



Comparison of Real Axle Loads and Wheel Pressure of Truck Units for Wood Transportation with Legal Restrictions



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Introduction

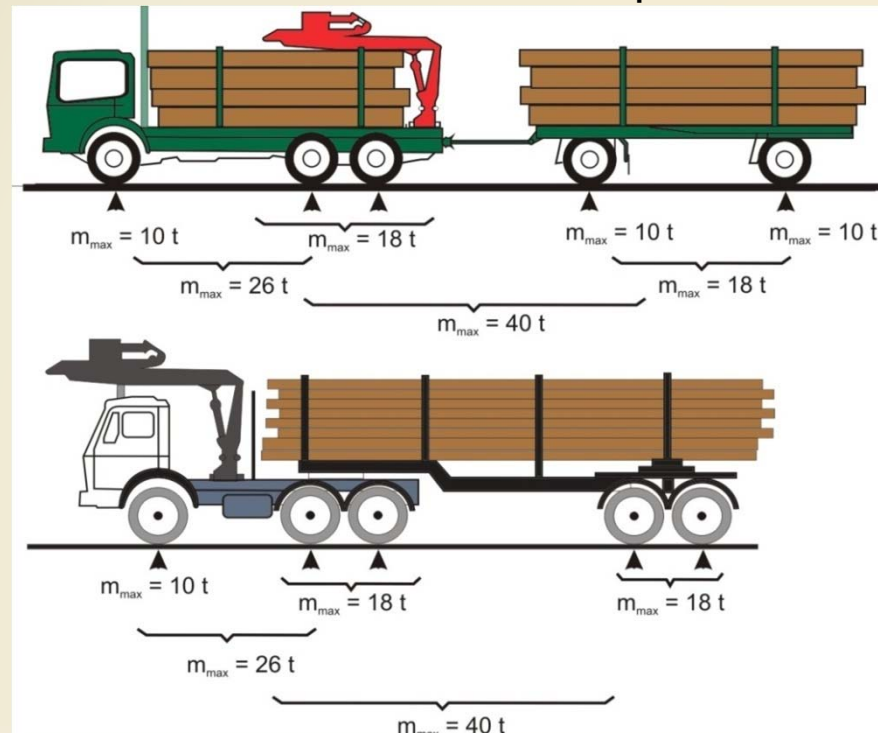
- In Croatia, wood transport is usually carried out by two variants of truck units :
 - truck with trailer
 - truck with two-axle semitrailer

- Since wood transportation by truck is the most expensive form of wood transport, special attention should be focused in new technical-technological and organizational solutions

- Success of truck transport depends on a series of factors, some of which are affected by forestry profession – technical construction of truck units, organization of forest road landings, while the legal regulations on dimensions and carrying capacity of truck units, speed restrictions, road condition and traffic frequency are beyond our control.

