

DOLLY performance

For an air-suspension to be classified as Road Friendly it is required to

- have a bounce frequency below 2.0Hz
- have damping greater than 20% of critical
- the suspension group achieves load sharing within 5%.

Triaxle dollies offer a productivity benefit of between 2.5 and 4.5 tonnes when compared to a tandem converter dolly

Some observations from simulations carried out by professor Sweatman of UMTRI Michigan. Road friendly characteristics are as we know them. Note however the requirement on load sharing. This article is very much about three or two axle dollies. Despite the higher mass of the tridem dolly per se there is as prof Sweatman finds a cargo benefit of up to 4 tonnes.

DOLLY performance

Simulation show that:

- Tandem air-suspended converter dollies
 - could pitch significantly under braking as compared to mechanically suspended dollies
- Triaxle air suspended dollies
 - pitch somewhat less than the tandem air-suspended dolly and
 - generated a lower longitudinal force in the coupling.
 - This indicated that the triaxle dolly has better brake balance and should be encouraged by allowing the weight increase.
- Rigid drawbars on converter dollies
 - reduce the amount of dolly pitch
 - hence have better brake balance.
 - tandem axle air-suspended converter dollies perform significantly better with a rigid drawbar.

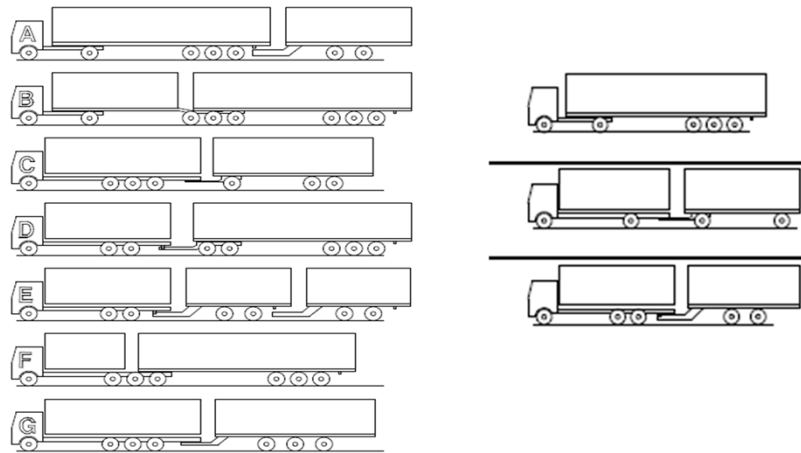
The tandem dolly pitches more with air suspended axles than with mechanical suspended axles. This is to some extent due to the time constant of the suspension bellows.

It is consistent that the tridem dolly pitches less than a tandem dolly as the wheel base of a tandem dolly is shorter. As pitching is one of the major mechanisms generating longitudinal forces it is expected that less pitching will result in lower longitudinal forces.

The lower pitching also results in a better (more even) distribution of axle loads, i.e. preconditions for better braking.

A rigid drawbar dolly is pitching less as the drawbar is supported by the towing vehicle coupling, thus preventing pitching. This fact is the same for tridem and tandem dollies of course. In particular it is observed that the tandem dolly is much improved from a braking perspective by a rigid drawbar.

DOLLY performance













So far we have looked at simulations performed by professor Sweatman. Now we have a couple of slides taken from a simulation thesis at the University of Eindhoven, the Netherlands. The combinations depicted to the left are modular vehicle combinations studied and the combinations to the right are reference combinations operated regularly today. For our purpose we focus on combination D versus the first combination to the right. As background to our observations on those two combinations we look at combination C versus the second combination on the right side.

DOLLY performance

Simulation show that:

Load transfer seen as axle loads is larger for Tractor – Semi-trailer than for Dolly – Semi-trailer

configuration		$f_{load} [-]$							
		axle 1	axle 2	axle 3	axle 4	axle 5	axle 6	axle 7	axle 8
tractor semitrailer		1.698	0.893	0.844	0.812	0.779	–	–	–
truck trailer		1.447	0.712	1.407	0.592	–	–	–	–
truck db trailer		1.595	0.983	0.830	0.763	0.860	–	–	–
LZV A		1.670	0.853	0.998	1.010	1.021	0.832	0.762	–
LZV B		1.630	0.835	1.019	1.036	1.052	0.861	0.822	0.782
LZV C		1.702	0.995	0.799	0.607	1.746	0.762	0.486	–
LZV D		1.535	1.023	0.888	0.945	1.145	0.856	0.816	0.777
LZV E		1.583	1.000	0.852	0.985	1.129	0.848	0.682	–
LZV F		1.552	1.105	1.013	0.914	0.808	0.800	0.791	–
LZV G		1.463	1.161	1.080	1.003	0.833	0.808	0.783	–

