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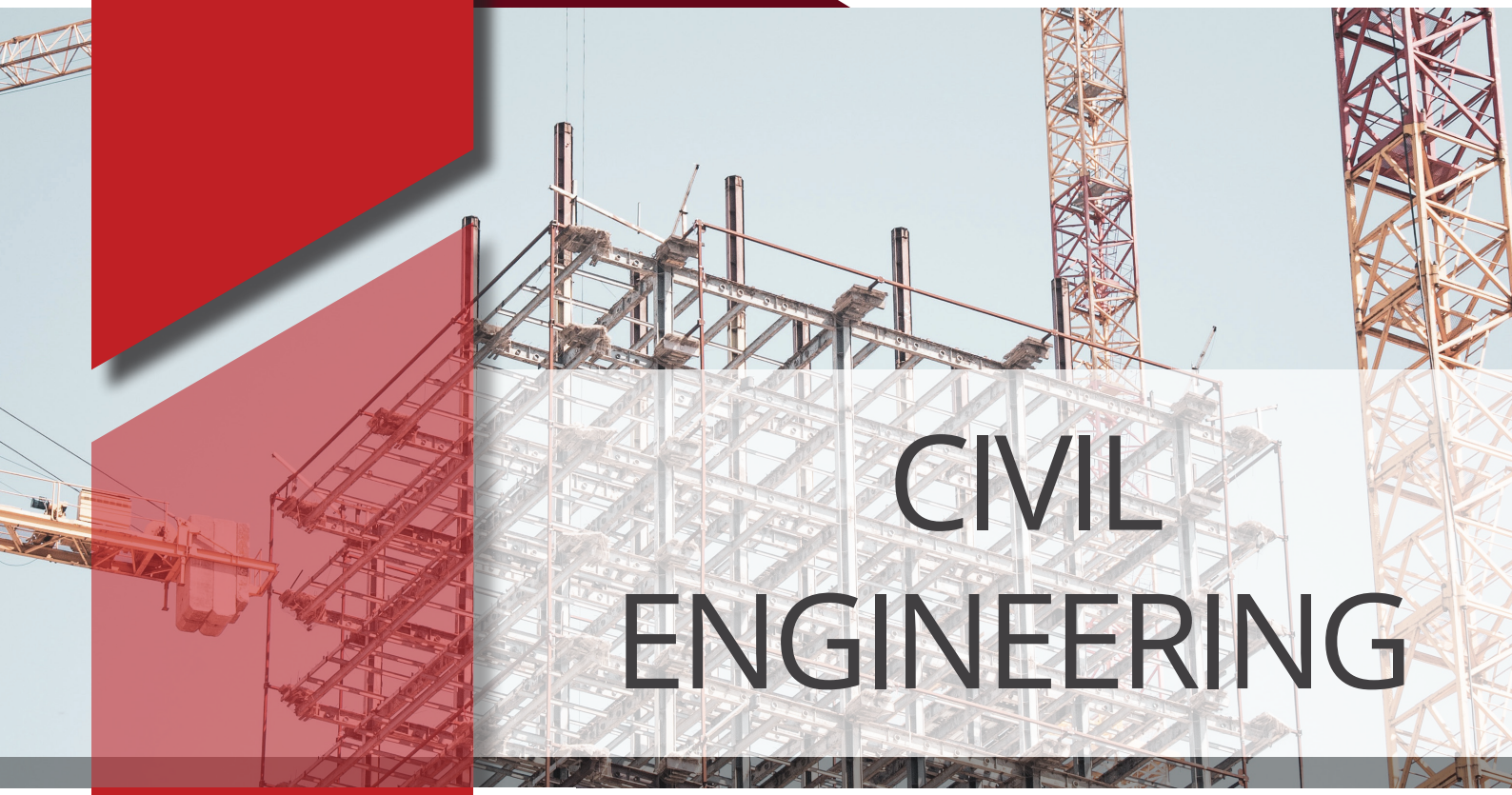

CIVIL ENGINEERING

Building machines

UNIVERSITY OF APPLIED SCIENCES UPPER AUSTRIA

VŠTE

EUROPEAN UNION

CONTENTS

1. INTRODUCTION TO BUILDING MACHINES

Building production and its peculiarities:

- Separating the project design from the actual realization of the building
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- Production at the heart of events
- The impact of seasonal work
- Transport and handling of material
- Changing the machines on building site
- Demands for self-propelled, agile and terrain accessible
- Demands for and increase range of use for earthwork machines
- The uniqueness of construction works
- Aesthetics and interventions in the landscape character

Division of machines according to mechanical properties:

- Machines with constant work resistances
- Machines with work resistances dependent on the work speed
- Machines with work resistances dependent on the track
- Machines with work resistances dependent on the track and the work speed
- Machines with work resistances dependent on the time

Division of building machines according to purpose of their use:

