BHU
CONSTRUCTION TECHNOLOGY AND MANAGEMENT
BSc. Program - Year III (Regular)

CONSTRUCTION EQUIPMENT AND PLANT MANAGEMENT

CHAPTER-3

PART-1

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- *Earth Work Equipment*



- *Crane Shovel Family*
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- *Grading Equipment*
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- *Hauling Equipment*







CONSTRUCTION EQUIPMENT

1. Introduction

Classification of Construction Equipment

- Generally equipment types can be classified into ***Productive*** and ***Support equipments***.
  - I. ***Productive equipment*** are those units that alone or in combination lead to an end product which can be recognized as a unit for payment;
    - Include pavers, haulers, loaders, rollers etc.
  - II. ***Support equipment*** are those equipments which are required for operations related to the placement of construction such as movement of personnel and materials, and activities that influence the placement of environment.
    - Include represented hoists, lighting sets, vibrators, scaffolds as typical support equipments

Construction Equipment

1. Introduction

Classification of Construction Equipment

- Another way of classifying construction equipment can also be based on whether the construction is a ***heavy*** or ***light*** construction works or services.
  - I. ***Heavy***: Road and Hydro Power works, Large Irrigation schemes, Water Supply and Sewage plants and High Rise buildings and often called ***equipment intensive***.
  - II. ***Light***: Low rise buildings, water supply and sewerage lines, electric and telecommunication lines and small irrigation schemes and called ***labor intensive*** services.

Construction Equipment

1. Introduction

Classification of Construction Equipment

- For the purpose of this course two major classifications of equipments largely based on the ***type of works*** involved are covered.

I. Construction Equipment

- ***Earth works equipment:*** Bulldozers, Shovels, Clamshells and Draglines, Loaders, Graders, Scrappers, Rollers, Drills, Grouting pumps, Pile driving and Hammers.
- ***Hauling and Hoisting equipment –*** Tractors, Normal and Dump trucks, Scrapers, Hoists, Conveyors and Cranes.
- ***Compaction and stabilization equipment***- Compactors
- ***Foundation Equipment*** - Pile Driving Equipments
- ***Pumping Equipment*** - Pumps, Hoses, Pipes, and Compressors.
- ***Concreting equipment –*** Mixers, Vibrators
- ***Tunnelling equipment –*** TBM
- ***Drilling and blasting equipment***

Construction Equipment

1. Introduction

Classification of Construction Equipment

II. Construction Plants

- Aggregate production plants,
  - Crushers, Screens, Conveyors, and Feeders.
- Asphalt mixing plant and
  - Aggregate Batchers, Bitumen Emulsifier, and Mixers.
- Concrete Batching Plant
  - Feeders, Mixers and Si





Construction Equipment

2. Earth Work Equipment

- Earth work includes:
  - Site preparation, excavation, loading, hauling
  - Embankment construction,
  - Backfilling, dredging,
  - Preparing base course,
  - Sub-base and sub-grade,
  - Compaction, road surfacing
- All the above works involve the use of a large number of highly efficient and versatile equipment.

Construction Equipmen

2. Earth Work Equipment

- Earth work equipments are broadly classified into ***earth moving, compaction, grading*** and ***hauling equipment***.

Earth Work

- ***Definition***:- Earth work is a process of moving soil or rock from one location to the other and processing it, so that it meets construction requirements of location, elevation, density, moisture content, etc.

- The ***proper selection*** of these equipment and the ***length of time*** they will have to be used are an essential part of the estimator's work.

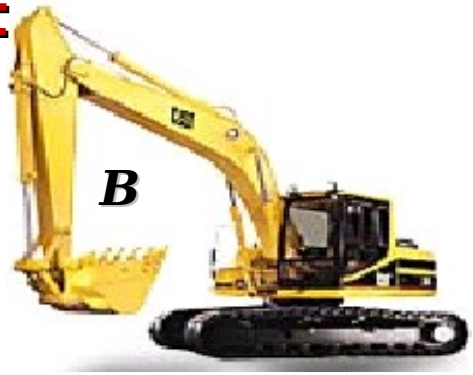
Construction Equipment

2. Earth Work Equipment

- Excavators
- Loaders
- Shovels
- Clamshells
- Draglines
- Scrapers
- Dumpers
- Dozers
- Graders
- Rollers



A



B



C



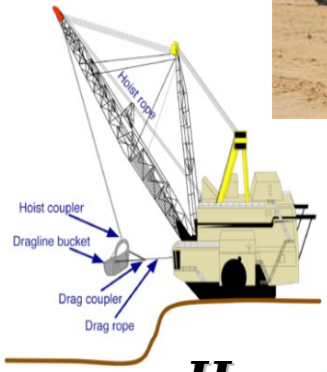
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E



F



H



G



I



J

Construction Equipment

2. Earth Work Equipment

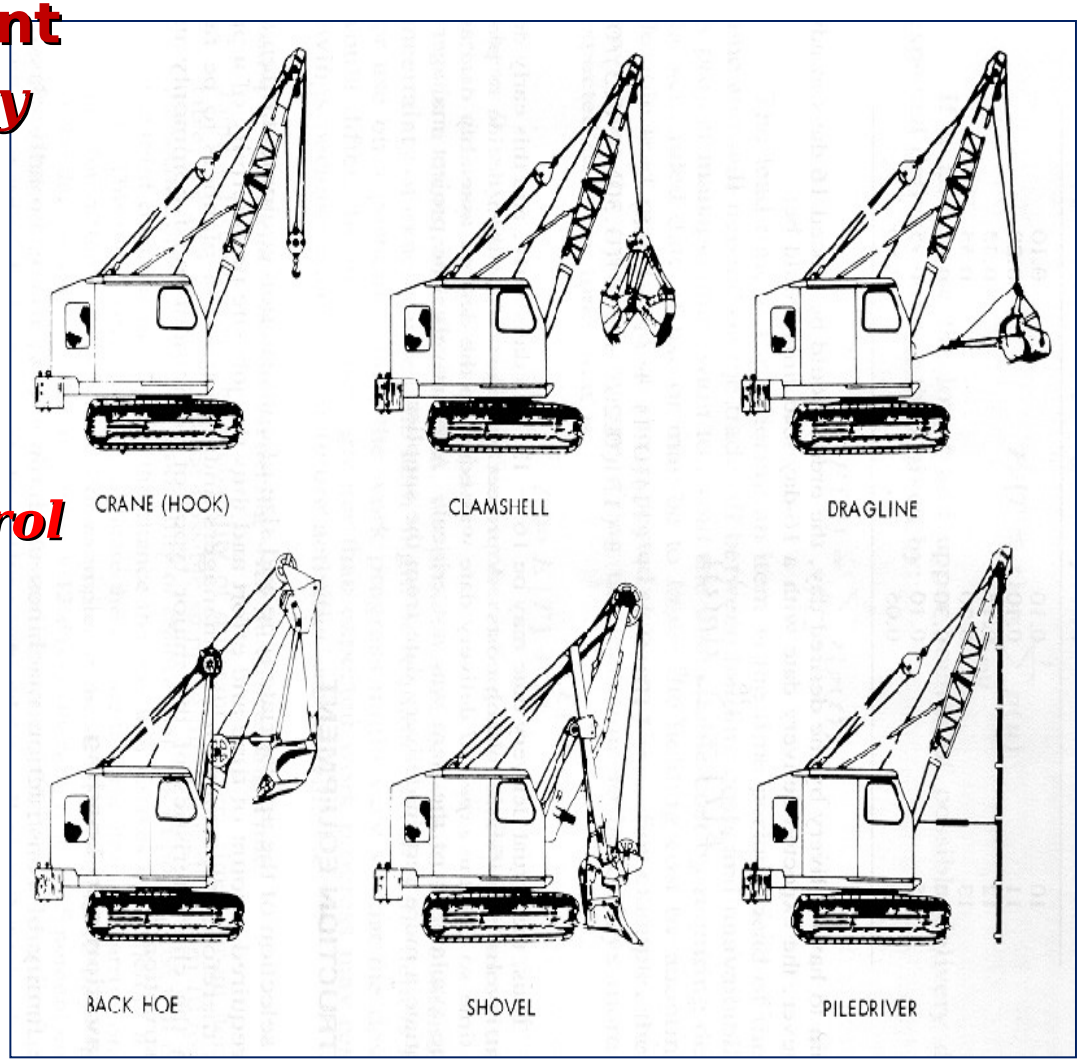
Kinds of Work	Equipments
Clearing	Bulldozer, Rakedozer, Backhoe, Chipper
Excavating	Shovel (Backhoe, Dragline, Clamshell) Bulldozer, Ripper, Rock breaker
Loading	Wheel Loader, Track Loader Loading shovel (Front shovel)
Excavating / Loading	Power shovel (Backhoe, Dragline, Clamshell) BWE(Bucket Wheel Excavator)
Excavating / Hauling	Bulldozer, Scrapedozer, Scraper
Hauling	Dump truck (Rigid, Articulated), Wagon, Conveyer Clowler dump
Spreading / Grading	Bulldozer, Wheel dozer, Motor grader
Compacting.	Tire roller, Steel roller, Vibration roller, Tamping roller, Vibration compactor, Tamper, Bulldozer
Trenching	Trencher, Backhoe
Maintaining macadam road	Motor grader
Slant finishing	Backhoe, Motor grader
Rock Braking	Drill, Breaker, Spliter

Construction Equipment

2. Earth Work Equipment

2.1 Crane Shovel Family

- Common Features
  - ***Mounting***
    - Crawlers/Tracks
    - Wheels
    - Tracks
  - ***Superstructure or control room***
  - ***Front end attachment***





2. Earth Work Equipment

2.1 Crane Shovel Family

A. Face Shovel

- Face shovel is an equipment used mainly in quarries, pits and on construction sites to excavate and load blasted rock.
- These equipments are more effective for excavations above the ***wheel or grade level.***
- The basic parts of a power shovel include the mounting, cab, boom, dipper stick, dipper (bucket), and hoist line.
- ***Optimum depth of cut***: is that depth which produces the greatest output and at which the dipper comes up with full load without undue crowding.
  - The depth varies with the class of soil and the size of the dipper.
- It may cost about 10 Million ETB

Construction Equipment

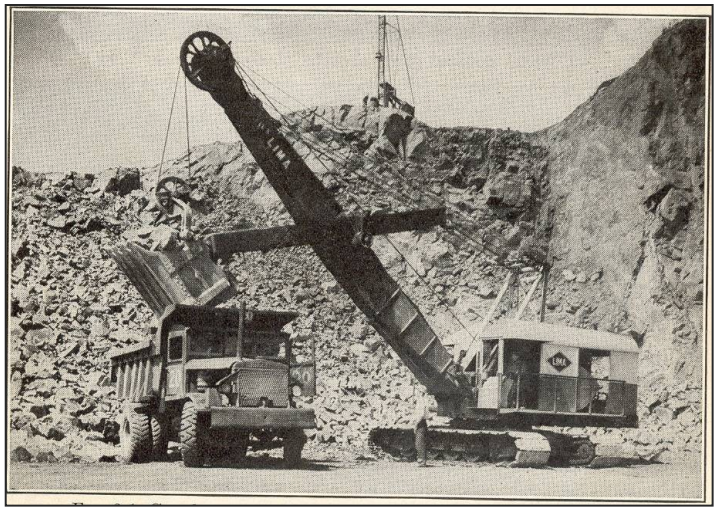
2. Earth Work Equipment

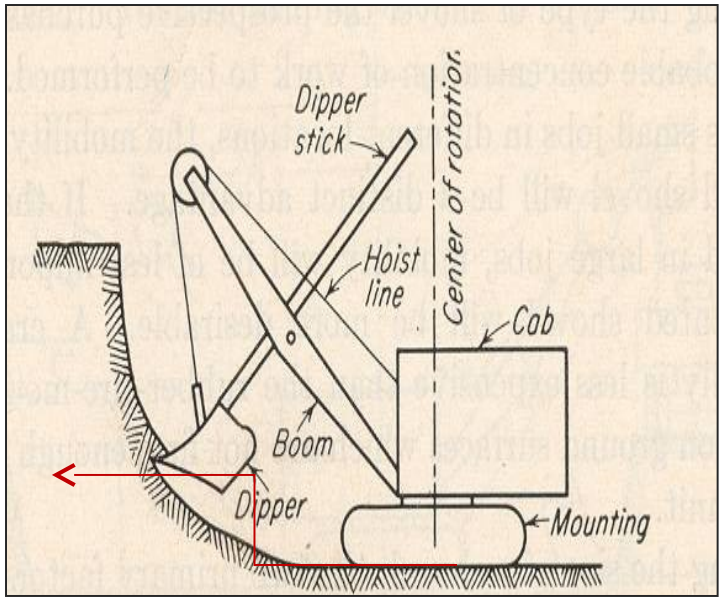
2.1 Crane Shovel Family

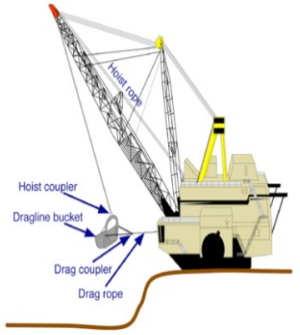
A. Face Shovel

- The output of a shovel is affected by numerous factors, including the following:
  - Class of material,
  - depth of cut,
  - angle of swing,
  - job conditions,
  - management conditions,
  - size of hauling units,
  - skill of operator and
  - physical condition of the shovel.







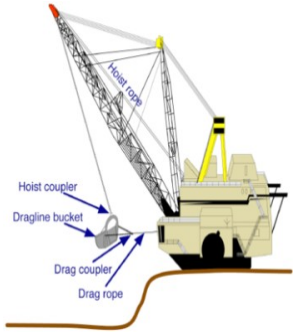


2. Earth Work Equipment

2.1 Crane Shovel Family

B. Drag Line

- Draglines are used to excavate earth and load it into hauling units, such as trucks or tractors-pulled wagons, or deposit it into levees, dams and spoil banks near the pits from which it was excavated.
- These equipment are more efficient for excavation below the grade level and have the longest reach of all shovel equipment.
- A dragline can be used for dragging out sediments and is efficient for under water construction.
- These equipment are weak while excavating hard materials and have a lesser productivity than a face shovels.

