Contact
Dipl.-Ing. Stefan Deutschle
deutschle@ika.rwth-aachen.de

Phone: +49 241 80 25630

Institut für Kraftfahrzeuge
RWTH Aachen University
Steinbachstr. 7
52074 Aachen, Germany

ROADTRAIN-CONCEPT FOR THE EUROPEAN FREIGHT TRANSPORTATION

The great number of industrial vehicles strongly influences the traffic on German motorways. Heavy trucks mustn't legally drive faster than 80kph in Germany. There are however no or by far higher speed limits for passen-ger cars, which often results in great divergences in speed especially on two lane motorways. Lane-changing vehicles often cause a local traffic breakdown on busy motorways. The average speed and possible traffic flow drops noticeably as soon as more trucks are on the road.

Two starting points of departure present themselves for improving the traffic flow:

1. Increasing the speed limit of trucks
2. Increasing the maximum load and transportation capacity of each truck

Raising the maximum speed of trucks up to 100kph seems to be potentially apt for this purpose. Trucks of the latest generation allow putting this idea into practice, as they are equipped with modern transmission-, brake- and chassis technology. If maximum load and transportation volume are both increased at the same time, the overall number of trucks can be reduced, whereas the number of goods transported remains constant. By increasing the number of axles it can be guaranteed that the road surface is not loaded more than by conventional trucks, possibly even less.

Apart from improving the traffic flow, increasing the maximum load has also positive economic effects, especially for the owner of industrial vehicle fleets. One chance of improvement is to enlarge conventional trains by an additional trailer. Due to the increasing of the maximum load by 24 t to 48 t altogether the costs for fuel, service and personnel can be considerably reduced. Modern vehicle technology makes it possible that such exceptionally long vehicles can be realized.

Both the dimensioning of the drivetrain and brake system and the stabilization of the faster and exceptionally long train are possible. Modern engines, disk brakes and new types of vehicle electronics such as distance control and vehicle dynamics control systems ensure more safety and higher profitability both at the same time.

Expect of considering the technical feasibility of such trains, it is necessary to take the conditions of the European traffic into consideration, too. We need to make sure that the trains are still able to use the entrance ramps of the existing motorways and that they are still able to turn off at intersections. To guarantee these premises we have to pay special attention to the space needed for cornering when dimensioning the train. Further, we have to adapt the hill-climbing capacity to European conditions.

First of all we analysed what effects a roadtrain concept being limited to 100kph will have on the traffic flow, the fuel consumption and the handling characteristics. We used the multi body simulation program ADAMS® for transversal dynamics investigations. For investigating the handling characteristics of the train, we employed a model of a truck-trailer, which had already been proofed beforehand. We extended this standard-truck-trailer by a coupling tow-bar and a second trailer. For our initial inves-tigations, two standard truck-trailers were modelled. Starting from this point we examined different concepts of additional steering axles to improve the cornering ability of the roadtrain.

We made it our objective to fulfil the requirements of §32d of the German Straßenverkehrszulassungsordnung (StvZO).

Further we investigated to what extent a stable dynamic handling could be achieved. The standard tests carried out so far comprise the handling on a circular course, lane changing and steering-angle jump.

We employed our own simulation program PELOPS for analysing the longitudinal dynamics and the effects on the traffic flow. PELOPS provides very detailed models of the driver characteristics, traffic environment and the longitudinal dynamics of the vehicle. The focus of the longitudinal dynamics analysis was on optimising the power train for its implementation in the roadtrain. For this purpose PELOPS was linked with an evolutionary algorithm. The evolutionary algorithm represents a method, which can be independently employed for complex multidimensional problems. Within the process of optimisation, the evolutionary algorithm determines an optimal combination of dimension parameters with respect to given criteria. In case of the roadtrain we chose the engine torque, the total vehicle weight, the rear-axle ratio, a selection of different gear-boxes and the gear-shifting behaviour of the driver as relevant parameters.

Assessing different dimensioning variations, the evolutionary algorithm uses the PELOPS models of the vehicle's longitudinal dynamics, driver characteristics and traffic environment. Ten scenarios were chosen as crite-ria for the optimisation, accounting for the top speed, fuel consumption and the number of gear shifts in different driving situations. The tests verify that the roadtrain consumes 26% less fuel per ton payload as conventional 40 t truck-trailers, although both achieve a similar driving performance. In steady-state operation the advantage of fuel consumption amounts to 35%.

We investigated the effects of the roadtrain on the traffic flow by simulating a two lane motorway once for medium and once for high traffic load. In both cases the percentage of trucks amounted to 25% of the total traffic. An increase of the speed limit from 80 kph up to 100 kph results in an enhancement of the average speed by 10% up to 120 kph. In the case of a high traffic load the enhancement even amounts to 14%.