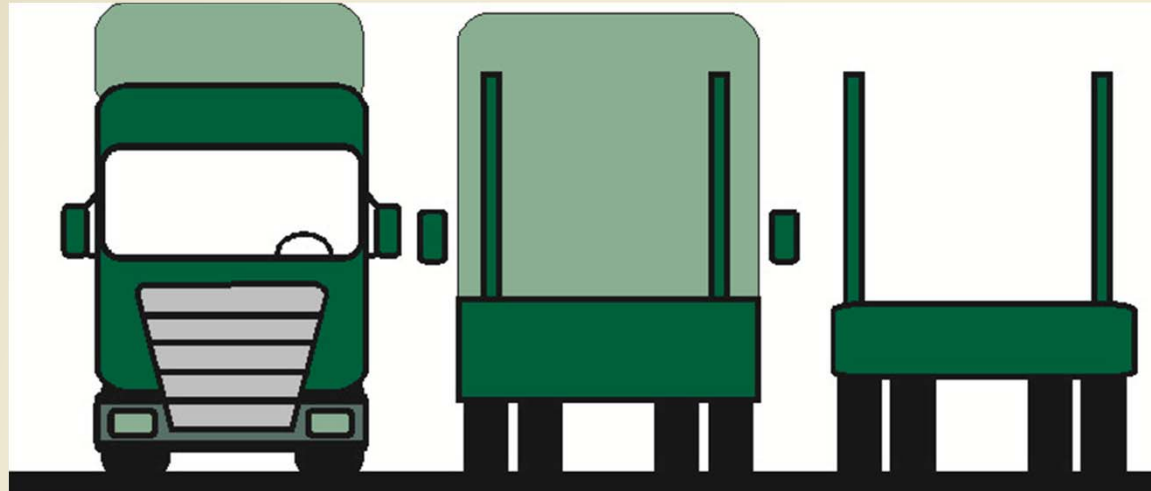
Introduction

➤ The basic law in Croatia that regulates technical characteristic of truck units is the “Regulation on Technical Conditions of Vehicles in Road Traffic” – (Official Gazette “Narodne novine”, No 51/10) which uses the mass measuring units for restrictions of technical conditions of truck transport.



Introduction

➤ At the same time, while the mass measuring units are used for axle load and total load, the truck and trailer axels are equipped with dual tires in order to lower the contact pressure of truck units on road surface.



➤ Aim of this research was to measure the axle loads of truck and semitrailer units with different types of load, so as to provide the possibility to calculate the wheel/road contact pressure based on selected equations for the calculation of wheel contact area

Materials and methods

- Research was carried out on two trucks with trailer (Iveco Trakker and Scania), and on MAN truck with semitrailer



Axles	Truck SCANIA with trailer	Truck IVECO with trailer	Truck MAN with semitrailer
1. truck	Continental 315/80 R22,5 HS45	Michelin 385/65R22.5	Sava 13R22.5
2. truck	Continental 315/80 R22,5 HS75)	Michelin 315/80R22.5	Sava 13R22.5
3. truck	Continental 315/80 R22,5 HS75	Michelin 315/80R22.5	Sava 13R22.5
1. trailer	Continental 315/80 R22,5 HS75	Michelin 295/80R22.5	Sava 12R22.5
2. trailer	Continental 315/80 R22,5 HS75	Michelin 295/80R22.5	Sava 12R22.5

Materials and methods

- Two measuring systems were used for measuring axle load
- First system is made from four independent scales; each scale is equipped with independent dynamometers intended for measurement of pressure strains. Load limit of each scale is 90 kN



NOTEBOOK



HBM - SPIDER AMPLIFIER

Materials and methods

- Second measuring system is a portable measuring platform, which is equipped with four sensors, each of four sensors have load limit of 30 tones





Materials and methods

Author	Contact area	Nominal pressure of the vehicle wheel
Mellgren (1980)	$A = r \cdot b$	$NGP = \frac{G_k}{r \cdot b}$
		Contact pressure of the vehicle wheel
Komandi (1990)	$A = \frac{c \cdot G_k^{0,7} \cdot \sqrt{\frac{b}{d}}}{p_i^{0,45}}$	$p = \frac{G_k^{0,3} \cdot p_i}{c \cdot \sqrt{\frac{b}{d}}}$
Maclaurin (1997)	$A = b^{0,8} \cdot d^{0,8} \cdot \Delta^{0,4}$	$p = \frac{G}{b^{0,8} \cdot d^{0,8} \cdot \Delta^{0,4}}$
Legend key: <p>p – contact pressure, kPa NGP – nominal pressure, kPa G – vehicle mass, kN G_k – vehicle wheel load, kN A – contact area, m² d – diameter of unloaded wheel tire, m</p>	<p>r – radius of unloaded wheel tire, m Δ – tire deflection of vehicle wheel, m b – width of unloaded wheel tire, m p_i – tire inflation pressure, kPa c - coefficient of soil type:(3 - 3.2 for hard soil)</p>	