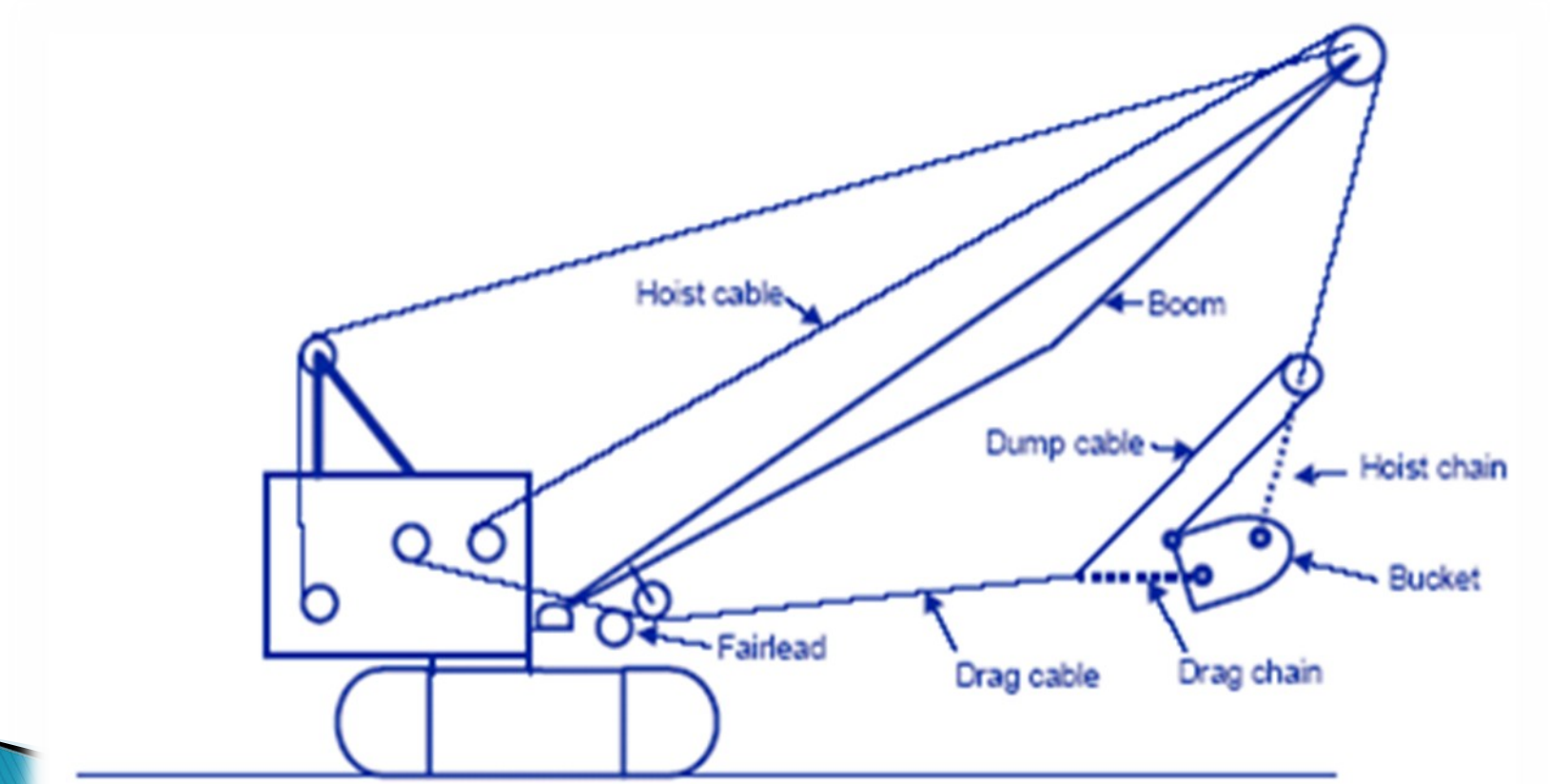


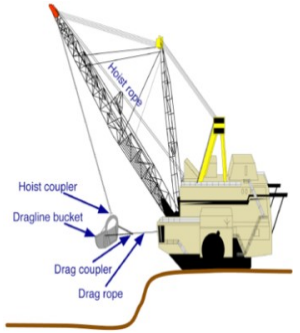
2. Earth Work Equipment

2.1 Crane Shovel Family

B. Drag Line

- Basic Components of a drag line





2. Earth Work Equipment

2.1 Crane Shovel Family

B. Drag Line

- ***Types of Drag Lines***: Drag lines may be divided into three types:
  - Crawler-mounted
  - Wheel-mounted, self-propelled
  - Truck-mounted
- ***Crawler-mounted draglines*** *can operate* over soft ground conditions that would not support wheel or truck - mounted equipment.
  - The travel speed of a crawler machine is very slow, frequently less than 1 mph,
  - It is necessary to use auxiliary, hauling equipment to transport the unit from one job to another.
- ***Wheel and track-mounted*** units may have travel speeds in excess of 30 mph.

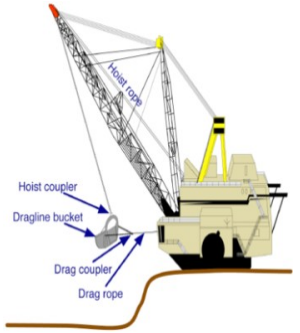
Construction Equipment

2. Earth Work Equipment

2.1 Crane Shovel Family

B. Drag Line

Size of a Drag Line

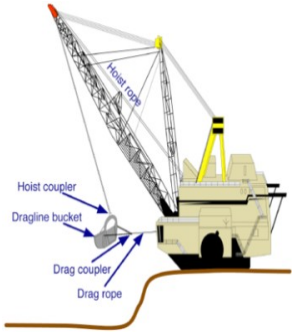


- The size of a dragline is indicated by the size of the bucket, expressed in cubic meter (cu m).
- Most draglines may handle more than one size bucket, depending on the length of the boom utilized and the class and weight of the material excavated.
- Since the maximum lifting capacity of a dragline is limited by the force which will tilt the machine over, it is necessary to reduce the size of the bucket when a long boom is used or when the excavated material has a high unit weight.
- In practice, the combined weight of the bucket and its load should not be greater than 75% of the force required to tilt the machine.

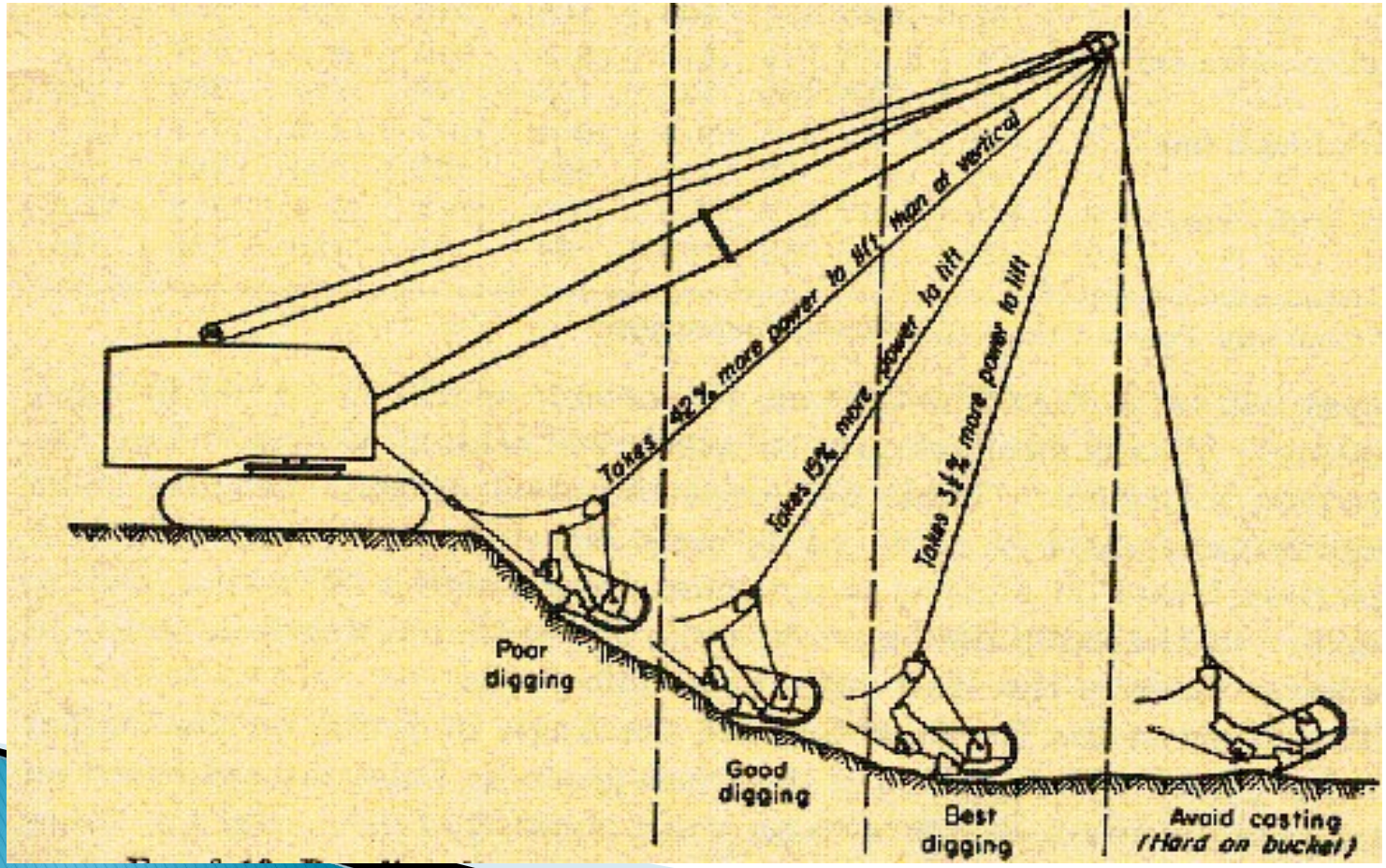
2. Earth Work Equipment

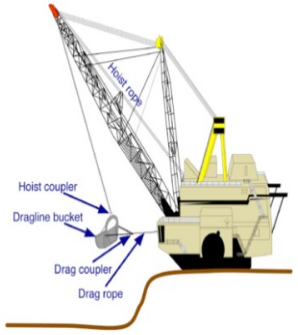
2.1 Crane Shovel Family

B. Drag Line



Operation of a Drag Line





2. Earth Work Equipment

2.1 Crane Shovel Family

B. Drag Line

Output of drug lines

- The output of drag lines will vary with the following factors
  - Class of material
  - Depth of cut
  - Angle of swing
  - Size and type of bucket
  - Length of boom
  - Method of disposal, casting, or loading
  - Size of the hauling units, when used
  - Skill of the operator
  - Physical condition of the machine
  - Job conditions





2. Earth Work Equipment

2.1 Crane Shovel Family

C. Clamshells

- Clamshells are used primarily for ***handling loose materials*** such as sand, gravel, crushed stone, coal, etc. and for removing materials from inside cofferdams, pier foundations, sewer manholes, sheet-lined trenches, etc.
- They are specially suited to ***vertically lifting materials*** from one location to another, as in charging hoppers and overhead bins.
- The limits of vertical movements may be relatively large when they are used with long crane booms.
- Clamshell buckets are available in various sizes, and in ***heavy-duty types*** for digging, ***medium-weight types*** for general-purpose work and ***lightweight types*** for rehandling light materials.
-

Construction Equipment



2. Earth Work Equipment

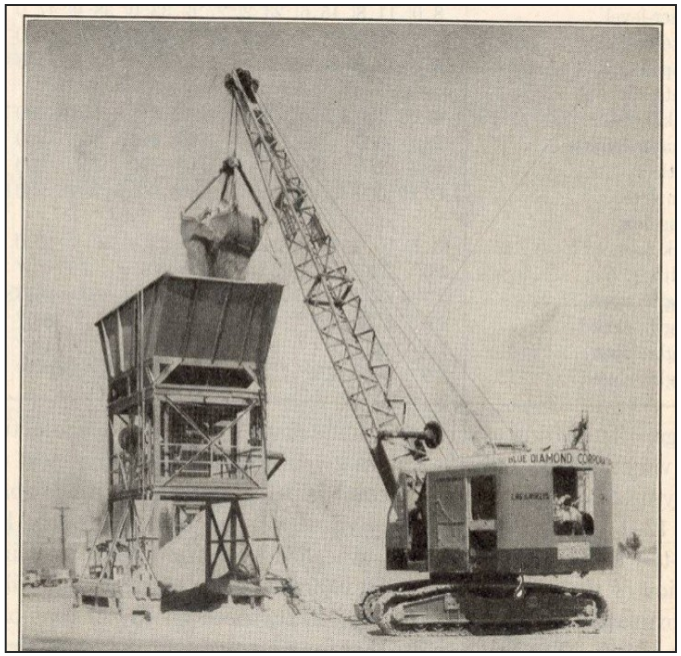
2.1 Crane Shovel Family

C. Clamshells

- Manufacturers supply buckets either ***with removable teeth*** or ***without teeth***.
- Teeth are used in digging the harder types of materials but are not required when a bucket is used for re-handling purposes.









2. Earth Work Equipment

2.1 Crane Shovel Family

C. Clamshells

- The capacity of a clamshell bucket is usually given in cubic meter.
- The variable factors affecting operations include:
  - The difficulty of loading the bucket,
  - The size load obtainable,
  - The height of lift,
  - The angle of swing,
  - The method of disposing of the load, and
  - The experience of the operator.

