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Timber Haulage

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Contents and Goals

- Timber haulage
  - Types of haulage trucks
  - Basic add-ons of the haulage trucks
  - Timber haulage technology
  - Productivity and economics of timber haulage

Timber Haulage

- Transport of raw stems or logs from the roadside to depots or to the customer
- Final phase of raw timber production
- Theoretically and practically best managed phase of raw timber production
  - Research and development from the automotive industry
  - Haulage takes place on clearly defined roads
  - Variability of conditions is lower than in other phases

Types of haulage trucks

- We use
  - Trucks
  - Hauling rigs
    - Created by attaching a trailer to the truck
- Trailers can be
  - Platform
  - Pole

Truck

Trailer

Articulated trailer

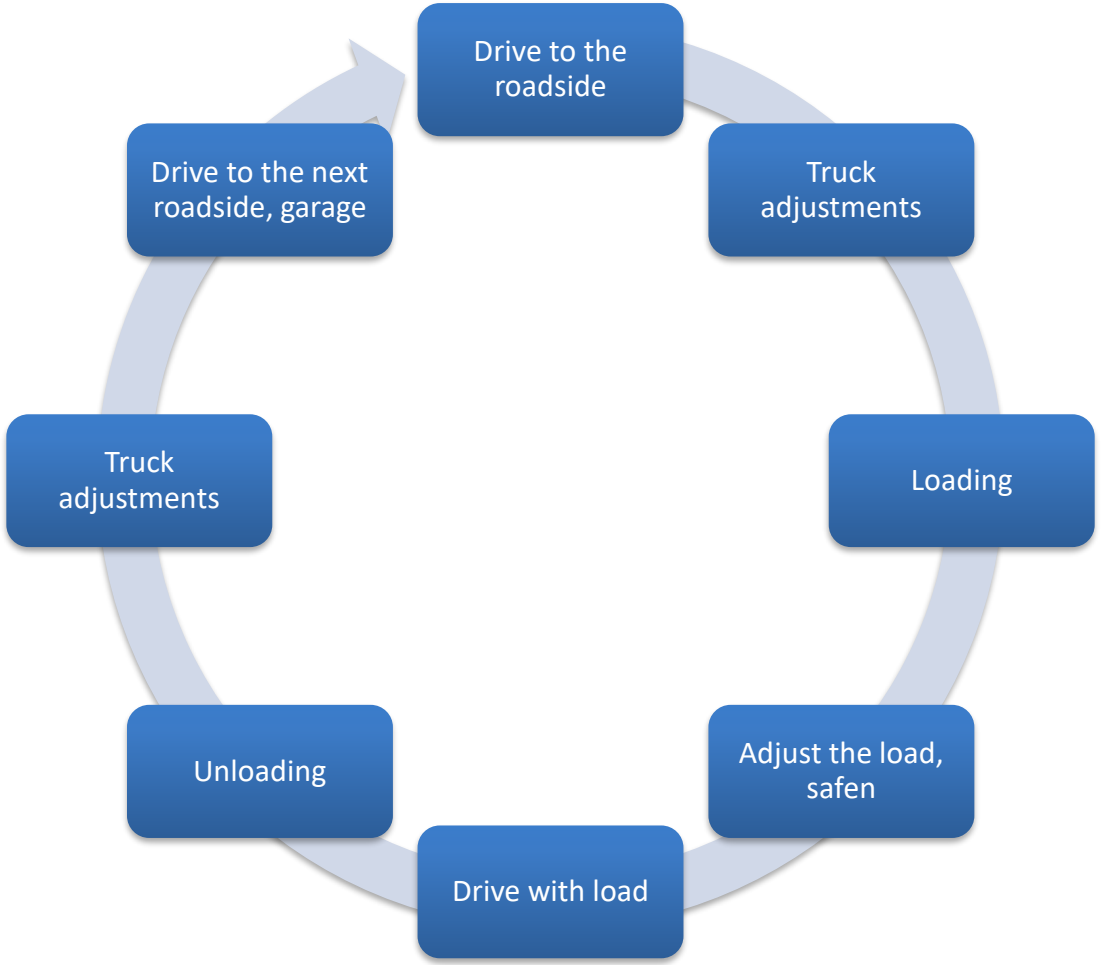
Semi-trailer

Basic add-ons of the haulage trucks

- Basic add-ons include
  - Device for loading and unloading timber
    - Winch, hydraulic crane
  - Device for load assembly
    - Fixed or turn poles, side plates, protection plate
  - Device for fixing the load
    - Binding devices, protection mesh
  - Guiding device for semi-trailers
    - Steerable axle
  - Other devices
    - Ladders, fixation wedges, crow bars, red flags, maintenance gear

