the work and shall have that person carry out the following

- 1 Determine the work procedure and direct the work directly.
- 2 Monitor the usage of safety columns, safety blocks, etc. specified in the provision of Article 151-9, Paragraph 1.

Explanation

The purpose of this article is to prevent accidents such as unexpected start-up of machines and falling of heavy objects due to insufficient coordination among workers when more than one worker is working. It is not necessary to appoint a conductor for work that does not pose a danger to workers, such as simple replacement of parts that is performed independently.

(Showa 53.2.10 Basic No. 78)

Subsection 3 Shovel-loader, etc.

(Headlights and backlights)

Article 151-27 The employer shall not use the shovel loader or fork loader (hereinafter referred to as "shovel-loader, etc.") unless it is equipped with headlights and backlights. However, this does not apply in places where the illuminance required for safe work is maintained.

Explanation

The "place where the illuminance required for safe work is maintained" in the provision of this article means the place outdoors in the daytime, the place where sufficient lighting is provided, etc. For machines to which the road transport vehicle law is applied, if there is a headlight installed under the provisions of the same law, it shall be treated as if there is a headlight installed in this article.

(Showa 53.2.10 Basic No. 78)

(Head guard)

Article 151-28 The employer shall not use the shovel loader, etc. unless it is equipped with a solid head guard. However, this shall not apply if there is no risk of danger to the driver of the shovel loader, etc. from falling loads.

Explanation

1. The structural criteria for a "firm head guard" should specifically be considered in accordance with the criteria set forth in Article 151-17 (abbreviation).
2. The phrase "when there is no risk of danger to the driver such as a shovel loader due to a fall of the load" in the book means, for example, when using a fork loader that grabs the timber from above and below and handles it so that the timber does not fly in the direction of the driver.

(Showa 53.2.10 Basic No. 78)

(Loading of the load)

Article 151-29 The employer must load the shovel loader, etc. so as not to obstruct the operator's view.

(Restriction of use)

Article 151-30 The employer shall not use the shovel loader, etc. beyond the maximum load or other capacity.

Explanation

"Other abilities" should include stability. The stability of the shovel loader, etc. shall be in accordance with the structural standard specified separately. Until the structural standard is established, the stability indicated by the manufacturer should be used as a guide.

(Showa 53.2.10 Basic No. 78)

(Periodic inspection)

Article 151-31 The employer shall, for shovel loaders, etc., conduct an inspection on the following matters once for a period not exceeding one year. However, this does not apply to the non-use period such as a shovel loader that is not used for a period exceeding one year.

- 1 Whether the motor is abnormal
 - 2 Whether there is any abnormality in the power transmission device and traveling device
 - 3 Whether there is any abnormality in the braking device and control device
 - 4 Whether there is any abnormality in the cargo handling equipment and hydraulic equipment
 - 5 Whether there is any abnormality in the electrical system, safety devices and
- ② When resuming the use of the shovel loader, etc. in the proviso of the preceding paragraph again, the employer shall conduct an inspection on the matters listed in each item of the same paragraph.

Explanation

For machines to which the road transport vehicle law is applied, the periodic inspection may be omitted for the parts that have undergone vehicle inspections, inspections, etc., as provided for in the law.

(Showa 53.2.10 Basic No. 78)

Article 151-32 A employer shall carry out an inspection of the following matters periodically, once every month or less, with respect to a shovel loader, etc. However, this does not apply to the non-use period such as a shovel loader that is not used for a period exceeding one month.

- 1 Whether there is any abnormality in the braking device, clutch and control device
 - 2 Whether there is any abnormality in the cargo handling and hydraulic systems
 - 3 Whether there is any abnormality in the head guard
- ② The employer shall, when resuming the use of the shovel loader, etc. in the proviso of the preceding paragraph, carry out an inspection on the matters listed in each item of the same paragraph.

Explanation

Same as the interpretation of basic No. 78 regarding the preceding article.

(Record of Periodic Inspections)

Article 151-33 When an employer conducts an inspection set forth in the preceding two Articles, the employer shall record the following matters and preserve them for three years.

- 1 Inspection date
- 2 Inspection method
- 3 Inspection points
- 4 Results of the inspection
- 5 Name of the person who conducted the inspection
- 6 Details of any repairs or other measures taken because of the inspection

Explanation

This article has the same purpose as article 135-2.

(Showa 53.2.10 Basic No. 78)

[Note] The interpretation of Article 135-2 is as follows.

1. This article clarifies the contents of the record of the results of the periodic inspection, which has been established in the past.
2. The "inspection method" in paragraph 1, item 2 shall include the name of the inspection equipment when the inspection equipment is used.
3. The "contents" of paragraph 1, item 8 shall include the repair location, repair date and time, repair method, and parts replacement status.

(Showa 53.2.10 Basic No. 78)

(Inspection)

Article 151-34 When working with a shovel loader, etc., the employer must inspect the following items before starting the work for the day.

- 1 Functions of braking device and control device
- 2 Functions of cargo handling equipment and hydraulic equipment
- 3 Presence or absence of wheel abnormality
- 4 Functions of headlights, backlights, turn signals and alarm devices

Explanation

Same as the interpretation of basic No. 78 regarding Article 151-31.

(Repair, etc.)

Article 151-35 In the event that an employer finds any abnormality during the inspection set forth in Article 151-31 or 151-32 or the inspection set forth in the preceding article, the employer shall immediately repair or take other necessary measures.

Chapter 6 Regulations for Driving Skills Such as Shovel Loader (Textbook p.188)

Chapter 7 Safety and Health Special Education Regulations (Extract) (Textbook p.196)

Chapter 8 Structural Standards for Shovel Loader, Etc. (Textbook p.197)

Chapter 9 Periodic Inspection Guidelines for Shovel Loaders, Etc. (Textbook p.203)

Volume 6: Accident Cases

List of accident cases (type of accident) (Textbook p.217)

Crash and fall accidents

Case 1: Falling off the shoulder of a road

Case 2: Falling from a fork loader due to vibration

Accidental collision

Case 3: Hit by a fork loader moving backwards while checking the condition of a load

Case 4: Run over by a shovel loader during the opening inspection

Case 5: Run over by a shovel loader running away

Case 6: Crashed by a log thrown out by a fork loader

Collision and trapped accidents

Case 7: Caught between driver's seat and arm during loading of round steel

Case 8: Caught between machine and sheet pile

Case 9: Head is caught in the arm of an excavator loader Flying and falling accidents

Case 10: A concrete block lifted by the shovel falls and caused damage

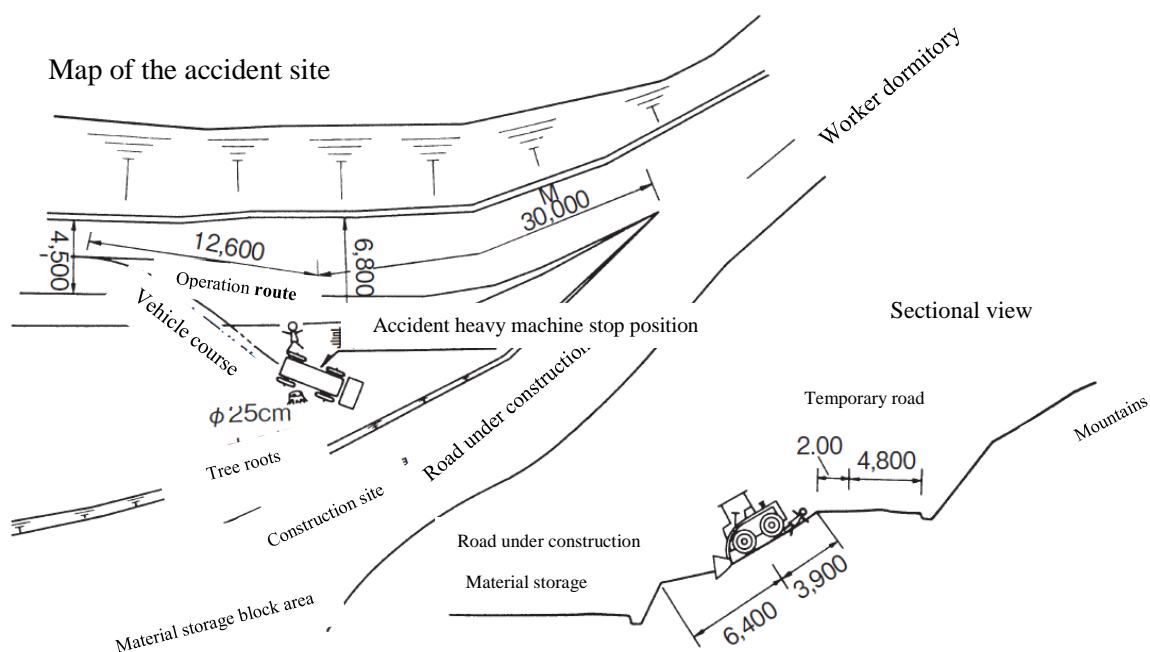
Case 1 Fall from the Shoulder (Textbook p.218)

(1) Place of business: Construction industry (construction of forest roads)

(2) Damage: 1 death

(3) Overview

On the day of the forest road construction, the victims had completed the work of transporting light oil from the temporary storage site to the designated storage site with a shovel loader and were on the way back to the heavy equipment storage site through the temporary storage site. As he was driving the shovel loader 426m from the starting point, he accidentally fell off the shoulder of the road. As there were no witnesses, but just before the fall, the victim jumped from the driver's seat and hit the right shoulder. It seems that he was run over by the rear wheel. The foehn phenomenon occurred on that day, and the heat of the site was 39.2 degrees Celsius.



(4) Causes and countermeasures

The cause of this accident was, firstly the fact that the shovel loader was driven by an unqualified person. It is also presumed that the driver was fatigued from lack of sleep due to the heat wave, which caused him to be distracted and failed to turn the steering wheel.

As a countermeasure,

1. Thorough safety training for drivers and strict prohibition of driving by unqualified persons.
2. Under abnormal weather conditions, pre-work meetings should be carefully held, work plans should be made to adapt to the conditions, health management of workers should be taken into consideration, and measures should be taken to change working hours and extend rest periods.
3. If there is a risk of falling on curves or bridges, try to prevent the fall by installing guardrails.
4. The driver should pay sufficient attention to daily health management and strive to maintain good physical condition.

Case 2: Fall from a Fork Loader Due to Vibration (Textbook p.220)

- (1) Place of business: Harbour transport industry
- (2) Damage: 1 death
- (3) Overview

The victim was a coastal cargo handling worker at K Port in F Prefecture and Y Port Transport Company. On the day of the accident, the victim was engaged in the wood pedestal placement work of moving 10 semi-finished products (20 mm x 40 mm x 80 mm) of external materials piled up at the storage yard in R city into one package with a fork loader. At around 10:30 am, the victims got on top of this and signaled the loader to move while holding the material with their hands in order to prevent the semi-finished product scooped up by the fork loader from falling during movement. The loader drove slowly and arrived at the desired location, but when unloading the semi-finished products, the loader suddenly lowered them and the vibration of the loader caused the loader lost balance, leaned forward, and fell from a height of about 3 m, and the helmet flew to the ground. He smashed the back of his head and died.



(4) Causes and countermeasures

The cause of this accident was that the load on the fork was piled up more than necessary, and a worker was carried on the fork to prevent the load from collapsing. Another cause of the accident was that the victim did not fasten the chin strap of his helmet.

As a countermeasure,

1. When working with a fork loader, do not put workers on any part other than the passenger seat, such as on the lifted fork.
2. The load on the fork should not be so high that it will collapse when the machine is operated.
3. The chin strap of the helmet must be securely fastened.
4. Provide safety education to related workers on how to handle the excavator loader, etc. and how to handle cargo.
5. When working with a fork loader, make a work plan, appoint a work commander, and perform safe work under the command of that person.