2. Earth Work Equipment

2.1 Crane Shovel Family

D. Hoes

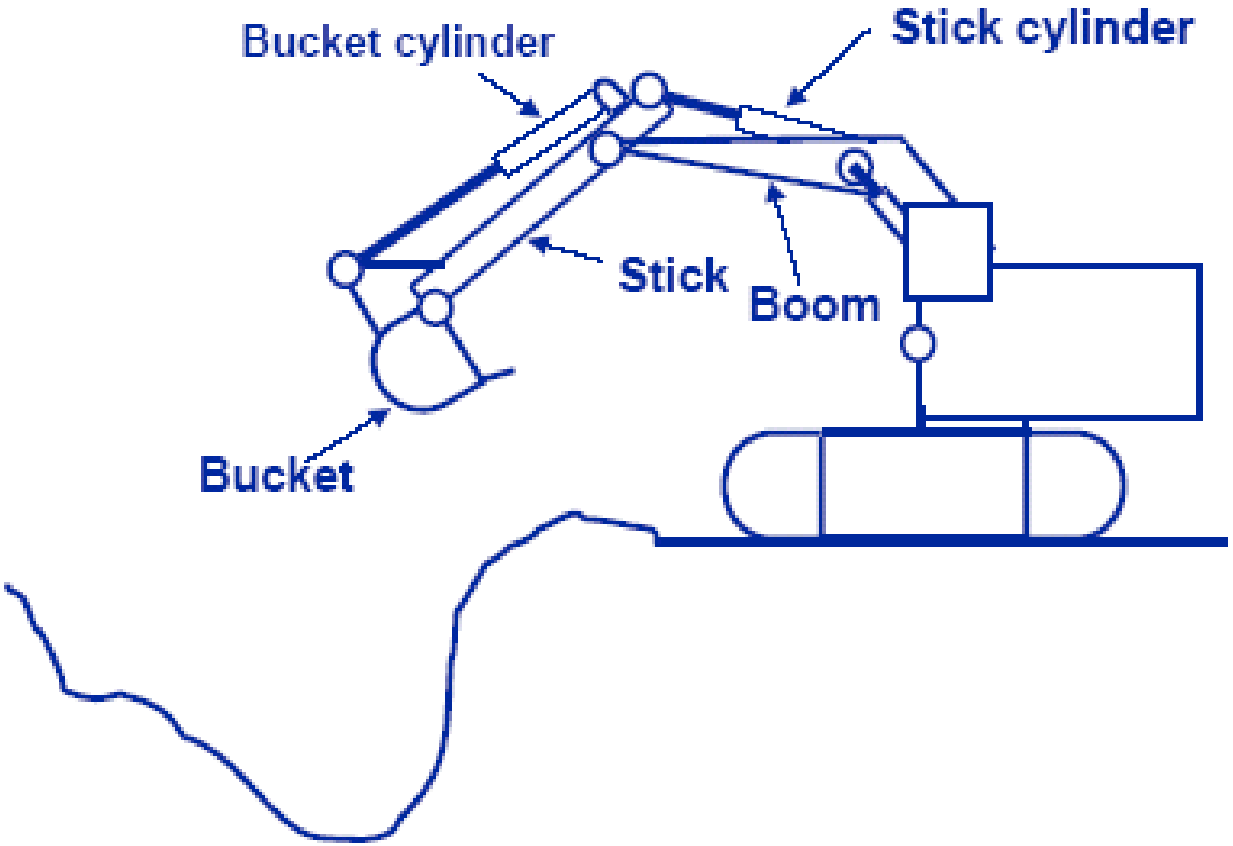
- Hoes are used primarily to excavate below the natural surface of the ground on which the machine rests.
- hoe is sometimes referred to by other names, such as ***backhoe*** or ***back shovel***.
- They are adapted to excavating trenches, pits for basements, and general grading work, which requires precise control of depths.
- Because of their rigidity they are superior to draglines in operating on close-range work and dumping into trucks.
- Because of the direct pull on the bucket, backhoes may exert greater tooth pressures than face shovels.
- In storm drain and utility work the hoe can perform the trench excavation and handle the pipe, eliminating a second machine.

2. Earth Work Equipment

2.1 Crane Shovel Family

D. Hoes

Basic component of backhoes



Construction Equipment

2. Earth Work Equipment

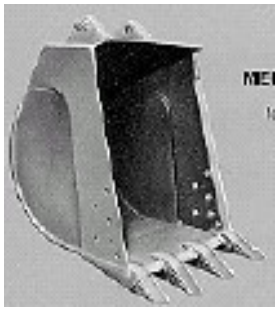
2.1 Crane Shovel Family

D. Hoes

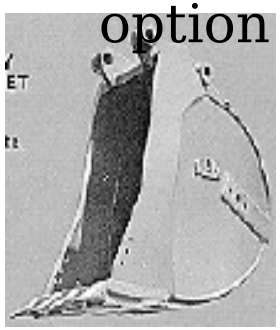
Hoe Buckets

- There are special buckets for everything from light sand to hard rock digging.

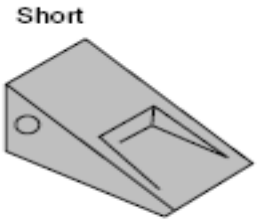


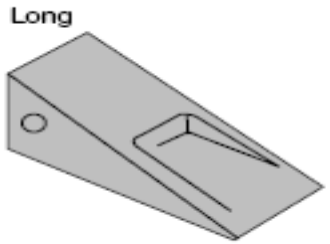


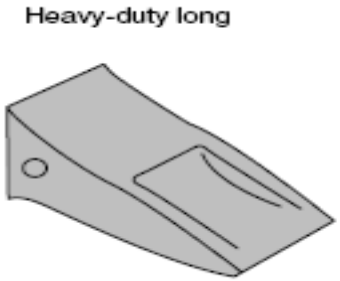


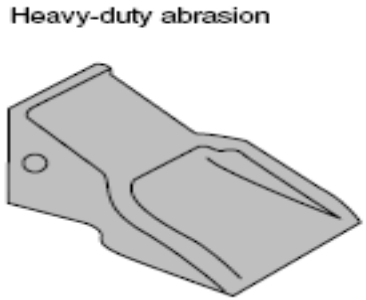


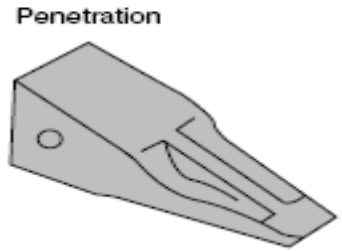
Bucket option











Teeth option

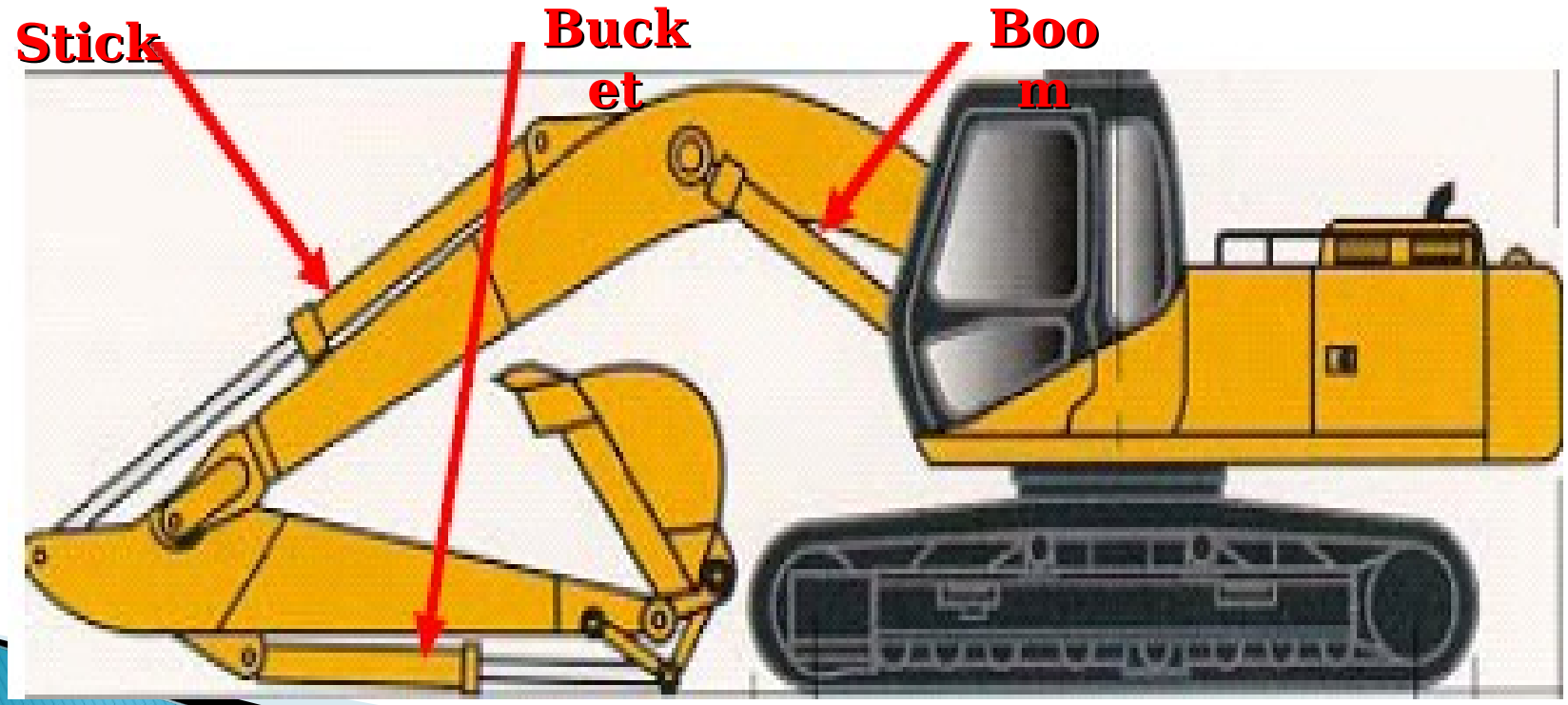
2. Earth Work Equipment

2.1 Crane Shovel Family

D. Hoes

Hydraulic Hoes

- Bucket penetration (break out force) is developed by the ***hydraulic cylinders*** of the ***boom***, ***stick*** and ***bucket***.



Construction Equipment



2. Earth Work Equipment

2.1 Crane Shovel Family

D. Hoes

Hydraulic Hoe Types

- The hoe can be track or wheel mounted





CONSTRUCTION EQUIPMENT



2. Earth Work Equipment
2.1 Crane Shovel Family
D. Hoes





2. Earth Work Equipment

2.1 Crane Shovel Family

Comparison between the shovel family

Comparison between the shovel family members:

No.	Parameters of comparison	Face shovel	Dragline	Backhoe	Clamshell
1	Operation in hard soil or rock	Good	Poor	Good	Good
2	Reach distance b/n machinery and digging point	Small	Longest	Small	Long
3	Loading efficiency on vehicles	Very good	Fair	Fair	Precise but slow
4	Digging Level	Mainly above grade level	Below its grade level	Below its grade level	At, above or below grade level

Construction Equipment



2. Earth Work Equipment

2.2 Heavy Earth moving Equipment

A. Excavators

- Replaced the cable operated crane shove family
- Excavators are basically digging machines, having the following three main components
  - An ***undercarriage*** to give mobility. This may be crawler track mounted or wheel mounted.
  - A ***superstructure*** with operator's cabin mounted on either a slew ring to traverse through 360° or on a rigid frame.
  - Hydraulically articulated ***boom*** and ***dipper arms with bucket***.
- Excavators are designed to excavate below the ground surface on which the machine rests.
- Good mobility and versatility and excellent for general-purpose work, such as excavating trenches and pits.



2.2 Heavy Earth moving Equipment

A. Excavators

Basic Parts of Excavator

Arm
This part functions same as our lower arm; from the elbow to the wrist.

Boom
This part functions like our upper arm; from the shoulder to the elbow.

The important devices to make the machine move are stored here. They include fuel, oil, an engine, a motor, and other things.



Bucket
This part can be replaced with a drill type, scissors type, or other types.

Crawler
The crawler makes it possible for the machine to literally "crawl". It has no problem moving on very rough roads.



2.2 Heavy Earth moving Equipment

A. Excavators

- Functions of excavators:
  - Excavating – Earthworks
  - Loading Excavated Material
  - Scarification
  - Making of Drains
- Advantages of hydraulic excavators include:
  - Faster cycle time,
  - Higher bucket penetrating force,
  - More precise digging, and easier operator control.
  - Many attachments can be made to increase the versatility of the equipments.



2.2 Heavy Earth moving Equipment

A. Excavators

Types of excavators

- Excavators are of the following types based on the type of carriers on which they are mounted:
  I. Crawler mounted excavator
  II. Truck mounted excavator
  III. Self propelled excavator
  IV. Excavators mounted on barge or rail

I. Crawler mounted excavator:

- These excavators are mounted on the crawler system and are very suitable for carrying out large works in rough terrain.



2.2 Heavy Earth moving Equipment

A. Excavators

Types of excavators

I. Crawler mounted excavators:

- Crawler excavators have the following main characteristics;
  - Can be used for work on soft or wet grounds
  - Can be used on sharp rocks or other adverse conditions
  - These can climb steep grades (even up to 40 percent)
  - Requires very less turning space
  - Have very less speed for travelling
  - Can be shifted from one site to another only on trailors





2.2 Heavy Earth moving Equipment

A. Excavators

Types of excavators

II. Truck mounted excavators:

- These excavators are mounted on truck chassis and has the following main characteristics:
  - High road speed and mobility is the main advantage.
  - Lower stability over sides and hence require counter-weight or outriggers.
  - Require more operating space.
  - Tyres or outriggers give high ground pressure and hence it requires firm and smooth operating locations.
  - Have two engines and two cabs, separately for truck chassis and excavator.



2.2 Heavy Earth moving Equipment

A. Excavators

Types of excavators

III. Self propelled excavators:

- These excavators are self propelled and has rubber tyres. The main characteristics are:
  - Medium travel speed generally between 10-30 Km per hour.
  - Has one engine and one cab for control by one operator.

