

厚生労働省委託事業

**車両系建設機械  
（整地・運搬・積込み用及び掘削用）  
運転技能講習  
補助テキスト**

**Vehicle-type construction machine  
(for leveling ground, transport, loading and excavating)  
Driver Technical Training  
Supplementary Text**



厚生労働省 労働基準局 安全衛生部

英語版 English Version



本補助テキストは、建設業労働災害防止協会のご協力の下、「車両系建設機械運転者教本[整地・運搬・積込み用及び掘削用]技能講習テキスト」(建設業労働災害防止協会発行、令和元年7月15日第2改訂7版5刷)を基に、令和2年度厚生労働省委託事業において作成した対訳による抜粋版です。外国人労働者に対する教育効果を高める等の目的で作成されたものです。

技能講習の実施に当たっては、本補助教材を単独で使用するのではなく、原本となった講習テキストと併せて使用することで、講習の実効性を確保することができます。

2021年3月



## Contents

<b>1. Basic knowledge about Vehicle-type construction machinery</b> .....	5
<b>1.1. Types and uses of Vehicle-type construction machinery (text p.1)</b> .....	5
<b>1.1.1. Machine for leveling, Transport, and loading (text p.2)</b> .....	5
<b>1.1.2. Excavation machine (text p.7)</b> .....	8
<b>1.2. Terminology related to Vehicle-type construction machinery (text p.10)</b> .....	10
<b>2. Motors and hydraulics for Vehicle-type construction machinery</b> .....	12
<b>2.1. Prime Mover (text p.15)</b> .....	12
<b>2.1.1. Structure of a diesel engine (text p.17)</b> .....	12
<b>2.1.2. Fuel and engine oil (text p.22)</b> .....	13
<b>2.2. Hydraulic system (text p.23)</b> .....	14
<b>2.2.1. Hydraulic system (text p.24)</b> .....	14
<b>3. Structure of equipment related to the running of Vehicle-type construction machinery</b> .....	15
<b>3.1. Tractor-type construction machinery (text p.35)</b> .....	15
<b>3.1.1. Crawler tractor (text p.35)</b> .....	15
<b>3.1.2. Wheel-type tractor (text p.47)</b> .....	16
<b>3.2. Shovel (shoberu) construction machinery (text p.55)</b> .....	18
<b>3.2.1. Hydraulic shovel (shoberu) type construction machine (crawler type) (text p.56)</b> .....	18
<b>3.3. Motor grader (text p.61)</b> .....	19
<b>3.4. Scraper (text p.64)</b> .....	20
<b>4. Handling of equipment related to the running of vehicle-type construction machinery</b> .....	21
<b>4.1. Handling of the start of driving (text p.69)</b> .....	21
<b>4.1.1. Before starting the engine (text p.69)</b> .....	21
<b>4.1.2. Starting the engine (text p.69)</b> .....	21
<b>4.1.3. After starting the engine (text p.70)</b> .....	21
<b>4.2. Handling while driving (text p.70)</b> .....	22
<b>4.2.1. Start (text p.70)</b> .....	22
<b>4.2.2. When running (text p.72)</b> .....	23
<b>4.2.3. Climbing, descending, etc. (text p.74)</b> .....	25
<b>4.2.4. Stop the Running (text p.75)</b> .....	26
<b>4.3. Parking handling (parking) (text p.76)</b> .....	27
<b>4.4. Grease, oil, etc. (text p.77)</b> .....	28
<b>5. Structure and type of equipment related to the work of Vehicle-type construction machinery</b> .....	29
<b>5.1. Tractor-type construction machinery, structure, and type of work equipment (text p.79)</b> .....	29
<b>5.1.1. Work equipment structure (text p.79)</b> .....	29

5.1.2.	Type of work equipment (text p.80) .....	29
5.1.3.	Safety devices, etc. (text p.85) .....	33
5.2.	Structure and type of work equipment for shovel (shoberu)-type construction machinery (text p.86)	
	35	
5.2.1.	Hydraulic shovel (shoberu) construction machine (text p.87) .....	35
5.2.2.	Mechanical shovel (shoberu) construction machine (text p.88) .....	35
5.2.3.	Safety devices, etc. (text p.89) .....	36
5.3.	Motor grader (text p.92) .....	38
5.4.	Scraper (text p.94) .....	39
5.5.	Muck loader (text p.95).....	40
5.5.1.	Crawler type Muck loader machine (text p.95).....	40
6.	Handling of equipment related to the work of Vehicle-type construction machinery, etc. ....	41
6.1.	Handling of tractor-type construction machinery and safe work (text p.97).....	41
6.1.1.	Bulldozer (text p.97) .....	41
6.1.2.	Tractor shovel (shoberu) (text p.115) .....	56
6.2.	Handling of shovel (shoberu)-type construction machinery and safe work (text p.123) .....	62
6.2.1.	Hydraulic shovel (shoberu) (backhoe) (text p.123).....	62
6.2.2.	Hydraulic shovels (shoberu) (loading shovels (shoberu)) (text p.131).....	68
6.2.3.	Clamshell (text p.136).....	73
6.2.4.	Dragline (textbook p.137) .....	74
6.3.	Handling and safe operation of motor graders and scrapers (textbook p. 140).....	77
6.3.1.	Motor grader (textbook p.140) .....	77
6.3.2.	Scraper (motor scraper (mota sukurepa)) (textbook p. 147) .....	82
6.3.3.	Scraper (wowed scraper) (textbook p.150) ) .....	85
6.4.	Handling and safe operation of crawler type Muck loaders (textbook p.154) .....	86
6.4.1.	Crawler-type Muck loaders (textbook p.154).....	86
6.5.	Transport of vehicle-based construction machinery (textbook p.157).....	87
6.5.1.	Loading and unloading (textbook p.157) .....	87
6.5.2.	In the case of Transport by self-propelled vehicles (textbook p.161) .....	90
6.6.	Mounting and dismounting of work equipment (textbook p. 162).....	91
7.	Inspection and Maintenance for Vehicle-type Construction Machine. ....	92
7.1.	General precautions for inspection and maintenance (Text p.163) .....	93
7.2.	Daily Inspection Procedure (Text p. 164) .....	93
7.3.	Inspection points when malfunctions detected during operation (Text p.172).....	98
8.	Safety Driving Guidelines, Cue Signs, and Guiding.....	99
8.1.	Safety driving guidelines (Text p.175) .....	99
8.2.	Signals and guiding points (Text p.177).....	101

<b>9. Force and Electricity Knowledge</b> .....	102
<b>9.1. Force (Text p.181)</b> .....	102
<b>9.1.1. Moment of force (Text p.184)</b> .....	102
<b>9.2. Mass and specific gravity (Text p.187)</b> .....	103
<b>9.2.1. Mass and specific gravity (Text p.187)</b> .....	103
<b>9.2.2. Center of Gravity (Text p.189)</b> .....	104
<b>9.2.3. Object Stability (<i>Suwari</i>) (Text p.191)</b> .....	105
<b>9.3. Object movement (Text p.192)</b> .....	105
<b>9.3.1. Speed and acceleration (Text p.192)</b> .....	105
<b>9.3.2. Inertia (Text p.194)</b> .....	106
<b>9.3.3. Centripetal and centrifugal (Text p.194)</b> .....	106
<b>9.3.4. Friction (Text p.196)</b> .....	108
<b>9.5. Electrical Knowledge (Text p.200)</b> .....	108
<b>9.5.1. The relationship between voltage, current, and resistance (Text p.201)</b> .....	108
<b>9.5.2. Electrical level of danger (Text 202)</b> .....	109
<b>9.5.3. Battery Handling (Text p.204)</b> .....	110
<b>9.5.4. Battery charging (Text p.204)</b> .....	110
<b>10. Topography and Construction Knowledge</b> .....	111
<b>10.1. Rock and soil characteristic (text p.207)</b> .....	111
<b>10.1.1. Rock characteristic (Text p.208)</b> .....	111
<b>10.1.2. Soil (Text p.209)</b> .....	111
<b>10.2. Landslides cause and indication (Text p.218)</b> .....	115
<b>10.3. Engineering works application method, etc. (Text p.223)</b> .....	119
<b>11. Disaster cases</b> .....	121
<b>11.1. Disaster case 1 Earthwork is pinched between counterweights of drag shovel (shoberu). (Text p.230)</b> 122	
<b>11.2. Disaster Case 2 The driver was caught in the lever and short strut while laying the soil with a drag shovel (shoberu). (Text p.231)</b> .....	123
<b>11.3. Disaster Case 3 Blocks are fallen from buckets of drag shovel (shoberu) to a worker. (Text p.232)</b> 124	
<b>11.4. Disaster Case 4 The guide became underlay falling the drag shovel (shoberu) down on the sloping ground. (Text p.233)</b> .....	125
<b>11.5. Disaster Case 5 After the meeting, hit by a turning bucket walking in front of the drag shovel (shoberu). (Text p.234)</b> .....	126
<b>11.6. Disaster Case 6 After inspected the Bulldozer, lost balance, and got legs caught while attaching the cover. (Text p.235)</b> .....	127

<b>11.7. Disaster Case 7 The Bulldozer fell on a slope (nori men), and the driver was crush under the Bulldozer. (Text p.236).....</b>	<b>128</b>
<b>11.8. Disaster Case 8 Marking worker got caught in Bulldozer crawler while moving backward. (Text p.237) .....</b>	<b>129</b>
<b>11.9. Disaster Case 9 The tractor shovel (shoberu) hanging a load crashed into a worker while driving (Text p.238).....</b>	<b>130</b>
<b>11.10. Disaster Case 10 The guide got caught in a tractor shovel (shoberu) bucket in the mine (Text p.239) .....</b>	<b>131</b>
<b>11.11. Disaster Case 11 The worker was attracted by a motor grader that is moving backward. (Text p.240) .....</b>	<b>132</b>
<b>12. Related Laws and Regulations.....</b>	<b>134</b>
<b>12.1. Industrial Safety and Health Act and Order for Enforcement of the Industrial Safety and Health Act (Extract) (Text p.243) .....</b>	<b>134</b>
<b>12.2. Ordinance on Industrial Safety and Health (Extract) (Text p.256).....</b>	<b>138</b>
<b>12.3. Structural standard of Vehicle Type Construction Machine (Text p.276).....</b>	<b>146</b>
<b>Exam questions.....</b>	<b>147</b>

# 1. Basic knowledge about Vehicle-type construction machinery

## 1.1. Types and uses of Vehicle-type construction machinery (text p.1)

There are many kinds of Vehicle-type construction machinery (for leveling, transport, loading, and excavation), and their applications are wide-ranging. Vehicle-type construction machinery is classified as shown in Table 1-1 based on Appendix 7 of the Industrial Safety and Health Act Enforcement Ordinance.

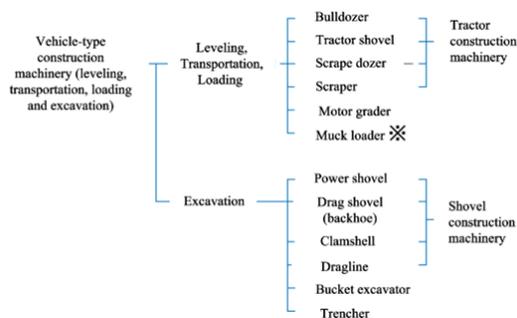


Table 1-1 Classification of vehicle-type construction machinery

※Muck loader : Mining of tunnels, etc., debris such as rocks due to blasting.

### 1.1.1. Machine for leveling, Transport, and loading (text p.2)

A Bulldozer is a tractor body with a blade (soil removal plate), a work device, attached to it and used for work such as leveling and dozing (oshido). Bulldozers are typical of tractor-type construction machinery (see Table 1-1).

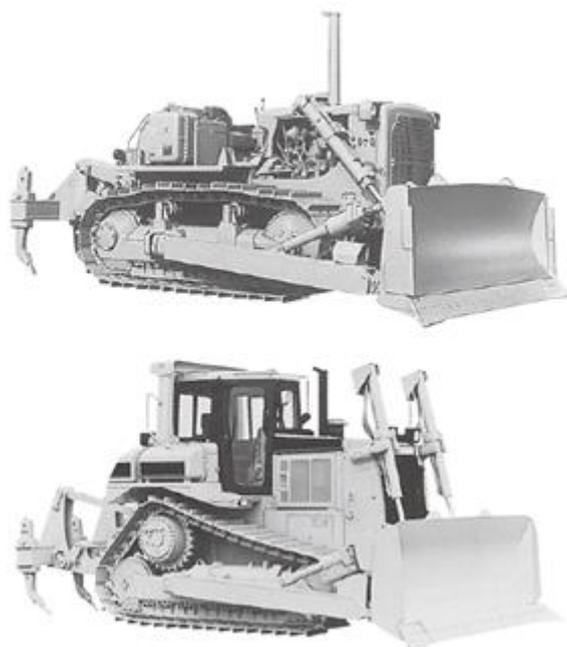


Table 1-1 Example of Bulldozers

A tractor shovel (shoberu) is a crawler-type or wheel-type tractor body with a bucket, a work device, attached to it and used for work such as loading, transport, and cutting on the ground surface. Tractors and shovel (shoberu)s are typical loadings machines (see Table 1-2).



Table 1-2 Example of tractor shovel

The scraper includes a towed scraper that is towed by a tractor and a self-propelled motor scraper that integrates the tractor and the scraper. The scraper can perform excavation, transport, and leveling operations consistently, it is suitable for transport a large amount of earth and sand, and it is effective when used for large-scale land reclamation work and civil engineering work such as dam construction (See Table 1-3).



Table 1-3 Example of scraper

The scrape dozer is a combination of a crawler type tractor body and a scraper mechanism, and its use is almost the same as that of a scraper (see Table 1-4). In particular, it is used on soft ground where scrapers cannot enter.



Table 1-4 Example of scrape dozer

Motor graders are widely used for work such as shaping, leveling, and snow removal (see Table 1-5). In particular, it is suitable for the precision finishing of road surfaces. The snow removal work is performed by attaching a snow plow.



Table 1-5 Example of motor grader

The Muck loader machine is mainly used for shearing of road construction work, and there are crawler type, wheel type, and rail type in which wheels run on rails, which can work on rough terrain without any limitation on loading width (Table 1 -6).



Table 1-6 Example of Muck loader machines

**1.1.2. Excavation machine (text p.7)**

Power shovels (shoberu) have a bucket, which is a work device attached upward to the main body. It is mainly used for excavation above the earth's surface (see Table 1-7).

A drag shovel (shoberu) has a bucket, which is a work device, attached downward to the main body, which is the opposite of a power shovel (shoberu), and it is also called a backhoe. It is mainly used for excavation from the earth's surface and it is a typical shovel (shoberu) type construction machine. In particular, in urban civil engineering, ultra-small turning type and rear small turning type hydraulic shovels (shoberu) are often used for narrow spaces (see Table 1-8).



Table 1-7 Example of power shovel (shoberu)



Table 1-8 Example of drag shovel (shoberu)

A clam shell is an excavator-type construction machine with a working device, clam shell bucket, attached to the main body, and is used for excavating relatively soft soil and crushed rock below the surface of the earth. In particular, it is suitable for deep and small cross-section excavation.

There is also a model in which a clam shell bucket is attached to the tip of an arm, such as a telescoping or a regular drag shovel (shoberu) that allows deep digging by expanding and contracting the arm instead of hanging the clam shell bucket with a wire (see Table 1-9).



Table 1-9 Example of clam shell

The drag line is a work device with a drag line attached to the main body of a shovel (shoberu)-type construction machine. Like the clamshell, it is used for excavation below the surface (see Table 1-10). The drag line has a wide excavation range because it excavates by throwing a bucket far away and is suitable for work when other excavation machines cannot approach the excavation site such as rivers and soft areas.



Table 1-10 Example of drag line

The bucket excavator, also called a bucket wheel excavator, is used for large-scale civil engineering work, and since the bucket rotates, excavation and loading can be performed continuously (see Table 1-11). Suitable for excavating relatively soft soil.



Table 1-11 Example of bucket excavator

The trencher can continuously dig a ditch and is used to dig ditches to bury gas pipes, water pipes, etc. (see Table 1-12).

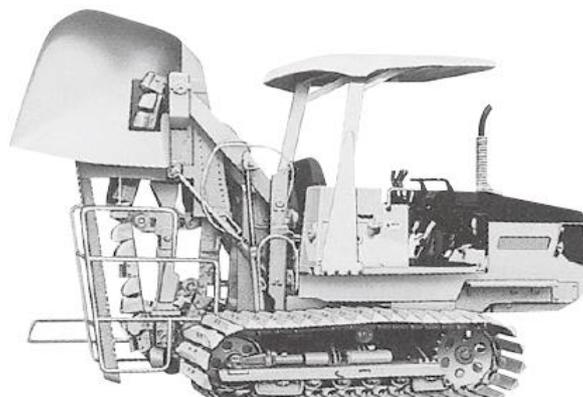


Table 1-12 Example of a trencher

## 1.2. Terminology related to Vehicle-type construction machinery (text p.10)

The work device is a device for performing work such as leveling, Transport, loading, excavation, etc. It refers to blades, buckets, scarifiers, etc., and booms, arms, yokes, etc., that support them.

The machine body weight is the dry mass (a mass that does not contain fuel, oil, water, etc.), excluding the work equipment from the vehicle-type construction machine.

The machine weight is the mass that includes the work equipment required for Vehicle-type construction machinery attached to it and the wet mass (fuel, oils, water, etc.). However, it is in the state where the bucket is not loaded with anything, etc., (no-load state).

Gross vehicle weight is the sum of the machine weight, the maximum load weight, and the weight obtained by multiplying 55 kg by the passenger capacity.

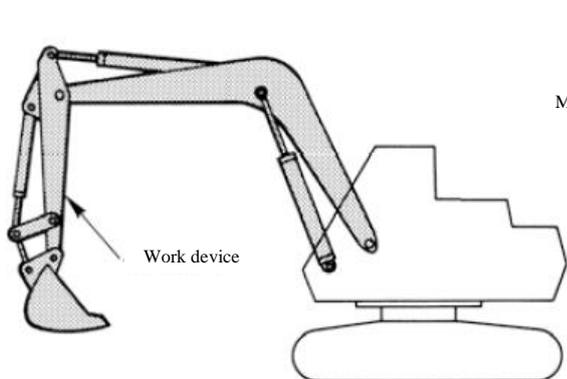


Figure 1-1 Work device



Figure 1-2 Machine body weight

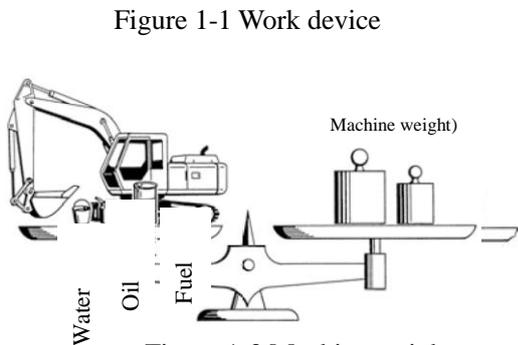


Figure 1-3 Machine weight

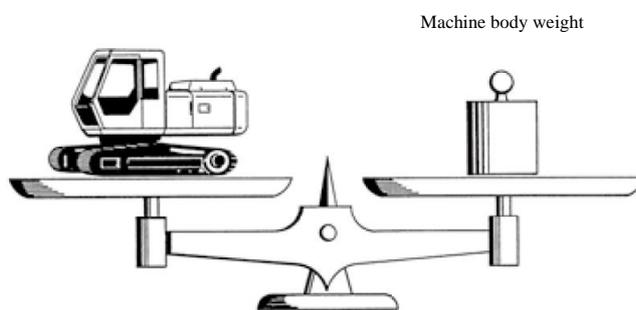


Figure 1-4 Total machine weight

Stability is the degree to which a vehicle-type construction machine does not fall over up to a certain angle. The greater the Stability, the less likely it is to fall over. In other words, Stability indicates the difficulty of falling.

Gradeability is the maximum slope (nori men) climbing capacity of a vehicle-type construction machine, calculated based on the prime mover's capacity, etc. It is generally expressed as an angle ( $\alpha^\circ$ ) or inclination (%).

It should be noted that in reality, it is expected that the vehicle cannot climb up to that angle due to slippage between the crawler (crawler belts) or tire and the surface.

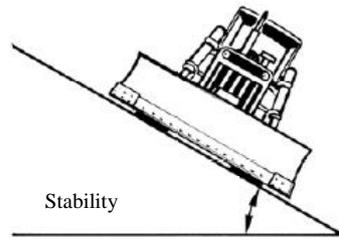


Figure 1-5 Stability

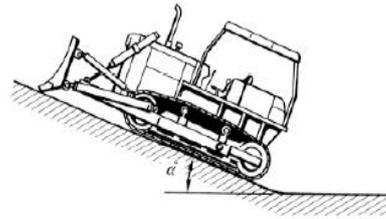


Figure 1-6 Gradeability

The average ground pressure represents the force applied to the ground by a vehicle-type construction machine and is generally expressed by the following equation.

① In the case of the crawler type, the value is the total machine weight divided by the total ground contact area of the crawler. The ground contact length of the crawler, in this case, is the length of L shown in FIG. 1-7.

$$\text{Average ground pressure} = W \times 9.8 / S = W \times 9.8 / (2B \times L) \quad (\text{kN/m}^2)$$

W : Total machine weight (t)

S : Total ground contact area =  $B \times L$  ( $\text{m}^2$ )

L : Center distance between Idler (idle wheel) and sprocket (sprocket wheel) under total weight state (m)

B : Crawler width (m)

② In the case of the wheel type, it is the value obtained by dividing the axial load of the front or rear wheels calculated from the gross vehicle weight by the total apparent contact area of the front or rear wheels (see Fig. 1-8).

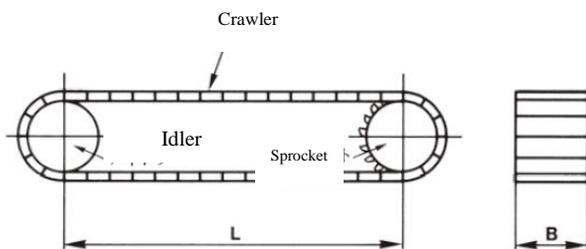


Figure 1-7 Relationship between L and B

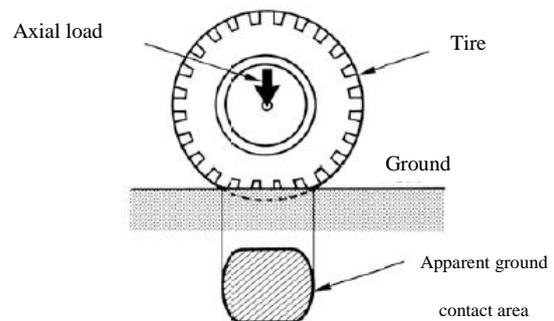


Figure 1-8 Apparent ground contact area

## 2. Motors and hydraulics for Vehicle-type construction machinery

### 2.1. Prime Mover (text p.15)

The prime mover has a function of converting various energies into mechanical work, and typical prime movers used in machines and the like include internal combustion engines such as diesel engines, gasoline engines, and electric motors.

In general, diesel engines are mainly used as prime movers for vehicle-type construction machines. Gasoline engines are used in some small and special types. In addition, there are construction machines that employ electric motors instead of internal combustion engines.

Table 2-1 Comparison between diesel engine and gasoline engine

Item	Type	Diesel engine	Gasoline engine
Fuel type		Diesel fuel	Gasoline
Type of ignition		Self-ignition by air compression	By electric spark
Engine mass per horsepower		Heavy	Light
Price per horsepower		High	Cheap
Thermal efficiency		Good (30~40)	Bad (22~28%)
Operating cost		Low	High
Fire danger level		Low	High

※ Be careful not to use the wrong type of fuel (diesel fuel or gasoline).

#### 2.1.1. Structure of a diesel engine (text p.17)

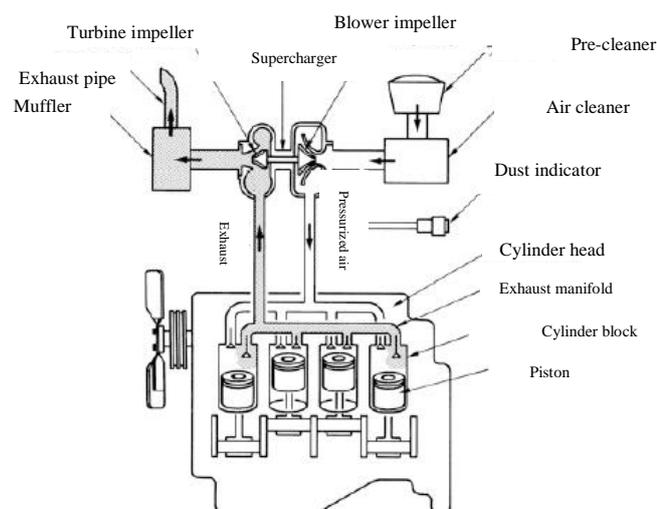


Figure 2-3 Example of intake / exhaust device

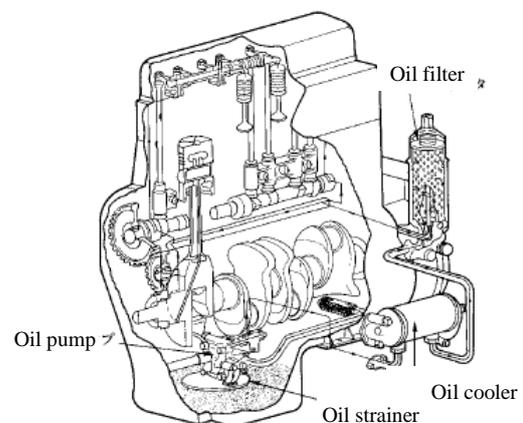


Figure 2-4 Example of lubrication system

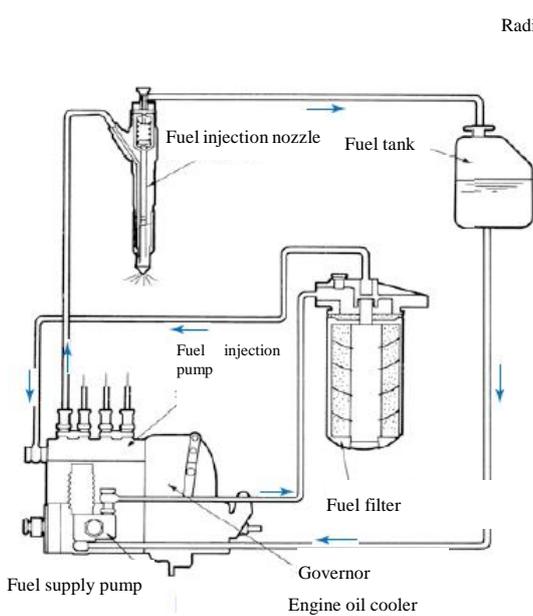


Figure 2-5 Fuel system example

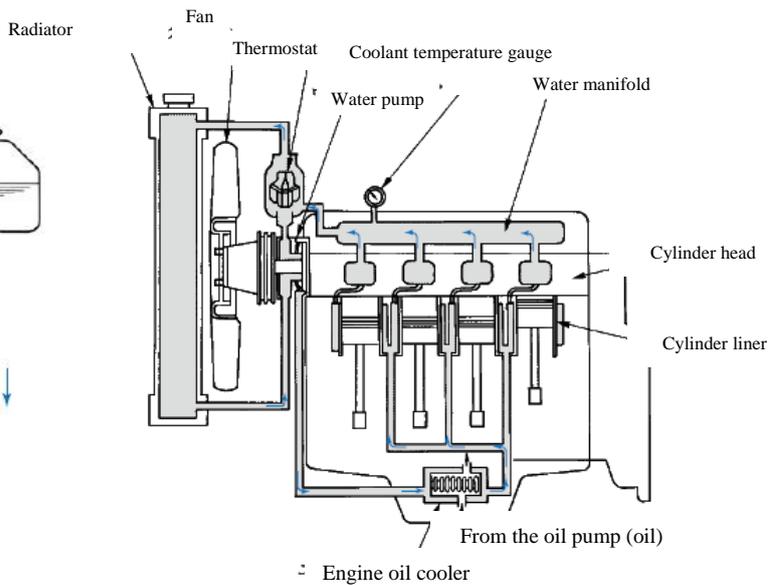


Figure 2-6 Water-cooled engine example

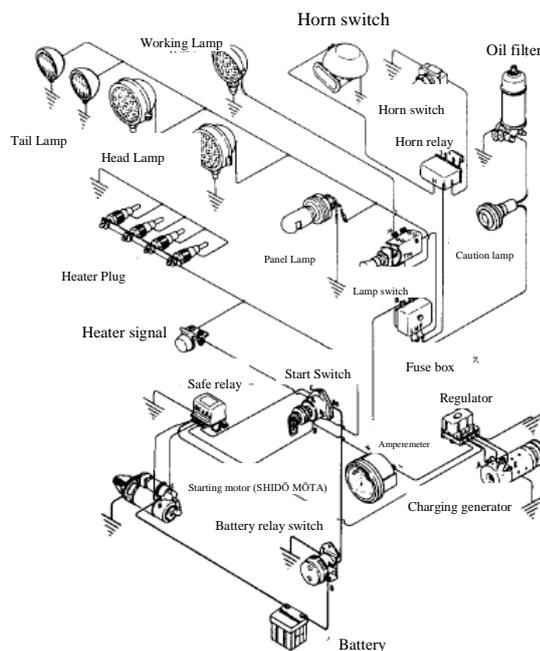


Figure 2-7 Electric circuit example

### 2.1.2. Fuel and engine oil (text p.22)

1 . . . Engine oil (lubricating oil)

Engine oil has the following functions: (1) lubricating, (2) cooling, (3) sealing, (4) cleaning, and (5) rust prevention. Although there are many different engine oil brands, it is necessary to use the standard specified in the instruction manual of the construction machine.

## 2.2. Hydraulic system (text p.23)

### 2.2.1. Hydraulic system (text p.24)

Note that a pump is a precision machine, and dust, sand, etc., can cause wear and tear, which may not allow the pressure to rise. The filter performs the filtration of the hydraulic oil in the hydraulic circuit and removes dust. Note that if the filter gets clogged, the pressure will not rise.

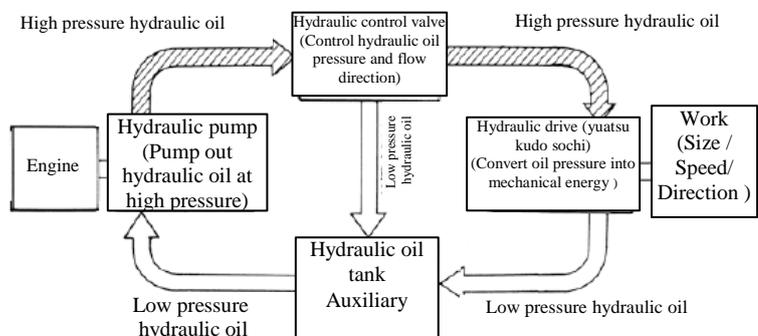


Figure 2-10 Hydraulic system structure's scheme

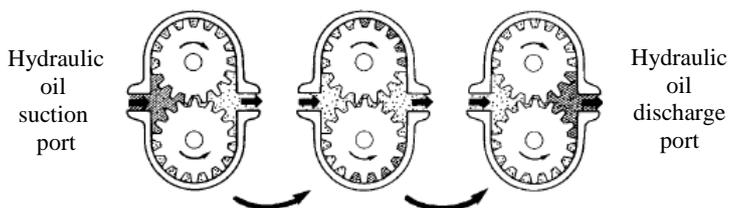


Figure 2-11 Overview of the gear pump operating principle

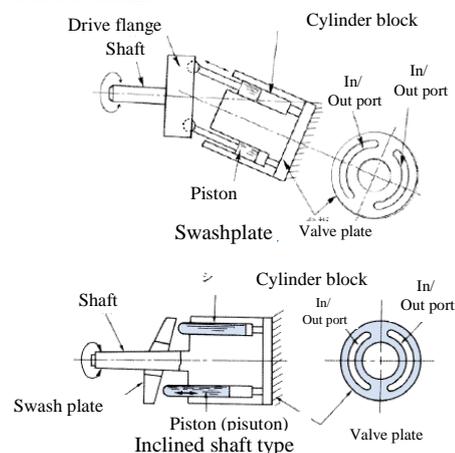


Figure 2-12 Example of inclined shaft type and swash plate

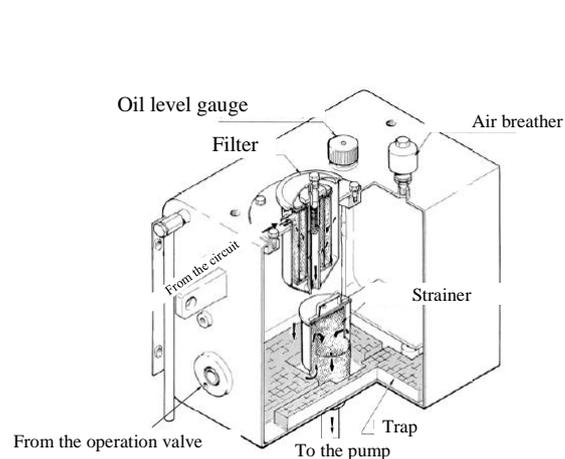


Figure 2-21 Example of hydraulic oil tank

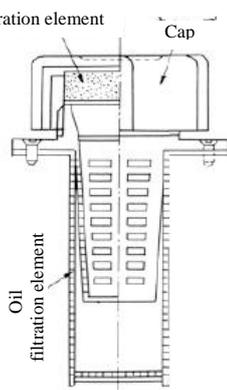


Figure 2-22 Example of combination air breather

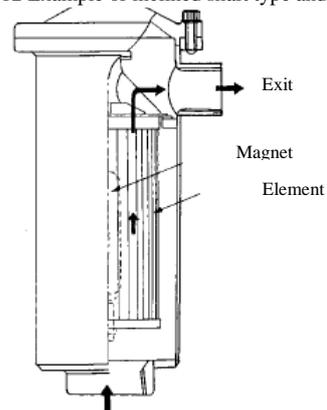


Figure 2-23 Example of pipe line filter

3. Structure of equipment related to the running of Vehicle-type construction machinery

3.1. Tractor-type construction machinery (text p.35)

3.1.1. Crawler tractor (text p.35)

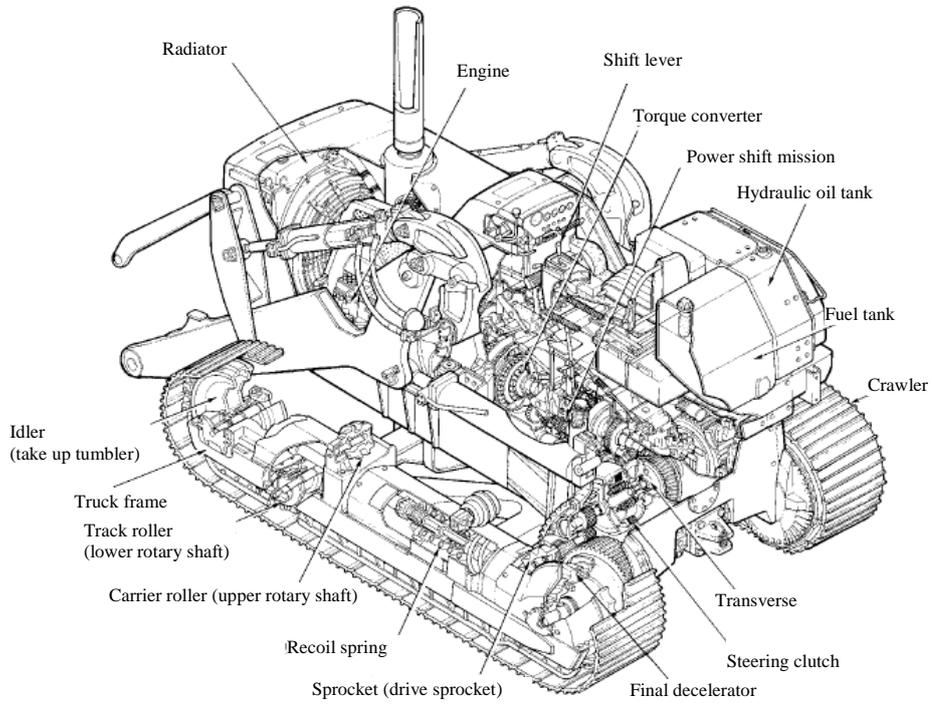
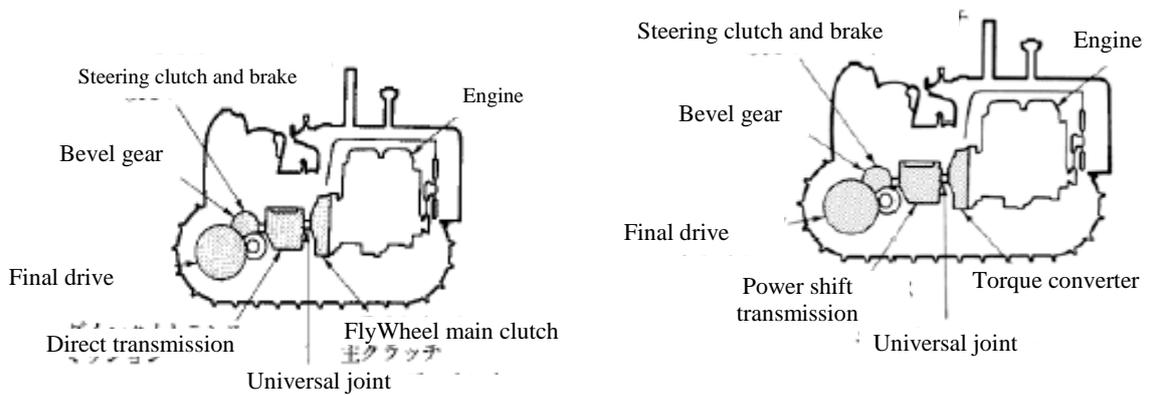


Figure 3-1 Example of crawler type tractor (torakuta) structure



3.1.2. Wheel-type tractor (text p.47)

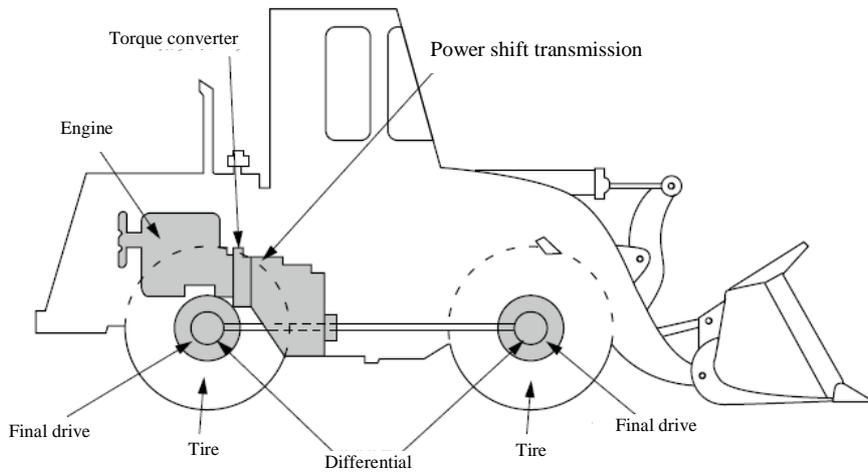
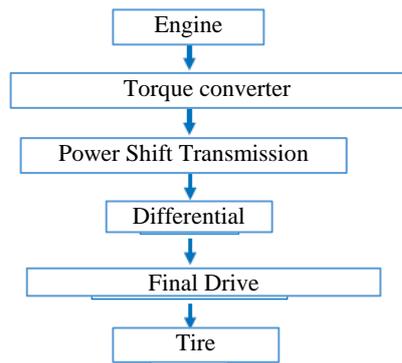


Figure 3-18 Example of power transmission

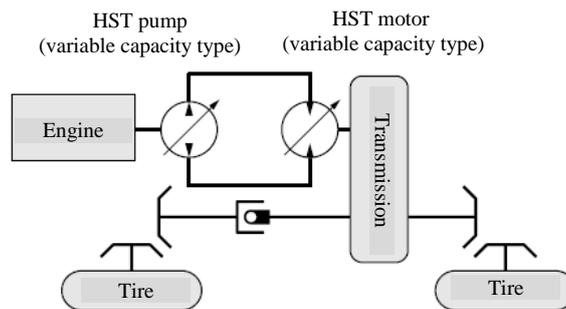
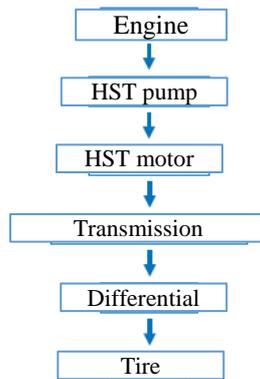


Figure 3-19 Example of HST (Hydro-static-transmission) type power transmission

### ① Tire air pressure

As shown in Table 3-2, it is important to adjust the air pressure because the air pressure condition affects the construction machine's workability and tire life. Whether or not the air pressure is appropriate is determined by measuring with a tire gauge.

Table 3-2 Tire air pressure

When the Air Pressure is Too Low	When the Air Pressure is Too High
1) Tires are crushed, heat due to deflection is severe, causing peeling.	1) Only the center part of the tire touches the ground, and this part wears quickly.
2) Both ends of the tire touch the ground and this part wears quickly.	2) In soft areas, the tire digs deep into the soil and reduces traction.
3) On hard roads, resistance increases and traction decreases.	3) Even small rocks' edges can easily damage the tire.

3.2. Shovel (shoberu) construction machinery (text p.55)

3.2.1. Hydraulic shovel (shoberu) type construction machine (crawler type) (text p.56)

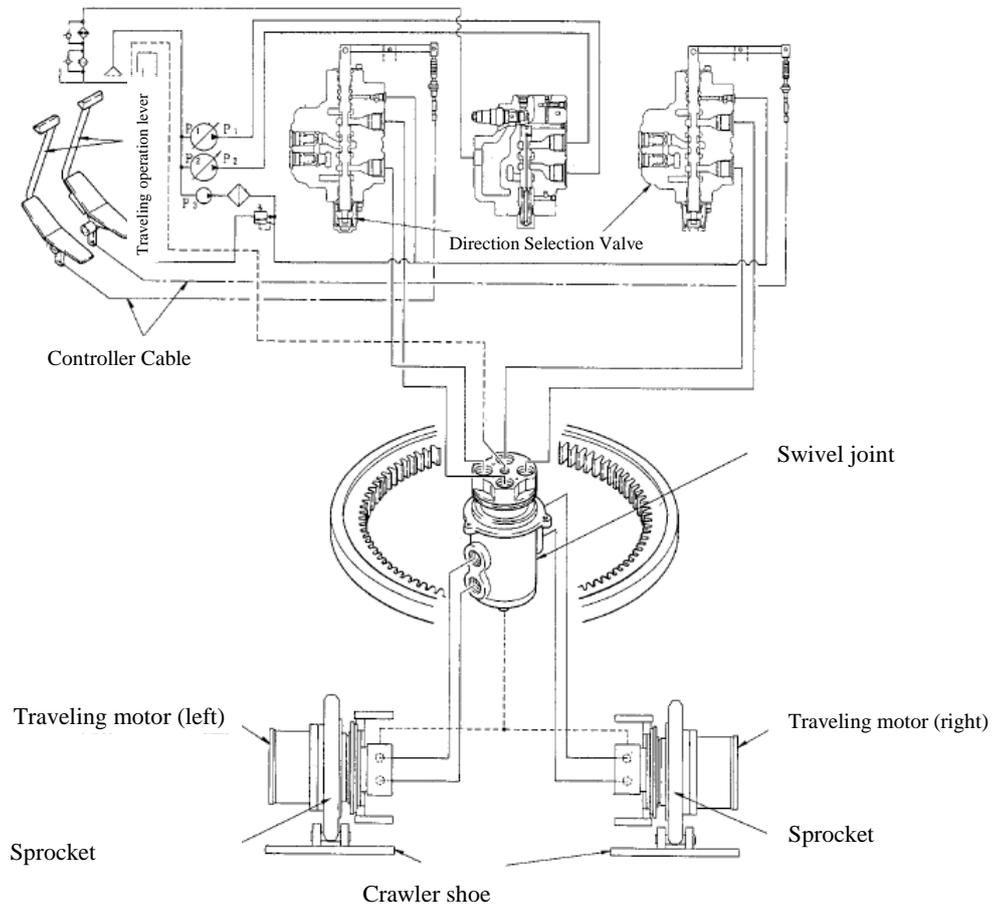


Figure 3-31 Example of hydraulic shovel construction machinery hydraulic circuit example

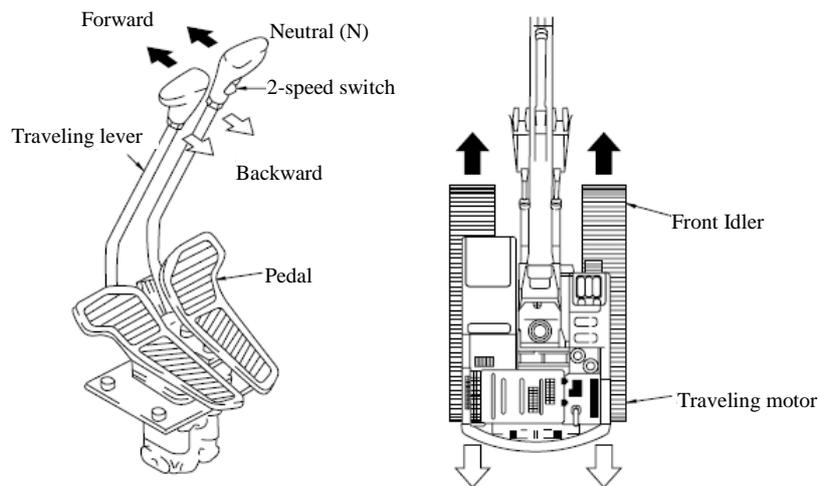


Figure 3-34 Example of crawler type running operation device

### 3.3. Motor grader (text p.61)

The arrangement of the motor grader's rear wheels consists of four wheels, two on each side are lined up in the front and back. This is called a tandem mechanism; a tandem drive device is a device that transmits power by gears or the like to the front and rear wheels.