Looking at the first line marked with yellow we can see the load transfer from trailer to tractor. The table is made up such that when travelling at constant speed the axle loads are nominal and set at an index value of 1.0. When the axle load becomes less than the nominal constant speed load this lower value is divided by the constant speed load, i.e. giving an index below 1.0. Then in the first line we see that during braking (-6.0 m/s^2) the axle loads of the trailer come down to between 78% to 84%. The front axle gets a higher load the index comes up to 1.7 i.e. a 70% increase of the front axle load during that braking. This combination has 5 axles as the tractor is a 4x2.















We now look at the combination D and more close to the five axles of the trailer plus dolly. (second yellow line) We then note that the axle loads of the last three axles (the semitrailer axles similar to those in the first yellow line) come down to the same values as in the first yellow line. The two dolly axles however do not take as much load as did the tractor in the first yellow line. I.e. we could say possibly that the semitrailer + dolly does not bring such a sharp or concentrated load transfer as the tractor + semitrailer. In the next slide we will have a closer look at this.

Before we do so however look at the two red lines in the table above. These are two full trailers with a hinged drawbar. We note that we have in both cases a sharp load transfer from the rear axle(s) to the front axle.

DOLLY performance

Simulation show that:

Load transfer seen as coupling loads is about the same for
Tractor – Semi-trailer than for Dolly – Semi-trailer

Forces coupling 1		0 m/s ²			-6 m/s ²		
configuration		F _x [kN]	F _y [kN]	F _z [kN]	F _x [kN]	F _y [kN]	F _z [kN]
tractor semitrailer		-1.4	0.0	-117.8	106.3	0.0	-153.0
truck trailer		-1.2	0.0	0.0	-0.5	0.0	0.0
truck db trailer		-0.9	0.0	-4.4	19.7	0.0	-29.1
LZV A		-2.7	0.0	-116.4	98.8	0.0	-143.0
LZV B		-2.8	0.0	-100.7	87.0	0.0	-126.3
LZV C		-1.9	0.0	0.0	-2.0	0.0	-0.1
LZV D		-2.3	0.0	0.0	20.5	0.0	-30.6
LZV E		-2.3	0.0	-2.9	19.4	0.0	-30.8
LZV F		-1.7	0.0	-125.3	110.6	0.0	-167.7
LZV G		-1.8	0.0	-5.7	37.4	0.0	-60.0
Forces coupling 2		0 m/s ²			-6 m/s ²		
configuration		F _x [kN]	F _y [kN]	F _z [kN]	F _x [kN]	F _y [kN]	F _z [kN]
LZV A		-1.3	0.0	-5.1	31.0	0.0	-47.6
LZV B		-1.4	0.0	-118.1	101.2	0.0	-158.0
LZV D		-1.4	0.0	-114.8	95.5	0.0	-153.2
LZV E		-1.4	0.0	-4.9	28.5	0.0	-43.1

To analyze the observations in the previous side a bit closer we take a look at the coupling forces. In particular we have a look at the vertical coupling forces. The first combination (tractor + semitrailer) shows an increase from 117,8 kN to 153.0 kN in the vertical load on the “first coupling” i.e. the fifth-wheel of the tractor. Then we look at the vertical load of the “second coupling” i.e. the fifth-wheel of the dolly of combination D. We observe very close to the same increase in this vertical load as did we in the first combination. However we did not observe this equal performance as we looked to the axle loads. What might be the explanation of this? To find out this we look at the “first coupling” of combination D i.e. the drawbar coupling of the rigid truck of combination D.

There we see an increase in vertical load from 0.0 kN at constant speed to 30.6 kN at -6.0 m/s² deceleration. I.e. out of the 38.8 kN increase in the vertical load on the fifth-wheel of the dolly in combination D 30.6 kN is through the rigid drawbar transferred to the drawbar coupling of the rigid truck of the combination D. I.e. only a small share of the increased vertical load on the dolly comes down to the axles of the dolly.

This mechanism makes a dolly from a braking perspective somewhat different from a tractor. On the other hand looking at the complete combination the load transferred to the drawbar coupling of the towing vehicle will be available to support better braking by that vehicle.