IV. Excavators on barge or rail:

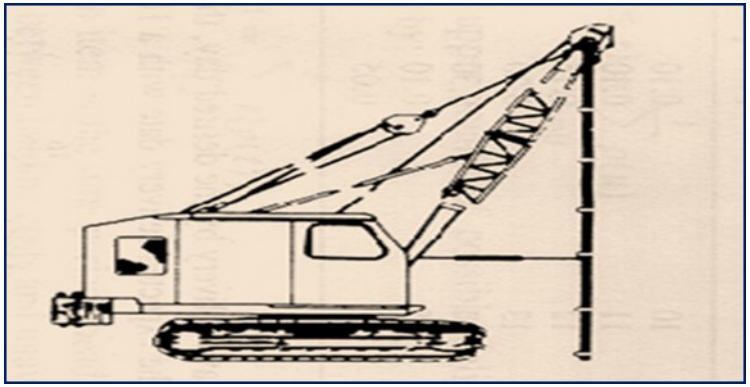
- These excavators are mounted on barge or rail to carry out work of excavation in water or near railway line respectively.

2.2 Heavy Earth moving Equipment

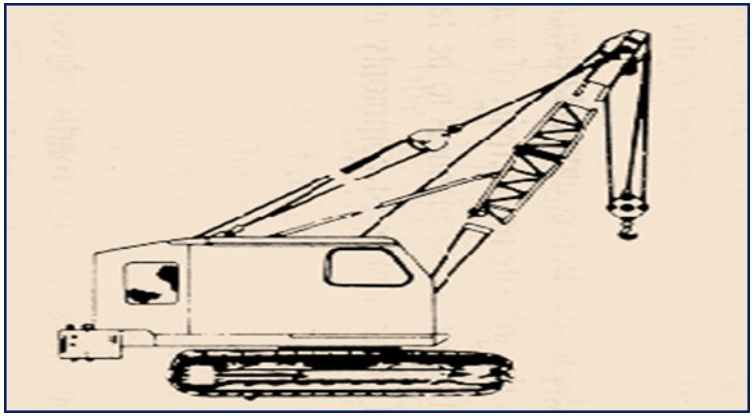
A. Excavators

Common attachments

- Some common attachments include:
  - ***Augers***: Drills holes for poles, posts, soil sampling, and ground improvement
  - ***Jack Hammer***: vibratory hammer used to break up concrete and rock.
  - ***Bucket Ripper***: The bucket sides and bottom are lined with ripper teeth to break up hard soil or soft rock.
  - ***Thumb Bucket***: attached to bucket to provide a hook capacity.









2.2 Heavy Earth moving Equipment

B. Loaders

- A bucket is attached to the arms and capable of being raised, lowered, and dumped through mechanical or hydraulic controls.
- The loaders having bucket in the front, known as "***front end loaders***" are very common.
- The loaders are versatile, self propelled equipment mounted either on crawler or wheel-type running gear.
- These are equipments used primarily:
  - To load excavated materials to a hauling unit,
  - Excavate soft to medium materials,
  - Loading hoppers,
  - Stockpiling materials,
  - Backfilling ditches, and
  - Moving concrete and other construction materials.



2.2 Heavy Earth moving Equipment

B. Loaders

Basic Parts of a loader





2.2 Heavy Earth moving Equipment

B. Loaders

Types of Loaders

- Loaders are of the following two types:
  - Crawler loaders
  - Wheel Loaders





2.2 Heavy Earth moving Equipment

B. Loaders

Types of Loaders

I. Crawler loaders

- Crawler track types are generally preferred for digging and loading jobs where ground conditions are poor and low pressure characteristics are required.
- They are preferable for applications involving rock and sharp stony ground as there is no possibility of tyre damage.
- These are best employed for short moves between loading and dumping points.
- They should be transported from one site to another after loading on the trailors.



2.2 Heavy Earth moving Equipment

B. Loaders

Types of Loaders

II. Wheel loaders

- As a result of the development of more capable power trains (axel and tires), there was a steady trend towards wheel loaders at the expense of crawlers.
- Wheel loaders are generally ***four wheel drive***. However, for handling light jobs on good ground conditions ***two-wheel drive*** varients are also used.
- ***Four wheel drive loaders*** are generally used for ***construction jobs***, whereas, ***two wheel drive loaders*** are used for ***bulk handling*** of coal, cement, fertilizer etc.



2.2 Heavy Earth moving Equipment

B. Loaders

II. Wheel loaders

- From manoeuvrability point of view, wheel loaders are of
  - A. Articulated type (Pivot steer)
  - B. Rigid frame- two wheel steer or all wheel steer.

A. Articulated type of loaders

- They are hinged in the middle of the front and rear axels.
- Due to their ***operational characteristics*** and capability of ***working in limited space*** and ***short turning radius***, resulting higher speed of work, they have become popular.
- The articulation permits the loader to pivot 30-45 degree either side of the center.



2.2 Heavy Earth moving Equipment

B. Loaders

II. Wheel loaders

A. Articulated type of loaders

- Some advantage of articulated type of loaders are:
  - Quick manoeuvring and thereby easier spotting of loads
  - Less rolling resistance on turns
  - Better mobility on soft surface
  - Give better performance and high productivity.

B. Rigid frame type loaders

- These are comparatively cheaper than articulated frame type of loaders.
- Manoeuvring back and forth before dumping is required in most cases.
- Rigid frame loaders are of two types, namely two wheel steer and all wheel steer.

CONSTRUCTION EQUIPMENT



2.2 Heavy Earth moving Equipment

B. Loaders

II. Wheel loaders

- Some models of wheel loaders are designed as a combination of a backhoe and loader and often called ***backhoe loader***.





2.2 Heavy Earth moving Equipment

B. Loaders

Backhoe loader features

- Very common piece of equipment
- Many subcontractors own/lease
- Very versatile
- Easily transported
- “Low” maintenance costs
- Operator “friendly”
- Easily rented





2.2 Heavy Earth moving Equipment

B. Loaders

Operations

- Loaders are used to carry out the following main operations;

A. Loading

- Loading operation is the main operation performed by the loaders.
- Loading consists of scooping, lifting, turning and dumping materials such as sand, gravel, and crushed materials from stockpiles, bank or construction site into the hauling units.

B. Hauling

- Wheel loaders are excellent for moving loose materials over short distances to dump into hauling units, hoppers, conveyors, bins, or any other place of work in the construction site.



2.2 Heavy Earth moving Equipment

B. Loaders

Operations

C. Excavating

- Crawler loaders and heavy duty wheel loaders are excellent for many excavation jobs.
- These loaders can excavate as well as lift the excavated material and dump it into trucks or on the stockpiles

D. Clearing

- Loaders can scoop up and load the debris of demolished buildings into hauling units.
- Loaders are the first equipment to prepare the site for building and construction operations; and also the last equipment in order to backfill, spread, level and top with selected good soil.



2.2 Heavy Earth moving Equipment

B. Loaders

Attachments

- The following are main attachments which can be fitted to a wheel loader

a) Back filling attachment

- Back filling can be done with the bucket of this attachment when used with the loader.

b) Forklift attachment

- An industrial forklift when attached with the loader gives more stability, more tractive power and greater clearance than the normal.

c) Sweeping attachment

- A sweeping attachment can be fitted to a wheel loader for general cleaning of roads and parking areas in the industries.



2.2 Heavy Earth moving Equipment

B. Loaders

Attachments

- The following are main attachments which can be fitted to a wheel loader

d) Multi purpose bucket

- A multi purpose or four-in-one bucket can be used as a dozer, scraper, clamshell and a general purpose loading.

e) Ripper-scarifier a attachment

- These are mounted on the rear of the loader to loosen hard surfaces.

f) Miscellaneous other attachments

- A large number of attachments for specialized jobs are also available for fitting to the loaders. Some of these are pipe laying attachments, pole handling attachments, boom for loader crane set up.



2.2 Heavy Earth moving Equipment

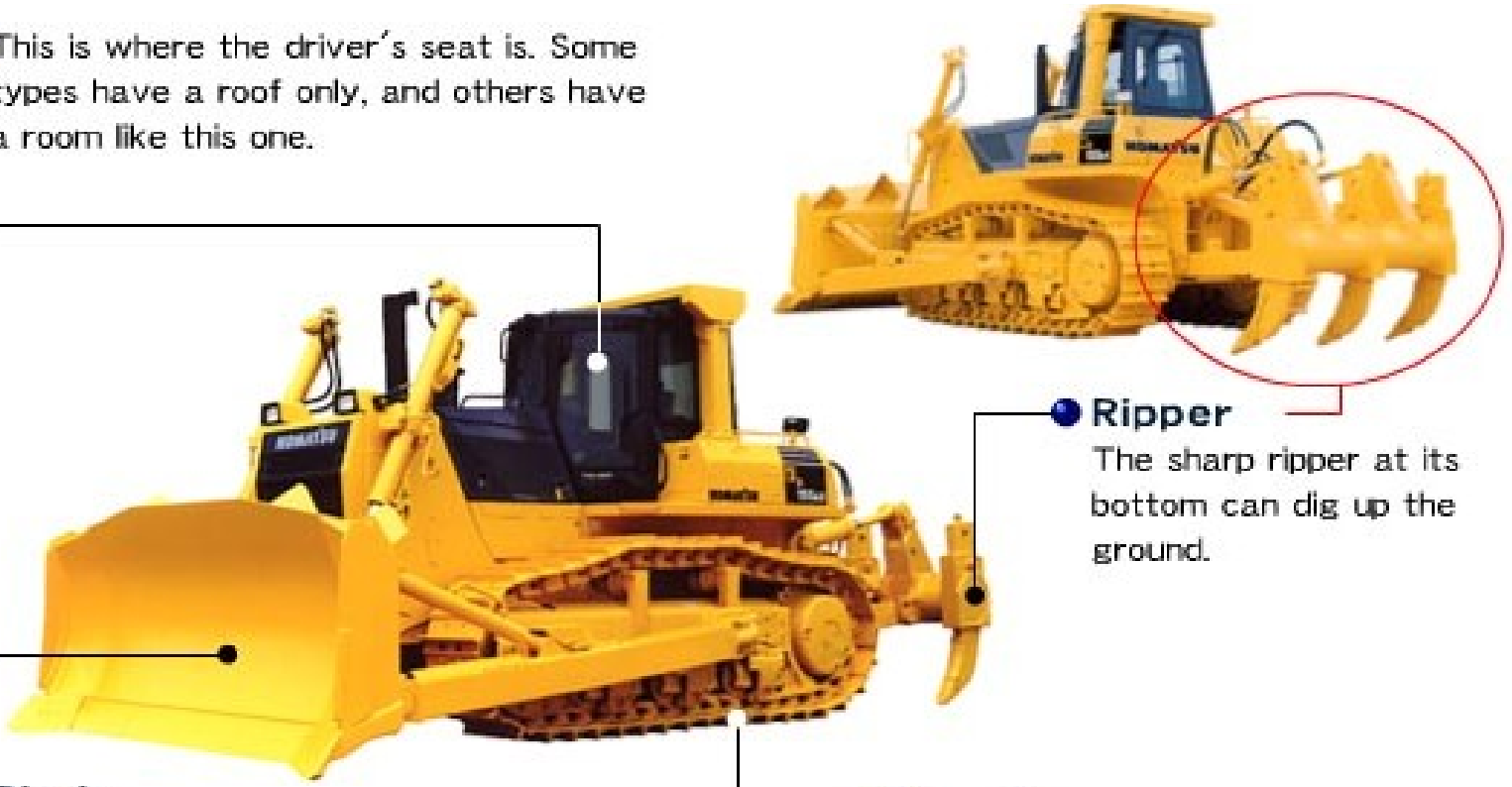
C. Dozers

- Dozers are machines designed primarily for ***cutting*** and ***pushing*** the material over relatively short distance.
- They consist of a tractor equipped with a ***front–mounted earthmoving blade*** controlled by ***hydraulic cylinders*** to vary the depth of cut.
- A dozer moves earth by lowering the blade and cutting until a full blade load of materials is obtained. It then pushes the material across the ground surface to the required location.
- Rear mounted hydraulic ***scarifiers*** and ***rippers*** can be fitted to loosen hard material prior to dozing.



2.2 Heavy Earth moving Equipment

C. Dozers





2.2 Heavy Earth moving Equipment

C. Dozers

Application of Dozers

- The following are the main dozer application
  - ***Clearing land*** of timber and stumps,
  - ***Opening up pilot roads*** through mountains and rocky terrain,
  - ***Moving earth*** for the haul distances up to approximately 100m,
  - ***Helping load*** tractor-pulled scrapers,
  - ***Spreading*** earth fills,
  - ***Backfilling*** trenches,
  - ***Side hill cuts***
  - ***Clearing*** construction sites of derbies, and
  - ***Maintaining*** haul roads.



2.2 Heavy Earth moving Equipment

C. Dozers

Application of Dozers



Moving earth



Helping scrappers



2.2 Heavy Earth moving Equipment

C. Dozers

Application of Dozers





2.2 Heavy Earth moving Equipment

C. Dozers

Dozer Blades

- A heavy blade of ***slightly concave profile*** is attached in the front of the tractor.
- The blades has a ***replaceable cutting edge***, which wears out with the use of the blade.
- The dozer blades are available in sizes from ***2m to 7.5m wide*** and ***0.8m to 1.5m height***.
- Dozer blades are of the following types:

A. ***U-Blade***: Used for moving ***big loads*** over ***longer distances***; curved shape and side and top extensions reduce the spillage of loose material; best suited for ***lighter materials***.



2.2 Heavy Earth moving Equipment

C. Dozers

Dozer Blades

B. ***Straight Blade***: Used primarily for ***shallow surface removal***, land clearing; designed to push dirt for short distances, versatile, lightweight and maneuverable, handles a wide range of materials.

C. ***Angle Blade***: It is designed to move material towards the sides of a cut, backfilling or cutting ditches, and sustainably reduces the amount of maneuvering.

D. ***C (cushion Blade)***: Used primarily with scrapers for ‘‘on the go’’ push loading; can be used for lighter excavation and other general tasks.