Case 3: While Checking Condition of a Load, the Worker Was Run Over by a Fork Loader Moving Backward (Textbook p.222)

- (1) Place of business: Harbor transport industry
- (2) Damage: 1 person
- (3) Overview

The victim was in charge of the coastal cargo handling work of the F transportation company in the F port of I prefecture. On the day of the accident, he was working on monitoring and directing the sorting area where imported logs were loaded onto trucks. Since there are two work locations, when he was patrolling to check the condition of the cargo, at around 1:10 am, he entered the dangerous area where three fork loaders were moving and tried to go to the loading location. While walking, he was pushed down by a fork loader that was moving backward and was run over by the left rear wheel.



(4) Causes and countermeasures

The cause of this accident was that the victims entered the danger zone even though there was the sign of no entry, and when it was unavoidable to enter the danger zone, he did not give a signal to the fork loader driver and did not turn on the back buzzer of the fork loader.

As a countermeasure,

1. When the fork loader moves backward, the driver must make sure to check backwards.
2. When more than one fork loader is operated in one place, a watchman or a guide shall be assigned to monitor the movement of the fork loader and the actions of other workers, and to give the necessary guidance and instructions.
3. The back buzzer should be checked, maintained, and repaired daily to ensure that it operates when the fork loader is moving backwards.
4. When working with a fork loader, forbidding fences, signs, etc. shall be set up to prevent entry into areas where there is a risk of danger to workers. If it is unavoidable, inform the relevant workers of the signal, etc. before entering.
5. When working with a fork loader, make a work plan and inform the relevant workers. In addition, a work supervisor should be appointed to perform safe work under the direction of that person.

Case 4: Run Over by a Shovel Loader During a Start-up Inspection (Textbook p.224)

(1) Place of business: Land freight transportation business

(2) Damage: 1 person seriously injured

(3) Overview

In the garage, the shovel loader driver A had an oil leak from the engine during the start-up inspection, so when he put his upper body under the shovel loader and was looking for the oil leak, his colleague driver B was unaware of this and got on the loader and moved forward, so he was hit by the rear wheels and suffered damage.

(4) Causes and countermeasures

The direct cause of the accident was that B moved the vehicle on his own without checking the surrounding conditions (including under the shovel loader) while the victim A was carrying out his opening inspection.

1. When going under the fork loader for inspection, make sure to put a perch (stop) etc., and if possible, lower the sign indicating that the inspection is in progress in the driver's seat so that other workers can see it.
2. The start-up inspection should be carried out by appointing a person in charge, and the person concerned should be informed that the fork loader under inspection should not be touched by anyone other than the person in charge.
3. Sufficiently educate all drivers about the method of starting inspection and the knowledge during inspection.



Case 5: Shovel loader escapes and is run over (Textbook p.225)

(1) Place of business: Civil engineering work

(2) Damage: 1 dead, 1 injured

(3) Overview

As this private residence was to be built facing a steep slope, a retaining wall had to be constructed around the house to prevent it from collapsing. The retaining wall was constructed over a width of 7.5m by a first-tier subcontractor of the construction company that had undertaken the new building.

After discussing the day's work, victims A and B loaded the shovel loader onto a truck and transported it to the construction site. Upon arriving at the site, A unloaded the shovel loader from the truck and stopped the shovel loader at the intersection at the corner of the site. As the place where the shovel loader was parked was in the way of a truck carrying earth and sand, A moved the shovel loader onto the road, which was downhill (with an angle of about 1 degree). He then raised the bucket, pulled the side brake with the engine running, and got off the driver's seat.

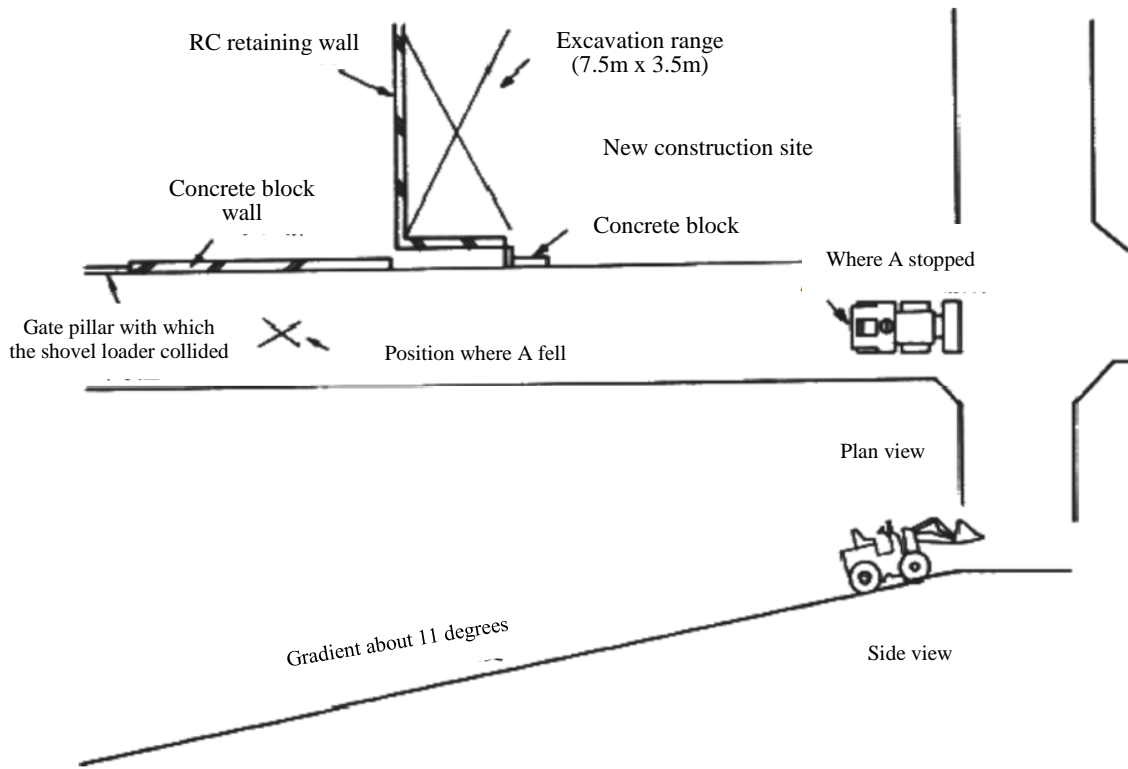
After this, the shovel loader suddenly started to move, and A, noticing this, ran to the bottom of the shovel loader to stop it, tried to hold it, but could not, then tried to get into the driver's seat, but could not, and he was dragged along by the shovel loader. B also noticed and tried to get in the driver's seat, but he couldn't get through and was dragged. In the meantime, A was shaken off from the shovel loader and was run over, B remained clinging and crashed into the gatepost of the next house with the shovel loader, A died, and B was injured.

(4) Causes and countermeasures

The cause of the accident was that victim A raised the bucket, and with the engine running, applied the parking brake (side brake) to stop the machine on a steep slope, which caused the machine to deviate because the braking performance such as braking was not sufficient. In addition, the work plan for the truck and shovel loader had not been decided.

As a countermeasure,

1. When the shovel loader is stopped and the driver leaves the driving position, lower the bucket to the ground surface, stop the engine, and apply the parking brake (side brake). If necessary, the wheels should be secured. In addition, do not park vehicles such as shovel loaders on steep slopes as much as possible.
2. Regular inspections and pre-operational checks should be carried out and any abnormalities repaired immediately.
3. Before starting work, the operation route, stop position, and working method of machines used such as trucks and shovel loaders shall be planned and communicated to the workers related.



Accident Situation Map

Case 6: Crashed into a Log Thrown by a Fork Loader (textbook p.227)

(1) Place of business: harbour transport industry

(2) Damage: 1 death

(3) Overview

This business is mainly engaged in the port cargo handling and transportation business.

The day's work involved using a fork loader to pile up approximately 2.0 m³ of logs that had been unloaded from the ship to the temporary storage site, where they had been piled up five times the day before.

The work was carried out by three people: a work commander, a driver, and an assistant worker. First, the driver uses a fork loader to transport five logs to the south side of the mountain, where the work commander and assistant workers bundle the logs on the fork, and the driver uses a fork loader to move the logs to the south side of the mountain.

Subsequently, the driver used a fork loader to carry two logs to the south side of the mountain to fill the ditch near the center of the mountain with logs. At this time, the work commander and assistant workers were on the east and west sides of the mountain, respectively. Since the distance from the tip of the fork to the target ditch is about 2.5 m, the driver decided to throw out the log of the fork and put it in the ditch.

The method of throwing out the log is to lower the fork tip, roll the log on the fork to near the fork tip, then raise the fork tip and then throw the log forward in reaction.

When the driver threw the log toward the ditch by the above method, the log fell to the other side (north side) of the mountain without entering the ditch and struck the work commander who was near the north-east side of the mountain. The work commander died of brain trauma after being hit.

(4) Causes and countermeasures

The main causes of this accident were the use of a fork loader to throw out logs to fill a ditch near the middle of the mountain, and the work commander being in a dangerous area that could be hit by the logs. The driver also did not confirm that there were no workers in the dangerous area.

As a countermeasure,

1. When working with a fork loader, do not allow related workers to enter dangerous places such as the work range of the fork and the place where the load is likely to collapse.
2. When working with a fork loader, in order to prevent danger due to the collapse of the load, make sure that there are no workers on the front, back, left, right, or opposite side of the piled logs.
3. Provide sufficient safety education and work guidance to related workers on how to handle fork loaders and cargo handling.
4. When using a fork loader to pile up logs, etc., a work plan and work procedures shall be established to inform the relevant workers, and then carry out safe work.

Case 7: Trapped Between Driver's Seat and Arm During Loading of Round Steel
(Textbook p. 229)

(1) Place of business: Land freight transportation business

(2) Damage: 1 death

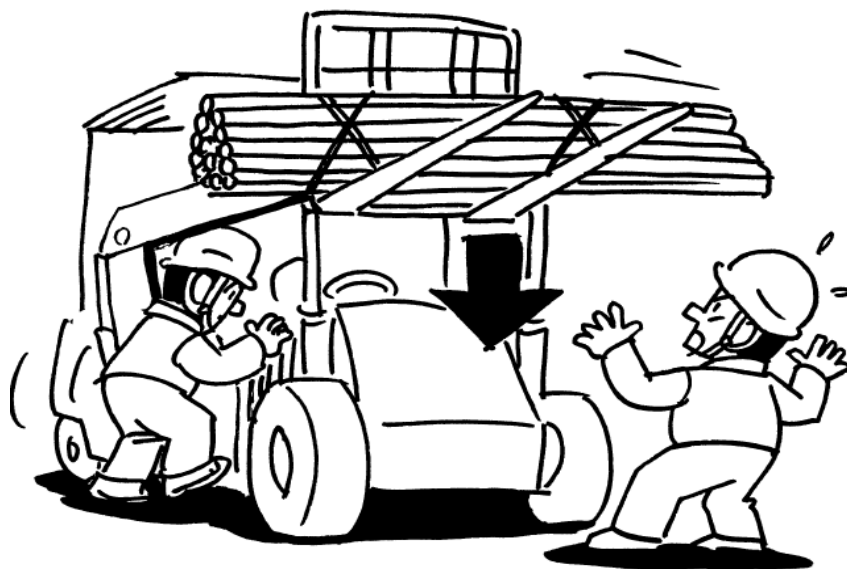
(3) Overview

On the day of the accident, the victim A and his colleague driver B were working on loading steel materials (round steel, diameter 2 mm, length 5 m to 7 m) onto a truck with a fork loader (5.9 tons) at the material storage area in the factory. rice field.

The operated a fork loader and first scooped 20 round steels (5 m long) with a fork, and then scooped 7 m long round steels 15 m away.

There was about 40m to the truck to load the round steel, and the road was uneven, so they decided to tie the round steel with a wire in order to prevent the round steel from being scattered.

A left the driver's seat with the fork loader's arm raised about 2 m, searched for a wire, tied the round steel together with B, He then climbed halfway in through the right-hand door to return to the driver's seat. The arm suddenly was lowered, and the chest was caught between the driver's seat and the arm, and he died.