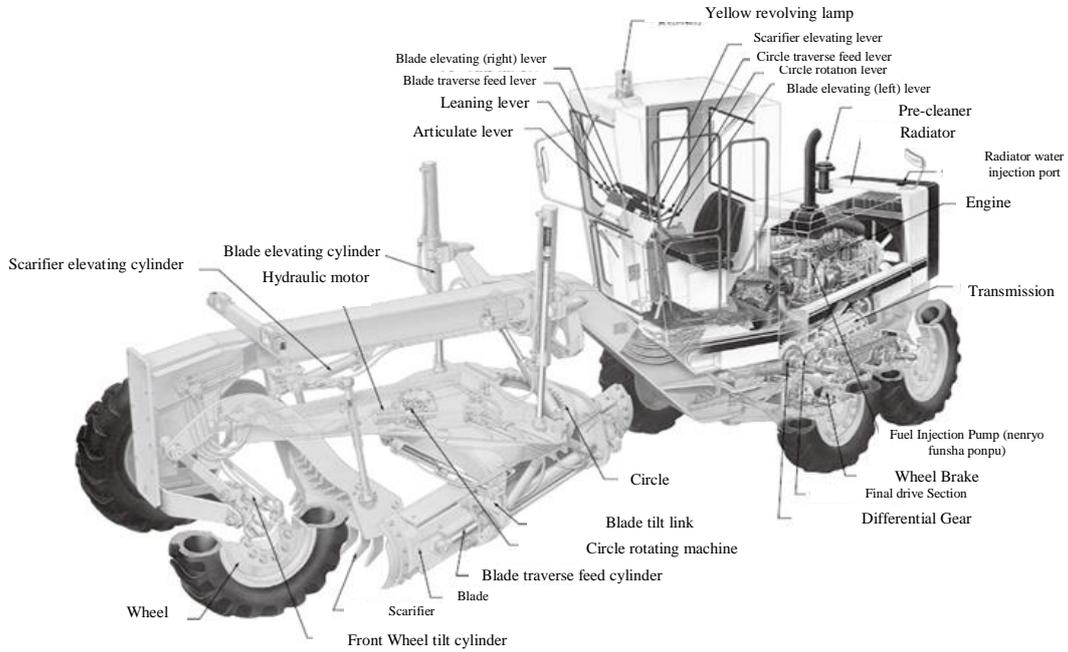


Figure 3-39 Example of motor grader structure

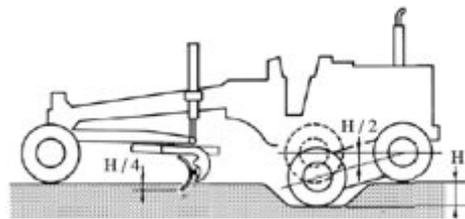


Figure 3-40 Example of Up and Down Swing

The front axle of the motor grader is connected to the fuselage's head by a pin at the center, and the pin works to soften the front wheels from swinging left and right due to the unevenness of the terrain.

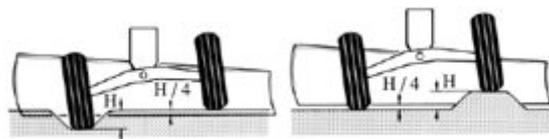


Figure 3-41 Example of front axle movement

### 3.4. Scraper (text p.64)

The scraper consists of a tractor part and a scraper part, and are connected by a joint part in the center of the vehicle.

On the tractor part, an engine, power transmission device, operation device, etc. are installed.

Figure 3-43 shows an example of the structure of the motor scraper.

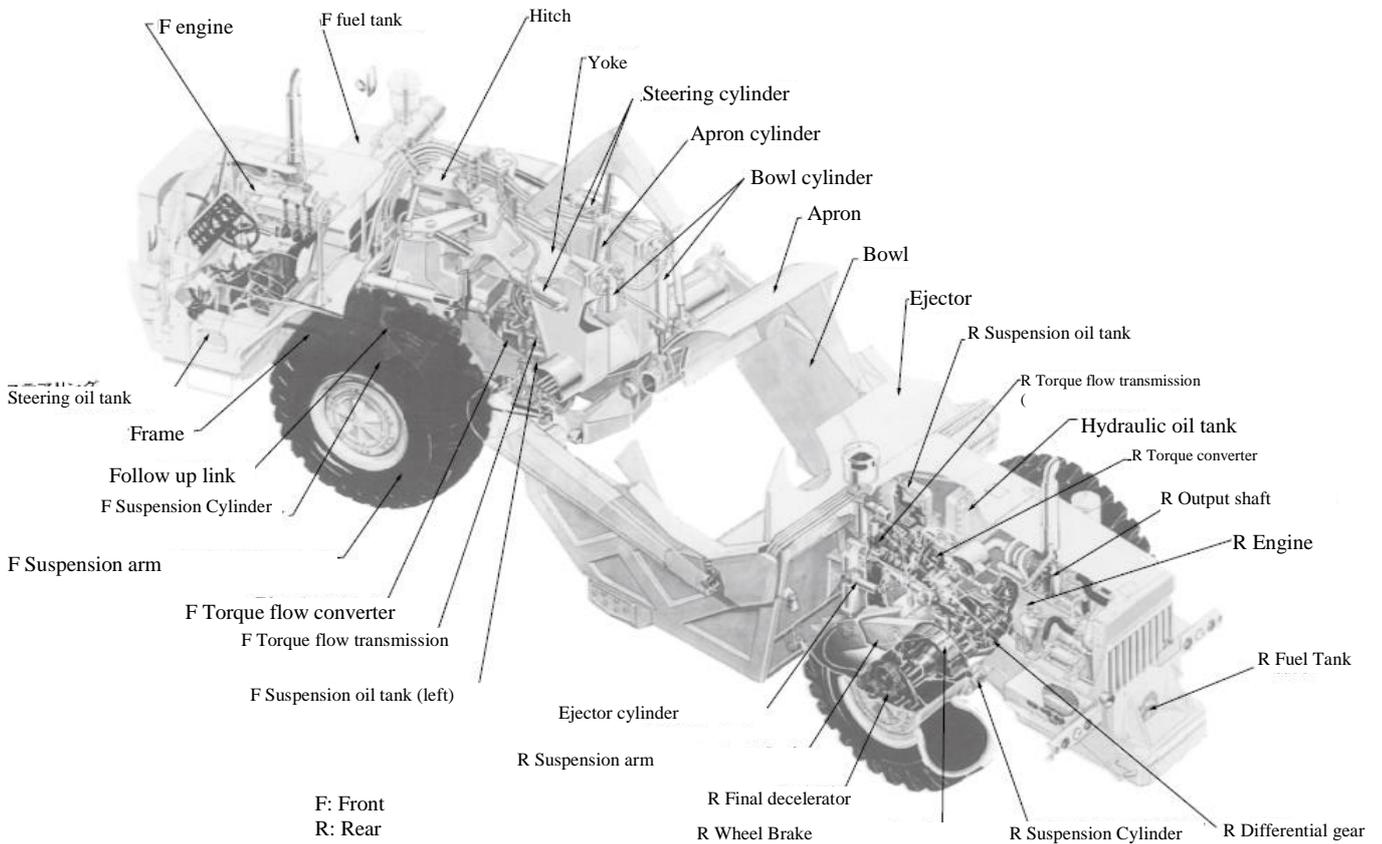


Figure 3-43 Example of motor grader structure

#### **4. Handling of equipment related to the running of vehicle-type construction machinery**

##### **4.1. Handling of the start of driving (text p.69)**

###### **4.1.1. Before starting the engine (text p.69)**

Perform inspection before starting operation (for inspection method, refer to section “7.2 Daily Inspection Procedure”).

Go around the vehicle and check that there are no oil or water leaks, no abnormalities in crawlers, tires, work equipment, etc., and that there are no people or obstacles in the surroundings. After checking this, get to the driver’s seat.

The basic operation before starting the engine is as follows.

- ① Keep the shift lever and each working device lever in the neutral position and hydraulic lock lever in lock condition.
- ② Set the main clutch lever to “OFF”.
- ③ Set the fuel lever to low idling.
- ④ Make sure that the parking brake lever is engaged. (Wheel type, etc.).
- ⑤ Fasten your seat belt on vehicles equipped with a seat belt.

###### **4.1.2. Starting the engine (text p.69)**

The basic operation for starting the engine is as follows.

- ① Insert the key into the start switch to the “start” side and turn the start motor to start the engine. As soon as the engine starts, release the key, and the key will automatically return to “on”.
- ② If the construction machine's engine that comes with a preheating plug does not start well, operate as follows. After turning the key of the start switch to “preheat” (usually about 30 seconds), start the engine described in ① above. It should be noted, do not turn the starting motor for too long (about 20 seconds or more). If the engine does not start after turning the start motor, after about 2 minutes, restart the start motor again.

###### **4.1.3. After starting the engine (text p.70)**

The basic operation after starting the engine is as follows.

- ① When the engine is cold, sudden acceleration should not be done.
- ② While warming up for a few minutes after starting the engine, check the following (inspection method, refer to the section “7.2 Daily Inspection Procedure”).
  - a Is the pointer for each meter instrument good?
  - b Check for water leaks, oil leaks, engine noise, exhaust color, vibration, and other abnormalities.
  - c Others (checking the monitoring system, etc.)

## **4.2. Handling while driving (text p.70)**

### **4.2.1. Start (text p.70)**

When driving forward or backward, pay close attention to people around you, other construction machinery, and other obstacles. Starting basic operation is as follows.

#### **1 • • • Power shift type**

- ① Remove the work equipment safety device (lock plate, etc.). Raise the bucket, blade, etc., to a height of about 40 cm above the ground.
- ② Step into the brake pedal and remove the brake lock (or parking brake).
- ③ Remove the gearshift lever safety device.
- ④ Adjust the shift lever according to the work, put it in the desired position, release the brake pedal.
- ⑤ Pull the fuel adjustment lever (or step into the accelerator pedal) and increase the engine's rotation.

#### **2 • • • Direct drive type**

- ① Push the main clutch lever (or pedal) forward and disconnect.
- ② Insert the shift lever to the desired position according to the work. If the gears are difficult to mesh, set the shift lever to neutral, intermittently connect the clutch to adjust the gear position, and reinsert the lever. Do not forcibly mesh the gear.
- ③ Insert forward-reverse lever to forward (or backward).
- ④ Remove the device work lever's safety device, raise the bucket, blade, etc., around 40 cm above the ground.
- ⑤ Step on the brake pedal, and remove the brake lock or parking brake.
- ⑥ Gently pull (or release) the main clutch lever (or pedal) while releasing the brake pedal then take off.
- ⑦ Pull the fuel adjustment lever or step on the accelerator pedal to increase the engine speed.

#### **3 • • • Other**

For shovel (shoberu)-type construction machinery,

- ① Move the turning switch button or lever to the running position.
- ② Operate the traveling brake button or lever and loosen the brake.
- ③ Pull the fuel adjustment lever, increase the engine speed.
- ④ Pushing the travel lever forward will move the machine forward, and pulling it backward will move the machine backward.

#### 4.2.2. When running (text p.72)

##### 1 . . . General caution matters

Pay particular attention to the following during power shift driving.

- ① In the following scenarios, when the load suddenly decreases, the running speed becomes faster and dangerous, so make sure to slow down the running speed.
  - a When you go uphill.
  - b When earth or sand fall from a cliff.  
Also, when this occurs, move the shift lever to neutral at the same time.
  - c When approaching the dump (danpu) truck to load earth or sand.  
At this time, it is advisable to change gears to a slower speed.

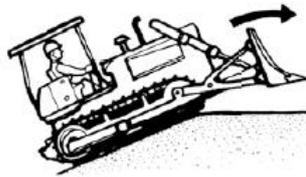


Figure 4-2 Points to keep in mind when climbing a hill

- ② If the oil temperature gauge rises too much during work, slow down and reduce the load.
- ③ Operation must be at full throttle, but if it's merely for moving or waiting inside the truck, reduce the engine speed.

##### 2 . . . Steering (turning direction)

When steering (direction change), pay particular attention to the following (crawler-type).

- ① When trying to steering, disengage the steering clutch on the corresponding side and steer gently. When you need to make a sharp turn, apply the brake on the side that you are heading.
- ② Avoid steering when the machine is being pushed from behind on a steep slope (nori men) or downhill where it descends under its own weight.
- ③ Do not make a sharp turn on high-speed places, on bedrock, or on clay, this will accelerate the wear of the undercarriage and the crawler may come off.
- ④ When steering while descending a slope (nori men), if one side of the steering lever or steering pedal is operated halfway, it may turn in the opposite direction of the operated side, so pull the lever to a position where the brake is sufficiently effective.



Figure 4-3 Points to keep in mind when turning at high speed

### 3 • • • Hydraulic shovel (shoberu) construction machine

Pay particular attention to the following while the hydraulic shovel (shoberu) construction machine is running.

- ① When moving forward or backward, operate the driving device after sufficiently checking the machine direction and the travel direction.
- ② When necessary to make a turn, the left and right traveling levers are switched alternately in the front-rear direction.

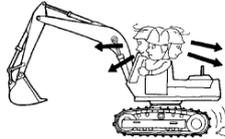


Figure 4-4 Check the orientation of the machine when moving forward or backward

### 4 • • • Mechanical shovel (shoberu) construction machine

Pay particular attention to the following when running a mechanical shovel (shoberu) construction machine.

- ① The upper turning body may turn while driving, causing an unexpected accident, so be sure to lock the turning lock.

### 4.2.3. Climbing, descending, etc. (text p.74)

#### 1 • • • Tractor construction equipment

Pay particular attention to the following when running a tractor-type construction machine.

- ① When the engine stops while climbing a slope (nori men), step into the left and right steering brakes to stop the construction machine, disengage the main clutch (in the case of direct drive type), set the shift lever to neutral, and start the engine.
- ② When descending in reverse, put the shift lever to the back and descend with the engine brake applied according to the descending slope (nori men)s' operation procedure.
- ③ When going downhill, even if the distance is short, do not disengage the clutch to descend. Especially on steep slope (nori men)s, put the shift lever in the low-speed stage, descend using both the engine brake and the driving brakes at the same time.

Note that with direct-drive construction machines, if the main clutch is disengaged and the vehicle goes down a slope (nori men), the speed will increase, in this state if the main clutch is engaged, the clutch plate will be damaged.

- ④ Note that crawler-type construction machinery may go in the opposite direction when steered on a steep descent.
- ⑤ When loading up and down on a steep slope (nori men), lower the bucket up and down.
- ⑥ Do not drive beyond the climbing capacity and stability of the designated construction machinery.
- ⑦ When overcoming obstacles, be careful of falling, slow down and drive carefully.



Figure 4-5 Points to keep in mind when overcoming obstacles

## 2 • • • Shovel (shoberu) construction machinery

Pay particular attention to the following when running a shovel (shoberu) construction machine.

- ① Do not drive beyond the specified climbing ability and stability.
- ② Avoid steering in the middle of the slope (nori men) as much as possible.

If it is unavoidable to steer while climbing a slope (nori men), set the traveling clutch to the “ON” state to prevent the machine from descending, and then operate the steering operation device.

If it is unavoidable to steer while descending a slope (nori men), slide the traveling clutch in the same direction as when climbing a slope (nori men) to stop the construction machine, and then operate the steering operation device.

- ③ Be careful when driving on uneven roads as the crawler may come off.
- ④ In soft ground, use road boards to prevent falls due to uneven subsidence.
- ⑤ When stopping in the middle of a slope (nori men), lower the bucket, etc., on the ground even for a short time, then make sure to put a drag on the undercarriage.

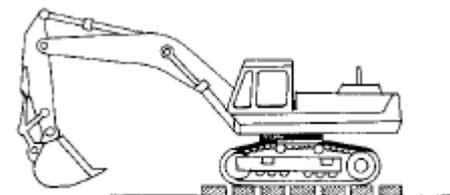


Figure 4-6 Example of use road boards in soft areas

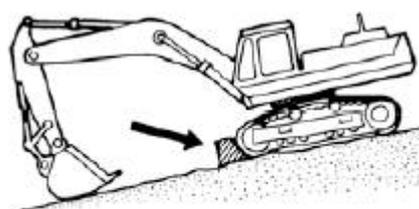


Figure 4-7 Example of stopping on a slope (nori men)

### 4.2.4. Stop the Running (text p.75)

#### 1 • • • Power shift type construction machine

Pay particular attention to the following when stopping the running of power-shifted construction machinery.

- ① Set the shift lever to neutral and step on the driving brake to stop.

Note that the torque converter's oil will overheat if the brake pedal is stepped in with the shift lever turned on. (However, in general, it does not matter if it is within about 30 seconds).

- ② Pay attention to ②, ③, and ④ in the “Direct drive type construction machinery” section.

#### 2 • • • Direct drive construction machine

Pay particular attention to the following when stopping the running of direct-drive construction machinery.

- ① Generally, the main clutch lever is tilted forward, the brake pedal is stepped on to stop, and the shift lever is neutral.
- ② Stop the engine after idling for about 5 minutes. Especially for engines with a supercharger, it is absolutely essential.
- ③ After stopping, if you will not continue driving immediately, lower the bucket, etc., to the ground and lock the brake pedal.

- ④ When you stop on a slope (nori men) to prevent the construction machine from escaping, make sure to put a brake on the suspension.

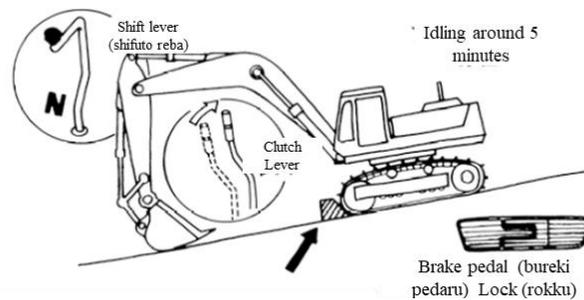


Figure 4-8 Stop on a slope (nori men)

### 4.3. Parking handling (parking) (text p.76)

Pay particular attention to the following after operating construction machinery.

- ① Stop the construction machine on a flat surface with good ground, lower the bucket, etc.
- ② Stop the engine, check that the key has returned to the [OFF] position, and then remove the key. The key should be securely stored by the responsible person.
- ③ Apply the brakes completely. If it is unavoidable to stop on an inclined surface, be sure to put a brake on the suspension.

In excavator-type construction machinery, lock the swivel lock, apply the parking brake, and always lock the boom, hoist, and drum.

- ④ Do not move the boom or bucket while the engine is stopped.

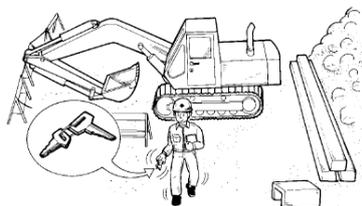


Figure 4-9 Points to keep in mind when parking

#### **4.4. Grease, oil, etc. (text p.77)**

##### **1 • • • Grease**

The main uses of grease are as follows.

- ① Good sealing performance, making it difficult for dust, water, etc., to enter the friction part.
- ② It improves lubricity and forms a coating on the metal surface to reduce frictional force. Lithium-based and molybdenum-based greases are used in construction machinery. Replace and replenish according to the instructions in the manufacturer's instruction manual.

##### **2 • • • Antifreeze**

Antifreeze is mixed with cooling water to prevent freezing and corrosion; this is a translucent solution containing ethylene glycol as the main component. Since the concentration varies depending on the operating temperature, refer to the manufacturer's instruction manual.

##### **3 • • • Oil**

The oil contains various additives such as the following to improve performance, and it is desirable to use the oil specified in the manufacturer's instruction manual.

- Oily agent (reduction of coefficient of friction)
- Extreme pressure additive (improves pressure resistance)
- Viscosity index improver (viscosity change is small with temperature changes)
- Pour point depressant (improves low-temperature fluidity)
- Anti-foaming agent
- Rust preventive
- Antioxidants, etc.

Follow the instruction manual when changing the oil. If the oil deteriorates or runs short, the gears wear faster, and the bearings may burn.

## 5. Structure and type of equipment related to the work of Vehicle-type construction machinery

### 5.1. Tractor-type construction machinery, structure, and type of work equipment (text p.79)

#### 5.1.1. Work equipment structure (text p.79)

The work equipment of a tractor-type construction machine is composed of blades, buckets, etc., mounted in front of the tractor, supporting arms, yokes, and the like.

Some of these working devices are operated via a hydraulic cylinder, and some are operated by a mechanical power transmission method. However, recently, the hydraulic type is often used.

With the hydraulic type, the hydraulic oil that moves the hydraulic cylinder is pressurized by a hydraulic pump attached to the engine, and the pressurized hydraulic oil enters the hydraulic cylinder and pushes the piston to move the rod in and out to operate the work device.

Figure 5-2 shows an example of the hydraulic circuit and hydraulic operation of a crawler type tractor shovel (shoberu). Many hydraulic cylinders are used in work devices that move in a complicated manner.

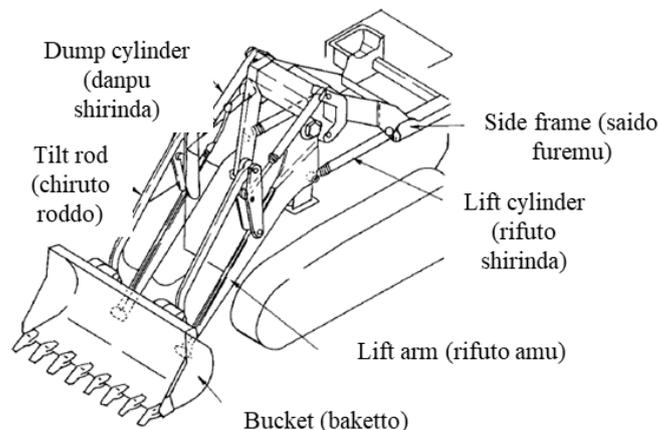


Figure 5-2 Example of hydraulic operation of crawler type tractor shovel (shoberu)

#### 5.1.2. Type of work equipment (text p.80)

##### 1 . . . Bulldozer

A bulldozer is a tractor with blades attached to the front of the tractor via an arm, frame, or the like.

Also, there are various types of blades depending on the application, and the blades can be classified as follows according to the type of the operating device.

### ① Angle dozer

The blade can be tilted left and right, soil can be discharged to one side, snow can be removed (see Fig. 5-3). It is also useful for excavating mountain roads.

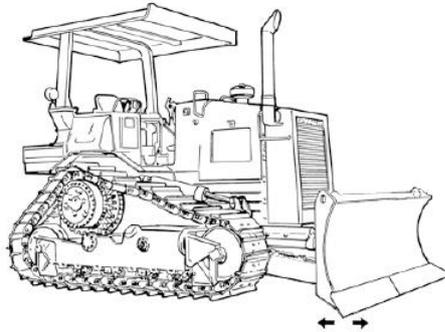


Figure 5-3 Example of angle dozer (anguru doza)

### ② Straight dozer

Although the blade cannot be tilted to the left or right, the structure is stiffer than the angle blade, and heavy excavation work is possible (see Fig. 5-4). Many are also equipped with a tilt device and a ripper.

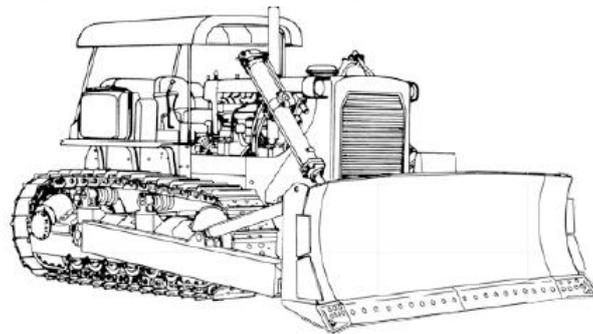


Figure 5-4 Example of straight dozer

### ③ Rake dozer

Used for rooting, fallen trees and stone removal, etc., by the rake. There are angle rakes (anguru reki) and straight rakes (sutoreito reki) (see Fig. 5-5).

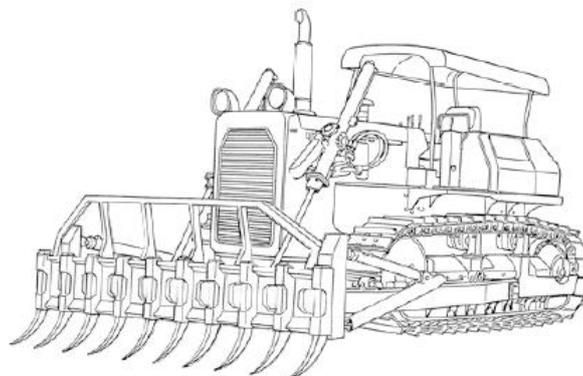


Figure 5-5 Example of rake dozer

④ **U dozer (U doza)**

Both ends of the blade are bent forward, and it is used when a large amount of dozing (oshido) is pushed at one time by reducing the escape of soil (see Fig. 5-6).

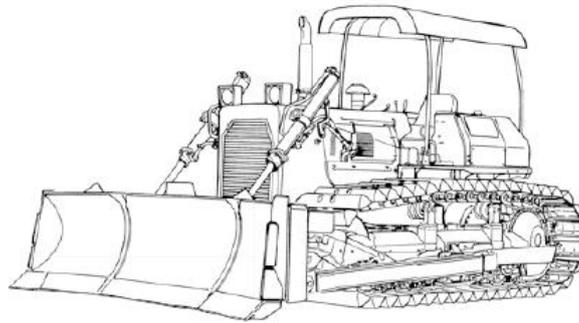


Figure 5-6 Example of U dozer

⑤ **Trimming dozer (two-way dozer)**

The blade can be tilted back and forth and is used for scraping coal, ore, etc. in ships and warehouses (see Fig. 5-7)

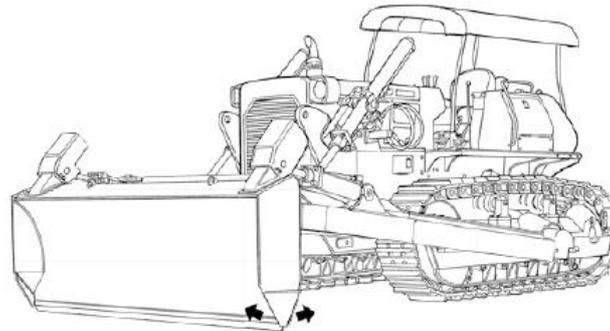


Figure 5-7 Example of trimming dozer

⑥ **Ripper**

It has large claws on the back and is used to crush or dig soft rock and hard soil (see Fig. 5-8).

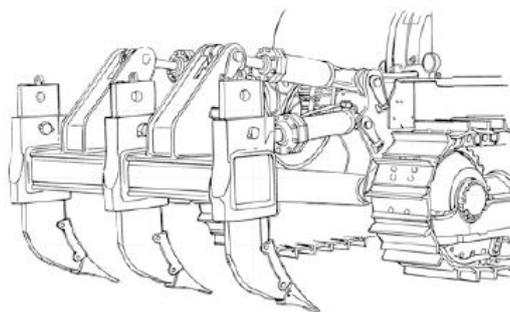


Figure 5-8 Example of ripper

### ⑦ Wetland Bulldozer

A wide shoe is attached to increase the contact area of the crawler, and it is used for work on soft ground (see Fig. 5-9).

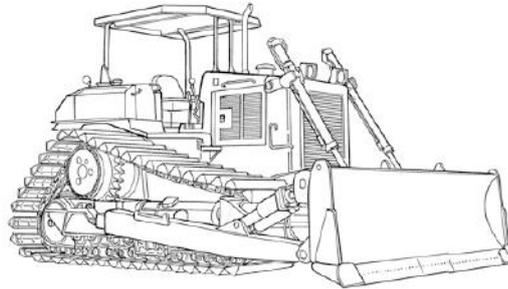


Figure 5-9 Example wetland bulldozer

### ⑧ Push dozer

A pusher plate is attached to protect the Bulldozer's blade, or a buffer (cushion) is attached to strengthen the blade, and it is used to boost the traction force for the scraper's excavating and loading. (See Figure 5-10).

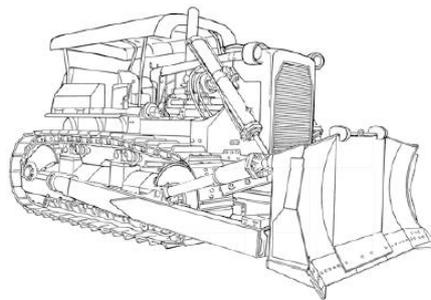


Figure 5-10 Example of push dozer

### 2 • • • Tractor shovel (shoberu)

As shown in Fig. 5-11, a tractor/shovel (shoberu)'s work equipment consists of a bucket and a supporting arm and is used for loading and transport work.



Figure 5-11 Example of tractor shovel (shoberu)

### 5.1.3. Safety devices, etc. (text p.85)

#### 1 • • • Headlight

Headlights are installed on construction machinery to ensure safe work at night.

#### 2 • • • Alarm system

Construction machinery is equipped with an alarm system to alert workers to ensure safety during driving and work.

#### 3 • • • Head guard and Rollover Protection Structure (ROPS)

The Industrial Safety and Health Act requires that a solid head guard be attached to the driver's seat when working in a place where there is a risk of falling objects such as rocks. In addition, there is a protective device for construction machinery in case of falling, as shown in Fig. 5-12, but it is not common. Because it is not obligatory to install it at present, but it can be easily installed on equipment with a mass of 3 tons or more. Some have a body structure that allows them to do so. Always use seat belts when operating this construction machine.

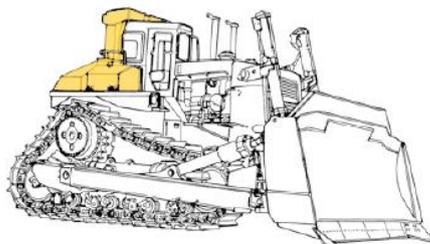


Figure 5-12 Example of fall protection device

#### 4 • • • Safety device

Tractors and shovels (shoberu) may be forced to keep their buckets raised for machine inspection and maintenance. At this time, a lock plate for fixing the operation lever, etc., is attached so that the bucket does not drop or dump (danpu) even if the operation lever is accidentally touched. Alternatively, some have safety devices such as safety pins (see Fig. 5-13) that prevent the lifted bucket's lift arm from descending.

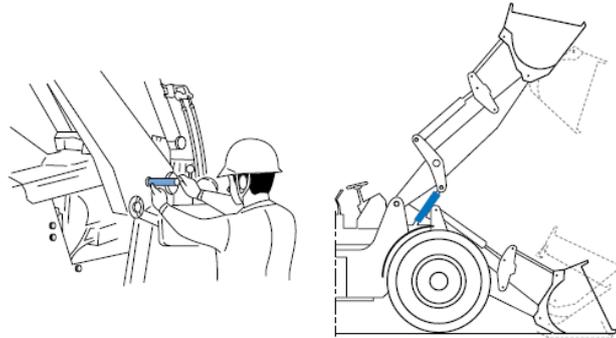


Figure 5-13 Example of lift arm safety pins

## 5.2. Structure and type of work equipment for shovel (shoberu)-type construction machinery (text p.86)

### 5.2.1. Hydraulic shovel (shoberu) construction machine (text p.87)

The type of hydraulic shovel (shoberu) construction machine varies depending on the work equipment used and includes drag shovels (shoberu), power shovel (shoberu), clamshells, and the like.

Therefore, for excavation work, some work devices are equipped with a bucket for drag shovels (shoberu), bucket for power shovels (shoberu), a bucket for clamshells, etc. (see Fig. 5-14). There are also hydraulic excavators equipped with blades.

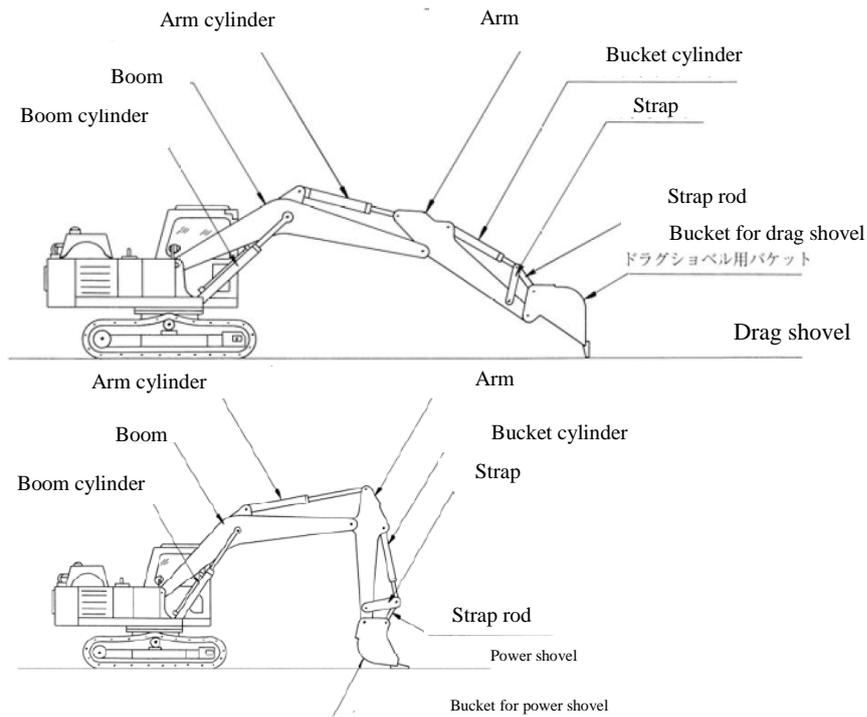


Figure 5-14 Example of working equipment for hydraulic excavators

### 5.2.2. Mechanical shovel (shoberu) construction machine (text p.88)

The type of mechanical shovel (shoberu) type construction machine varies depending on the work equipment used and includes draglines and clamshells.

#### ① Clamshell

Mechanical clamshell work equipment generally uses the left drum for the holding rope and the right drum for opening and closing the bucket. As shown in Figure 5-16

Bucket support rope and opening/closing rope are used with the same diameter. Also, a tagline is attached to prevent the bucket from shaking.

Those equipped with a bucket with claws have the function of excavation. Those equipped with buckets that do not have the function of excavation correspond to mobile cranes.

(A different qualification is required for crane work)

Crane work cannot be performed with the qualification of vehicle-type construction machine operation (for leveling, transport, loading, and excavation), so a separate qualification such as a mobile crane is required.

**5.2.3. Safety devices, etc. (text p.89)**

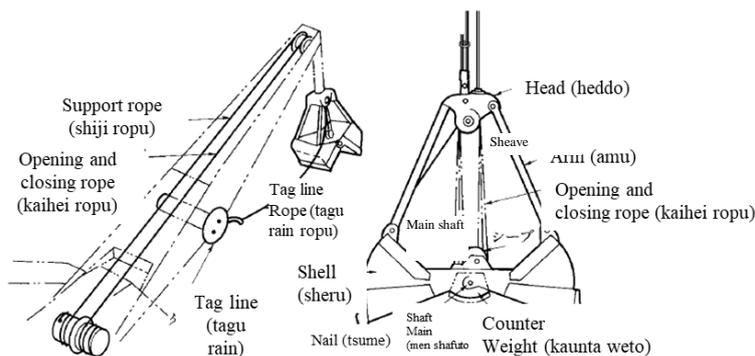


Figure 5-16 Example of mechanical clamshell

**① Lock lever**

If you leave the driver's seat, pull the lock lever on the left operating lever stand to cut the operating pilot pressure to stop the work equipment's operation.

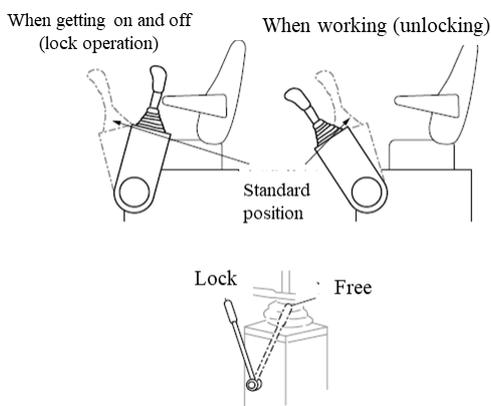


Figure 5-17 Example of lock lever

**② Revolving Parking Brake**

This brake prevents the upper turning part from turning due to its weight and descending naturally when parking on the inclined ground.

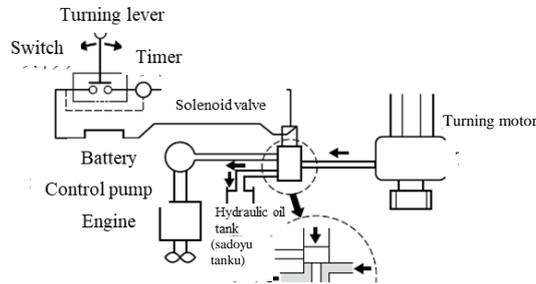


Figure 5-18 Example of swivel parking brake

**③ Boom fall prevention device**

Generally, the boom inclination angle is designed to be used within the range of 30 to 80 degrees.

The boom fall prevention device is used to prevent the boom from suddenly being unloaded during use with the boom raised or to prevent the boom from falling backward when traveling on an uneven road.

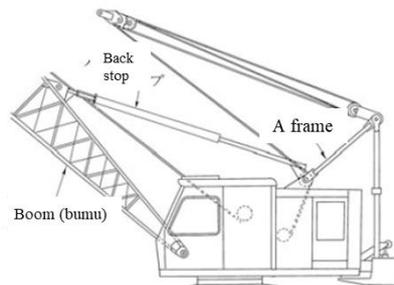


Figure 5-19 Example of boom fall prevention device

**④ Boom undulation shutdown system**

When the boom reaches a certain specified angle, it stops regardless of the operating lever's position.

Boom undulation stop devices are used for draglines, mechanical clamshells, etc. however, it is necessary to work with enough caution and without overconfidence in this safety device.

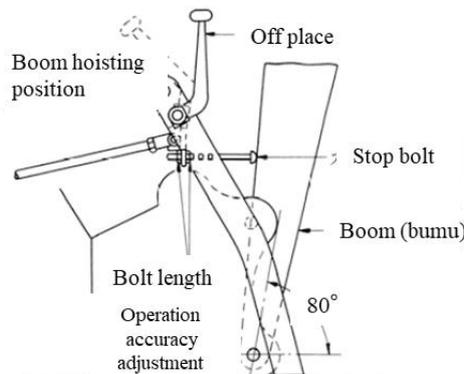


Figure 5-20 Example of Boom undulation stop device

### 5.3. Motor grader (text p.92)

There are mechanical and hydraulic working devices for motor graders depending on the operating method, but recently most of them are hydraulic.

The work equipment of the motor grader consists of the following main parts.

#### 1 . . . Blade device

The blade device consists of drawbars, circles, and blades. The blade can change the cutting angle and make it possible to feed sideways (See Figure 5-21).

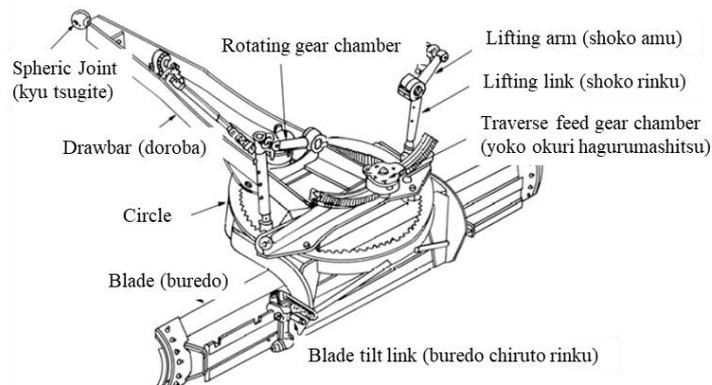


Figure 5-21 Example of blade device

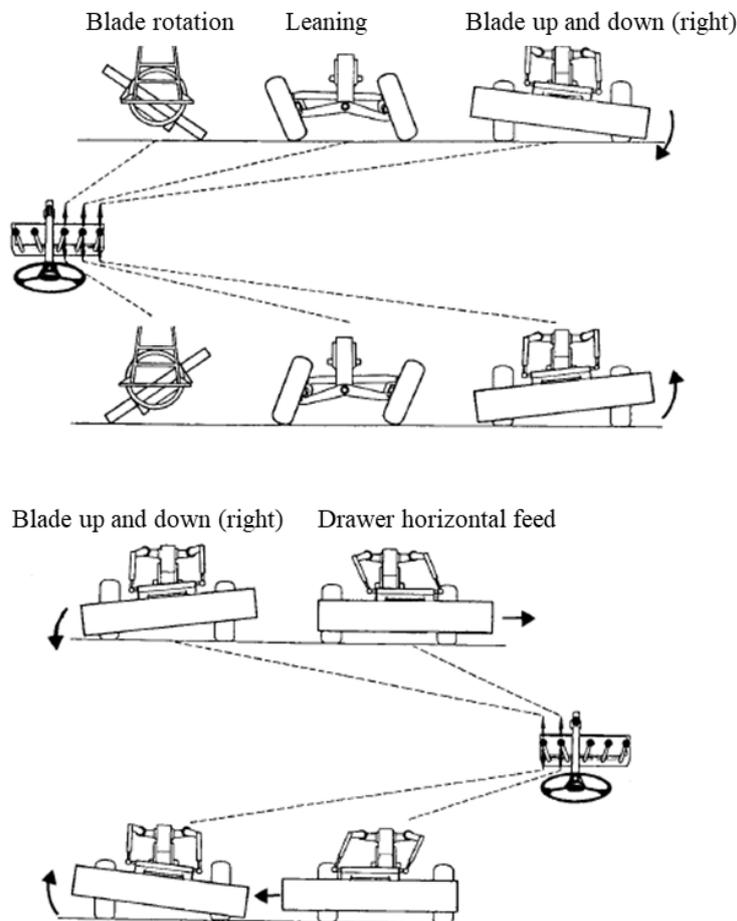


Figure 5-21 Example of motor grader work equipment

## 2 . . . Scarifier device

Some soil-loosening devices are attached to the frame with a drawbar, while others are attached to the blade mounting arm or blade drawbar (See Figure 5-23).

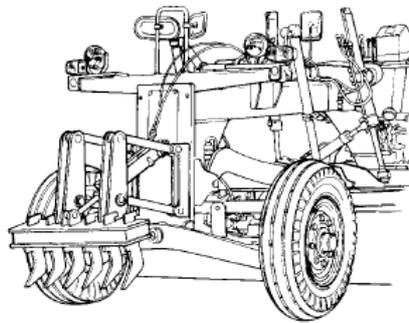


Figure 5-23 Example of scarifier device

## 5.4. Scraper (text p.94)

The scraper working device comprises a bowl, an apron, an ejector, and the like, and its operating method includes a mechanical type and a hydraulic type.

