

Building machines

The tasks:

- choose the right machines for the works
- plan the using of the machines
- choose the most economical method for the works

Building machines



The type of the machines*:

- **hand-tools** (boring machine, cutting machine)-for simple use, without planning.
- **simple tools** (concrete mixer, plaster mixer...) we must prepare to the using with a simple site plan (because we want to use energy and some building materials for the works).
- **heavy machines** (main machine)-You have to make a site plan for the works.

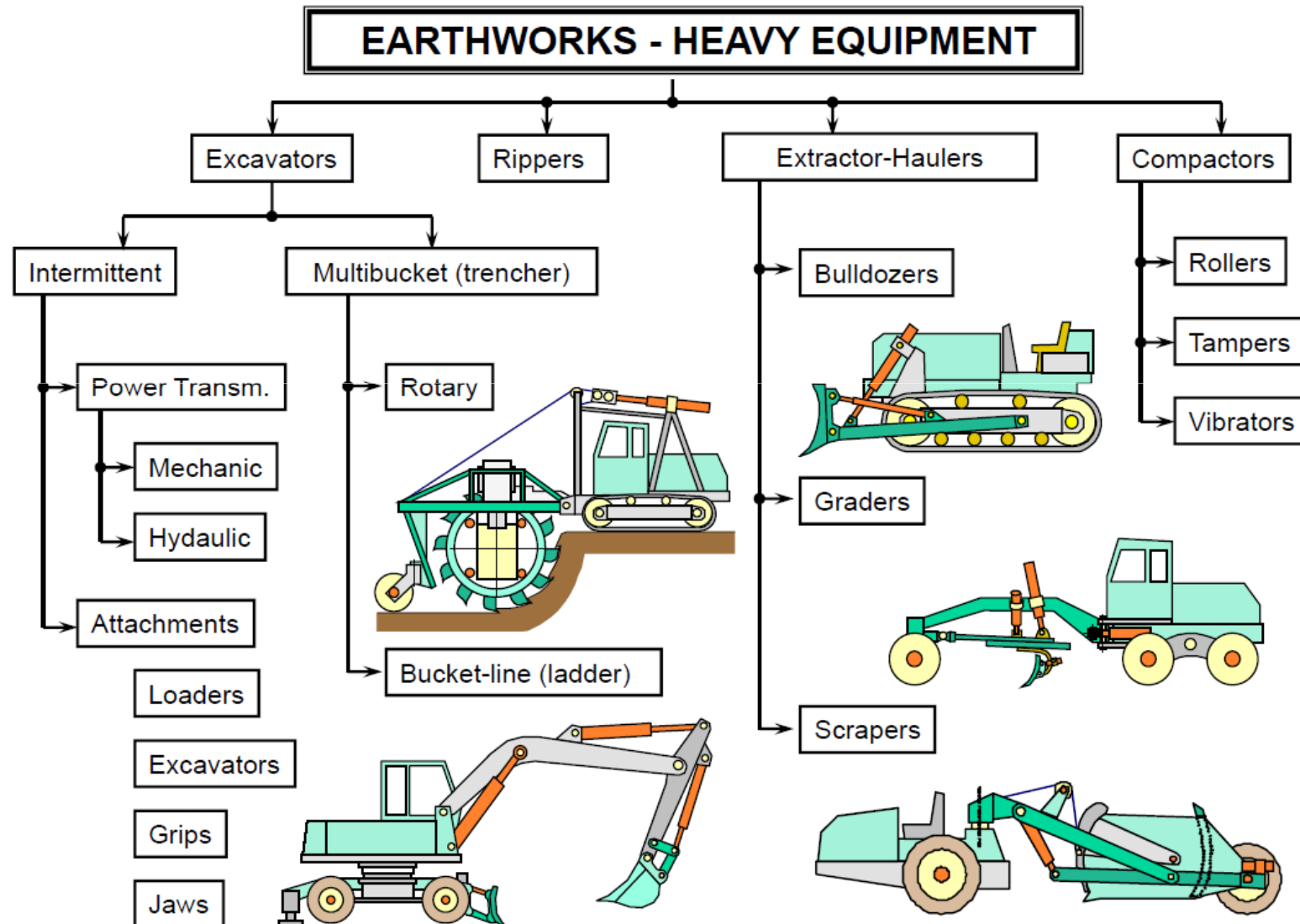
Earthwork machines



The machines by the
technologically sequencing:

- **Ground surface planning**
- **Surface ripping/dozers**
prepare to the cutting
- **Scrapers, graders**
- **Excavators**
- **Soil loading**
(prepare to the transport)
- **Soil dumping**
- **Soil compacting**

Earthwork machines





- **1.1 Ground surface planning**
- With special machines: stone collector, bush cutter. We prepare the ground to next works.
- **Hydraulic excavator attachments:**
- Wood/bush cutter, root remover attachment
- Stone collector,
- Ripping attachment.

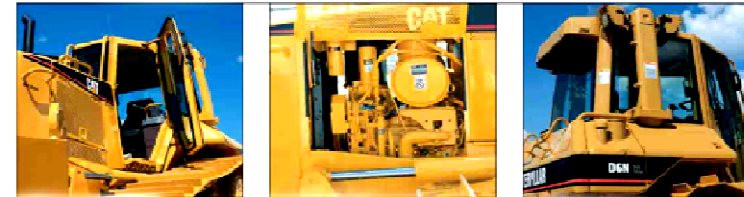
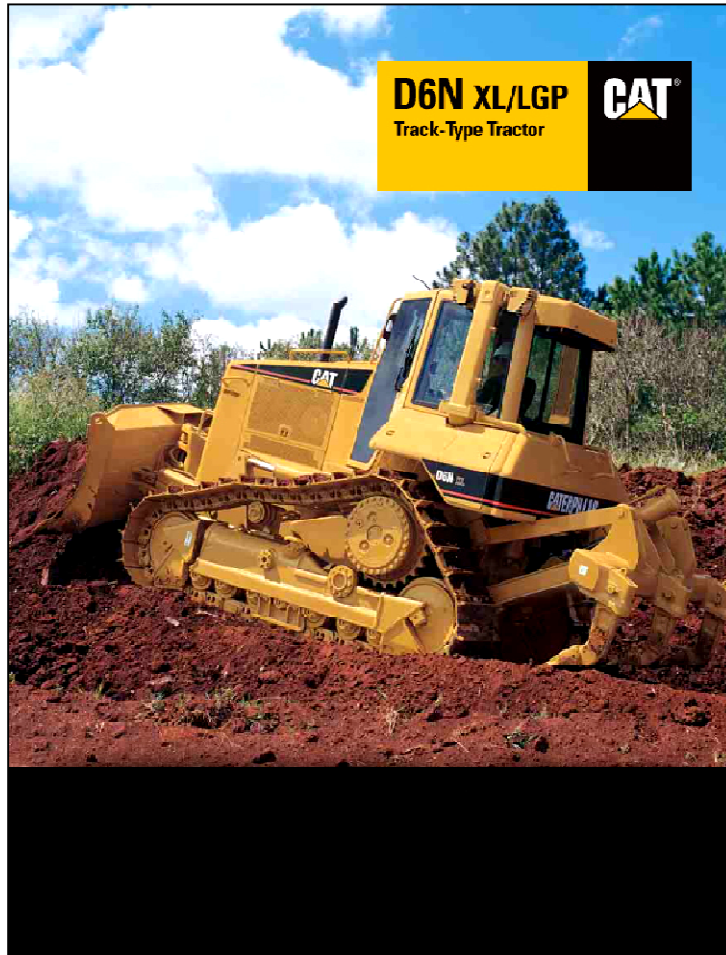
The main machine is the dozer by the ripping.



- **1.1 Ground surface planning**
- With special machines: stone collector, bush cutter. We prepare the ground to next works.
- **Hydraulic excavator attachments:**
- Wood/bush cutter, root remover attachment
- Stone collector,
- Ripping attachment.

The main machine is the dozer by the ripping.

Soil ripping machines



- **Surface ripping/dozers** prepare to the cutting

Before the cutting we have to ripping **the solid surface** of the soil.

This way we can prepare to the next work phases - for

graders,

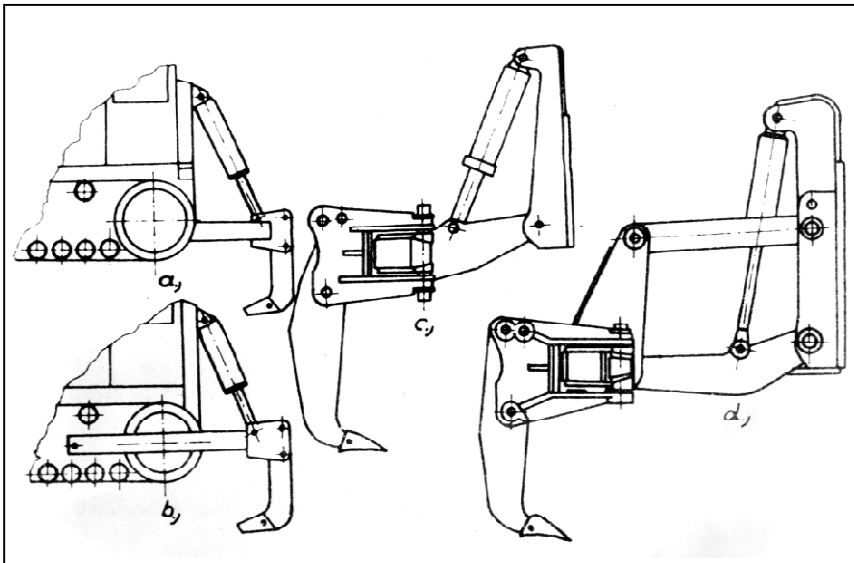
scrapers,

excavators...

Soil ripping machines



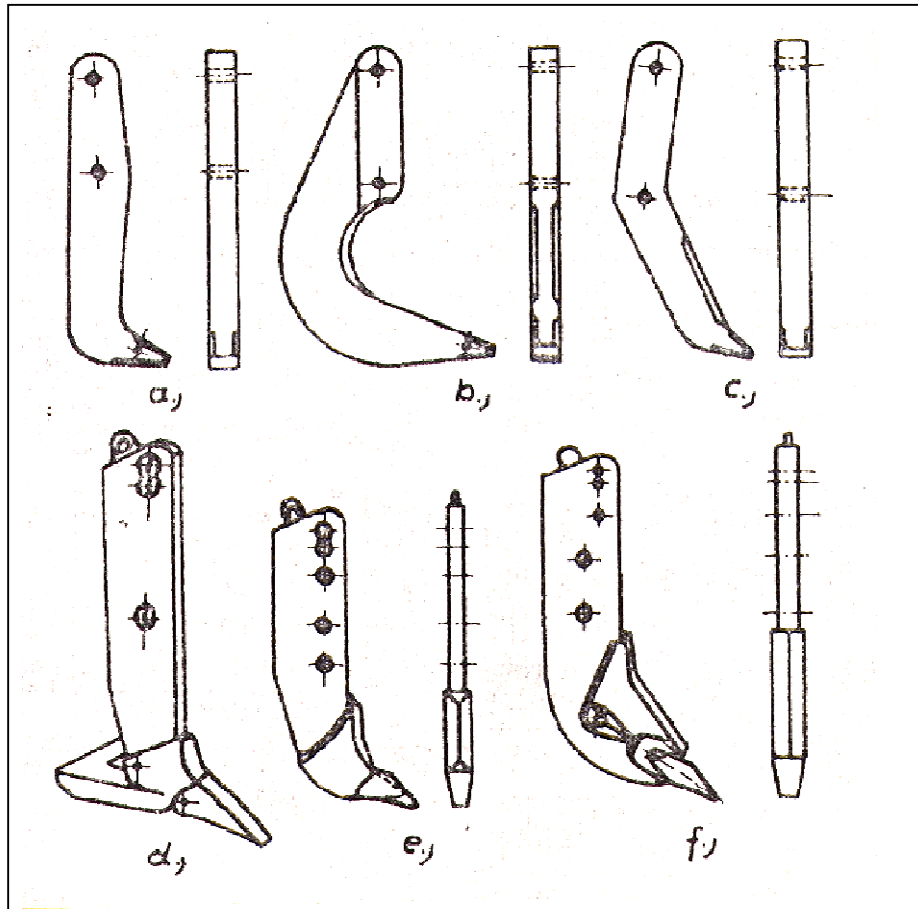
- Structure of the ripping attachment
- Moved with hydraulic cylinders:
- High pressure in the cylinder (about 6tons)
- Hanging attachment back of the bulldozers:



Big efficiency,
Frame from strong steel,
moved with hydraulic cylinders.