- Earthworks machines:
    - excavators, dozers, scrapers, graders, loaders, drilling rigs, compactors, universal finishing machines
- Machines for the production, transport and processing of mortars and concrete mixtures:
    - Mixers: gradient (gravity), with forced mixing; truck finishing mixers or truck mixers
    - Belt conveyors, roller bins, motor carts

- Machines for transport and handling material:
    - transport equipment, means of transport, loaders, pumping equipment
- Vertical transport machines:
    - cranes: road crane, tower crane; elevators
- Machines for engineering and road construction:
    - machines for road construction, for underground work and for railway superstructure
- Machines and equipment for finishing and special works:
- Machines and equipment for the conversion and transmission of energy on construction sites:
    - machines and equipment for the production of electric energy, for the production and conversion of compressed air, hydraulic oil pressure sources

Mechanization of construction production

Comparison of machine and manual performance:

Machine	**Workers replaced by Machine**
Dozer with performance 80 – 120 kW	70 - 90
Motor grader 50 – 120 kW	30 - 50
Excavators – bucket volume 0,15 – 3 m^3	20 – 160
Compaction machines weighting 4 – 25 t	20 – 50
Portable belt conveyor	5 – 8
Concrete mixer	15 – 20

2. EARTHWORKS - INTRODUCTION

Character and social significance of earthworks

Earthworks are works that deal with the rocks disintegration, the relocation of the excavation, or the dikes, their pouring, including their possible reinforcement and other modifications related to these works.

Construction creates good living conditions for the population, it significantly influences the life and cultural level of society and its activities are indispensable for most other sectors of the economy.
The manufacturing process in the construction industry is characterized by considerable demands for soil transfer - in the case of earth and rock works it is necessary to extract, transport, store and compact millions of cubic meters of soil and aggregate.

Earthworks account for about 10 % of the total volume of construction and civil engineering assembly works in the construction sector.

Earthworks

Earthworks in construction:

- This term includes a broad area from the functional and constructive design of earthworks through their technological preparation, performance and control to exploring the interactions between working objects, working means and labor forces in the production process

- cross-section complex of ground and underground construction

- a major component of water and water management works, road and railway constructions, airport construction, residential, communal and industrial buildings, agricultural buildings, etc.

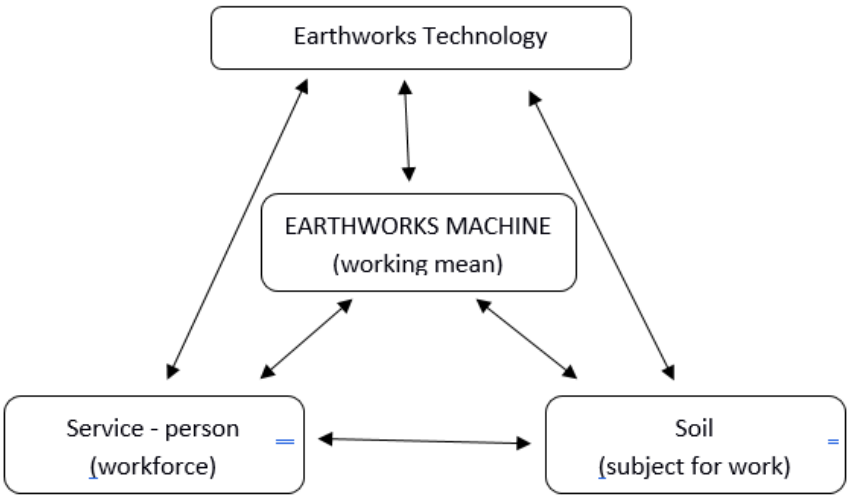
Earthworks related to extraction of other commodities:

- stone
- sand
- brick clay
- kaolin
- gypsum, etc. ...

Large-scale earthworks - for quarrying of most raw materials for:

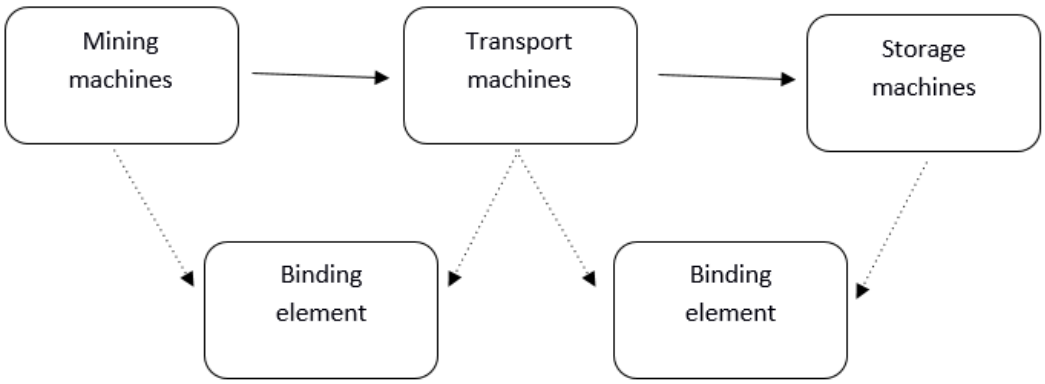
- Power engineering
- Heat engineering
- Metallurgy (brown coal and iron ore)
- Building machinery for earthworks