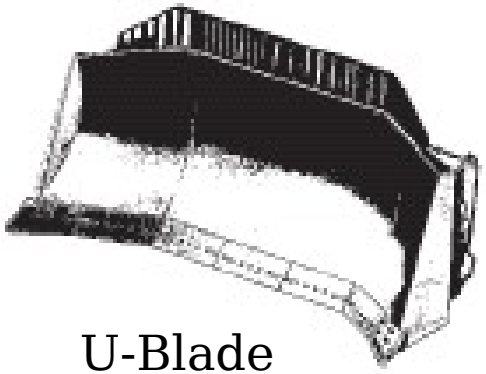
E. ***Land fill Blade***: These blades are specially designed to handie refuse and/or fill material.



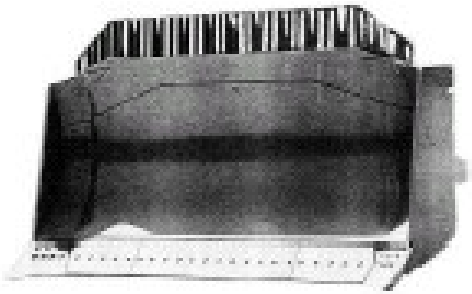
2.2 Heavy Earth moving Equipment

C. Dozers

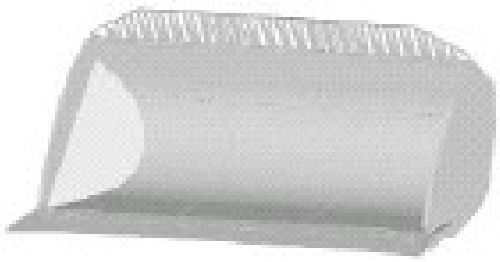
Dozer Blades



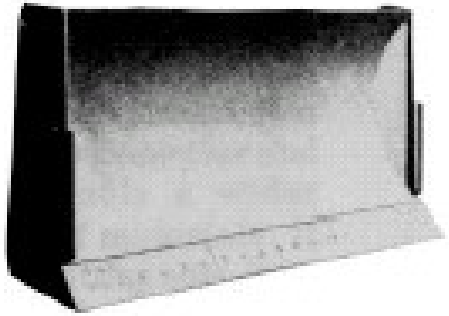
U-Blade



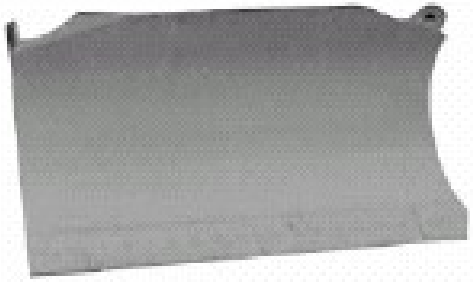
SU-Blade



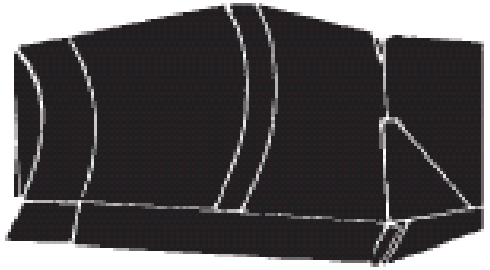
Carry Dozer “CD” Blade



Straight “S” Blade



Power Angle & Tilt Blade



Variable Radius “VR” Blade



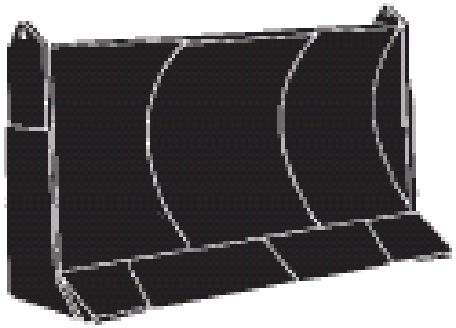
2.2 Heavy Earth moving Equipment

C. Dozers

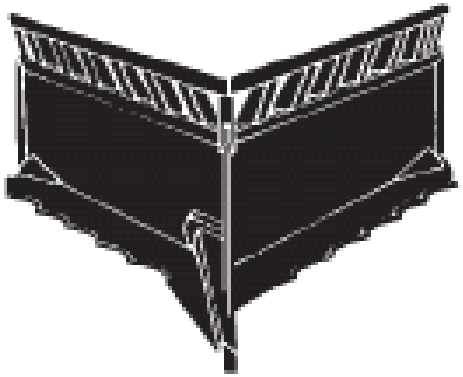
Dozer Blades



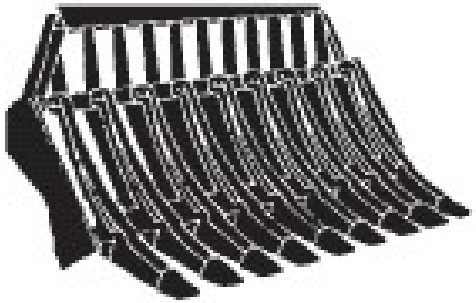
Angle “A”-Blade



Cushion “C”-Blade



V-Tree cutter - Blade



Rakes



K/G - Blade



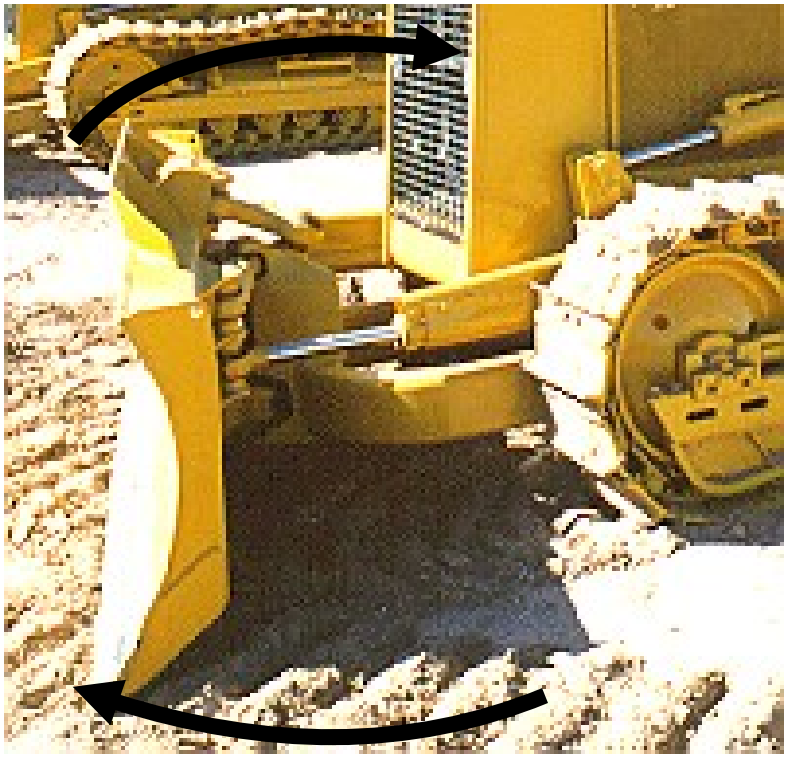
2.2 Heavy Earth moving Equipment

C. Dozers

Blade adjustments



Tiltin
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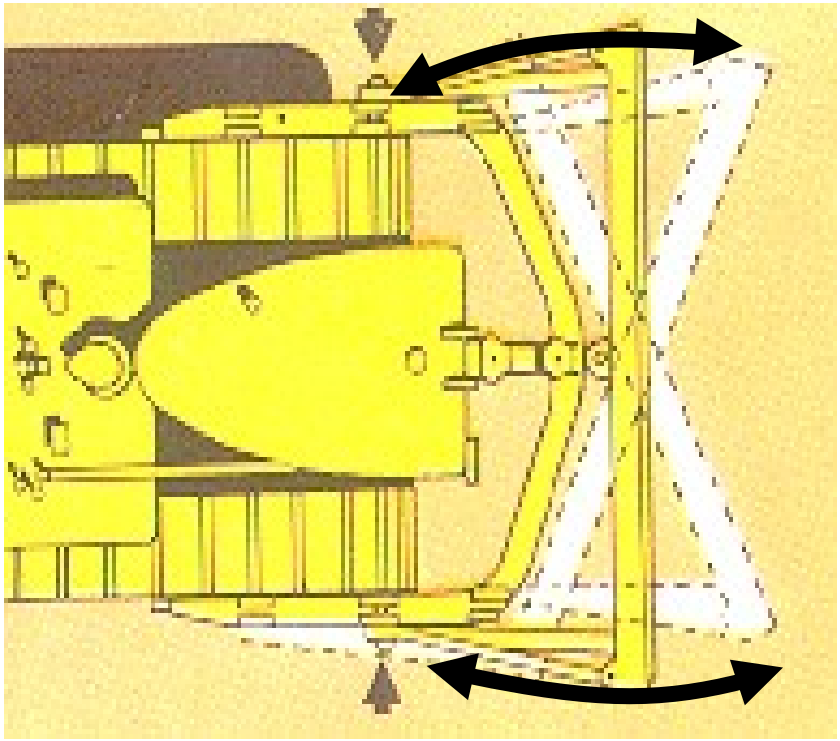
Angle adjustment



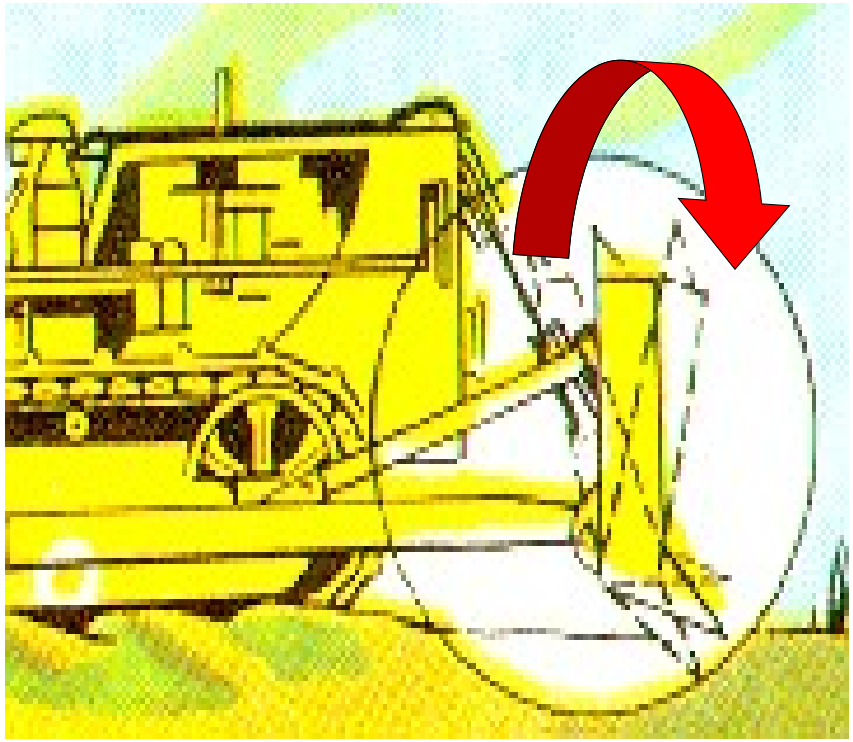
2.2 Heavy Earth moving Equipment

C. Dozers

Blade adjustments



Angle adjustment (Top View)



Pitch adjustment



2.2 Heavy Earth moving Equipment

C. Dozers

Dozer Blades and Material Evaluation

- Besides job requirement, several other consideration determine choice of attachment.
- ***Moisture content***, ***particle size***, and ***number of voids*** are the more important characteristics influencing dozing performance.

a) ***Moisture content***: If the moisture content increases above the optimum, material becomes heavy and will thus have a ***negative effect on dozing performance***.

b) ***Particle size***: Large particles resist penetration more than smaller ones, requiring more dozing power.

  - Materials consisting of ***irregularly*** and ***sharp-edged*** particles are more difficult to doze than material composed of ***round-edged*** particles



2.2 Heavy Earth moving Equipment

C. Dozers

Dozer Blades and Material Evaluation

c) ***Voids***: Relatively dense materials with few voids contain large numbers of individual particles in close contact with each other . Because of this more force is required to break up this tightly bonded material.





2.2 Heavy Earth moving Equipment

C. Dozers

Rippers

- Crawler-tractor, mounted with ripper is finding increasing use in construction, mining and quarrying.
- ***Characteristic of material*** to be ripped influence the selection of ***ripper type***; ***number of shanks*** required, ***ripping speed*** and ***amount of ripper penetration***.

Types of Rippers

A. ***Fixed multiple-shank ripper***: used for comparatively simple ripping operations.

B. ***Variable multiple-shank ripper***: These are used where there are many boulders, or where the quality of rock is not consistent.



2.2 Heavy Earth moving Equipment

C. Dozers

Types of Rippers

c. ***Fixed giant ripper***: has only one single powerful shank, but is not common as compared to variable giant rippers.

d. ***Variable giant ripper***: has a single powerful shank . The angle of this ripper ca[illegible] to t[illegible]nts.