We can change the deep of the ripping with these hydraulic cylinders.

Soil ripping attachments



- a straight
- b, c curved
- d, e, f with steel blade

- The structure of the teeth*:

It's depend on the type of soils.

The angle of the ripping: 35-45°

- Straight

in the case: deeper than 80 cm

- Curved

soil with stones, until 80cm

- Special(with blade)

soil with stones, until 80cm

- **Distance of the teeth:**

- 0,80-1,00 m, by heavy machines
- 0,90-1,3 m, by normal machines

Bulldozers



- Bulldozers: with tracked or wheeled undercarriage.

We can use it for:

- Cutting of the soil
- Move the soil
- Fill up a ditch
- Cutting the topsoil

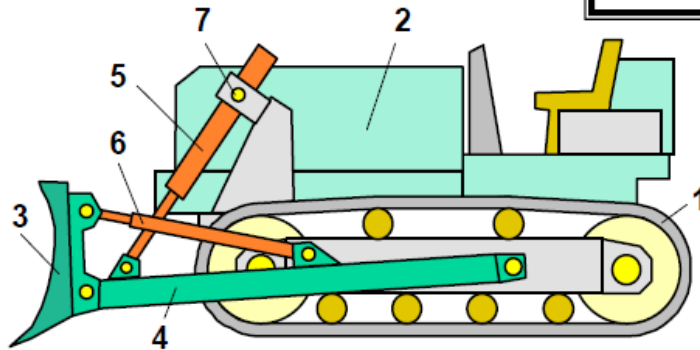


- The distance of the moving*:
 - Wheeled machines: 100-150m
 - Caterpillar tracked 60-80 m

Bulldozers

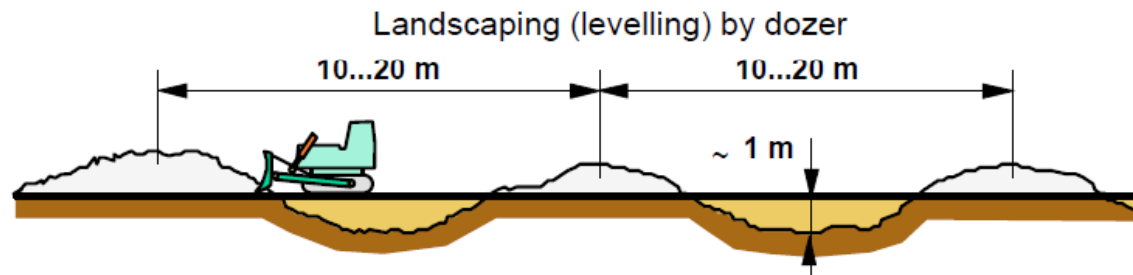
A. with rigid frame

Bulldozers (dozers)



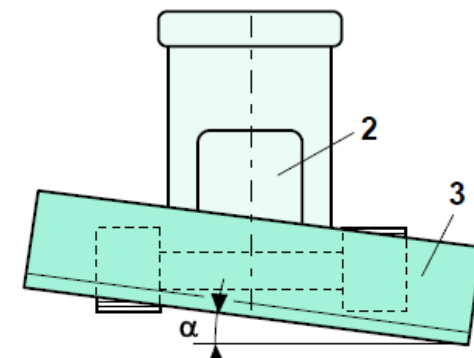
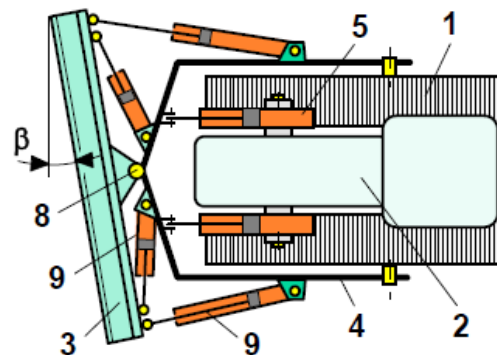
Adjustability of blade:

- ⇒ Cutting depth
 - ⇒ Cutting angle (tilt, adjusted to soil type)
 - ⇒ Slope angle (α)
 - ⇒ Heading angle (β)
- } Ball-jointed main frame only

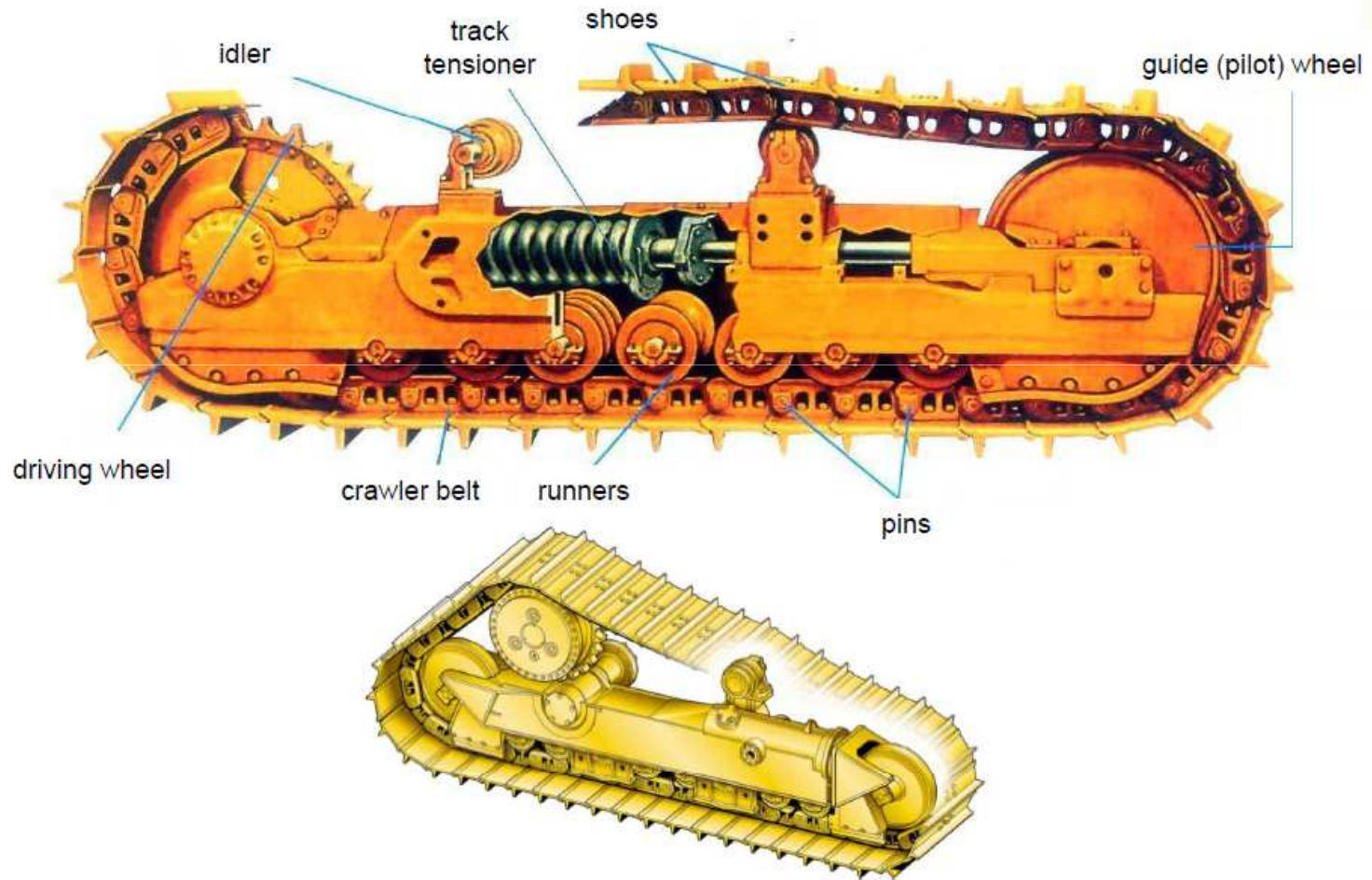


B. with ball-jointed frame

1. track (caterpillar)
2. engine
3. blade
4. main frame
5. lifting cylinder
6. tilting cylinder
7. bolt
8. ball-joint
9. swivel cylinders

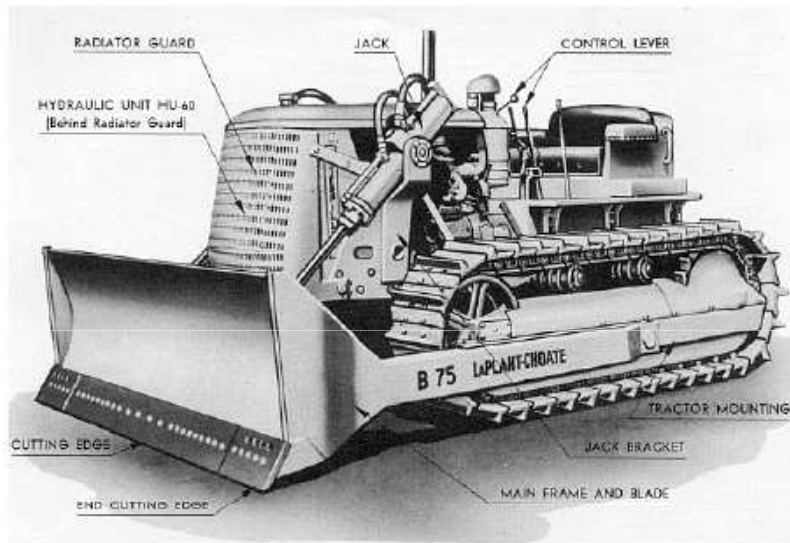


Bulldozers



Bulldozers

„Oval drive” (track)



„Delta drive” (track)



Advantages of delta drive:

- due to elevated engine and drive risk of getting dust (mud) in is less
- longer operation (life) time
- increased bulk clearance

Disadvantages of delta drive:

- higher costs of manufacturing
- more components, longer crawler belt

Bulldozers

Up-to-date controls



Bulldozer equipped with ripper attachment

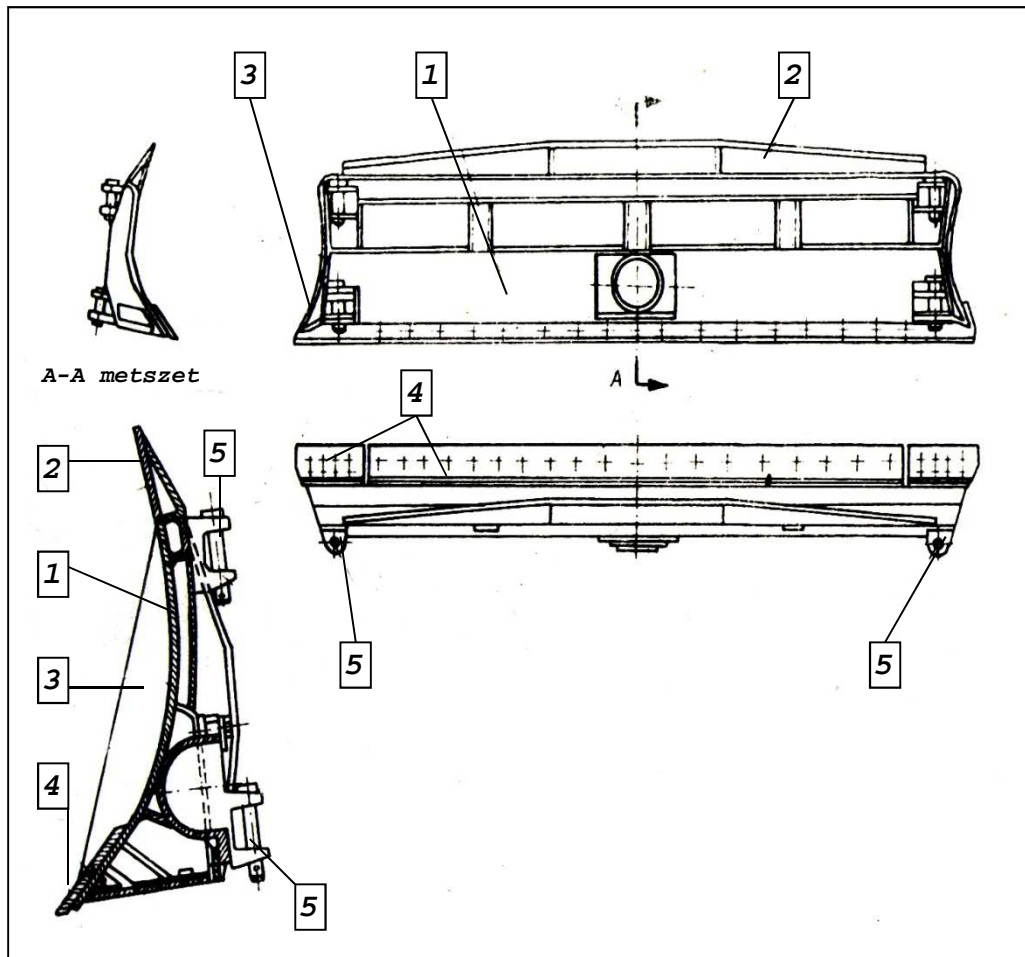


Laser control



Satellite control

Bulldozers



- The main parts of the blade*:

1 - Front plate:

a curved welded steel plate

2 - Head plate:

a straight welded steel plate

3 - Side plates:

both sides of the blade- to reduce the soil losses.