Earthworks technology – the connection of technology with the basic elements of the production process



Earthwork machines – form central, auxiliary and accompanying technology

Basic types of earthwork machines:



Soil extraction:

- disintegration
- loading

Mining machines:

Cyclically operating machinery

- rippers
- dozers
- graders
- grader-elevators
- excavators
- loaders
- scrapers

Continuously operating machinery

- wheel excavators
- crawler excavators
- trench depths
- drilling kits
- suction dredgers

Soil transport

a) On tracks = by rail means
- narrow gauge trolleys
- rail wagons
- draw gear
- electric locomotives
- diesel locomotives
- diesel electric locomotives

b) on roads and off-roads = road and off-road means
- towing vehicles
- self-moving vehicles
- dumpers
- self-bulking vehicles
- tippers
- scrapers
- loaders

c) independent of terrain = other
- belt conveyors
- piping
- ships

Soil storage

- flattening and profiling
- compaction
    - scrapers
    - graders
    - dozers
    - universal: finishing machines

3.ROCKS – CLASSIFICATION AND DIS-INTEGRATION OF ROCKS

Classification of rocks

There are 7 classes of rocks distinguished according to the characteristic properties and the difficulty of disintegration = classification of rock exploitation. Properly classifying the rock is a key prerequisite for an optimal choice of earthworks machine or other way of rocks disintegration.

Class	Rock	Texture transient, permanent (%)
1	fine-grained soils, soft consistencies such as earthy, clay, sandy soil; sandy and gravelly soil: grains of up to 20 mm in grains, with grains over 20 mm in volume up to 10%, e.g. sand, gravel sand, fine grain and medium grain, construction waste and weights of a similar character	loose soil, can be picked up by shovel, loader
2	fine-grained soils, solid consistencies such as earthworms, earth, dusty loess, sandy soil, peat; sandy and gravelly soil: medium grain up to 20 mm, grains 20-50 mm above 10% volume and grains over 50 mm to 10% volume, e.g. sandy gravel, medium and coarse gravel, with stones; construction waste and weights of a similar character	cramped soil, disassemble by spade, loader
3	fine-grained soils of solid and hard consistency and soft and rigid, e.g., clay, loess, clay clay, sandy clay, clay; sandy and gravely or 50-100 mm above 10% grain, grains over 100 mm to 10%, e.g. rough sandy gravel, rough gravel with stones; rock rocks intensely altered or disturbed, weathered, eluvia; construction waste and weights of a similar character	digging rocks, dismountable by a pick-ax, excavator
4	fine-grained, solid and hard consistency, clay, sandy clay, clayey soil, sandy soil; sandy and gravely grains of 100-250 mm up to 50%, grains over 250 mm to 10% vol., e.g. stones, boulders, rough gravel, small and medium gravel with clay or clay cement; rocks weathered to weathered, such as weathered claystones, dustbins, tufa, tufts, weathered sandstones and slate, weathered limestone and opaque; rocky, disturbed, weathered, broken; sludge and liquid consistency, IC <0.05 as muddy water, liquid sand; construction waste and weights of a similar character	crumbly solid rocks, dismountable wedge, excavator

5	sand and gravel soils with grain size of 100-250 mm above 50%, with grains over 250 mm to 0,1 m3 in the volume of 10-50% or more. fine-grained cement; rough gravel with stones and boulders, medium and coarse-grained gravel with clayey or clay cement; rocks solid, healthy, in layers up to 15 cm, e.g. puddle with clay cement, claystone, clay slate, sand slate, travertine, sandstone with clay cement, fyliths, chlorite shale; rock, broken, weathered, cracked with discontinuities distant from each other up to 15 cm; weighing of a similar character; frozen soil	easily tear-off, disconnectable by ripper, heavy excavator, explosives
6	sand and gravel with boulders up to 0,1 m3 above 50% vol., with boulders above 0,1 m3 to 50%; rocky, healthy, with a density of discontinuities up to 1 m, such as granitoids, diorites, porous basaltoids, phylitic slate, coarse glue, agglomerates, limestone, offal, sandstone	30-40, 20-30 difficult to tear, disconnectable by heavy ripper, explosives
7	sandy and gravel-sanded grains above 0,1 m3 above 50% vol.; rocky limestone, quartz diorites, andesites, phonolites, roughly columnar basaltoids, diabases, granulites, amphibolites	40-90, 20-30 very difficult to tear, disassemble by explosives

Rock disintegration

Rock disintegration can be defined as the resistance of the rock to the action of the tool separating its parts. The disconnect can be expressed by the amount of work required to disconnect the volume unit of the rock.