Technology of timber haulage

- Selection of the haulage truck is affected by the length of timber
- We differentiate between haulage of:
  - Short logs (1–2,5m)
  - Logs (2,5–6m)
  - Long logs, stems (+6m)
- Operational cycle consists of:
  - Drive to the roadside
  - Preparation for loading
  - Loading
  - Adjustments to the load
  - Drive with load
  - Unloading
  - Preparation for return drive
  - Drive to the next roadside or garage
- When using a haulage rig, it is also necessary to:
  - Attach the trailer
  - Separate the trailer or unload it from the platform at the roadside
  - Prepare and safen the trailer, adjust poles, check the poles



Permitted weights of the haulage trucks

- Total loading of the haulage truck with a semi-trailer
  - The sum of loading of the truck and the semi-trailer
- One axle can be loaded to:
  - Individual axle 10 t
  - Individual driven axle 11,5 t
  - Double axle, the total load of both axles cannot exceed x at partial wheel base
    - Up to 1,0 m 11,5 t
    - From 1,0 m up to 1,3 m 16 t
    - From 1,3 m up to 1,8 m 18 t
- Upmost permitted weight of road vehicles:
  - Two-axled vehicles 18 t
  - Three-axled vehicles 25 t
  - Three-axled trailers 24 t
  - Haulage rigs 48 t

Weight distribution of long logs on a haulage rig

- For easier drive through curves, it is advised to adjust the pole trailer closer to the center of gravity of the load
- The load has to be optimized; this prevents:
  - Excessive wear of the trailer tyres
  - Decrease of the lifespan of the trailer
- In real traffic, the following can happen:
  - Truck has lower payload than the trailer
  - Truck has the same payload as the trailer
  - Truck has greater payload than the trailer
- Most common are cases when trailers have the same payload as trailers – we adjust the semi-trailer at ¾ of the average log longth
- If this is not the case, trailer should be moved closer to the truck by 10%

Productivity of timber haulage

- Productivity depends on the load volume and the trip duration

- Load volume of a truck can be determined by:

$$Q = \frac{Q_{uvz}}{\rho}$$

Legend: Q – load volume [m^3]; Q_{uvz} – payload of the truck [kN]; ρ – density of the timber [$kN.m^{-3}$]

- Trip duration depends on several factors:

$$n = \frac{(Tt_{pz})\gamma}{lt_1 + Qt_2}$$

Legend: T – duration of the shift [min]; t_{pz} – time for preparation and finishing work [m^3]; Q – mean load volume per trip [m^3]; l – trip range [km]; t_1 – mean duration of drive loaded and unloaded [min]; t_2 – mean duration of loading and unloading 1m^3 timber [min]; γ – coefficient of shigt utilization (0,8)

Productivity of timber haulage

- Shift productivity is the number of trips and the load volume per one cycle
- Haulage performance:

$$P = \sum_{i=0}^{n} q_i l_i$$

Legend: P – haulage performance, q_i – haulage volume at i-th trip, l_i – haulage range of the i-th load

- If the company has trucks equipped with GPS, it can use them to determine the haulage performance

Haulage performance - example

Assignment: to create a model of costs for timber haulage from the forest stand to the depot. Mean transport range was 20km, weight of the rig was 40t, the rig drove on: 2km hard forest road, 7km paved forest road, 4km state road (municipality), 7km state road II. class. Purchase price of the rig: 227 000 €.

- We had a database of GPS location of the rigs at our hands, and their operational parameters – fuel consumption, elevation, speed, etc.
- We estimated the haulage performance using the database
- We constructed a linear model of the relationship between speed and (e.g.):
  - RPM of the truck's engine,
  - Road slope,
  - Load volume,
  - Road type.

Haulage performance - Example

- The output of linear modeling was an equation

$$y = -10.76 + 0.02x_1 + 0.06x_2 + 0.12x_3 + 2.55x_4$$

Legend: y – mean speed of the haulage rig (km.h^{-1}); x_1 –RPM of the truck's engine; x_2 – road slope (%); x_3 – load volume (m^3); x_4 – road type,

- Through this equation we can predict the speed of the haulage rig in given conditions:
  - On hard forest road – 20,61 km/h load, 20,68 km/h no load
  - On paved forest road – 20,57 km/h load, 26,02 km/h no load
  - On paved road (municipality) – 27,31 km/h load, 25,05 km/h no load
  - On paved road (out of municipality) – 29,27 km/h load, 27,13 km/h no load
- From the GPS database we read how long the rigs were moving per year
- The rig was in operation for 1 146 hod/year, so the haulage performance was
  - On hard forest road – 2362,29 km load, 2369,84 km no load
  - On paved forest road – 8223,66 km load, 10437,39 km no load
  - On paved road (municipality) – 6260,33 km load, 5742,12 km no load
  - On paved road (out of municipality) – 11739,66 km load, 10881,77 km no load
  - On total the rig had driven for 132 000 km per year, with half utilization, the haulage distance was about 66 000 km

