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Technology 2000

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THE WORLD-WIDE TRENDON MASS AND DIMENSIONS

Size, Weight and Performance of Heavy Vehicle Combinations

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Summary

There is a number of driving factors which determine the development of goods transportation in general and vehicle combinations in particular. Cost has naturally an impact. The capacity and capability of the road network as well as the type of goods and the traffic situation are important. The traffic safety and environmental aspects have to be considered.

Also in the past there were long vehicle combinations. Even if the size could be large, the weight was low. As the need for more goods transportation developed, both the size and weight of heavy vehicles grew. Growing internationalisation of the transports has led to a certain harmonisation of vehicles and regulations. The most universal load units are the 40-ft and 20-ft ISO containers and they require a total length of 15-15.5 meters for a tractor/semitrailer. It is of utmost importance that the regulations are properly formulated, otherwise the consequences may be bizarre. Regulations have a large impact on the design of vehicle combinations.

In Europe the total length was maximised for tractor/semitrailer to 15.5 m and for truck/trailer to 18.35 m. These measures were later increased to 16.5 respectively 18.75. Other countries, e.g. USA, instead maximised the total load length, which of course has consequences for the look of their vehicles.

Weight regulations, axle loads in particular, show large dispersion throughout the world. This depends to a large degree on the infrastructure, because the axle loads have the largest impact on the road wear. Harmonisation is going on and Europe is one example. Northern Europe has increased the axle loads and southern Europe has gone the other way. See **Table 1**.

