

High Cube Engineering Laid Down



To date, the high cube container debate has been strong on point scoring and crossfire between personalities, but weak on the dissection of engineering fact from fiction.

Any Automobile Engineer should be able to dust off his text books and give a reasonable indication of the stability of a given vehicle and its standing against other bench marks. But whether by design — to muddy the waters — or by accident, the 3 ‘experts’ referred to by the Harbour Carriers Association in support of their case, would seem to be varying steps away from Automobile Engineers.

So first to correct the misinformation:

TMT Projects

TMT Projects, the consultants behind the report “Legalising the transport of high cube containers by road in South Africa”, name “seven directors and professionals” among their 54 staff, all with an armoury of diplomas, but none which suggest an Automobile Engineering bent of any discipline.

Their report states (with reference to trailer coupling heights and neck thicknesses) an absolute; “none of these components can be reduced in size” when, in fact, they are the key areas for dimension reduction that enables Europe to carry high cube containers within 4000mm overall height — all without ‘rocket science’ design (tyres remaining the ‘standard’ 385/65 x 22.5, a reduced neck thickness and only 130mm squeezed out of the current RSA truck coupling height achieving the necessary result). TMT Projects continued to misinform on International height limits. At best, taking a single state or province’s legislation/dispensation and then quoting it as a national limit, at worst, being totally incorrect, as shown in the table below.

	Australia	USA	EU	Scandinavia	RSA	Brazil
TMT Report	4900mm	5000mm	5000/4300mm**			5000mm
Legislation	4300mm	4150mm	4000mm	4000m	4300mm	4400mm

* Report contradicts: “The European standard of **5 metres** height for containers on road vehicles”
“In Europe..... thereby achieving about **4.3 metre** overall height.”

Finally, in their conclusion, suggesting that an “ISO container” be added in legislation to the same exemption regulation (262) as double deck buses, would appear technically illogical and expensive, with trailer designs having to meet, undertake, and pass, the tilt test which these exempted vehicles are subject to.

(Kevin Martin’s presentation to the IRTE was erroneous in suggesting that tilt testing was not carried out as a ‘worst case scenario’. In fact the requirement is for only the upper deck seats to be loaded with passenger weight, and the regulation further requires that the fuel tank is empty. This is presumably to prevent fitment (and filling) of a super large fuel tank to act as low down ballast.)

Otto van Griethuysen

- Since elements of his calculation did not seem relevant to the argument, this well-qualified and respected Engineer was approached and commented:
 - “The page used in the report is part of a stability calculation I do for the transportation of wide and high loads”.
 - “I cannot remember the exact brief from ‘Natro’ or the reason why they wanted this calculation in May 2005”.

- “The calculation was done almost 4 years ago. Nobody has tried to contact me to establish whether the calculation is still valid or acceptable in accordance with the Road Traffic Regulations or the Policy on Conveyance of Abnormal Loads (TRH11)”.
- “The Harbour Carriers Association is using this calculation out of context and without my permission”.
- “I cannot condone their use of this information without my permission”

Captain Martin

A misunderstanding of the definition ‘track’ in its relationship to stability and roll over, and, it is suspected, a total lack of comprehension of effective track as it applies to semi-trailers, devalues his exercise without going further.

In summary then, case enhancing factors included the misinformation regarding international legislation and of what mechanical modifications are possible using high, unrealistic, trailer tare masses to effectively lower the overall centre of gravity, not using full payload masses in calculations, confusing the dimensions of track and width over tyres (‘WOT’), and making no allowance for the inherent instability of a semi-trailer through the fact that its front ‘track’ is no more than the width of the 5th wheel coupling; and finally the fact that long before even the era of Kevin Martin’s “dinosaur trailers”, legislation has required trailers to have suspension, yet none of the experts included this effect on stability in their calculations.

The true Technical case

Since to drive a vehicle in a circle at increasing speeds until it falls over is somewhat impracticable – and expensive, a tilt test is the preferred practical stability simulation.

Since the tilt test itself is not without expense, many bodies and individuals have carried out experiments to find acceptable formulae accurate enough to offer a substitute for tilt testing in legislation.

By 2001 formulae had been refined sufficiently for a rollover calculation to be included as an alternative to tilt testing in the United Nations Economic Commission for Europe (UNECE) Regulation 111 – Rollover stability of Road Tanker Vehicles.

Visualising a vehicle rolling could suggest the vehicle would stand on ‘tip toe’, i.e. the outer edge of the tyre, before rolling over, and that WoT (width over tyres), not ‘track’, should be the factor to be considered. But the dynamics of tyre flexing and other considerations affect this view, and, internationally, it is clear from many modern papers on ‘stability’, that the use of track, not width over tyres in calculated results, gives the most accurate comparison to actual dynamic, and/or tilt table, testing.

The instability of an articulated combination compared to a rigid is generally known, but rarely understood. A rigid’s front axle, with single tyres, generally has a wider track than the rear with duals. All other factors being equal, this adds to stability of the rigid vehicle.