(4) Causes and countermeasures

The cause of this accident was that A left the driver's seat with the arm raised, and when he returned to the driver's seat, he entered from the right side where there were various levers, and a part of his body touched the lever, causing the arm to drop. Another reason is that the round steel was not tied with a wire in advance for each unit so that it would not be scattered when it was transported by a fork loader.

As a countermeasure,

1. When the driver leaves the fork loader, lower the fork to the floor, stop the engine, and apply the parking brake to stop the vehicle.
2. When the driver goes in and out of the driver's seat, do so from the side without various levers.
3. When transporting round steel, etc. with a fork loader, tie it with a wire rope, etc. to prevent it from scattering or falling.
4. Provide safety education to related workers on how to handle the excavator loader, etc. and how to handle cargo.
5. Create a work procedure for loading and unloading steel materials and have them perform the work accordingly.
6. When loading and unloading trucks with fork loaders, especially when each load is 10 kg or more, a work plan shall be made, and a work commander shall be appointed to supervise the loading and unloading work.

Case 8: Trapped between the machine and the built-in sheet pile (Textbook p. 231)

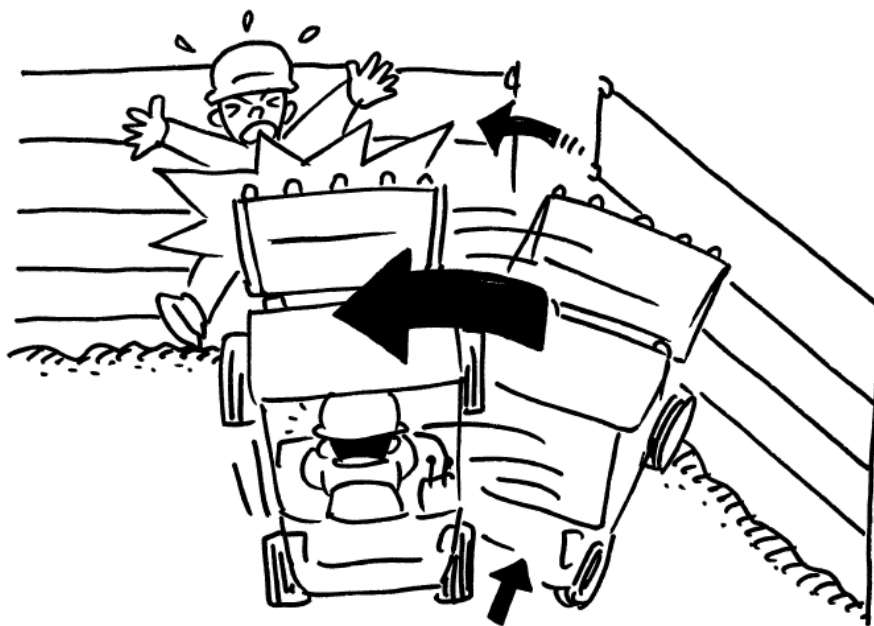
(1) Place of business: Construction

(2) Damage: 1 death

(3) Overview

On the day of the accident, the victim was engaged in the construction work of the earth retaining horizontal sheet pile (thickness 6 cm, length 1.5 m) near the depth of 12.5 m with three subordinate workers as the work commander. Since it was not easy to enter, he instructed one of the workers to push it with the bucket of the shovel loader, evacuated the other workers, while he held the sheet pile himself.

When the sheet pile was pushed with the bucket of the shovel loader, the claws of the bucket slipped, and the machine moved forward at an angle causing the victim was caught between the built-in sheet pile and the machine and die from ruptured internal organs.



(4) Causes and countermeasures

The cause of this accident was the use of the shovel loader to push the sheet pile into the ground, it was used for purposes other than the intended purpose, and other workers were working in the dangerous area, and the work supervisor's instructions and judgment were not appropriate.

As a countermeasure,

1. Do not use the shovel loader for any purpose other than its intended purpose.
2. Do not allow other workers to enter dangerous places.
3. When assembling the earth retaining support, a work commander should be appointed and the work should be carried out under the direct command of that person (however, if a person in charge of the work is appointed, the work may be carried out concurrently).
1. When working with a shovel loader, establish a work plan and proceed with the work based on it, and appoint a work commander and perform the work under the direction of that person.
4. Provide sufficient safety education and work guidance on driving and cargo handling of excavator loaders, etc. to work commanders and drivers.

Case 9: Head Caught in the Shovel Loader's Arm (Textbook p.233)

(1) Place of business: Scrap iron processing

(2) Damage: 1 death

(3) Overview

Company A was engaged in the collection, processing and sales of iron scraps, non-ferrous scraps, wastepaper, containers, etc.

Worker A (victim) and B of Company A were working together at a steel processing plant in the factory to use waste iron as a raw material for iron making.

First, A drove a fork loader and transported steel materials for processing (waste products) to the shear for processing waste products in the factory, and B was in charge of operating the shear to cut the carried steel materials. A put the cut steel in the bucket of the shovel loader and transported it to the product storage area about 15 meters away.

From here, it is estimated that there are no witnesses, but after the afternoon break, A resumed work and tried to carry the scrap with a shovel loader and remove it from the bucket. At that time, he found a piece of iron (4cm x 9cm) sticking into the driver's side of the right front inner drive wheel tire.

It is presumed that when A leaned his body out of the driver's seat to remove a piece of iron from the driver's seat, part of his body touched the lever for lifting and lowering the lift arm on the right side of the seat, and he was trapped between the lift arm and the driver's seat leg cover ((interval of about 13 cm) and suffered damage.

(4) Causes and countermeasures

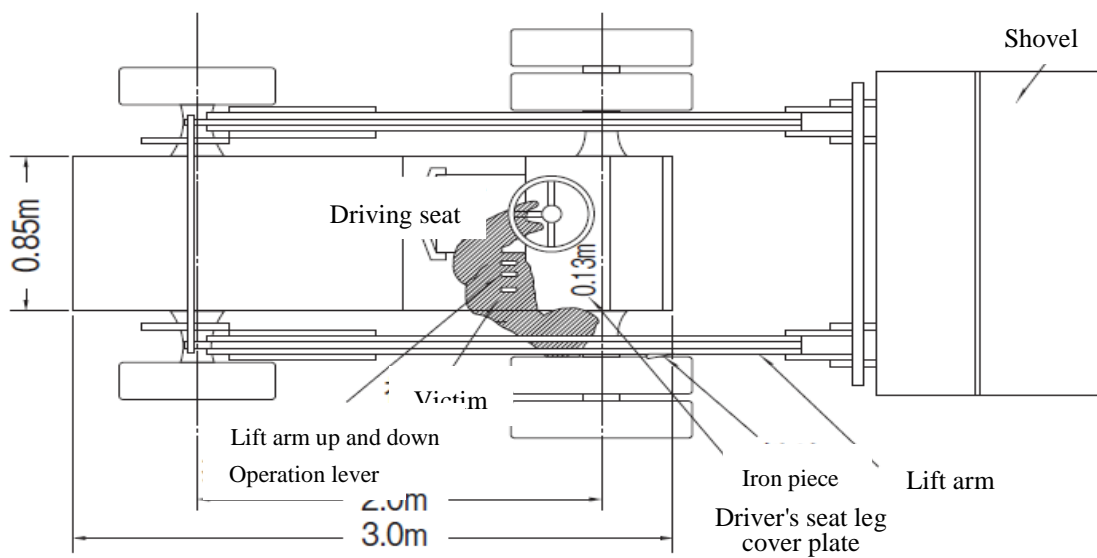
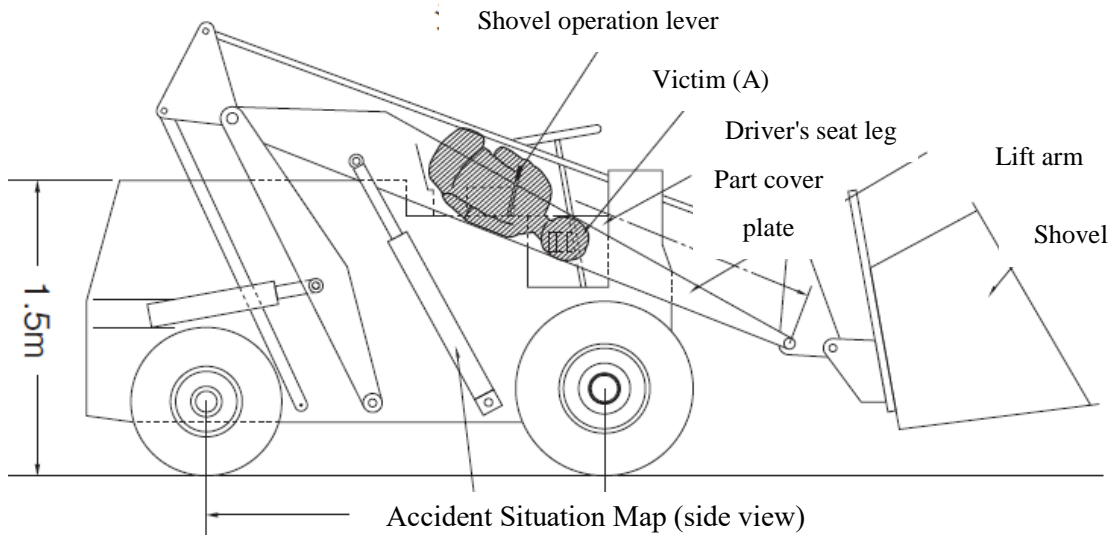
The primary cause of this accident is having an unqualified person drive the shovel loader. In addition, equipment such as enclosures was not provided to prevent the danger of accidental raising and lowering of the lift arm of the shovel loader. Although the lift arm lift operation lever was equipped with a manual lock device to maintain neutrality, it was damaged and was in a non-functional state, and regular inspections and daily inspections were inadequate. In addition, defects and failure points were not improved or maintained.

In addition, since no work commander was appointed when carrying out cargo handling work, it is also possible that a safe work method was not implemented.

As a countermeasure,

1. Make sure that the shovel loader is operated by a qualified person
2. When removing foreign matter from getting into the tires, stop the excavator loader completely, stop the engine, apply the parking brake securely, and lower the cargo handling device such as a bucket to the ground to prevent it from running off.

3. To prevent danger due to raising and lowering the lift arm of the shovel loader, install equipment such as an enclosure in the driver's seat.
4. Carry out periodic inspections and inspections before starting the work and strive to ensure that the functions of safety devices, work devices, etc. are fully functional.
5. Provide sufficient safety education and work guidance on how to handle the excavator loader, etc. regarding running and cargo handling.



Accident Situation Map (plan view)

Case 10: A Concrete Block Lifted by a Shovel Falls and it Gets Damaged (Textbook p.235).

(1) Business establishment concrete product manufacturing industry

(2) Damage: 1 death

(3) Overview

In a concrete factory, a concrete block (width 1.6 m, length 2.5 m, thickness 5 cm, weight 1.95 kg) is lifted using a shovel loader (maximum load capacity 2.3 tons), and the block is repaired under the block. When the work was being done by three workers, the block fell and was damaged.