4 - Cutter:

Heat-treated steel / bolted to the bottom of the blade /

5 - Bolts:

Fixation to the mainframe

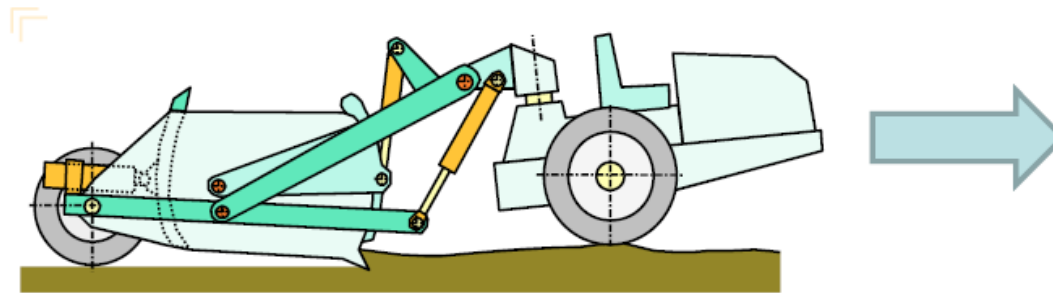
Scrapers



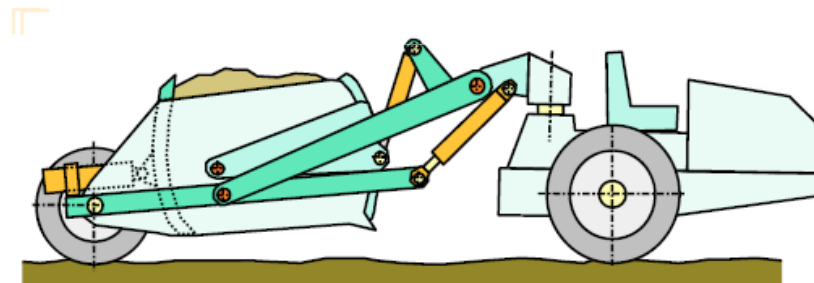
- We can use the scrapers for the*:
- Excavating of the soil
- Hauling (and compacting)
- Discharging (spreading and compacting)
- By the construction of linear structures (roads, dams, large surface excavations).
- The main part of scraper is: the scraper bowl

Scrapers*

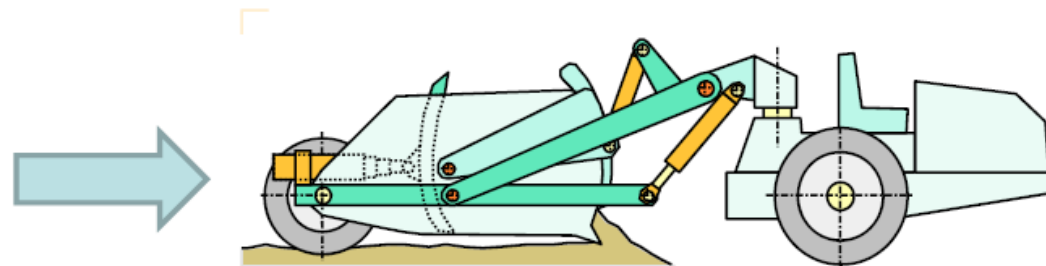
Phases of a cycle (turn)



Excavating (charging): apron up (open), bowl down (penetrating into the soil)

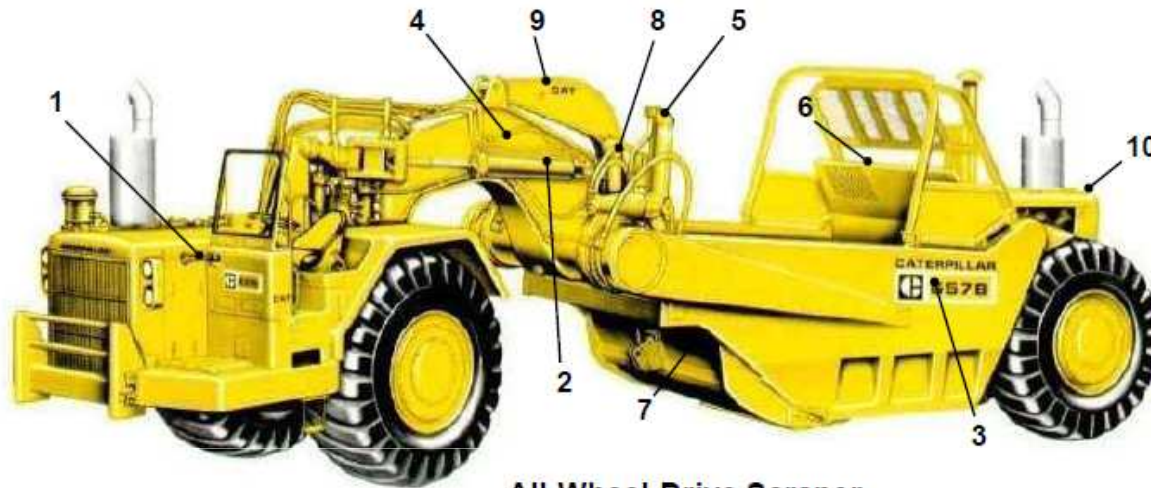


Hauling (and compacting): apron down (close), bowl up



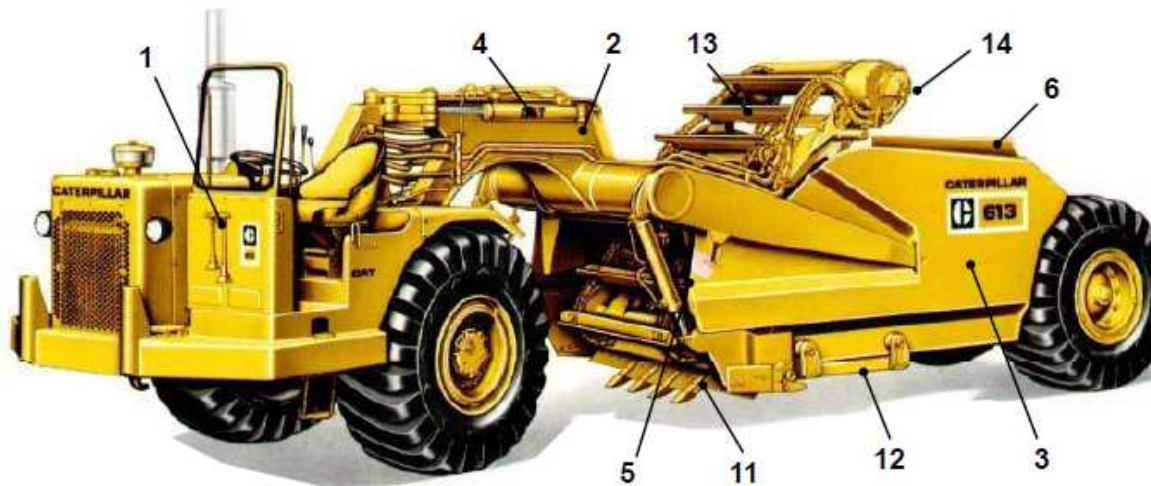
Discharging (spreading and compacting): apron up (open), bowl up, ejector forward

Scrapers



1. tractor
2. gooseneck
3. scraper bowl
4. steering cylinder
5. bowl cylinder
6. ejector
7. apron
8. apron cylinder
9. apron rods
10. rear engine
(rear wheel drive)

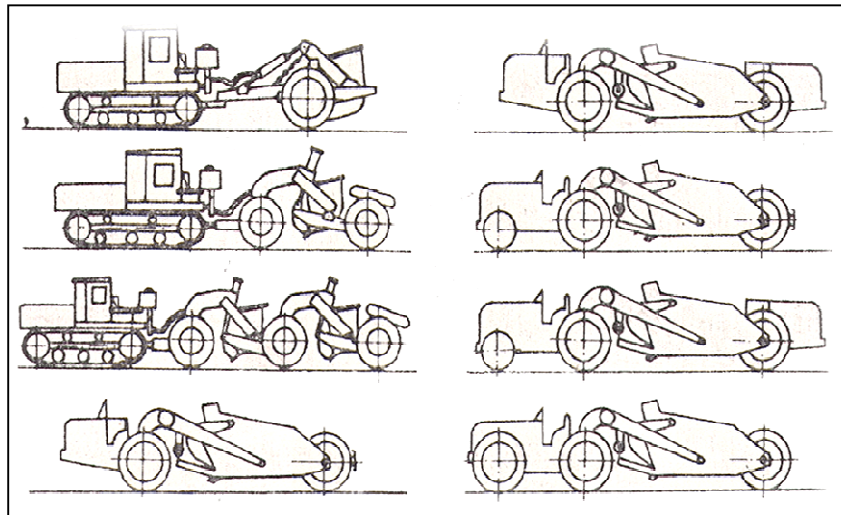
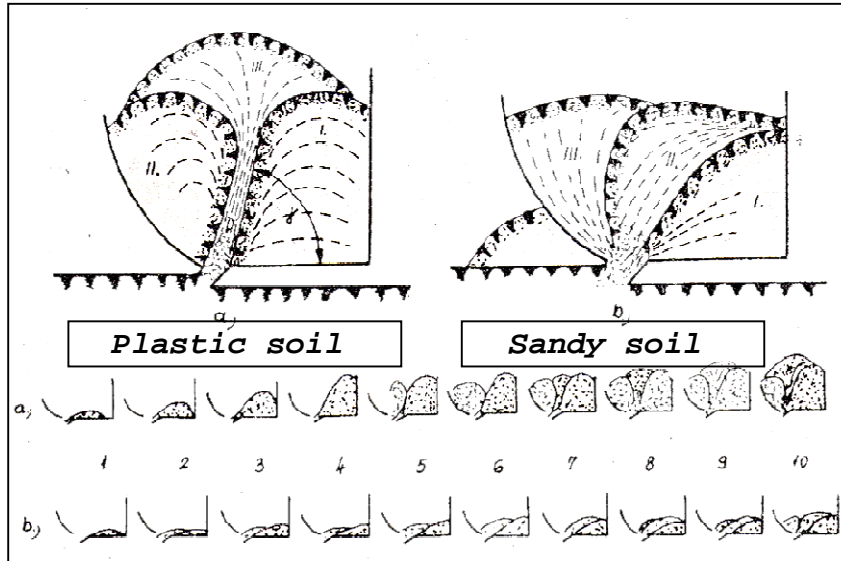
All-Wheel-Drive Scraper
(Charging and penetration provided by towing power of tractor)



11. cutting edge
12. discharge slide
13. elevator
14. hydro-engine
(of elevator)

Elevator-scraper

Scrapers



- The thickness of the cutting is: 120 - 500 mm .
- The soil **should not contain stones** . We have to work with these machines in the **IV.th soil class** but we have to use ripping too.
- **Hauled scrapers** - economically distance: 300 - 500
- **Mobile scrapers: 5000 - 8000**
- **The large of the bowl:**
 - Small (5 m³)
 - Middle sized (5 - 12 m³)
 - Big (over 12 m³)
- In Hungary the most popular size : 3 - 10m³.