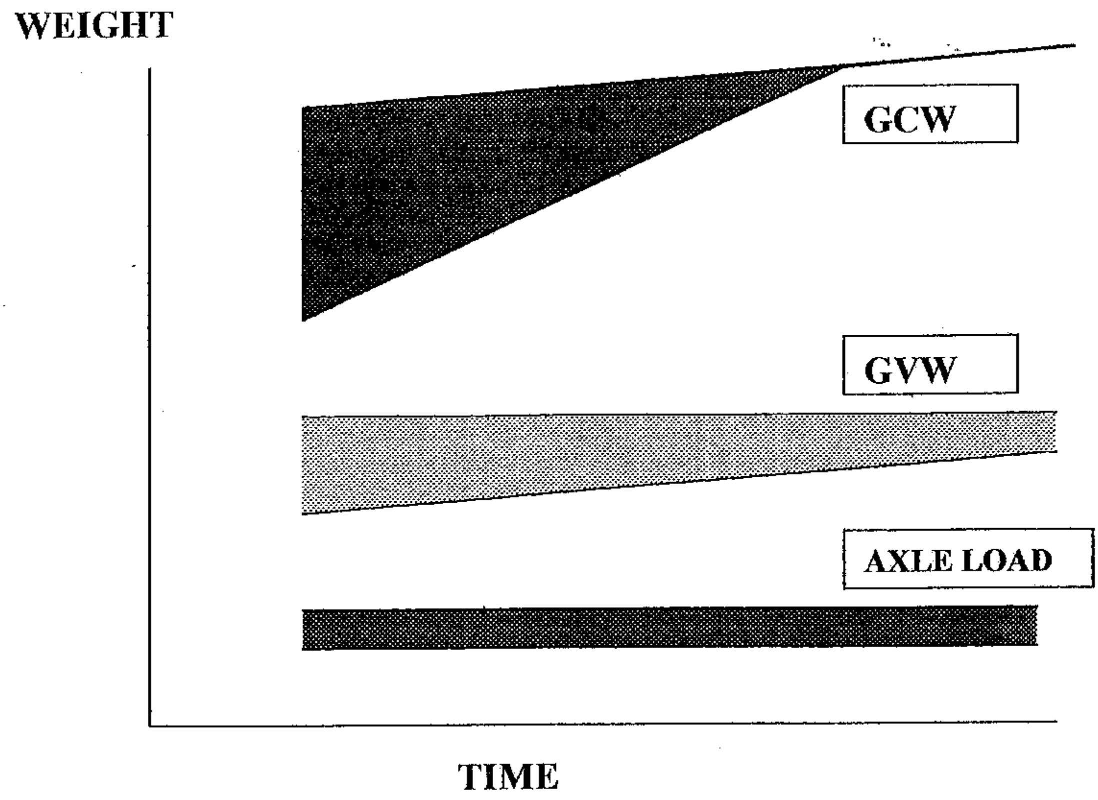
Table 1

	Northern Europe	EU	Southern Europe
Drive axle	10	11.5	13
Tandem	16	18/19*	21
GVW 2 axles	16	18	19
GVW 3 axles	22	25/26*	26

* The higher weight for road-friendly suspension

It is not likely that neither the axle loads nor the GVW will increase, except in conjunction with road-friendly suspensions. There will also be countries with road networks that only can allow lower weights. The allowed GCW will however probably increase thanks to improved road network, more powerful vehicles and demands on improved transport economy. See **Figure 1.**

Figure 1. Anticipated development of weights



The increased gross combination weight must however be combined with longer vehicle combinations. An example on this trend is the launch of the modular system in Europe. This system allows each country in the union to have arbitrarily long and heavy combinations as long as they are based on the load modules 7.82 and 13.6 m and as long as operators from other countries are allowed to enter with the same type of vehicles. Sweden and Finland have now adopted the system and some more countries are likely to follow shortly. These countries allow 25.25 m long and 60 t heavy combinations. The most popular vehicle configuration is a straight truck, a converter dolly and a semitrailer, which carries one 7.82 module and one 13.6 m module. One of the ideas behind the system is that the road network is divided into road classes, allowing the long combinations only on the primary network. Before entering the secondary network or urban areas, the long combinations are split up into shorter units at terminals. The load modules also facilitate intermodal transport, integration of rail and waterways with road transports. There are obvious advantages with these long and heavier combinations of which two vehicles can replace three. Fuel consumption and pollution are reduced. Congestion is reduced. Less obvious is that the safety becomes higher, but this is the case. A strong trend is an increased use of swap-bodies and the modular system is very well suited for this.

Another pronounced tendency is that a growing part of the goods is volume goods, i.e. low-density goods. The way to increase the available space for the payload is to lower the vehicle chassis, which has a number of drawbacks. It is then more appealing to use longer vehicles. Increasing the width further is probably out of the question, and making higher vehicles is feasible, but is not a brilliant idea from a traffic safety point of view, especially as the rollover problem currently is focused.

Beside the risk for rollover, always inherent in heavy vehicles, the lateral stability has to be considered for heavy vehicle combinations. The predominant way to quantify the lateral stability is in terms of rearward amplification and damping. Damping is relevant only for such combination types that have low damping. Methods for determining these quantities are standardised in ISO 14791. The damping is determined by measuring the attenuation of the oscillations during free vibrations. The rearward amplification is the gain of the yaw velocity or the lateral acceleration between the last and first vehicle unit in the combination and is determined in one of several optional manoeuvres.

The five vehicle combinations shown in **Figure 4.** were studied with respect to lateral stability. The first three ones have a GCW of 40 t and the two last ones have 60 t. The length of the two latter ones is 25.25 m, the length of the first one 16.5 m and # 2 and 3 are 18.75 m long.