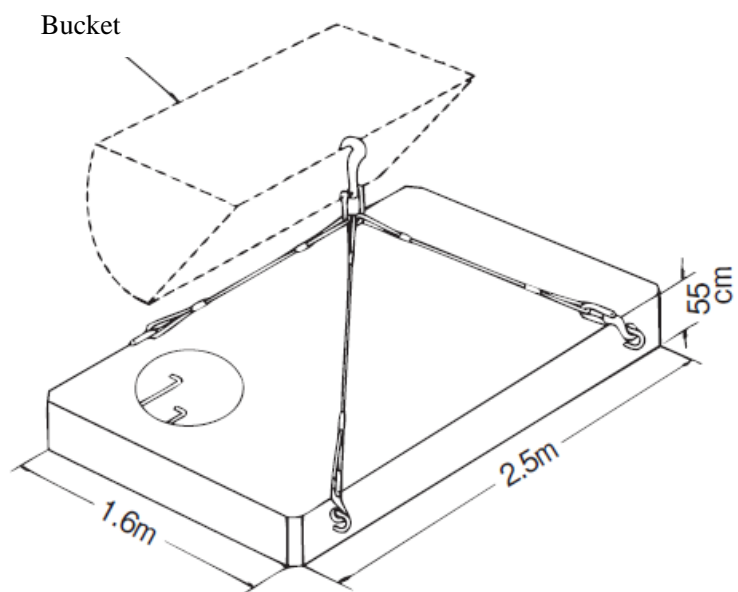
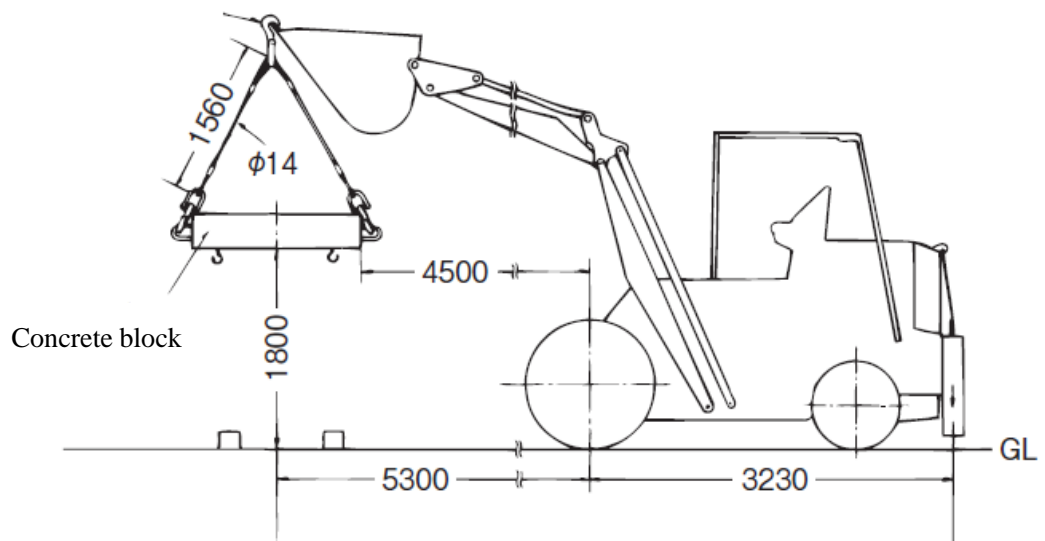
For lifting, use a wire rope for slinging with a hook (diameter 1.4 cm, length 156 cm), connect one end to the hanging bracket of the block, and hook the other end to the center of the bucket of the shovel loader. The bucket was not equipped with a hook dedicated to lifting and was lifted by hooking directly to the center of the bucket edge. The driver was unqualified for driving the shovel loader.

(4) Causes and countermeasures

The primary cause of this accident was that the shovel loader was operated by an unqualified person. It may also be that the shovel loader was used for lifting work, which is not its original purpose, or that the operator entered the lower part of the load while it was lifted.

As a countermeasure,

1. Do not allow an unqualified person to drive the shovel loader.
2. Do not hang or transport the load with a shovel loader, and do not use it for any purpose other than its intended purpose.
3. Do not work under the load lifted by a bucket or the like.
4. When working with a shovel loader, appoint a work commander and have them perform safe work based on the work plan.
5. Provide sufficient safety education and work guidance on how to handle the shovel loader's running and cargo handling



Situation Diagram of Lifting a Block with a Bucket

ショベルローダー一等運転技能講習
試験問題集

Shovel Loader Driving Technical Training
Exam Questions

英語版 English Version

Shovel Loader Driving Technical Training

Exam Questions

■Question No. 1 (Definition of Shovel Loader, etc.)

Choose one of the following four explanations about the definition of shovel loader, etc. that is correct.

- (1) A fork loader is a two-wheel drive vehicle that, in principle, uses a lift arm to raise and lower a shovel (bucket) installed in the front of the vehicle body to handle cargo.
- (2) A shovel loader is a two-wheel drive vehicle that, in principle, uses a lift arm to raise and lower the forks in the front of the vehicle to handle lumber and other materials.
- (3) Tractors shovels (crawler type or tire type with all 4-wheel drive) are considered to be vehicle construction machinery, but those with incompatible forks, even if they are 4-wheel drive, are applied as fork loaders.
- (4) The criteria for stability are the same for shovel loaders and tractor shovels.

■Question No. 2 (Characteristics of Shovel Loaders, etc.)

Choose one of the following four explanations about the characteristics of shovel loaders, etc. that is incorrect.

- (1) Similar to counterbalanced forklifts, it has a rear-wheel drive and front-wheel steering system.
- (2) Its compact body size makes it easier to maneuver in small spaces.
- (3) Slip resistance is poor due to the two drive wheels.
- (4) Forward visibility is poor due to handling devices such as arms and buckets mounted in the front.

■Question No. 3 (Characteristics of Shovel Loaders, etc.)

Choose one of the following four explanations about the characteristics of shovel loaders, etc. that is correct.

- (1) Because the load rises in an arc rather than vertical, the stability of the vehicle changes depending on the height of the load.

- (2) Cargo handling and transportation can be performed on public roads.
- (3) Wheel loaders are characterized by the fact that they are two-wheel drive and require a "Training course in the operation of shovel loaders, etc." to obtain certification.
- (4) Shovel loaders are characterized by their four-wheel drive and require a "Training course in the operation of vehicle-based construction machinery" to obtain certification.

■ Question No. 4 (Types and Characteristics of Buckets)

Choose one of the following four explanations about Types and characteristics of buckets that is incorrect.

- (1) Shape I is the most common shape, with a straight edge and no claws. It is used for handling small objects and is used for scooping sand, gravel, and soil.
- (2) Shape II is the same as Shape I bucket, and is used for handling small objects, but has a flat edge for better scooping performance.
- (3) Shape III is a bucket with a claw added to the straight edge of Type I, and is used for scooping crushed stone, etc., as it is suitable for handling materials with large grain size.
- (4) Shape IV is a bucket with claws added to the chevron edge of Shape II and is used for better scooping performance of handling materials with large grain size.

■ Question No. 5 (Functions of Shovel Loaders, etc.)

Choose one of the following four explanations about functions of shovel loaders, etc. that is incorrect.

- (1) The speed at which the bucket is raised and lowered tends to be higher because it significantly affects the efficiency of cargo handling work.
- (2) In the case of lowering, some buckets are equipped with a valve that limits the lowering speed according to the weight of the load when the operation valve is fully opened.
- (3) You can think of it as the operation of an ordinary car with the addition of cargo

handling functions. Also, switching between forward and backward, clutch, brake, lift, and dump maneuvers are frequently performed.

- (4) In a shovel loader, when driving with the bucket lifted to the middle position, the forward view is obstructed and the stability of the vehicle worsens, so it is necessary to drive with the bucket in the upper position.

■ Question No. 6 (Structure of a Gasoline Engine)

Choose one of the following four explanations about structure of a gasoline engine that is incorrect.

- (1) A gasoline engine is a device that compresses a mixture of gasoline and air, ignites it, and converts the resulting explosive force into rotational energy.
- (2) The main parts of the engine body include the cylinder, piston, piston rings, connecting rod, crankshaft, flywheel, valves, camshaft, crankcase, carburetor, distributor, and ignition plug.
- (3) As the piston rises inside the cylinder, the atomized gasoline is sucked into the top of the piston along with the air (about 14 parts air to 1 part gasoline by weight ratio) by the atomizing mechanism of the carburetor.
- (4) As the piston rises and the exhaust valve and intake valve are closed, the gasoline/air mixture gets compressed (around 1/6 to 1/9).

■ Question No. 7 (Structure of a Gasoline Engine)

Choose one of the following four explanations about structure of a gasoline engine that is incorrect.

- (1) When the piston rises, an electric spark is sent into the spark gap of the ignition plug to ignite and explode the gas mixture (the maximum pressure at this time is about 3 MPa), and this pressure pushes the piston down.
- (2) When the piston is near bottom dead point, the exhaust valve opens, and then as the piston rises, the burnt gas is pushed out through the exhaust valve and through the exhaust manifold, pipes, and muffler.
- (3) The up and down movements of the pistons are converted into rotational

movements of the crankshaft through the connecting rod and become the power source.

- (4) An engine that four performs strokes of (intake, compression, combustion, and exhaust) during one rotation of the crankshaft is called a four-stroke engine.

■Question No. 8 (Structure of a Diesel Engine)

Choose one of the following four explanations about structure of a diesel engine that is incorrect.

- (1) A diesel engine is a device that converts the explosive force into rotational energy by compressing air to high pressure and injecting diesel fuel into the air at high pressure, causing the diesel fuel to spontaneously ignite and explode due to the heat of compression of the air.
- (2) The main part of the engine itself can generally be thought of as a gasoline engine with the carburetor, ignition plugs, and other ignition devices removed, and instead equipped with a throttle, injection pump, and injection nozzles.
- (3) The four strokes of action; intake, compression, combustion, and exhaust are the same as in a gasoline engine, but while a gasoline engine absorbs a mixture of gasoline and air, a diesel engine absorbs and compresses a mixture of diesel fuel and air (the compression ratio is $1/17 - 1/23$, which is greater than the gasoline engine).
- (4) The difference is that while the former is ignited and explodes, in the latter, when diesel fuel is injected into the compressed air at a higher pressure (about 20 MPa), the diesel fuel spontaneously ignites and explodes due to the heat of compression of the air.

■Question No. 9 (Maneuvering Gear)

Choose one of the following four explanations about maneuvering gear that is incorrect.

- (1) Unlike ordinary cars, shovel loaders have a small steering angle. In addition, the steering wheel operating force differs considerably between empty and loaded

- vehicles, and the frequency with which the steering wheel is operated is also low.
- (2) The ball nut type is often used in small excavator loaders.
 - (3) The speed reduction ratio is generally 20 to 25 for the speed reduction device, and the total number of steering wheel revolutions is about 4 to 5.
 - (4) In order to reduce the steering wheel operating force, it is common to use a steering booster device (power steering) that uses hydraulic pressure for maximum loads of 0.7 tons or more.

■ Question No. 10 (Steering Device)

Choose one of the following four explanations about steering device that is correct.

- (1) In the case of the full hydraulic type, the steering deceleration device and valve body are integrated, and the cylinder is installed separately.
- (2) In the case of the Semi-integral type, the steering deceleration device, valve body and cylinder are separately installed, or the valve body and cylinder are integrated.
- (3) In the linkage type, a steering valve with a built-in hydraulic circuit switching valve and metering hydraulic pump that is linked to the rotation of the steering wheel sends oil to the cylinder of the rear axle to steer as much as the steering wheel is turned.
- (4) The steering link connects the steering deceleration device to the rear axle, and consists of a drag link, tie rods, and bell cranks.

■ Question No. 11 (Braking Device)

Choose one of the following four explanations about braking device that is correct.

- (1) Shovel loaders are generally equipped with a hydraulic foot brake acting on the front wheels and a mechanical parking brake acting on the rear wheels or output shaft transmission.
- (2) The maximum speed of shovel loaders is usually 15 to 30 km/h, and when loaded it applies a high load on the rear wheels.
- (3) Unlike ordinary cars, hydraulic foot brakes are usually installed only on the rear

wheels and not on the front wheels, except for special large vehicles.

- (4) In a hydraulic foot brake, the tread force of the foot is transmitted to the master cylinder, and the hydraulic pressure generated is sent to the wheel cylinder to expand the brake shoes and apply braking by friction with the brake drum.

■ Question No. 12 (Braking Device)

Choose one of the following four explanations about braking device that is incorrect.

- (1) In larger vehicles, the hydraulic foot brake alone may not provide enough braking force, a booster (servo type) is required to reduce the tread force to apply the brake.
- (2) The servo-type takes and uses energy from the engine in the form of hydraulic pressure, vacuum force, and air pressure.
- (3) If the engine stops or the hydraulic system or air system malfunctions during operation, stop the vehicle immediately.
- (4) It is OK to move the vehicle by towing it with a brake or steering system malfunction.

■ Question No. 13 (Braking Device)

Choose one of the following four explanations about braking device that is correct.