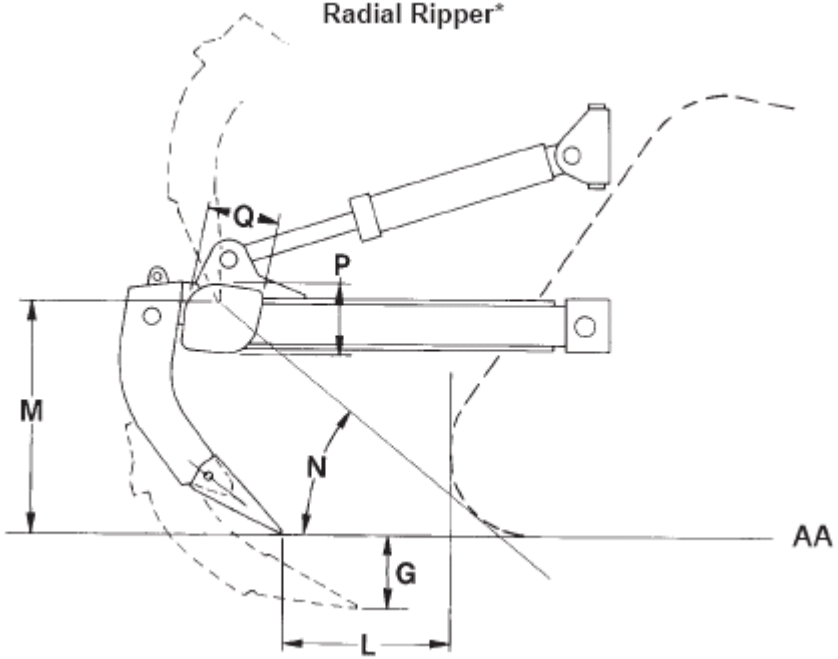


2.2 Heavy Earth moving Equipment

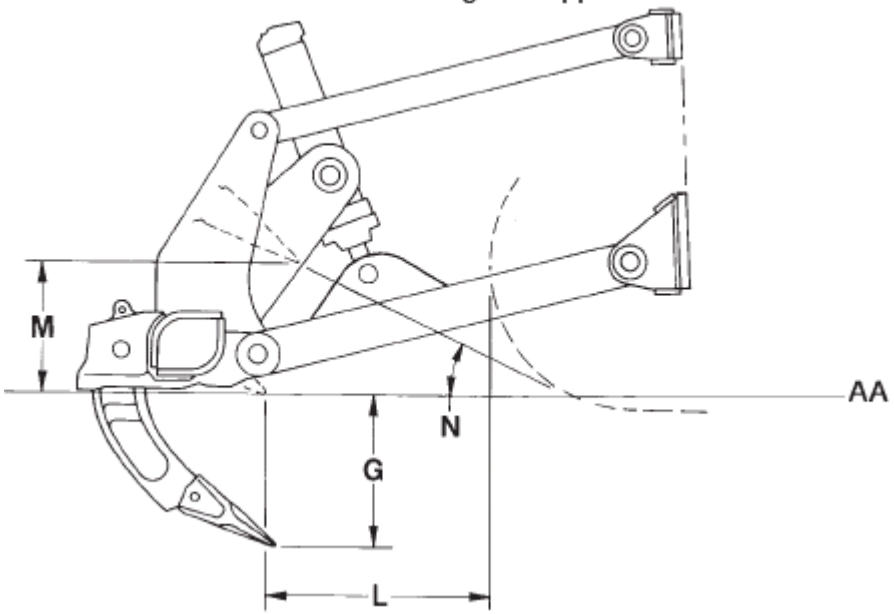
C. Dozers

Types of Rippers

Radial Ripper*



Fixed Parallelogram Ripper





2.2 Heavy Earth moving Equipment

C. Dozers

Ripping Efficiency

- In order to achieve ***high ripping efficiency***, following suggestion should be considered.
  1) When material is not broken, loosen the surface in one direction, then cross-ripping should be adopted.
  2) If material is soft, use more than one shank ripper.
  3) Ripping should be done downhill.
  4) Avoid reversing when shank is in the ground.
  5) When both dozing and ripping operations are required to be done, it should rip going out and doze on the way in.
  6) For hard material, use shorter tips, and for ordinary work use longest and sharpest point.



2.2 Heavy Earth moving Equipment

C. Dozers

Crawler Vs Tyre Tractors



A. Crawler Mounted tractors



B. Wheel Mounted tractors



2.2 Heavy Earth moving Equipment

C. Dozers

Crawler Vs Tyre Tractors

- Each type of tractor has certain advantages in certain conditions.
- ***Advantages of crawler mounted tractors:***

1) More tractive effort, hence can also operate on loose or muddy soil.
2) In absence of tyres, can easily operate in rocky conditions.
3) Where maintenance of haul roads is difficult, it can easily travel, especially in rough terrain.
4) Crawler tractors are more compact and powerful and hence can handle difficult jobs as well.
5) Greater floatation because of the lower pressure under the trucks.



2.2 Heavy Earth moving Equipment

C. Dozers

Crawler Vs Tyre Tractors

- ***Advantages of wheel mounted tractors***:
  1) Can travel at higher speeds during operations and also from one job to the other.
  2) Ease in operation. Operator feels less fatigue.
  3) Can travel on paved roads without damaging them.
  4) Can travel long distances at its own power, whereas crawler mounted needs trailors.
  5) When work is spread over long area, these are found to be producing more output.
  6) Operation, maintenance and repair costs are less in wheeled tractor as compared to crawler tractors.



2.2 Heavy Earth moving Equipment

D. Scrapers

- Scrapers are capable of ***excavating***, ***hauling***, and ***dumping*** material ***over medium- to long-haul distances.***
- The scrapers are designed to ***dig***, ***load***, ***haul***, ***dump*** and ***spread*** and sometimes called as ***carry all***.

Types of scrapers

- The scrappers are of three types:

I. Towed scrapers:

- They are provided with either cable or hydraulic control.
- They are becoming obsolete.
- When coupled to a suitably powered crawler tractor, they can operate in extremely adverse conditions.
- Travel at ***slower speed*** and can be used for short hauls only



2.2 Heavy Earth moving Equipment

D. Scrapers

Types of scrapers

II. *Self propelled or motorized or conventional scrapers:*

- Generally manufactured in ranges from ***10-20*** cubic meters.
- Needs push loading by a crawler mounted or wheeled tractor.
- Have ***more hauling speed*** and hence are suitable for long distance hauling .

III. *Self loading or elevating scrapers:*

- The problem of loading by a pusher is overcome by these type of scrappers.
- These are twin engine scrappers and can work completely independently of all other plants.
- Pay loads are restricted because of the additional weight of the loading elevator and its drive system.



2.2 Heavy Earth moving Equipment

D. Scrapers

Types of scrapers

- Another classification method of scrapers

I. Push-loaded (Conventional):

- Single powered axel
- Tandem powered axels

II. Self loading:

- Push-pull, tandem powered axels
- Elevating
- Auger



2.2 Heavy Earth moving Equipment

D. Scrapers

Types of scrapers



Conventional (Push loaded)

Become uneconomical when

- Haul grades > 5%
- Return grades > 12%

Tandem powered Twin Engine

- Good for jobs having adverse grade
- Owning operating costs are about 25% higher

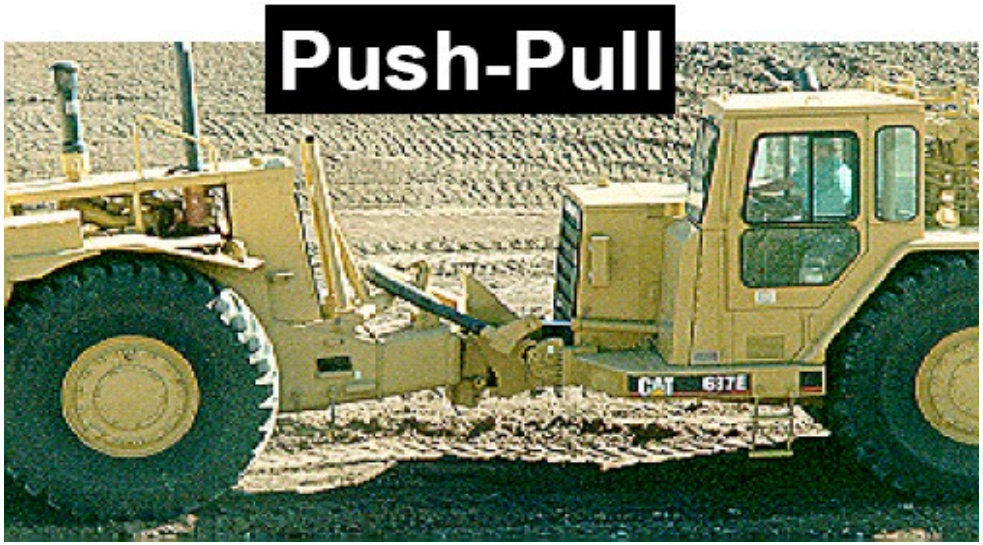


2.2 Heavy Earth moving Equipment

D. Scrapers



Types of scrapers



Push pull scrapers

- Can work as a team or operate individually with a pusher.
- Tire wear will increase in rock or abrasive materials.

Elevating scrapers

- Good for short hauls and in favourable materials.
- Can work alone in the cut.
- Cost more initially and to operate.

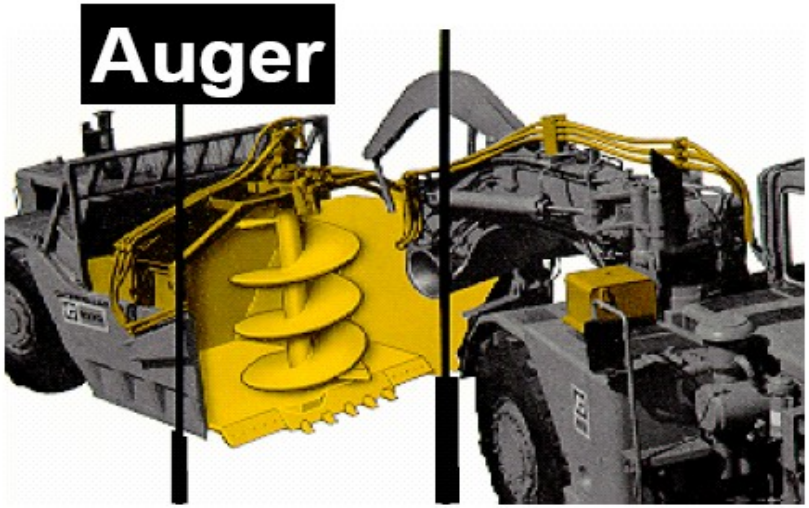


2.2 Heavy Earth moving Equipment

D. Scrapers



Types of scrapers



Auger Scrapers

- Can self load in difficult condition, laminated rock or granular material.
- The augers add weight to the scraper during travel and it is more costly to own and operate than the conventional.





2.2 Heavy Earth moving Equipment

D. Scrapers

Basic Parts of a scraper

- A scraper has the following main parts:

i. Bowl

- The bowl is a pan to hold the scraped dirt
- It is hinged at the rear corners to the rear axle inside the wheels, and is capable of tilting down for digging or ejecting.

ii. Cutting edge

- The bowl has a cutting edge attached to the bottom.
- The cutting edge is lowered into the dirt to make a shallow cut.

iii.Apron

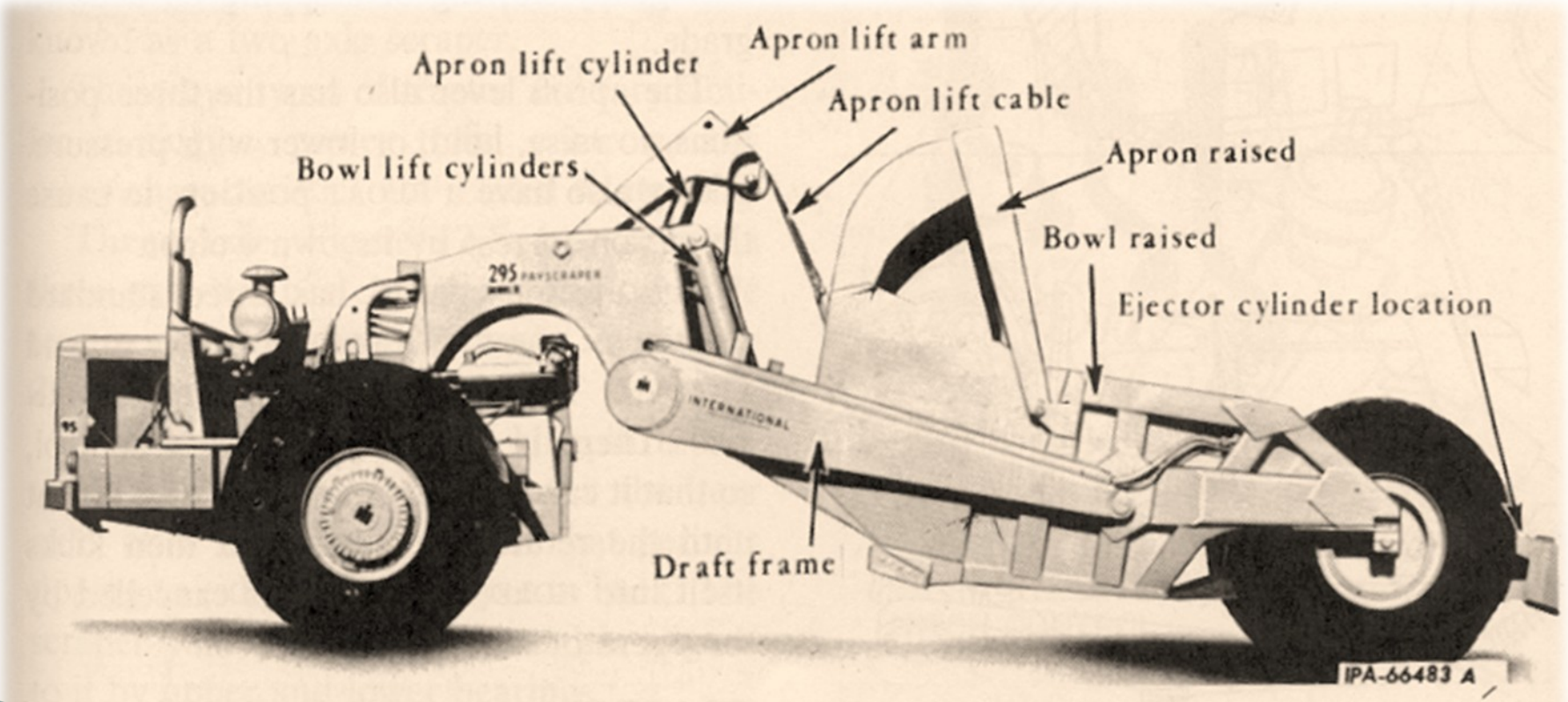
- This is a wall in front of the bowl, which opens and closes to regulate the flow of the earth in and out of the bowl.