### 1 . . . Bowl

The bowl is a container for transport earth and sand. While moving forward, the bowl is pressed against the ground with a hydraulic cylinder for excavation and loading.

### 2 . . . Apron

The apron prevents the earth and sand loaded in the bowl from spilling forward. The apron is raised at the dumping ground and dump (danpu) the soil.

### 3 . . . Ejector (or tilting floor)

The ejector is a device for pushing out earth and sand from the back when the soil is discarded. The working device of the scrape dozer is almost the same as the working device of the scraper.

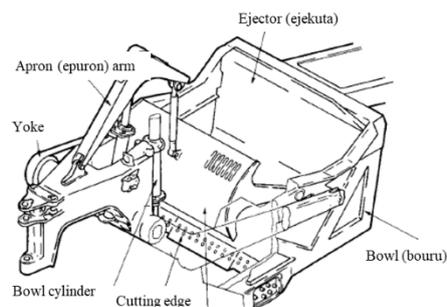


Figure 5-24 Example of scraper work equipment device

## 5.5. Muck loader (text p.95)

### 5.5.1. Crawler type Muck loader machine (text p.95)

Crawler-type Muck loader mainly includes large tunnel-type tractor shovel (shoberu)s and scrap-type loaders.

The tractor shovel (shoberu)'s working equipment is precisely the same as the tractor shovel (shoberu) described above.

The scraping loader's working device consists of a scraping device consisting of a bucket, an arm, a boom, a cylinder, a revolving frame, and a conveyor. It is operated by a hydraulic pump. The hydraulic pump is driven by an electric motor.

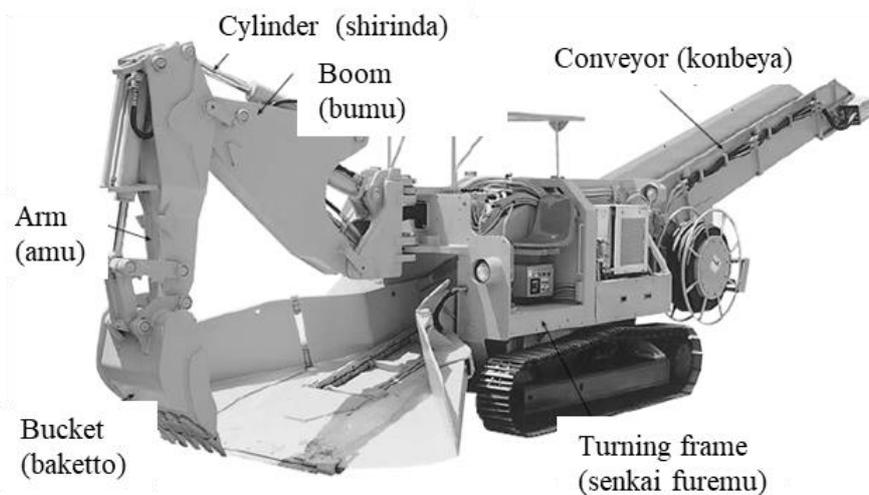


Figure 5-25 Example of work equipment for transferring loader

6. Handling of equipment related to the work of Vehicle-type construction machinery, etc.

6.1. Handling of tractor-type construction machinery and safe work (text p.97)

6.1.1. Bulldozer (text p.97)

1 . . . Basic operation

Figure 6-1 is an example of the bulldozer's operation device work device.



Photo 6-1 Example of bulldozer operating device

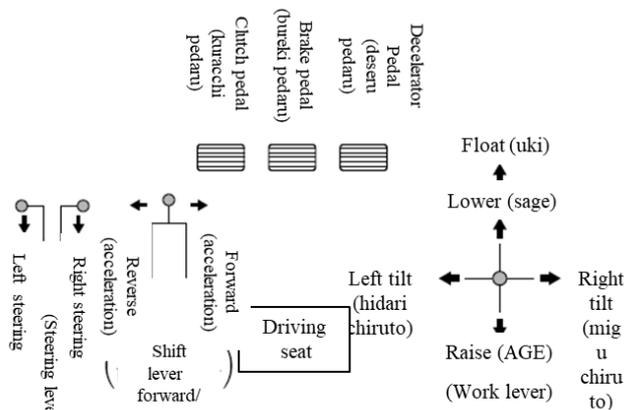


Figure 6-1 Bulldozer standard operation method

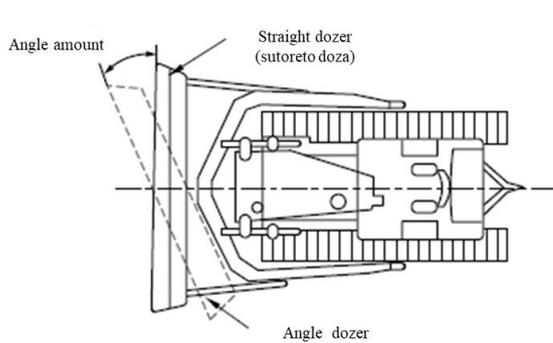


Figure 6-2 Example of angling

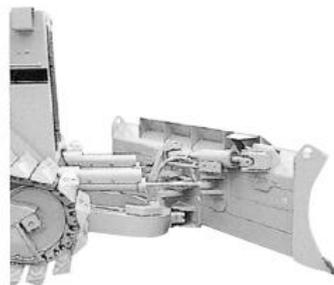
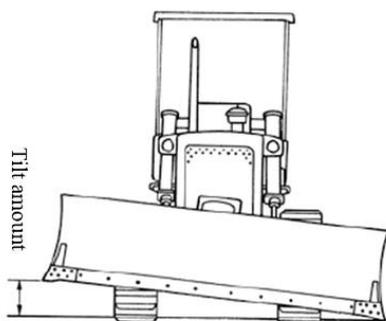


Photo 6-2 PAT vehicle angle posture



Tilting

Figure 6-3 Example of tilting

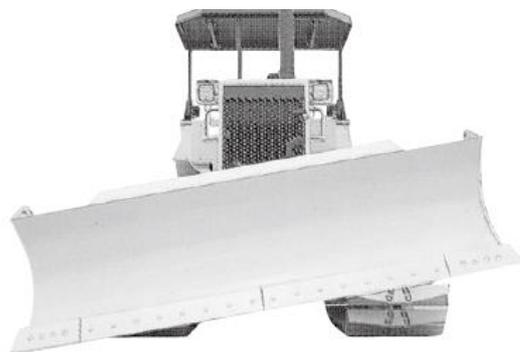
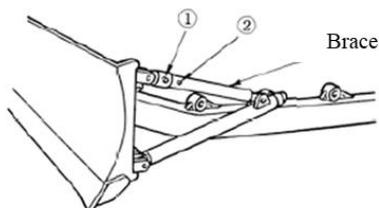


Photo 6-2 PAT vehicle tilt posture

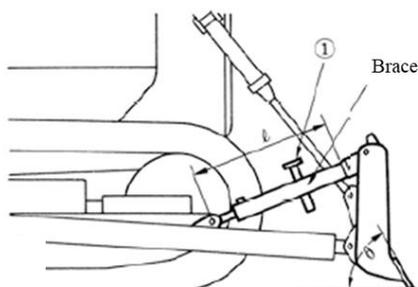


Figure 6-4 Cutting edge angle adjustment

## 2 • • • Basic Operation

### ① Basic caution notes

- a When driving, keep the edge of the blade at the height of about 40 cm from the ground and check the surroundings' safety.
- b As a general rule, climb up and down the slope (nori men) at a right angle. However, on a steep slope (nori men), do not climb backward or descend forwards.  
Note) If you have to descend a steep slope (nori men), descend in reverse or in a zigzag.
- c Dozing (oshido) work and excavation work have to be clearly separated. Set up so that dozing (oshido) distance is the shortest and perform it at low speed.  
Also, make sure that the crawler's entire surface is completely on the ground. Always keep the machine body in a horizontal state and operate.
- d For dozing (oshido) work, work efficiency is good when the downward gradient is used.  
Note) The most efficient downward gradient is about 20% (10 to 11 degrees), but it will be difficult to move backward if it exceeds that, and work efficiency will decrease.
- e The tension of the tractor crawler changes according to the soil quality. On gravel roads, loosen the tension below the specified level.
- f If the crawler slips on wetlands or soft ground, the fuel lever should be half-opened, the main clutch should be engaged slowly, and the steering clutch should not be operated.
- g The blade for leveling work should be finely operated so that it goes up at once, and the drop should be about 2 cm.

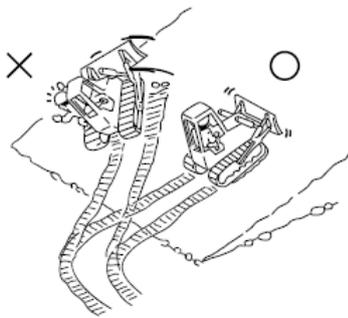


Figure 6-5 Example of driving on a slope (nori men)

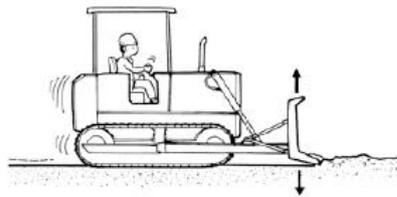


Figure 6-6 Example of blade operation

### ② Adaptation work

Bulldozers are used for earthwork such as excavation, dozing (oshido), and leveling with short-distance soil transport (about 50 m or less). In particular, Bulldozers are effective for excavating and linearly dozing (oshido).

In addition, when cutting the hillside, cutting one side of the hillside road, etc., a tilt blade or angle blade is used; when excavating frozen soil, hard soil, or ditches, it is efficient to use tilt blades.

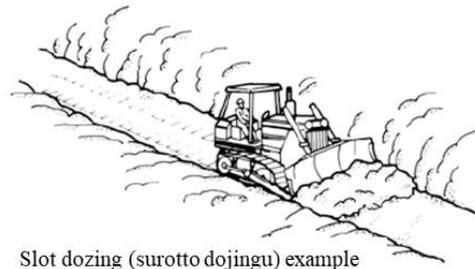
**a) Excavation work**

The excavation work is planned so that the excavated soil's transportation distance is the shortest.

Also, to improve drainage during rainfall, excavation should be carried out considering the natural drainage gradient. If necessary, a drainage ditch should be provided for excavation.

**<Ditch excavation work (slot dosing)>**

The excavation order shall be in the order of ①②③ in Fig. 6-7, the excavation depth shall be limited to the height of the blade, and the groove shall be excavated in a straight line. The bottom of the ditch will be excavated horizontally.



Slot dozing (surotto dojingu) example

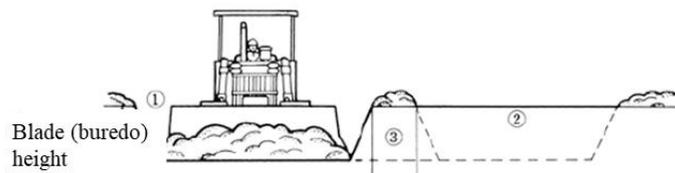


Figure 6-7 Example of ditch excavation

**<Slope (nori men) excavation work>**

**A. Grading works**

To perform the most effective grading work according to the lowering of the excavated ground, it is basically important to note the following.

- Improve drainage (HAISUI) on the slope (nori men).
- Be careful of rockfalls from the slope (nori men) and take measures to prevent rockfalls as necessary.
- Protect the toe of the slope (nori men) to prevent the slope (nori men) from collapsing.

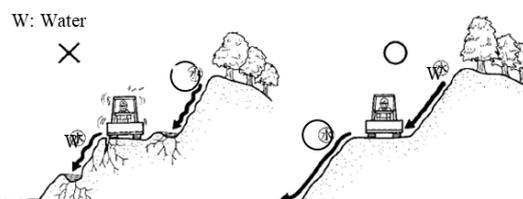


Figure 6-8 Example of slope (nori men) drainage (norimen haisui)

## B. Side cut work

The side cut work is performed by the following method.

- i) As shown in (a) of Fig. 6-9, Create a horizontal surface and excavate from that horizontal surface.
- ii) As shown in (b) of Fig. 6-9, After excavating a gentle slope (nori men), excavate so that it becomes a horizontal surface.
- iii) Like in i) and ii) without using embankment (MORIDO), work is performed only by excavation as shown in (c) of Fig. 6-9.

Note) If the slope (nori men) is steep, the method shown in Fig. 6-9 (c) is dangerous, so a different approach will be considered.

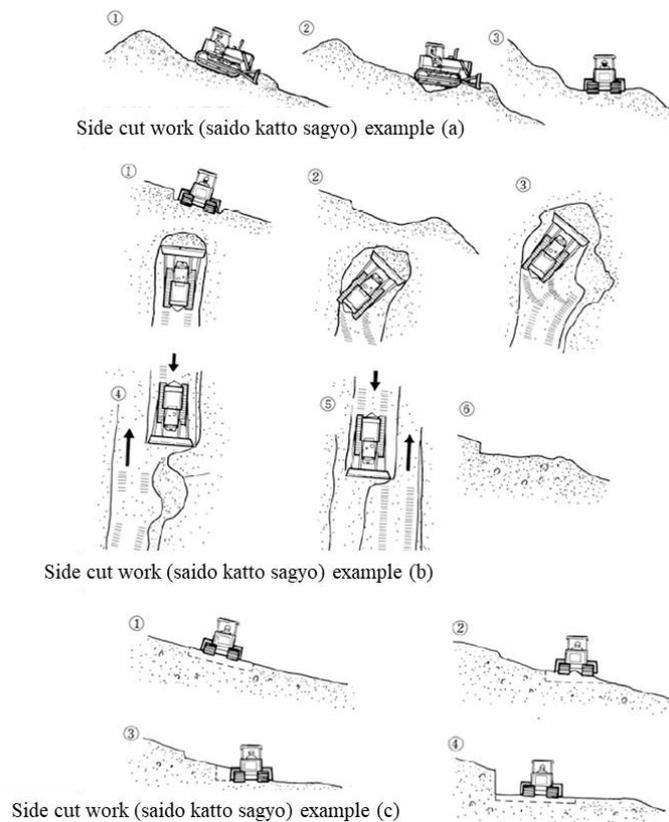


Figure 6-9 Example of side cutwork (saido katto sagyo)

### b) Dozing work (OSHIDO)

It should be remembered that the dozing (oshido) work pushes the earth and sand with a blade and at the same time creates a path for the machine.

In particular, pay attention to the following points in the dozing (oshido) work.

A. When the pressed soil's distance becomes long, do it in two steps push. The rough estimation if using this method can be considered when the blade's earth and sand are reduced by half or when the load is lightened a little after increasing the speed to 2nd speed (see Fig. 6-10).

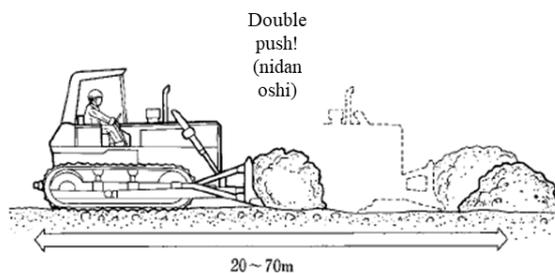


Figure 6-10 Example of double push

B. If the dozing (oshido) distance is long in a wide site, relaying with two units is more efficient than two-step pushing (see Figure 6-11).

C. Parallel dozing (oshido) work. Use the same machine model as much as possible (see Fig. 6-12).

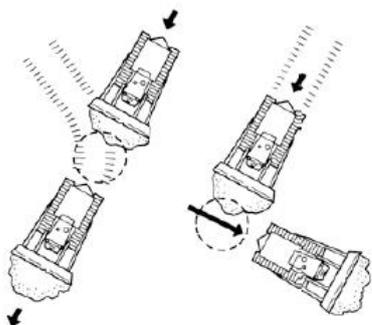


Figure 6-11 Example of relay pushing work

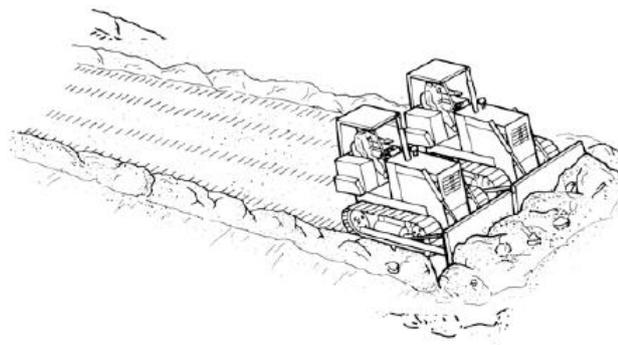


Figure 6-12 Example of parallel soil pressing work

Note) A heavy burden is placed on the steering clutch and final drive. Besides, slippage and machine stoppage reduce efficiency.

D Do not turn suddenly during dozing (oshido).

E When pushing the crushed rock, do not doze (oshido) until the bedrock is exposed.

F If the dozed (oshido) soil is leveled in consideration of compaction, it won't become double work (see Figure 6-13).

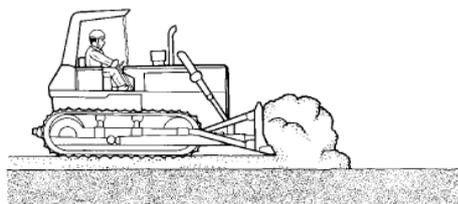


Figure 6-13 Example of spreading work

**c) Embankment (MORIDO) work**

Since excavation and dozer work is done consistently, the part to be filled from (embankment) is determined by a pre-planned method.

The piled-up soil is spread with a crawler every 15 to 20 cm of the thickness (see Fig. 6-14).

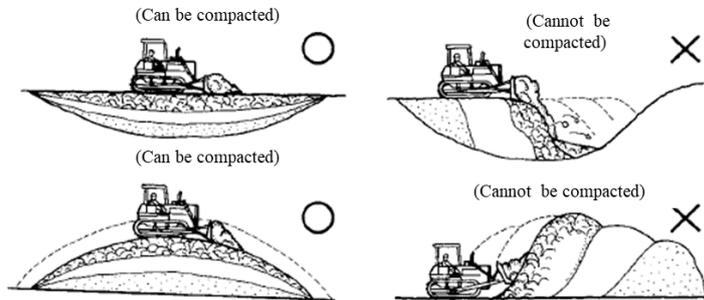


Figure 6-14 Example of compacting (shimegatame) embankment (morido)

The blade's operation when embankment (morido) while pushing the soil is shown in Figure 6-15. Push it with the tip of the embankment (morido) until all the sediment on the blade slides down, and then retreat. At this time, stop where the crawler does not come out from the embankment's (morido) shoulder.

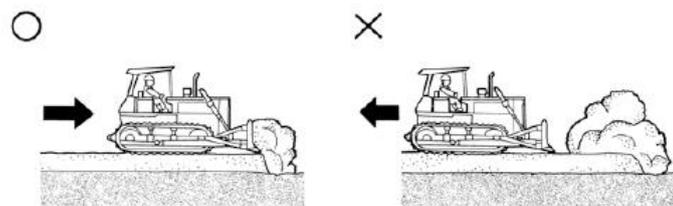


Figure 6-15 Example of embankment (morido) work

**d) Soil laying (removal) work**

For soil laying work, stand the blade vertically, raise the cutting edge slightly from the ground's surface, and make sure that the soil comes out from under the cutting edge. The thickness of the laying and the degree of compaction depend on the geological features.

e) Finishing work

When performing finishing work with a Bulldozer, if the machine starts lowered forward, the blades will rise from the ground when the machine is level; make sure the machine is level before lowering the blades.

Bulldozers are not suitable for fine finishing work (about 2 to 3 cm), so they are used for rough finishing. Fine finishing should be done with a motor grader (see Fig. 6-16).

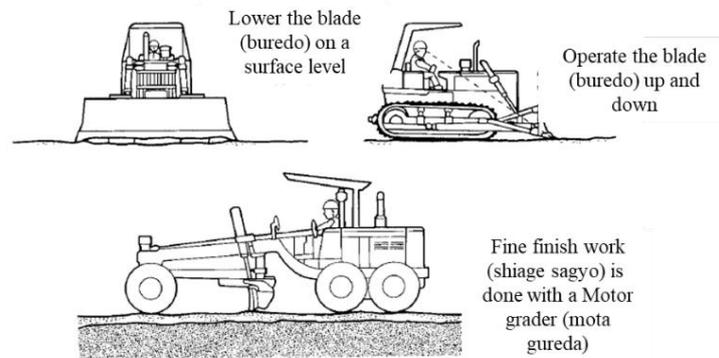


Figure 6-16 Example of finishing operation

For finishing work, since it is easier to fill the blade with soil than to empty the blade, fill the blade with about half of the soil and finely operate the blade according to the unevenness while pressing the soil to finish the surface flat. Rough finishing is done at medium speed. The finished surface should be finished by overlapping 1/4 of the blade each time (see Fig. 6-17).

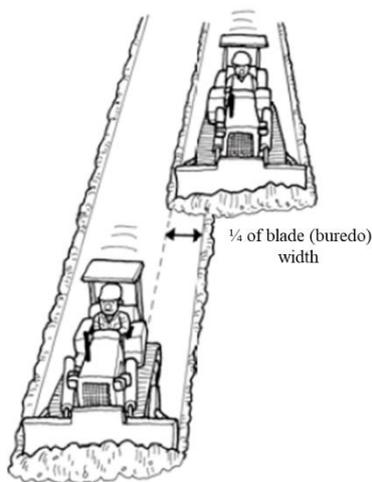


Figure 6-17 Example of rough finishing (ara shiage)

As a general rule, to finish the slope (nori men), climb forward to level the ground, descend in reverse. Also, pay particular attention to the following.

- A. Avoid leveling as much as possible when climbing or descending diagonally to the slope (nori men).
- B. Do not turn more than necessary when steering.
- C. Do not load the blade more than necessary.

To finish a gentle slope (nori men), start working parallel to the slope (nori men) from above. Also, be careful not to let the end of the blade get stuck in the ground, and be careful not to make the gradient more than the specified value.

D. For leveling a vast area (airports, field maintenance), use a blade control device (laser leveler) that uses a laser beam to improve efficiency and achieve a high-quality finish.

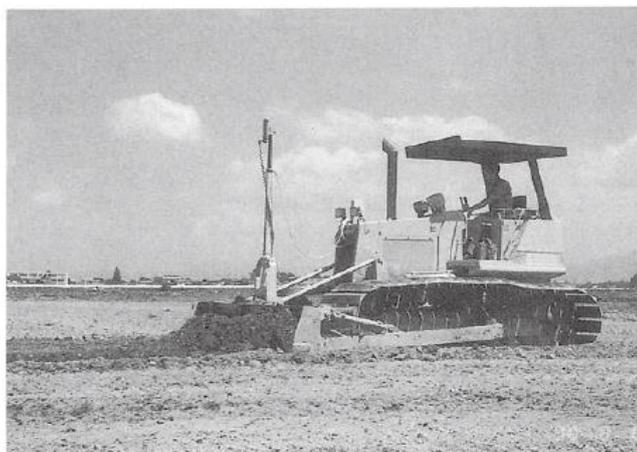


Photo 6-4 Example of blade control device

### 3 • • • Applied work

In the applied work by the bulldozer, pay particular attention to the following.

#### ① Logging/root removal work

After cutting trees and bamboo with a chainsaw, remove the weed and root with a bulldozer (see Figure 6-18).

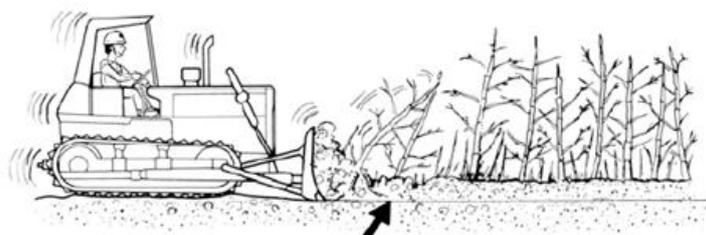
For weeds and small trees, push the blade 10 to 15 cm into the ground to cut the roots and move forward in 1st or 2nd speed.



Figure 6-18 Example of rooting and weeding work

Also, sometimes go backwards to remove roots and weeds that get caught on the cutting blade and then excavate again.

For root cutting of bamboo and bushes, it is easier to work with a hydraulic ripper.



For bamboo and bushes, set the depth to 20 to 30 cm.

Figure 6-19 Example of cutting roots of bamboo and bushes

Note) Since the blade may slip on bamboo and bushes' roots, it is necessary to cut to a depth of about 20 to 30 cm.

If there is continuous rooting and weeding work, it is desirable to replace the regular blade with a rake dozer.

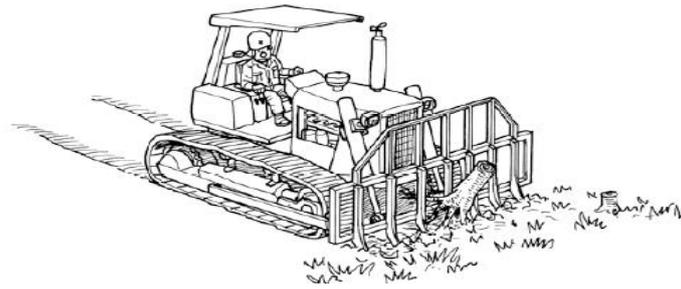


Figure 6-20 Example of rake dozer

## ② Boulder removal work

To remove boulders, tilt the blade so that the bulldozer force is concentrated on the edge of the blade and use the edge of the blade to remove the boulder (see Figure 6-21).



Figure 6-21 Example of soft stone removal work

To remove large rocks, first, cut the roots around with a Bulldozer while pressing raise the blade, disengage the steering clutch on the other side of the rock, separate and remove the ground and rocks.

As for the removal of concrete pavement, first, the concrete is broken with a concrete crusher (breaker, pick, etc.) and dig up with a tilted blade. When a part comes off, push it up toward the edge. Do the same type of digging as done in frozen areas. (See Figure 6-22)



Figure 6-22 Example of pavement removal work

### ③ Backfilling Work (Umemososhi Sagyo)

When using a bulldozer to backfill (umemososhi) a groove, approach the groove diagonally and drop the soil to backfill (umemososhi). Thoroughly compact the backfilled soil (see Fig. 6-23).

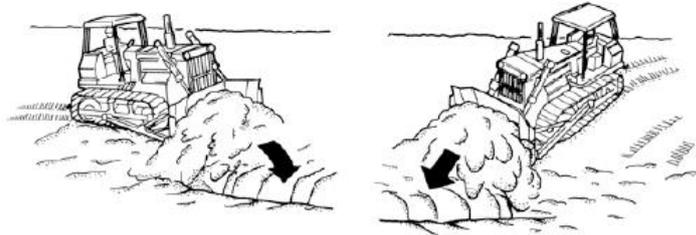


Figure 6-23 Example of backfilling (umemososhi) work

### ④ Ripping work

#### a) Hydraulic ripper

A ripper is the most common attachment that can be attached to the rear of a tractor.

Recently, there have been many restrictions on using the blasting method from the viewpoint of preserving the environment; also, due to the increase in the bulldozers' size, the traction force has increased, making it possible to excavate hard rock. The use of ripper is increasing.

Rippers include single shank clippers for heavy rock drilling and multi-shank clippers with multiple shanks for soft rocks (see Figure 6-24).

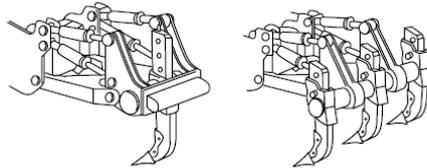


Figure 6-24 Example of single shank clipper and multi shank ripper

#### b) Ripper work

Blasting work and ripper work are generally used for rock excavation work.

Regarding the relationship between blasting work and ripper work, in general, the harder the rock, the better the blasting effect is, and conversely, the softer the rock, the better the efficiency of the ripper work.

It is difficult to judge whether or not the ripper work can be performed on-site and the difficulty (Ripperability), but there are the following three methods.

A. Ripper work is tested on-site. This is the most secure method.

- B. Observe the surface of the rock. Rocks with cracks and faults, weathered rocks, rocks containing brittle crystals, alternating or thin rocks, and rocks with low coupling are considered to be capable of ripper work.
- C. Judgment is made by measuring the elastic wave velocity of rocks with instruments called ripper meters, seismographs, etc. This uses the fact that the elastic wave velocity differs depending on the type and hardness of the rock.

In order for the ripper work to be performed sufficiently efficiently, it is necessary to correctly perform driving operations such as the mass and towing of the tractor, the penetration depth of the tip, and speed.



Photo 6-5 Ripper work

The basic items in construction are as follows.

- A. In principle, the working speed is 1st.
- B. Let the vehicle go straight. If you make a sharp turn while penetrating, the shank may break.
- C. The crushing depth is constant. When the crushing depth changes, the surface becomes uneven when pushing the slip or the next ripping, making the work difficult.
- D. Do not move backward while penetrating.
- E. Reduce the number of claws the harder the ground,

On the contrary, in a place where ripping is easy, it is more efficient to increase the number of claws than to increase the vehicle speed.

- F. Ripper depth is better to be as deep as possible to the extent that the car body's rear part does not rise.
- G. The ripper interval should be narrowed as the rock becomes harder and should be planned so that the degree of crushing does not vary depending on the location and leakage of crushing.
- H. Work should use the downward gradient as much as possible.

I. If the rock is hard and the rock layer, cracks, etc., are diagonal to the ground, rip in the opposite direction (see Figure 6-25).

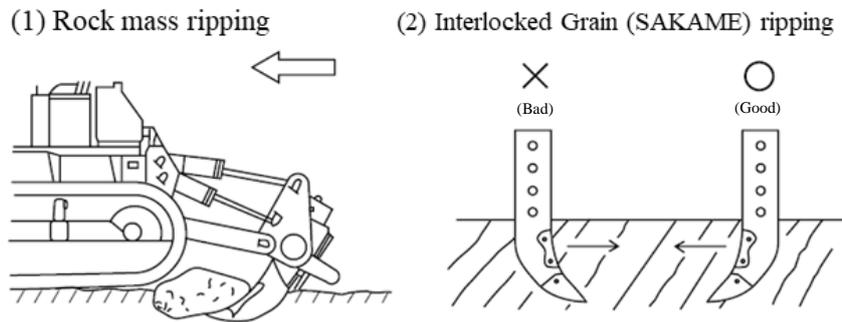


Figure 6-25 Ripper work in case of rock mass and interlocked grain (sakame)

J. If you encounter a rock mass that is difficult to crush during ripping and cause a shoe slip:

- i) Step on the decelerator pedal to reduce the engine speed to the extent that it does not slip.
- ii) Tilt to crush and dig up.

K. If one-way work is not enough, use vertical and horizontal crosses (see Fig. 6-26).

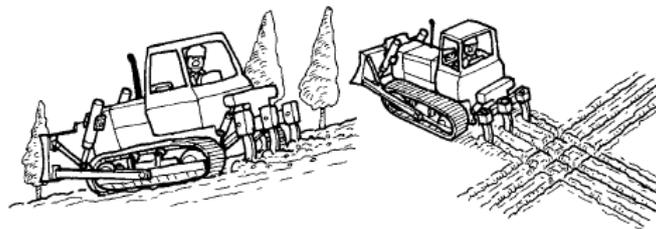


Figure 6-26 Downhill slope (nori men) and cross ripping

### ⑤ Working on soft ground

Drain the water that collects on the surface of the earth so that it can be drained as much as possible. When pushing the soil, do not let the blade hold too much soil to prevent the Bulldozer from slipping. On soft ground, try not to turn the steering wheel as much as possible and do not drive on the same road surface.

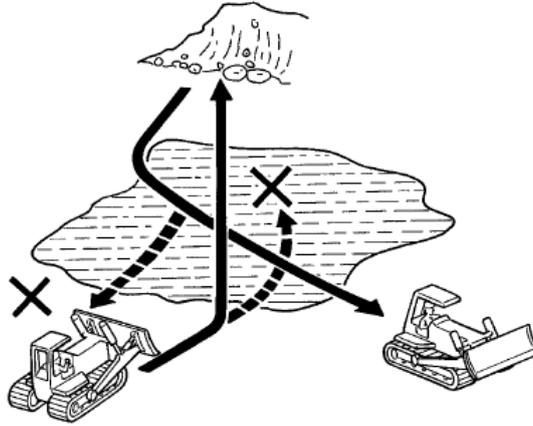


Figure 6-27 Example of passing through soft ground

In soft ground, bulldozers equipped with shoes for soft ground are often used because they have low ground pressure and good buoyancy.

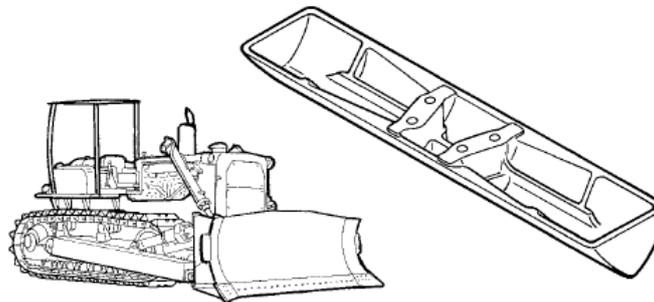


Figure 6-28 Example of soft ground shoe

### 6.1.2. Tractor shovel (shoberu) (text p.115)

Some tractor shovel (shoberu), both crawler type and wheel type, operate the lift arm and bucket with separate operating devices (generally levers), and some can operate both with a single operating device (See Fig. 6-29).

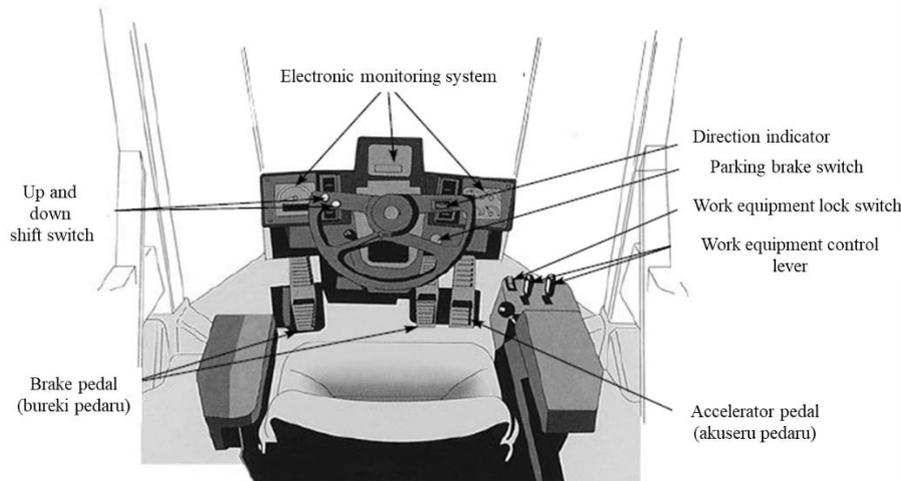


Figure 6-29 Example of tractor shovel (shoberu) operating device

The lift arm operating device can be roughly divided into the following positions for work.

- [Raise (age)]...... When raising the lift arm, use this position.
- [Hold]...... The lift arm's position is fixed; it does not move even if an external force is applied.
- [Lower (sage)]...... The lift arm is lowered hydraulically.
- [Float]......The lift arm moves up and down by an external force.

The bucket operating device is roughly divided into the following three positions for work.

- [Tilt]...... Raise the bucket toward you.
- [Hold] ..... The bucket is fixed to the lift arm and becomes one.
- [Dump (danpu)]...... Tilt the bucket forward.

Even if the operating device is set to the "raise (age)" or "tilt" position, the operating device automatically returns to the "hold" position when the bucket reaches the kick out or positioner adjustment position, and the bucket stops.

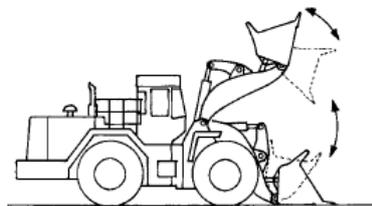


Figure 6-30 Example of lift arm and bucket operation

① Basic notes

- a If the road surface is rough, by the shaking of the machine, the bucket's spillage increases, so the road surface should be sufficiently maintained.
- b Reduce the half-clutch condition as much as possible and operate the clutch lever (or pedal) quietly and quickly.
- c If you lift (age) the bucket high, visibility and stability will be poor, so keep the bucket at the height of about 40 cm above the ground when driving.
- d The slope (nori men) should be climbed up and down as straight as possible toward the inclined ground.
- e When descending a steep slope (nori men) and the bucket is loaded, lower (sage) the bucket and use the engine brake at low speed to descend. Do not drive beyond stability.
- f The tension of the tractor crawler changes according to the soil quality. On gravel roads, it loosens from the predetermined tension (crawler type).
- g If the crawler slips on wetland or soft ground, the fuel lever should be half-opened, engage the main clutch softly and slowly, and the steering clutch should not be operated.

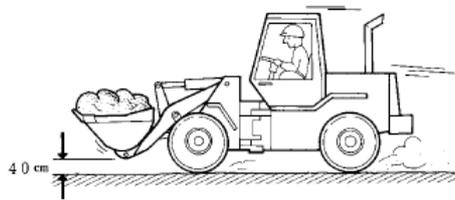


Figure 6-31 Example of bucket height when driving

a) Excavation work

A. Excavation is done with the car body at a right angle to the mountain. (See Figure 6-32.) In this case, the bucket is lowered to the ground in front of the mountain.

B. Excavation is performed so that the central part of the bucket comes to the overhanging part of the mountain (weak part of the mountain), as shown in Fig. 6-33.

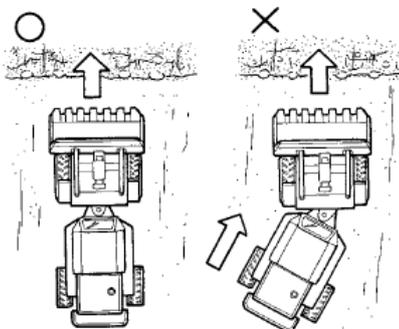


Figure 6-32 Example of excavation work (1)

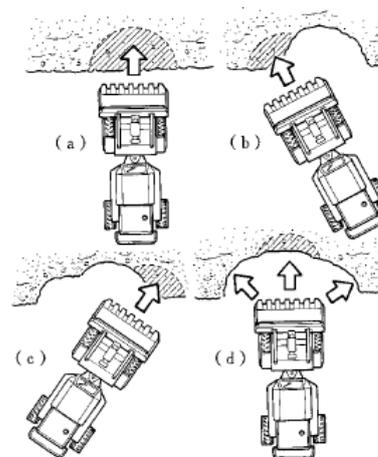


Figure 6-33 Example of excavation work (2)

C When scooping the bucket in excavation, push in as much earth and sand as possible before raising the bucket, raise (age) the lift arm a little, and then raise the bucket. If it is a little heavy, slowly divide it into 2 to 3 times.

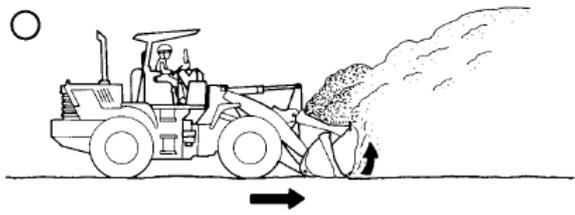


Figure 6-34 Example of excavation work (3)

D. In mountain excavation, where the work face (kiriha men) is self-supporting, be careful as it may result in undermining (sukashi bori). When such a situation is predicted, excavate from the top of the mountain, as shown in Fig. 6-35.

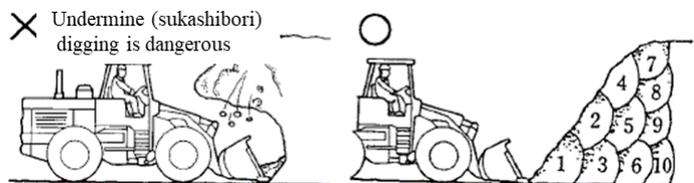


Figure 6-35 Example of excavation work (4)

**b) Loading and Transport work**

- A. Work at the 1st speed as much as possible in the speed stage.
- B. When loading a dump (danpu) truck, it is convenient to set the lift kick out at an appropriate position according to the truck's height.

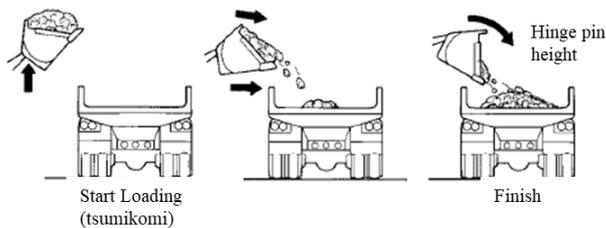


Figure 6-36 Example of loading and transporting work

C To dump (danpu) the bucket, keep the lift lever locked upwards, approach the dump (danpu) truck, raise (age) the bucket to a height suitable for loading, and when you get close to the loading platform, start opening the bucket dump (danpu) as soon as possible.

D. When loading the dump (danpu) truck, align the center of the earth and sand loaded on the centerline of the loading platform. If the loading platform is long and in case of loading about 3 to 4 buckets, start from the front of the loading platform.

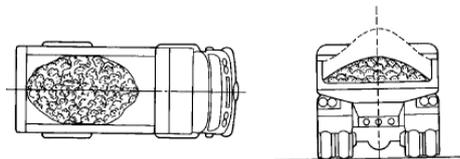


Figure 6-37 Example of loading conditions (1)

E. When loading large stones, if they are not loaded properly, the large stones will shift during transportation, and the dump (danpu) truck will roll over or rocks will fell off, which will interfere with the track. Also, it is dangerous for other machines and people, so unstable loading and overloading are prohibited.

If it cannot be transported by a dump (danpu) truck, move the boulders, and, after breaking them into small pieces, transport.

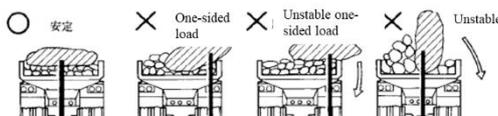


Figure 6-38 Example of loading conditions (2)

There is a method shown in Fig. 6-39 for arranging trucks when loading work. Also, when the same cycle is repeated, it is efficient to adjust the kick out and the positioner in advance according to the working condition.

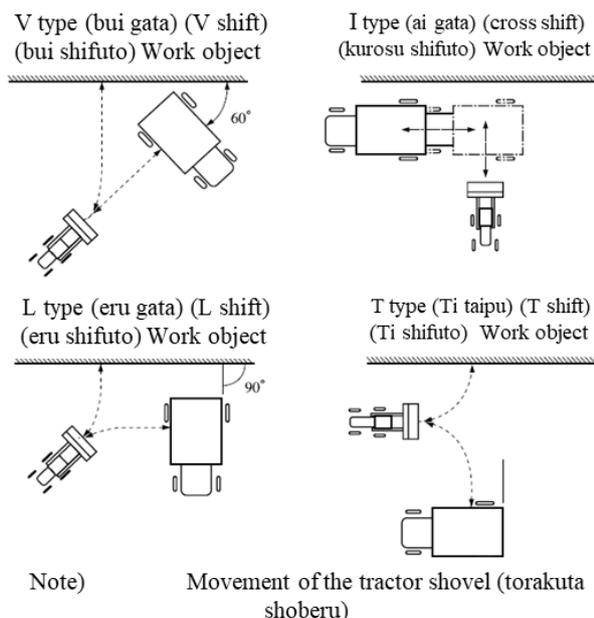


Figure 6-39 Example of loading work

V shift, etc.

Also, the road and carry method a method of continuously scooping, transport, and loading with only a tractor shovel (shoberu). (See Table 6-2). This method is effective for crushing sites where the distance from the work face (kiriha) to the loading entrance is short without the need for a dump (danpu) truck.

Figure 6-2 Table of example of load and carry method

<p>① Turning on an even bench</p>	<p>Do not turn regardless of whether the ground is flat or not. In general, the place to turn on a flat bench should be near the face when loading, and near the inlet (tonyuko) when heading for the face after loading.</p>
<p>② Turning on a bench with upward slope</p>	<p>The bench is usually transported backward to prevent spillage on benches with upslope toward the face (downslope toward the inlet). Select an even place as much as possible for the turning place, and depending on the bench's condition, it is often the case that the turning place is near the inlet (tonyuko).</p>
<p>③ Turning on a bench with downward slope</p>	<p>On a bench with a downward slope toward the face (upward slope toward the inlet), turns near the face during transportation, and when returning, turns by selecting an even place in the area depending on the presence or absence of spillage. Even if the distance between the inlet (tonyuko) and the face is short, turn as described above.</p>

This construction method varies depending on the size of the tractor shovel (shoberu) work setup, etc., but generally, it is suitable for transport distances of about 30 to 100 m; the standard load for buckets is flat stacking. Do not raise (age) the bucket high or make sharp turns.