Disconnection compact and dense rocks means breaking, loosening, or swinging them so that they can be removed or extracted for construction purposes.

Rock disconnection factors

- Type and properties of the rock
- Basic tool parameters
- Technology of work

Methods of rock disconnection

- Mechanical: The tool acts directly on the rock (cutting + drilling)
- Hydraulic: Effect of pressure water flow
- Explosive: the effect of explosive energy
- Physical and chemical: not normally used (test stage).

Mechanics of rock disengagement by working tools

A difficult factor in disconnecting rocks is the heterogeneity and variability of the disconnected material. The basic characteristic of the rocks due to their disconnection is the specific resistance against mechanical disconnection.

Rock extraction

It depends on the resistance that the rock places on the disconnection, and on other circumstances, such as the adhesion of the rock to the working tools, the rock loose, and the resistance of the rock when it is loaded and tilted. The degree of profitability is the amount of work required to perform the activities. However, rock capacity can't be determined because of the absence of a test procedure.

4. PERFORMANCE OF BUILDING MACHINERY FOR EARTHWORKS

Definition of machine performance for earthworks:

- performance is determined by the amount of rock extracted and processed at a given time unit: [m^3 / h]
- It is one of the main indicators of use and in many cases the decisive parameter when selecting a machine
- the performance of the machines significantly influences the physio-mechanical properties of the rock, in particular the bulk density and density of the rock, because it affects the volume and weight of a certain amount of rock
- for each class of rock disintegration, the rocks can be divided into three types: rocks in a raised state; crumbly rock; compacted rock
- the amount of rock can be determined by the weight: [t] or volume: [m^3]

Division of machines for earthworks according to the way of work:

- cyclically operating machines - with a regular operating cycle (dozers, excavators, loaders)
- continuously operating machines - operate without repeating cycles (bucket and wheel excavators)

Machine performance types:

For all machines, performance can be divided into theoretical and operational.

Theoretical performance:

Q = 3600 * V / T, where:

- Q … theoretical performance[m^3/h]
- V … the volume of rock extracted and processed during one theoretical work cycle [m^3]
- T … 1 theoretical work cycle time [s]
- 3600 …. constant for conversion to hours (s -> h)

Operational performance

$Q_p = Q \times k_1 \times k_2 \times \ldots \times k_a$,where:

- Q_p …. operational performance [m^3/h]
- k_1- k_a ….. correction coefficients

5. BUILDING MACHINES FOR BUILDING FOUNDATION

During the construction of engineering structures, but also increasingly for residential and civil structures, special methods are required and these methods require specific machinery.

Methods of building founding

The choice of the type of foundation depends mainly on the physio-chemical properties of the soil, from which its strength is derived, such as compressibility, saturation, consolidation and other deformation properties. The choice of the method of building founding is further dependent on the foundation soil (origin, age, mechanical properties), foundation conditions (simple and complex) and the complexity of buildings (low and demanding) and geotechnical categories (1-3 gc).

Types of building foundation:

- Surface foundations:
    - Footings – under the columns
    - Belts – under the columns or walls
    - Grids – under the columns or walls
    - Plates
- Deep foundations:
    - Piles:
        - carries the load by heel, jacket or both
        - pile division: group / lonely, according to material, according to inclination, according to transversal dimension, according to load transfer, according to the method of loading, according to the production process: perennial, vibrated, fluttered, screwed, drilled and spotted
    - Wells:
        - Construction of a prismatic or cylindrical shape, up and down open, lowering underneath

- Caissons:
  - Hollow bodies closed by a ceiling, triggered by submerging

- Underground walls
  - A filled layer is created with the appropriate material (or prefabricate)

The excavation pits of building pits - armor and sealing structures are used:

- Negative cladding:
  - type I beams are inserted into the borehole - the negatives, the spans and the wedges

- Pile-head walls
  - vibrate-pouring or flooding of steel piles

- Pilot walls
  - capture higher earth pressures, form directly the walls of objects

- Underground walls
  - forms a continuous wall

Machines used for building founding:

Digging holes for drilled piles are performed by impact rigs - the earth is extracted by a grab moving in a steel casing and hung on the excavator's rope, or by means of rotary kits - the soil is extracted by a screwdriver and spirally ejected from the borehole.

Another structural element in the deep foundation is the underground walls, which capture the earth pressures and load from the building. Underground walls are excavated using dredger sets or milling sets.

For pouring the pilots and piles into the ground, impact blades are used - they are mounted on excavators and piles into the ground by their own impact weight, or vibratory piles - piles into the soil (possibly pulling them out) using vibrations.

6.MACHINES FOR THE TRANSPORT AND HANDLING OF BUILDING MATERIALS –CONTINUOUSLY OPERATING

Importance of material handling

The concept of material handling includes a set of operations that are predominantly related to displacement, stowage, rectifying, positioning, weighing, dosing, packaging and storage of material in the production and circulation spheres. Manipulation operations are mostly activities that do not increase the utility values of the objects, but are a prerequisite for their creation. Objects that are manipulated during manipulation operations change their space and time.