- (1) In the air-servo type, the hydraulic pressure from the hydraulic pump attached to the engine is sent to the wheel cylinder via a brake valve linked to the brake pedal to expand the brake shoes and apply braking.
- (2) The servo hydraulic system uses a brake booster that uses the differential pressure between the vacuum pressure generated by the vacuum pump or engine intake side and atmospheric pressure to increase the fluid pressure generated in the master cylinder.
- (3) The air servo type uses compressed air obtained from the engine with a compressor installed.
- (4) The vacuum servo type uses compressed air obtained from the engine with a compressor installed.

■ Question No. 14 (Braking Device)

Choose one of the following four explanations about braking device that is incorrect.

- (1) It is used for parking and unexpected braking, just like an ordinary car.
- (2) A hand or other force is transmitted to a cam via a link, which moves in parallel, causing the brake shoe to contract and the friction between it and the brake drum to apply braking.
- (3) The parking brake lever is equipped with a ratchet or over-lock structure to maintain the braking state even when the hand is released.
- (4) It is an internal expansion type, but there are also external contraction types.

■ Question No. 15 (Handling Methods)

Choose one of the following four explanations about handling methods that is incorrect.

- (1) Unlike cars, shovel loaders involve not only driving but also load handling work.
- (2) Compared to cars, the mass and driving force of shovels loaders are larger, and their structure and characteristics are different, so there are fewer accidents caused by carelessness on the part of the operator.
- (3) Since load handling and transportation is often performed in a narrow space, the driver and guide must pay close attention to the surrounding conditions, especially pedestrians and highly loaded cargo.
- (4) Before starting work, the operator must check the effectiveness of brakes, the play of the steering wheel, and tire pressure.

■ Question No. 16 (Handling Methods)

Choose one of the following four explanations about handling methods that is incorrect.

- (1) It is not necessary to stop the engine when refueling.

- (2) It is necessary to wipe off any fuel or hydraulic oil leaks.
- (3) Each manufacturer and model of shovel loader has its own unique handling precautions, so it is important to read and understand the instruction manual that comes with the machine before actually operating it.
- (4) If a malfunction of the shovel loader is found, it is necessary to immediately report it to the vehicle supervisor to have it repaired.

■ Question No. 17 (Instructions Before Starting Work)

Choose one of the following four explanations about instructions before starting work that is incorrect.

- (1) Before starting the engine, check for water and oil leaks in every part.
- (2) Before starting the engine, check the tire pressure and tire damage.
- (3) Before starting the engine, check the lens of the turn signal and lamp for dirt and damage.
- (4) Before starting the engine, it is not necessary to check the rearview mirror for dirt or damage.

■ Question No. 18 (Instructions Before Starting Work)

Choose one of the following four explanations about instructions before starting work that is incorrect.

- (1) Before starting the engine, check the operation of the turn signal and each lamp on the vehicle.
- (2) After starting the engine, check the rear view of the rearview mirror on the vehicle.
- (3) After starting the engine, check the alarm device (horn) to see if it sounds on the vehicle.
- (4) After starting the engine, check the operation of each indicator on the vehicle.

■Question No. 19 (Instructions Before Starting Work)

Choose one of the following four explanations about instructions before starting work that is incorrect.

- (1) After starting the engine, check the fuel amount on the vehicle.
- (2) After starting the engine, check for abnormal engine noise and exhaust color on the vehicle.
- (3) After starting the engine, check the play of the clutch pedal on the vehicle.
- (4) Before starting the engine, check the foot pedal of the foot brake.

■Question No. 20 (Instructions Before Starting Work)

Choose one of the following four explanations about instructions before starting work that is incorrect.

- (1) After starting the engine, inspect the parking brake lever pull and the effectiveness of the parking brake on the vehicle.
- (2) After starting the engine, check the steering wheel on the vehicle to see if it has any play or looseness.
- (3) After starting the engine, check the operation of the cargo handling equipment on the vehicle.
- (4) Check the ascending and descending of the bucket at a slow speed.

■Question No. 21 (Instructions Before Starting Work)

Choose one of the following four explanations about instructions before starting work that is incorrect.

- (1) After starting the engine, check the reach of the dump arm on the vehicle.
- (2) Check clutch disengagement at a slow speed.
- (3) After starting the engine, check the effectiveness of the foot brake while the vehicle is stopped.
- (4) Check the swing and control of the steering wheel while moving slowly.

■Question No. 22 (Periodic Inspections)

Choose one of the following four explanations about periodic inspections that is correct.

- (1) The law does not require employers to conduct periodic inspections.
- (2) Periodic inspection includes inspection every three months, inspection every three years, and inspection upon resumption of use.
- (3) When performing periodic inspections, the results must be recorded and stored for one year.
- (4) The inspection must be conducted by a person with sufficient ability (a person who has received a certain level of training on the implementation of periodic inspections or a maintenance service provider) in accordance with the "Guidelines for Periodic Inspections of Shovel Loaders, etc." published by the Minister of Health, Labor and Welfare.

■Question No. 23 (Periodic Inspections)

Choose one of the following four explanations about periodic inspections that is incorrect.

- (1) Monthly inspections shall be conducted periodically once in a period not exceeding one month to check for abnormalities in braking system, clutch, steering device, cargo handling system, hydraulic system (including safety valve), head guard, etc.
- (2) Annual inspections are inspections to check for abnormalities in each part of the shovel loader, etc., periodically, once in a period not exceeding one year.
- (3) Shovel loaders, etc. that have been out of use for a period of more than one month but less than one year shall be subject to inspection that corresponds to the monthly periodic inspection when they restart activities.
- (4) Shovel loaders, etc. that have been out of use for more than three years shall be subject to inspection that corresponds to the annual periodic inspection when they restart activities.

■Question No. 24 (Gasoline Engine Type Starting Operation Guidelines)

Choose one of the following four explanations about gasoline engine type starting operation guidelines that is incorrect.

- (1) Make sure the gearshift lever is in the neutral position and the parking brake is pulled.
- (2) Insert the engine key into the start switch and turn the key to the ON position.
- (3) After the engine starts, let it warm up for a while.
- (4) Since the auto choke is working, the engine number of revolutions will gradually increase, and when the engine is warmed up, the revolutions will automatically increase.

■Question No. 25 (Diesel Engine Type Starting Operation Guidelines)

Choose one of the following four explanations about diesel engine type starting operation and guidelines that is incorrect.

- (1) Make sure that the gearshift lever is in the neutral position and the parking brake is pulled.
- (2) For diesel models with a preheating system (except direct injection models), the preheating system must be heated, so turn the engine key to the "GLOW" position and turn on the preheating signal lamp.
- (3) When heating by the preheating device is completed and the signal lamp turns off, turn the key to the "START" position, and remove your hand from the key when the engine starts.
- (4) Once the engine has started, it is not necessary to warm up the engine.

■Question No. 26 (Starting and Driving Operation)

Choose one of the following four explanations about starting and driving operation guidelines that is correct.

- (1) Operate the lift, dump, and reach levers to activate the full stroke of each cylinder

two or three times.

- (2) Pull the lift lever to lift the bucket 2 to 3 cm above the ground.
- (3) Pull the dump lever to move the bucket fully downward.
- (4) Pull the reach lever to fully release the bucket from the machine side.

■ Question No. 27 (Clutch-type Driving Operation)

Choose one of the following four explanations about clutch-type driving operation that is incorrect.

- (1) Fully depress the clutch pedal.
- (2) Insert the gearshift lever into 1st gear (F-1 for forward, R-1 for reverse).
- (3) Loosen the parking brake. Push the stick-type brake forward. For lever type, push down while turning.
- (4) Depress the accelerator pedal further to accelerate, then release your foot and at the same time, depress the clutch pedal and insert the gearshift lever into 2nd gear.

■ Question No. 28 (Clutch-type Driving Operation)

Choose one of the following four explanations about clutch-type driving operation that is incorrect.

- (1) Depress the accelerator pedal, and at the same time, quickly release the clutch pedal.
- (2) When moving off, it is OK to apply the same amount of pressure to the accelerator pedal when the vehicle is empty and when it is loaded.
- (3) When driving a loaded vehicle, be careful to depress the accelerator pedal more than usual or the vehicle may stall.
- (4) When start going uphill, the parking brake is released while depressing the accelerator pedal and taking your foot off the clutch pedal.

■ Question No. 29 (Driving Operation)

Choose one of the following four explanations about driving operation that is incorrect.

- (1) Many of the torque converter models have an inching pedal on the left side. This pedal, when depressed, will neutralize the transmission as well as the brake, making it easier to perform slow speed driving operations such as approaching a dump truck.
- (2) There is no need to set a speed limit when the vehicle is used in a factory or indoors.
- (3) For example, it is safer to set a separate speed limit of 15 km/h when empty and 10 km/h when loaded.
- (4) When using a shovel loader in a focused manner, these restrictions are definitely necessary, and over-speeding and overtaking must not be done.

■ Question No. 30 (Driving Operation)

Choose one of the following four explanations about driving operation that is incorrect.

- (1) When changing direction at an intersection or turn, use a turn signal to indicate the direction in which you are turning, and check for safety before turning the wheel.
- (2) If there are pedestrians or other vehicles ahead of you trying to turn, stop and wait.
- (3) When turning a corner, unlike ordinary cars, the rear wheels are used to steer the car, so when moving forward, it is necessary to pull the car all the way inward to turn.
- (4) When turning a corner, unlike ordinary cars, the front wheels are used to steer the car, so when moving forward, it is necessary to pull the car all the way to the outside to turn.

■ Question No. 31 (Driving Operation)

Choose one of the following four explanations about driving operation that is correct.

- (1) The frequency with which shovel loaders move backward is extremely low.
- (2) The ratio of backward movement to forward movement is about 80% (backward) and 20% (forward).
- (3) When moving backward, a vehicle with a reach should have the arm pulled fully backward and the bucket lowered to a height of 2 to 3 cm above the ground.
- (4) After confirming the stability of the cargo, turn back and hold on to the grips, etc., and drive carefully.

■ Question No. 32 (Driving Operation)

Choose one of the following four explanations about driving operation that is incorrect.

- (1) When passing through an area with poor visibility, such as a turn or an entrance/exit of a warehouse or premises, be sure to stop, check for safety on both sides, and then start immediately in one go.
- (2) Obstacles (e.g., stone blocks, wood, depressions or salient) should be avoided or removed as much as possible before passing through.
- (3) If the road conditions are muddy or snowy, it is effective to use double tires on the front wheels as the drive wheels.
- (4) If the road conditions are muddy or snowy, it is effective to use tire chains.

■ Question No. 33 (Parking, End of Driving)

Choose one of the following four explanations about parking and end of driving that is incorrect.

- (1) Fully pull the parking brake or pull it toward you.
- (2) Set the gearshift lever to neutral.
- (3) Lower the bucket to the ground, dump it forward, and keep it on the ground in a horizontal position.
- (4) Turn the engine key to the left to stop the engine. Leave the key inserted when leaving the driver's seat.

■ Question No. 34 (End of Driving)

Choose one of the following four explanations about the end of driving that is incorrect.

- (1) At the end of operation, it is necessary to clean and inspect each part of the vehicle and leave it ready for work at any time.
- (2) Clean the outside of the vehicle with a rag or brush. when it's too dirty, wipe it dry.
- (3) Open the engine hood and wipe off the dusty parts with a rag.
- (4) Check the tires for damage.

■ Question No. 35 (End of Driving)

Choose one of the following four explanations about the end of driving that is incorrect.

- (1) Check the exterior of the vehicle for any abnormalities (dents, cracks, etc.).
- (2) Check the remaining fuel level and refill it.
- (3) Check if there is any leakage in the hydraulic oil, engine oil, fuel, and cooling water.
- (4) It is not necessary to check if there is any looseness in the hub nut and the piston rod joint of each cylinder.

■ Question No. 36 (Driving Precautions)

Choose one of the following four explanations about driving precautions that is incorrect.

- (1) Pay full attention while driving and perform your work carefully.
- (2) Looking aside while driving can cause a disaster, so pay attention to the direction of travel and pay attention when approaching people working around you.
- (3) The condition of the road surface and the strength of a bridge should be checked in advance.