In this case, if the transport path is incompletely maintained and uneven, the bucket may vibrate, the tilt relief (safety device for the hydraulic circuit) may be activated, and the bucket may move in the dump (danpu) direction, so be careful.

Ideally, the loading operation should be performed from transport, speedily and safely, without stopping the machine.

For that purpose, as shown in Fig. 6-40, the area around the inlet should be a slope (nori men) where natural deceleration of the tractor shovel (shoberu) can be expected, and the timing should be well-matched with the dump (danpu) state of the bucket.

Also, since it is easy to make a mistake when working at night, install lighting.

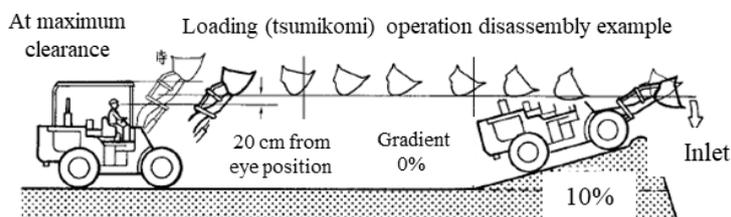


Figure 6-40 Example of throwing work

**6.2. Handling of shovel (shoberu)-type construction machinery and safe work (text p.123)**

**6.2.1. Hydraulic shovel (shoberu) (backhoe) (text p.123)**

**1 . . . Basic operation**

The basic operation of hydraulic shovels (shoberu) includes raising and lowering the boom and the arm, stretching and scooping the bucket, there is turning of the upper frame.

The Ministry of Land, Infrastructure, Transport, and Tourism decided to popularize machines with a unified operation method. Since 1993, it has been obliged to use it for construction under the Ministry of Land, Infrastructure, Transport, and Tourism jurisdiction.

This operation method is consistent with JIS (Japanese Industrial Standards) established in 1990.

Also, a designated label is attached to this operation method.

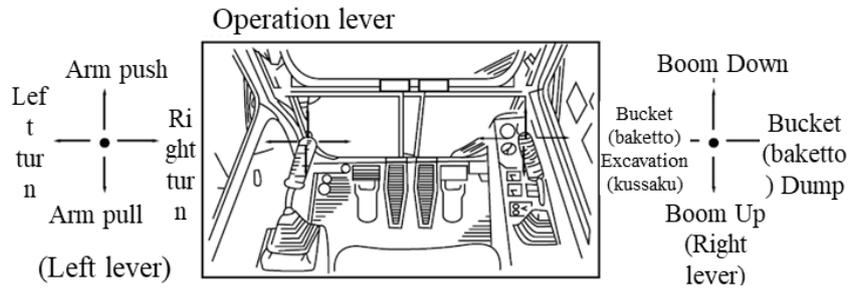


Figure 6-41 Example of hydraulic shovel (shoberu) operating device

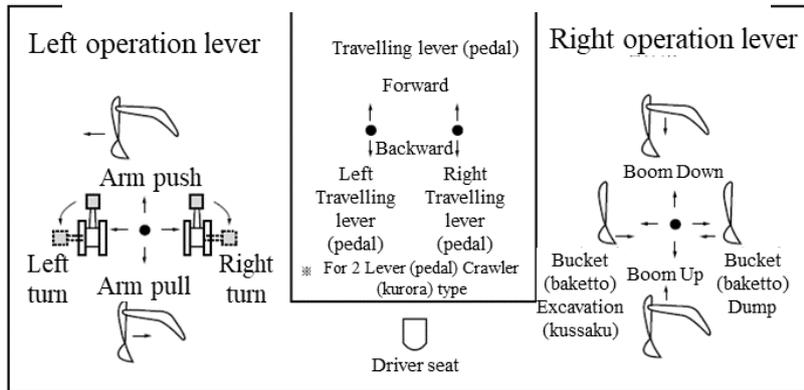


Figure 6-42 JIS Standard operation method

## 2 • • • Basic operation

The hydraulic shovel (shoberu) is mainly suitable for excavation under the ground surface, but various operations can be performed, as shown in Fig. 6-43. Please also refer to the section "6.2.2 Hydraulic shovel (shoberu) (loading shovel (shoberu)) 2 Basic work" for the hydraulic shovel (shoberu).

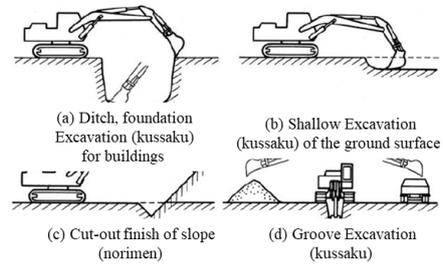


Figure 6-43 Basic work with a hydraulic shovel (shoberu) (Backhoe)

① **Basic notes**

- a When traveling, keep the bucket at the height of about 40 cm from the ground surface and check the machine's orientation, the traveling direction, and the surroundings' safety (see Fig. 6-44).
- b Do not climb or descend steep slopes (nori men) that exceed Stability. Also, in the middle of a steep slope (nori men), do not turn the steering.
- c When driving on inclined, be sure to apply the turning brake.
- d If you have to overcome obstacles, use the boom, arm, and bucket to raise (age) the crawler's front and pass. However, the machine's inclination at this time should be within the range of stability.
- e When traveling on soft ground, bring the bottom of the bucket into contact with the soft ground and travel quietly while sliding.
- f Do not scoop or crane with a bucket.
- g Use the bucket for its suitable work.
- h Do not drop the work equipment suddenly after the engine is stopped.

Note) If abnormal pressure is applied to the hydraulic equipment, the hydraulic hose, etc., may be damaged.

- i Depending on the soil quality and surrounding conditions, do not excavate to the machine's feet.

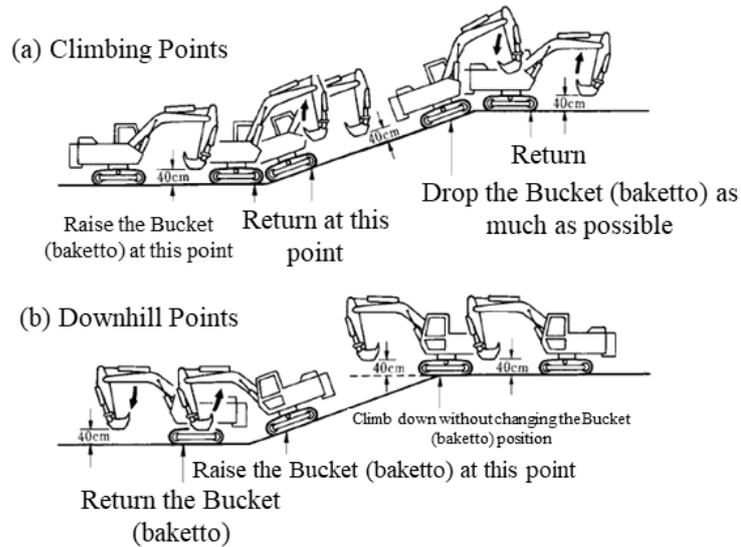


Figure 6-44 Climbing and descending points

## ② Precautions for excavation work

In particular, the following points should be noted in excavation work using a hydraulic shovel (shoberu).

- a When the angle between the arm cylinder and the arm is 90 degrees, as shown in Fig. 6-45, the excavation force by the arm cylinder is maximized. When the angle between the bucket cylinder and the link is 90 degrees, the excavation force by the bucket is maximized.

The angle between the bucket's cutting edge and the ground is about 30 degrees, which improves excavation.

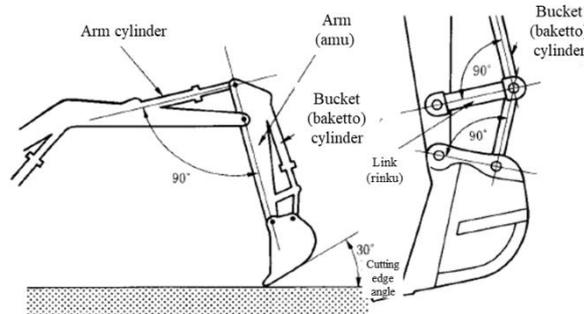


Figure 6-45 Example of basic work with a hydraulic shovel (backhoe)

- b The most efficient excavation range by the arm is about 45 to 50 degrees forward and 15 to 30 degrees in front of the arm from the vertical.

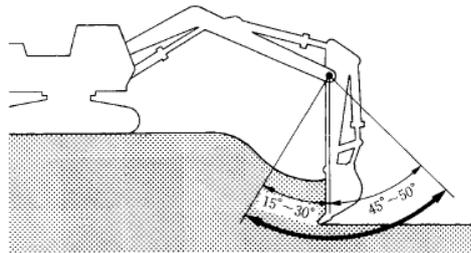


Figure 6-46 Most efficient excavation range with arms

- c The vehicle will be installed in a horizontal position for better stability during excavation and turning.  
If it is unavoidable to install it on a slope (nori men), etc., fill the slope (nori men), etc., to make the vehicle body as horizontal as possible.
- d Pay attention to the drainage at the excavation site, remove any obstacles to the excavator's working range, and run the transport truck.
- e Excavation work varies depending on the soil quality, but the height of excavation can be safely worked depending on the boom's length. The excavation depth is the maximum excavation depth considering the road shoulder's visibility and collapse. (Indicated in the instruction manual). Do it with more margin.
- f When excavating to your feet in underground excavation, the shoulder may collapse, sideways excavation of crawlers is dangerous, so consider evacuation in an emergency.
- g Do not excavate using the vehicle body's weight by floating the bottom of the vehicle body.

- h Do not turn during excavation; use the turn force to backfill or level the soil.
- i Do not excavate by fixing the bucket and running the crawler.

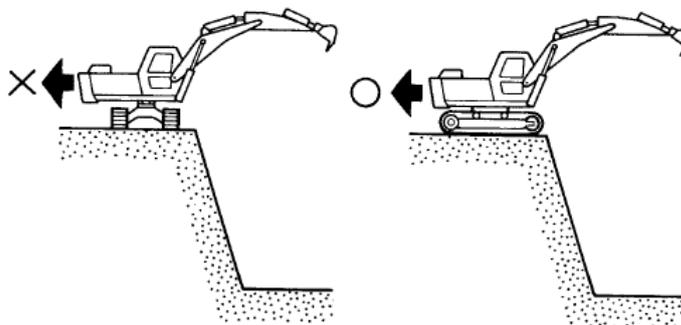


Figure 6-47 Direction of crawler when excavating on the

### ③ Precautions for loading work

Particular attention should be paid to the loading work using the hydraulic shovel (shoberu) as follows.

- a When loading excavated sediment onto a dump (danpu) truck, the vehicle fixed position is about the height of the dump (danpu) truck (up to 2.5 m), which gives good visibility to the dump (danpu) truck. A large damping clearance can be obtained only above and below the boom cylinder.

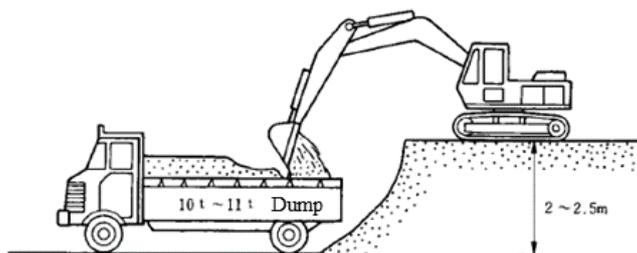


Figure 6-48 Example of loading work (1)

- b When loading on a dump (danpu) truck, do not turn over the driver's seat but turn from behind the loading platform.

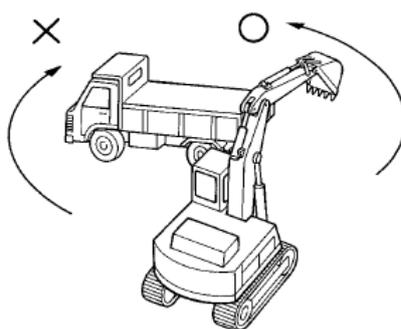


Figure 6-49 Example of loading work (2)

c The turning angle for loading on the dump (danpu) truck should be as small as possible.

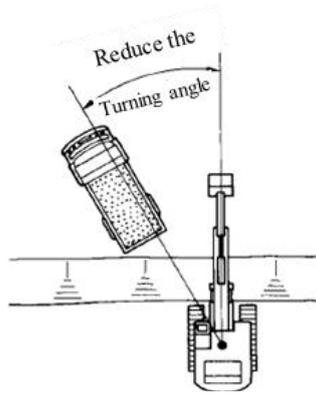


Figure 6-50 Example of loading work (3)

d How to attach a dump (danpu) truck, as shown in Figure 6-51, this Imposition is efficient.

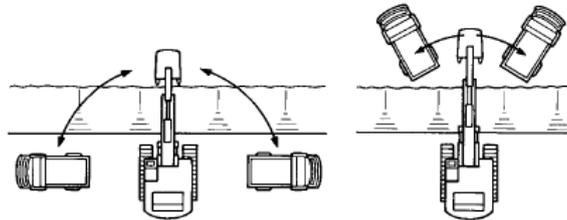


Figure 6-51 Example of loading work (4)

e Attach a dump (danpu) truck to the rear of the machine in tight spaces.

Keep the distance between the dump (danpu) truck and the machine when turning.

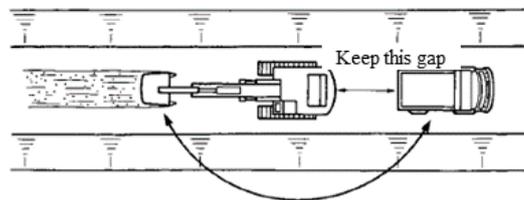


Figure 6-52 Example of loading work (5)

f For loading work of dump (danpu) trucks on soft ground, workability will be improved if gravel or the like is laid on the dump (danpu) truck running path.

g For sediment, It is better to load the dump (danpu) truck from the front to the back. The soil removal status of the bucket is easy to see, and loading is easy.

When loading large stones, etc., if you first load small items on the loading platform and then load large stones on it, the shock given to the dump (danpu) truck will be small.

Many hydraulic shovel (shoberu) (backhoe) attachments have been developed, including excavation telescoping, clamshell buckets, long arms, and long booms.



Figure 6-53 Example of telescoping

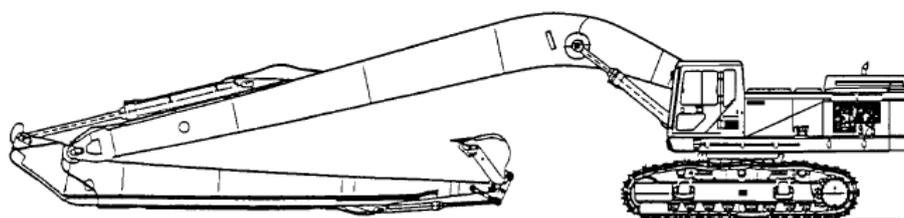


Figure 6-54 Example of long arm

### 6.2.2. Hydraulic shovels (shoberu) (loading shovels (shoberu)) (text p.131)

There are two types of loading shovels (shoberu), hydraulic and mechanical, but since the mechanical type is rarely used at present, the hydraulic loading shovels (shoberu) are shown below.

#### 1 • • • basic operation

The loading excavator's operation includes moving up and down the boom and the arm, rotation of the bucket, and rotation of the upper pedestal.

Since the loading shovels (shoberu) use the parts of the hydraulic shovel (shoberu) (backhoe) as they are, the work operation is performed according to the case of "6.2.1 Hydraulic shovel (shoberu) (backhoe) 1 basic operation".

## 2 . . . Basic work

The loading excavator is most suitable for excavation from the position where the machine is placed to the upper part, but it can also perform operations such as excavation along the ground surface and slope (nori men) shaping.

Also, refer to the section "6.2.1 Hydraulic shovel (shoberu) (backhoe) 2 basic work" for the hydraulic shovel (shoberu).

### ① Excavation method

These are the following methods for excavation by loading shovel (shoberu).

#### a Upper excavation

As shown in Fig. 6-55, excavate with a slight uphill slope (nori men) in consideration of drainage. Also, don't dig deep at once; excavate by scraping thinly.

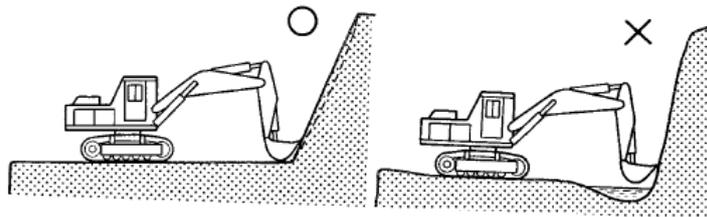


Figure 6-55 Example of upper excavation work

#### b Lower excavation

In lower excavation, the excavation work surface is first created and excavated. Figure 6-56 is an example of this, and the width of the approach slope (nori men) should be wide enough to be loaded onto a dump (danpu) truck on the site at a turning angle of 90 degrees. If it becomes impossible to load the dump (danpu) truck, put the dump (danpu) truck backward on the approach slope (nori men) and load the shovel (shoberu) by turning 180 degrees.

When a sufficient cut surface is created, the work area is expanded, and the main work is started.

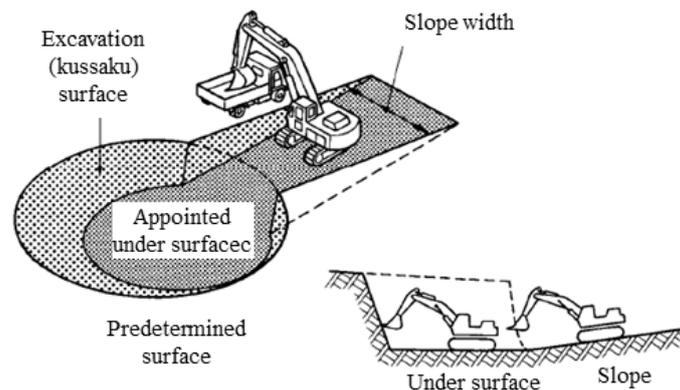


Figure 6-56 Example of lower excavation work

**c Direct excavation**

This method of excavation is to dig forward from position (a) as shown in Figure 6-57, and if the dump (danpu) truck does not enter within the 90-degree turn of the shovel (shoberu) in (b), as shown in (c), move the machine next to it and excavate. According to this method, both the shovel (shoberu) and the truck separated from the excavated surface, so there is an advantage that it is easy to evacuate when a landslide occurs at the time of high cutting.

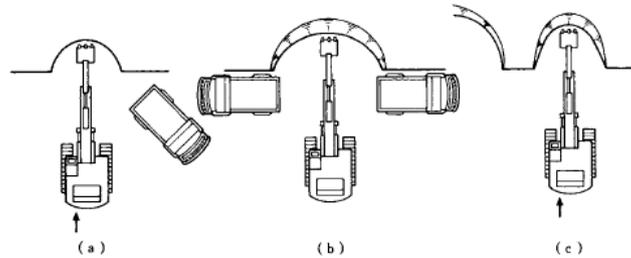


Figure 6-57 Example of straight-ahead excavation work

**d Translational excavation**

In this excavation method, as shown in Fig. 6-58, the loading shovel (shoberu) excavates and loads while proceeding parallel to the cut surface. This method is suitable for cutting the ground linearly.

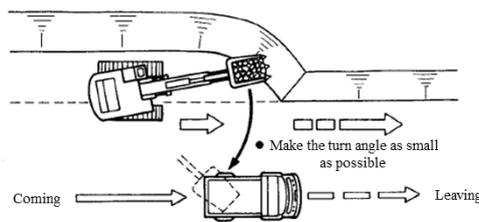


Figure 6-58 Example of translational excavation work

**e Bench cut**

There are two types of excavation of large amounts of soil with a loading shovel (shoberu): the sidehill type bench cut method and the box type bench cut method.

The sidehill bench cut method is a method suitable for excavating across slopes (nori men), such as hillside road excavation work. The cutting height shall be the optimum excavation height of the shovel (shoberu), and the excavation width shall be the width that allows translational excavation. Excavation proceeds in the order of ①②③ . . . in Fig. 6-59.

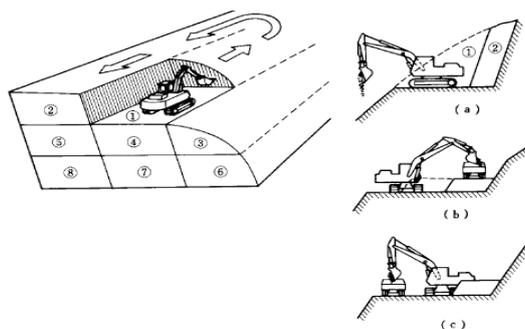


Figure 6-59 Example of side hill bench cutting method

The box-type bench cut method is an excavation method suitable when the local board is almost flat, and the excavation procedure is almost the same as the side hill type bench cut method (see Fig. 6-60).

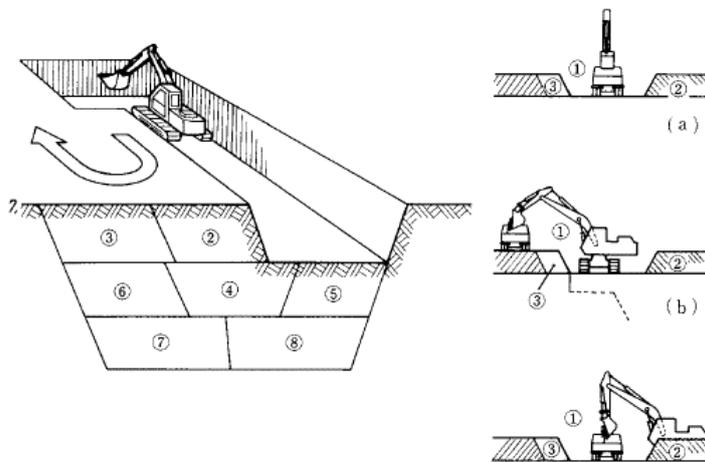


Fig. 6-60 Example of box-type bench cutting method

## ② Precautions for excavation work

In the excavation work with the loading shovel (shoberu), special attention should be paid to the following in addition to the section "6.2.1 Hydraulic shovel (shoberu) (backhoe) 2 Basic work (2) Precautions for excavation work".

a) The cutting angle (rake angle) of the bucket should be small for hard soil or high cuts (see Figure 6-61).

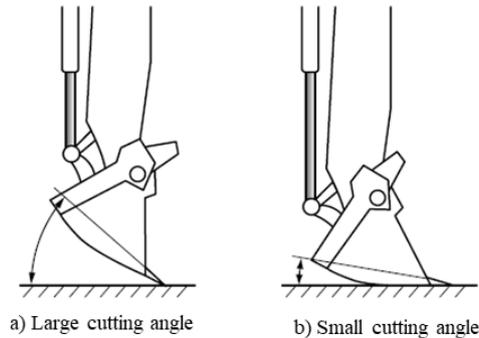


Figure 6-61 Bucket cutting angle

b) The machine should be placed at a position not too far from the excavation surface and not too close to the excavation surface for excavation. The bucket should also not hit the base of the boom or the crawler.

c) Do not turn the bucket's claws even though they are stuck in the sediment, and do not shake the bucket from side to side to use it as a broom for leveling.

d) Work with the turning angle as small as possible.

### ③ Precautions for loading and dumping work

The method of loading and dumping excavated soil with a loading shovel (shoberu) is shown in Fig. 6-62; the excavated soil is not discharged from a high position during loading. For other precautions, refer to the section "6.2.1 Hydraulic shovel (shoberu) (backhoe) 2 basic work ③ Precautions for loading work".

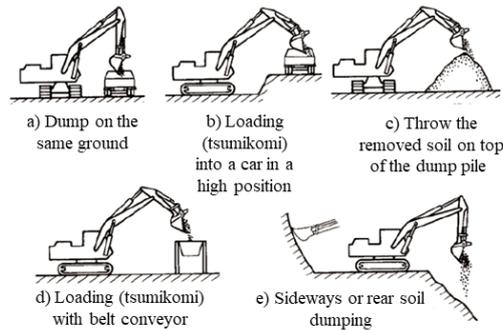


Figure 6-62 Example of loading soil with a loading shovel

### 6.2.3. Clamshell (text p.136)

#### 1 · · · Basic operation

The basic operations in mechanical clamshell work are as follows.

#### ① Unwinding

Open the excavation open-close brake and open the bucket; while adjusting the hoisting support brake, loosen and unwind the bucket.

#### ② Excavation

When you reach the excavation surface, loosen the hoisting (supporting) brake and engage the excavation clutch.

After excavation, when starting to wind the bucket with an excavation rope, at the moment of winding the bucket, engage the winding (support) clutch, loosen the hoisting brake. At this time, if the timing to engage the winding clutch is delayed, the winding wire rope will slacken, and if it is too early, the contents of the bucket will spill, so be careful.

#### ③ Turn, release, prepare for excavation

When winding up the bucket, tighten the excavation (opening and closing) wire rope. When the bucket is out of the ground and reaches a predetermined height, the turning clutch is gradually operated to turn to the release position. When the release position is reached, disengage the hoisting clutch and excavation clutch, apply both brakes, loosen only the excavation brake, and release the bucket.

When the release is completed, apply the excavation brake while turning to the excavation position. Then loosen the excavation brake while applying the winding brake to unwind the bucket and start the next excavation.

## 2 . . . Basic work

Clamshells are used for vertical excavation under the ground surface. Soil suitable for excavating is limited to relatively soft to moderate hardness, but underwater excavation is possible.

In addition, it is often used for processing loose objects such as gravel and crushed stone, and can be effectively used for loading into a storage bottle at a high position.

### ① Excavation method

This is an example of work with a clamshell.

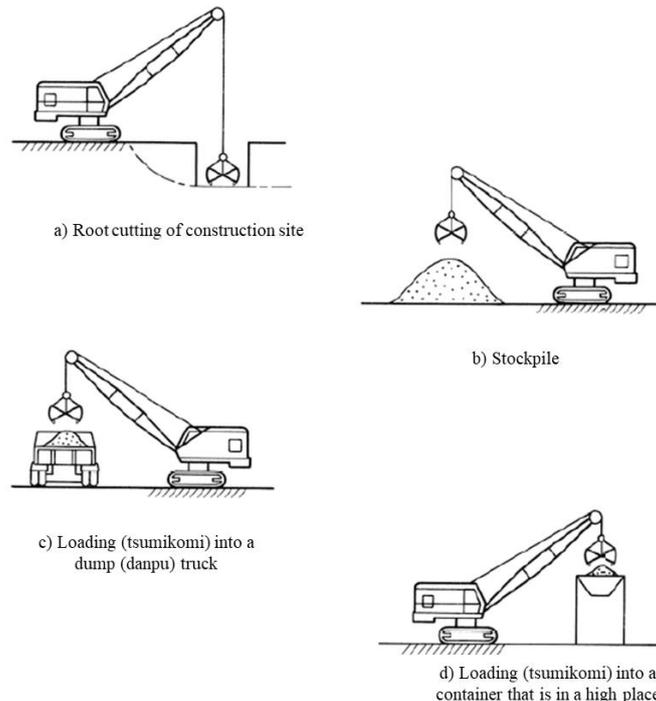


Figure 6-63 Example of work with clamshell

### ② Precautions for excavation work

In clamshell excavation, special attention should be paid to the following points.

- When excavating in soft soil, the machine should be mounted on a sturdy base or on a horizontal roadbed.
- Keep the boom as short as possible and set it upright.
- Use an anti-sway wire rope for the bucket and swing the machine gently.

## 6.2.4. Dragline (textbook p.137)

### 1 . . . Basic operation

The basic operations in dragline work are as follows.

#### ① Excavation

The digging depth is adjusted by operating the hoisting clutch and hoisting brake together.

## ② Hoisting

When the hoisting bucket becomes full, turn off the excavation clutch, apply the excavation brake, and turn on the hoisting clutch. At that time, the excavation brake is used to gradually slide and roll the bucket upward. The excavation brake balances the bucket so that the contents do not spill.

## ③ Turning

After lifting off the bucket, gradually operate the turning clutch to turn the bucket. At this time, the bucket should be wound up to a height where the tip of the bucket claw does not come in contact with a target object such as a truck when it is dumped.

## ④ Dump (danpu)

When the bucket reaches the dump (danpu) target, loosen the drag rope and excavation rope and dump (danpu). At this time, if the excavation brake is suddenly loosened, the bucket will move farther than expected, and not only will it not be possible to dump (danpu) accurately, but it will also hit the cab of the truck, so be careful.

## ⑤ Turning, excavation standards

At the same time as the dump (danpu) is finished, loosen the excavation brake and hoisting brake while turning to return to the original excavation position. At this time, the method of loosening the brake must be adjusted according to the predetermined arrival position of the bucket. Also, be careful not to loosen the wire rope too much.

## 2 • • • Basic work

Draglines are mainly used for riverbed dredging, waterway excavation, soft ground excavation, aggregate collection, etc., and are not suitable for excavation of hard soil or deep excavation compared to drag shovels (shoberu), but are suitable for excavation of shallow and wide areas

### ① Excavation method

This is an example of excavation and loading work using a dragline.

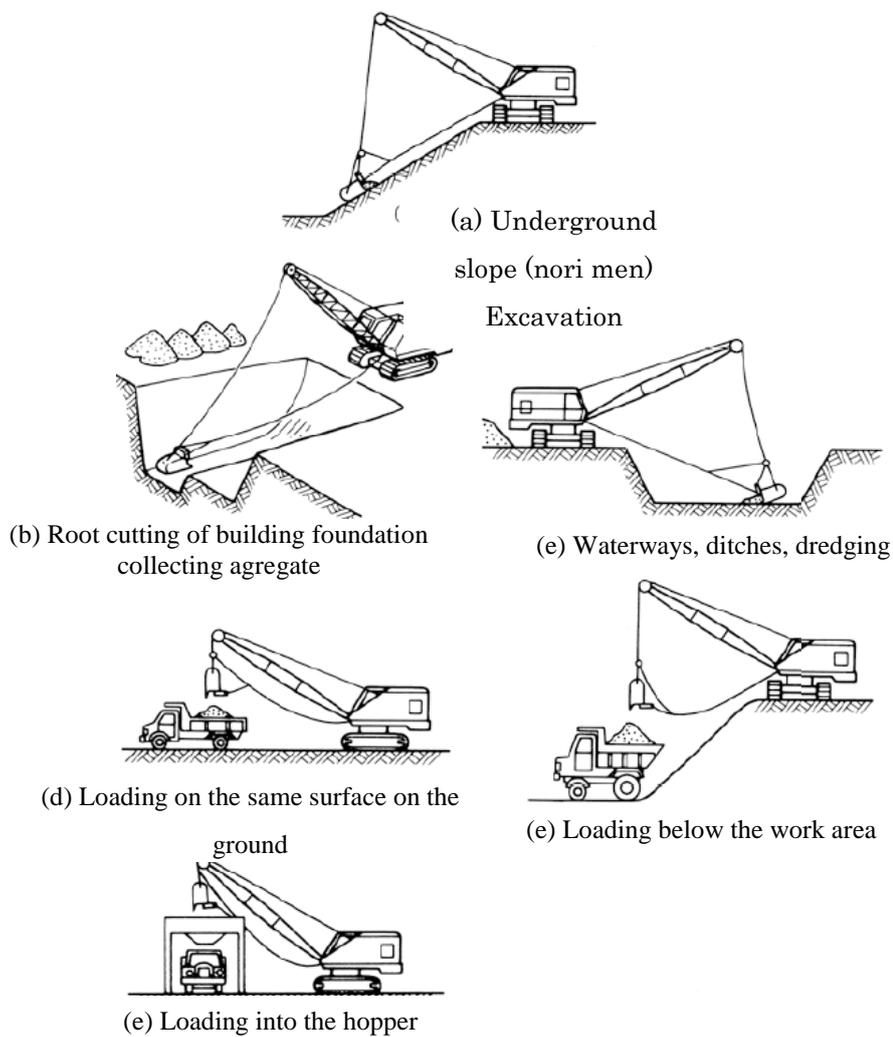


Figure 6-64 Example of excavation and loading work by drag line

**② Precautions in excavation work.**

During excavation work using a dragline, pay special attention to the following.

- a Use a bucket of a size appropriate for the machine's capacity.
- b Since drag chains and shackles (shakkuru) are subject to severe wear, inspect them thoroughly and replace defective ones.
- c Use a dump (danpu) rope of an appropriate length.
- d The boom should be raised (age) as high as possible.
- e The boom angle should not be used at an angle less than the limit (usually about 30 degrees) specified for the machine. (See Figure 6-65).

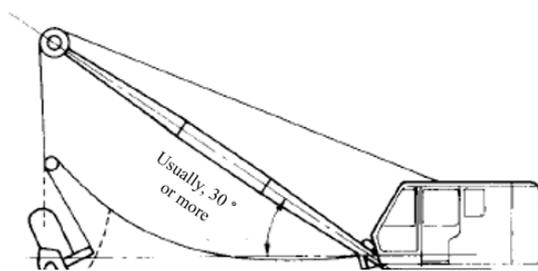


Figure 6-65 Boom limit angle

- f Try to dig thin and wide.
- g Do not hit the boom with the bucket or slam the bucket into the ground.

**6.3. Handling and safe operation of motor graders and scrapers (textbook p. 140)**

**6.3.1. Motor grader (textbook p.140)**

**1 . . . Basic operation**

The operating devices of the work equipment of the motor grader include the operating levers for blade lifting and lowering (left and right), leaning operation lever, blade lateral feed, drawbar lateral feed, articulating operate lever, blade rotation operate lever and scarifier lifting and lowering operate lever. There are two types of operation methods: mechanical and hydraulic.

Figure 6-66 shows an example of the operating device of the motor grader work equipment.

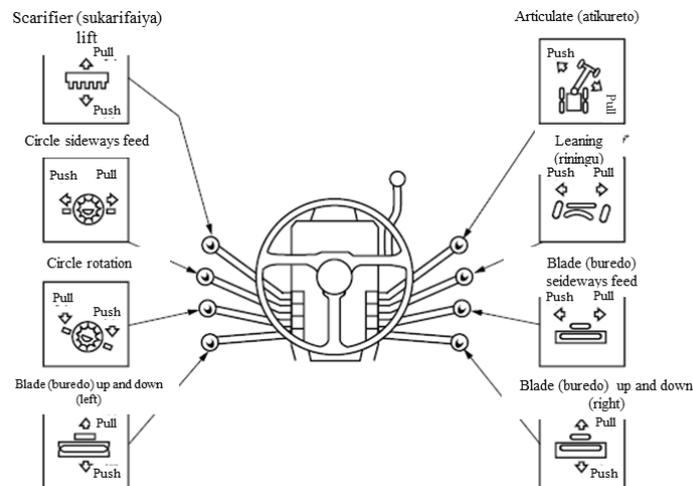


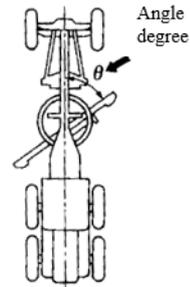
Figure 6-66

The following is a list of things to keep in mind when operating the system.

- ① As shown in Table 6-3, the blade's angle should be reduced when cutting deeply and increased when cutting shallowly, but since the angle affects the efficiency of the work, the work should be performed at an appropriate angle for the work. Normally, the standard angle is about 60 degrees, but the angle should be about 90 degrees when finishing.

**Table 6-3 Soil quality and angle degree**

Soil quality	Angle degree ( $\theta$ )
Hard soil	45°
Soft soil	55°
Soil gathering	60°
Finishing	90°



- ② The standard blade tip (cutting) angle is 30 to 40 degrees, but basically, it should be reduced for hard soils and increased for soft soils (see Figure 6-67).

- ③ Excavation of asphalt, gravel, etc., is done with a scarifier, and the edge of the blade (cutting) angle is around 60 degrees, but for digging up asphalt roads, the angle is around 70 degrees (see Figure 6-68).

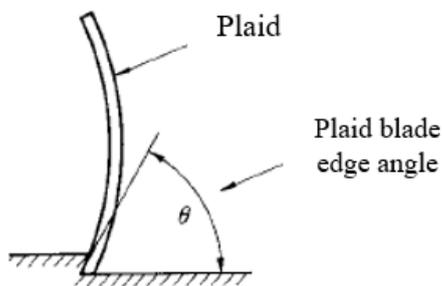


Figure 6-67 Blade edge angle

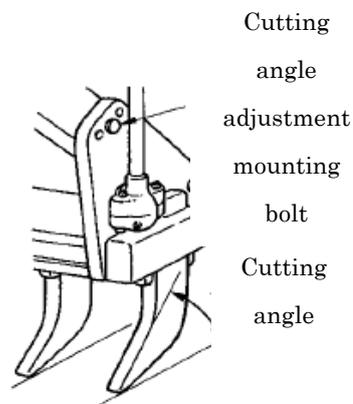


Fig. 6-68 Scarifier cutting angle

## 2 • • • Basic work

### ① Basic precautions

- a Although it depends on the type of work, the work speed should be approximately 3 to 6 km/h.
- b Tire leaning (tilting) during work should be done in the windrow direction according to the degree of load (see Fig. 6-69).

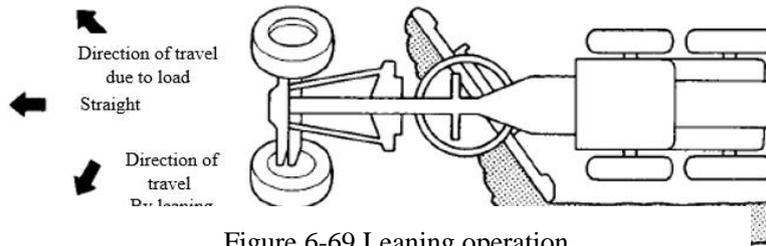


Figure 6-69 Leaning operation

- c When only driving, keep the blade within the vehicle's width and raise (age) the blade and other work equipment off the ground as much as possible to avoid contact with the ground surface.

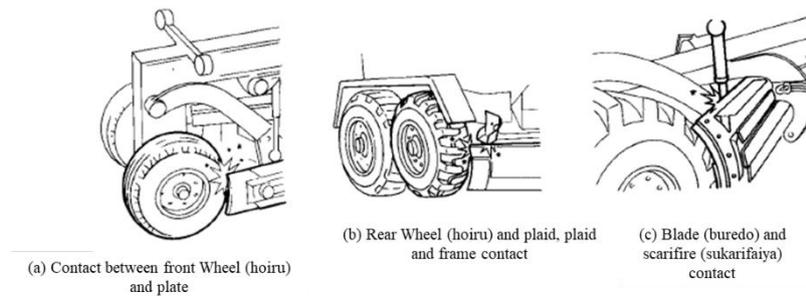


Figure 6-70 Blade contact example

- d Slow down as much as possible before maneuvering when driving. In particular, articulated types have a greater risk of falling.
- e When descending a slope (nori men), use the engine brake, and if the speed still increases, use the foot brake.
- f On slope (nori men), climb and descend at right angles to the slope (nori men), and do not ride diagonally or make sharp turns.
- g Be careful not to brake suddenly at high speeds, as this can be dangerous.
- h When leaning the tires while driving, incline the tires in the direction of the turn for forward turning and the opposite direction of the forward turn for backward turning (see Figure 6-71).

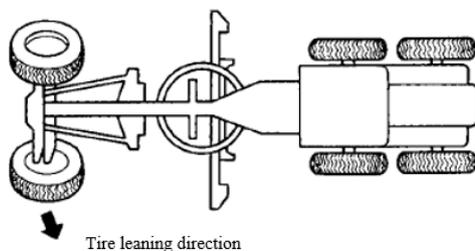


Figure 6-71 Tire leaning for turning

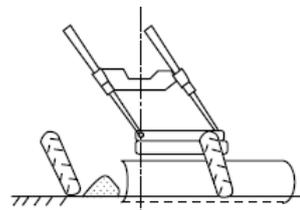


Figure 6-72 Shoulder reach position example

## ② Adaptive work

Motor graders are mainly used for relatively large earthwork projects, such as leveling road surfaces and cutting trenches of defined shapes, and are also used for snow removal.

### a) Ground leveling and excavation work

The speed of land preparation work is 6 to 10 km/h for rough finishing and 2 to 3 km/h for precise finishing. At this time, the blade's angle is usually 90 degrees, but some angles may be added depending on the remaining windrow. During finishing, the blade should not be operated abruptly.

When excavating, select the blade tip angle and angle according to the excavation surface, soil type, etc., and be careful not to discharge soil on the rear wheels' line of passage.

When the excavated surface is too hard to be excavated the blade alone, use a scarifier. The claws of the scarifier should be driven in as deeply as possible. Do not make sudden maneuvers while working with the scarifier, as it may bend the claws and drawbar.

### b) Shoulder reach position

Use the blade to push the vehicle sideways when the road's shoulder is too soft to pull the vehicle over. There are two ways to use this posture: one is to use the blade lateral feed cylinder only. The other is to use the lateral circle feed together and bring it to the limit (maximum shoulder reach posture). When stepping on the windrow with the rear wheels, you should straddle the windrow between the left and right rear wheels.

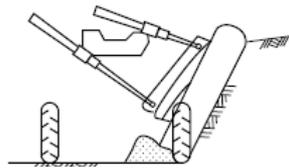


Figure 6-73 Example of bank cut posture

### c) Bank cut position

The bank cut position is used for cutting and shaping work on slope (nori men) and low slope (nori men), but each piece of equipment often interferes with each other, so work carefully to ensure that the procedure for adopting the bank cut position is correct.

The procedure is as follows: take a propulsion angle of about 60 degrees to the side you want to bank-cut, push the blade and circle to the ground, operate the left and right blade lift cylinders to change the attitude of their brackets, retract the blade lift cylinder on the side you want to bank-cut and extend the blade lift cylinder on the other side. In the bank cut position, be sure to repeat short strokes throughout the operation.

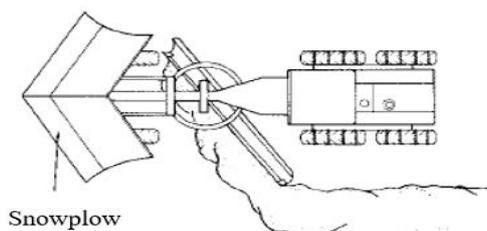


Figure 6-74 Example of work with a snowplow

### ③ Articulate

Articulate is used when the purpose is to reduce the turning radius, when the driver's seat and drive wheels need to be separated from the work area, and when the front wheels are offset to stabilize the vehicle.

Articulate means that the angle between the front and rear wheels is increased by steering, which reduces the turning radius to about  $\frac{2}{3}$  of that without articulation. The action in a T-turn (is different from leaning) changes the articulate direction as required. In U-turns, you can also turn efficiently by changing the articulate direction in the middle of the turn. Also, the turning radius becomes smaller, and corners can be processed efficiently (even corners can be leveled without turning over) by using the shoulder reach position in combination. In addition, it is possible to level even the corners of S-shaped roads with small curvature.

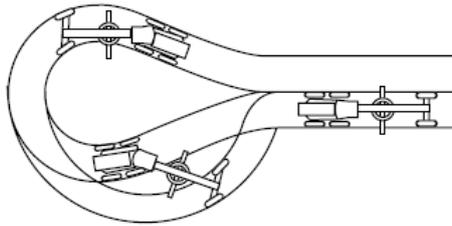


Figure 6-75 U-turn at articulate

Articulating and steering in the opposite direction will allow the front and rear wheels to go straight through different trajectories. This can be used to offset the front wheels so that they are running on the part of the ground that has already been leveled, when leveling or spreading the ground, so that the vehicle is stable and can work smoothly. Also, when the shoulder is weak, and shoulder reach alone does not provide sufficient average line pressure, it is possible to offset the front wheels and work with only the drive wheel portion of the mass off the shoulder. Besides, when there is a lot of soil to be removed by the bank cut and the rear wheels ride up on it (such as when shaping snowbanks for snow removal), it is possible to ensure the vehicle's safety by keeping the rear wheels off the ground.

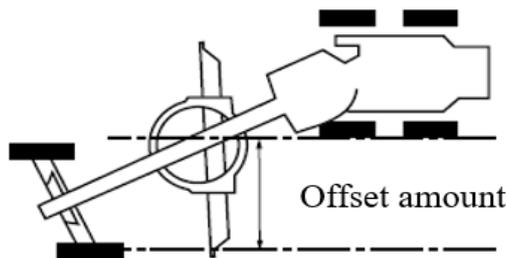


Figure 6-76 Offset running

#### ④ Scarifier

A scarifier, although slightly, can change the cutting angle as well as the blade, making it larger for harder objects. The direction of the scarifier's claws cannot be changed, they are oriented the same way as the frame, so they cannot be used in an articulated position.