Division of manipulated materials:

According to the state of aggregation:

- Rigid - from the point of view of manipulation, we are dividing solid materials into:
    - Bulk loose substrates: heterogeneous (unsorted) and homogeneous (sorted)
    - Loading units (single piece or compactly securely joined items such as packages, bundled goods, bags, etc.). A specific case of a loading unit is goods carried on means of transport (pallet units, containers).
    - Individual pieces: can be packed or unpacked
- Liquid
- Gaseous

Continuously operating handling means

Continuously operating handling means are a mechanization device primarily designed to convey loose materials. These machines are characterized by a continuous flow of conveyed material. These include conveyors, pneumatic and hydraulic transport systems. Most of these devices are used to transport bulk material, some are also adapted for the transport of piece materials.

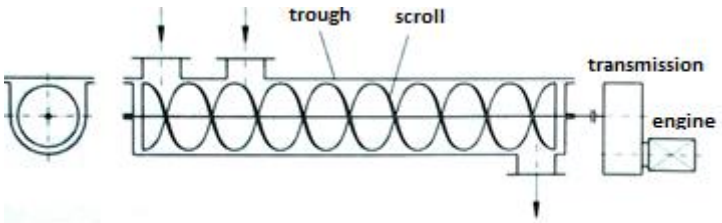
Conveyors

The conveyor is a continuously operating device for the continuous movement of bulk material, piece goods or integral handling units. Conveyor parameters: transport speed, weight flow, volume flow, conveyor length, and the way of volume flow control.

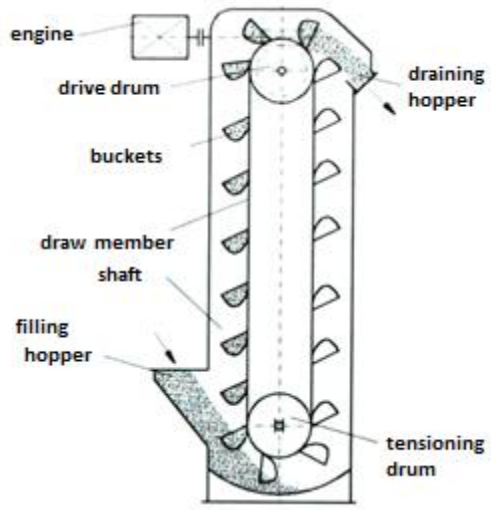
Division:

- transport direction (horizontal, obliquely uphill, vertically)
- with towing means (with carrier towing means, with trailing towing means)
- without trailer (screw conveyor)
- depending on the transported material

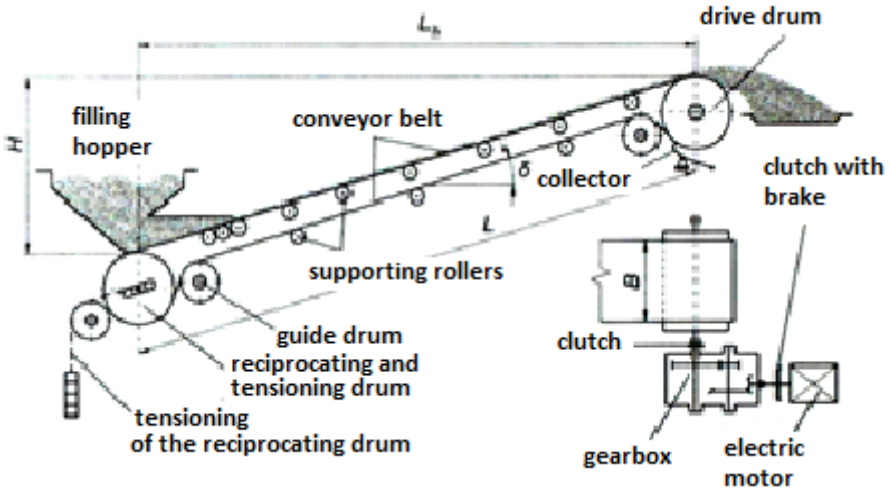
Screw conveyor transports the material through the rotating auger even in the oblique direction. It consists of a trough, a scroll (shaft and a screwdriver) and a drive. Rotating the screw causes the material to be shuffled due to the effects of gravity and material friction. It is used to transport dusty, granular materials up to 60 mm, fibrous materials. It is used to mix, wash, heat and cool the material.



The bucket conveyor (elevator) moves the material through buckets mainly in the vertical direction. It consists of a pulling member, drive, tensioning drum and belt buckles. It is used for transportation of fine-grained and piece material. We encounter several types of filling: popping, raking or combining. Buckets are emptied by gravity or centrifugal force.