(4) In a factory or indoors, it is OK to drive with a person on the bucket or vehicle.

■ Question No. 37 (Driving Precautions)

Choose one of the following four explanations about driving precautions that is incorrect.

- (1) Do not travel with the bucket raised higher than necessary. Travel in the basic running position with the bucket raised regardless of whether it is empty or loaded.
- (2) Do not run at high speed, turn at high speed, or brake suddenly on a slippery surface.
- (3) Do not drive at a right angle on a steep slope, as the vehicle may slide sideways and fall over.
- (4) Be careful when handling fire, if the vehicle is near fire, there is a risk of catching fire.

■ Question No. 38 (Driving Precautions)

Choose one of the following four explanations about driving precautions that is incorrect.

- (1) When getting in and out of a vehicle, always face the vehicle and use handrails or steps to always hold yourself in two or more places.
- (2) Be careful do not get caught in the operating device accidentally.
- (3) When there is an obstacle, turn and drive in such a way that the vehicle or the bucket does not collide with other obstacles.
- (4) At night, it is easy to mistake the perspective and height of the ground, so drive at a speed appropriate for the lighting.

■ Question No. 39 (Driving Precautions)

Choose one of the following four explanations about driving precautions that is correct.

- (1) Bulk cargoes tend to be overloaded, so be careful not to overload them.
- (2) Load the vehicle so that it is loaded on one side.
- (3) When the vehicle is loaded, drive backward on uphill slopes and forward on downhill slopes.
- (4) When the vehicle is empty, drive forward on uphill slopes and backward on downhill slopes.

■ Question No. 40 (Fork Loaders)

Choose one of the following four explanations about fork loaders that is correct.

- (1) Pallet forks can perform cargo handling operations the same as forklifts.
- (2) The log forks have fork, fork bars, and backrest welded together, and the backrest is tilted forward against the fork. It is suitable for handling lumber, logs, etc.
- (3) In the sharp dumping fork, the fork and backrest are designed to be folded by a hydraulic cylinder. If the fork is used at a right angle to the backrest without folding the fork, normal fork work can be performed making it versatile.
- (4) Hinged forks can hold the load on the forks from above with a clamp arm, preventing long objects from falling or wobbling.

■ Question No. 41 (Load and Vehicle Stability)

Choose one of the following four explanations about load and vehicle stability that is incorrect.

- (1) Shovel loaders are like a balance between the load on the rear wheels and the weight in front of the front wheels, with the center of the front wheels as the support.
- (2) In the case of a vehicle with a reach mechanism, there will be a considerable difference in the load capacity between the minimum and maximum reach, so be sure to familiarize yourself with the capabilities of the machine and make no

mistakes.

- (3) When loading, raise the lift arm as high as possible and pull the bucket toward you as much as possible.
- (4) Due to changes in the position of the center of gravity when driving with the bucket raised high, there is an increased risk of tipping over on rough roads or when braking suddenly.

■ Question No. 42 (Load and Vehicle Stability)

Choose one of the following four explanations about load and vehicle stability that is incorrect.

- (1) Driving with the lift arm in horizontal position should be avoided as it obstructs visibility and is dangerous.
- (2) Even when carrying the specified load, if the load is carried eccentrically to the left and right, the stability of the left and right will deteriorate, and it will be overloaded on only one side of the vehicle, so the load must be carried so that the center of the load (center of gravity) is aligned with the center line of the vehicle.
- (3) Two-wheel drive "shovel loaders" and "fork loaders" are equipped with buckets and forks similar to those of four-wheel drive tractor shovel loaders (which are classified as vehicle-type construction machines), so the standards for stability are identical.
- (4) When changing from a vehicle of a different classification to operate a "shovel loader" or "fork loader," it is necessary to pay particular attention to stability and vehicle performance.

■ Question No. 43 (Road Surface Maintenance and Scooping Work)

Choose one of the following four explanations about road surface maintenance and scooping operations that is correct.

- (1) If the road surface near sediments is uneven, the scooping operation efficiency will be significantly increased.
- (2) Before work, it is necessary to level the road surface near the work area, even if it

takes some time and labor, to improve work efficiency and at the same time to reduce the strain on the various devices of the machine and to reduce malfunctions.

- (3) In the case of a shovel loader equipped with a reach mechanism, the reach should be set to the farthest position during scooping work.
- (4) It is easier to use the reach lever during scooping work.

■ Question No. 44 (Scooping Work)

Choose one of the following four explanations about scooping work that is incorrect.

- (1) Operate the reach lever if the resistance to scooping is too high and it is better to operate the reach.
- (2) The bucket should be horizontal or slightly downward. If the angle of the bucket with respect to the ground is too upward, the load on the front wheels will decrease as the bucket plunges, and the tires will slip, making it impossible to exert enough driving force to achieve sufficient scooping.
- (3) Point the bucket at a right angle to the sediment and shove it in.
- (4) If the bucket is shoved into the sediment at a right angle, an excessive force will be applied to only one side of the bucket, causing malfunction and uneven loading.

■ Question No. 45 (Scooping Work)

Choose one of the following four explanations about scooping work s that is correct.

- (1) When shoving in, if the vehicle is equipped with a torque converter, accelerate the vehicle with some help distance, shove in the sediment, and then move forward by operating the semi-clutch to prevent the vehicle from stalling.
- (2) For vehicles with a clutch, there is no need for run-up, so when the vehicle reaches the sediment, fully depress the accelerator pedal, and drive forward.
- (3) When the vehicle stops moving forward, turn the dump angle of the bucket slightly upward or lift it slightly to reduce the shoving in resistance, and the

vehicle will move forward again.

- (4) After scooping and before driving, be sure to pull the reach lever to check if the bucket is at the far end.

■ Question No. 46 (Transportation Work)

Choose one of the following four explanations about transportation work that is incorrect.

- (1) When driving a loaded vehicle, the load on the rear wheels is reduced compared to when the vehicle is empty, so the speed must be carefully monitored.
- (2) Driving with the bucket raised is very dangerous because it is unstable and obstructs the forward view.
- (3) Raise the lift as high as possible and pull the bucket to drive.
- (4) Always drive carefully to ensure that there is a sufficient gap between you and any obstacles above you.

■ Question No. 47 (Transportation Work)

Choose one of the following four explanations about transportation work that is incorrect.

- (1) When turning around a corner, the rear wheels of shovel loaders are steered so that if they are not turned all the way inward, the rear of the vehicle will swing widely and the rear of the vehicle will hit the outer wall.
- (2) When turning, it is better to increase the speed.
- (3) When the vehicle is loaded, do not drive with cargo held high.
- (4) When it is unavoidable to drive with the cargo lifted high when the vehicle is loaded, be especially careful and drive slowly.

■ Question No. 48 (Loading Work)

Choose one of the following four explanations about loading work that is incorrect.

- (1) When loading the contents of the bucket into a truck or freight car, first lift as much as necessary, gently move the vehicle body forward, and then stop the vehicle at the loading position before dumping.
- (2) If the shovel loader is equipped with a reach mechanism, perform reach operation as necessary. If the loader is moved forward or backward while lifting or reaching, the front/rear stability of the vehicle may become unstable, and the loader may fall forward so it must be done carefully.
- (3) When dumping high-moisture particles, dump gently so that the load does not remain attached to the corner of the bucket.
- (4) When dumping the contents of the bucket into a truck or freight car, carefully consider the position of the bucket in relation to the loading platform of the truck or freight car.

■ Question No. 49 (Handling Precautions)

Choose one of the following four explanations about handling precautions that is incorrect.

- (1) Buckets, forks, and arms shall not be used to carry loads hanging from them.
- (2) Do not push trucks, freight cars, etc. with the tips of buckets and forks.
- (3) Do not pull trucks, freight cars, etc. by attaching wires, etc. to the tips of buckets, forks, and arms.
- (4) When handling loads that are larger than the bucket, it is better to use two vehicles to hold and suspend the load together.

■ Question No. 50 (Moment of Force)

Choose one of the following four explanations about moment of force that is correct.

- (1) When tightening a nut with a wrench, it is better to hold the wrench so that there is excess force on the handle of the wrench to tighten the nut with the same strength.
- (2) The force is minimized when the direction of application of force is perpendicular

to the wrench.

- (3) When using a lever to raise an object, it is better to use a long pry bar to bring the support as close as possible to the object, and make the handle longer to raise it, so that more force can be applied.
- (4) There is no relationship between the point of action when the force is applied to the wrench, the length of the handle, and the length of the pry bar at hand in this case.

■ Question No. 51 (Balancing Parallel Forces)

Choose one of the following four explanations about balancing parallel forces that is incorrect.

- (1) When carrying a load with a balance bar, if the weight of both loads is equal, the load is centered on the balance bar.
- (2) When carrying a load with a balance bar, if the weight of the load is different, bring the heavier load closer to your shoulder.
- (3) When carrying a load with a balance bar, if the weight of the load is different, bring the lighter load closer to your shoulder.
- (4) An object with an axis of rotation is said to be balanced if the sum of all positive moments equals the sum of all negative moments.

■ Question No. 52 (Mass and Weight)

Choose one of the following four explanations about mass and weight that is correct.

- (1) The amount of an object itself that does not change even if the location changes are called "weight".
- (2) Weight is expressed in units such as kilograms (kg), tons (t), etc.
- (3) The weight of an object felt on the earth is the force toward the center of the earth generated by the acceleration of gravity on the object.
- (4) The unit of mass is expressed in newtons (N) and kilonewtons (kN).

■ Question No. 53 (Moment of Force, Mass, and Weight)

Choose one of the following four explanations about moment of force, mass, and weight that is incorrect.

- (1) Mass is mass per m^3 multiplied by volume.
- (2) An object has a mass of 10 kg per m^3 and a volume of 40 m^3 has a mass of 0.25 kg .
- (3) The weight of an object with a mass of 1 kg under the acceleration of gravity (9.8 m/s^2) is expressed as $1 (\text{kg}) \times 9.8 (\text{m/s}^2)$.
- (4) If a perpendicular line is drawn from the center of gravity of a load of mass $w \text{ kg}$ and the horizontal distance to the front wheels is determined and set as L , the moment of the load against the front wheels is $9.8wL$.

■ Question No. 54 (Load and Specific Gravity)

Choose one of the following four explanations about load and specific gravity that is incorrect.

- (1) "Load" is originally a technical term that means force. Therefore, the unit of load is expressed in newton (N) or kilonewton (kN).
- (2) Laws and regulations may use the term "load" even when expressing mass, such as in the case of "rated load" or "lifting load".
- (3) The ratio of the mass of an object to the mass of pure water at 4°C in the same volume is called the specific gravity of the object.
- (4) The mass of pure water at 4°C is 1 kg for 1 l and 100 kg for 1 m^3 .

■ Question No. 55 (Center of Gravity or Center of Mass)

Choose one of the following four explanations about center of gravity or center of mass that is incorrect.

- (1) The point where the gravitational force acting on each part of an object apparently gathers and acts on it is called the "center of gravity" (or center of mass) of the object.

- (2) A uniform bar has its center of gravity at the center of the bar, and a disk of a certain thickness has its center of gravity at the center of the circle, so if a force equal to the weight of the bar or disk is applied to support it, the bar or disk will become unstable.
- (3) When an object is suspended in the air, its center of gravity is on a vertical line drawn from the point where it was suspended, and the object comes to stand still.
- (4) The center of gravity of an object can be determined by the point of intersection of the vertical lines when the object is suspended at different points.

■ Question No. 56 (Stability of Objects)

Choose one of the following four explanations about stability of objects that is incorrect.

- (1) An object is said to be "unstable" if it tries to return to its original position when you tilt it slightly and release your hand.
- (2) An object is said to be "unstable" when you tilt it slightly and release your hand, and the tilt becomes larger.
- (3) An object is said to be "neutral" when it stands still without tilting.
- (4) When an object is tilted slightly, it is stable when a moment is generated on the side that stabilizes it, and unstable when a moment is generated on the side that causes it to fall.