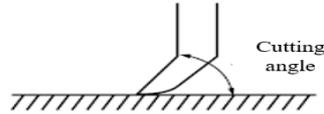


Figure 6-77 Scari cutting speed

#### 6.3.2. Scraper (motor scraper (mota sukurepa)) (textbook p. 147)

##### 1 . . . Basic operation

The operating device of the motor scraper's working equipment consists of the operating lever for raising and lowering the apron and the operating lever of the ejector. Figure 6-78 shows an example of the operating device of the working device of the scraper.

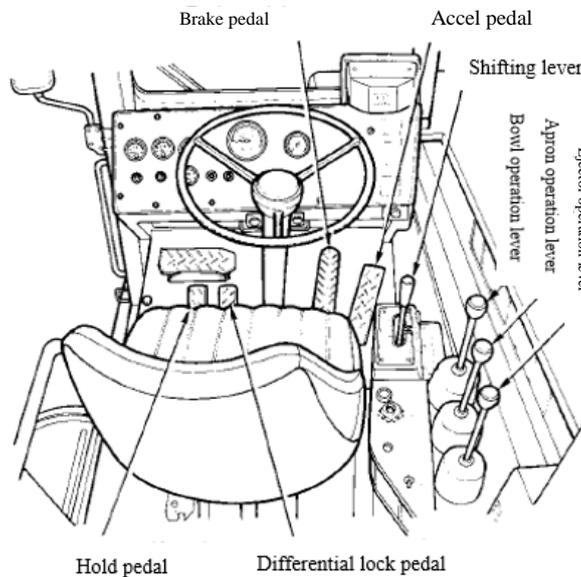


Figure 6-78 Example of scraper operating device

##### 2 . . . Basic operation

###### ① Basic important points

- a Prepare the road surface to reduce unevenness.
- b Slow down when turning curves.

In particular, be careful when driving with a load of earth and sand, as the rear wheels may turn more than expected due to centrifugal force and come off the road surface or even rollover.

- c Avoid sharp turns as much as possible.  
Small S-shaped curves are especially dangerous.
- d Cross soft ground in a straight line, do not meander or turn.
- e Do not cross inclined ground.

- f Keep the bowl low (about 2 cm above the ground) and reduce gravity center while traveling. In particular, do not drive with the apron raised except for soil spreading operations.

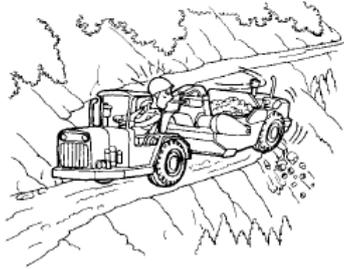


Fig. 6-79 Caution for derailment due to centrifugal force

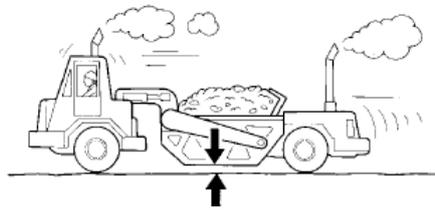


Figure 6-80 Be careful not to raise the bowl too much

- g When descending a steep slope (nori men), use the engine brake and foot brake (brake pedal) together. If the speed still increases and it becomes dangerous, lower (sage) the bowl and let it sink into the ground to reduce the speed. Never raise (age) the bowl in the middle of a hill.
- h The runways of scrapers and other vehicles should not intersect, and when intersections are unavoidable, a guide should be stationed.
- i When the aisle width is narrow, several waiting areas should be established, and the principle of giving priority to slope (nori men) climbers and loading vehicles should be observed.
- j If you turn the steering wheel while digging or loading, the pusher may push the machine and cause it to turn and roll over, so steering should be done gradually.

## ② Adaptive work

Scrapers can perform excavation, transport, and consistently spreading operations. They are also suitable for medium distances of 100 to 400 m for towed scrapers and long distances of 300 m or more (up to 2 to 3 km) for motor scrapers.

### a) Excavation and loading operations

The basic principle of excavation and loading work (see Fig. 6-81) is to keep the front and rear wheels in line and use a descending slope (nori men).

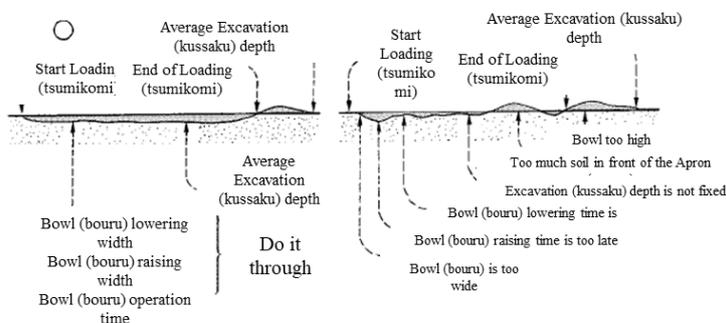


Figure 6-81 Basic excavating (kussaku) work example

The depth of excavation varies depending on the soil type and gradient, but the excavation should be as shallow and long as possible at an average depth so as not to cause tire slippage.

Also, to avoid disturbing the earth removal site, excavation and loading should be done in the order of (1), (2), and (3), as shown in Figure 6-82.

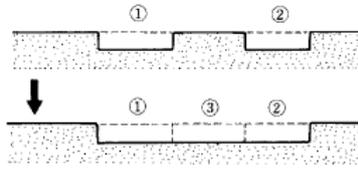


Figure 6-82 Excavation order example

### b) Transport work

Transport should be carried out with the bowl lowered and at as high speed as possible. For this purpose, it is important to prepare the route to be hauled using motor graders and maintain a surface with few unevenness and undulations. It is also necessary to provide a cant following the turning radius.

The transport should be set in the natural ground as much as possible, and gravel or sand should be added to the road surface if it is soft.

Also, the runway should be well-drained and watered if there is a lot of dust.

### c) Soil spreading (spreading out) work

A) Adjust the bowl's height and spread the soil at the specified height.

B) Spreading should not be done all at once but should be done in order from the lowest place to the thickest place to make the embankment flat and wide (see Fig. 6-83).

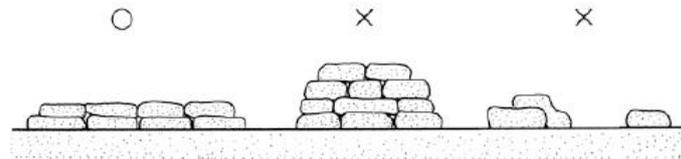


Figure 6-83 Soil spreading example

### 6.3.3. Scraper (wowed scraper) (textbook p.150 )

The basic operation is the same as that of the bulldozer in 6.1.1. regarding driving, so follow the procedure as in the section "6.1.1 Bulldozer 1 Basic Operation".

Raise (age) and lower (sage) the bowl, raise (age) and lower (sage) the apron, and push out the ejector using the work equipment control device of the bulldozer.



Photo 6-1 Bulldozer operation device example

- a In excavation and loading work using a scraper, the excavated soil is used for embankment (morido), etc., so be careful about drainage, etc., as in excavation and pushing work by a bulldozer.
- b The soil condition that can be driven by a scraper is said to be a cone index of 7 to 10 for a towed scraper of 9 m<sup>3</sup> class or less, which is required to be much better than the cone index of 5 to 7 for a bulldozer.  
Therefore, it is necessary to maintain a good work site by always considering the driving path's drainage (including Excavation, earth moving, and spreading out sites).
- c In the drilling and loading operation, raise (age) the apron sufficiently (about 15 to 30 cm), pull the ejector (tailgate) to the very rear, lower (sage) the bowl and scrape the ground surface while driving to load.
- d During excavation and loading, the bowl should be lowered so that the tractor crawlers do not stop or slip.
- e Load to full bowl capacity at low travel speed.
- f Lower (sage) the bowl gently so that the blade gently penetrates the ground.
- g When excavating, keep the tractor and scraper in a straight line and work on a descending slope (nori men) toward the transport destination to increase the work speed.
- h The excavation depth varies depending on the soil type and elevation, but excavate as shallow and long as possible at an average depth without slipping the undercarriage.
- i Since grooves formed by excavation will form ridges on both sides, remove these before starting the next operation.

- j The bowl should be kept level at all times during the work. If the soil is loaded on one side while the ground surface is level, it is necessary to check the tires' pressure on both sides.



Photo 6-6 Towed-type scraper working condition

#### 6.4. Handling and safe operation of crawler type Muck loaders (textbook p.154)

##### 6.4.1. Crawler-type Muck loaders (textbook p.154)

There are two main types of crawler-type Muck loaders: large tractor-shovel (shoberu) and scraping loaders, but since the tractor-shovel (shoberu) is the same as described above, the scraping loader will be explained here.

##### 1 • • • Basic operation

The basic operations of a scraping loader include raising and lowering the boom, raising and lowering the arm, extension and scooping of the bucket, and turning of the jib (jibu) and raising and lowering the conveyor and forward and reverse rotation of the conveyor. Depending on the model, the loading table's width can be increased or decreased.

Figure 6-86 shows an example of a work equipment operator for a scraping loader.

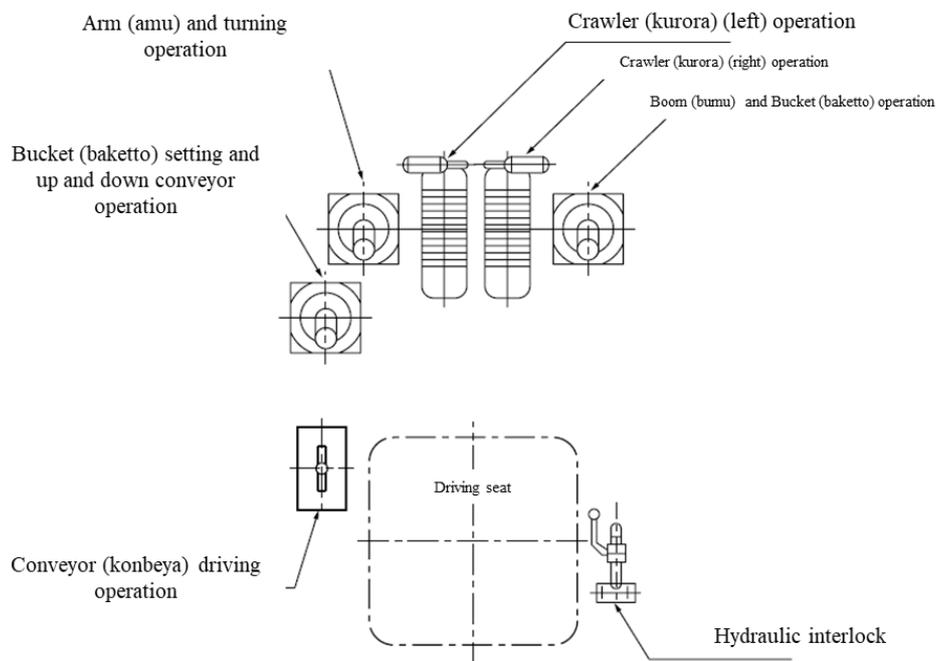


Figure 6-66 Scraping loader example

- ① The operation of swinging the boom, arm, bucket and jib (jibu) shall be performed following the procedures described in "6.2.1 Hydraulic excavator (backhoe) 1 Basic operation.
- ② The conveyor operation device shall be operated by using the conveyor drive motor's levers in the following positions.
  - "Forward"... The conveyor moves forward.
  - "Neutral"... The conveyor stops.
  - "Back"... The conveyor reverses.
- ③ The conveyor lift lever is used in the following positions to operate the conveyor up and down.
  - "Forward"... The conveyor lift is lowered.
  - "Neutral"... The conveyor lift is held in that position.
  - "Back"... The conveyor lift goes up.

## **6.5. Transport of vehicle-based construction machinery (textbook p.157)**

### **6.5.1. Loading and unloading (textbook p.157)**

When loading or unloading construction machinery onto or from trailers, etc., pay attention to the following points.

#### **1 • • • General Notes**

- ① When loading and transport construction machinery on a trailer or truck, use a vehicle specially designed for transport construction machinery.
  - ② When transport, take care not to exceed the following limits specified in the Vehicle Restriction Order.
    - Width ..... 2.5m or less
    - Gross weight ..... 20t or less
    - Axial weight ..... 10t or less
    - Wheel load ..... 5t or less
    - Height ..... 3.8m or less
    - Length ..... 12m or less
    - Minimum turning radius ..... 12m or less
- ※ Vehicles exceeding these limits are called special vehicles, and as a general rule, they are not allowed to operate on roads. However, suppose it is unavoidable to operate a special vehicle that exceeds this regulation limit. In that case, the vehicle is allowed to pass on the road only after applying for and receiving permission from the road administrator.
- ③ A work supervisor shall be appointed for loading and unloading of the construction equipment to be transferred. The work shall be performed under the supervisor's supervision.
  - ④ As a general rule, the site where loading and unloading are to be carried out should be flat and solid ground, and all vehicles used for transport should be parked with parking brakes and tires secured.

- ⑤ Climbing equipment (ramp) hung on the back of vehicles, etc., should be able to withstand the mass of the construction machinery to be loaded and unloaded. Climbing equipment with claws should be used so that they do not come off the back of the vehicle due to the rotation of the crawler (tire) (see Figure 6-87 and Table 6-7).

Table 6-7 Muckloader mass and climbing equipment relationship example

Mass of loading machine (t)	Number of climbing tools		Shape dimensions Length x height x width
	Material	Number	
40	Aluminum alloy	4	2900 × 310 × 220
30	Aluminum alloy	4	2900 × 310 × 175
15	Aluminum alloy	2	2900 × 232 × 220



Figure 6-87 Climbing equipment with claws attached example

- ⑥ When loading and unloading with embankment (morido), do as follows.
- The width of the embankment (morido) should be wide enough to accommodate the construction equipment's width.
  - The slope (nori men) of the embankment (morido) should be as gradual as possible.
  - The embankment (morido) should be compacted sufficiently to prevent the slope (nori men) from collapsing and tipping over when loading construction machinery. In particular, pay attention to prevent the slope (nori men) shoulders from collapsing and reinforce them by driving piles, etc., if necessary.
  - The height of the embankment (morido) should be the same as the height of the trailer bed.

**2 . . . Loading and unloading onto trailers, etc.**

When loading or unloading by using a slope (nori men) climbing equipment, do the following.

- Hold a meeting with all members to discuss loading methods and procedures.
- Check the clutches, brakes, etc., of the loading machines and check the machines to be used.
- Stop the trailer at the loading position, apply the brakes, and secure the tires (pay attention to the ground level).
- Make sure that the climbing equipment is securely attached to the cargo bed to prevent it from being detached and that the climbing angle is less than 15 degrees (see Figure 6-88).

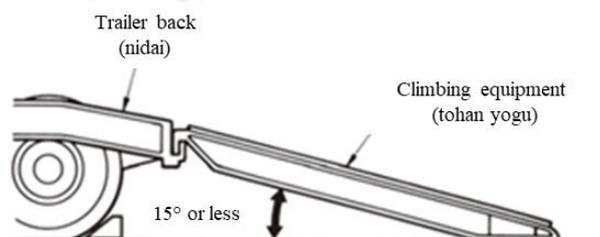


Figure 6-88 Climbing tool usage example

- ⑤ Place the vehicle so that the centerline of the vehicle bed and the centerline of the construction equipment to be loaded, and the centerline of the hill climbing equipment and the crawler (tire) coincide (see Figure 6-89).

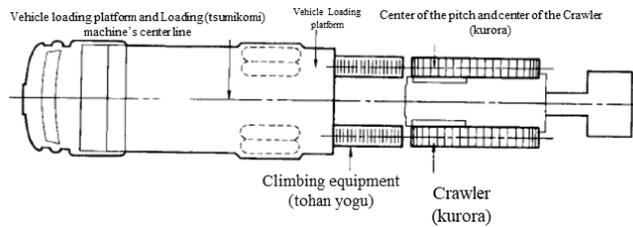


Figure 6-89 Loading position

- ⑥ When loading, make sure that no one is around and take measures to keep out of the way.
- ⑦ Run at low speed following the guide's signal, stopping about 1 m before the climbing tool and reconfirming item (5).
- ⑧ On the way up a slope (nori men), climb at a low speed without turning the steering wheel (if necessary to turn the steering wheel, descend to the ground and correct the direction).
- ⑨ After climbing up the climbing equipment, when the front part of the crawler (tire) floats and lands on the cargo bed, the loading machine tends to shake vertically, so drive with care to land quietly.
- ⑩ When there is a large difference in the trailer bed level, use the foot stall and drive gently (see Figure 6-90).



Figure 6-90 Foot stall usage example

- ⑪ Check that the loading machine does not extend beyond the trailer bed's width.
- ⑫ Stop at the designated position on the load bed and lock the brakes.
- ⑬ When swinging a hydraulic excavator, etc., on the load bed, check the surrounding area for safety, ensure that the load bed is not tilted by the swing, the hydraulic excavator, etc., does not slide down.  
Also, after turning, apply the turning lock and stop the engine.
- ⑭ When loading large shovel (shoberu)-type construction machinery with the work equipment removed, the counterweight should also be removed.

### 3 • • • Securing the cargo after loading onto a trailer, etc.

- ① Check that the trailer, etc., has been loaded correctly in the specified position and that the trailer, etc., is not tilted.
- ② After confirming that there is no abnormality in the trailer, etc., secure the construction machinery to the trailer, etc., using gears, chains, wire ropes, etc. (See Fig. 6-91), as the equipment may move due to vibration during transport.

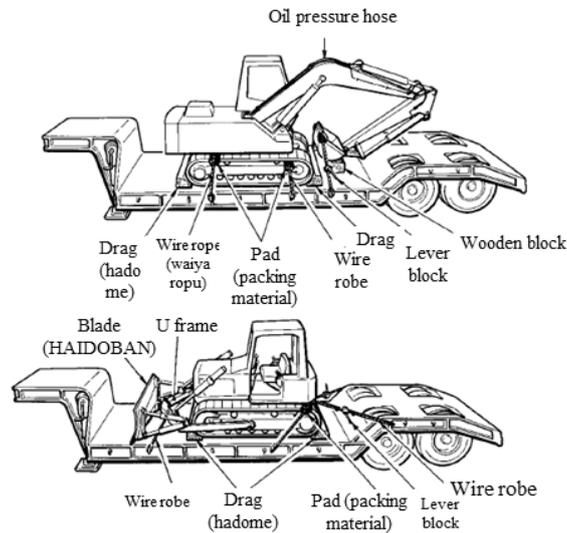


Figure 6-91 Fixing trailer example

- ③ On shovel (shoberu)-type excavation machines, the boom, arm, and other work equipment should be lowered so that they do not exceed the height limit, and the bucket and other equipment should be lowered and secured on the floor of the trailer or other equipment.
- ④ After loading, apply the brakes and locks, stop the engine, turn off the power, set the main clutch to the "in" position, set the shift lever to the "low speed" position, and set the fuel lever to the "fully closed" position.
- ⑤ Check that the loading and securing conditions are complete.

#### 6.5.2. In the case of Transport by self-propelled vehicles (textbook p.161)

When it is unavoidable to transport construction machinery on its own, it must be done in compliance with the Road Traffic Law, Road Vehicles Law, Vehicle Restriction Order, and other related laws and regulations but in particular, pay attention to the following points.

- ① When driving on a soft road surface, be careful of collapsed shoulders.
- ② When passing through unmanned railroad crossings or narrow sections, stop in front of the crossing and make sure it is safe before passing through. Do not force your way through.
- ③ For shovel (shoberu)-type construction equipment, when passing under railroad wires, electric cables, bridge girders, etc., ensure that the boom tip does not touch and that the separation distance is sufficient.

## 6.6. Mounting and dismounting of work equipment (textbook p. 162)

When installing or removing work equipment of construction machinery, pay particular attention to the following points.

- ① The work shall be performed under the direct supervision of a supervisor who is fully familiar with and experienced installing and removing work equipment.
- ② Attach and detach the work equipment following the procedures specified in the construction machinery's instruction manual.
- ③ Use safety poles, safety braces, etc., to prevent the arm, boom, etc., from falling or collapsing.
- ④ Heavy work equipment should be mounted or dismounted using a mobile crane. At this time, care should be taken when slinging (tamagake) work equipment, and slinging (tamagake) should be done by qualified personnel.
- ⑤ Tighten the bolts securely so that there is no omission of tightening.
- ⑥ Attach the wire rope securely using a clip or other special attachment hardware.

(Separate qualifications are required for crane operation and slinging)

Crane work and slinging cannot be performed with the qualifications of vehicle construction equipment operation (for leveling, transport, loading, and excavation), so the qualifications of mobile cranes, etc. are required separately.

## 7. Inspection and Maintenance for Vehicle-type Construction Machine.

In order to use construction machinery safely and efficiently, it's important to use well-maintained construction machinery. Besides the daily inspections shown in the instruction manuals for construction machinery, it is necessary to perform construction machinery inspections and maintenance even if an abnormality is felt during work. The law state that construction machinery should be inspected once a year, regularly inspected once a month and inspected before the start of work. The section related to inspector qualification, inspection table retention period, and mandatory inspection attachment is stipulated as follows.

Table 7-1 Related Laws

Inspection Classification	Article	Enforcer · Qualifications	Inspection table (kensahyo) retention period
Inspection before starting operation	Industrial Safety and Health Act (ISHA) Art. 170 Art. 171	Driver/ Operator	*store the check list (tenkenhyo) As long as machine is in production
Regular Independent Inspection (Once per month)	ISHA Art. 168, 169 ,171	Person instructed by Business Operator (Safety Manager)	Store the inspection table (kensahyo) 3 years retention
Specific Independent Inspection (Once per month)	ISHA Art. 167, 169, 169 Par. 2, 171	In-company inspector Inspection Company	Store the inspection table (kensahyo) 3 years retention (with inspected mark)

\*It is not stated in the law but it is best to store the inspection result as long as machine is in use.

## 7.1. General precautions for inspection and maintenance (Text p.163)

- ① When performing on-site inspections and maintenance, stop the construction machinery in a safe and even area.  
If it is unavoidable to stop on inclined ground, use drag on the machine undercarriage.
- ② Make sure to turn off the clutch, put on the brake, swing lock, and other construction machinery safety locks.
- ③ Be sure to lower the work equipment (attachment) such as blades and buckets to the ground. If it is unavoidable, raise (age) the blade, bucket, etc., and must perform inspections and repairs under them, use safety columns or safety blocks to prevent the work equipment from dropping unexpectedly.
- ④ Construction machinery repairs are carried out under the supervisor's direction.
- ⑤ It is necessary to perform inspections and self-inspections based on inspection sheets or inspection check sheets, and record and save the results.
- ⑥ Other than the person concerned is not allowed to enter the inspection and maintenance work area.

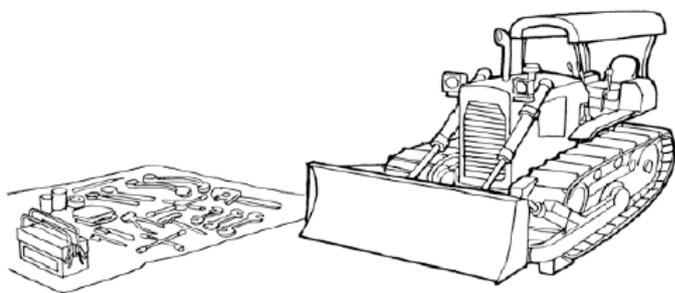


Figure 7-1 Points to remember when inspecting, etc.



Figure 7-2 Restricted area (tachiiri kinshi) during inspection  
(Unified safety sign for construction disaster prevention-Example  
of foreign language display-)

## 7.2. Daily Inspection Procedure (Text p. 164)

### 1. . . . Before Starting The Engine

Before starting the engine, especially check the following:

#### ① Oil and water leak inspection

Check around the vehicle for leaks from the pipe and inspect if there are any traces of water or oil leaks on the ground.

## ② Cooling water inspection and replenishment

Open the Radiator cap and check if the water full to the mouth. When refilling the Radiator, add it little by little. If you put it all at once, the air inside will not be completely gone and will make the water difficult to enter.

Hot water may blow out, and you may get burned if you open the cap suddenly, when the Radiator is hot. Especially in the case of a pressurized Radiator, it is important to open the level cock (or loosen the cap) to reduce the pressure and then remove the cap to prevent danger.

Furthermore, it is necessary to correctly maintain the dilution ratio according to the antifreeze type since the relationship between the dilution ratio of antifreeze and the temperature at which it does not freeze differs depending on the type.

## ③ Each part oil amount inspection and replenishment

The inspection for each part oil amount measurement is done by making the machine horizontal and check whether it is within the specified level with an oil level gauge or the like.

### a) Inspection and replenishment of oil in the hydraulic oil tank amount

If the amount of oil in the hydraulic oil tank is less than the specified amount, the oil temperature will rise abnormally. It may deteriorate quickly, or air may enter, which harmful to the machine. The tank's oil level frequently fluctuates during work, so it may bulge abnormally and be damaged if filled too much.

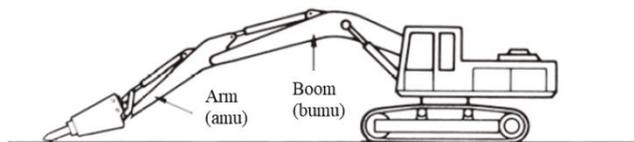
Further, if you remove the cap while the hydraulic oil is still hot, the oil may blow out and burn you. The hydraulic oil's appearance and odor may change due to highly oxidized substances or water, but to judge it requires skill, so replace it when the time specified in the instruction manual is reached. However, replace it immediately if you see the condition shown in the table below.

Table 7-2 How to discern Hydraulic oil

Appearance	Smell	Cause
Change to Opaque White	Good	Contamination with other fluids
Change to Dark Brown	Pungent	Deterioration
Has small black dots	Good	Contamination of foreign materials
Bubbling/ Foaming	-----	Contaminated with grease

**b) Hydraulic tank oil inspection and replenishment position**

For the drag shovel (shoberu), the work equipment is checked and repaired by deciding a certain posture, as shown in Fig. 7-3, for example. If the posture related to the work equipment is not determined, the hydraulic tank's oil level will rise and fall due to the cylinder expansion and contraction, and the correct amount of oil cannot be measured.



Figures 7-3 Inspection and replenishment position

**c) Use the oil specified by the manufacturer for checking, replenishing, and replacing the oil in the engine and other oil-used locations**, as shown in the instruction manual for the construction machinery. Also, as with item a), replace oils mixed with different oils or lack oxidation or viscosity.

**d) Brake fluid inspection (wheel type)**

When the brake fluid is insufficient, replenish it with the prescribed brake fluid.

**④ Draining fuel tank**

Replenish the fuel after the work is finished and drain the fuel tank water before the work started. It is because water and foreign matter are precipitated during the vehicle night resting.

**⑤ Fan belt tension inspection and adjustment**

Push the middle of the fan pulley and crank pulley (the center of the V-belt) with a finger, and check if there is about 10 to 15 mm of looseness.

Also, check if the V-belt is not abnormally worn or damaged and the pulley is not damaged.

**⑥ Tire pressure inspection (wheel type)**

Tire pressure is measured before work when the tires are cold and adjusted according to the work road surface (adjust the pressure slightly lower than the standard on soft ground and slightly higher on hard ground). Also, air pressure on the left and right tires should be equal.

At the same time, check that the tires are not scratched or swelled, not pierced by metal pieces, and not abnormally worn.



Figures 7-5 Tire inspection

**⑦ Crawler tension inspection**

If the crawler’s tension is too loose, the pin and the bush will wear faster, and if the crawler’s tension is too tight, it may become the cause of failure. Tighten the crawler on hard grounds and loosen on soft grounds.

**⑧ Loose bolts and nuts inspection**

Check if the bolts and nuts of each part are not loose by using a hammer, and if they are loose, retighten them. Especially, pay more attention when inspecting the air cleaner, intake/exhaust pipe, muffler mounting, and undercarriage part.

**⑨ Inspection for broken electrical wiring, short circuits, loose terminals, etc.**

Check if there are any disconnections on the electrical wiring and short circuits.

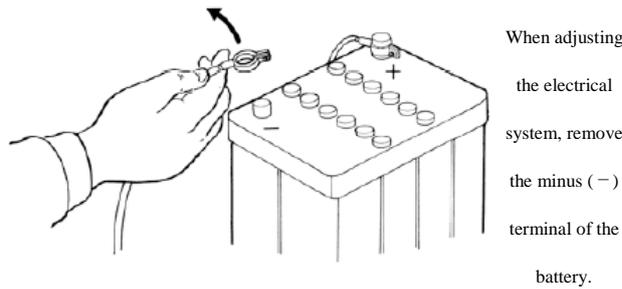


Figure 7-6 Attention point when adjusting

Also, check any looseness on the battery terminal. At the same time, also check the battery fluid, and if it is insufficient, replenish it with distilled water.

**2 . . . After starting the engine**

After starting the engine, especially check the following:

**① Measuring instrument and pointer operation inspection**

After starting the engine, put it on idle and check each instrument operation and pointer condition.

**② Water, oil, and air leaks inspection**

Although there is no leak when the engine is stopped, there’s a possibility of leaks when the engine is started.

**③ Engine condition**

Inspect if there are abnormalities in the exhaust color (see table 7-4), engine noise, exhaust odor, and vibration simultaneously by changing the rotation speed to low idle, high idle, and full stall.

Table 7-4 Emission color and criteria

Emmision Color	Criteria for Inspection
Black	Concentrated vapor, Defective combustion
Faint Yellow	Thin vapor
White/ Blue	Burnt oil, faulty timing
Ash Gray	Concetrated vapor and Burnt oil
No Color	Adequate Vapor, Full combustion

**④ Inspection and adjustment of main clutch pedal and main clutch lever play, operating force, lever stroke, and cutting condition**

Check the pedal or operation lever (by moving it 2 or 3 times).

If the clutch plate is worn, the operating lever play is reduced, and the clutch slips, so adjust it with the adjusting screw (except for construction machines that run hydraulically).

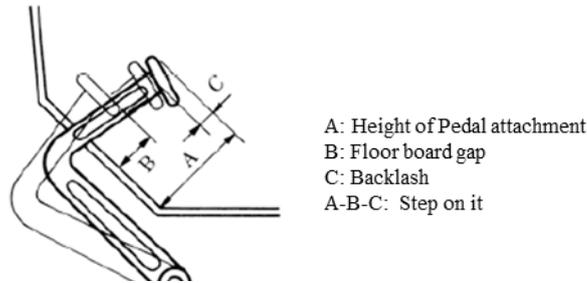


Figure 7-10 Clutch adjustment

**⑤ Work equipment operation inspection**

Check if the blade, lift arm, arm, boom, etc., moves smoothly or not. Make sure that the surrounding area of the inspected machine is safe from people or obstacles.

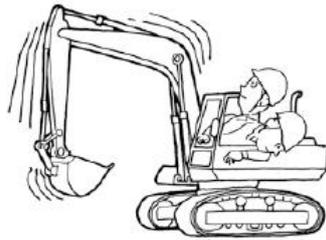


Figure 7-11 Operation inspection

**⑥ Travelling brake operation condition inspection**

Check if the brake pedal play is not large and that the brakes are working sufficiently. If the brake lining wears, the pedal play becomes bigger, and the brakes won't work unless the pedal is pressed deeply.

**⑦ Steering clutch and brake operating condition inspection**

Run the construction machine and check the left and right side steering clutch cutting condition. Quickly adjust if the brake reaction is slow.

**⑧ Inspecting turning brake operation condition**

Check if the turning brake is working sufficiently.

**3 • • • After the work is finished.**

After the work is finished, especially check the following:

**① Machine body cleanliness**

Wipe cleanly because if there is mud or oil on the floor-board, pedals, levers, etc., it will be slippery.

Especially, remove soil on the crawler and clean the machine body from any dirt.

② **Refueling**

Stop the engine when refueling. Be careful not to let any dust or water mixed when refueling.

③ **Storing the vehicle**

- a The parking place shall be a flat place with no rockfall, flooding, landslides, etc.
- b When parking outdoors, cover the vehicle with a sheet (especially to prevent rainwater from entering the muffler).
- c Turn off the battery switch, set the main clutch lever to “ON”, and apply the parking brake. Also, the blades, buckets, etc., should be lowered to the ground.



Figure 7-12 Points during storing

**7.3. Inspection points when malfunctions detected during operation (Text p.172)**

If during the operation the construction machine feels that it may have trouble, it is necessary to immediately stop the machine in a flat place, report the faulty area to the responsible officer, repair the part before going back to operation.

## 8. Safety Driving Guidelines, Cue Signs, and Guiding

### 8.1. Safety driving guidelines (Text p.175)

#### 1 · · · Safety driving guidelines

The following are the guidelines necessary for construction machine safe operation

#### 1. General safety guidelines

- ① Wear helmet and safety equipment, tidy your clothes up, and drive.
- ② Driver needs to bring driving qualification when operating the vehicle.
- ③ Before starting operation, always perform the prescribed pre-work inspections, such as brakes and clutches, to confirm no abnormalities.
- ④ It is prohibited for anyone other than the driver to sit in the driver's seat or elsewhere.
- ⑤ Use the built-in ramp and handrail when boarding the vehicle.
- ⑥ Always keep the vehicle body clean and do not operate the levers with oily or dirty hands.
- ⑦ The driver must not leave the driver's seat with the engine running.



Figure 8-1 Turn off engine when leaving the vehicle

- ⑧ When stopping or after finishing the work, lower the attachment to the ground, cut the clutch, apply the brakes securely, stop the engine, remove the key, and store it in the designated place.

#### 2. Safety guidelines during working

- ① When approaching a place where there is a possibility of overturning, falling, or contact with danger, place an inducer/guide then perform the task.
- ② Drive with obeying the specified work range, speed limit, and work method.
- ③ Do not drive inattentively.
- ④ Never drive beyond machine capacity or drive recklessly, such as sudden start or sudden braking.
- ⑤ Always prepare yourself to stop immediately while driving in case of a sudden situation occur.
- ⑥ Stop work where people are nearby. When a person approaches, stop driving and warn with a whistle.
- ⑦ When backing, especially, make sure that there are no people around and honk to warn. Follow the guide instructions, if any.
- ⑧ Do not use work equipment such as buckets as brakes except in an emergency.

- ⑨ Always consider machine Stability and do not make sudden turning operations. In particular, never turn on steep slope (nori men).
- ⑩ Do not carelessly approach cliffs (gakeppuchi), weak road shoulders, or the top of a slope (nori men). Be especially careful after the rain.
- ⑪ In closed places such as underground and basements, ventilate well, install and use an exhaust gas purifier and maintain its performance.
- ⑫ Be careful when using noise control vehicles and dust-prevention in urban areas.
- ⑬ Excavation work in urban areas should be done after confirming buried objects' presence and location. In the unlikely event that the buried object is damaged, immediately contact the person in charge and receive the necessary instructions.
- ⑭ Work where there are electric wires, obstacles, etc., need to be carried out under the superintendent direction.
- ⑮ Do not use construction machinery for any purpose other than its main purpose.
- ⑯ For excavation work where shoring is established, work should be done carefully so that the bucket or other machine part does not touch the strut material.

**2 · · · Precautions when using rented construction machinery**

Rented construction machinery should be handled after fully confirming the following in the provided document.

- ① Machine ability
- ② Machine maintenance condition
- ③ Machine characteristic and weakness
- ④ Other precaution points for driving

Especially, carefully check the operating conditions of brakes and clutches, the presence or absence of head guards and headlights, damage to wire ropes and chains, damage to buckets, etc., and avoid operating construction machinery with deficiency.

Also, confirm the regular self-inspection status and maintenance recorded on the inspection record table.



Figure 8-2 Check the inspection condition

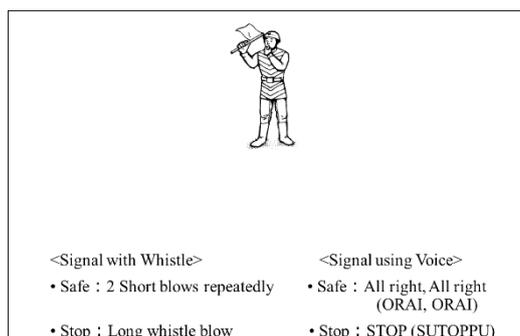
## 8.2. Signals and guiding points (Text p.177)

In principle, when operating a construction machine, it must be done under the guide or inductor guidance or signal.

Therefore, the driver must discuss the work position and the signaling method with the signaler or the guide before the work started.

Furthermore, the signaler or inductor is specially selected by the supervisor, and the driver will drive under that person's command. Also, it is essential to stop the construction machine if there's any unclear signal. Avoid driving under prediction or without signal.

The following are examples of standard signal use at the sites.



The inductor must also wear clothes that are visible and stand in a location where the driver can see at ease.

## 9. Force and Electricity Knowledge

### 9.1. Force (Text p.181)

#### 9.1.1. Moment of force (Text p.184)

As shown in Fig. 9-7, when tightening a nut with a spanner, the rotational force applied to the nut, and when moving a heavy object using a lever, the "force" that tries to move the object is called the "moment of force".

The equation for moment of force is,  $M = P \times \ell$ .

If the unit of force  $P$  is N (Newton) and the unit of  $\ell$  is cm, the unit of moment of force  $M$  is N cm (Newton centimeter).

Therefore, when tightening the bolt, the farther the wrench handle is from the bolt, the smaller the force, and the closer it is, the larger the force is required.

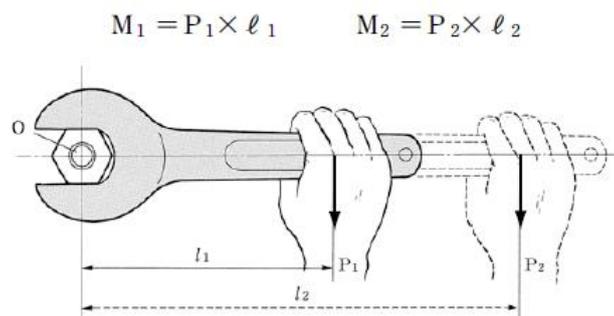


Figure 9-7 Moment of force

In the state shown in Fig. 9-8, the moment that works to overturn the construction machine is  $W_1 \times \ell_1$  when the mass of the cargo is  $W_1$ , and the construction machine in Fig. 9-8 moment is  $W_0 \times \ell_0$ , where  $W_0$  is the mass of the machine (bucket in no-load condition).

Therefore, when  $(W_0 \times \ell_0) > (W_1 \times \ell_1)$ , the machine won't fall.

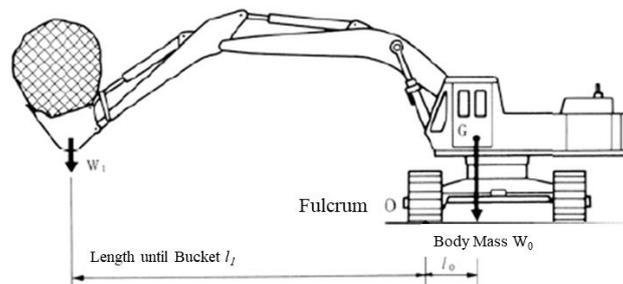


Figure 9-8 Moment of fall

## 9.2. Mass and specific gravity (Text p.187)

### 9.2.1. Mass and specific gravity (Text p.187)

To find the object mass, other than using a gauge, the mass of an object can be calculated from object volume and specific gravity.

That is the mass of the object = volume x specific gravity.

The object unit mass means the mass per unit volume of an object, and the unit mass of major objects are shown in Table 9-1. In Table 9-1, the column of mass (t) per 1 m<sup>3</sup> also shows each object's specific gravity.

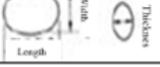
The object volume calculation is shown in Table 9-2. In other words, the mass of an object can be roughly calculated by measuring the object's dimensions, estimating the volume by this table, and multiplying the number by the specific gravity of the object.

Table 9-1 Object unit weight

Material type	Mass per 1m <sup>3</sup> (t)	Material type	Mass per 1m <sup>3</sup> (t)
Lead	11.4	Sand	1.8
Copper	8.9	Coal (powder)	1.0
Steel	7.8	Cokes	0.5
Cast Iron	7.2	Oak	0.9
Aluminum	2.7	Pine	0.5
Concrete	2.3	Cedar	0.4
Soil	2.0	Cypress	0.4
Gravel	1.9	Paulownia	0.3

\*Wood mass is dry mass. Soil, gravel, sand, lime and cork are appearance unit weight.

Table 9-2 Volume formula chat

The shape of the object		Volume approximation formula
Name	Shape	
Rectangular		Vertical x horizontal x height
Cylinder		(Diameter) <sup>2</sup> x height x 0.8
Disk		(Diameter) <sup>2</sup> x thickness x 0.8
Ball		(Diameter) <sup>3</sup> x 0.53
Missing ball		(Height) <sup>2</sup> x (Diameter x 3 - height x 2) x 0.53
Cone		(Diameter) <sup>2</sup> x height x 0.3
Heading cone		[(Bottom base diameter) <sup>2</sup> + bottom base diameter x upper base diameter + (upper base diameter) <sup>2</sup> ] x height x 0.3
Circle		Length x width x thickness x 0.53
Triangular pyramid		Base area x height ÷ 3 (Base area = base x base height ÷ 2)

**9.2.2. Center of Gravity (Text p.189)**

Gravity works on all objects.

When an object is divided into small pieces, gravity works on each of the divided parts. Hence, it can be considered that many parallel forces (gravity) are acting on the object, and when the resultant force of these forces is obtained, this is equal to the gravity acting on the object. The point of action of this resultant force is called the center of gravity.

For a certain object, the center of gravity is fixed, and the center of gravity does not change even if the object's position or placement changes.

When the object motion (excluding the rotational force of the object itself) is treated mechanically, it can be considered that the object's total gravity is concentrated on the center of gravity.

When a force acts on an object, the object does not rotate if the force's line of action passes through the center of gravity.

When the force line of action does not pass through the center of gravity, a moment is generated around the center of gravity, and the object rotates.

As shown in Figure 9-12, the center of gravity is somewhere on the vertical line of the string if you string an object. Also, if you hang a string in another place, the center of gravity is somewhere on the same string line. If you find the intersection of the two straight lines, that is the center of gravity.

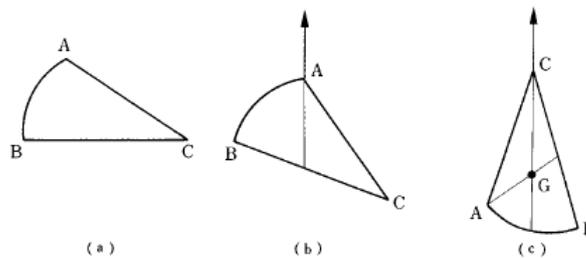


Figure 9-12 How to find center of gravity

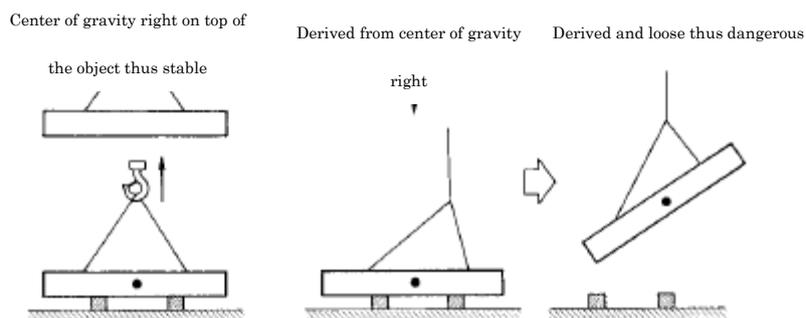


Figure 9-13 Center of gravity

**9.2.3. Object Stability (Suwari) (Text p.191)**

If you apply a force to a still object, tilt it by a certain angle, and then remove the force, if the object return to its original position, then the object is said to be "stable". It can be said that its suwari is good. On the contrary, if the inclination becomes larger in the same state, the object is said to be "unstable" and can be said that its suwari is not good.

Also, when an object stands still at an inclined position, it is called "neutral".