The belt conveyor transports the material predominantly in the horizontal direction. It consists of a traction element, a drive, a drum and a supporting element - a belt supported by rollers (roller stool) or a planar surface. The belt may be of mesh, rubber, PVC or steel. It is used for transporting loose and piecewise materials on a distance up to 5 km. Types of roller stools: single-roller (piece material), two-roller, three-roller (bulk material) or garland stool.



Pneumatic transport - the conveyed material is entrained by flowing air. During transport, the material may be dried by hot air (mined coal in power stations).

Hydraulic transport - the conveyed material is carried by flowing fluid, most often water. During transport, water can also be used to wash transported items.

Lorries

Road vehicles are divided according to their layout and purpose on flat-tipped flatbed and dump-type dumpers. Off-road vehicles - Dump trucks are robust machines with rigid or articulated chassis. Towing vehicles are connected to basic cars - to lorry chassis as trailers or semi-trailers.

Transport trolleys

The transport trolleys are designed for transporting bulk and piece materials along paved roads over short distances. Depending on the structure, it is divided into platform, bulwark, low lift, forklift (lift above 1.5 m).

Handling equipment

The handling equipment ensures the loading and unloading of materials from the means of transport or their handling at the construction site, in factories. This group includes hydraulic arms mounted on trucks or other vehicles, telescopic manipulators.

7.HANDLING MACHINES FOR BULK MATERIALS – CYCLICALLY OPERATING

Cyclically operating handling machines for bulk materials

Cyclically operating handling machines are devices that move the material from the initial place to the destination. This displacement takes place in closed working cycles and in batches. The working cycles of such devices differ:

- The distance on which the material is moved
- Moving speed
- Different sizes of batch
- Different time interval between batches

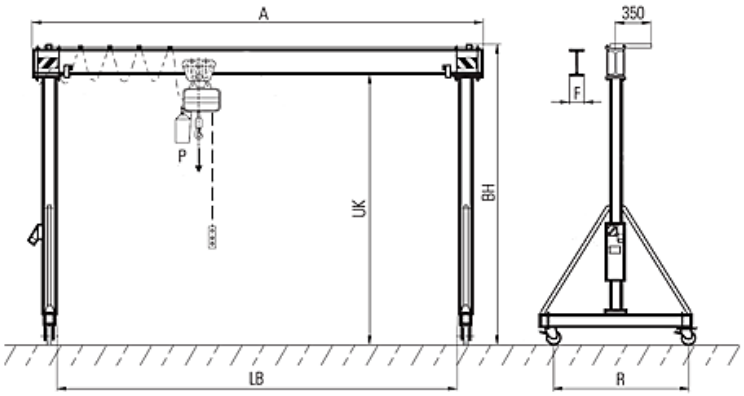
The basic cyclically operating handling equipment used in the building industry are:

- Cranes
- Load gripping devices
- Shovel excavators
- Bulldozers (dozers)
- Rolling mechanical shovels and rope rakes

Cranes

Cranes are cyclically operating mechanization devices that are designed to move loads in space. They are tied to a fixed crane track in terms of movement. According to the crane design, we distinguish bridge cranes, portal gates, gantry and cantilever. Load capacity is the main technological parameter of the crane and the capacity of the crane is dependent on the type of crane and the way of its construction. These cranes are equipped with various means for gripping loads, for loose material such as a grab. They are used for loading operations and for handling external material dumps.

Light gantry crane



Source: www.krantechnik.cz

Load grippers

The safety and speed of handling the loads depends primarily on the choice of suitable means. For bulk materials, therefore, it is necessary to choose the means which are adapted to this kind of material. Such means include containers and jaw claws.

- load grip can be:
    - pure hand - for example hooks, binding means
    - partially mechanized - claw or gaffer hinges and containers
    - or fully mechanized - grabs, electromagnets, suction hinges, etc.

Jaw grab

Source: http://stavebni-technika.cz/

Shovel excavators

It is a cyclically operating machinery designed mainly for earthworks but can also be used for loading and unloading of transport means by bulk material.

A shovel excavator includes a tracked, wheeled, automotive or special chassis, a drive, a boom with a working device at the end, and control elements. The excavator's working tool is usually a shovel attached to the boom so that it is both sliding and swinging. The volume and shape of the shovel depends on the material being handled and the working position of the excavator. Shovel capacity ranges from 1.5 m^3 (small excavators) to 6 m^3 (middle excavators) and heavy excavators have a shovel volume of over 6 m^3. Another working tool of the excavator can be, for example, a grab or other tool.

Tracked excavator

Source: www.mitophb.cz

Bulldozers (dozers)

Bulldozers belong to the mechanization equipment for earthworks and are also very well used in the handling of bulk material dumps. They are derived from tracked tractors and their work tool is a blade that is placed perpendicular to the tractor's axis at the head of the drive.

Bulldozers are used to break loose materials, such as coal or earth, to the blade edge. The material continues to flush in front of each other, moving it at the same time. Bulldozers are used to move soil to relatively short distances, up to about 60 to 100 m.