All these vehicle combinations except #2 are well damped. For this vehicle combination it is essential to have proper geometry and mass/inertia distribution otherwise, at a certain speed, the damping may approach and even become less than zero and create a true instability. The rearward amplification of the yaw velocity is used for the comparison. The random steer input method is chosen as it gives a true representation of the system gain in the frequency domain. The frequency response of the yaw velocity gain at 90 km/h for vehicle combination 4 is shown in **Figure 2.**

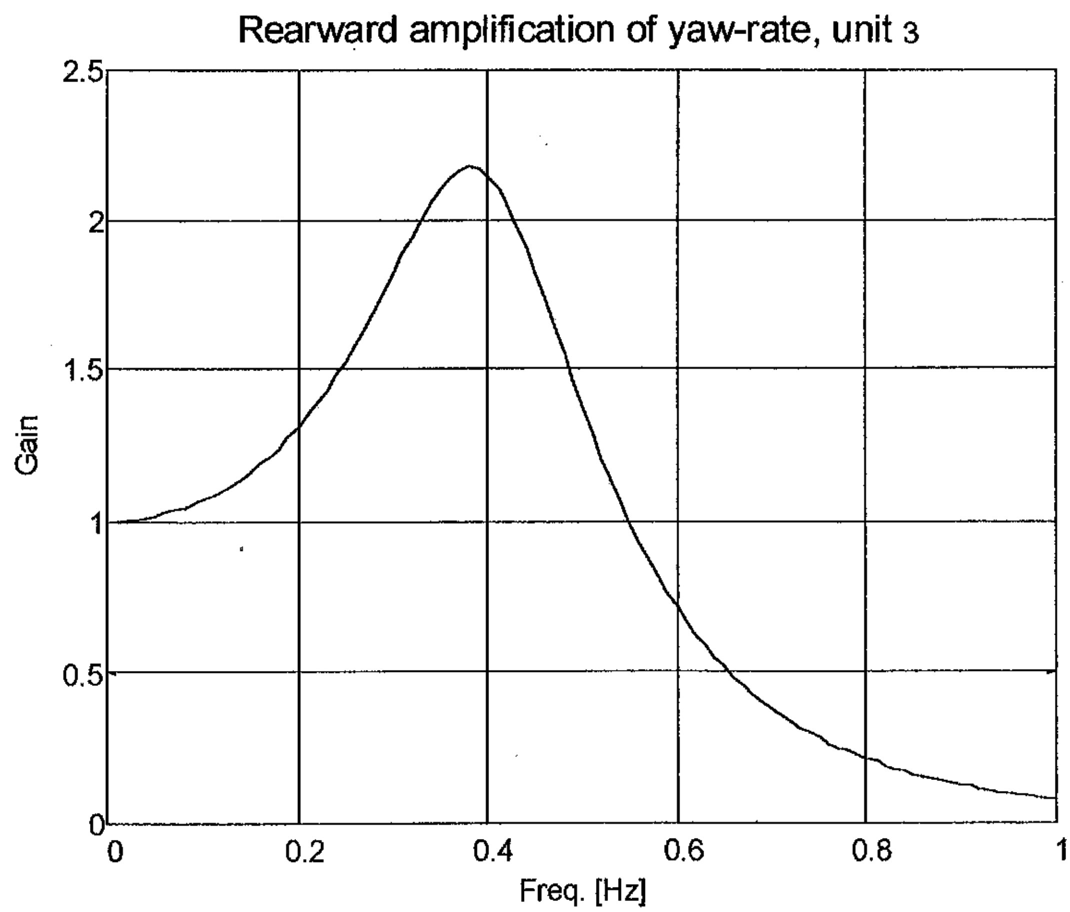


Figure 2

The rearward amplification obtained from a single lane change procedure would differ from this result, because the lane change has distributed frequency content and provides only a composite gain. **Figure 3.** shows the yaw rate responses from a 0.4 Hz single sine-wave steer input at 90 km/h. It appears that the amplification factor is 2 instead of 2.2 from the frequency response.