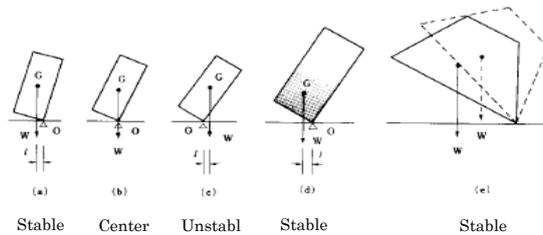


Figure 9-14 Object Stability (anteido)

**9.3. Object movement (Text p.192)**

**9.3.1. Speed and acceleration (Text p.192)**

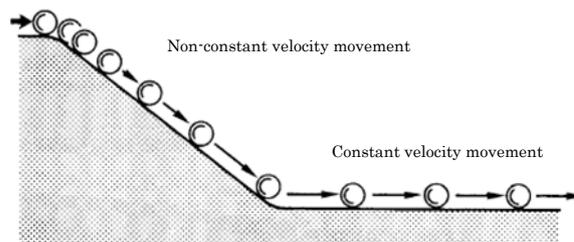


Figure 9-15 Speed and acceleration

The quantity used to expresses object movement degree of fast or slow is called speed, and it is expressed by the distance that the object has moved in a unit of time.

In non-constant motion, or when an object moves while changing its velocity, the amount indicating the degree of the change is called acceleration.

### 9.3.2. Inertia (Text p.194)

When trying to rotate a bucket in a clamshell, the bucket feels to swing in the opposite direction of the direction it is trying to rotate, and when it stops turning, the bucket swings in the direction of rotation.

Unless an external force acts on it, an object has the property of trying to stay still when it is not moving and to continue to move when it is moving. This is called inertia.

To put it the other way around, an external force is required to move a still object or change the moving object's speed or direction of movement, and the greater the change in speed, the heavier the object. This means, the heavier the force, the greater the force required when suddenly pulling up a load or suddenly stopping a moving object. Because of this, the wire rope may break due to impact.

Also, if a load is loaded on a bucket with a drag excavator or the like and start or stopping a turning suddenly, a large force is applied to the gear due to inertia, and there is a risk that the gear teeth may be damaged.

### 9.3.3. Centripetal and centrifugal (Text p.194)

If you hold a string that holds the weight on end and makes a circular motion with it, the hand will be pulled in the weight direction. As you turn the weight faster, you will feel your hand is pulled harder. 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.

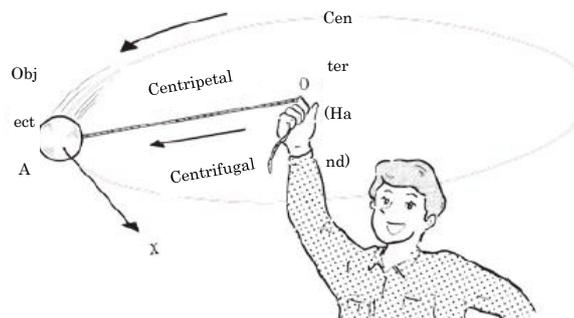


Figure 9-17 Centripetal and centrifugal (a)

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 force with the same magnitude and opposite directions is called the centrifugal force (the force that pulls the hand in the above example).

As shown in Fig. 9-18, when the bucket is hung on the boom and turned during work, the bucket will rotate with a radius larger than the working radius when it is still due to centrifugal force. In this case, the centripetal force that causes the bucket to move in a circular motion is the resultant force ( $F$ ) with the gravity ( $W$ ) acting on the bucket and the force ( $P'$ ) that supports the bucket of the wire rope.

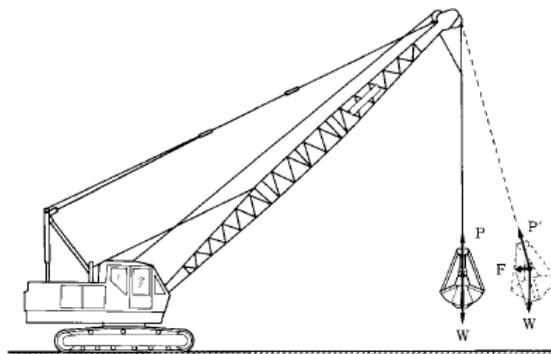


Figure 9-18 Centripetal force, centrifugal force (b)

Also, when the turning working radius is the same, the faster the bucket turns, the greater the centrifugal force, and as a result, the bucket will move more and more outward, and in some cases, can cause the construction machine to tip over.

For example, when a tractor shovel (shoberu), motor grader, etc., go down a steep slope (nori men), as what had been explained before, if the steering is suddenly turned off, centrifugal force will act on the center of gravity of the tractor shovel (shoberu), motor grader, etc., and added with the slope (nori men) inclination angle, the vehicle will be pulled strongly toward the outside, increasing the risk of falling.

Moreover, if the drag shovel (shoberu) is loaded with soil and turned on sloping ground, centrifugal force is further applied to the work equipment weight and the load and increasing the risk of falling.



Figure 9-19 Falling because of centrifugal force

### 9.3.4. Friction (Text p.196)

#### 1 • • • Static friction and dynamic friction

When objects come into contact with each other, resistance called frictional force occurs. If you place an object on the floor or board and try to move it by pushing or pulling it, it will not move even if you push it with force below a certain limit, but if the force exceeds this, the object will start moving. The frictional force below this limit is called the static frictional force, and the frictional force at the limit is called the maximum static frictional force.

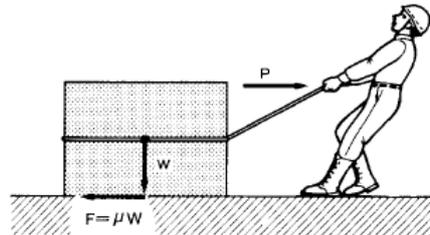


Figure 9-20 Static frictional force

$$\text{Maximum static frictional force (F)} = \mu \times \text{normal force (W)}$$

The frictional force is related to the normal force and the contact surface condition and but not related to the contact surface size. Even when an object is sliding on the floor, it will stop if it is not applied by force constantly. This is because there is a frictional force even when moving. This is called dynamic friction (also called kinetic friction) and is smaller than the maximum static friction force. This is why the brakes are hard to work when driving (especially because the inertial force is also applied).

### 9.5. Electrical Knowledge (Text p.200)

#### 9.5.1. The relationship between voltage, current, and resistance (Text p.201)

For electricity, if the electric resistance (ohm:  $\Omega$ ) of the electric circuit is equal, the larger the voltage (volt: V), the larger the current (ampere: A). Moreover, the larger the resistance (for example, in the case of an electric wire, the thinner it is), the current will be limited. This relationship can be expressed by an equation as follows, which is called Ohm's law.

$$\text{Current (Ampere: A)} = \text{Voltage (Volt: V)} / \text{resistance (Ohm: } \Omega \text{)}$$

### 9.5.2. Electrical level of danger (Text 202)

Electric shock is a reaction when a part of the human body touches the live part, and an electric current flows through the human body—the reaction range from numbness to muscle stiffness, nerve paralysis, and even death. The degree of electric shock varies depending on the situation (wet place, sweating, electric path, electric current magnitude, electrification time, etc.), but generally, when alternating current and direct current flow through the human body, the situation can be described as follows.

Table 9-3 Reaction when electric current passes human body

Shock Effect	Alternate Current (AC)		Direct Current (DC)	
	Male	Female	Male	Female
1. Tingling Sensation	1.1	0.7	5.2	3.5
2. Shock with pain (but still able to move muscles)	9.0	6.0	62.0	41.0
3. Shock with pain (with muscle stiffness, and shortness of breath)	23.0	15.0	90.0	60.0
4. Often causes death instantly	100		100	

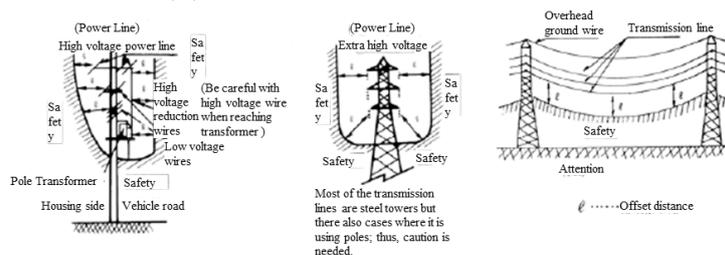
Note) 1 mA is equal to 1/1000 A (Ampere)

The human body resistance is divided into the resistance of the skin and the resistance inside the human body. The resistance of the skin is about 10,000 Ω (ohm) when the skin is dry, but it drops to about 500 to 1,000 Ω when sweating or when the limbs and clothes are wet. The resistance inside the human body is about 500Ω.

Table 9-4 Offset distance from transmission line

Circuit	Transmission Voltage (V)	Minimum Offset Distance	
		Director of Labour Standards Bureau	Electric company standard value
Power line	Under 100 · 200	Over than 1.0	Over than 2.0
	6, 600 *	1.2 *	2.0 *
Transmission line	22, 000 *	2.0 *	3.0 *
	66, 000 *	2.2 *	4.0 *
	154, 000 *	4.0 *	5.0 *
	275, 000 *	6.4 *	7.0 *
	500, 000 *	10.8 *	11.0 *

(Att.) \*Basic Notification No. 759, 17th December 1975



### 9.5.3. Battery Handling (Text p.204)

A battery is a storage that can convert electrical energy into chemical energy (this is called charging) and can take it out as electrical energy when needed (this is called discharging). These are types of batteries that currently in practical use: lead batteries and alkaline batteries.

The following points are precautions needed when handling batteries.

- ① Always remove dust and dirt attached to it and keep it clean (it can be the source of leakage (discharge)).
- ② Distilled water should be replenished between H (High) and L (Low) levels. (Do not add dilute sulfuric acid.)
- ③ Do not add too much distilled water (the specific gravity will change if leaks).
- ④ Adjust the battery fluid level for each room.
- ⑤ Do not discharge unreasonably/forcibly.
- ⑥ Do not handle it roughly.
- ⑦ Tighten the terminal from time to time to avoid failure in the circuit.
- ⑧ Do not use a spanner or the like to short circuit it.
- ⑨ Measure the specific gravity and recharge immediately when it becomes 1.22 or less.
- ⑩ Measure the voltage with a battery tester.

Attention) Replenishing distilled water: Wear protective glasses and gloves since the liquid inside the battery is dilute sulfuric acid. If it gets on your skin, wash it off with plenty of water. If exposed to the eyes, rinse with plenty of water and consult an ophthalmologist.

### 9.5.4. Battery charging (Text p.204)

It can be charged with a charging generator while the engine is running. Still, depending on the machine operating conditions and the voltage regulator setting, the power consumed from the battery may not be sufficiently supplemented. If keep used in this manner, the battery life will be shortened, so it is important to conduct auxiliary charging.

Attention) Battery charging: Hydrogen (H<sub>2</sub>) gas and oxygen (O<sub>2</sub>) gas are generated during charging, so perform in a well-ventilated place, and use of fire is strictly prohibited.

**10. Topography and Construction Knowledge**

**10.1. Rock and soil characteristic (text p.207)**

**10.1.1. Rock characteristic (Text p.208)**

**1. . . Rock Hardness**

Rock hardness is generally represented rock hardness and bedrock hardness. Rock hardness is indicated by lithic fragment compression tests.

Rock hardness varies depending on the hardness of the rock itself, cracks and weathering degrees, and the presence of faults and fracture zones. Recently, the evaluation of rock quality as a whole of rock unit has been conducted by a test based on the ground elastic wave speed and rock fragments' compression.

Generally, the compressive strength of rock is about 10 N / mm<sup>2</sup> to 300 N / mm<sup>2</sup>, and it can be said that the faster the ground elastic wave speed, the harder the rock.

Table 10-1 Rock Hardness Classification

Classification	Compression Rate (N/mm <sup>2</sup> )	Elastic Wave Velocity(km/s)	Rock Type Examples
Soft-rock	10	Below 1.5	Tertiary Pelitic Rock, Partial Sandstone
Medium-hard rock	10~50	1.5~3.0	Majority of Tertiary Sedimentary Rock
Hard rock	50~150	3.0~5.0	Mesozoic/Paleozoic era Pelitic Rock
Superhard rock	150 and up	5.0 and above	Chert, Hard sandstone, Gabbro, Igneous rock like Diabase, Gneiss, Quartz Schist, Hornfels

**10.1.2. Soil (Text p.209)**

**1. . . Soil types**

Soil is formed by weathering rocks into fine particles and Transported by the wind and water after eroded and piled up. It was then accumulated by vegetation and deposited with volcanic ash.

There are various methods in this soil classification, but generally, soil material is a material that makes up soil and has a size less than 75 mm.

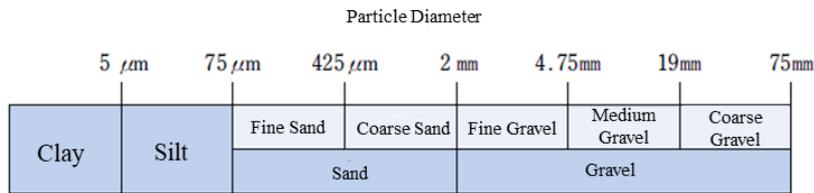


Figure 10-2 Classification of particle diameter and Terms

## 2 . . . Soil composition

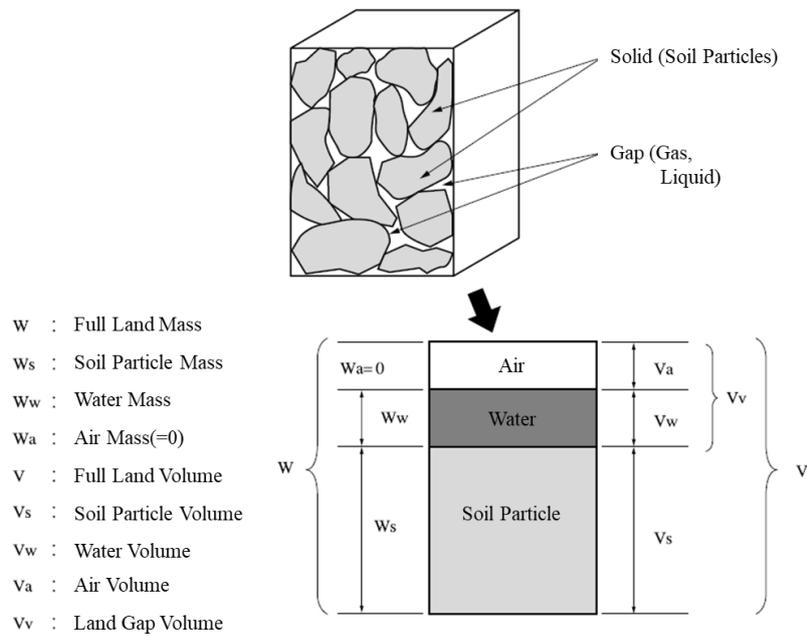


Figure 10-4 Soil Composition

## 3 . . . Main terms that used to describe soil condition

### ① Density

Dry soil density = soil particle mass ( $W_s$ )/full land volume ( $V$ )

Wet soil density = (soil particle mass ( $W_s$ ) + water mass ( $W_w$ ))/full land volume ( $V$ )

### ② Moisture ratio

Moisture ratio = water mass in the gap ( $W_w$ )/soil particle mass ( $W_s$ ) x 100%

### ③ Porosity

Porosity = (Soil particle volume's air ( $V_a$ ) + Soil particle volume's water ( $V_w$ ))/Soil particle volume ( $V_s$ ) =

### ④ Soil saturation

Soil saturation = water mass in the gap ( $V_w$ )/soil particle volume ( $V_s$ ) x 100%

#### 4 • • • Soil compaction

If a force is applied to the soil from the outside, the air in the gaps between the soil particles is pushed out, and the soil particles become closely engaged with each other. As a result, the gap between soil particles is reduced, the soil volume is reduced, and the density is increased. This is called soil compaction. The compacted soil increases the soil's strength, decreases the permeability, and increases the durability against rainwater and running water. When performing banking work, compaction is always performed to obtain banking Stability by increasing the bank's strength and reducing the permeability in this way.

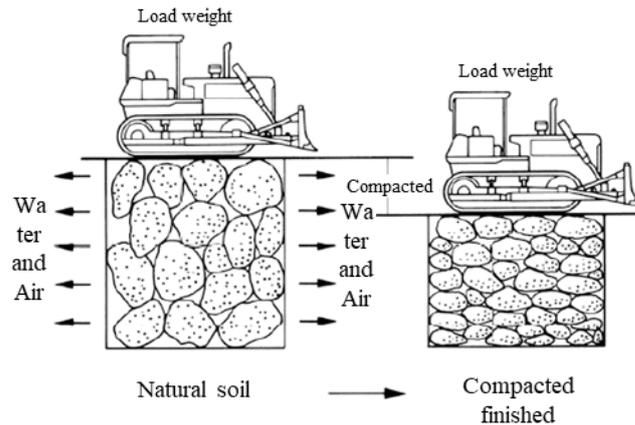


Figure 10-5 Compacted soil (shimegatame) composition

#### 5 • • • Ground strength

Ground strength is called ground bearing.

The ground bearing capacity is done to measure the strength of the load (10N / mm<sup>2</sup>) that is required to cause 1 cm depression within the range that does not cause sudden subsidence when a load is applied, and the ground coefficient or bearing capacity coefficient is expressed by (K value) and (10N / mm<sup>2</sup>)—the greater the load required to sink per cm, the greater the ground bearing capacity.

#### 6 • • • Ground hardness

To indicate the hardness of the stratum, the cone index or N value is used. The cone index is used to measure the ground hardness to judge whether the construction machine can run when the construction machine operates on soft ground (see Table 10-3).

Table 10-3 Cone index

Machine Type	Cone Index (N/mm <sup>2</sup> )	Ground Pressure (N/mm <sup>2</sup> )
Medium size swamp Bulldozer (burudoza)	0.3 Above	0.026~0.028
Medium size Bulldozer (burudoza)	0.5 "	0.055~0.062
Large size Bulldozer (burudoza)	0.7 "	0.074~0.121
Scrapedozer	0.6 " (Bog-type)	0.074 (Load Capacity)
Carryall Scraper (sukurepa)	0.7 "	
Motor Scraper (sukurepa)	1.0 "	
Dumptruck	1.2 "	

Note) Numbers may change depending on soil texture

## 7 • • • Change in soil volume

The composition of soil consists of soil particles, water, and air. Therefore, the soil volume when the soil of the ground is dug up and unraveled is different from the volume of soil when the unraveled soil is compacted. The ratio of the excavated soil volume to the soil volume in the ground is called the rate of change in the soil amount due to excavation and is represented by L. On the other hand, the ratio of the soil volume when the unraveled soil is compacted to the soil volume in the ground is called the rate of change in the soil amount due to compaction and is represented by C.

$L$  (excavated soil volume due to excavation rate of change) = unraveled soil volume (m<sup>3</sup>)/soil volume in the ground (m<sup>3</sup>)

$C$  (soil volume rate of change due to compression) = compressed soil volume (m<sup>3</sup>)/soil volume in the ground(m<sup>3</sup>)

「Soil volume rate of change (L)」differs depending on the soil quality, generally, rock, viscous soil, sandy soil, and sand is made smaller following the mentioned order and used in the soil transport planning. Furthermore, "soil volume rate of change (C)" is used when making a soil distribution plan since the value is below 1 or less with smaller particles than sand.

Table 10-5 Soil volume rate of change

Name		L	C
Rock and Stone	Hard Rock	1.65~2.00	1.30~1.50
	Medium-hard Rock	1.50~1.70	1.20~1.40
	Soft Rock	1.30~1.70	1.00~1.30
	Rock Lump/Precious Stone	1.10~1.20	0.95~1.05
Sand mixed with gravel	Gravel	1.10~1.20	0.85~1.05
	Hard Soil	1.10~1.30	0.85~1.00
	Hardened Hard Soil	1.25~1.45	1.10~1.30
Sand	Sand	1.10~1.20	0.85~0.95
	Rock Lump/Sand mixed with precious stone	1.15~1.20	0.90~1.00
Common Soil	Sandy Soil	1.20~1.30	0.85~0.95
	Rock Lump/Sandy soil mixed with precious stone	1.40~1.45	0.90~1.00
Viscous Soil, etc.	Viscous soil	1.20~1.45	0.85~0.95
	Viscous soil mixed with gravel	1.30~1.40	0.90~1.00
	Rock Lump/Viscous soil mixed with precious stone	1.40~1.45	0.90~1.00

Note: This table shows the approximate average rate of change for each soil type.

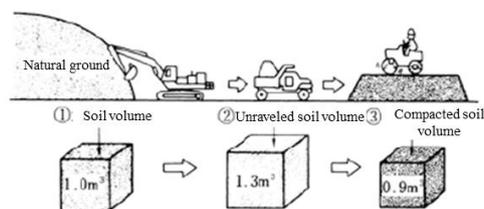


Figure 10-6 Change in soil volume

**10.2. Landslides cause and indication (Text p.218)**

**1 . . . Landslides cause**

For slope (nori men) in their natural condition and have not collapsed for many years means that the soil that forms the slope (nori men)s is strong enough to withstand the forces that can make it collapse.

However, even for slope (nori men) or slanting surface that has been stable for long years,

- ① Can collapse due to rainfall, freezing, thawing, etc.
- ② Originally unstable and easy to collapse terrain, joints, and faults, discontinuous geological features, high groundwater level, weathering, etc., and are further affected by excavation work and rainfall and collapse.

Other causes for a ground collapse are,

- ① Existence of faults and weak stratum that could not be found in the survey for excavation work
- ② Different execution from the plan, such as digging deeper than planned
- ③ Affected by vibration and impact from blasting and construction machinery
- ④ Decrease in sandy soil viscosity due to drying, cracks, and fractures in viscous soil

Or other cases that can become the cause.

To prevent such collapse, the standard of excavation surface height and gradient according to the type of ground is determined as shown in Table 10-7 for the excavation by hand-drilling. It is important to refer to this standard when performing mechanical excavation.

Table 10-7 Reclaimed Slope (nori men) Surface and Height Basis

Soil Type	Excavated surface's height · Slope
Ground made of bedrock or hard clay	
Other type ground	
Ground made of sand	
Ground that easily collapse due to blast, etc.	

## 2 · · · Collapse form

### ① Slope (nori men) (norimen) or slanting surface

Slanting surface and slope (nori men) (norimen) collapses generally occur on slope (nori men)s and certain surfaces along the slope (nori men) (norimen). This is called as rupture surface or slip surface. The slip surface is often curved. Furthermore, the slip surface changes depending on the type of soil. Such a collapse phenomenon is likely to occur after heavy rain.

### ② Vertical slope (nori men)s (norimen)

A collapse in a vertical surface is more likely to occur than a slanting surface.

In figure 10-7(a), sandy soil loses its viscosity, develops fractures, and cause the slope (nori men)'s face to peel off due to dryness.

In figure 10-7(b), a more likely to happen collapse form, cracks occur on top of slop and created slip surface.

Figure 10-7(c) often happens in soil with a weak stratum, the ground face is sinking, and a bulge is formed on the slope (nori men) toe.

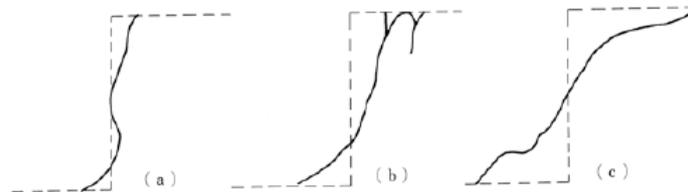
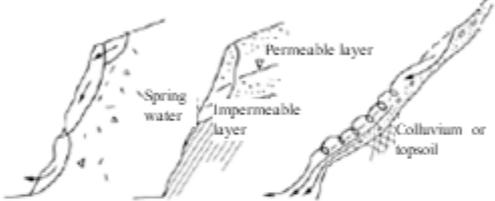
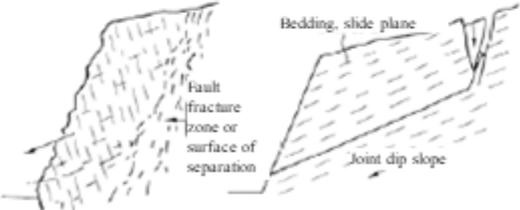
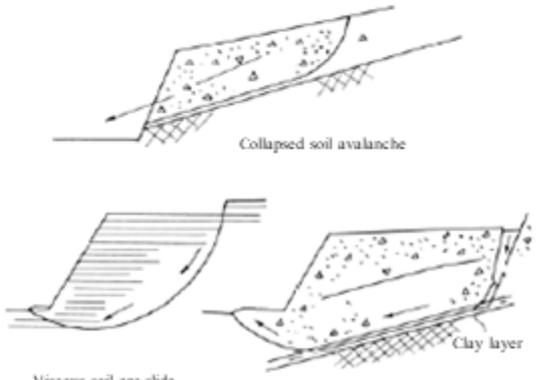


Figure 10-7 Example of collapse on vertical surface (norimen)

In addition, the 10-8 figures are used as a reference for collapse form

Figure 10-8 Slope (nori men) collapse form explanation

	Rock Collapse Pattern	Soil Collapse Pattern
<p>Rock mass falls in the range of one or several rock (rockfall type)</p> <p>Type I</p>	 <p>Rock with lot of crack</p> <p>Rock hardness alternating layer</p> <p>Fragmented rock type rockfall (abrasion type)</p>	 <p>Cliff cone deposit (cliff cone type)</p> <p>Terrace gravel layer (Conglomerate type)</p> <p>Weathered granites (layered structure like an onion)</p> <p>Boulder type rockfall (falling type)</p>
	<p>It is a type in which the rock mass separated by the crack is flaked along the crack.</p>	<p>If the filling inside the gravel layer (matrix) is made of a material with a low degree of solidification, such as rock mass or boulder, weathered and eroded, the boulder will float and lose its balance. It's a type that collapses.</p>
<p>Surface collapse is shallow, small-scale collapse (detachment type/breakdown type)</p> <p>Type II</p>	 <p>Rock with lot of crack</p> <p>Hardness alternating layer</p> <p>Rocks with columnar joints</p> <p>Soft rock or soil</p> <p>Rock separation/breakdown type collapse</p>	 <p>Unconsolidated soil</p> <p>Presence of impermeable layer</p> <p>Debris flow</p> <p>Permeable layer</p> <p>Impermeable layer</p> <p>Spring water</p> <p>Colluvium or topsoil</p> <p>Soil shedding, breakdown type collapse</p>
	<p>It's a medium-scale collapse that collapses along the rock joints. Excavation (kussaku) can open potential cracks, where rainwater, etc., percolate and weaken the ground, and often collapse along a straight line on the slide surface.</p>	<p>Stress is released by the Excavation (kussaku) of soil and earthen ground, and weathering progresses, and it absorbs water and collapses due to subsequent rainfall, etc., and is the most common type of ground collapse.</p>
<p>Collapse surface is deep or widespread</p> <p>Type III</p>	 <p>Dislocation, dike</p> <p>Stratum, joint dip slope</p> <p>Bedding, slide plane</p> <p>Fault fracture zone or surface of separation</p> <p>Joint dip slope</p> <p>Large scale collapse (rockslide)</p>	 <p>Collapsed soil avalanche</p> <p>Viscous soil arc slide</p> <p>Composite slide</p> <p>Clay layer</p> <p>Large scale collapse (land slide type)</p>
	<p>It is a type of collapse caused by the development of an extremely low-strength weak line in the bedrock, and the soil layer slips down along that line. The avalanche scale depends on the relationship between the slope and the weak line, inclination, etc. The scale of collapse is determined by the relationship between the slope and the weak line, the inclination angle, and so on. Also, the tip may protrude out.</p>	

### 3 • • • Collapse indication

When the soil collapses, it is usually accompanied by some sign. In general, cracks and depressions occur on the collapsing surface, or small collapses appear on the excavated slope (nori men). Moreover, it is also a sign of danger of collapse when the sound of trees' root is cut off, or in the case of rocks, abnormal sounds are generated. In case timbering is established, the sound of wall members are squeezed or squeaked is also an indication. There are also many cases when a collapse occurs after some time passed after rainfall or when frozen soil melts.

To prevent the danger of soil collapse, the construction machine operator should thoroughly check the soil condition and whether there are any cracks or depressions on the top of the slope (nori men), berm, slope (nori men), etc., before work. Furthermore, it is also important to warn the concerned parties and evacuate immediately to a safe place during the work when excavation surface height is adjusted and perform excavation on a slope (nori men), and the danger of collapse is continuously predicted.



Figure 10-8 Collapse indication

10.3. Engineering works application method, etc. (Text p.223)

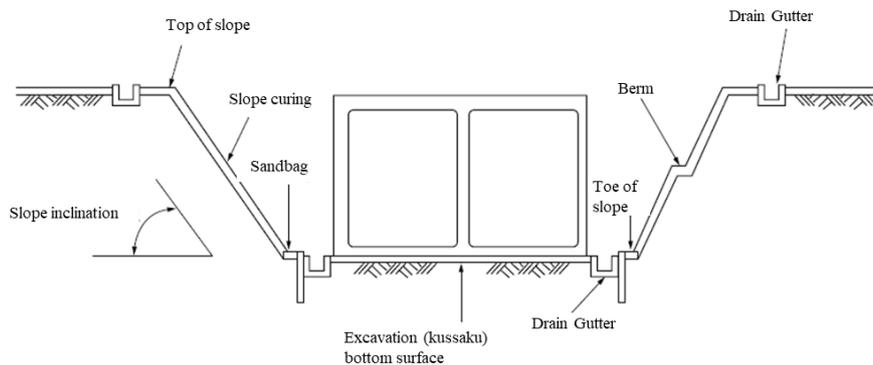


Figure 10-9 Open Cut Grading Works Example

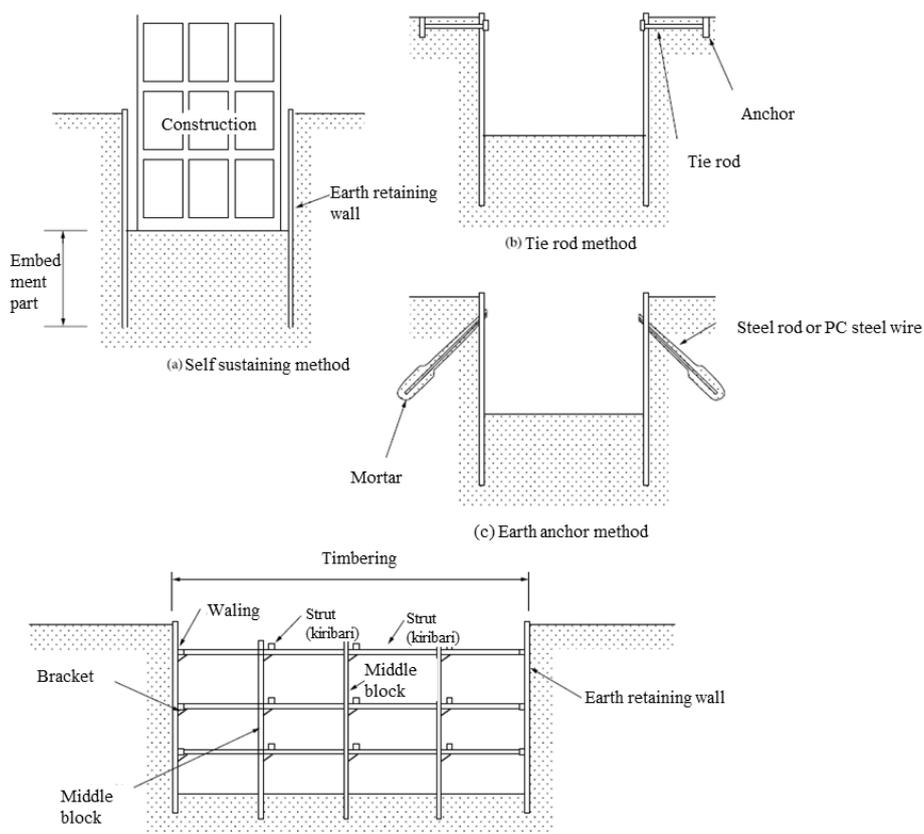


Figure 10-10 Open Cut Binder Construction Method Example

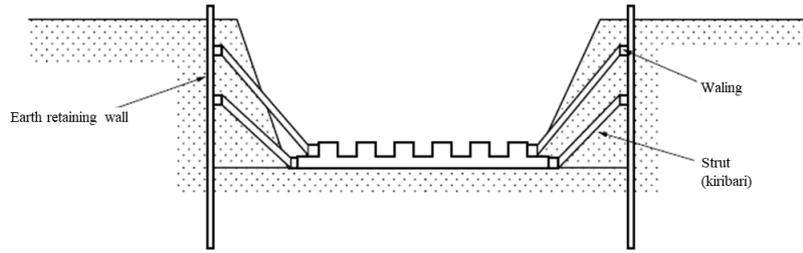


Figure 10-11 Island Construction Method

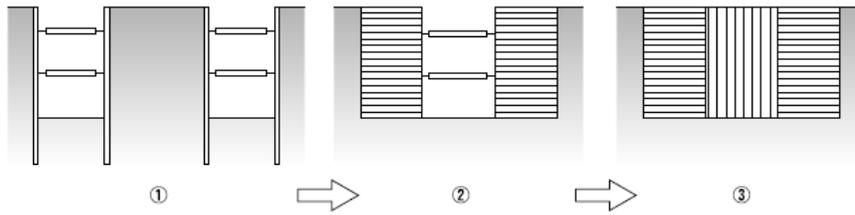


Figure 10-12 Trench cut Construction Method Example

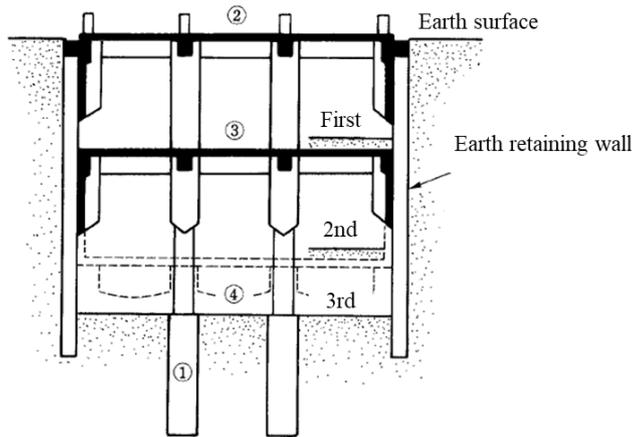


Figure 10-13 Inverted Lining Example

## 11. Disaster cases

Chart 11-1 shows the transition of casualties disaster taking over 4 days off in the construction industry.

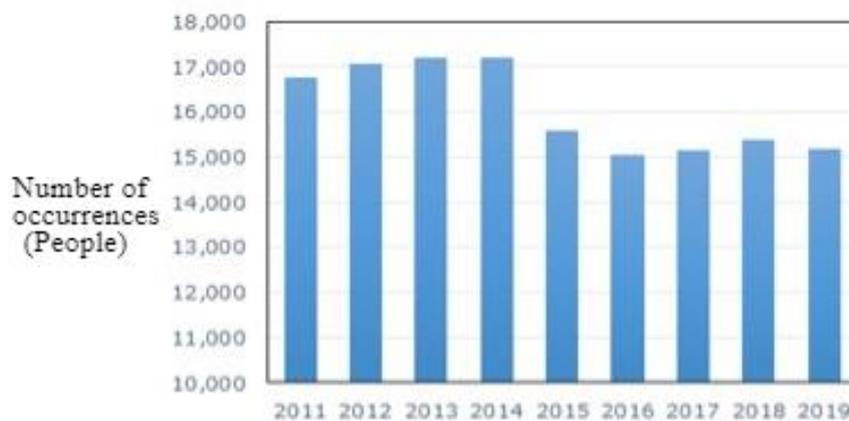


Chart 11-1 The transition of casualties disaster took over 4 days off in the construction industry.  
(Excepting those directly caused by the Great East Japan earthquake. )

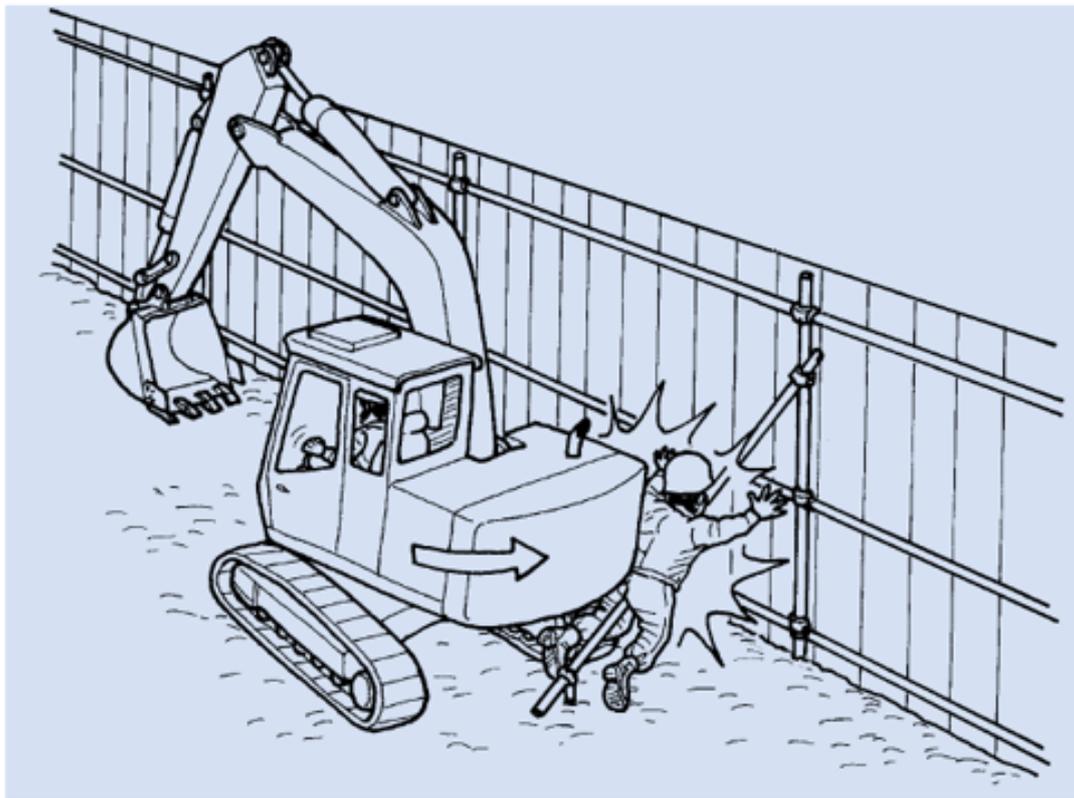
Also, in the case of compiling by cause of disasters extracted from casualties disaster of taking 4 days off in 2017, approximately 56% was for leveling, Transport, stowage, and excavation, and approximately 15% is for demolition in the cause of construction machines, etc.

(Reference) Ministry of Health, Labor and Welfare Occupational accidents situation workplace safety site:  
Analysis of factors causing occupational accidents. (construction industry in 2009)

11.1. Disaster case 1 Earthwork is pinched between counterweights of drag shovel (shoberu). (Text p.230)

Disaster Case		1			
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Cause (Machine etc.)	Accident Type
August 7	Building construction	Excavating	Second	Drag shovel (doragu shoberu)	Caught
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Chest	Earthwork	68 years old	15 years	1 day	30 days off

Occurrence status: The construction worker was caught between drag shovel (shoberu) counterweights.



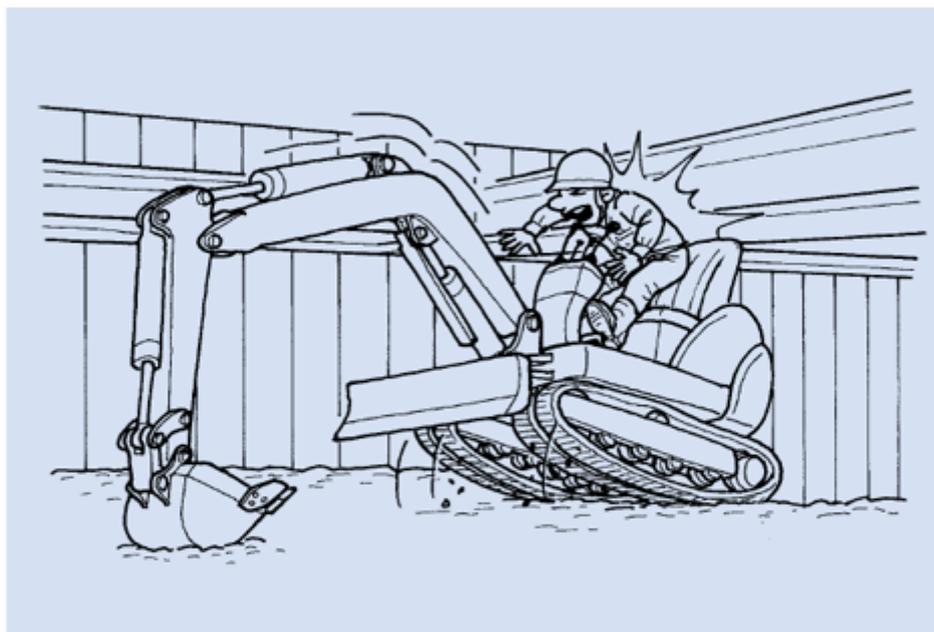
During the excavation work of establishing a water tank, the counterweight of drag shovel (shoberu) was likely to hit the temporary enclosure, so worker entered in his own decision and got pinched between the reserve pipe and the counterweight.

Cause	<ol style="list-style-type: none"> <li>1. Entered into a danger place.</li> <li>2. Not gave signals to driver.</li> <li>3. Not being used to location because of newcomer.</li> </ol>
Countermeasures	<ol style="list-style-type: none"> <li>1. To consider the establish location of the machine and establish in a safe location.</li> <li>2. To operate after stop machines and checked if it is safe.</li> <li>3. To educate new visitors and prohibit independent operation.</li> </ol>

**11.2. Disaster Case 2 The driver was caught in the lever and short strut while laying the soil with a drag shovel (shoberu). (Text p.231)**

Disaster Case		2			
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Cause (Machine etc.)	Accident Type
January 13	Shield	Backfill (umemodoshi)	Second	Drag shovel (doragu shoberu)	Caught
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Chest	Driver	45 years old	28 years	70 days	Dead

Ocurrence status: While leveling the soil with the Drag shovel (shoberu), the operator was caught between strut and lever.



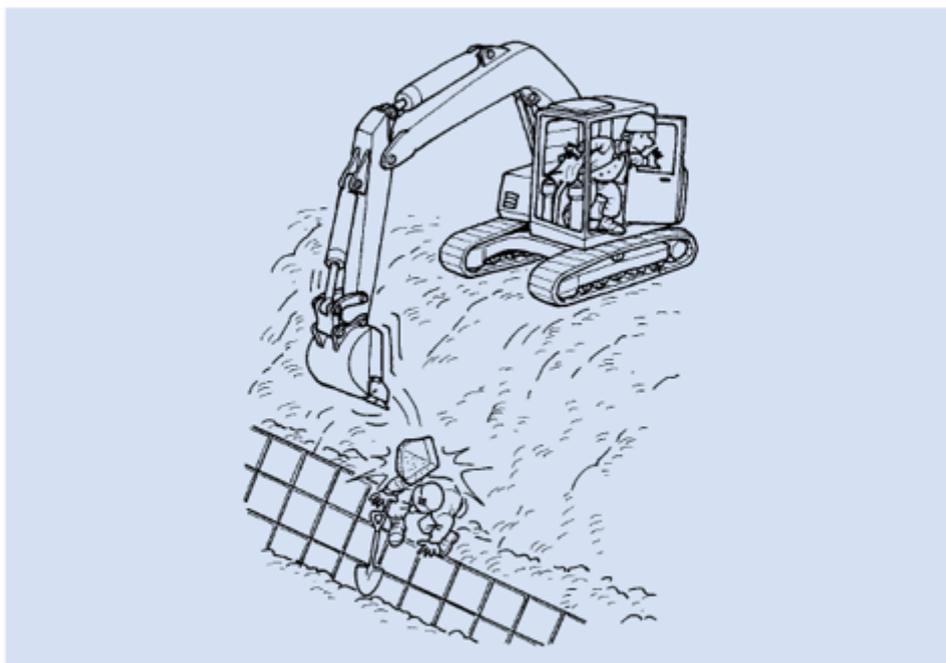
When the victim was driving a mini-drag shovel (shoberu) for backfilling (umemodoshi) work to dismantle the struts, the front of the shovel (shoberu) lifted up when the bucket was pushed, and the operating lever hit the victim's chest, causing the shovel (shoberu) to rise even higher, and the victim's body was caught between the upper struts and the lever on the driver's seat.