Graders*

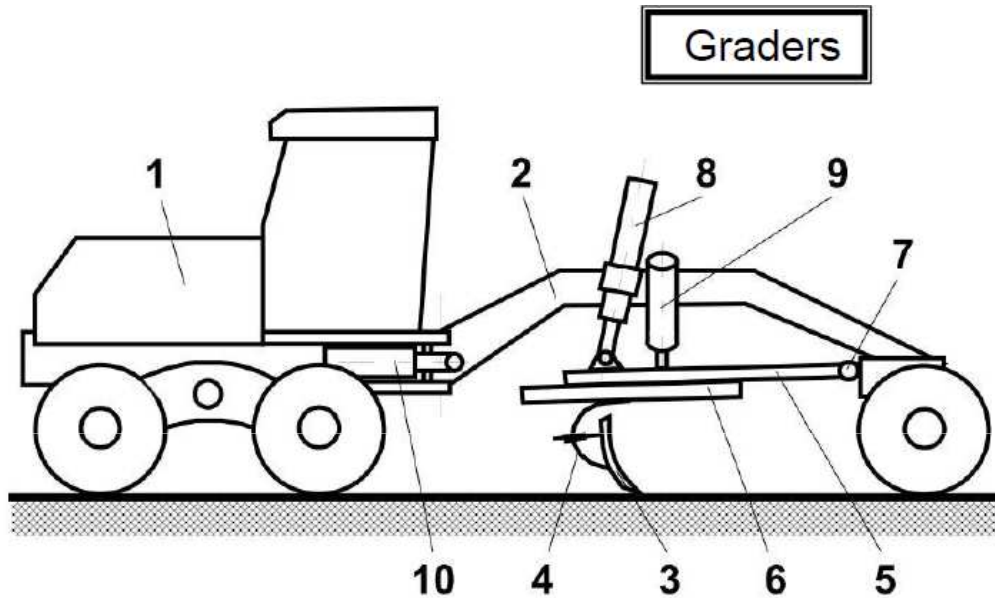


- Mainly for **road construction**, road crown designs are applied.
- In addition to the construction of roads suitable for performing a wide variety of work:
 - **To make road profiling**
 - **Landscaping**
 - **To making slopes**



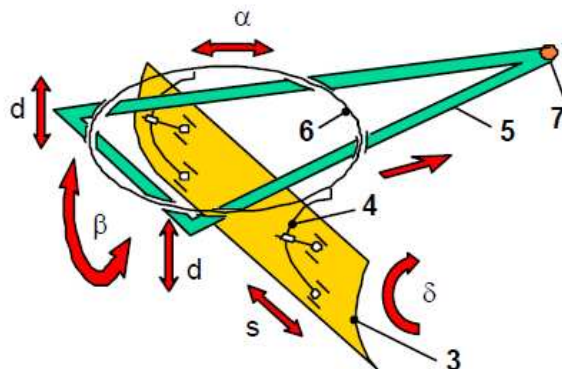
Graders

Graders



- 1. tractor (engine)
 - 2. articulated carriage
 - 3. blade
 - 4. tilting frame
 - 5. main frame
 - 6. swivel ring
 - 7. ball-joint
 - 8. lifting cylinder (jack)
 - 9. tilting cylinder
 - 10. swivel cylinder
- (d) cutting depth
 - (δ) cutting angle
 - (β) slope angle
 - (α) heading angle
 - (s) sliding

Adjustability of the blade



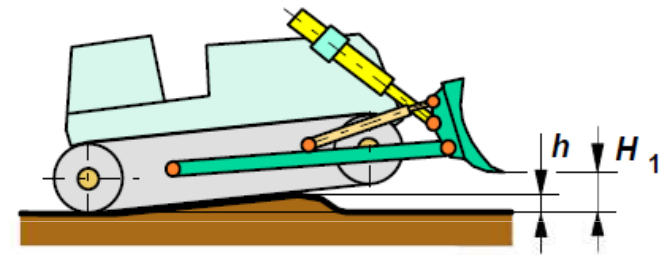
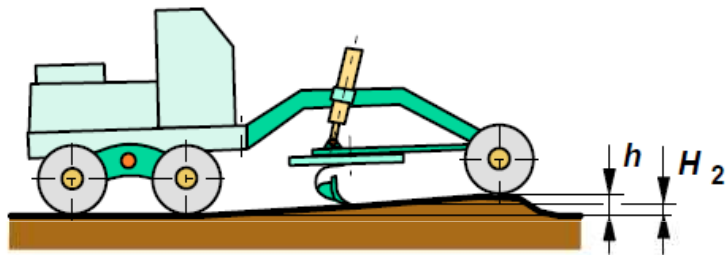
Graders

Typical application: refinery earthworks, levelling, topsoil excavation, spreading

a. grader: $H_2 < h$

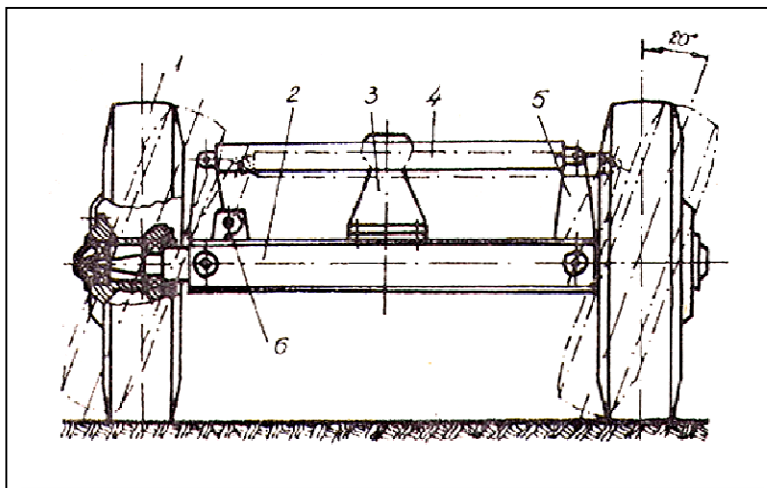
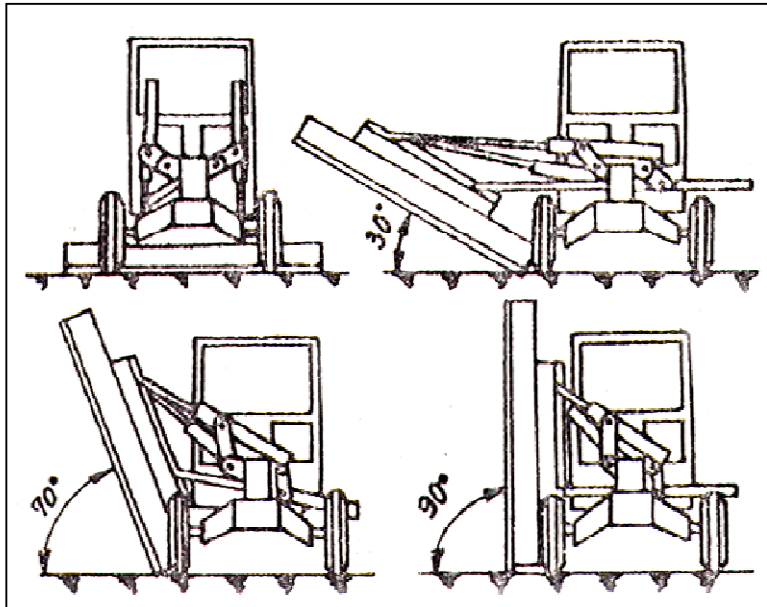
Effect of uneven surface (h)
on position of blade (H)

b. dozer: $H_1 > h$



Laser controlled (C) grader equipped with ripper (A) and front blade (B) attachment

Graders



- The **positions of the blade** are changeable.
- **The angle of the suspension** is different on a horizontal and on a sloping terrain. (changeable)
- This way the graders can be work more safely.
- **We can change the angle of the suspension** with hydraulic cylinders.

Excavators

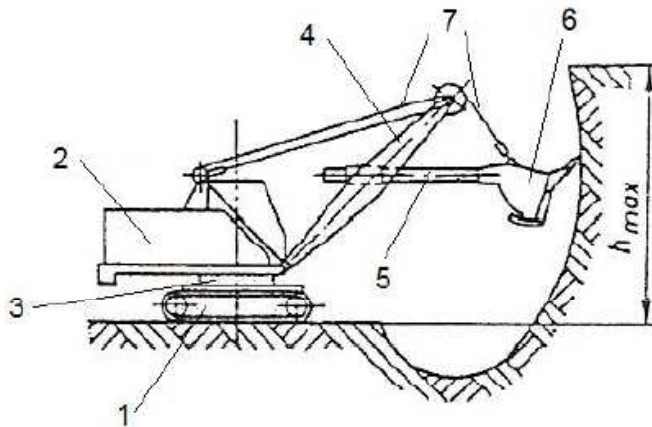


- Excavators are suitable for the **soil extraction and move to a very short distance** (relocation).
- **Continuous excavators** (multibucket trencher)
- **Intermittent excavators**—
Slewing excavators



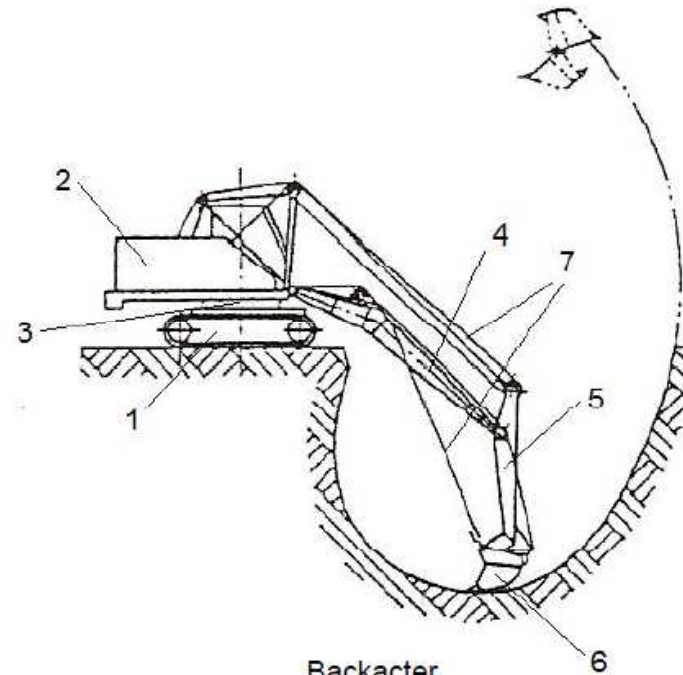
Excavators

Cable-operated excavators



Front shovel

1. bogie undercarriage
2. slewing upper machinery (drive, operator's canopy, counter-weight)
3. turn mechanism
4. boom
5. arm
6. bucket
7. cable-lines



Backacter

Features:

- complicated driving system
- many moving elements → manifold potential failures
- low working performance
- extensive maintenance requirements

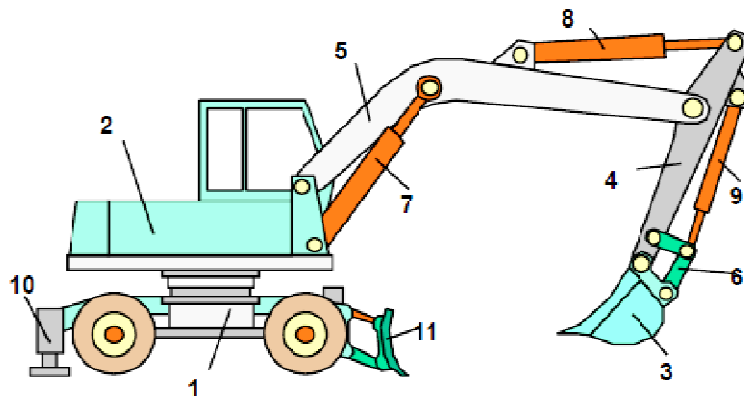
Excavators

Cable-operated excavators



- Intermittent (cyclic) operation
- Attachments:
shovel, hook, dragline,
clamshell, boring equipment

Excavators



Backhoe, wheel-mounted



Front shovel, track-mounted

Hydraulic excavators (slewing excavators)