2.2 Heavy Earth moving Equipment

D. Scrapers

Basic Parts of a scraper



Courtesy of International Harvester Company

Fig. 17-2. Names of scraper parts



2.2 Heavy Earth moving Equipment

D. Scrapers

Basic Parts of a scraper

iv. Tail gate or ejector

- These are the rear of the pan which is capable of forward and backward movement inside the bowl





2.2 Heavy Earth moving Equipment

D. Scrapers

Operation

- Operation of a scraper is described here under for an earth work:

i. *Loading or digging*

- The operator moves to the cut with the ejector at the rear and the apron raised approximately to 40 cm.
- The bowl is then lowered to the desired depth of cut, increase engine speed, move forward in first gear keeping optimum depth of cut.
- When the bowl is full, the apron is closed and the bowl is then raised.

ii. *Transporting*

- The bowl is transported in high gear in raised position to provide sufficient clearance.
- During transporting, apron should be fully closed to prevent loss of material



2.2 Heavy Earth moving Equipment

D. Scrapers

Operation

- Operation of a scraper is described here under for an earth work:

iii. *Unloading*

- The bowl should be positioned to spread the material to the desired depth during this operation.
- A partial opening of the apron during the initial unloading will help in even spreading.
- For wet and sticky material, the apron should be raised and lowered repeatedly until the material behind it is loosened and drops out of the bowl.
- Then the ejector is moved forward to push the remaining material out of the bowl at a uniform rate.
- When the dump is complete, the tail gate is fully retracted, the apron dropped and the 'bowl' raised to transporting position.



2.2 Heavy Earth moving Equipment

D. Scrapers

Operation

- Following are some of the suggestions for ***increasing scraper production***:
  - Construct and maintain smooth haul roads for faster travel.
  - Depth of cut should be according to the type of soil being cut.
  - Use ripper teeth in hard or abrasive materials for easy handling.
  - Where possible, loading be done in down grade
  - To increase the stability of the scraper during travel, carry the bowl as close to the ground as possible.
  - If necessary pre-wetting of the soil is done so that the soil is reasonably moist, as most soils load easily when they are moist.
  - Whenever possible, plan the work to eliminate all avoidable turns.



2.3 Grading Equipment

Graders

- Grading is the process of bringing earth work to the desired ***shape*** and ***elevation*** (grade).
- Motor graders are used for leveling and smoothening the earthwork, spreading and leveling the base course in the construction of roads and air fields.
- Motor graders can be used for the following types of works:
  - Gravel road repairing
  - Road shoulder reshaping, bank cutting and reshaping
  - Ditch filling or digging
  - Levelled or slopped ground finishing
  - Base course spreading and levelling
  - Material mixing, hard surface cutting, snow clearance,
  - Land clearance, frozen top soil and asphalt breaking



2.3 Grading Equipment

Graders

Comparison with dozers

- A grader is restricted to making shallow cuts in medium-hard materials.
- They should not be used for heavy excavations.
- A grader can move small amounts of material but cannot perform dozer-type work because of the structural strength and location of its moldboard.
- Graders can work on slopes as steep as 3:1.
- Grader are capable of progressively cutting ditches to a depth of 3 ft.



2.3 Grading Equipment

Graders

Basic parts of grader

- The components the grader that actually do the finishing are:
  - ***Blade (Moldboard)***
  - ***Scarifier***
  - ***Rippers***

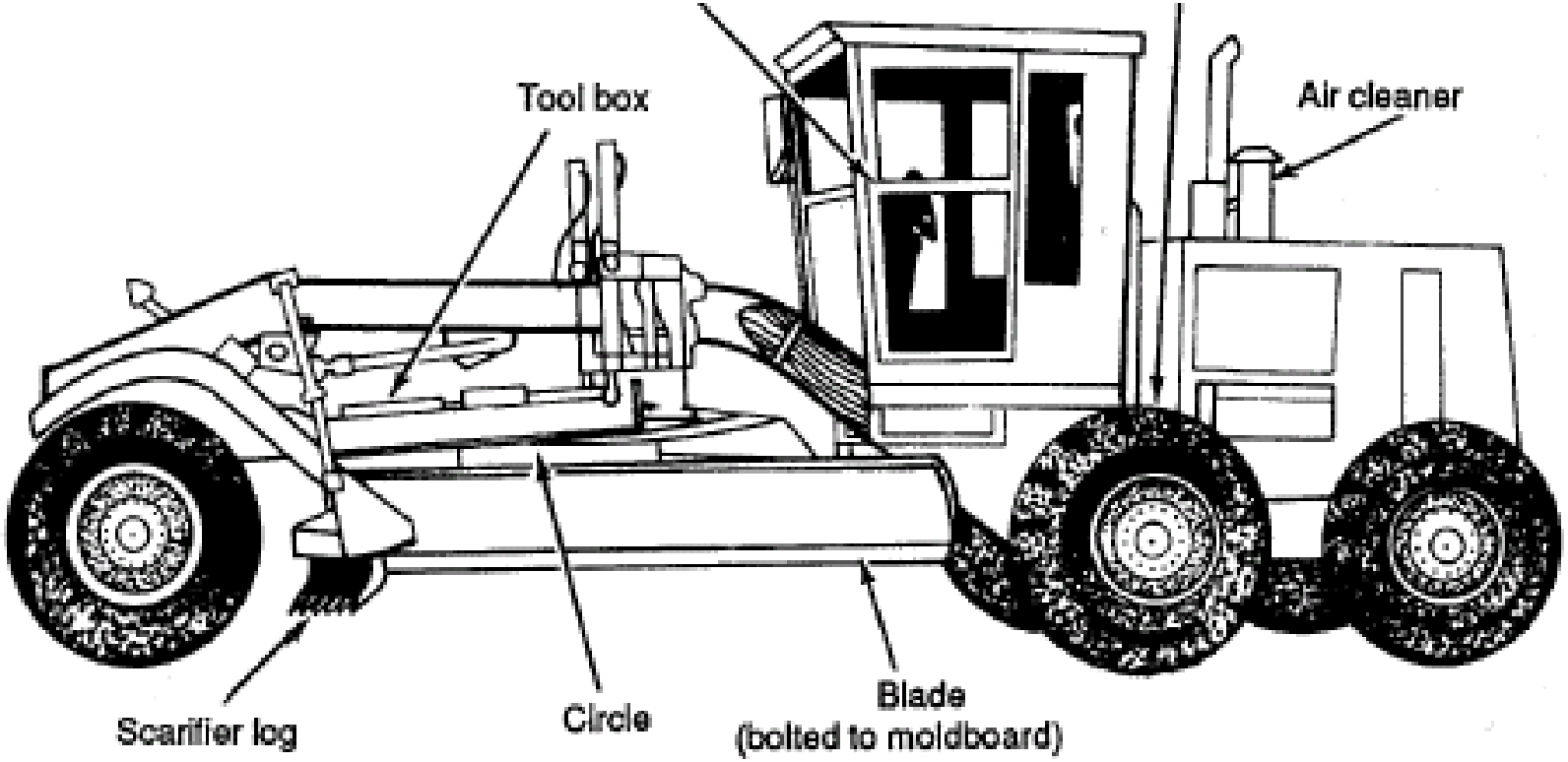




2.3 Grading Equipment

Graders

Basic parts of grader





2.3 Grading Equipment

Graders

Blade

- The blade (Mould Board) is the ***main tool*** of the grader.
- It is carried by a ***rotating circle*** and is easily maneuverable to a wide range of cutting positions with the help of hydraulic controls.
- The blade and the circle are mounted on a frame and is supported at the front of the machine by a ball joint.
- The blade can be adjusted to any position with help of levers as indicated below:
  - ***Side shift***: the blade has Blade Sideshift Ram
  - ***Lifting the blade***: The blade can be lifted or lowered by levers operating the two rams.
  - ***Rotating the circle***: A hydraulic motor is provided to rotate the circle and blade. Blade can be rotated either in clockwise or counter clockwise direction.



2.3 Grading Equipment

Graders

Blade

- ***Adjusting blade cutting angle (Blade pitch)***: The vertical angle of the blade can be adjusted.

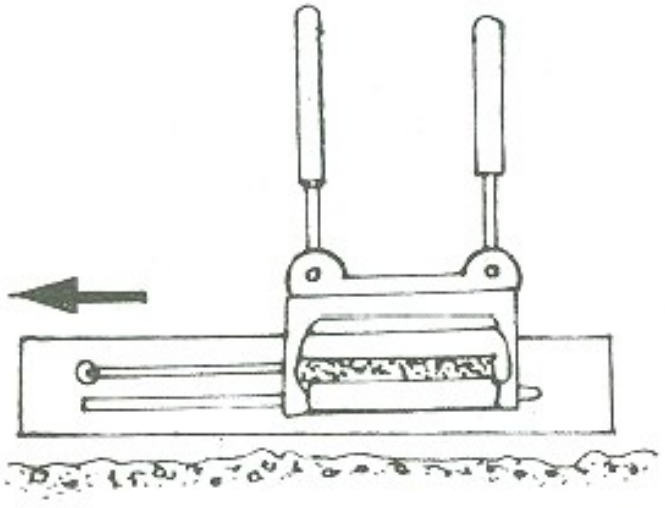


Fig. 4.2. Blade sideshift.

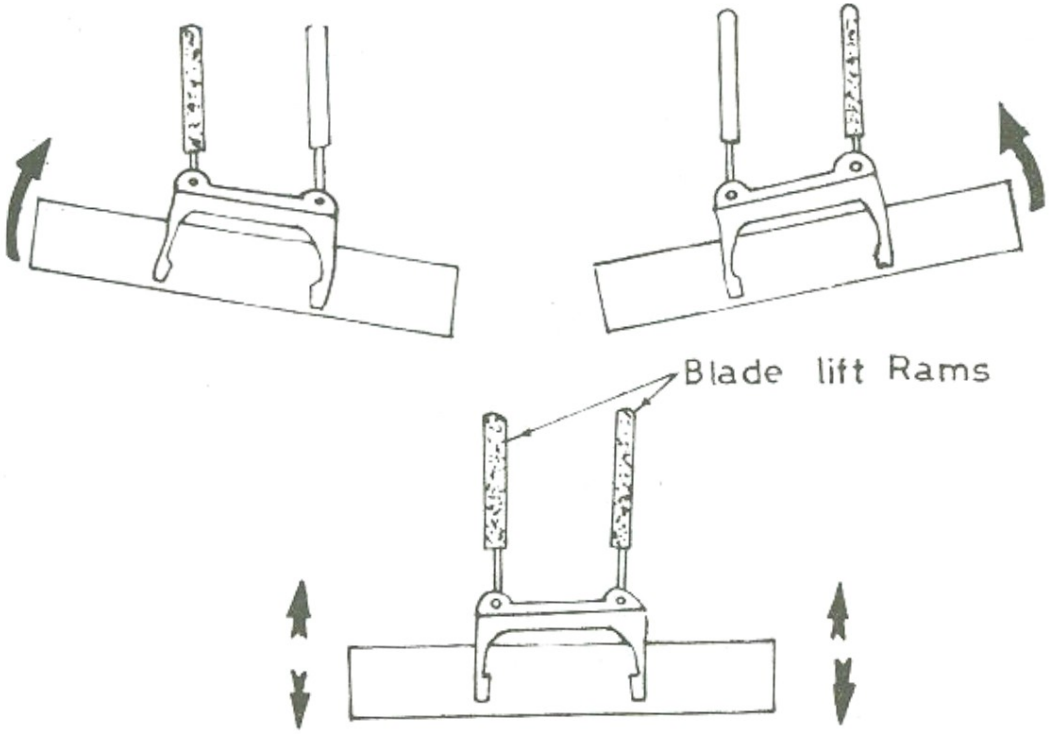


Fig. 4.3. Lifting the blade.



2.3 Grading Equipment

Graders

Blade

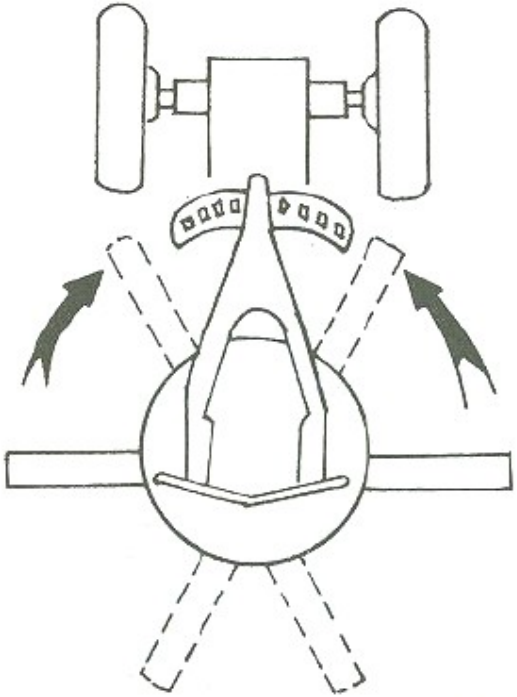
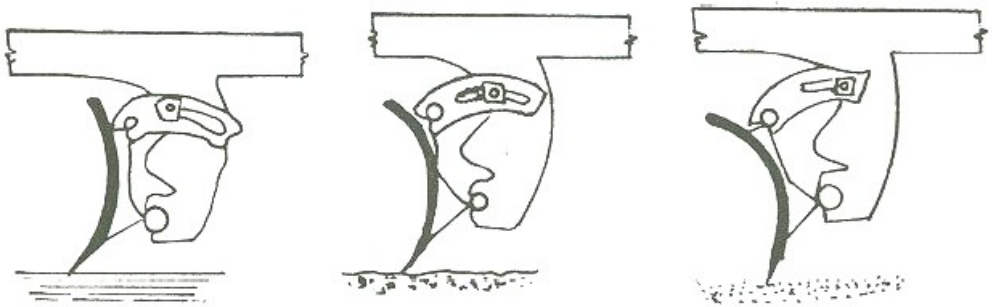
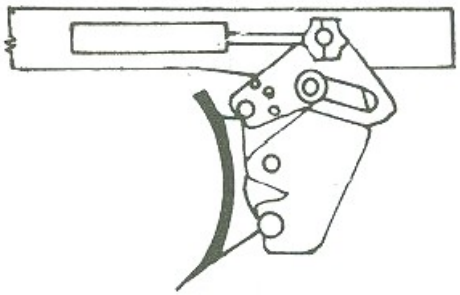


Fig. 4.4. Rotating the Circle.