■ Question No. 57 (Inertia and Centrifugal Force)

Choose one of the following four explanations about inertia and centrifugal force that is correct.

- (1) An object has the property of trying to remain stationary forever unless a force acts on it from the outside this is called centrifugal force.
- (2) Force is necessary to move a stationary object or to change the speed or direction of motion of a moving object.
- (3) In order for an object to move in a circular motion it is necessary to have a certain force acting on it. This force that makes an object move in a circle is called

centrifugal force.

- (4) The force that is equal in magnitude to the centripetal force but opposite in direction is called inertial force.

■ Question No. 58 (Centripetal Force)

Choose one of the following four explanations about centripetal force that is correct.

- (1) Centripetal force is expressed by $\text{mass} \times (\text{peripheral velocity})^2 / \text{radius}$.
(2) Centripetal force is expressed by $\text{mass} \times \text{peripheral velocity} / \text{radius}$.
(3) Centripetal force is expressed by $\text{mass} \times \text{radius} / \text{angular velocity}$.
(4) Centripetal force is expressed by $\text{mass} \times \text{radius} \times \text{angular velocity}$.

■ Question No. 59 (Friction)

Choose one of the following four explanations about friction that is correct.

- (1) When there is a phenomenon of friction between a stationary object and the ground, the resistance acting on the contact surface in this case is called static friction force.
(2) The static frictional force is related to the size of the contact surface.
(3) The static friction force is minimized at the moment the object begins to move when force is applied to it.
(4) The ratio of the normal force acting on the contact surface of an object to the maximum static friction force is called the coefficient of dynamic friction.

■ Question No. 60 (Friction)

Choose one of the following four explanations about friction that is correct.

- (1) The frictional force acting after an object starts moving is called the frictional force of motion, and its value is greater than the maximum static frictional force.
(2) The magnitude of the friction force is not related to the area of the contact surface but is inversely proportional to the vertical force acting on the contact surface.

- (3) When you roll an object without letting it slide along the contact surface, the same phenomenon of friction appears. This is called rolling friction.
- (4) The rolling friction force is much higher than the friction force in motion.

■ Question No. 61 (Relevant Laws and Regulations)

Choose one of the following four explanations about relevant laws and regulations that is incorrect.

- (1) The Industrial Safety and Health Law stipulates matters that must be observed in order to ensure the safety and health of workers and to promote the formation of a comfortable working environment.
- (2) Specific matters associated with the enforcement of the law are indicated in government ordinances, ministerial ordinances, public notices, etc.
- (3) Government ordinances concerning the safety and health of workers include the Industrial Safety and Health Law Enforcement Ordinance.
- (4) Ministerial ordinances related to the safety and health of workers include the Regulations on Driving Skills Training for Shovel Loaders, etc.

■ Question No. 62 (Responsibilities of Employers, etc.)

Choose one of the following four explanations about responsibilities of Employers, etc. that is incorrect.

- (1) Employers shall not only comply with the minimum standards for the prevention of occupational accidents set forth in this Act but shall also ensure the safety and health of workers in the workplace through the realization of a comfortable working environment and the improvement of working conditions.
- (2) Employers are not required to cooperate with measures implemented by the government to prevent occupational accidents.
- (3) Workers shall observe the matters necessary to prevent occupational accidents.
- (4) Workers shall endeavor to cooperate with measures to prevent occupational accidents implemented by the employer and other related parties.

■ Question No. 63 (Periodic Inspections)

Choose one of the following four explanations about periodic inspection that is incorrect.

- (1) Employers shall conduct periodic inspections of boilers and other machines, etc., specified by Cabinet Order, pursuant to the provisions of the Ordinance of the Ministry of Health, Labour and Welfare, and shall not be required to record the results of such inspections.
- (2) When the employer conducts an inspection specified by an Ordinance of the Ministry of Health, Labour and Welfare, the employer shall have a worker employed by the employer who has qualifications specified by an Ordinance of the Ministry of Health, Labour and Welfare or a person who is registered as prescribed in Article 54-3, paragraph 1 and who conducts a specified inspections for said Machinery, etc. at the request of another person conduct the inspection.
- (3) The Minister of Health, Labour and Welfare shall publicize the inspection guidelines necessary for the proper and effective implementation of inspections.
- (4) The Minister of Health, Labour and Welfare may, when deeming it necessary in the case where the Minister has published the inspection guidelines, provide necessary guidance, etc. for said inspection guidelines to Employers, inspectors, or organizations thereof.

■ Question No. 64 (Work Pertaining to Work Restrictions)

Choose one correct answer out of the following four explanations about the duties pertaining to work restrictions specified by government ordinance under Article 61, paragraph 1 of the Act refer to the driving of shovel loaders or fork loaders with a maximum load of tons or more (excluding driving on roads).

- (1) 1 ton
- (2) 2 tons
- (3) 3 tons
- (4) 5 tons

■ Question No. 65 (Reissuance, etc. of a Certificate of Completion of Technical Training)

Choose one of the following four explanations about reissuance, etc. of the Certificate of Completion of Technical Training that is correct.

- (1) A Certificate of Completion of Technical Training cannot be reissued.
- (2) When a Certificate of Completion of Technical Training is lost or damaged, it can be reissued by submitting an application for reissuance of a Certificate of Completion of Technical Training to the registered training institute that issued the said certificate.
- (3) When a Certificate of Completion of Technical Training is lost or damaged, it can be reissued by submitting an Application for Reissuance of a Certificate of Completion of Technical Training to the Ministry of Health, Labour and Welfare.
- (4) A Certificate of Completion of Technical Training cannot be reissued when a person changes his/her name.

■ Question No. 66 (Work Plan)

Choose one of the following four explanations about work plan that is correct.

- (1) The work plan does not need to indicate the type and capacity of the vehicle type construction machine to be used.
- (2) The work plan does not need to indicate the method of work using the vehicle type construction machine.
- (3) The work plan does not need to show the operation route of the vehicle type construction machine.
- (4) The work plan should indicate the type and capacity of the vehicle type construction machine to be used.

■ Question No. 67 (Work Supervisor)

Choose one of the following four explanations about work supervisor that is incorrect.

- (1) When an operator carries out work using a vehicle type cargo handling and transportation machine, etc., the operator shall appoint a supervisor for the work and have the supervisor carry out the work based on the work plan.
- (2) A supervisor is not required to be appointed when performing the work alone.
- (3) In the case where a work leader, etc., has been appointed, even if these persons are able to conduct the work at the same time, they may not also serve as a supervisor under this Article.
- (4) When cargo is delivered and received by different employers, or when there is congestion of work by different employers, a work supervisor shall be appointed for each business, and in this case, the work shall be coordinated among the work supervisors.

■Question No. 68 (Speed Limit)

Choose one of the following four explanations about speed limit that is incorrect.

- (1) When an employer carries out work using a vehicle cargo handling and transportation machine, etc. (excluding those with a maximum speed of 10 km/h or less), the employer shall determine in advance the appropriate speed limit for the vehicle cargo handling and transportation machine, etc. according to the topography, ground conditions, etc. of the place where the work is to be carried out and perform the work accordingly.
- (2) The operator of a vehicle cargo handling and transportation machine, etc. shall not operate such machine at a speed exceeding the speed limit.
- (3) The "speed limit" shall be determined as deemed appropriate at the discretion of the employer, but workers shall be bound by the established speed limit, but the employer shall not be bound.
- (4) The "speed limit" shall be determined by vehicle type and place as necessary.

■Question No. 69 (Prevention of Falls, etc.)

Choose one of the following four explanations about prevention of falls, etc. that is correct.

- (1) When work is carried out using vehicle-based construction machine, it is not necessary to take necessary measures to prevent danger to workers from falls or tipping over of the vehicle-based construction equipment.
- (2) When work is carried out using vehicle-based construction machine, etc. on the shoulder of a road or on a slope, etc., it is not necessary to deploy a guide even when there is a risk of danger to workers due to the tipping or falling of the equipment.
- (3) The operator of a vehicle-based construction machine, etc. must follow the guidance given by the guide.
- (4) The operator of a vehicle-based construction machine is not required to follow the guidance given by the guide.

■Question No. 70 (Prevention of Contact)

Choose one of the following four explanations about prevention of contact that is correct.

- (1) When working with vehicle-based construction machines, etc., workers shall not be allowed to enter any area where there is a risk of danger to workers under any circumstances.
- (2) Workers may be allowed to enter the work area when work is carried out using vehicle-based construction machines, etc., if a guide is posted.
- (3) The operator of a vehicle-based construction machine, etc. does not need to follow the guidance given by the guide.
- (4) A guide of a vehicle-based construction machine, etc. does not need to follow the guidance given by the operator.

■Question No. 71 (No trespassing)

Choose one of the following four explanations about not trespassing that is incorrect.

- (1) For vehicle-based loader machines, etc. (excluding those that are structurally equipped with a device that prevents the forks, excavators, arms, etc. from dropping unexpectedly), the employer shall not let the worker enter under the forks, shovels, arm, etc. or under the load supported by these.

- (2) When performing repairs, inspections, etc., to prevent danger due to sudden drop of forks, excavators, arms, etc. safety columns are provided to the workers engaged in the work, this is not limited when using safety blocks etc.
- (3) Workers performing repair and inspection, do not need to use safety columns, safety blocks, etc.
- (4) Safety columns, safety blocks, etc. have resistance to support forks, shovels, arms, etc.

■ Question No. 72 (Signals and loading)

Choose one of the following four explanations about signaling and load that is incorrect.

- (1) When positioning a guide for a vehicle-based machinery for loader, transportation etc. signals must be determined, and the guide must perform these signals.
- (2) The driver of a vehicle-based machinery for loader, transportation etc. Do not have to follow the signals given by the guide.
- (3) Employer is obliged to comply with the following provisions when loading the load on a vehicle-type material handling machine. To prevent unbalanced load when loading.
- (4) For fork loader, to avoid load imbalance when loading the load by making sure that timber is not unevenly stored.

■ Question No. 73 (Measures when leaving the driver's seat)

Choose one of the following four explanations about measures when leaving the driver's seat that is correct.

- (1) Employer needs to have the driver lower the handling device of the fork, shovel, etc., to the ground when the driver of the said vehicle-type construction machines leaves the driver seat.
- (2) Employer does not need to have the driver lower the handling device of the fork, shovel, etc., to the ground when the driver of the said vehicle-type construction machines leaves the driver seat.

- (3) Employer does not need to have the driver of the said vehicle-type construction machine take measures to prevent the vehicle-type construction machine from escaping when the driver leaves the driving seat.
- (4) The driver of the vehicle-type construction machine is not required to take any measures when leaving the driver seat.

■ Question No. 74 (Transport of vehicle-based machinery for loader, transportation etc.)

Choose one of the following four explanations about transport of vehicle-type machinery for loader, transportation etc. that is correct.

- (1) When using a loading plate, embankments etc., to load and unload freight vehicles, etc., loading and unloading must be carried out in a flat and solid place.
- (2) When using a loading plate, embankment, etc. to load and unload freight vehicles, etc., it is not necessary to carry out loading and unloading in a flat and solid place.
- (3) When using a loading plate, it is not necessary to use a board having sufficient length, width, and strength.
- (4) When using embankment or a temporary stand, etc. it is not necessary to secure a sufficient width, strength, and appropriate gradient (incline).

■ Question No. 75 (Boarding restriction)

Choose one of the following four explanations about boarding restrictions that is false.

- (1) Employer is restricted to place workers in place other than the passenger seats when working with vehicle-type material handling machines (excluding rough terrain vehicles and cargo truck).
- (2) Employer is allowed to place workers in place other than the passenger seats when working with vehicle-type material handling machines (excluding rough terrain vehicles and cargo truck) as a measure to prevent workers from danger due to falling.
- (3) Employer is not allowed to place workers in place other than the passenger seats when working with vehicle-type material handling machines (excluding rough terrain vehicles and cargo trucks) as a measure to prevent workers from danger due

to falling.

- (4) "Danger Prevention Measure" refers to providing cover, enclosure, etc., to prevent workers from falling from high places, etc.