Haulage performance - Example

- We still have not expressed the haulage performance:
  - The average speed of the rig in one trip was 24,57 km/h
  - At haulage distance 20km (transport dist. 40km) the time consumption per trip was 1,63 h
  - On total the rig did 704 trips per year
  - The rig's weight was 40 t, when we subtract the weight of the rig itself, we find that the payload was 20,2t
  - At full payload utilization, the haulage performance was about 14 000 m^3/ year

Economics of timber haulage

- Price calculation of 1m³ hauled timber depends on the basic cost model
- To estimate unit costs, we have to know the unit, i.e.
  - m³
  - km
  - m³km (cubekilometer)
- Cost model of timber haulage is the total annual costs of operating a rig divided by the transport performance (or haulage performance)

1. Fuel
2. Direct material
   A. Lubricants
   B. Tyres
3. Personal costs
   A. Direct wages
   B. Social and health insurance
4. Depreciation and amortization
5. Repairs and maintenance of the rigs
6. Other direct costs
   A. Travel expenses
   B. Road tax
   C. Other direct costs

= Direct costs (items 1–6C)

7. Operational overhead

= Operational costs (items 1–7)

8. Administration overhead

= Total costs of haulage (items 1–8)

9. Profit

= Price of haulage (items 1–9)

Item	Total costs	km	m^3	m^3km
1. Fuel	36 318,67 EUR	1,34 EUR	2,81 EUR	0,1403 EUR
2. Direct material	1 394,44 EUR	0,06 EUR	0,09 EUR	0,0058 EUR
2.1. Lubricants	149,10 EUR	0,01 EUR	0,00 EUR	0,0013 EUR
2.2. Tyres	1 245,33 EUR	0,04 EUR	0,09 EUR	0,0045 EUR
2.2.1 Truck	854,88 EUR	0,03 EUR	0,06 EUR	0,0031 EUR
2.2.2 Trailer	390,45 EUR	0,01 EUR	0,03 EUR	0,0014 EUR
3. Personal costs	29 430,34 EUR	1,01 EUR	2,12 EUR	0,1060 EUR
3.1. Direct wages	21 768,00 EUR	0,75 EUR	1,57 EUR	0,0784 EUR
3.2. Social and health insurance	7 662,34 EUR	0,26 EUR	0,55 EUR	0,0276 EUR
4. Amortization and depreciation	37 839,00 EUR	1,30 EUR	2,73 EUR	0,1363 EUR
5. Repairs and maintenance	6 740,00 EUR	0,23 EUR	0,49 EUR	0,0243 EUR
6. Other direct costs	3 932,54 EUR	0,14 EUR	0,28 EUR	0,0142 EUR
6.1. Travel expenses	1 507,68 EUR	0,05 EUR	0,11 EUR	0,0054 EUR
6.2. Road tax	2 424,86 EUR	0,08 EUR	0,17 EUR	0,0087 EUR
6.3. Other direct costs	573,23 EUR	0,02 EUR	0,04 EUR	0,0021 EUR
Direct costs (items 1 – 6.3)	115 654,99 EUR	4,08 EUR	8,51 EUR	0,4268 EUR
7. Operational overhead	9 450,00 EUR	0,33 EUR	0,68 EUR	0,0340 EUR
Operational costs (items 1 – 7)	125 104,99 EUR	4,41 EUR	9,19 EUR	0,4609 EUR
8. Total costs of haulage	125 104,99 EUR	4,41 EUR	9,19 EUR	0,4609 EUR
9. Profit				
9a. Profit 3%	3 753,15 EUR	0,13 EUR	0,28 EUR	0,0138 EUR
9b. Profit 5%	6 255,25 EUR	0,22 EUR	0,46 EUR	0,0230 EUR
9c. Profit 10%	12 510,50 EUR	0,44 EUR	0,92 EUR	0,0461 EUR
9d. Profit 15%	18 765,75 EUR	0,66 EUR	1,38 EUR	0,0691 EUR
Haulage price a.	128 858,14 EUR	4,54 EUR	9,47 EUR	0,4747 EUR
Haulage price b.	131 360,24 EUR	4,63 EUR	9,65 EUR	0,4839 EUR
Haulage price c.	137 615,49 EUR	4,85 EUR	10,11 EUR	0,5069 EUR
Haulage price d.	143 870,74 EUR	5,07 EUR	10,57 EUR	0,5300 EUR

End of section 5

THANK YOU FOR YOUR ATTENTION