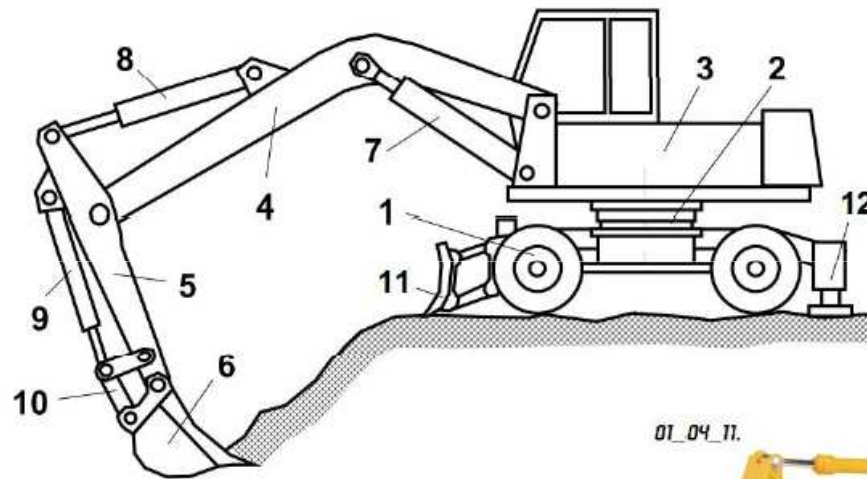
1. frame (carriage)
2. slewing upper machinery (engine, operator's canopy, counter-weight)
3. hoe (shovel or bucket)
4. arm
5. boom (monoblock or articulated)
6. hoe rods
7. boom lifting cylinder
8. arm moving cylinder
9. hoe moving cylinder
10. outrigger (strut, jack)
11. auxiliary attachment (blade)



Excavator (in action)

Excavators

Hydraulic excavators (slewing excavators)



1. wheel-bogie
2. turn mechanism
3. slewing upper machinery
4. boom
5. arm
6. backacter
7. boom cylinders
8. arm cylinder
9. bucket cylinder
10. bucket moving rods
11. auxiliary attachment
12. outrigger

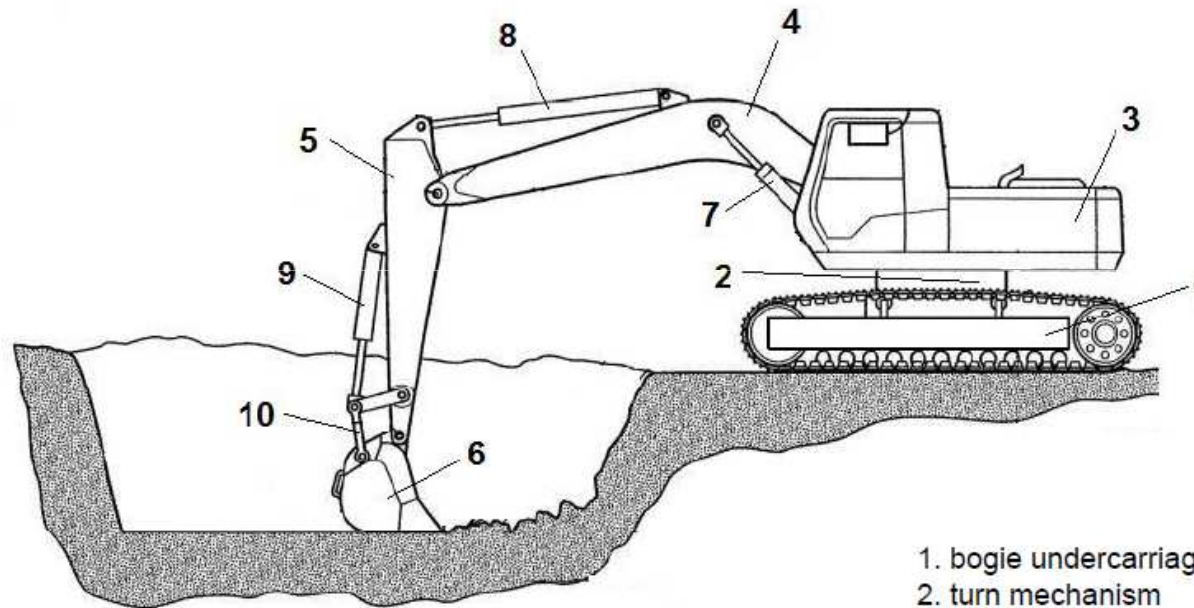
01_04_11.

Wheel-mounted backacter slewing excavator



Excavators

Hydraulic excavators
(slewing excavators)

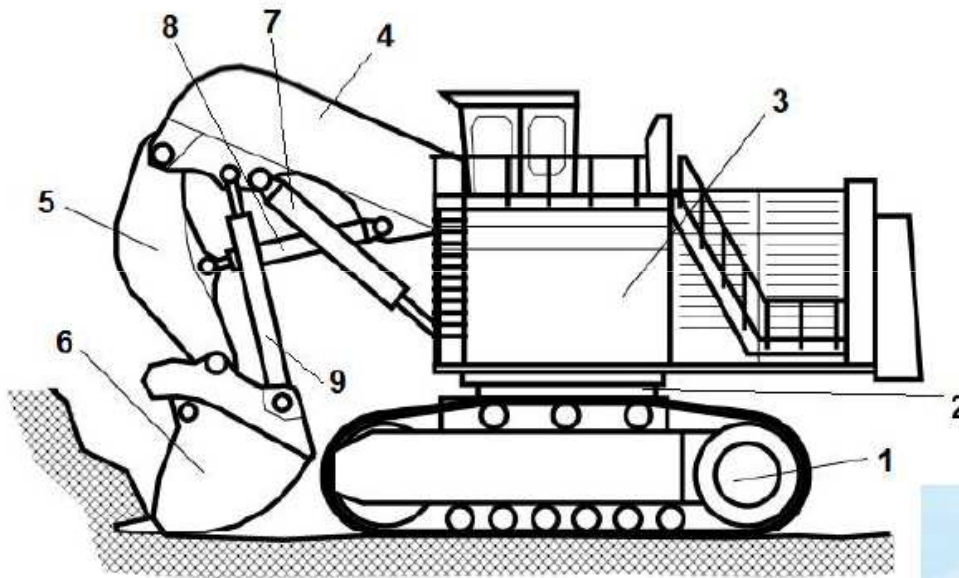


Track-mounted backacter slewing excavator

1. bogie undercarriage
2. turn mechanism
3. slewing upper machinery
4. boom
5. arm
6. backacter
7. boom cylinders
8. arm cylinder
9. bucket cylinder
10. Bucket moving rods

Excavators

Hydraulic excavators (slewing excavators)



1. bogie undercarriage
2. turn mechanism
3. slewing upper machinery
4. boom
5. arm
6. front shovel
7. boom cylinders
8. arm cylinder
9. shovel moving cylinders

Track-mounted front shovel slewing excavator



Excavators*

Attachments



Clamshell bucket (for granular material)



Screening adapter (for recycled material)



Breakers, Jaws
(for concrete, reinforced concrete and steel)

Others: loader bucket; drill; trunk-grip; cutter; trencher; fingered grips (for fibers or bars); crusher; vibro-plate; etc.

Excavators

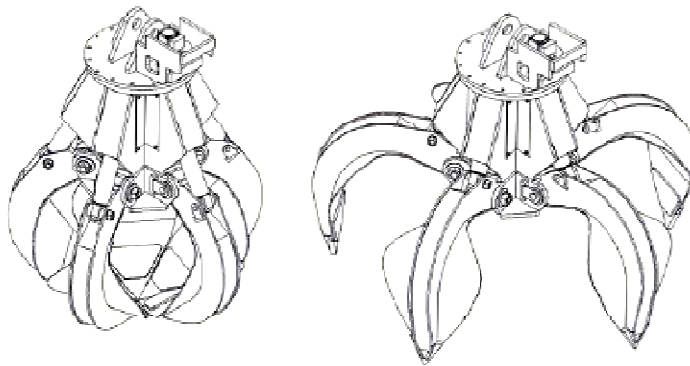
Attachments



Sheet-wall piling equipment



Boring (auger) equipment



Fingered grip



Crusher adapter

Excavators

Hydraulic excavator attachments



Backacter bucket



Clamshell

Earthwork attachments



Auger



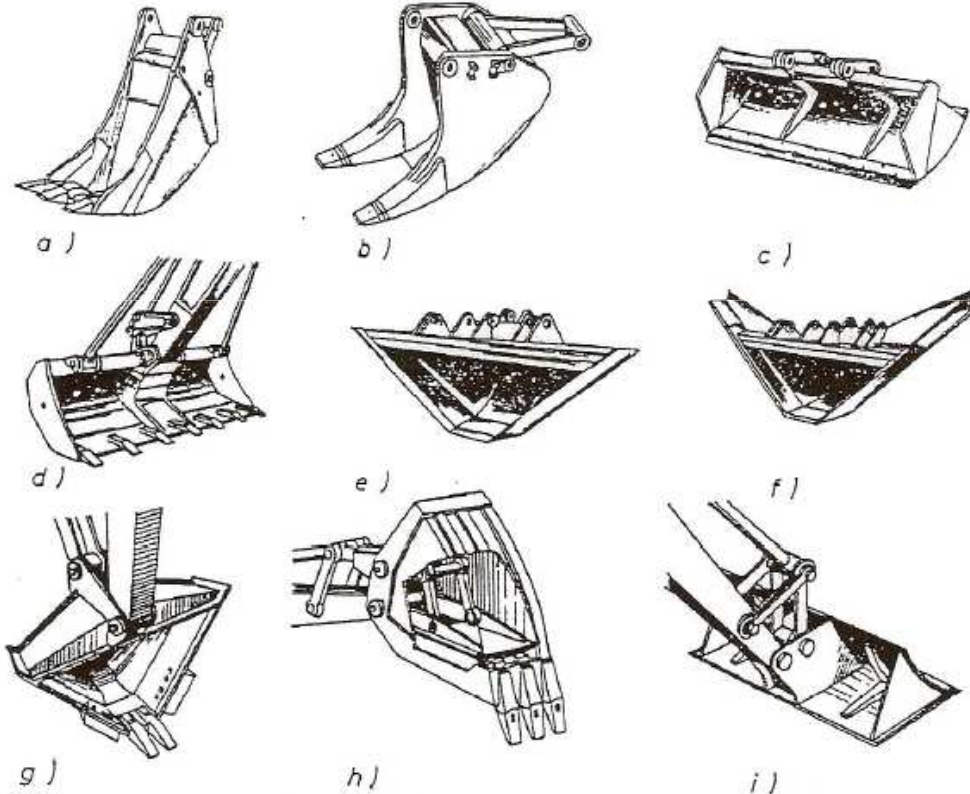
Ripper

Others: loading attachment; surface vibrator; roller compactor; bucket-lined or rotary trencher; profile buckets; sheet-wall driver; etc.