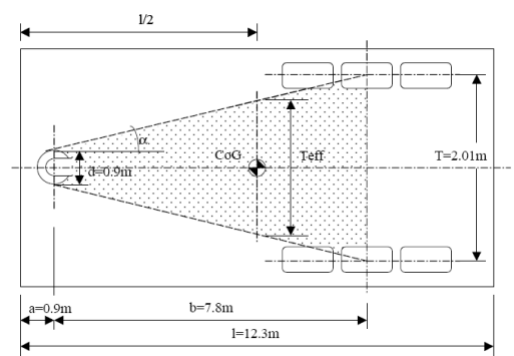
On a semi trailer the ‘front track’ is the width of the fifth wheel; and the effective track (‘Teff’ in the drawing on the right) is the distance, at the longitudinal Centre of Gravity, between lines drawn between rear track and fifth wheel width.

Using ‘Teff’ in the quoted ‘abnormal’ formula (TRH 11/4.10) would require ‘proof of stability’ from less than 4 metres high!!

This suggests Europe is correct, and opens another can of worms as to whether ‘effective track’ was the intended dimension to use in TRH 11, and, if not, how it differentiates rigid against ‘unstable’ semi?



Those who observed recent Knorr Bremse stability tests at Gerotech will have first hand knowledge of trailer roll-over only being prevented by the outrigger safety wheels, whilst the truck-tractor remained firmly on the ground and offered little roll resistance to the trailer.



Any other disbelievers of the limited resistance offered by the truck-tractor may observe the following film sequence of what was supposed to be a controlled test – until it all went horribly wrong with failure of the safety outrigger!.



The following lateral acceleration calculations then, limited only by the need to assume a spring stiffness and roll centre height (but constant across all), show both the individual effect, and total effect, of the various errors in submissions — included for reference, **in bold type**, are known international benchmarks.

	Lateral Acceleration at Threshold of Roll Over		Load Mass Kg	Trailer Tare Kg	Un-sprung Mass	Sprung Chassis Mass	Total Sprung Mass	Total Mass Kg	Height COG metre
	G	Degrees							
UK Single Deck Bus	0.700	35							
UK Double Deck Bus	0.532	28							
Consultant(OvG)'s flawed submission	0.473	25.325	24000	9660				33660	2.539
Submission - corrected for full load	0.460	24.692	30480	9660				40140	2.614
Submission - plus realistic trailer tare	0.456	24.495	24000	7000				31000	2.638
Submission - plus suspension effect	0.449	23.28	24000	9660	4000	5660	29660	33660	2.457
RSA Double Deck Bus	0.424	23							
Euro draft spec. for Road Tankers *	0.424	23							
New Zealand minimum lateral %G	0.350	19.290							
Submission - corrected for track	0.303	16.86	24000	9660				33660	2.539
Submission – with correctly defined track, full payload, realistic tare and allowance for suspension effects.	0.231	13.02	30480	7000	3500	3500	33980	37480	2.635

* United Nations Economic Commission for Europe (UNECE) Regulation 111

The aforesaid is still limited by assumptions on spring stiffness & roll centre heights, and the proof has to be in a tilt test – for which vehicle preparation and submission cost would be miniscule against the delays and restrictions that TMT reports as the costs of operating the permit system for an annual “384,000 High Cube Dry and Reefer boxes”. Could the reluctance to simply settle the debate by tilt test be one, not of cost, but a (known) fear of the result?

Conclusions

The above table highlights that container carrying, and similar high and potentially heavy vehicles, have stability problems when compared to known benchmarks. It must also question whether the move from 4.1 metres to 4.3 metres was done on sound advice, and whether, to maximise safety, there should be a time scale to take legislation back to 4.1 metres.

Approaches to trailer manufacturers show that, contrary to all suggestions otherwise, South Africa’s trailer industry has, for many years, been able to offer solutions for the legal carriage of High Cube containers, on Interlink as well as semi-trailers. Solutions that still provide clearance for coupling to the beloved, in RSA, high articulation, 2 spring bogie 6 x 4 truck tractor.

It is suggested that the lack of take up by the Industry, despite many years of High Cube container transport, has more to do with a past lack of law enforcement than for any other reason.

All parties must agree the problem has been clear for a number of years and that unsuitable equipment has continued to be purchased during that time, to a degree understandable in the interest of standardisation, but had that investment being made in change over those years, it would have cushioned the current financial input now required.

There has to be an uncomfortable period when old trailers will only fit old trucks, and new trailers new trucks, until the time when a new standard is created. The height of spacer/ripple plates now appearing on new generation truck tractors, merely to meet outdated local coupling heights, is clearly obvious.

It is quite clear for the Country's economy, if nothing else, that the carriage of over-height High Cube containers must continue in a controlled fashion, until such time as operators in the container transportation industry have acquired the correct vehicles for that transportation. Since there has been dispensation through the Abnormal Load permit system, and since this could give the required amount of control, it is recommended that any move to stop that dispensation should be suspended for a time period appropriate to the time required for legal equipment to be ordered, built, and put into service.

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Jim Mason
03 April 2009