Bulldozer

Source: http://buldozer.unas.cz/

Rolling mechanical shovels and rope rakes

Rolling mechanical shovels and rope rakes are cyclically operating mechanical devices that are designed for the horizontal transport of loose materials. The material flush and move to the designated place in two ways:

- Thanks to a motorized shield (shovel) - so-called **rolling mechanical shovels**. These consist of a scraper metal shield, a tow rope and a motor-driven winch. They are used for unloading sand, coal, sawdust, etc.
- Or bucket (vessel) - so called **rope rake**. It works on a similar principle as a shovel mechanical bucket, the difference is another rope, which returns via the return pulley to the winch, which makes it possible to rotate the container by 180 ° and to break the material. They are used on large landfills that cannot be served by bulldozers or cranes.

8.MACHINES FOR LOAD LIFTING AND SLIDING

Shovel loaders

Loaders are used to handle both bulk and piece materials and light earth extraction. Front loaders perform all operations only on the front and are located on a wheeled or tracked chassis. The so-called mini-loaders have a working weight of 1-6 tons. Rotary loaders have a boom with a rotating bucket 90° on both sides.

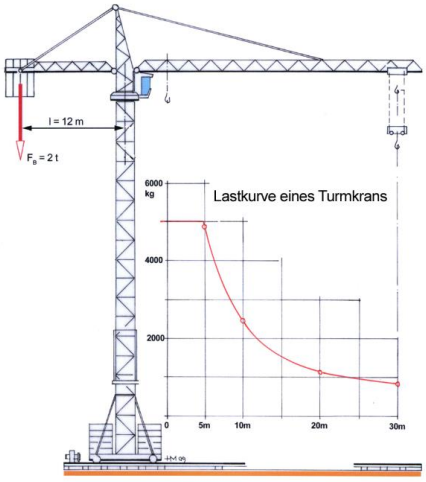
Construction lifts, platforms and bridges

A construction lift with a cab attached to the construction of the building is used to transport persons and loads. The construction platforms are led by poles and anchored to the construction of the building or free standing (up to 30 m high). The construction bridges are suspended by ropes on the beams anchored to the construction of the building and are especially designed for work on facades. Mobile lifting platforms are telescopic, shoulder or scissor structures that can replace a stable scaffolding.

Cranes

Cranes can be divided into several types of machines. It also serves to lift loads. Individual types of cranes exist in combinations (e.g. portal rope crane).

Tower crane is a device that is used to handle loads. The design may be without running or with running. There are self-leveling cranes that have a truss or full-height tower, and universal tower cranes (climbing) that consist of individual parts and sections. Tower cranes have a horizontal, swingarm and boom with a cat. Boom cranes are equipped with a counterbalance that can be equipped with a running to achieve balance.



Crane load capacity curve

Pillar crane is made up of a pivoting arm mounted on a pillar. It is anchored to the floor.

Mobile crane (automotive crane) is a lifting device mounted on an automobile chassis. It has high mobility, allowing it to be smooth and fast on the road. They have a telescopically removable boom.

Gantry crane enables the lifting of heavy loads (Taisun - capacity 20 000t). They can be fixed or mobile.

The most powerful crane Taisun

Rope crane is a crane that uses ropes as carrier elements. The ropes are fixed to the upper parts of the cranes.

Sinks (slides) for building debris and waste material

These are easily assembled parts. It consists of the sliding parts, the filling part (funnel), the hopper part and the frames for attachment.

9. ADDITIONAL HANDLING MACHINES

Loose materials reservoirs

Reservoirs are underground or above ground tanks, which can have different shapes. They are designed for long-term or short-term storage of loose materials. Their main purpose is to create a reserve that is required for the operation of production facilities or the proper operation of transport facilities. Reservoirs thus compensate for differences in supply and material drawdowns.

The content, that is the capacity, of the reservoirs, determines the size of the required reserve and also the unevenness of the supply of the particular material.

According to the type of stored material, thus the determination of the reservoirs, we can divide them into:

- Loose material reservoirs: filled from above and discharged either from the bottom or from the side and in a forced manner. These reservoirs include bunkers (low reservoirs) and silos (high reservoirs)

- Bulk material reservoirs: They differ from classical reservoirs by preventing the material from clogging over the discharge opening, which would allow the formation of a vault

- Non-solid bulk reservoirs - that is materials with irregular cohesive particles: they are special reservoirs used to store materials that tend to form a vault in the reservoir. Such masses have limited mobility in classical reservoirs, and most of them tend to stop the material outflow. These reservoirs include trough reservoirs (moving material in a sloping trough), cylindrical (rotated bottom, wheel drive and cone with vibrator) and slit reservoirs (with forced take-off by wagons).