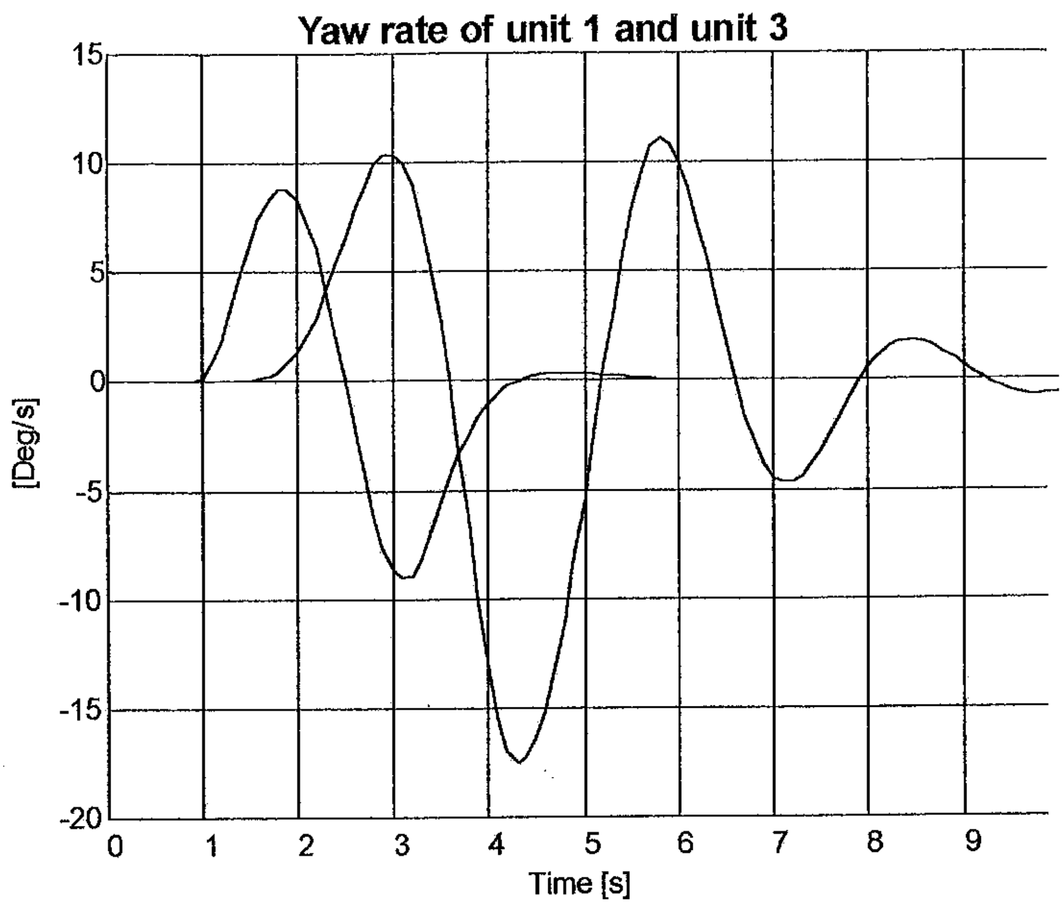


Figure 3.

The maximum rearward amplification at 90 km/h of the five vehicle combinations is shown in **Table 2**. These values are higher than would be obtained in a specific lane-change manoeuvre.

Table 2

1. Tractor/semitrailer	**1.4**
2. Truck/centre axle trailer	**2.3**
3. Truck/full trailer	**5.5**
4. Truck/dolly/semitrailer	**2.2**
5. Tractor/B-semitrailer/semitrailer	**1.8**

It appears from the results that vehicle combination 1 has the lowest gain, but it is obvious that the long vehicle combinations are doing quite well, especially the B-train. The worst one is #3, which has a trailer with a short wheelbase. Increasing the trailer wheelbase improves the stability drastically.

The following future trends may be anticipated.