Cause	<ol style="list-style-type: none"> <li>1. Not equip head gird on min-drag shovel.</li> <li>2. Not being used to drive machine due to new visitor.</li> <li>3. Not being well-considered operation procedure.</li> </ol>
Countermeasures	<ol style="list-style-type: none"> <li>1. To equip head gird on min-drag shovel.</li> <li>2. To assign driver who is used to operate with machine.</li> <li>3. Operating machines in narrow space, accurately understand the procedure and method according to the work situation.</li> </ol>

**11.3. Disaster Case 3 Blocks are fallen from buckets of drag shovel (shoberu) to a worker. (Text p.232)**

Disaster Case		3			
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Cause (Machine etc.)	Accident Type
September 2	River	Block storing	Second	Drag shovel (doragu shoberu)	Flying/Falling
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Waist	Concrete block masonry	53 years old	10 years	30 days	90 days off

Occurrence status: Blocks from the drag shovel (shoberu) bucket fell on a worker.



The operator placed several blocks in the bucket of the drag shovel (shoberu) and lowered it to the block stacking area under the bank. When the operator tried to leave the driver's seat unintentionally, the control lever got caught in the pocket of his jumper and the blocks in the bucket fell, hitting the operator who was working below.

<b>Cause</b>	<ol style="list-style-type: none"> <li>1. Not to take fall prevention measures such as binding, etc. when placing blocks in the bucket.</li> <li>2. Inadvertently leaving the driver seat while lifting block highly in the bucket.</li> <li>3. Not giving signals and make workers move from the location where you put blocks when lowering the bucket with blocks.</li> <li>4. No guide was placed during loading and unloading work.</li> </ol>
<b>Countermeasures</b>	<ol style="list-style-type: none"> <li>1. To take fall prevention measures.</li> <li>2. When the driver leaves the driver's seat, take measures to ensure that the "bucket and other working positions are lowered to the ground".</li> <li>3. Display a "No entry"</li> <li>4. Assign a guide.</li> </ol>

11.4. Disaster Case 4 The guide became underlay falling the drag shovel (shoberu) down on the sloping ground. (Text p.233)

Disaster Case		4			
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Cause (Machine etc.)	Accident Type
August 2	Water and sewage	Block storing	First	Drag shovel (doragu shoberu)	fallen
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Chest	Concrete block masonry	50 years old	18 years	2 days	Dead

Occurrence status: The Drag shovel (shoberu) was overturned on a slope and crushed the guide beneath it.



A drag shovel (shoberu) was moving through a slope of bamboo bushes (about 20 degrees of gradient) to perform uneven terrain shaping at a designated rest area after completing water drainage work at the excavation site.

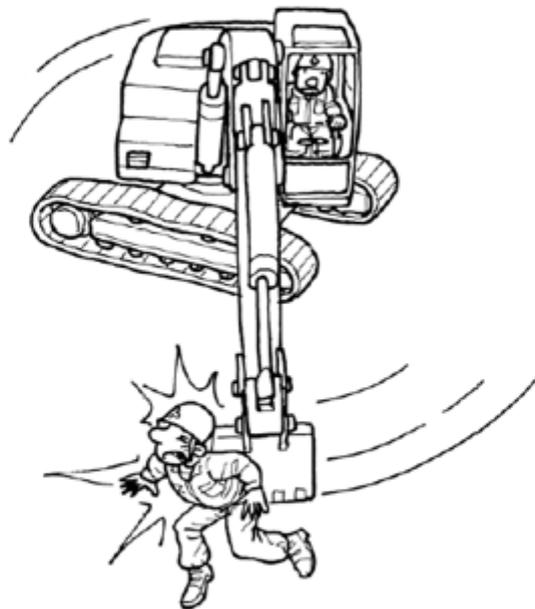
In doing so, the drag shovel (shoberu) fell over, and an earth worker who was guiding became trapped underneath the drag shovel (shoberu).

Cause	<ol style="list-style-type: none"> <li>1. The driver and the victim a work apart from that agreed at the meeting.</li> <li>2. The victim entered the operating radius of the drag shovel (shoberu).</li> <li>3. The driver did not investigate the route in advance.</li> <li>4. Moved places outside the aisle.</li> <li>5. The bamboo bush was so deep that ground could not be confirmed.</li> </ol>
Countermeasures	<ol style="list-style-type: none"> <li>1. Never operate other than the meeting.</li> <li>2. Do not enter into operating radius of heavy machines when guiding.</li> <li>3. For the crisis area, investigate grounds, shapes, etc in advance and measures to not enter.</li> </ol>

**11.5. Disaster Case 5 After the meeting, hit by a turning bucket walking in front of the drag shovel (shoberu). (Text p.234)**

Disaster Case		5			
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Cause (Machine etc.)	Accident Type
September 2	Other engineering works	Block storing	Third	Drag shovel (doragu shoberu)	Crashed
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Waist	Concrete block masonry	47 years old	10 years	60 days	30 days off

Occurrence status: A worker was hit by a turning bucket when he was walking in front of a drag shovel (doragu shoberu).



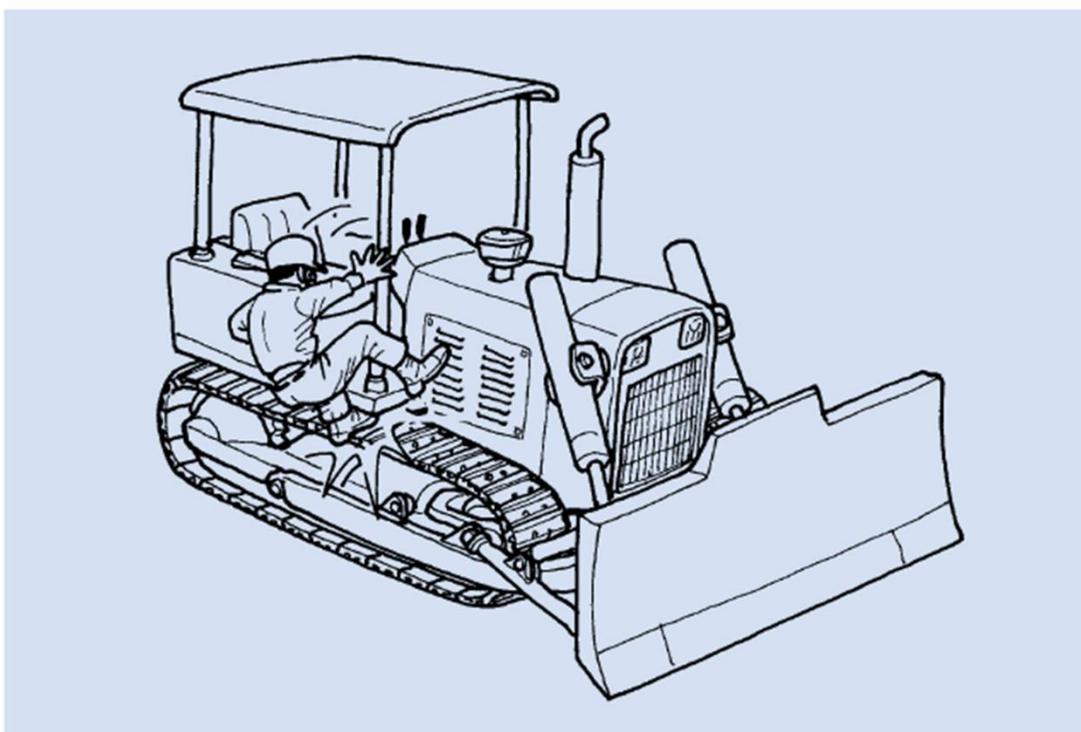
The victim, who had gone to the driver's seat of the drag shovel (shoberu) to have a meeting, was walking in front of the drag shovel (shoberu) after the meeting when the driver started to work and was hit by the turning bucket.

Cause	<ol style="list-style-type: none"> <li>1. The driver does not confirm at the start of working.</li> <li>2. Having a meeting in the turning of the machines.</li> <li>3. Walking right next to the machine.</li> </ol>
Countermeasures	<ol style="list-style-type: none"> <li>1. Warning sound a horn before starting work.</li> <li>2. Educating safety and health.</li> <li>3. Making signals each other thoroughly.</li> </ol>

**11.6. Disaster Case 6 After inspected the Bulldozer, lost balance, and got legs caught while attaching the cover.**  
 (Text p.235)

Disaster Case		6			
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Cause (Machine etc.)	Accident Type
October 31	Land Readjustment	Earthwork	First	Bulldozer (burudoza)	Caught
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Left Leg	Driver	43 years old	10 years	270 days	50 days off

Occurrence status: After finishing the inspection of the Bulldozer, while installing the cover, the worker lost his balance and his foot got caught.



After refueling the bulldozer during rough terrain work, the operator removed the engine cover for engine inspection. While putting the engine cover back on after the inspection, he lost his balance and got his left foot caught between the crawler and the stepping board to the driver's seat, resulting in an injury to his left ankle.

Cause	<ol style="list-style-type: none"> <li>1. Worked on an uneven crawler.</li> <li>2. Wore slippery boots on slippery crawler.</li> </ol>
Countermeasures	<ol style="list-style-type: none"> <li>1. Inspect by taking measures such as a plate to eliminate unevenness on the crawler.</li> <li>2. Raising safety awareness.</li> </ol>

**11.7. Disaster Case 7 The Bulldozer fell on a slope (nori men), and the driver was crush under the Bulldozer.**  
(Text p.236)

Disaster Case		7			
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Cause (Machine etc.)	Accident Type
April 23	Road	Earthwork	Second	Bulldozer (burudoza)	Fall
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Abdomen	Driver	41 years old	15 years	12 days	Death

Occurrence status: The bulldozer fell down the slope and the driver was squashed by the bulldozer.



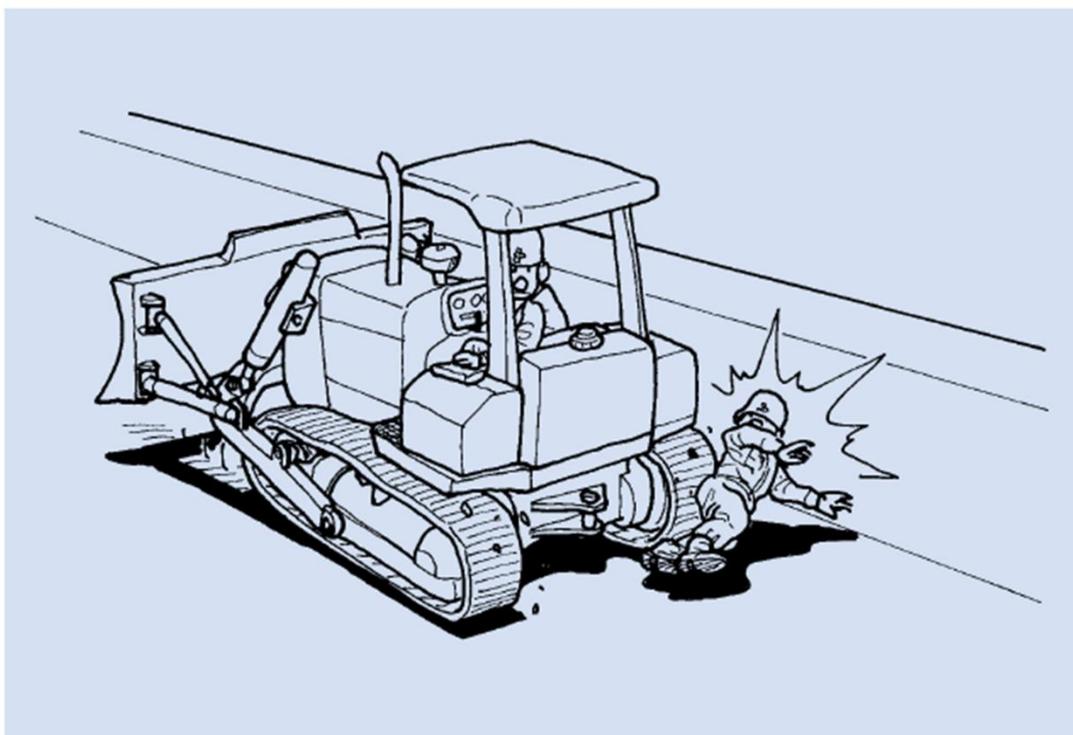
While pushing excavated soil (oshido) with a bulldozer during slope (nori men) re-cutting work, he fell from the edge of the pushing section together with the bulldozer and became trapped under the bulldozer.

Cause	<ol style="list-style-type: none"> <li>1. No soil was left at the front end of the pressed soil to prevent it from falling.</li> <li>2. Immediately after relocation, the driver was not accustomed to the work.</li> <li>3. Due to a driver's operation error.</li> </ol>
Countermeasures	<ol style="list-style-type: none"> <li>1. Clarify the work procedure instructions and check the implementation status, according to the construction implementation plan.</li> <li>2. Educate drivers about construction methods, work procedures, and safety</li> <li>3. When working with construction machinery, make a plan according to the work situation, such as model and capacity.</li> </ol>

11.8. Disaster Case 8 Marking worker got caught in Bulldozer crawler while moving backward. (Text p.237)

Disaster Case		8			
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Cause (Machine etc.)	Accident Type
February 15	Road	Prepare	First	Bulldozer (burudoza)	Caught
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Legs	Earthwork	63 years old	40 years	290 days	42 days off

Occurrence status: A marking worker was caught up by the Crawler while the bulldozer moving backward.



While marking (making) the embankment (morido) roll-out thickness, a bulldozer working on the bank embankment (morido) suddenly changed direction and backed up. The driver of a nearby roller sounded an alarm to notify the workers, but he did not notice and was caught in the crawler.

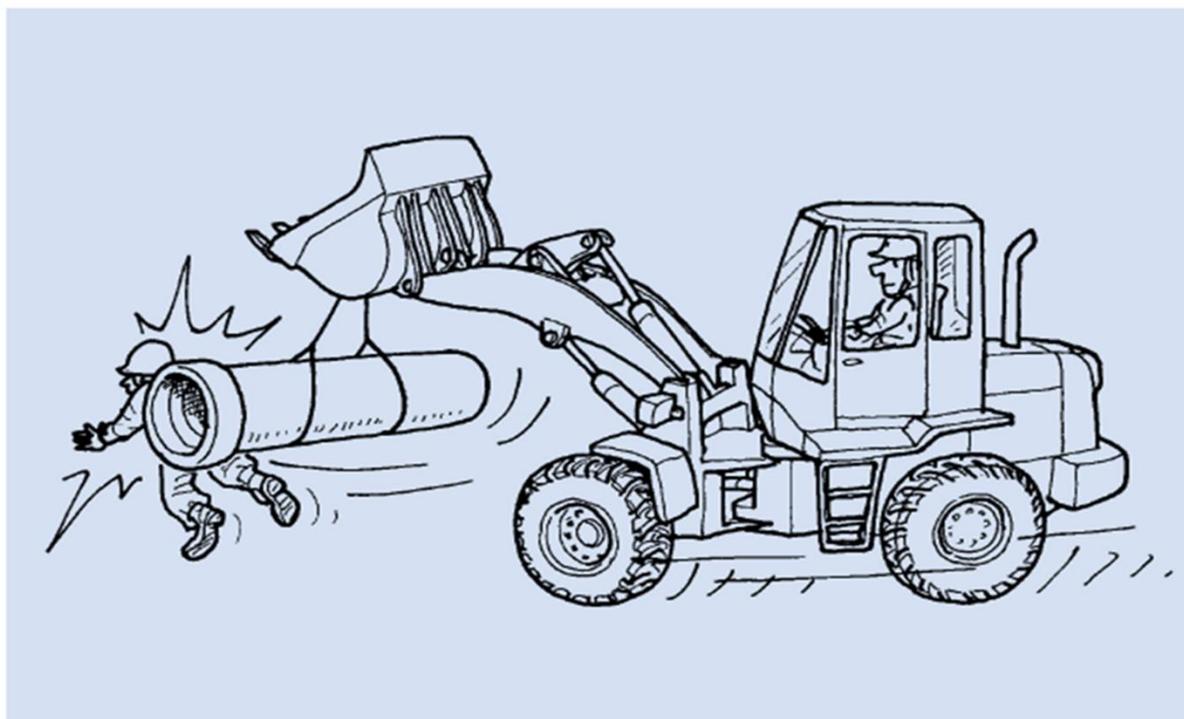
Cause	<ol style="list-style-type: none"> <li>1. The worker entered the heavy equipment area.</li> <li>2. Workers didn't have a meeting before work and didn't understand each other's work details.</li> <li>3. The bulldozer driver didn't confirm safety before moving backward.</li> </ol>
Countermeasures	<ol style="list-style-type: none"> <li>1. Barricades, etc. are prohibited from entering heavy machinery work areas by anyone other than those involved.</li> <li>2. Appoint a guide for mixed work of heavy machine and people</li> <li>3. The driver starts work after confirming the scheduled work in the work area.</li> </ol>

**11.9. Disaster Case 9 The tractor shovel (shoberu) hanging a load crashed into a worker while driving (Text p.238)**

Disaster Case		9		Tractor shovel (torakuta shoberu)	
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Tractor Shovel	Accident Type
May 10	Land Readjustment	Earthwork	First	Tractor Shovel	Crashed
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Abdomen	Earthwork	52 years old	15 years	25 days	40 days off

Occurrence status: While hanging a load using a tractor shovel (shoberu), it crashed into a worker.

Occurrence Status : The tractor shovel hanging a load crashed into worker while driving



At the driver's judgement, while hanging a fume pipe on the claws of his tractor shovel (shoberu), the driver speeded too much and crashed into a nearby worker.

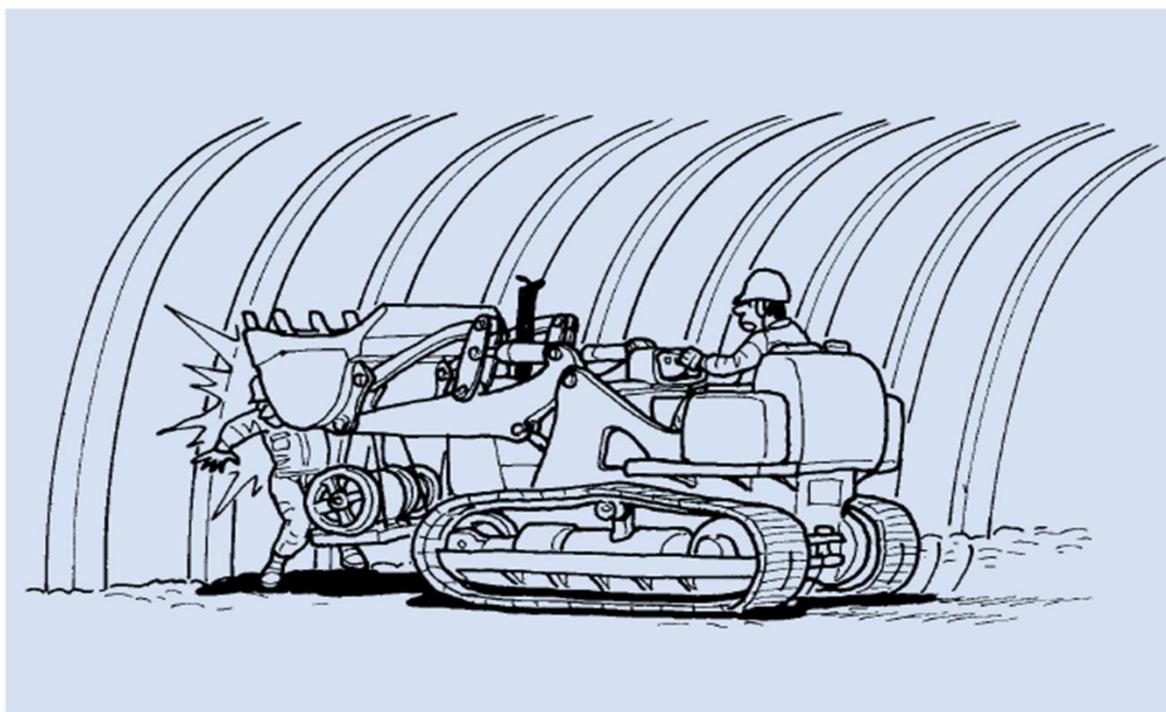
At the driver's judgment, while hanging a Hume pipe on the claws of a tractor shovel, driver speeded up too much and crashed into a nearby worker.

Cause	<ol style="list-style-type: none"> <li>1. Use for other purposes by his judgment.</li> <li>2. The driver drove violently.</li> <li>3. No work commander was assigned.</li> </ol>
Countermeasures	<ol style="list-style-type: none"> <li>1. Ensure work meetings and everyone must protect the rule</li> <li>2. Set a safe speed and must protect the rule</li> <li>3. Assign a work commander to proceed with the work</li> </ol>

**11.10. Disaster Case 10 The guide got caught in a tractor shovel (shoberu) bucket in the mine (Text p.239)**

Disaster Case		10			
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Cause (Machine etc.)	Accident Type
August 1	Tunnel	Miscellaneous Work	First	Tractor shovel (torakuta shoberu)	Caught
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Head	Digger	48 years old	4 years 3 months	15 months	Death

Occurrence status: At a mine, a guide was caught in the bucket of the shovel tractor shovel (shoberu).



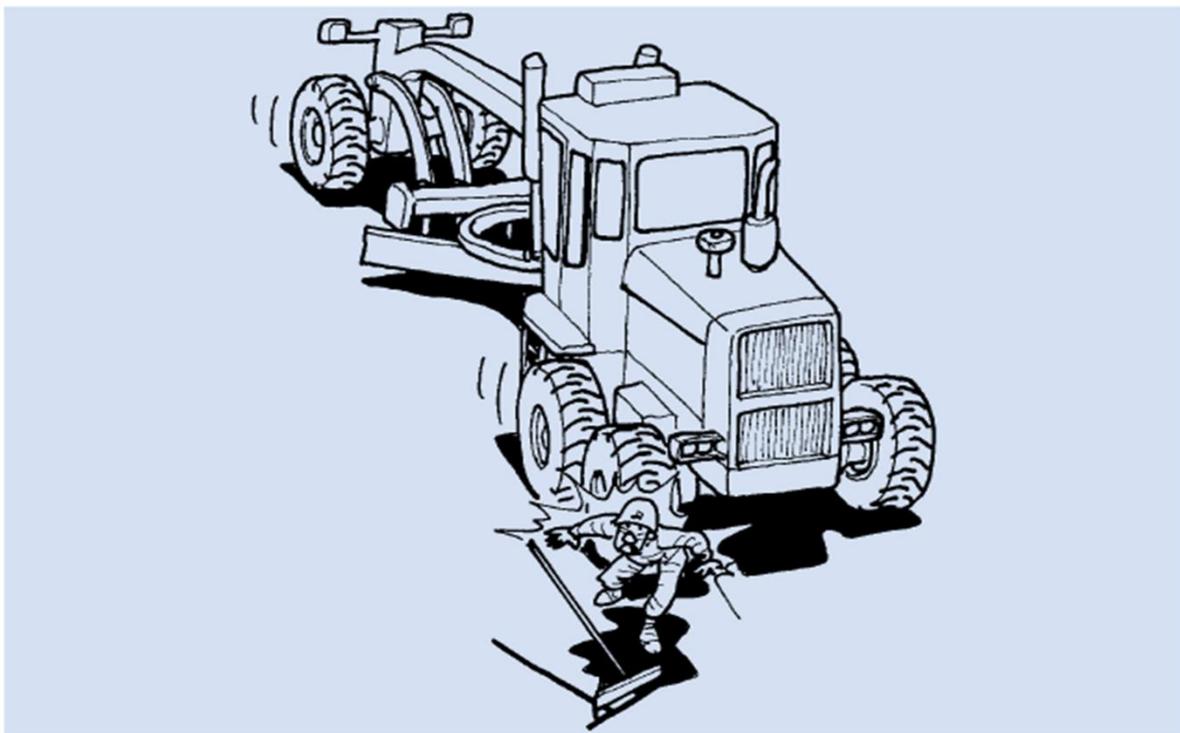
The hoist near the timbering was interfering with the planned work for the next day, so the guide went between the tractor shovel (shoberu) and the timbering to move the hoist and gave a signal. The driver moved the machine forward and stopped it once, but then signaled again, saying "a little more," so the driver moved the machine forward (the helmet of the guide was visible from the driver's seat). At this time, his head was caught between the bucket of the machine and the timbering.

Cause	<ol style="list-style-type: none"> <li>1. The guide entered directly across from the bucket and gave a signal.</li> <li>2. The driver moved forward with insufficient confirmation of the guide's position.</li> <li>3. There was no meeting before work and no instructions or guidance for work.</li> <li>4. There was a lack of instructions and caution regarding the prohibition of entry within the working radius.</li> </ol>
Countermeasures	<ol style="list-style-type: none"> <li>1. The guide should not enter within the working radius of the machine and guides, or guides in a position where the driver can see.</li> <li>2. The driver must confirm the guide's position before operating.</li> <li>3. Conduct a meeting before work, confirm the method and procedure, and inform the concerned parties. In particular, when performing work other than the main purpose, decide an appropriate work plan and proceed with the work based on that plan.</li> </ol>

**11.11. Disaster Case 11 The worker was attracted by a motor grader that is moving backward. (Text p.240)**

Disaster Case		11			
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Cause (Machine etc.)	Accident Type
June 20	Road	Leveling (seichi)	Second	Motor grader (mota gureda)	Attracted
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Lower Abdominal	Earthwork	61 years old	15 years	30 days	Death

Occurrence status: A construction worker was run over by a moving backward Motor grader.



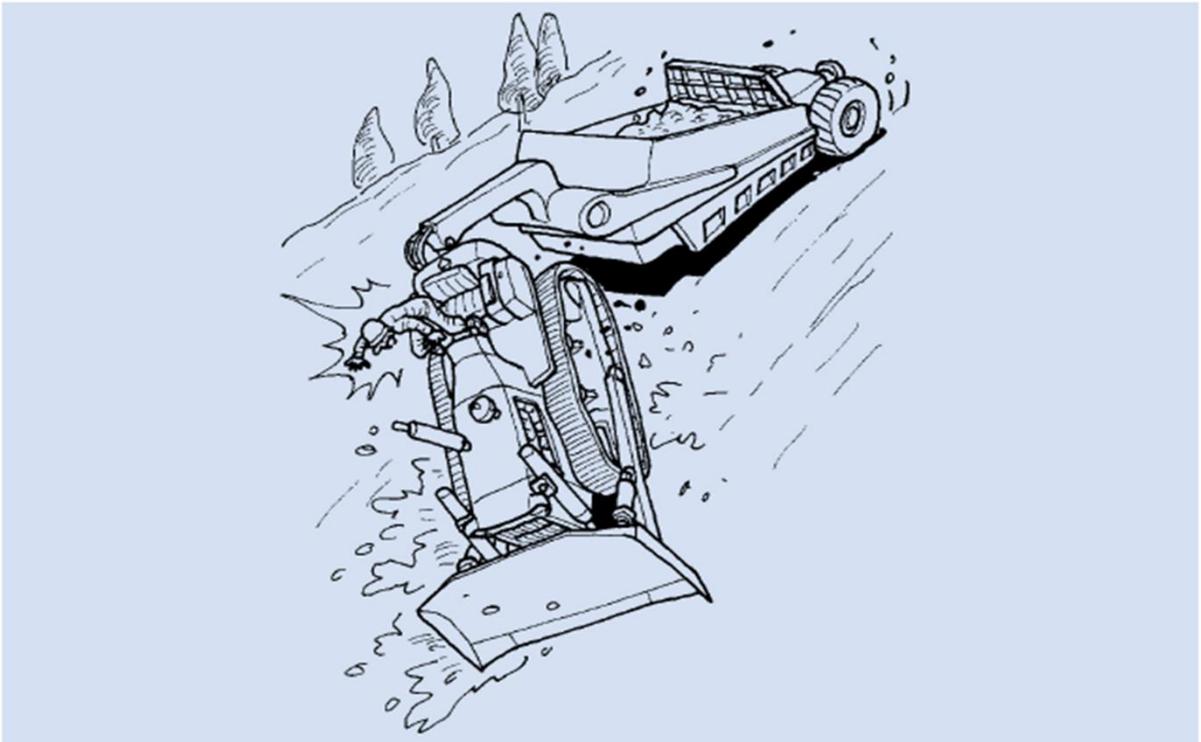
The victim was following the motor grader, which was leveling in the forward direction, and was shaping the land. A tire roller, which was working in close proximity to the motor grader, suddenly entered in front of the motor grader to change direction causing the driver of the motor grader to get surprised and move backward, resulting in the victim being run over by the motor grader.

Cause	<ol style="list-style-type: none"> <li>1. The driver was approaching the tire roller from the front, he didn't check backward and moved backward.</li> <li>2. The victim was approaching the machine and worked by look backward.</li> <li>3. Both the driver and the worker had belief that they should be able to see and avoid it.</li> <li>4. The process was delayed and the work was complicated throughout the site.</li> </ol>
Counter measures	<ol style="list-style-type: none"> <li>1. The driver sounds a horn before moving backward, confirms the rear, and then starts driving.</li> <li>2. Auxiliary workers of the machine mut work in a posture that does not turn their backs on the machine.</li> <li>3. Even if the construction period is close, the machine runs and many workers work, eliminating the complicated on-site environment.</li> </ol>

**Disaster Case 12** The scraper fell on a slope (nori men), and the driver was crush under the scraper.  
(Text p.240)

Disaster Case		12			
Date of Occurrence	Type of Construction	Type of Work	Contract Order	Cause (Machine etc.)	Accident Type
July 15	Land Readjustment	Earthwork	First	Scraper	Fall
Damaged Part	Sort of Occupation	Age	Years of Experience	Working Days	Degree of Damage
Abdomen	Driver	32 years old	8 years	150 days	Death

Occurrence status: A Scraper fell on a sloping ground and the driver was crushed beneath it.



While driving and digging a slope (nori men) with a towed scraper, the bulldozer fell down the slope (nori men) and the driver was thrown out of the driver's seat and became trapped underneath the scraper. it from the driver's seat, and was crush under the scraper.

Cause	<ol style="list-style-type: none"> <li>1. Due to an erroneous operation, the bowl floated up, the bulldozer was pushed, and the direction changed and then fell down.</li> <li>2. Worked on a steep slope (downhill slope about 5 degrees).</li> <li>3. There were boulders in some places.</li> </ol>
Countermeasures	<ol style="list-style-type: none"> <li>1. Do not steer on steep slope.</li> <li>2. Make the slope of the track surface gentler than 20 degrees.</li> <li>3. On the track surface, lead the bulldozer and remove obstacles such as rocks.</li> </ol>

## 12. Related Laws and Regulations

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 to ensure the safety and health of workers and promote the formation of a comfortable working environment. Specific issues associated with the law enforcement are indicated in Cabinet Order, Ministerial Order, Notifications, etc.

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

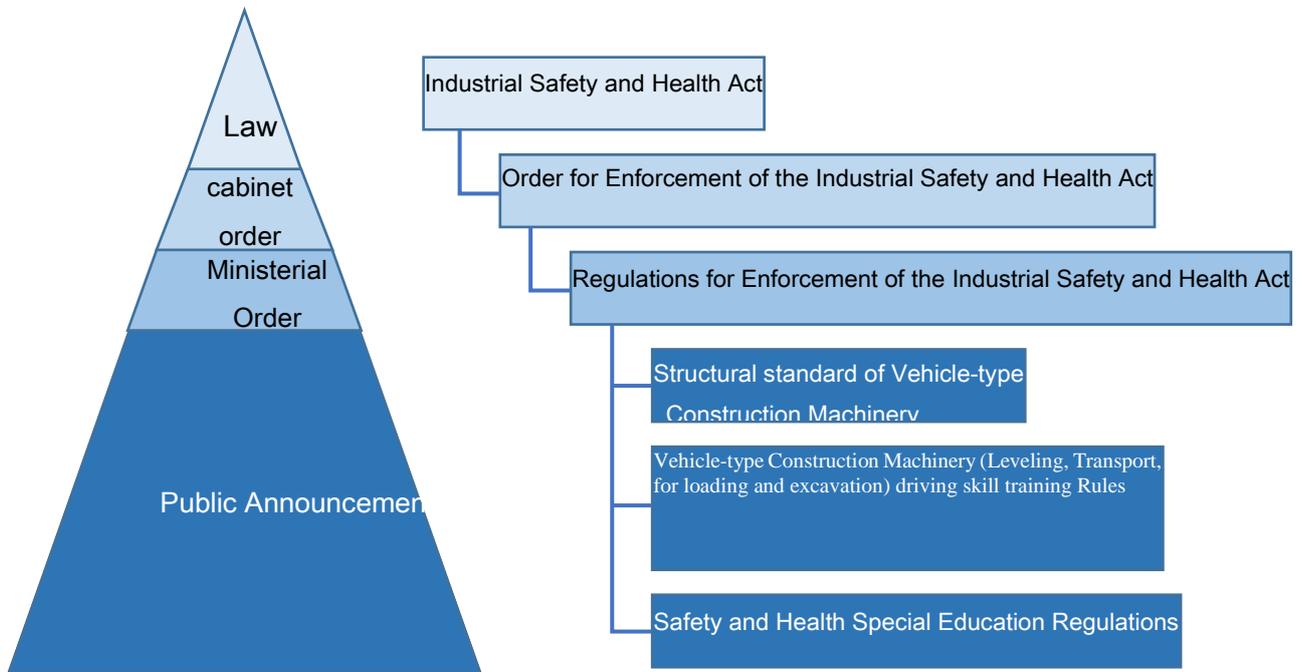


Figure 12-1 Legal system for Vehicle-type construction machinery (Leveling, Transport, For loading and excavation) Driving Skill

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

### 12.1. Industrial Safety and Health Act and Order for Enforcement of the Industrial Safety and Health Act (Extract) (Text p.243)

Chapter 1 General Provisions

Article 3 <Responsibilities of Employer, etc.>

The employer shall not only comply with the minimum standards for preventing industrial accidents provided for in this Act, but also endeavor to ensure the safety and health of workers in workplaces through creating a comfortable working environment and improving working conditions. He/she shall, furthermore, endeavor to cooperate in the measures for the prevention of industrial accidents to be taken by the State.

2 A person who designs, manufactures or imports machines, instruments and other equipment, or one who manufactures or imports raw materials, or one who constructs or designs buildings, shall endeavor, in designing, manufacturing, importing or constructing them, to contribute to the prevention of the occurrence of industrial accidents caused by their use.

3 An ordered of construction work, etc. who commissions work to others, shall consider not to impose on them conditions which may impede performing safe and healthy work in terms of construction methods, period, etc.

Article 4 Workers shall, not only observe matters necessary for preventing industrial accidents, but also endeavor to cooperate in the measures pertaining to prevention of industrial accidents conducted by employers or other said parties.

## Chapter 5 Regulations Concerning Machines, etc., Dangerous and Harmful Substances

### Article 45 <Periodical Self Inspection>

The employer shall, as provided for by the Ordinance of the Ministry of Health, Labor and Welfare, conduct self-inspection periodically and keep the records of the result in respect to boilers and other machines, etc., specified by Cabinet Order.

2 The employer shall - when he conducts voluntary inspection as provided for by the Ordinance of the Ministry of Health, Labor and Welfare (hereinafter referred to as “specified voluntary inspection”) among self-inspections under the provisions of the preceding paragraph in respect to machines, etc., as specified by Cabinet Order referred to in the same paragraph - have an employee who has the qualifications provided for by the Ordinance of the Ministry of Health, Labor and Welfare or one who registered under the provisions of paragraph (1) of Article 54-3 and carries out professional specified self-inspection in respect to the said machines, etc., in response to others’ requests (hereinafter referred to as “registered inspection agency”) carry it out.

3 The Minister of Health, Labor and Welfare shall make public the guidelines for self-inspection necessary to ensure the appropriate and effective implementation of voluntary inspection under the provisions of paragraph (1)

4 Omitted

Table 7-1 Related Laws and Regulations

Inspection Classification	Provision	Implementor /Qualification	Storage Period of inspection table
Inspection Before starting work	Safety Regulations Article 170 171	Driver	Checklist while the machine is running
Periodic Self-Inspection (Once a month)	Safety Regulations Article 168 169 171	A person designated by Business operator (Safety Manager)	Inspection table for 3 years
Specific Self-Inspection (Once a year)	Safety Regulations Article 167 169, 169-2 171	In-house inspector Inspection Company Inspector	Inspection table for 3 years (Attach the inspection mark)

※Although not stipulated by law, inspection results

Chapter 6 Measures in Placing Workers

Article 61 <Restrictions on Engagement>

The employer shall not place any person in the operation of cranes and other operations defined by Cabinet Order unless the person has obtained the license concerning the said operations from the Director of the Prefectural Labor Bureau, has finished the skill training course related to the said operations conducted by those who have been registered by the Director of the Prefectural Labor Bureau, or has other qualifications provided for by the Ordinance of the Ministry of Health, Labor and Welfare.

2 Any person other than those qualified to engage in the said operations under the provisions of the preceding paragraph shall not conduct the said operations.

3 A person who is qualified pursuant to the provision of paragraph (1) to engage in the said operations shall, at the time of the engagement in the said operations, carry with oneself the license concerning the said operations or other document to prove the qualification.

4 Omitted

Qualifications Required for Machine Operators

Machine Name		Machine Power				
Crane	Crane	Lifting Capacity	5 ton or more	<input type="radio"/>		
			Less than 5 ton			<input type="radio"/>
	Floor-operated Crane (Move with load)	"	5 ton or more		<input type="radio"/>	
			Less than 5 ton			<input type="radio"/>
Mobile Crane		Lifting Capacity	5 ton or more	<input type="radio"/>		
			1 ton or more		<input type="radio"/>	
			Less than 5 ton			<input type="radio"/>
			Less than 1 ton			<input type="radio"/>
Vehicle-type	Leveling, Transport (unpan)ation, For Loading and	Machine Weight	3 ton or more		<input type="radio"/>	
			Less than 3 ton			<input type="radio"/>
Construction	Compaction (Roller)		No limit			<input type="radio"/>
Machine	For Dismantling	Machine Weight	3 ton or more		<input type="radio"/>	
			Less than 3 ton			<input type="radio"/>
Shovel loader, fork loader		Maximum Load			<input type="radio"/>	<input type="radio"/>
Rough Terrain Hauler		Maximum Loading Capacity	1 ton or more		<input type="radio"/>	
			Less than 1 ton			<input type="radio"/>

Qualifications Required for Workers

Work Name	Work Detail	Type of Qualification		
		License	Skill Training	Special Education
Slinging Work	Lifting Capacity	1 ton or more	<input type="radio"/>	
		Less than 1 ton		<input type="radio"/>
Asbestos Work	Demolition work of buildings using asbestos		<input type="radio"/> (Work chief)	
				<input type="radio"/>

【Cabinet Order】

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:

1~11 Omitted

12 The operation of construction machines as listed in items (1), (2), (3) or (6) of Appended Table 7 having the base machine weight of 3 tons or more, and those capable of self-propelling to unspecified places by utilizing motive power (excluding the operations travelling on roads)

13 Omitted

**The law and orders regarding scope and time of training courses for employment of restricted workers specified by the Ministry of Health, Labor, and Welfare is based on the provisions of Article 83, paragraph 1, item 3 of the Ministerial Ordinance on Registration and Designation of the Industrial Safety and Health**

◆Ministry of Health, Labor and Welfare  
Notification No.144 (March 30, 2009)◆

**Article 1 and 2 are omitted**  
(Training for vehicle-based construction machinery driving workers)

**Article 3** the courses on Article 99-3 paragraph 1 of the law for those who can engage in the work mentioned in Article 20-12 of the ordinance are in the middle column of the same table, according to the courses listed in the upper column of the following table. The range listed in (1) must be performed for more than the time listed in the lower column of the same table.

Course Subject	Range	Time
Work restriction structure of operation machines, etc.	Structure of equipment related to running and work of vehicle-based construction machinery	1 hour
Functions of safety devices, etc. related to work-restricted business machines, etc.	Functions of safety devices and brakes for vehicle-based construction machinery	1 hour
Work restriction maintenance management of business machines, etc.	Inspection and maintenance of vehicle-based machinery	1 hour
Work method of work related to work-restricted business machines, etc.	Safety measures for work related to vehicle-based construction machinery	1.5 hours
Safety and Health related laws and regulations	Laws, ordinances and related provisions during security	1.5 hours
Cases of occupational accidents and their corrective measures	Case study of occupational accidents	2 hours

**Article 4 omitted**

## **12.2. Ordinance on Industrial Safety and Health (Extract) (Text p.256)**

### Part 1 General Rules

#### Chapter 7 License, etc.

#### Section 3 Skills Training Course

##### Article 82 < Reissuance, etc. , of the Skill Training Course Completion Certificate >

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.

### Part 2 Safety Standards

#### Chapter 2 Construction Machine, etc

#### Section 1 Vehicle Type Construction Machine

##### Subsection 1 General Provisions

##### Subsection 1-2 Structure

##### Article 152 < Providing of Front Lamp >

The employer shall provide a vehicle type construction machine with a front lamp. However, this shall not apply to a vehicle type construction machine used at a place maintaining necessary illumination for carrying out the work safely.

Article 153 < Head Guard>

The employer shall, when using a vehicle type construction machine (limited to a Bulldozer, a tractor shovel (shoberu), a Muck loader, a power shovel (shoberu), a drag shovel (shoberu) and a breaker) in ※1 a place where it is liable to cause dangers to workers due to falling of rocks, etc., provide the said vehicle type construction machine with ※2 a sound head guards.

Note 1) "A place where there is a risk of falling rocks, etc...." are places where Open-cut excavating work, excavating work for quarrying, construction work of a road, etc. is performed using the machine, and the work by the machine causes the falling of rocks, etc.

Note 2) Regarding the head guard, the structural standard is indicated by Circular No. 559 of 1975.9.26

Subsection 2 Prevention of Dangers Pertaining to the Use of a Vehicle Type Construction Machine

Article 154 < Investigation and Record>

The employer shall, when carrying out the work using a vehicle type construction machine, investigate in advance the landform and condition of the nature of the soil, etc., of the place pertaining to the said work in order to prevent workers from dangers due to falling of the said machine, collapse of natural ground, etc., and record the result of the investigation.

Article 155 < Work Plan>

The employer shall, when carrying out the work using a vehicle type construction machine, establish in advance a work plan in conformity with what is known by the investigation pursuant to the provision of preceding Article, and carry out the work by the said work plan.

2 The work plan set forth in the preceding paragraph shall be the one describing the following matters:

- 1 The type and capability of the vehicle type construction machine to be used.
- 2 The travelling route of the vehicle type construction machine.
- 3 The work method by the vehicle type construction machine.

3 The employer shall, when having established the work plan set forth in paragraph (1), make the matters set forth in item (2) and (3) of the preceding paragraph known to the workers concerned.

#### Article 156 <Speed Limit>

The employer shall, when carrying out the work using a vehicle type construction machine (excluding the one having maximum speed of 10 km/h or less), in advance, set the appropriate speed limit for the vehicle type construction machine corresponding to ※the landform and conditions of nature of the soil, etc., of the place pertaining to the said work and carry out the work by the set speed limit.

2 The operator of the vehicle type construction machine set forth in the preceding paragraph shall not operate the vehicle type construction machine at speeds exceeding the speed limit set forth in the same paragraph.

Note) "Etc. " in " the landform and conditions of nature of the soil, etc. " includes the case where other machinery and equipment are installed.

#### Article 157 < Prevention of Falling, etc.>

The employer shall, when carrying out the work using a vehicle type construction machine, take necessary measures for the travelling route of the said machine etc., such as preventing collapse of shoulder and uneven settling of the ground and maintaining the※1 necessary width etc., in order to prevent workers from dangers due to overturning or falling of the said machine.

2 The employer shall, in the case where the work using a vehicle type construction machine is carried out at road shoulder, inclined place, etc., and when it is liable to cause dangers to workers due to overturning or falling of the said machine, ※2arrange a guide, and have the said person guide the said machine.

3 The operator of a vehicle type construction machine set forth in the preceding paragraph shall follow the instructions given by the guide set forth in the same paragraph.

Note 1) "Etc. " in "necessary width etc." includes installation of guardrails, setting of signs, etc.

Note 2) If guardrails are installed and signs are set properly so that there is no risk of falling or falling, it is not necessary to arrange a guide in Paragraph 2.

#### Article 157-2

The employer shall, must use a vehicle type construction machine are equipped with seat belts and workers must use seat belts, at road shoulder, inclined place, etc., when it is liable to cause dangers to workers due to overturning or falling of the said machine.