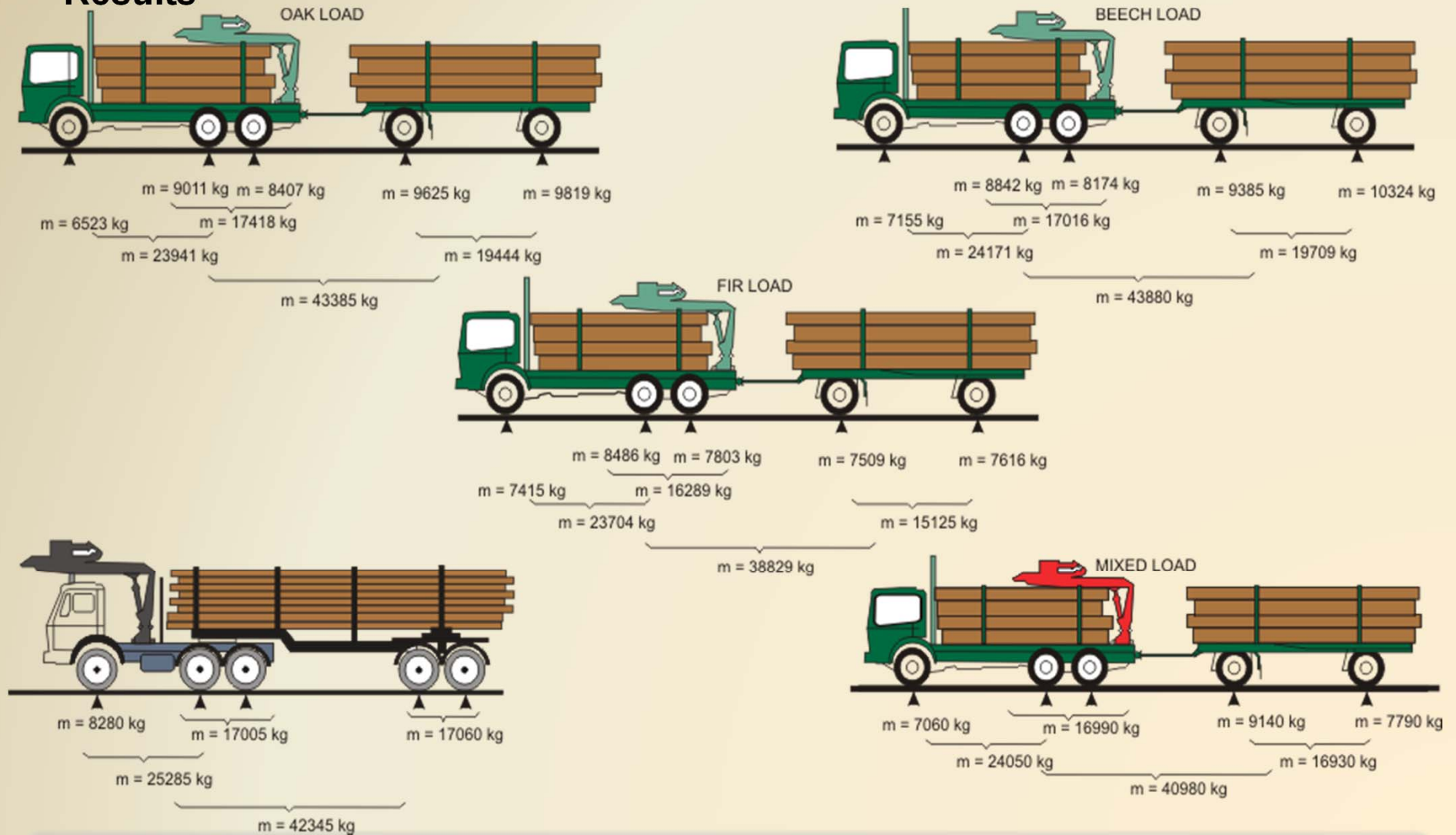


Results Axle loads and contact pressure of empty truck units

Truck with trailer		SCANIA				
Axles		1. truck	2. truck	3. truck	1. trailer	2. trailer
Measured loads (kg)		5010	4845	4283	2396	2189
Contact pressure (kPa)	Mellgren (1980)	145.05	70.13	62.22	34.71	31.70
	Komandi (1990)	1287.48	1035.29	998.78	838.36	815.85
	Maclaurin (1997)	219.98	133.08	118.07	64.15	58.58
Truck with trailer		IVECO				
Axles		1. truck	2. truck	3. truck	1. trailer	2. trailer
Measured loads (kg)		4690	5010	5010	2430	2820
Contact pressure (kPa)	Mellgren (1980)	135.78	72.55	72.55	35.18	40.85
	Komandi (1990)	1262.23	1045.89	1045.89	841.77	880.34
	Maclaurin (1997)	205.92	137.67	137.67	65.02	75.49
Truck with semitrailer		MAN				
Axles		1. truck	2. truck	3. truck	1. trailer	2. trailer
Measured loads (kg)		8336	4051	4051	2104	2104
Contact pressure (kPa)	Mellgren (1980)	241.33	58.68	58.68	30.46	30.46
	Komandi (1990)	1499.93	981.37	981.37	806.15	806.15
	Maclaurin (1997)	366.00	111.34	111.34	56.29	56.29



