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Load distribution plans for forwarders

The load calculation diagrams known from commercial goods traffic were used to assess the loading capacity of a forwarder. In order to be able to integrate the centre of gravity of the timber load into the diagram, it was assumed that the cross section of the stanchion basket was fully loaded. Based on this assumption, the load was calculated. For permissible axle loads to be shown, the coordinates were transformed so that the assortment length of the load, which is more clearly understandable for the user, can be employed in the diagram. This adapted load calculation diagram allows possible load, capacity, possible assortments, and load overhang to be determined.

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During the fully mechanized timber harvest, forwarders (*fig. 1*) are used for the hauling of the felled and logged timber from the felling place to the log depot. Here, the possible timber load is an important criterion. However, users cannot easily determine which timber assortments enable their machine to be fully loaded and when the danger of overloading arises. The complete filling of the cross section of the load bay with logs of different lengths depending on the individual assortments is typical of loading. The operator is then confronted with the question of how long logs may be in order to prevent overloading when the cross section of the load bay is fully utilized or to what height the load bay may be filled at a given length.

For commercial motor freight vehicles, load calculation plans [1, 2] are employed in order to evaluate and optimize the load. Depending on the position of the centre of gravity of the load, these plans show what mass can be loaded without the load carrying capacity of an axle being exceeded or steerability being compromised due to the reduction of the axle load. These requirements can be formulated in four demands which can be expressed in mathematical terms:

1. The maximum permissible payload and permissible gross weight may not be exceeded. This limitation results from the stability of frames and load bays as well as the limits set by the German Motor Vehicle Safety Standards.
2. The permissible axle load on the front axle may not be exceeded. This limit results from the technical carrying capacity of the axle.
3. The permissible axle load on the rear axle may not be exceeded. This limit also results from the technical carrying capacity of the axle.
4. The load on the steered axle may not fall below the required minimum. This limit is a result of the fact that steerability is no longer given if the percentage of the vehicle weight on the front axle is too low. The accident prevention regulations of the Agricultural Employers' Liability Insurance Associations and the utility value tests of the Committee for Forestry Work and Forestry Technology require that the front axle must carry at least 20% of the gross vehicle weight. The percentage of the weight carried by the front axle diminishes either because the load largely weighs on the rear axle (this effect is quite extreme in forwarders whose load bay is mainly situated above the rear axle) or if the centre of gravity of the load is be-

Fig. 1: Typical forwarder (company photo)

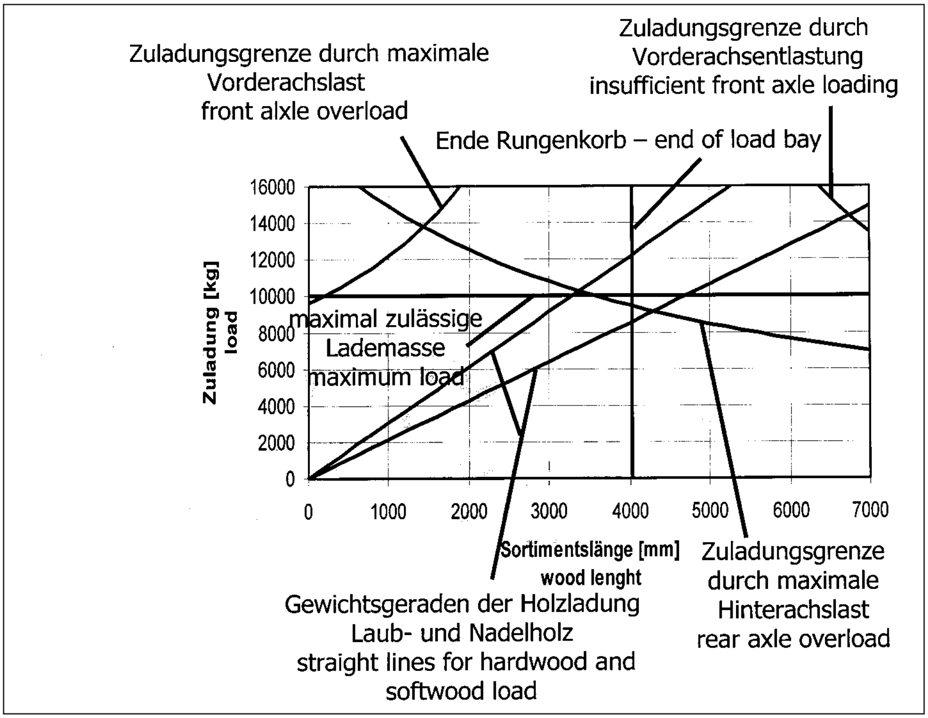

Fig. 2: Adapted load calculation diagram and load weight for a forwarder with reference to the load bay

hind the rear axle and weight is thus taken off the front axle due to the resulting leverage effect.

Together with a loading model, these four requirements can be expressed in a diagram which shows with which timber assortments the forwarder may be loaded to what point and which degree of machine capacity utilization can be achieved with different kinds of timber. Requirements 1 to 4 can be written as inequations. The timber load is modelled based on density and the volume used in the load bay. The latter is equalled with the value of the load bay cross section multiplied by assortment length.

Figure 2 shows the application of the presented approach using an example. Above the load bay of the machine, two lines are shown which represent the mass of the timber load if the load bay cross section is fully utilized, as assumed. The two lines result from the different specific weight of hard- and softwood. In addition, three hyperbolic limit curves are shown, which indicate the load mass permissible for timber of this length depending on the position of the centre of gravity or, here, the length of the timber (it is assumed that the centre of gravity of the timber is situated in the middle of the cylindrical log). These limit curves result from the above-formulated requirements 2 to 4. The horizontal line describes the load limit given by the permissible total mass (requirement 1).

One notices that in the shown case only hardwood allows the capacity of the machine to be fully exploited. If the load consists of softwood, however, the carrying capacity of the rear axle is exceeded before the permissible load is even reached due to the unfavourable position of the centre of gravity of the longer assortments. In order to attain the maximum permissible load, assortments must be chosen which are longer than the stanchion basket. At maximum load, the assortment projects significantly behind the rear end of the stanchion basket. Generally speaking, it can clearly be seen that the significant limiting factor is the carrying capacity of the rear axle if the forwarder is designed correctly. If, however, the design is less favourable and, in particular, the stanchion basket is arranged too far to the rear, this on the one hand very quickly results in excessive rear axle load, while on the other hand the front axle load falling below the required minimum (20% of the gross vehicle weight) due to the resulting reduction in the front axle load may also become the load-limiting factor.

Conclusions

The application of the load calculation diagrams known from commercial goods traffic, which has been presented here, and its connection with the representation of the assortment-dependent load provides an efficient tool for the assessment of the design and the capacity of a forwarder. The user can read the maximum possible load in the form of mass and total assortment length or the sum of assortment lengths and can plan the load accordingly. In addition, a fast and meaningful comparison of different machines becomes possible which by far exceeds the normally indicated maximum load.

Literature

Books are indicated by •

[1] *Lieber H., und A. Woda*: Technologie des Straßentransports. Vogel-Verlag, München, 1992

[2] *Hoepke, E.* (Hrsg.): Nutzfahrzeugtechnik. Vieweg-Verlag, Braunschweig/Wiesbaden, 2000