Silo for building materials

Source: http://www.zking.cz

Feeders

Feeders are devices that serve to uniformly deliver material to a conveyor or to manufacturing machines. Material is most often taken over the shutters. It is possible to control the volume or mass of the material flow and thereby control the flow itself

Loaders

Loaders for bulk material can have many design solutions. According to the temporal continuity of the result of their activity, we divide them into:

- continuously working loaders: bucket, bucket with roll augers, belt conveyor, claw, milling, wheel and screw

- cyclically working loaders: bucket or grapple

Unloaders:

- screw conveyor
- mobile portal bucket unloader
- bridge bucket unloader

Crawler Loader (Excavator)

Source: http://www.konstrukce.cz

10. BUILDING MACHINERY FOR THE PRODUCTION, TRANSPORT AND PROCESSING OF MORTARS AND CONCRETE

Production of concrete and mortar

In the production of concrete and mortar, the principles must be respected so that they have sufficient and required toughness and durability.

The production of concrete and mortar can take place in several places:

- at a construction site where production ensures:
    - individual mixers
    - site mixers (mortar)
- in central factories - factories outside the construction site:
    - concrete (mortar) must be delivered to the site

Kinds of mixers

- Gradient mixers (gravity):
    - Concrete or mortar components are dosed and mixed in a rotating drum using blades and gravity.
- Mixers with forced mixing:
    - Stirring of a mixture of concrete or mortar components is ensured by differently set blades in the drum
    - Types of execution:
        - manger (horizontal drum axis)
        - plate (vertical drum axis)

Transportation of concrete and mortar

Primary transport

Primary transport is the transport of concrete or mortar from the concrete plant to the building (pickup container) = transportconcrete.

- Long distance transport:
    - Machines that prevent the hardening process and blending of the mixture:
        - concrete mixers (filled with concrete)
        - drilling machines (filled with dry mixture of aggregate and cement)
- Short-distance transport:
-
    - In a short time horizon the hardening process or the mixing of the mixture does not begin:
        - Trucks - with a steel tub
        - Van transport containers

Secondary transport

The term secondary transport is meant to transport concrete within the construction site, either from the mixer, the pick-up tank or the concrete site.

- For transportation on construction site, use:
    - Belt conveyors
    - Pipeline transport (with pumps)
    - Roller bins
    - Motorized trucks
    - Troughs and slopes
    - Wheels

11. 3D SCANNING AND 3D PRINTING IN THE CONSTRUCTION INDUSTRY

Photogrammetric mensuration of object

Photogrammetry is a science field that deals with the processing of information on photographic images. It gets information about physical objects that are based on geometric relationships: shape, size, position.

3D object scanning

3D scanning is used in many industries. It is the process of digitizing a physical object in its virtual reality. It allows accurate digital form of real object to be created. In construction, it is often used with photogrammetry. 3D scanning is on the principle of light or laser beams.

3D printing technology

Printing on the principle of material bonding: The print head applies the fibers of the appropriate material over the layers. 3D printing is widely used in engineering or healthcare. In construction 3D fiber printers can print smaller models of building objects. But on the same principle, the construction itself can be made.

In order to realize the model or construction, a computer model is always needed to control the process of printing itself.

Materials for models:

- Plastic - a twisted string on a cartridge; PLA or ABS
- Powder (gypsum) - Applying layers to the entire printer board + Glue injecting; the residual powder is filtered off

3D printing technology in construction

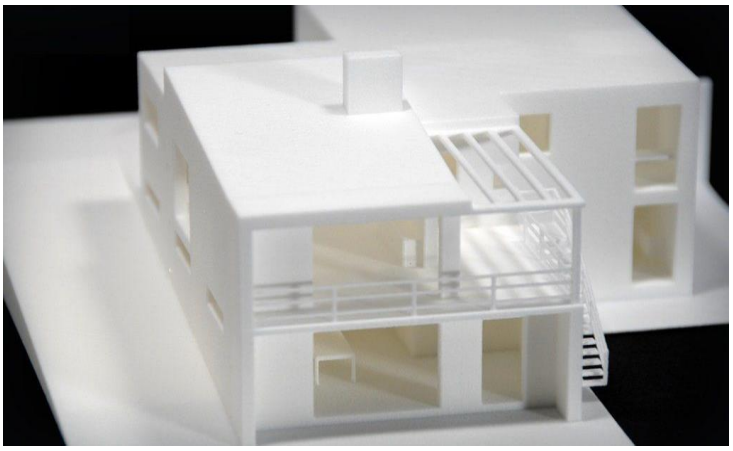
- Layer of fast-drying concrete, reinforced with steel fibers, fiber reinforced concrete

Source: http://www.youtube.com

Advantages of 3D printing in construction

Reduced construction model:

- Comprehensive visualization of design for better performance, better perception of space
- Output from the virtual model of the proposed or existing building



Source: https://i.materialise.com/blog/3d-printing-for-architects/
Construction itself:

- Automated construction - Contour Crafting
- Speed of construction
- Cheap and economical houses (building from concrete mixture without the need for additional thermal insulation

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