Excavators

Hydraulic excavator attachments

Earthwork attachmentst



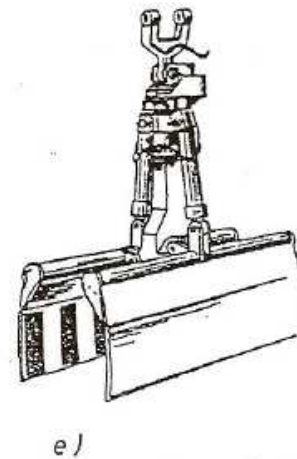
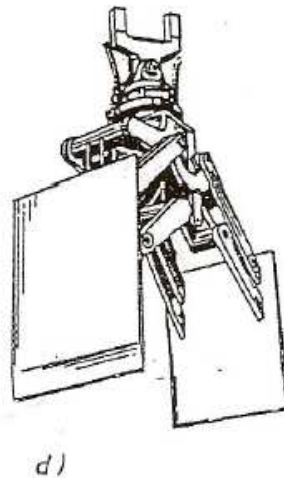
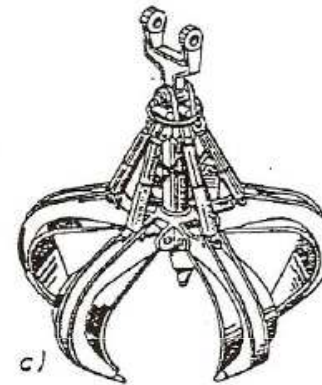
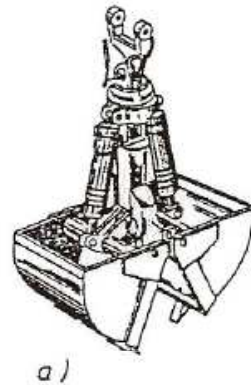
Special bucket-typed attachments

- a. drainer; b. ripper; c. canal maintainer; d. ripper-cleaner; e. profile bucket; f. extended cutter; g. ripper-profiler; h. ejector; i. tamper

Excavators

Hydraulic excavator attachments

Grabs, grips and loaders

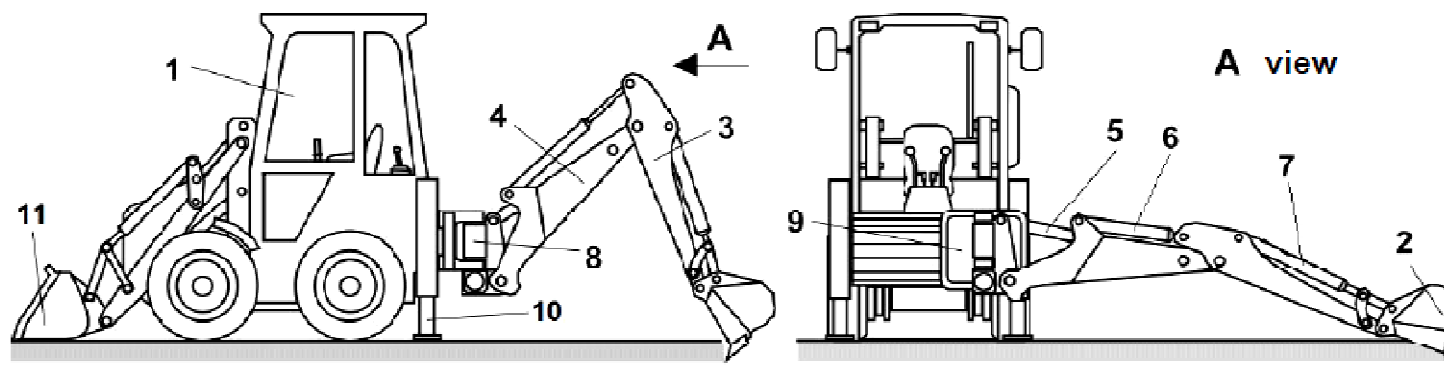


Grabbing and loading attachments

a. clamshell; b. boring; c. fingered; d. bale grip; e. barrel/pipe grip; f. logger

Excavators

Backhoe excavators



1. wheel tractor
2. backacter
3. arm
4. slewing boom
5. boom cylinder
6. arm cylinder
7. bucket cylinder
8. slewing mechaner
9. suspension (base) plate
10. outrigger
11. front attachment (loader)

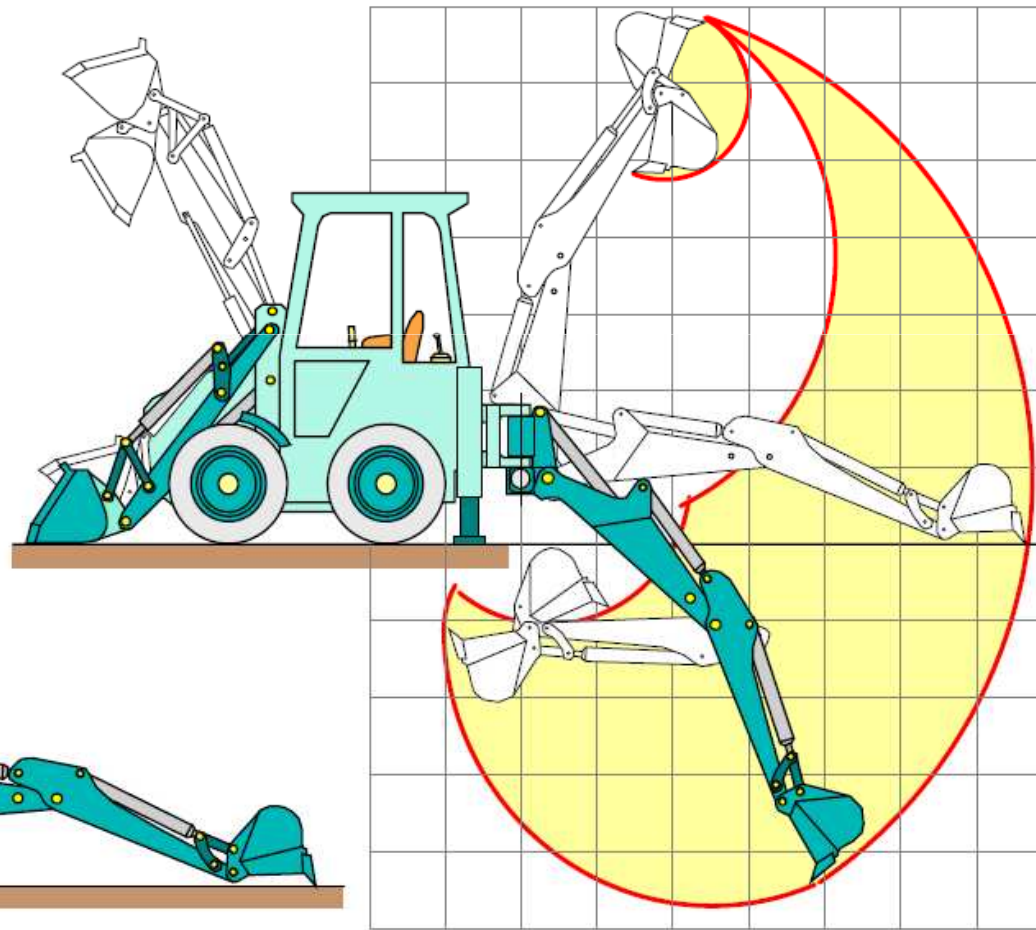
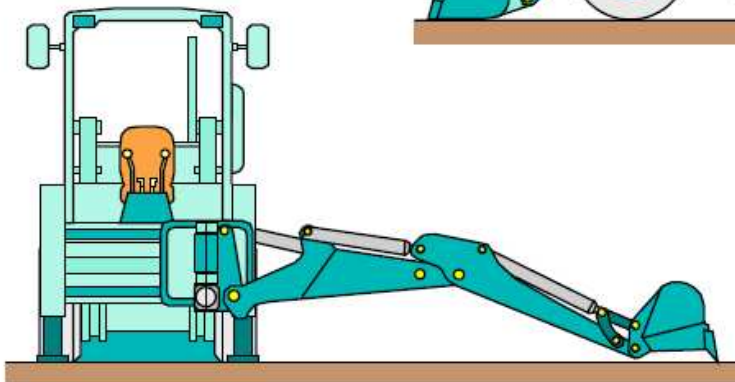


Excavators

Backhoe excavators

Features:

- ⇒ multifunctional (universal excavator)
- ⇒ base (frame): wheel or track mounted
- ⇒ attachment slewing ability: $\pm 90^\circ$
- ⇒ auxiliary attachment: front bucket or blade



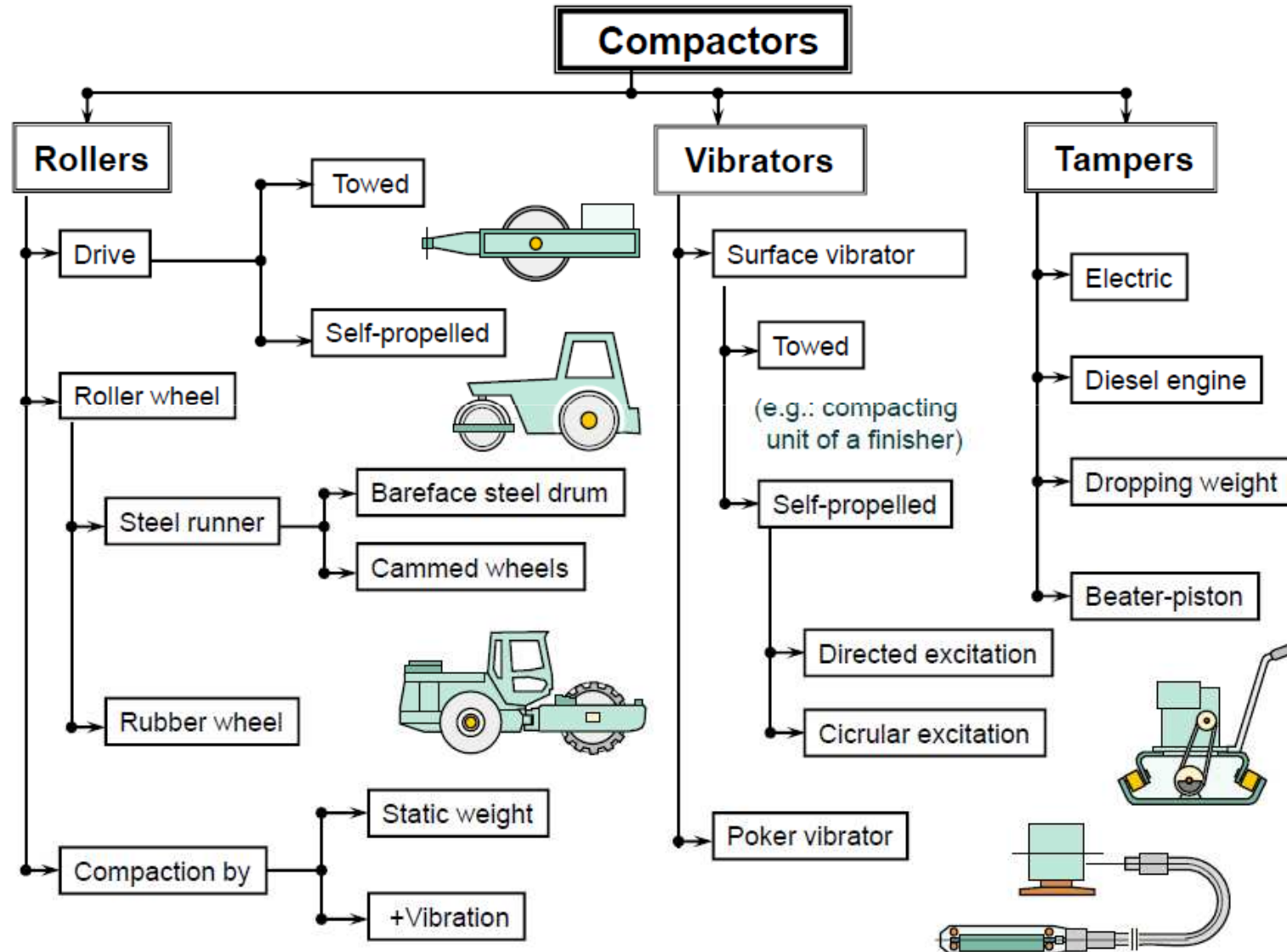
Backhoe's working range (trajectory)

Loading machines



- Wheel-mounted
- Caterpillar
- With telescopic beam

Soil compactors



Soil compactors



Compaction by static weight*

- Roller wheel
- Steel runner
- Rubber wheel
- Cammed wheels

Compaction by vibration*

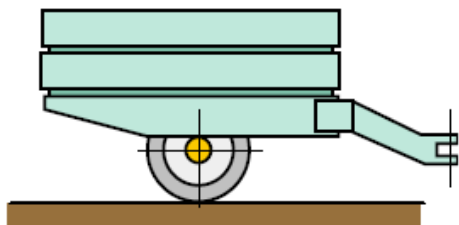
- Vibro-plates
- Tampers
- Type of use:
 - *Self-propelled*
 - *Towed*