Results





Results Axle loads and contact pressure of loaded truck units

Truck with trailer		SCANIA				
Load		OAK				
Axles		1. truck	2. truck	3. truck	1. trailer	2. trailer
Axle loads (kg)		6523	9011	8407	9625	9819
Contact pressure (kPa)	Mellgren (1980)	188.88	130.46	121.72	139.35	142.16
	Komandi (1990)	1393.62	1247.19	1221.50	1272.10	1279.74
	Maclaurin (1997)	292.51	217.23	205.13	229.28	233.04
Truck with trailer		SCANIA				
Load		BEECH				
Axles		1. truck	2. truck	3. truck	1. trailer	2. trailer
Axle loads (kg)		7155	8842	8174	9385	10324
Contact pressure (kPa)	Mellgren (1980)	207.18	128.02	118.35	135.88	149.47
	Komandi (1990)	1432.83	1240.13	1211.24	1262.50	1299.14
	Maclaurin (1997)	347.37	243.96	229.83	255.16	273.97
Truck with trailer		SCANIA				
Load		FIR				
Axles		1. truck	2. truck	3. truck	1. trailer	2. trailer
Axle loads (kg)		7415	8486	7803	7509	7616
Contact pressure (kPa)	Mellgren (1980)	214.71	122.86	112.97	108.72	110.27
	Komandi (1990)	1448.25	1224.93	1194.48	1180.80	1185.82
	Maclaurin (1997)	356.31	236.48	221.80	215.34	217.70



Results Axle loads and contact pressure of loaded truck units

Truck with trailer		IVECO				
Load		MIXED LOAD				
Axles		1. truck	2. truck	3. truck	1. trailer	2. trailer
Axle loads (kg)		7060	8495	8495	9140	7790
Contact pressure (kPa)	Mellgren (1980)	167.89	122.99	122.99	145.64	124.13
	Komandi (1990)	1288.45	1225.32	1225.32	1274.88	1215.20
	Maclaurin (1997)	293.92	236.67	236.67	270.07	239.16
Truck with semitrailer		MAN				
Load		MIXED LOAD				
Axles		1. truck	2. truck	3. truck	1. trailer	2. trailer
Axle loads (kg)		8280	8502.5	8502.5	8530	8530
Contact pressure (kPa)	Mellgren (1980)	225.83	115.95	115.95	128.30	128.30
	Komandi (1990)	1518.37	1243.15	1243.15	1263.83	1263.83
	Maclaurin (1997)	367.17	225.76	225.76	244.77	244.77



Conclusion

- Research results show that with approximately the same load volume, trucks with trailers or truck with semitrailer are overloaded – total mass higher than 40 tones. Only truck SCANIA with semitrailer with load of fir logs are not overloaded due to smaller wood density of fir. However, only one axle was overloaded which could be explained by irregular piled wood assortments in the load space.
- The law regulations uses the mass measuring unit for restrictions of technical conditions of truck transport but wheel load and contact pressure of truck wheels cause deformations of the road surface. Overloading the axles will affect on durability and utilization of trucks and the real impact of truck on road surface responds through contact pressure of wheels.



Conclusion

- The highest contact pressures were always noticed under the wheels of the front axle of the truck regardless on type of truck unit.
- It could be concluded that in the law regulations need to introduce contact pressure of truck wheels although there is no reasons for equipping rear axles of truck with dual tires. On the other hand, with equipping the front axle of trucks with wider tires or with dual tires will have a great impact of decreasing contact pressure in the aim to avoid the greater disturbance of road surface and to reduce maintenance costs of forest roads in a longer period.



Thank you for your attention!