Article 158 < Prevention of Workers Being Hit >

The employer shall, when carrying out the work using a vehicle type construction machine, not allow a worker to enter ※a place, which is liable to cause dangers to workers due to being hit by the vehicle type construction machine during operation. However, this shall not apply to when arranging a guide and having the said person guide the said machine, etc.

2 The operator of the vehicle type construction machine set forth in the preceding paragraph shall follow the instruction given by guide set forth in the proviso of the same paragraph.

Note ) “A place, which is liable to cause dangers to workers” includes not only the traveling range of the machine but also the operating range of the working device such as an arm and a boom.

Article 159 < Signals >

The employer shall, when placing a guide for operation of a vehicle type construction machine, set fixed signals and have the said guide give the signals.

2 The operator of the vehicle type construction machine set forth in the preceding paragraph shall follow the signals set forth in the same paragraph.

Article 160 < Measures to Be Taken in the Case of Leaving the Operating Station >

The employer shall, when the operator of a vehicle type construction machine leaves the operating station, have the said operator take the following measures:

1 To lower a working device of ※1 a bucket, ripper, etc., on the ground.

2 To stop a prime mover and take measures such as ※2 setting the brake ,etc., in order to prevent a vehicle type construction machine from breaking into a run.

2 The operator set forth in the preceding paragraph shall take measures listed in each item of the same paragraph when leaving the operating station of the vehicle type construction machine.

Note 1) "Etc. “ in " a bucket, ripper, etc. " includes shovel (shoberu), Blade, etc.

Note 2) "Etc. “ in " setting the brake ,etc.“ includes stopping with wedges, stoppers, etc.

Article 161 < Transfer of Vehicle Type Construction Machine >

The employer shall, when using a loading plate, embankments (morido), etc., in the case where a vehicle type construction machine is loaded to a truck, etc., or unloaded from a truck, etc., by ※1 self-propelling or towing for transferring the said machine, comply with the following provisions in order to prevent dangers due to overturning, falling, etc. of the said machine:

- 1 To load or unload at a level and firm place.
- 2 When using a loading plate, to use the one with a ※2 sufficient length, width and strength, and fix it securely with ※3 appropriate incline.
- 3 When using fills or a temporary stand, etc., to secure a sufficient width, ※4 strength and appropriate incline.

Note 1) "Self-propelling" includes trailer.

Note 2) "Sufficient" of "sufficient length" should be determined according to the weight and size of the vehicle type construction machine for loading and unloading

Note 3) "Appropriate incline" refers to incline within a safe range in consideration of the performance such as climbing power of the machine.

Note 4) The "strength of fills" is secured by striking logs that are difficult to fill and taking measures such as solidifying them sufficiently.

Article 162 < Restriction of Riding >

The employer shall, when carrying out the work using a vehicle type construction machine, not allow a worker to ride on places other than ※the seat.

Note ) "The seat" refers to the driver's seat, passenger seat, and other seats for boarding.

Article 163 <Restriction of Use >

The employer shall, when carrying out the work using a vehicle type construction machine, abide Stability, the maximum working load, etc., ※ decided on the basis of its structure in order to prevent workers from dangers due to overturning, destruction of working device of an arm or a boom, etc.

Note ) "Decided on the basis of its structure" is indicated by the structural standard of vehicle type construction machine

Article 164 <Restriction on the Use for Other than Main Purpose>

The employer shall not use a vehicle type construction machine for other than its main purpose of lifting a load by a power shovel (shoberu), ※1 raising or lowering a worker by a clamshell, etc.

2 The provisions of the preceding paragraph shall not apply to the following cases:

1 The case falling under all of followings, in the case where the ※2 load lifting work is carried out:

a. When it is ※3 unavoidable due to the nature of the work or necessary for the safe implementation of the work.

b. When metal parts of a hook and a shackle (shakkuru) or ※4 any other hoisting parts falling under all of following

conditions are fitted to work device such as an arm and a bucket:

(1) To have ※5 sufficient strength corresponding to the load to be burdened.

(2) To be unlikely to cause danger of the load falling from the said parts due to the use of a latch, etc.

(3) To being unlikely to cause coming off from the work device. ※6

2 In the case where works other than lifting a load is carried out, and when it is unlikely to cause dangers to the workers

Note 1) The "etc." of "raising or lowering a worker by a clamshell, etc." includes the use of a boom, arm(amu) instead of a ram

Note 2) "Load lifting work" includes turning the boom with the load and running with the load.

Note 3) "When it is unavoidable due to the nature of the work or necessary for the safe implementation of the work" "in order to reduce the risk of sediment collapse as part of excavation work using vehicle type construction machine, when temporarily lifting earth retaining sheet piles, hume pipes, etc., the work area is narrow, It may be considered that the work place becomes more complicated and the danger increases if a mobile crane is carried in and the work is performed

Note 4) "When metal parts of hoisting parts are fitted to work device" means that the hook, shackle (shakkuru), wire rope, hanging chain, etc. are attached to the working device so that they will not come off easily and can be used to lift the load. It does not include cases where a wire rope is hung on the claws of the bucket to lift the load, and cases where the wire rope is turned directly on the boom or arm to lift the load.

Note 5) The strength of the lifting equipment should have a safety factor of 5 or more (The value obtained by dividing the value of the cutting load of the lifting equipment by the value of the load in Paragraph 3, No.4)

Note 6) "To being unlikely to cause coming off from the work device" are those with hooks, attached by welding, which are welded so that sufficient penetration, throat thickness, can be obtained, and welded over the entire circumference of the attachment part.

Note ) For hanging or removing wire ropes for slinging, instruct those who have completed the slinging skill training or those who have completed the special education related to slinging work.

Article 165 < Repair, etc.>

The employer shall, when carrying out the work repairing a vehicle type construction machine, or fitting or removing its attachments, designate a person to direct the said work and have the said person take the following measures:

- 1 To decide a work procedure, and direct the work.
- 2 To monitor the use of a safety prop, a safety block, etc., prescribed by paragraph (1) of the next Article.

Article 166 <Prevention of Dangers Due to Lowering of a Boom, etc.>

The employer shall, when carrying out the work repairing, checking, etc., under the raised boom or arm, etc., of a vehicle type construction machine, have the worker engaging in the said work use a safety prop, a safety block, etc., in order to prevent workers from dangers due to unexpected descending of the boom or the arm, etc.

- 2 The worker engaging in the work set forth in the preceding paragraph shall use a safety prop, a safety block, etc.※, set forth in the same paragraph.

Note ) The "etc." of the "safety block, etc." includes a stand, etc.

Article 166 -2 <Prevention of Dangers due to Collapse of Attachments, etc.>

The worker engaging in the work must use stand when installing or removing attachments for vehicle type construction machine, to prevent the danger of workers due to the collapse of attachments, etc.

- 2 The worker engaging in the work set forth in the preceding paragraph must use stand, set forth in the same paragraph.

Article 166 – 3 <Restrictions on Attachment>

The employer shall, not attach attachments to vehicle type construction machine (sharyokei kensetsu kikai) that exceed the structurally specified weight.

Article 166 – 4 <Display of Weight of Attachment, etc.>

The employer must display the weight of the attachment (When a bucket, zipper, etc. is installed, the capacity or maximum load weight of the bucket, zipper, etc. is included. Same in this article below) in a position that is easy for the driver to see when Replaced the attachment of vehicle type construction machine, or equip the document on vehicle type construction machine that driver can easily check the weight of the attachment.

## Part 4 Special Regulations

### Chapter 2 Special Regulations Concerning Machine Lessor, etc.

#### Article 666 < Measures to Be Taken by Machine Lessor, etc. >

A person prescribed by the preceding Article (hereinafter referred to as “machine lessors etc.”) shall, when they lease machines, etc., take the following measures:

- 1 To check ※1 in advance the said machine, etc., and carry out the repair or other necessary maintenance when having found any abnormalities
- 2 To deliver the document indicating the following matters to the employers to whom machines, etc., are leased.
  - a. The capabilities of the said machines, etc. ※2
  - b. Characteristic of the said machines, etc., and other matters of the machines, etc., such as precautions for use. ※3
- 2 The provisions of the preceding paragraph shall not apply to the case that the selection of machines, etc., at the time of their purchase and their maintenance work after the lease which should originally be made by the owner are made by the employer to whom the machines, etc., are leased (including the small-scale enterprise facilities leasing business conducted by prefectural facilities leasing agency prescribed by paragraph (6) of Article 2 of the Act of Financial Aid on Facility Introduction for Small Scale Enterprises [Act No.115 of 1956])※4

Note 1) “In advance” does not necessarily mean to inspect the entire machine each time, but it may be limited to the necessary parts depending on the usage situation.

Note 2) “Capacity of the machine, etc.” refers to the capacity that is particularly necessary for use of using vehicle type construction machine, such as Stability and bucket capacity.

Note 3) “Other matters of the machines” refers to matters to be noted when using the machine, such as fuel used and adjustment method.

Note 4) The purpose of Paragraph 2 is not applicable to those that take the form of leasing as a financial means from the purpose of this Article.

### **12.3. Structural standard of Vehicle Type Construction Machine (Text p.276)**

Article 1 < Strength, etc. >

Article 2 < Stability >

Article 3 ( Stability of Piling Machine and Punching Machine )

Article 4 (Rear Stability of excavation machines (excluding crawler type) and dismantling machines (excluding crawler type))

Article 5 < Brakes for Driving, etc. >

Article 6 < Brake for Work Equipment >

Article 7 < Operating Parts of Traveling Devices, etc. >

Article 8 (Matters necessary for the operation such as the function of the operation part and the operation method )

Article 9 < Visibility Required for Driving , etc. >

Article 10 < Elevating Equipment >

Article 11 < Danger Prevention Equipment by Raising and Lowering Arms, etc. >

Article 12 < Direction Indicator >

Article 13 < Alarm Device >

Article 13-2 < Automatic Stop Device, etc. when the work range is exceeded >

Article 14 < Safety Valves, etc. >

Article 15 < Display >

Article 16 < Vehicle Type Construction Machine with a Special Structure >

Article 17 < Exclusion from Application >

## Exam questions

### Chapter 1 Basic knowledge about Vehicle-type construction machinery

#### ■ Question No.1(Ground leveling, transportation, and loading machine)

Select the correct answer of the following four explanations for ground leveling, transportation, and loading machine.

- (1) The tractor shovel (shoberu) has blades (soil removal plate) which are work equipment attached to the tractor and are used for tasks such as leveling and soil pushing (oshido).
- (2) Bulldozers are a typical shovel-type construction machine.
- (3) A bulldozer is a crawler-type or wheel-type tractor body with a bucket, which is a work device attached to it, and is used for tasks such as loading, transportation, and cutting on the ground.
- (4) Tractor shovel (shoberu) is typical for mechanical loading

#### ■ Question No.2(Excavation machine)

Select the correct answer of the following four explanations regarding the excavation machine.

- (1) The drag line is a work device with a drag line bucket attached to the main body of a shovel-type construction machine, and is used for excavation below the ground.
- (2) A bucket excavator has a wide excavation range because it excavates by throwing a bucket far away.
- (3) Bucket excavators are used for large-scale civil engineering work and are suitable for excavating relatively hard soil.
- (4) The bucket excavator can dig a ditch continuously, and is used for digging trenches burying gas pipes, water pipes, etc.

■ Question No.3(Terminology for vehicle-based construction machinery)

Select the correct answer of the following four explanations regarding terminology for vehicle-based construction machinery

- (1) The machine weight (or mass) is the dry mass (mass without fuel, oils, water, etc.) excluding the work equipment from the vehicle-based construction machine. This is the mass of the machine body.
- (2) The body weight (or mass) is the mass with the work equipment required for vehicle-based construction machinery attached, and the wet mass (mass containing fuel, oil, water, etc.) in a state that is not loaded with the load in such a bucket (no load state).
- (3) The body weight (or mass) is the sum of the machine weight (or mass), the maximum load weight (or mass), and the mass obtained by multiplying the passenger capacity by 70 kg.
- (4) The total machine weight (or mass) is the sum of the machine weight (or mass), the maximum load weight (or mass), and the mass obtained by multiplying the passenger capacity by 55 kg.

## Chapter 4 Handling of equipment related to the running of vehicle-type construction machinery

### ■ Question No.4(Basic operation before starting the engine)

Select the correct answer of the following four explanations regarding basic operation before starting the engine.

- (1) The shift lever and each work device lever should be in the neutral position, and the hydraulic lock lever should be in the locked position.
- (2) Set the main clutch lever to "ON".
- (3) Set the fuel lever to low idling.
- (4) For vehicles with seat belts, fasten the seat belts.

### ■ Question No.5(Basic operation after starting the engine)

Select the correct answer of the following four explanations regarding basic operation after starting the engine.

- (1) When the engine is cold, accelerate it rapidly.
- (2) While warming up, check whether the reading of each gauge is good
- (3) While warming up, check whether there are water leaks, oil leaks, engine noise, exhaust color, vibration, and other abnormalities.
- (4) Check the monitoring system while warming up

### ■ Question No.6(Handling of excavator-type construction machinery when starting)

Select the correct answer of the following four explanations for handling of excavator-type construction machinery when starting.

- (1) Move the turning switch button or lever to the running position.
- (2) Operate the button or lever of the traveling brake to release the brake.
- (3) Pull the fuel adjustment lever to increase the engine speed.
- (4) Pushing the travel lever forwards will move the machine backwards, and pulling it backwards will move the machine forward.

■ Question No.7(Handling of power shift type construction machinery while driving)

Select the correct answer of the following four explanations for handling of power shift type construction machinery while driving.

- (1) When going up the hill, the load suddenly decreases, and the running speed becomes slow. Increase the running speed as it will slow down and become dangerous
- (2) When approaching a dump (danpu) truck to load soil and sand, it will be dangerous, so slow down the running speed. At this time, it can lower the gear at the same time.
- (3) If the oil temperature gauge rises too much during work, increase the speed to increase the load.
- (4) It must be at full throttle while working, but it will increase engine revs even when just moving or waiting for a truck.

■ Question No.8(Handling of climbing and descending shovel-type construction machinery)

Select the correct answer of the following four explanations for handling of climbing and descending shovel-type construction machinery.

- (1) If it is unavoidable to steer while climbing a slope, set the travel clutch to the [on] state to prevent the machine body from descending and then operate the steering operation device.
- (2) Be careful when driving on uneven roads as the crawlers may come off.
- (3) In soft areas, use road boards to prevent falls due to uneven subsidence.
- (4) When stopping in the middle of a slope, keep the bucket raised from the ground and make sure to use a stopper etc. on the undercarriage.

■ Question No.9(Handling when stopping the running of direct drive type construction machinery)

Select the correct answer of the following four explanations for handling when stopping the running of direct drive type construction machinery

- (1) Generally, the main clutch lever is tilted forward, and step on the brake pedal to stop and set the shift lever to the [ON].
- (2) Stop the engine without idling.
- (3) If you do not drive immediately after stopping, raise the bucket etc. from the ground and lock the brake pedal.
- (4) When stopping on a slope, be sure to use a skid around the undercarriage to prevent the construction machinery from escaping.

■ Question No.10(Handling when parking (parking machine) construction machinery)

Select the correct answer of the following four explanations for handling when parking (parking machine) construction machinery.

- (1) Stop the construction machine on a flat place with good ground, and raise the bucket etc. from the ground.
- (2) Stop the engine, check that the key has returned to the [ON] position, and then remove the key.
- (3) The brakes are applied completely. If it is unavoidable to stop on an inclined surface, be sure to use a stop on the suspension.
- (4) The boom or bucket can be moved while the engine is stopped.

■ Question No.11(Antifreeze, oil, etc.)

Select the incorrect answer of the following four explanations for antifreeze, oil, etc.

- (1) The concentration of antifreeze to be mixed with cooling water to preventing freezing and corrosion is constant even if the operating temperature is different.
- (2) The antifreeze liquid to be mixed with the cooling water or antifreezing and anticorrosion is the aqueous solution mainly containing ethylene glycol.
- (3) The oil contains an oily agent (decreasing the friction coefficient) as an additive to improve the performance.
- (4) The gears wear becomes faster and the bearings may burn if the oil deteriorates or shorten.

## Chapter 5 Structure and type of equipment related to the work of Vehicle-type construction machinery

### ■Question No.12(The type and structure of operating equipment for tractor-based construction machines.)

Select the correct answer of the following four explanations for the type and structure of operating equipment for tractor-based construction machines.

- (1) The straight dozer can incline blade back and forth and is used for scraping coal, ore, etc., in ship and warehouses.
- (2) The rake dozer having a large claw at the rear is used for crushing or digging soft rock and hard soils.
- (3) The trimming dozer attaching a pusher plate to protect the blade of Bulldozer is used for boosting the scraper when the traction force is not enough during excavation and loading operation of the scraper.
- (4) The wetland bulldozer attaching wide shoes is used for operation in soft terrain to increase the contact area of crawlers.

### ■Question No.13(The safety devices for tractor-based construction machine, etc.)

Select the correct answer of the following four explanations for the safety devices for tractor-based construction machine, etc.

- (1) It does not require attaching a solid head guard to the driver seat, in the industrial Safety and Health Act, when you work at the place where there is a risk for danger of falling objects such as rocks etc.
- (2) It is required to attach the protective device when construction machines fall in the industrial Safety and Health Act.
- (3) It is not necessary to use a seat belt when you drive a tractor-based construction machine.
- (4) Some tractor shovels (shoberu) are attached with safety device such as safety pin, etc., to prevent falling the lift arm of raised bucket and the lock plate for fixing operating levers, etc.

### ■Question No. 14 (The equipment of the scraper.)

Select the correct answer of the following four explanations for the equipment of the scraper.

- (1) The equipment of the scraper composes bowl, apron, and ejector, etc., and there are mechanical and hydraulic operating methods.
- (2) The apron which is a container for transporting sand is excavated and loaded moving forward and pressing bowl against the ground hydraulic cylinder.
- (3) The ejector is for not spilling sand forward loaded in the bowl and raises the apron and dumps it at the dumping ground.
- (4) The bowl is a device for pushing out sand from the rear when dumping.

■ Question No. 15(The operating equipment for loading machines)

Select the incorrect answer of the following four explanations for the operating equipment for loading machines.

- (1) The loading machine typed crawler has mainly the large tunnel-type tractor shovel (shoberu) and the scraping loader.
- (2) The operating device for large tunnel-type tractor shovel is completely different from general tractor shovel (shoberu).
- (3) The operating device for scraping loader consists conveyor and scraping device consisting of bucket, arm boom, cylinder, and turning frame.
- (4) The operating device for scraping loader is operated by a hydraulic pump.

## Chapter 6 Handling of equipment related to the work of Vehicle-type construction machinery, etc.

### ■ Question No. 16 (Handling of Bulldozer)

Select one of the following four explanations about the handling of Bulldozer that is correct.

- (1) When driving, keep the cutting edge of the blade at a height of about 140 cm from the ground and check the safety of the surroundings.
- (2) As a general rule, ascend and descend slopes in an oblique direction.
- (3) Do not climb steep slopes backward or descend forward. If you have to descend a steep slope, descend in backward motion or in a zigzag pattern.
- (4) Dozing work (oshido sagyo) should be clearly separated from excavation work, and the dozing distance should be minimized and done at high speed.

### ■ Question No. 17 (Handling of leveling work by Bulldozer)

Select one of the following four explanations about the handling of leveling work by Bulldozer that is correct.

- (1) When operating the blade for leveling work, the blade should be operated so that it rises and falls about 20 meters at a time.
- (2) Bulldozer are used for earthwork operations such as digging, pushing (oshido) and spreading over long distances (300m or more).
- (3) Bulldozer are effective for excavating and dozing (oshido) in a straight line.
- (4) When excavating frozen or hard soil or trenches, it is more efficient to work with angle blades.

### ■ Question No. 18 (Handling of dozing (oshido) work by Bulldozer)

Select one of the following four explanations about the handling of dozing (oshido) work by Bulldozer that is correct.

- (1) When the distance of the dozing (oshido) becomes long, perform a two-step dozing. In this case, a good guideline is when all the earth and sand on the blade is gone, or when the load becomes a little lighter after increasing the speed to two.
- (2) In the case of a large site with a long distance of dozing (oshido), using two units in relay is more efficient than two-stage dozing (oshido).
- (3) Parallel dozing (oshido) work should be performed by different machines as much as possible.
- (4) When pushing crushed rock, the operation should be performed in such a way that dozing (oshido) is done until the rock is exposed.

■ Question No. 19 (Handling of finishing work by Bulldozer)

Select one of the following four explanations for the handling of finishing work by a bulldozer that is correct.

- (1) When performing finishing work with a bulldozer, if the machine is started in a downward position, the blade will be lifted off the ground when the machine is leveled so make sure the machine is in a horizontal position before lowering the blade.
- (2) The motor grader is not suitable for fine finishing (about 2 to 3 cm) and should be used for rough finishing.
- (3) For fine finishing, it is recommended to use a bulldozer.
- (4) Finishing work is easier with the blade empty than with it filled with soil.

■ Question No.20(Handling of applied work by bulldozer)

Select the correct one answer of the following four explanations regarding handling of applied work by bulldozer.

- (1) For removing boulders, tilt the blade so that the force of the bulldozer is concentrated in the center of the blade and use the center of the blade to remove the boulders.
- (2) For removing large independent rocks, firstly cut roots the surroundings and then push with a bulldozer to raise the blade or disengage the steering clutch on the side of the rock to separate and remove the ground from the rock.
- (3) For removing the concrete pavement, firstly break the concrete with a concrete crusher (breaker, pick, etc.) and dig it up with a tilted blade. When a part happens, push it up toward the edge.
- (4) When using a bulldozer to backfill (umemodoshi) the groove, backfill (umemodoshi) it so that it approaches perpendicular to the groove and drops the soil.

■ Question No.21(Handling of ripping work by bulldozer)

Select the correct answer of the following four explanations regarding handling of ripping work by bulldozer.

- (1) The ripper interval should be narrowed so that the rock becomes softer, and the crushing degree should not vary depending on the crushing leak or location.
- (2) Work should use uphill as much as possible.
- (3) If the rock is hard and there are rock layers, cracks, etc. diagonally to the ground, rip it in order.
- (4) If you encounter a rock mass that is difficult to crush during ripping and cause a shoe slip, you will depress the decelerator pedal to reduce the engine speed to the extent that shoe slip does not occur.

■ Question No.22(Handling of work on soft ground by a bulldozer)

Select the correct answer of the following four explanations regarding handling of work on soft ground by a bulldozer.

- (1) Dig a drainage ditch so that the water accumulated on the ground surface can be drained as much as possible.
- (2) When pushing soil (oshido), make sure that the blade holds as much soil as possible to prevent the bulldozer from slipping.
- (3) In soft ground, try not to turn the steering wheel as much as possible and drive on the same road surface.
- (4) In soft ground, Bulldozer equipped with shoes for soft ground are often used because they have a large contact pressure and good buoyancy.

■ Question No.23(Handling of tractor shovel (shoberu))

Select the correct answer of the following four explanations regarding handling of tractor shovel (shoberu).

- (1) When loading a bucket and descending a steep slope, raise the bucket and use the driving brake to descend at low speed.
- (2) When loading a bucket and descending a steep slope, do not drive beyond Stability.
- (3) The tension of the tractor crawler changes according to the soil quality. On gravel roads, it is tighter than the specific tension (crawler type).
- (4) When the crawler slips on a wetland or soft ground. Fully open the fuel lever is opened fully, the main clutch is put softly and slowly, and then the steering clutch will be operated.

■ Question No.24(Handling of excavation work for tractor shovel (shoberu))

Select the correct answer of the following four explanations regarding handling of excavation work for tractor shovel (shoberu).

- (1) For excavation, the vehicle will tilt along the mountain. In this case, the bucket is lowered to the ground in front of the mountain.
- (2) The excavation is done so that the end of the bucket is at the overhang of the mountain (the weak part of the mountain).
- (3) The scooping of buckets in excavation is that pushes in as much soil and sand as possible before raising the bucket, raise the lift arm slightly, and then raise the bucket.
- (4) For the excavation of a mountain where the tunnel face (kiriha men) is self-supporting, the watermark digging will be predicted to occur, excavation is performed in order from the bottom of the mountain.

■ Question No.25(Handling of tractor shovel (shoberu) for loading and transportation work)

Select the correct answer of the following four explanations regarding handling of tractor shovel (shoberu) for loading and transportation work.

- (1) As for the speed stage, it should work in 2nd speed as much as possible.
- (2) Bucket dump is that keeps the lift lever locked up, approaches the dump (danpu) truck, raises (age) the bucket to a height suitable for loading, and starts opening the bucket dump early when approaching the loading platform.
- (3) When loading the dump (danpu) truck, align the center of the earth and sand loaded on the centerline of the loading platform. If the loading platform is long and loading about 3 to 4 buckets is required, it will start from the back of the loading platform.
- (4) The loading operation should be performed slowly and safely with the machine stopped in front of the dump (danpu) truck. It is ideal.

■ Question No. 26(Handling and safe work of shovel-type construction machinery)

Select the correct answer of the following four explanations for handling and safe work of shovel-type construction machinery.

- (1) Perform the piling work with a bucket or the crane work.
- (2) After stopping the engine, the work equipment is lowered suddenly.
- (3) Use a bucket suitable for your work.
- (4) Excavate until the feet of the machine depending on the soil quality and surrounding conditions.

■ Question No. 27(Handling and safe work of shovel-type construction machinery)

Select the correct answer of the following four explanations for handling and safe work of shovel-type construction machinery.

- (1) When excavating until the feet in underground excavation so road shoulders may collapse. Crawler sideways excavation is dangerous considering evacuation in an emergency
- (2) Excavation uses the mass of the machine body by floating the bottom of the body machine.
- (3) It turns during excavation, and the force of the turn is used to backfill and level the soil.
- (4) The bucket is fixed and the crawler is run for excavation.

■ Question No. 28(Handling and safe work of shovel-type construction machinery)

Select the correct one of the following four explanations for handling and safe work of shovel-type construction machinery.

- (1) In the case of upper excavation, the track surface is slightly uphill and excavated in consideration of drainage. Also, do not cut thinly, but dig deep at once.
- (2) In the case of lower excavation, the excavation work surface is first created and excavated. The width of the approach slope shall be wide enough to be loaded onto a dump (danpu) truck on the site at a turning angle of 90 degrees.
- (3) The box-type bench cut method is a method suitable for excavating across an inclined surface such as hillside road excavation work.
- (4) The side hill bench cut method is an excavation method suitable when the local board is almost flat.

■ Question No. 29(Handling and safe work of shovel-type construction machinery)

Select the correct one of the following four explanations for handling and safe work of shovel-type construction machinery.

- (1) The cutting angle (rake angle) of the bucket should be large for hard soil or high cutting.
- (2) The bucket may be swiveled in a state where the claws of the bucket are not covered with soil and sand, or the bucket may be shaken left and right to use as a broom for leveling.
- (3) Work with the turning angle as large as possible.
- (4) The machine should be placed at a position not too far from the excavation surface and not too close to the excavation surface for excavation. Also, the bucket should not hit the base of the boom or the crawler.

■ Question No. 30(Handling and safe work of shovel-type construction machinery)

Select the correct one of the following four explanations for handling and safe work of shovel-type construction machinery.

- (1) The drag line is mainly used for riverbed dredging, waterway excavation, soft ground excavation, aggregate collection, etc. It is suitable for excavating hard soil and deep excavation compared to drag shovels, but it is not suitable for excavating shallow and wide areas.
- (2) The drag chain and shackle are heavily worn, so inspect them thoroughly and replace defective ones.
- (3) The boom angle must not be used beyond the limit angle (usually about 30 degrees) determined by the machine.
- (4) Try to excavate deeply and narrowly.

■ Question No. 31(Handling of motor graders and safe work)

Select the correct one of the following four explanations for handling of motor graders and safe work.

- (1) On slopes, climb up and down the slope diagonally and do not make sharp turns.
- (2) In the leaning of the tire during running, the tire is tilted in the turning direction in the reverse turning, and the tire is tilted in the opposite method in the forward turning.
- (3) The speed for leveling work is 6~ to 10 km / h for precision finishing and 2~3km/h for rough finishing.
- (4) The angle of the blade when performing ground leveling work is usually 90 degrees, but it may be slightly angled depending on the remaining condition of the windrow.

■ Question No. 32(Handling of scrapers and safe work)

Select the correct one of the following four explanations for handling of scrapers and safe work.

- (1) When you go through a curve, speed up and go through it.
- (2) When driving with a load of earth and sand, be aware that the rear wheels may turn more than expected due to centrifugal force and come off the road surface or even roll over.
- (3) Keep the bowl high and the center of gravity up while driving.
- (4) Drive with the apron raised except for soil spreading work.

■ Question No 33(Handling of scrapers and safe work)

Select the correct one of the following four explanations for handling of scrapers and safe work.

- (1) On steep descents, use only the foot brake (brake pedal) to descend.
- (2) On a steep descent, if the speed increases and it becomes dangerous, raise the bowl.
- (3) The runway of the scraper and the path of other vehicles should not intersect, and when intersection is unavoidable, a guide should be placed.
- (4) If the aisle width is narrow, set up several waiting areas and observe the principle of giving priority to downhill vehicles and loaded vehicles.

■ Question No. 34 (Transport of vehicle-based construction machinery)

Select one of the following four explanations about the transport of vehicle-based construction machinery that is correct.

- (1) Stop the trailer, etc. at the loading position, apply the brakes, and clamp the tires with gears (pay attention to the level of the ground).
- (2) Make sure that the climbing equipment are securely fastened to the cargo bed to prevent them from falling off, and that the climbing angle is 45 degrees or less.
- (3) Run at a low speed following the guide's signal and stop about 1 m before the climbing equipment.
- (4) On the way up the climbing equipment, do not turn the steering and climb at high speed.

■ Question No. 35 (Transport of vehicle-based construction machinery)

Select the most incorrect explanation out of the following four regarding the transport of vehicle-based construction machinery.

- (1) If it is unavoidable to transport construction equipment on its own, it must be done in compliance with the Road Traffic Law, Road Vehicles Law, Vehicle Restriction Order, and other relevant laws and regulations.
- (2) When driving on a soft road surface, be careful of collapsing shoulders.
- (3) When passing through unmanned level crossings or narrow sections, do not stop before passing through.
- (4) For shovel-type construction machinery, when passing under railroad lines, power lines, bridge girders, etc., make sure that the boom tip does not touch them and that the separation distance is sufficient.

## Chapter 7 Inspection and Maintenance for Vehicle-type Construction Machine

### ■ Question No. 36 (Inspection and maintenance of vehicle-based construction equipment)

Select one of the following four explanations about the inspection and maintenance of vehicle-based construction machinery that is correct.

- (1) Laws and regulations stipulate that specific voluntary inspections should be conducted once a month for construction machinery.
- (2) Laws and regulations stipulate that construction machinery should be subject to periodic voluntary inspections once a year.
- (3) The law stipulates that the storage period of the inspection sheet of the specified voluntary inspection is three years for construction machinery.
- (4) Laws and regulations stipulate that the storage period of inspection sheets for periodic voluntary inspections of construction machinery is one year.

### ■ Question No. 37 (General precautions when performing inspections and maintenance)

Select one of the following four explanations of general precautions to be taken when performing inspections and maintenance that is correct.

- (1) When inspection and maintenance must be carried out due to unavoidable circumstances on an inclined surface, ensure the use of gears on the undercarriage of the machine.
- (2) Always engage the clutch, brake, swing lock, and various safety locks on construction machines.
- (3) Always keep work devices (attachments) such as blades and buckets raised off the ground.
- (4) Inspections and self-inspections shall be conducted in accordance with inspection charts or inspection check sheets, and there is no need to record and store the results.

### ■ Question No. 38 (Guidelines for daily inspection)

Select one of the following four explanations of the procedure for daily inspections that is correct.

- (1) Measure the tire pressure when the tires are cold before work and adjust the pressure according to the working surface.
- (2) Adjust the air pressure slightly higher than standard for soft ground and slightly lower for hard ground.
- (3) If the crawler is too tight, the pins and bushes will wear out faster, and if it is too loose, it will cause failure.
- (4) On hard surfaces, the crawler should be loosened and on soft surfaces, it should be tightened.

■ Question No. 39 (Guidelines for daily inspection)

Select one of the following four explanations of the procedure for daily inspections that is correct.

- (1) As the clutch plate wears, the play of the operating lever will increase and the clutch will slip, so adjust it with the adjusting screw.
- (2) Check that there is not too much play in the brake pedal. If the brake linings get worn, the pedal play will decrease and the brakes will not work unless you press down deeply.
- (3) Stop the engine to refuel. When refilling, be careful not to allow dirt or water to get mixed in.
- (4) Turn off the battery switch, set the main clutch lever to "OFF", and apply the parking brake. In addition, raise the blade, bucket, etc. to a position high above the ground.

## Chapter 9 Force and Electricity Knowledge

### ■ Question No. 40 (Relationship between voltage, current and resistance)

Select one of the following four explanations of the relationship between voltage, current, and resistance that is correct.

- (1) If the electrical resistance (ohms:  $\Omega$ ) of an electric circuit is equal, the smaller the voltage (volts: V), the higher the current (amperes: A).
- (2) The smaller the resistance of an electric circuit (for example, in the case of an electrical wire the thinner it is), the more the current is limited.
- (3) Voltage (volts: V) = Current (amperes: A) / Resistance (ohms:  $\Omega$ ).
- (4) Current (amperes: A) = Voltage (volts: V) / Resistance (ohms:  $\Omega$ ).

### ■ Question No. 41 (Handling of batteries)

Select one of the following four explanations about handling of batteries that is correct.

- (1) A battery is a device that can convert chemical energy into electrical energy, store it, and retrieve it as electrical energy when needed.
- (2) A battery is a device that can convert electrical energy into chemical energy, store it, and retrieve it as electrical energy when needed.
- (3) The only battery currently in practical use is the lead-acid battery.
- (4) When handling batteries, take special care to measure the specific gravity, and if it becomes 1.22 or higher, immediately recharge the battery.

### ■ Question No. 42 (Mechanics)

Select one of the following four explanations about mechanics that is correct.

- (1) When tightening bolts, the farther away the position of holding the wrench handle is from the bolt, the less force is needed, and the closer it is to the bolt, the more force is needed.
- (2) When a force acts on an object, if the line of action of the force passes through the center of gravity, the object will rotate.
- (3) The force that causes an object to move in a circular motion is called centrifugal force, and the force that is equal in magnitude and opposite in direction to this is called centripetal force.
- (4) Dynamic friction is greater than the maximum static friction force.

## Chapter 10 Topography and Construction Knowledge

### ■ Question No. 43 (Causes and signs of landslide)

Select one of the following four explanations about the causes and signs of landslide.

- (1) The phenomenon of slope and artificial slope (norimen) collapse is more likely to occur after a series of sunny days.
- (2) Collapse is more likely to occur on a slope than on an upright artificial slope (norimen).
- (3) Drying increases the adhesive strength of sandy soil, which causes the surface of the artificial slope (norimen) to peel off.
- (4) Drying causes cracking in cohesive soils, which causes the surface of the artificial slope (norimen) to peel off.

## Chapter 12 Related Laws and Regulations

### ■ Question No.44 (Periodical Self Inspection)

Select the correct one from the following four explanations regarding to Periodical Self Inspection.

- (1) The employer shall, carry out Periodical Self Inspection of Vehicle-type Construction Machinery according to the Ordinance of the Ministry of Health, Labor and Welfare, and record the result.
- (2) The employer shall, carry out Periodical Self Inspection of Vehicle-type Construction Machinery according to the Ordinance of the Ministry of Education, Culture, Sports, Science and Technology, and record the result.
- (3) The employer does not need to carry out Periodical Self Inspection of Vehicle-type Construction Machinery according to the Ordinance of the Ministry of Health, Labor and Welfare, and record the result.
- (4) The Minister of Health, Labor and Welfare shall not publish the necessary Self Inspection guidelines in order to proper and effective implementation of Self Inspection.

### ■ Question No.45 (Reissuance, etc., of the Skill Training Course Completion Certificate)

Select the correct one from the following four explanations regarding to Reissuance, etc., of the Skill Training Course Completion Certificate.

- (1) Skill Training Course Completion Certificate cannot be reissued.
- (2) In the case of loss or damage of the certificate, it can be reissued by submitting the application document for the reissuance of the skill training course completion certificate to the registered training institution that issued the certificate.
- (3) In the case of loss or damage of the certificate, it can be reissued by submitting the application document for the reissuance of the skill training course completion certificate to the Ministry of Health, Labor and Welfare.
- (4) When the name is changed, the skill training course completion certificate cannot be rewritten.

### ■ Question No.46 (Providing of Front Lamp)

Select the correct one from the following four explanations regarding to Providing of Front Lamp.

- (1) Vehicle-type construction machinery does not need to be equipped with a front lamp.
- (2) The employer must provide a vehicle type construction machine with a front lamp even at a place maintaining necessary illumination for carrying out the work safely.
- (3) The employer does not need to provide a vehicle type construction machine with a front lamp at a place not maintaining necessary illumination for carrying out the work safely.
- (4) The employer does not need to provide a vehicle type construction machine with a front lamp at a place maintaining necessary illumination for carrying out the work safely.

■ Question No.47 (Speed Limit)

Select the correct one from the following four explanations regarding to Speed Limit.

- (1) The employer must set the appropriate speed limit in advance. when carrying out the work by using a vehicle-type construction machinery (excluding the one having maximum speed of 10 km/h or less).
- (2) The employer does not need to set the appropriate speed limit in advance. when carrying out the work by using a vehicle-type construction machinery (excluding the one having maximum speed of 10 km/h or less).
- (3) The driver of the vehicle-type construction machinery may drive beyond the speed limit if it is in a wide place.
- (4) The employer must set the appropriate speed limit in advance when carrying out the work by using a vehicle-type construction machinery (excluding the one having maximum speed of 30 km/h or less).

■ Question No.48 (Prevention of Falling, etc.)

Select the correct one from the following four explanations regarding to Prevention of Falling, etc.

- (1) When carrying out the work by using a vehicle-type construction machinery, the employer does not need to take necessary measures in order to prevent workers from dangers due to overturning or falling of the said machine,
- (2) The employer does not need to arrange a guide , in the case where the work using a vehicle-type construction machinery is carried out at road shoulder, inclined place, etc., and when it is liable to cause dangers to workers due to overturning or falling of the said machine.
- (3) The driver of a vehicle-type construction machinery must follow the guidance given by the guide.
- (4) The driver of the vehicle-type construction machinery does not have to follow the guidance given by the guide.

■ Question No.49 (Transfer of Vehicle-type Construction Machinery)

Select the correct one from the following four explanations regarding to Transfer of Vehicle-type Construction Machinery.

- (1) When using a slope tops, embankment (morido)when load to truck and unload from the truck, the employer must load or unload at a level and firm place.
- (2) When using a loading plate, embankment (morido) when load to truck and unload from the truck, the employer does not need to load or unload at a level and firm place.
- (3) When using a loading plate, the employer does not need to use the one with a sufficient length, width, and strength
- (4) When using embankment (morido) or a temporary stand, the employer does not need to secure a sufficient width, strength, and appropriate incline.

■ Question No.50 (Measures to Be Taken by Machine Lessor, etc.)

Select the correct one from the following four explanations regarding to measures to be taken by machine lessor, etc.

- (1) Machine Lessor does not need to inspect the said machine in advance, when they lease to the other employer.
- (2) Machine Lessor must inspect the said machine in advance, and carry out the repair or other necessary maintenance when having found any abnormalities, when they lease to the other employer.
- (3) Machine Lessor does not need to deliver the document indicating the capabilities of the said machines to the employers to whom machines are leased when they lease to the other employer.
- (4) Machine Lessor does not need to deliver the document indicating characteristic of the said machines, etc., and other matters of the machines, etc., such as precautions for use to the employers to whom machines are leased ,when they lease to the other employer.

## Correct answer

### Chapter 1 Basic knowledge about Vehicle-type construction machinery

- Question No.1 (Ground leveling, transportation, and loading machine) ..... : ( 4 )
- Question No.2 (Excavation machine) ..... : ( 1 )
- Question No.3 (Terminology for vehicle-based construction machinery) ..... : ( 4 )

### Chapter 4 Handling of equipment related to the running of vehicle-type construction machinery

- Question No.4 (Basic operation before starting the engine) ..... : ( 2 )
- Question No.5 (Basic operation after starting the engine) ..... : ( 1 )
- Question No.6 (Handling of excavator-type construction machinery when starting) : ( 4 )
- Question No.7 (Handling of power shift type construction machinery while driving) : ( 2 )
- Question No.8 (Handling of climbing and descending shovel-type construction machinery) : ( 4 )
- Question No.9 (Handling when stopping the running of direct drive type construction machinery) : ( 4 )
- Question No.10 (Handling when parking (parking machine) construction machinery) : ( 3 )
- Question No.11 (Antifreeze, oil, etc.) ..... : ( 1 )

### Chapter 5 Structure and type of equipment related to the work of Vehicle-type construction machinery

- Question No.12 (The type and structure of operating equipment for tractor-based construction machines.) : ( 4 )
- Question No.13 (The safety devices for tractor-based construction machine, etc.) .. : ( 4 )
- Question No. 14 (The equipment of the scraper.) ..... : ( 1 )
- Question No. 15 (The operating equipment for loading machines) ..... : ( 2 )

## Chapter 6 Handling of equipment related to the work of Vehicle-type construction machinery, etc.

- Question No. 16 (Handling of Bulldozer) ..... : ( 3 )
- Question No. 17 (Handling of leveling work by Bulldozer) ..... : ( 3 )
- Question No. 18 (Handling of dozing (oshido) work by Bulldozer)..... : ( 2 )
- Question No. 19 (Handling of finishing work by Bulldozer) ..... : ( 1 )
- Question No.20 (Handling of applied work by bulldozer) ..... : ( 3 )
- Question No.21 (Handling of ripping work by bulldozer) ..... : ( 4 )
- Question No.22 (Handling of work on soft ground by a bulldozer) ..... : ( 1 )
- Question No.23 (Handling of tractor shovel (shoberu)) ..... : ( 2 )
- Question No.24 (Handling of excavation work for tractor shovel (shoberu)) ..... : ( 3 )
- Question No.25 (Handling of tractor shovel (shoberu) for loading and transportation work) : ( 2 )
- Question No. 26 (Handling and safe work of shovel-type construction machinery) . : ( 3 )
- Question No. 27 (Handling and safe work of shovel-type construction machinery) . : ( 1 )
- Question No. 28 (Handling and safe work of shovel-type construction machinery) . : ( 2 )
- Question No. 29 (Handling and safe work of shovel-type construction machinery) . : ( 4 )
- Question No. 30 (Handling and safe work of shovel-type construction machinery) . : ( 2 )
- Question No. 31 (Handling of motor graders and safe work) ..... : ( 4 )
- Question No. 32 (Handling of scrapers and safe work) ..... : ( 2 )
- Question No 33 (Handling of scrapers and safe work) ..... : ( 3 )
- Question No. 34 (Transport of vehicle-based construction machinery) ..... : ( 1 )
- Question No. 35 ( Transport of vehicle-based construction machinery )..... : ( 3 )

## Chapter 7 Inspection and Maintenance for Vehicle-type Construction Machine

- Question No. 36 (Inspection and maintenance of vehicle-based construction equipment)· : ( 3 )
- Question No. 37 (General precautions when performing inspections and maintenance)· : ( 1 )
- Question No. 38 (Guidelines for daily inspection) ..... : ( 1 )
- Question No. 39 (Guidelines for daily inspection) ..... : ( 3 )

## Chapter 9 Force and Electricity Knowledge

- Question No. 40 (Relationship between voltage, current and resistance) ..... : ( 4 )
- Question No. 41 ( Handling of batteries )..... : ( 2 )
- Question No. 42 (Mechanics) ..... : ( 1 )

## Chapter 10 Topography and Construction Knowledge

- Question No. 43 (Causes and signs of landslide)..... : ( 4 )

## Chapter 12 Related Laws and Regulations

- Question No.44 (Periodical Self Inspection) ..... : ( 1 )
- Question No.45 (Reissuance, etc., of the Skill Training Course Completion Certificate) ..... : ( 2 )
- Question No.46 (Providing of Front Lamp) ..... : ( 4 )
- Question No.47 (Speed Limit) ..... : ( 1 )
- Question No.48 (Prevention of Falling, etc.)..... : ( 3 )
- Question No.49 (Transfer of Vehicle-type Construction Machinery)..... : ( 1 )
- Question No.50 (Measures to Be Taken by Machine Lessor, etc.)..... : ( 2 )