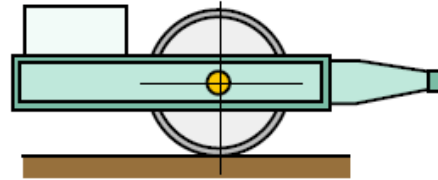
Soil compactors

Towed rollers

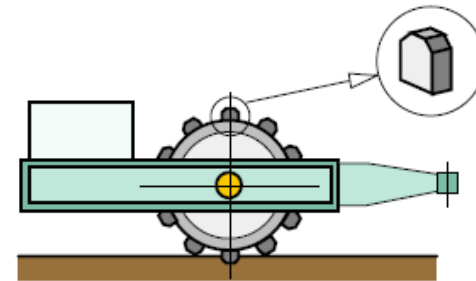
Basic types:



a. rubber-wheel roller



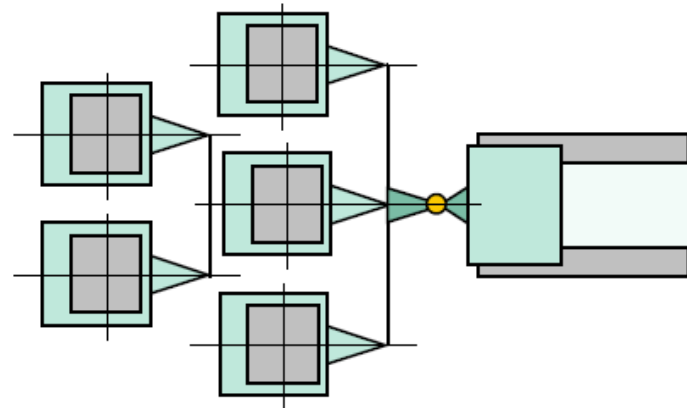
b. barefaced steel-drum



c. tamping (spiked/cammed) roller
(for clay and adherent soil)

Features:

- Main application is soil compaction
- Towed individually or in groups
- Static load transferred to the soil can be controlled by weights mounted



Towed group of static rollers

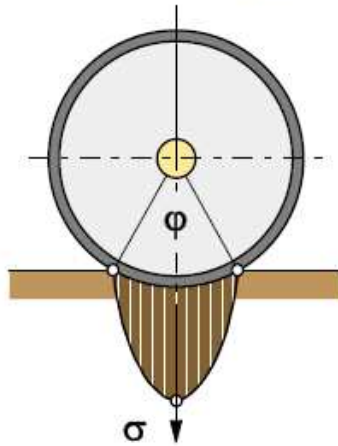
Soil compactors

Self-propelled rollers

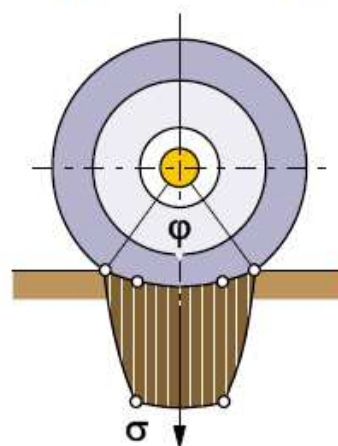


Typical configurations

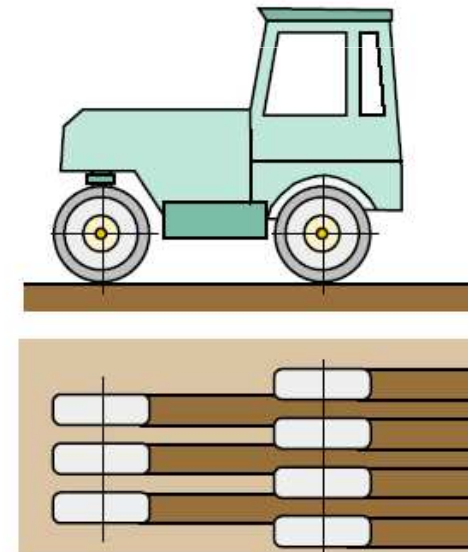
a. bareface steel roller



b. rubber-wheel roller



Soil compression (stress) under roller wheels



Rubber-wheel configuration

Soil compactors

Vibratory compaction

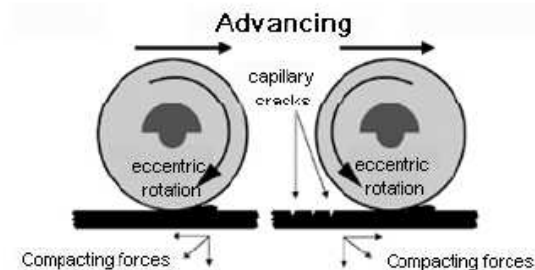
Principle of vibratory compaction:

Grains of soil are effected by periodically alternating inertial forces. These forces make grain particles 'floating', so ordering is progressed without friction.

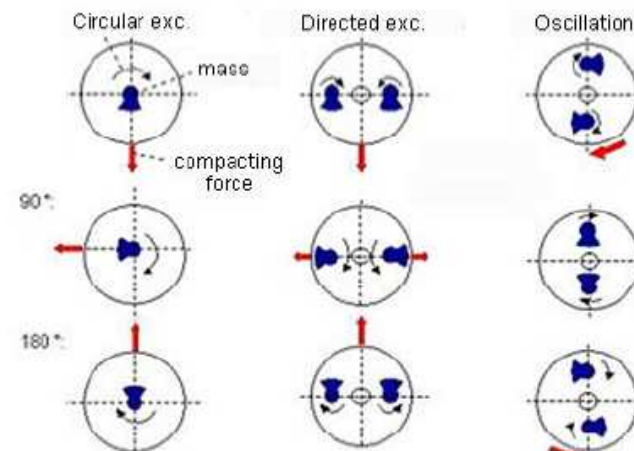
At vibratory compaction low amplitude high frequency excitation is used for loose soil or for deep layers. High amplitude low frequency excitation is used for cohesive soils in thin layers. Frequency of excitation should be close to characteristic frequency of the soil.

Ways of excitation:

- circular excitation: simple construction, single exciter unit, eccentric should always rotate in direction of advancing
- directed excitation: double exciter unit, generates both compressing and shearing forces in the soil simultaneously
- oscillation: the two exciter masses generate moment at the surface of the drum creating compressing and shearing forces in the soil, so grains are ordered horizontally. Vertical force is provided by the weight of the drum



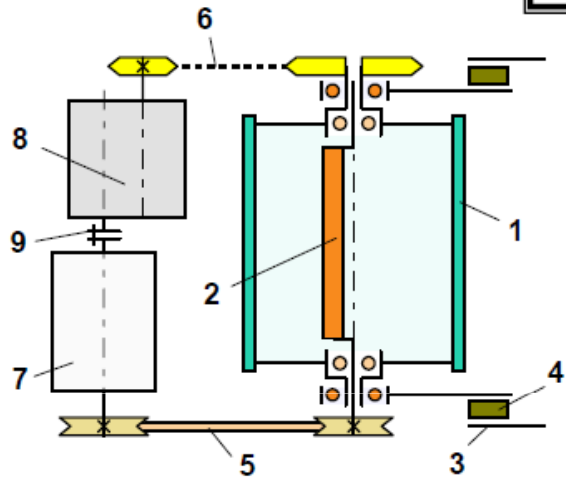
Effect of direction of rotation on the quality of compacted surface



Comparison of excitation methods

Soil compactors

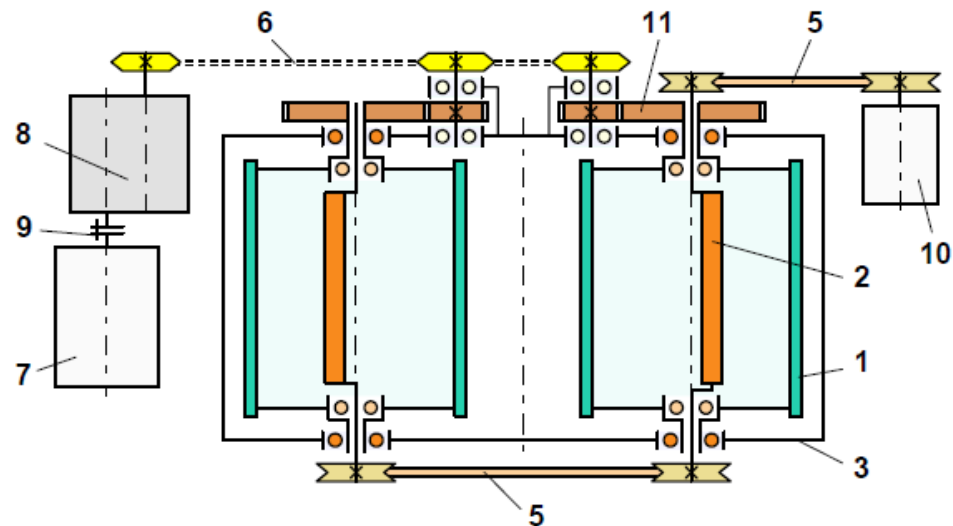
Vibratory roller drives



Roller Compactor: low working speed ($v = 5 \dots 20 \text{ km/h}$)
 Mechanic drive: gear-down unit (cogwheel gear, chain drive)
 Hydraulic drive: low r/min hydro-motor, high driving torque

Excentric axle: high r/min value is needed for excitation
 and for efficient compaction ($n = 2400 \dots 4500 \text{ r/min}$)

1. vibrating roller
2. excentric axle
3. carriage (frame)
4. rubber spring
5. V-belt drive
6. chain drive
7. engine
8. gear-down unit
9. clutch
10. exciting motor
11. cogwheel gear



Double engine drive (both roller wheels are driven)

Soil compactors

Vibratory roller remote control

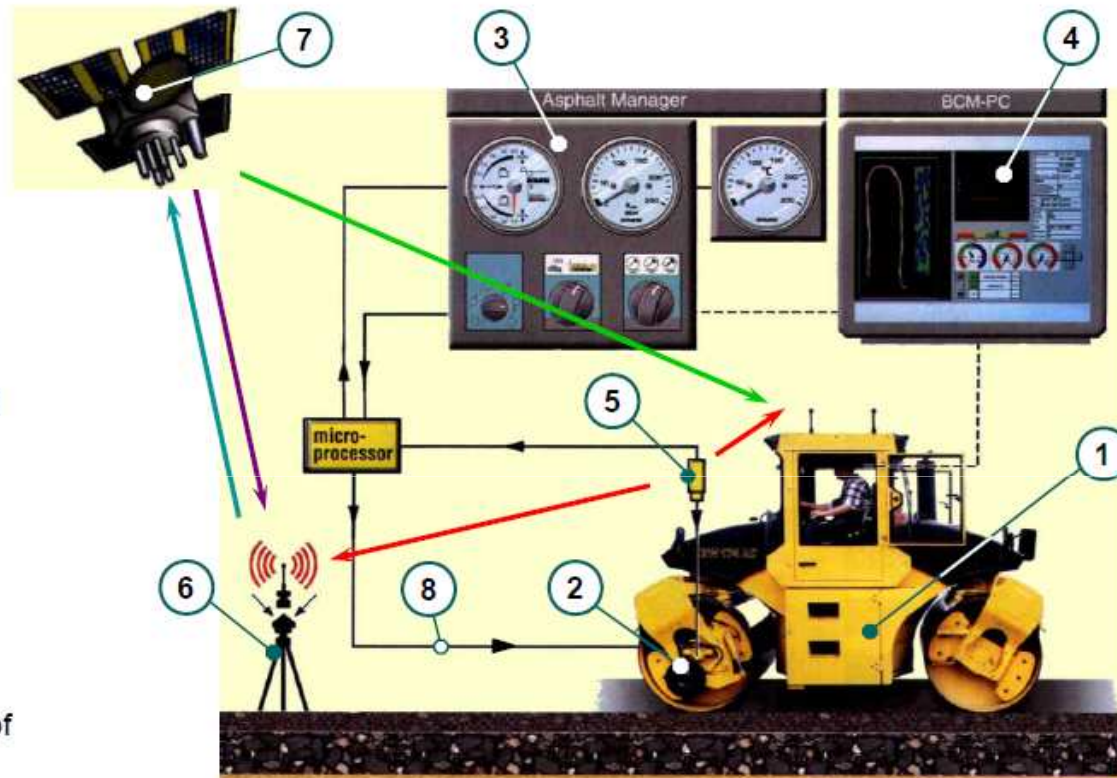
1. vibro roller
2. exciter unit
3. controlling unit
4. monitor
5. acceleration sensor
6. radio receiver-transmitter
(database + controlling-monitoring system)
7. satellite
8. adjusting direction angle

Controlling parameters:

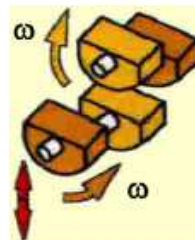
dynamic elastic modulus of material to be compacted
(via measuring acceleration)

Controlled parameters:

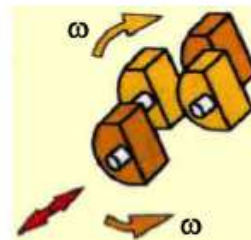
vertical excitation force (F_{ve})
frequency of vibration
working direction of the unit