- **Increased goods transportation**

- **Less pollution**
- **Harmonisation**
- **Standardisation**
- **Increased use of swap-bodies**
- **Longer, heavier, safer vehicle combinations**

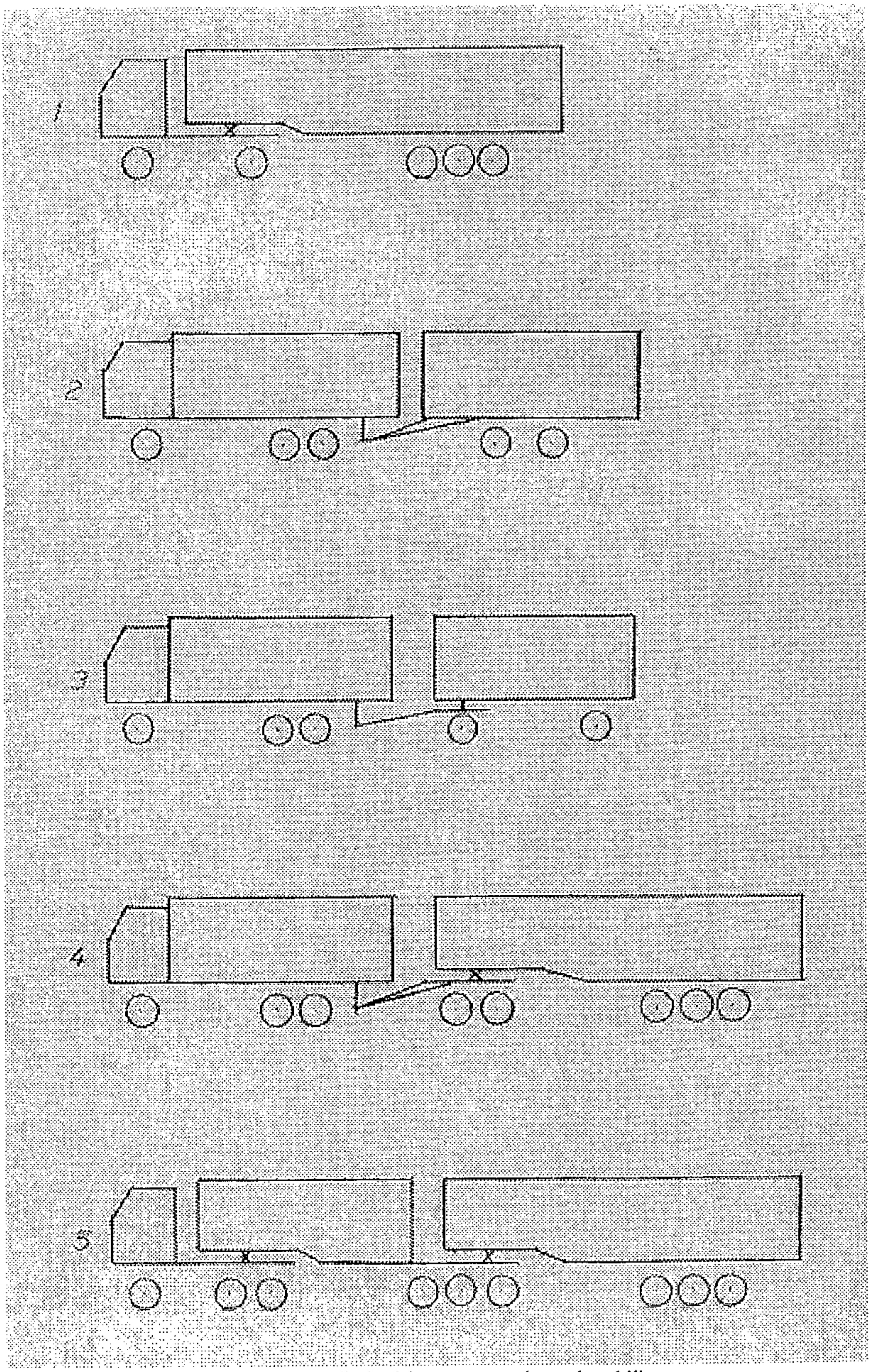


Figure 4. Vehicle combinations studied with respect to lateral stability