■ Question No. 76 (Restriction for other than the primary use)

Choose one of the following four explanations about restriction for other than the primary use that is false.

- (1) It is prohibited from using vehicle-based construction machinery, etc., for any purpose other than its main purpose.
- (2) There are restrictions on using vehicle-type construction machines other than their main purpose.
- (3) Shovel loader's primary use is for handling the cargo load.
- (4) Fork loader's primary use is for handling timber, etc.

■ Question No. 77 (Repair etc.)

Choose one of the following four explanations about repair that are false.

- (1) When performing repairs or removal of the attachment device of vehicle-type material handling machine, the employer is required to appoint a person to direct the work and have them perform the following matters. Deciding the work procedures and leading the work directly.
- (2) Supervise the usage status of safety support, safety blocks, etc.
- (3) It is not necessary to appoint a supervisor for work that does not pose a risk to workers, such as simple replacement of parts that can be performed independently.
- (4) It is necessary to appoint a supervisor for work that does not pose a risk to workers, such as simple replacement of parts that can be performed independently.

■ Question No. 78 (Front and rear lamps)

Choose one of the following four explanations about front and rear lamps that are true.

- (1) It is not necessary to equip vehicle-type construction machinery with front lamps.
- (2) In order to maintain the area intensity of illumination required to perform safe work, front lamps must also be installed on vehicle-type construction machinery, etc.
- (3) It is not necessary to install front lamps for vehicle-type construction machinery used in places where the area intensity of illumination is not required to perform safe work.
- (4) In order to maintain the area intensity of illumination required to perform safe work, front lamps are not required to be installed on vehicle-type construction machinery, etc.

■Question No. 79(Head guard)

Choose one of the following four explanations about head guard that are true.

- (1) It is not necessary to have a strong head guard when using vehicle-type construction machines, etc., in places with a risk of dangers to workers.
- (2) It is necessary to have a strong head guard when using vehicle-type construction machines, etc., in places where there is no risk of dangers to workers.
- (3) It is necessary to have a strong head guard when using vehicle-type construction machines, etc., in places with a risk of dangers to workers.
- (4) It is necessary to have a strong headlamp when using vehicle-type construction machines, etc., in places with a risk of danger to workers such as due to falling rocks, etc.

■Question No. 80>Loading and use restrictions)

Choose one of the following four explanations about loading and use restrictions that are false.

- (1) In order not to obstruct the driver's field of vision, the employer must load the shovel loader, etc.
- (2) Employer is allowed to use shovel loader, etc., exceeding their maximum load and other capacities.

- (3) The terms "Other capabilities" should include stability. In addition, the shovel loader, etc., stability depends on the structural standard specified separately.
- (4) Until the structural standard is determined, refers to the stability indicated by the manufacturer.

■ Question No. 81 (Periodic inspection records)

Choose one of the following four explanations about periodic inspection records that are true.

- (1) Employer is required to keep periodic inspection records for 1 year.
- (2) Employer is required to keep periodic inspection records for 2 years.
- (3) Employer is required to keep periodic inspection records for 3 years.
- (4) Employer is required to keep periodic inspection records for 5 years.

■ Question No. 82 (Periodic inspection records)

Choose one of the following four explanations about periodic inspection records that are false.

- (1) Employer is required to write the inspection date when performing inspection.
- (2) Employer is required to write the inspection method when performing inspection.
- (3) Employer is required to write the inspection location when performing inspection.
- (4) Employer is required to write the inspection supervisor's name when performing inspection.

■ Question No. 83 (Inspection)

Choose one of the following four explanations about inspection that are false.

- (1) Employer is required to perform an inspection for braking and control devices function before starting work for the day.
- (2) Employer is required to perform an inspection for handling, and hydraulic devices

function before starting work for the day.

- (3) Employer is required to perform an inspection for wheels' abnormalities before starting work for the day.
- (4) Employer is required to perform an inspection for front lamps, rear lamps, turn signal, and warning device function after finishing work for the day.

■ Question No. 84 (Accident example)

Choose one of the following four explanations about accident examples that are false.

- (1) Driver is required to lower the fork to the floor, stop the engine, and ensure the parking brake is applied to stop when leaving the fork loader.
- (2) When entering or leaving the driver's seat, the driver needs to do it from the side with various levers.
- (3) When transporting round bars with a fork loader, tie them with a wire rope to prevent them from scattering or falling.
- (4) Create a work procedure for loading and unloading steel materials and perform the work following the established procedure.

■ Question No. 85 (Accident example)

Choose one of the following four explanations about accident examples that are false.

- (1) It is allowed to use shovel loader other than its primary purpose.
- (2) Keep other workers out of dangerous areas.
- (3) When assembling earth retaining support, a supervisor is appointed, and the work is performed under the supervisor's direct command.
- (4) It will not hinder the work even if the supervisor is also working for other posts when they are appointed.

■ Question No. 86 (Accident example)

Choose one of the following four explanations about accident examples that are false.

- (1) Shovel loader can be operated by a person without qualification.
- (2) When removing foreign matter that is stuck into the tires, stop the excavator loader completely, stop the engine, apply the parking brake securely, and lower the cargo handling device such as a bucket to the ground to prevent escape.
- (3) Install equipment to enclose the driver seat to prevent danger due to the lift arm ascending and descending movement of shovel loader.
- (4) Thoroughly perform the periodic inspection and inspection before starting work and ensure that safety devices, work devices, etc. are fully functional.

■ Question No. 87 (Accident example)

Choose one of the following four explanations about accident examples that are false.

- (1) Unqualified people are not allowed to drive the shovel loader.
- (2) Shovel loader can be used for hanging and transporting a load, or other than its primary purpose.
- (3) When working with a shovel loader, appoint a supervisor and perform safe work based on the work plan.
- (4) Provide sufficient safety education and work guidance on how to handle the shovel loader when driving and load handling.

< Correct Answers >

- Question No. 1(Definition of Shovel Loader, etc.) : Correct answer:(3)
- Question No. 2 (Characteristics of Shovel Loaders, etc.) : Correct answer:(1)
- Question No. 3(Features of Shovel Loaders, etc.) : Correct answer:(1)
- Question No. 4(Types and Characteristics of Buckets) : Correct answer:(2)
- Question No. 5(Functions of Shovel Loaders, etc.) : Correct answer:(4)
- Question No. 6(Structure of a Gasoline Engine) : Correct answer:(3)
- Question No. 7(Structure of a Gasoline Engine) : Correct answer:(4)
- Question No. 8(Structure of a Diesel Engine) : Correct answer:(3)
- Question No. 9(Maneuvering Gear) : Correct answer: (1)
- Question No. 10(Steering Device) : Correct answer:(4)
- Question No. 11(Braking Device) : Correct answer: (4)
- Question No. 12(Braking Device) : Correct answer:(4)
- Question No. 13(Braking Device) : Correct answer:(3)
- Question No. 14(Braking Device) : Correct answer:(2)
- Question No. 15(Handling Methods) : Correct answer:(2)
- Question No. 16(Handling Methods) : Correct answer:(1)
- Question No. 17(Instructions Before Starting Work) : Correct answer:(4)
- Question No. 18(Instructions Before Starting Work) : Correct answer:(1)
- Question No. 19(Instructions Before Starting Work) : Correct answer:(4)
- Question No. 20(Instructions Before Starting Work) : Correct answer:(4)
- Question No. 21(Instructions Before Starting Work) : Correct answer:(3)
- Question No. 22(Periodic Inspections) : Correct answer:(4)
- Question No. 23(Periodic Inspections) : Correct answer:(4)
- Question No. 24(Gasoline Engine Type Starting Operation Guidelines) : Correct answer:(4)
- Question No. 25(Diesel Engine Type Starting Operation Guidelines) : Correct answer: (4)
- Question No. 26(Starting and Driving Operation) : Correct answer: (1)
- Question No. 27(Clutch-type Driving Operation) : Correct answer: (3)
- Question No. 28(Clutch-type Driving Operation) : Correct answer:(2)
- Question No. 29(Driving Operation) : Correct answer: (2)
- Question No. 30(Driving Operation) : Correct answer: (4)
- Question No. 31(Driving Operation) : Correct answer: (4)
- Question No. 32(Driving Operation) : Correct answer: (1)
- Question No. 33(Parking, End of Driving) : Correct answer: (4)

- Question No. 34(End of Driving) : Correct answer: (2)
- Question No. 35(End of Driving) : Correct answer: (4)
- Question No. 36(Driving Precautions) : Correct answer: (4)
- Question No. 37(Driving Precautions) : Correct answer: (1)
- Question No. 38(Driving Precautions) : Correct answer: (1)
- Question No. 39(Driving Precautions) : Correct answer: (1)
- Question No. 40(Fork Loaders) : Correct answer: (1)
- Question No. 41(Load and Vehicle Stability) : Correct answer: (3)
- Question No. 42(Load and Vehicle Stability) : Correct answer: (3)
- Question No. 43(Road Surface Maintenance and Scooping Work) : Correct answer: (2)
- Question No. 44(Scooping Work) : Correct answer: (4)
- Question No. 45(Scooping Work) : Correct answer: (3)
- Question No. 46(Transportation Work) : Correct answer: (3)
- Question No. 47(Transportation Work) : Correct answer: (2)
- Question No. 48>Loading Work) : Correct answer: (3)
- Question No. 49(Handling Precautions) : Correct answer: (4)
- Question No. 50(Moment of Force) : Correct answer: (3)
- Question No. 51(Balancing Parallel Forces) : Correct answer: (3)
- Question No. 52(Mass and Weight) : Correct answer: (3)
- Question No. 53(Moment of Force, Mass, and Weight) : Correct answer: (2)
- Question No. 54(Load and Specific Gravity) : Correct answer: (4)
- Question No. 55(Center of Gravity or Center of Mass) : Correct answer: (2)
- Question No. 56(Stability of Objects) : Correct answer: (1)
- Question No. 57(Inertia and Centrifugal Force) : Correct answer: (2)
- Question No. 58(Centripetal Force) : Correct answer: (1)
- Question No. 59(Friction) : Correct answer: (1)
- Question No. 60(Friction) : Correct answer: (3)
- Question No. 61(Relevant Laws and Regulations) : Correct answer: (4)
- Question No. 62(Responsibilities of Employers, etc.) : Correct answer: (2)
- Question No. 63(Periodic Inspection) : Correct answer: (1)
- Question No. 64 (Work related to employment restrictions) : Correct answer: (1)
- Question No. 65(Reissuance, etc. of a certificate of completion of technical training) : Correct answer: (2)
- Question No. 66(Work plan) : Correct answer: (4)
- Question No. 67(Work Supervisor) : Correct answer: (3)

- Question No. 68(Speed Limit) : Correct answer: (3)
- Question No. 69(Prevention of falls, etc.) : Correct answer: (3)
- Question No. 70(Prevention of Contact) : Correct answer: (2)
- Question No. 71(No trespassing) : Correct answer: (3)
- Question No. 72(Signals and loading) : Correct answer: (2)
- Question No. 73(Measures when leaving the driver's seat) : Correct answer: (1)
- Question No. 74(Transport of vehicle-based machinery for loader, transportation etc.) : Correct answer: (1)
- Question No. 75(Boarding restrictions) : Correct answer: (3)
- Question No. 76(Restriction for other than the primary use) : Correct answer: (1)
- Question No. 77(Repair) : Correct answer: (4)
- Question No. 78(Front lamps and rear lamps) : Correct answer: (4)
- Question No. 79(Head guard) : Correct answer: (3)
- Question No. 80>Loading and use restrictions) : Correct answer: (2)
- Question No. 81(Periodic inspection records) : Correct answer: (3)
- Question No. 82(Periodic inspection records) : Correct answer: (4)
- Question No. 83(Inspection) : Correct answer: (4)
- Question No. 84(Accident Example) : Correct answer: (2)
- Question No. 85(Accident Example) : Correct answer: (1)
- Question No. 86(Accident Example) : Correct answer: (1)
- Question No. 87(Accident Example) : Correct answer: (2)