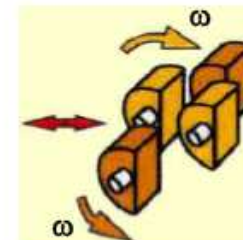
$F_{ve} = \text{MAX}$



F_{ve}



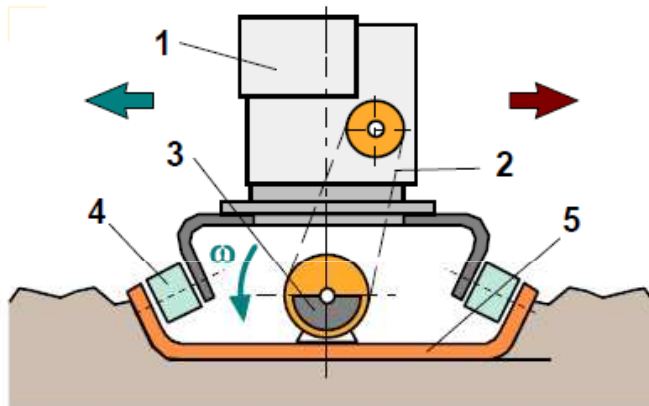
$F_{ve} = 0$



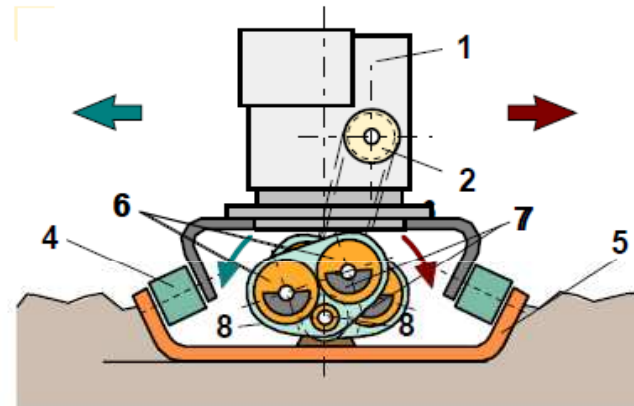
Soil compactors

Vibro-plates

Circular excitation
(changing direction of rotation)

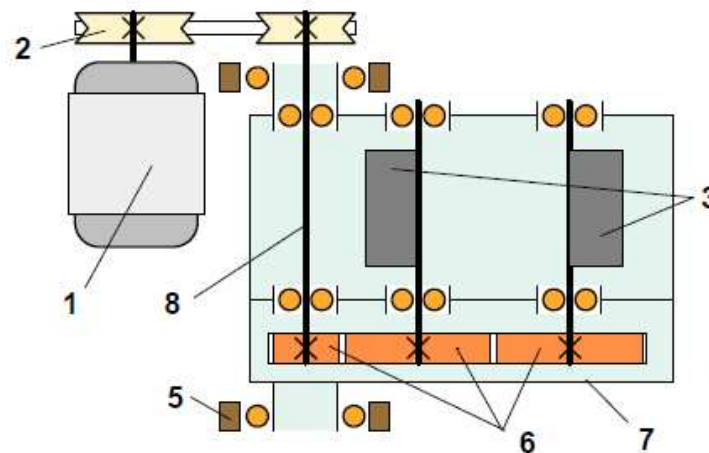


Directed excitation
(changing angle of direction)

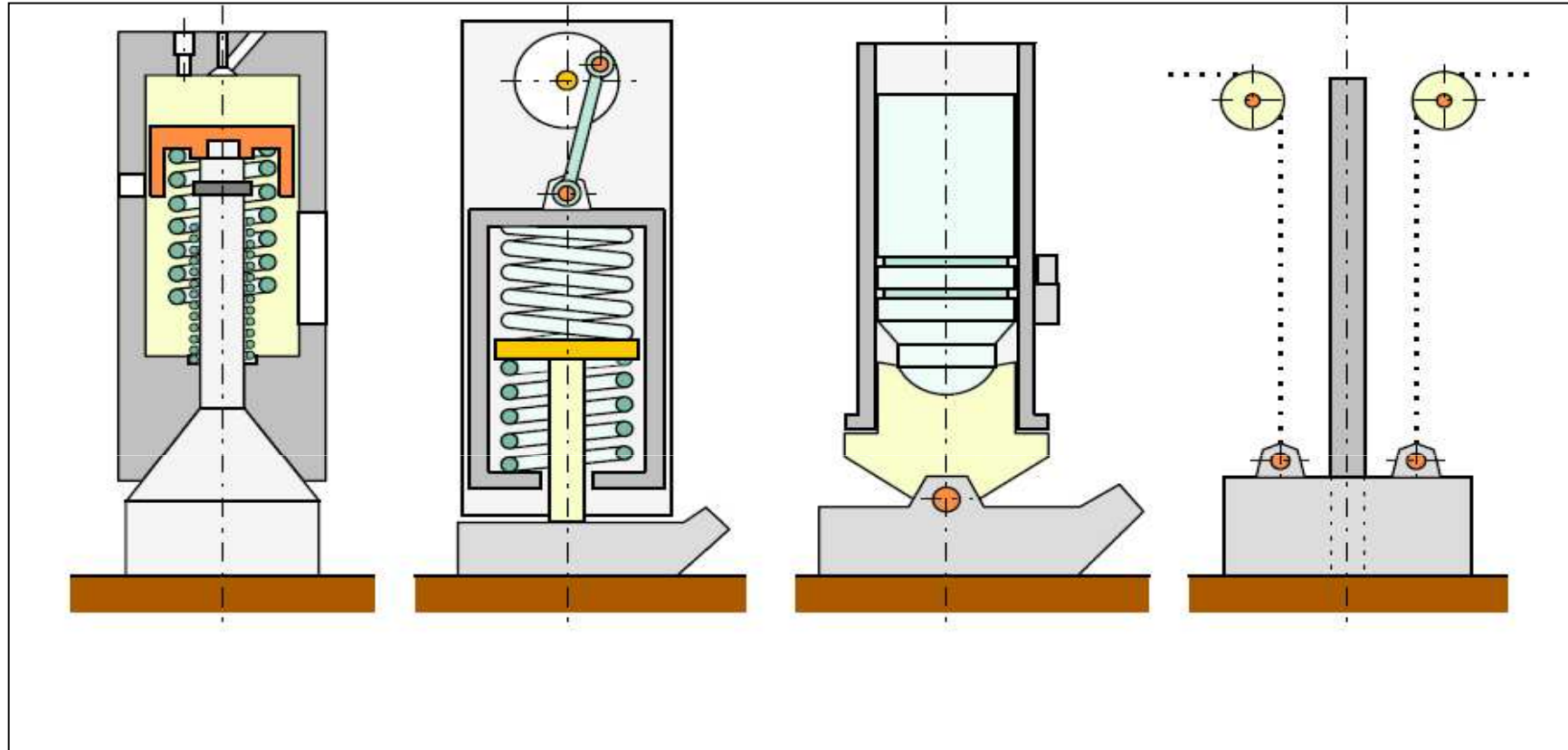


Exciter unit drive

1. engine
2. V-belt drive
3. exciting mass
4. rubber spring
5. compactor plate
6. cogwheel
7. exciter unit
8. layshaft



Soil compactors



Diesel engine
tamper

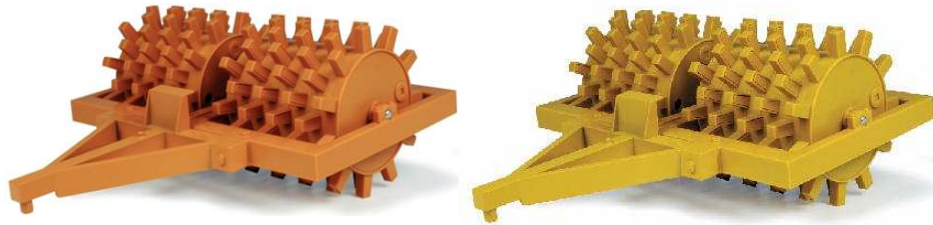
Electric tamper

Beater-piston
rammer

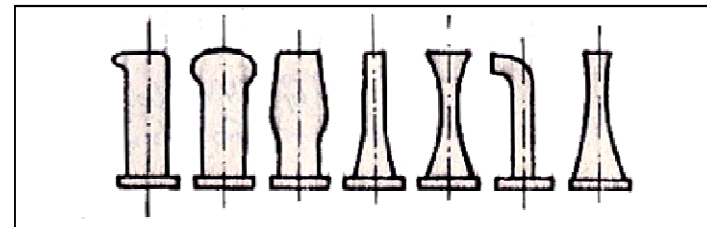
Dropping weight
compactor

Tampers can be used for to compact nearly all types of soil. Thickness (depth) of layer can be compacted effectively is about 40 cm. Compaction frequency is between 2 and 15 Hz.

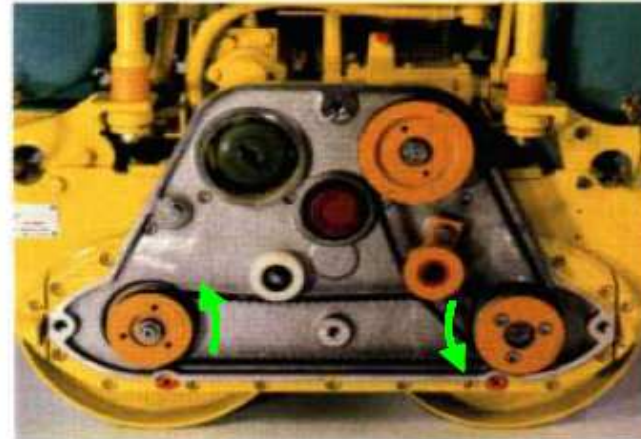
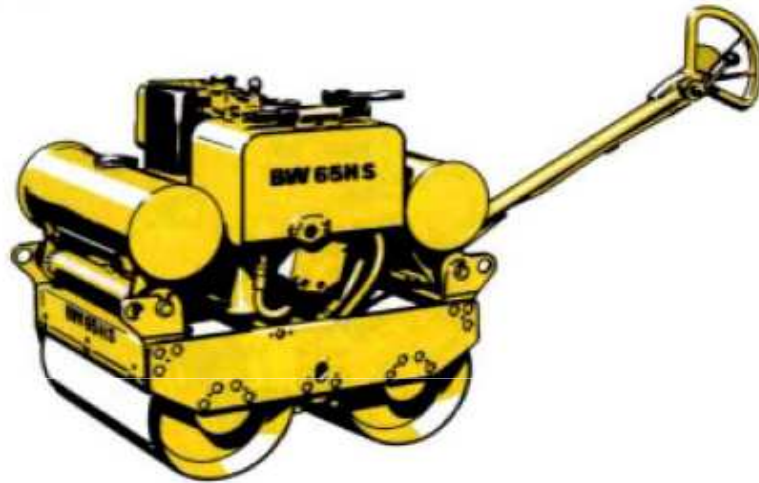
Soil compactors



- Cammed wheels*
- Static and vibration
- **On a wet surface** (clay with stones)
- To dry the terrain!
- We can change the weight of the drums with sand and water filling.
- With steel and rubber wheel

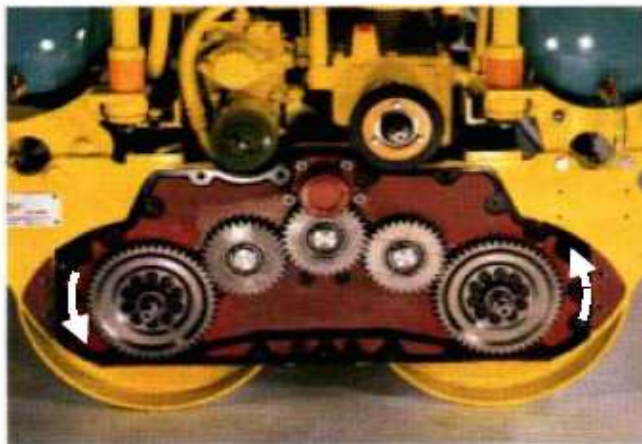


Soil compactors



Gerjesztő tengely hajtása

- a forgásirány azonos,
 - az excenterek helyzete ellentétes,
- Következmény: „Kettősvibráció”



Haladómű hajtása