(a) Manual Adjustment



(b) Hydraulic Adjustment

Fig. 4.5. Blade Cutting Angle.

CONSTRUCTION EQUIPMENT

2.3 Grading Equipment

Graders

Blade







Adjusting blade cutting angle

CONSTRUCTION EQUIPMENT

2.3 Grading Equipment

Graders

Blade







Adjusting blade cutting angle

2.3 Grading Equipment

Graders

Scarifier



- Scarifier is a special tool attached with the motor grader for loosening the hard soil and has a set teeth mounted on adjustable shanks.
- This attachment digs up hard ground like asphalt, old pavement, frozen surface and hard soil with vegetation and brushes which can not be removed by the blade.
- The teeth are replaceable, and the number of teeth can be varied to suit the ground hardness.
- High strength alloy steel tips can be mounted on the teeth to prevent teeth wear and extend their service for economical performance.

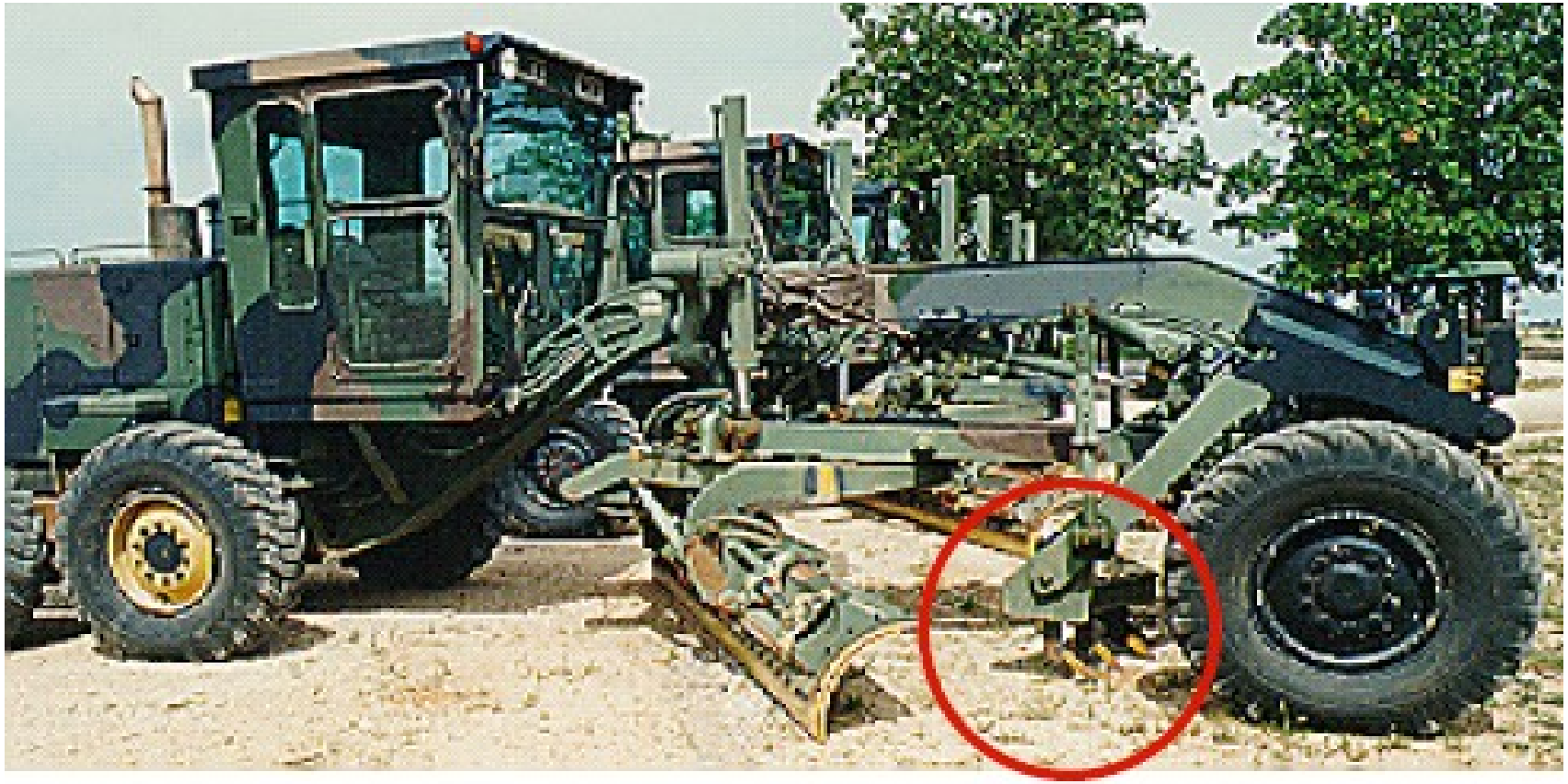
CONSTRUCTION EQUIPMENT



2.3 Grading Equipment

Graders

Scarifier





2.3 Grading Equipment

Graders

Ripper

- The ripper is used to break up materials too hard to cut with moldboard blade.
- The depth of cut is controlled by hydraulically operated ripper control lever.
- Type of material to be ripped will determine position of the rip





2.3 Grading Equipment

Graders

Various Operations

A. *Grading:*

- Grading in road construction means flattening and smoothening the road surface and others by the scrapping action of the blade, includes working operation like, ***surface skimming***, ***light duty bulldozing***, ***leveling***, ***spreading*** and ***crowning***.
- A cutting depth of 2 to 3cm is considered to be the best for optimum efficiency. Under no circumstances it should be greater than 5cm.

B. *Spreading:*

- Gravel together with binding material is spread by the motor grader.
- For spreading the cutting angle is set at 60° nearly.
- Cutting edge of the blade is set above the ground at a distance equal to the depth to which the material is to be spread.



2.3 Grading Equipment

Graders

Various Operations

C. Finishing and Leveling:

- In final finishing and leveling, surface have to be finished to fine limits.
- In such cases make the finishing pass with the blade only slightly angled and set to skim the surface.

D. Ditch Digging:

- The front end of the blade is tilted down and the rear end is tilted up above the road surface. The front end cuts into the ground.
- This is used to dig drainage ditches and road side ditches.

E. Cutting:

- For the purpose of cutting in soft dirt, set the blade to an angle b/n 40-55 degree, while in hard dirt an angle of 30-45 degree is proper.

Construction Equipment

2.3 Grading Equipment

Graders

Various Operations





Laser Blade controls



Ditch Cutting

2.4 Earth work Equipment Summ

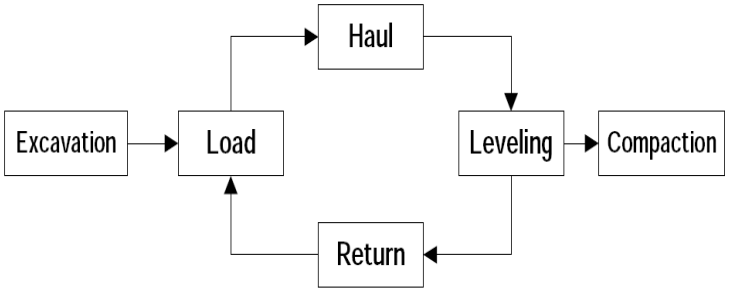


Fig.1 Earthmoving Flow

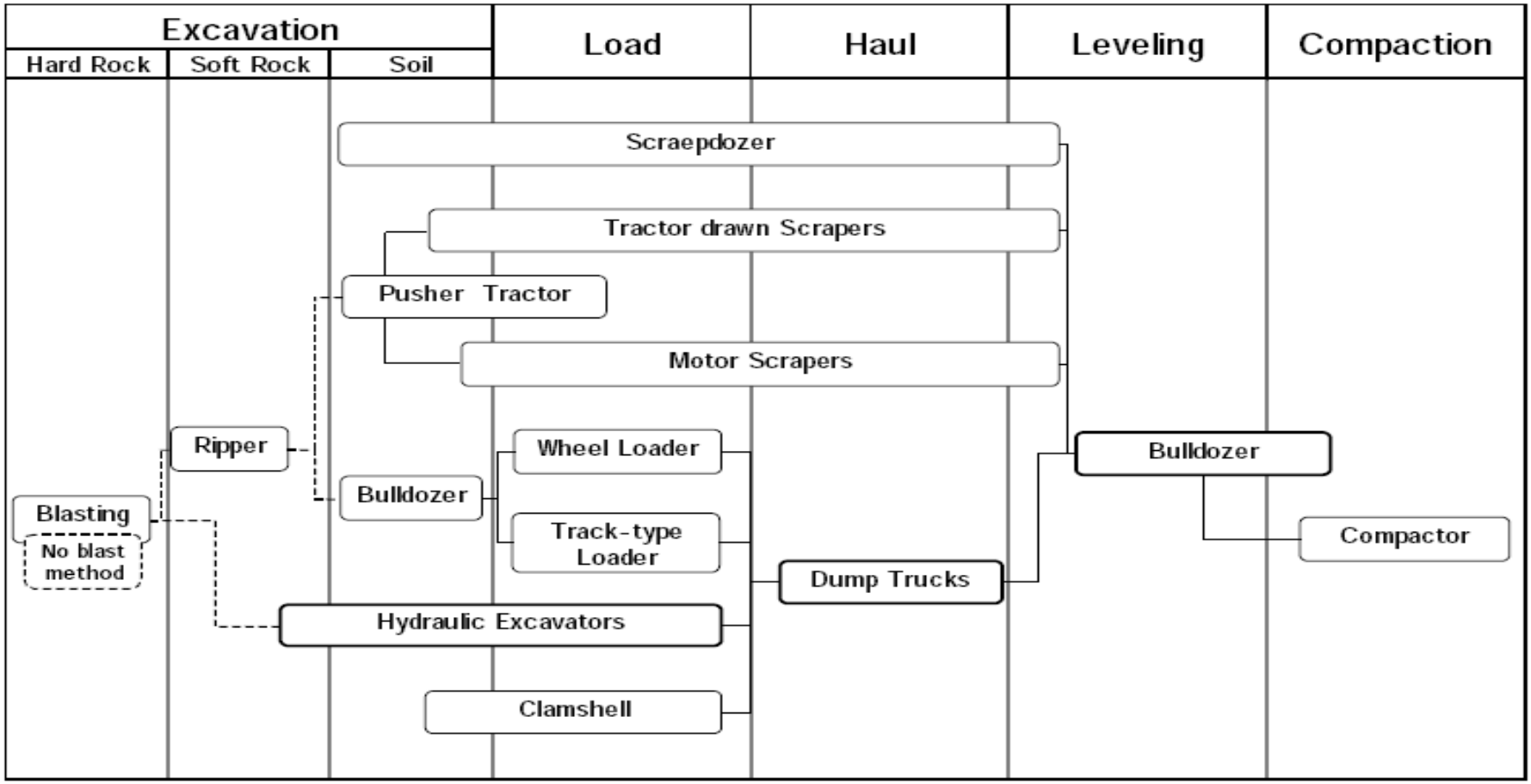


Fig.2 Co-Operation



2.4 Earth work Equipment Summary

- Choice of Excavation Equipment for Building Site Excavation depends on:
  - Size of the job: - Bucket Size and Number of Excavators
  - Activity time constraints: - Number of equipment
  - Availability of equipment:
  - Cost of transportation of equipment:
  - Type of excavation:
  - Soil characteristics:
  - Geometric characteristics of elements of the soil to be excavated:
  - Space constraints:
  - Characteristics of haul units:
  - Location of dumping areas:
  - Weather and temperature:

CONSTRUCTION EQUIPMENT

2.4 Earth work Equipment Summary

Earthmoving and Excavating Work Activities and Equipment Packages

Activity	Dozer	Loader	Grader	Scraper	Dump Truck	Backhoe	Excavator	Front Shovel
Excavating above grade								×
Excavating below grade	×			×		×	×	
Grubbing	×						×	
Heavy ripping	×							
Light ripping			×					
Tree stump removal	×						×	
Topsoil removal/storage	×		×	×				
Rough cutting	×			×			×	
Rough filling	×	×		×	×			
Finish grading			×					
Foundation excavation						×	×	
Foundation backfilling		×				×	×	
Footing excavation						×	×	
Road base construction	×	×	×		×			
Temporary road construction	×	×	×		×			
Haul road maintenance			×					
Culvert placement	×		×		×	×	×	
Earth berm/ dam construction	×		×		×			
Drainage ditch maintenance						×	×	

CONSTRUCTION EQUIPMENT

2.4 Earth work Equipment Summary

Earthmoving and Excavating Work Activities and Equipment Packages

Activity	Dozer	Loader	Grader	Scraper	Dump Truck	Backhoe	Excavator	Front Shovel
Haul less than 500′	×	×						
Haul 500′ to 2 miles				×				
Haul over 2 miles					×			
Soil windrowing	×		×					
Soil spreading	×	×	×	×	×			
Excess loose soil removal		×			×			
Deep trench excavation							×	
Shallow trench excavation						×		
Trench backfilling	×	×				×	×	
Utility pipe placing — small						×	×	
Utility pipe placing — large							×	
Trench box placement/ movement						×	×	
Debris/trash removal		×			×		×	
Rock removal	×	×			×		×	
Asphalt paving removal	×	×			×		×	
Concrete removal	×	×			×		×	
Structure demo	×	×			×		×	
Assisting scrapers	×			×				
Towing other equipment	×	×						
Concrete placement — bucket							×	
Crane pad construction	×		×		×			
Detention pond excavation	×			×			×	
Benching	×		×				×	
Side sloping	×							

THANK YOU!