



TRAILER STABILITY ASSIST IN SIMULATION

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SCS Virtual Tools and Analysis

Introduction



TSA (Trailer Stability Assist) development in simulation allows the tuning of the system to be performed using CarMaker and other software tools, removing the requirement for physical trailer towing tests.

Drivers for capability:

- Elimination of associated risks to personnel, vehicles and test locations
- Programme costs reduced due to physical prototypes not being required

TSA – Sub Functions Overview



- Trailer Probability Learning
 - Trailer Plug Detection
 - Maximum Velocity Analysis
 - Yaw Rate Damping Analysis
 - Constant Driving Analysis
 - Mass Analysis
- Sway Detection
- Sway Mitigation

Trailer Probability Learning – eg. Constant Run Analysis



Current Method:

- Physical Testing
- 1 of each engine variant vehicle required
- 1x 800kg trailer
- Trailer ballast
- Dummies and vehicle ballast
- Use of Proving Ground
- 1 Application Engineer
- 1-3 weeks work based on Timing
- Repeat with changes in engine calibration and prototype vehicle level.

Developed Method:

- Virtual Testing
- 1 of each engine variant vehicle model required:
 - Accurate engine model data
 - Accurate aerodynamic data
 - Correct gearbox data (ratios, inertias and shift limits)
 - Correct Torque Converter data (ratios, inertias and shift limits)
 - Correct drive train data (Converter factors, look up logic, inertias & spring constant)
- 2x Trailer models required, min and max weights (800kg and 1800kg) (built from Trailer Builder tool)
- Const_Run_Result TestWare script
- Constant_Run_Result.m Script for post processing data and Report Generation.
- 1hr per engine variant

Vehicle Model Correlation

Trailer Probability Learning



Correlation Manoeuvres used:

Coast Downs in Neutral

60 kph, 80kph, 120kph

Constant Runs in Drive

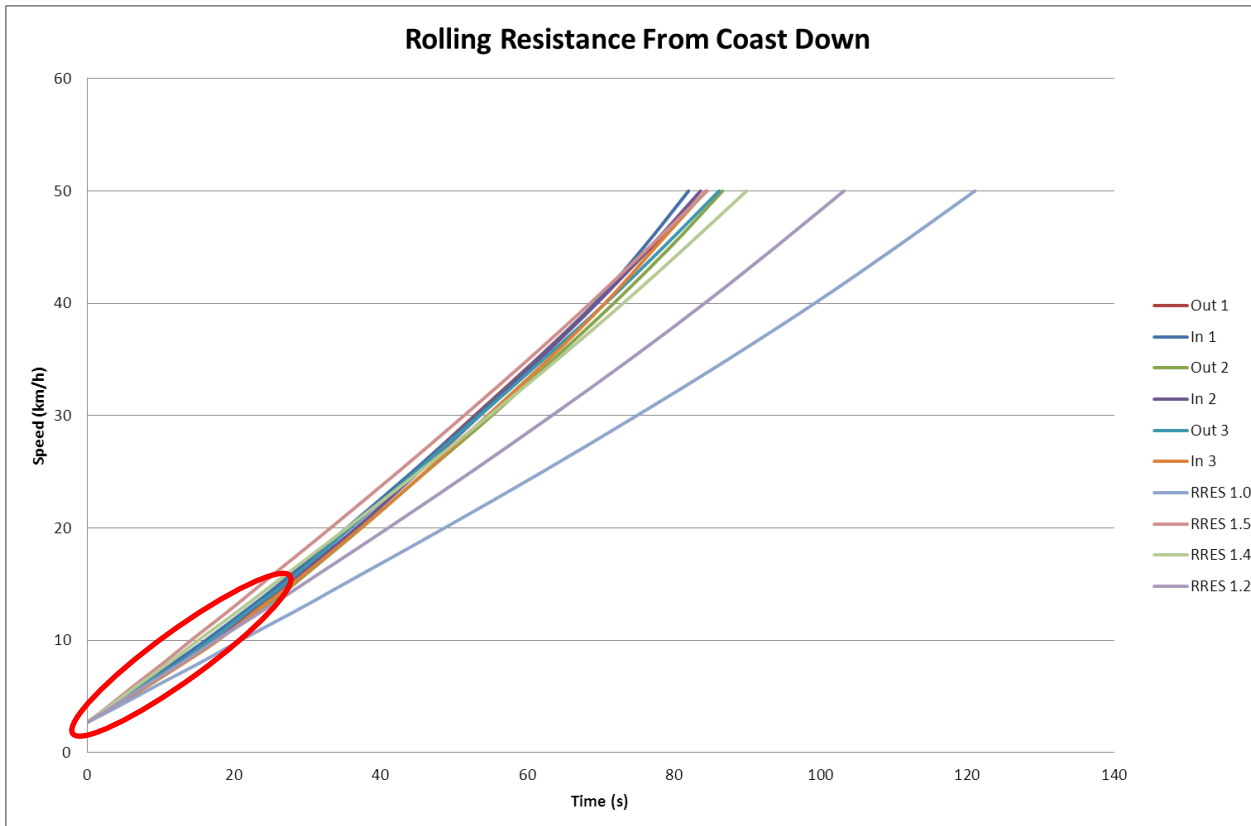
60 kph, 80 kph, 120 kph

Study:

1. Effects of Tyre Rolling Resistance
2. Effects of Aerodynamic Data
3. Effects of Wheel Bearing Friction

Constant Run Analysis- Vehicle Model Correlation

Effects of Tyre Rolling Resistance

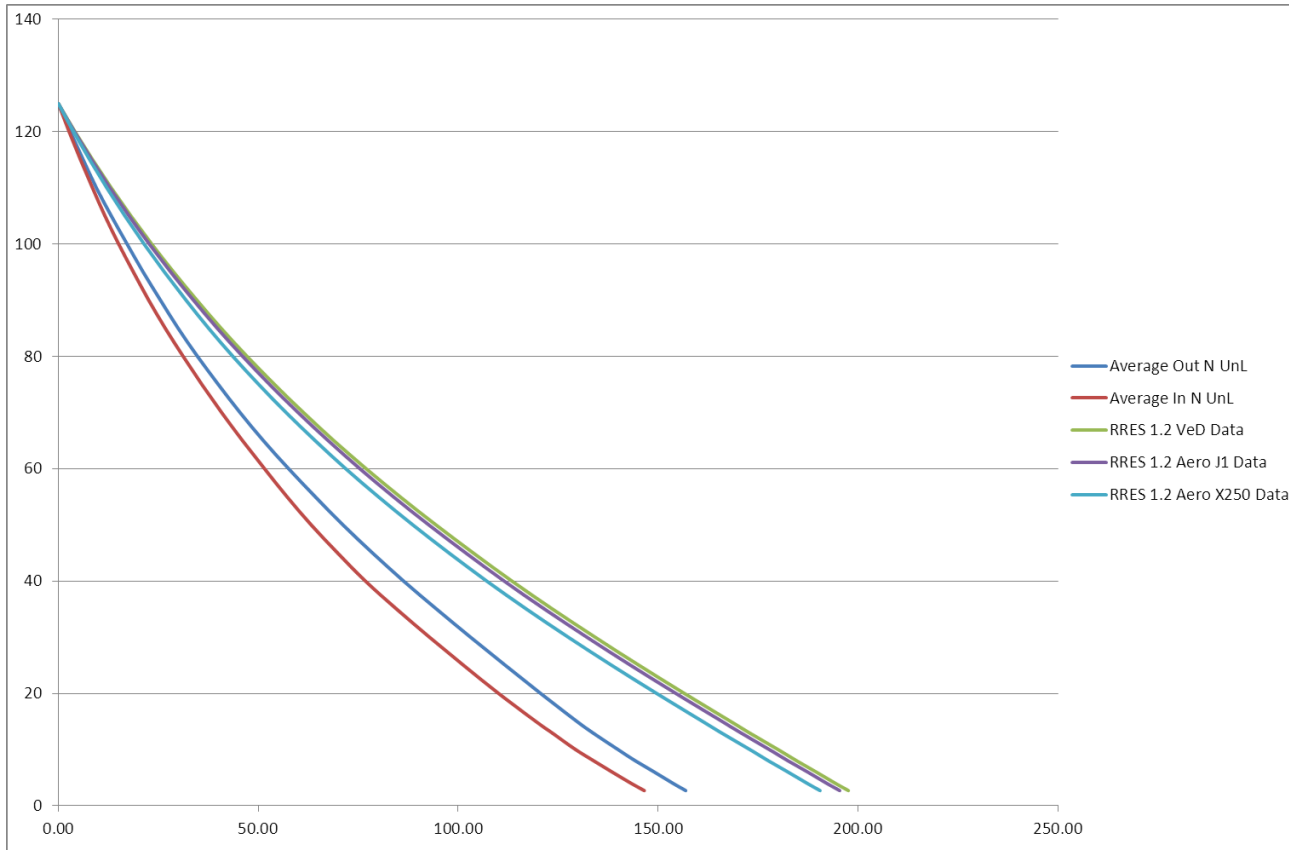


Looking at physical coast down data (in N) for the same vehicle changes were made to the LMY scaling factor for rolling resistance inside the tire model, this was done until the 0-15km/h range is matched.

Aerodynamics will not have an effect at this low speed. For this vehicle it is equivalent to 1.2.

Constant Run Analysis- Vehicle Model Correlation

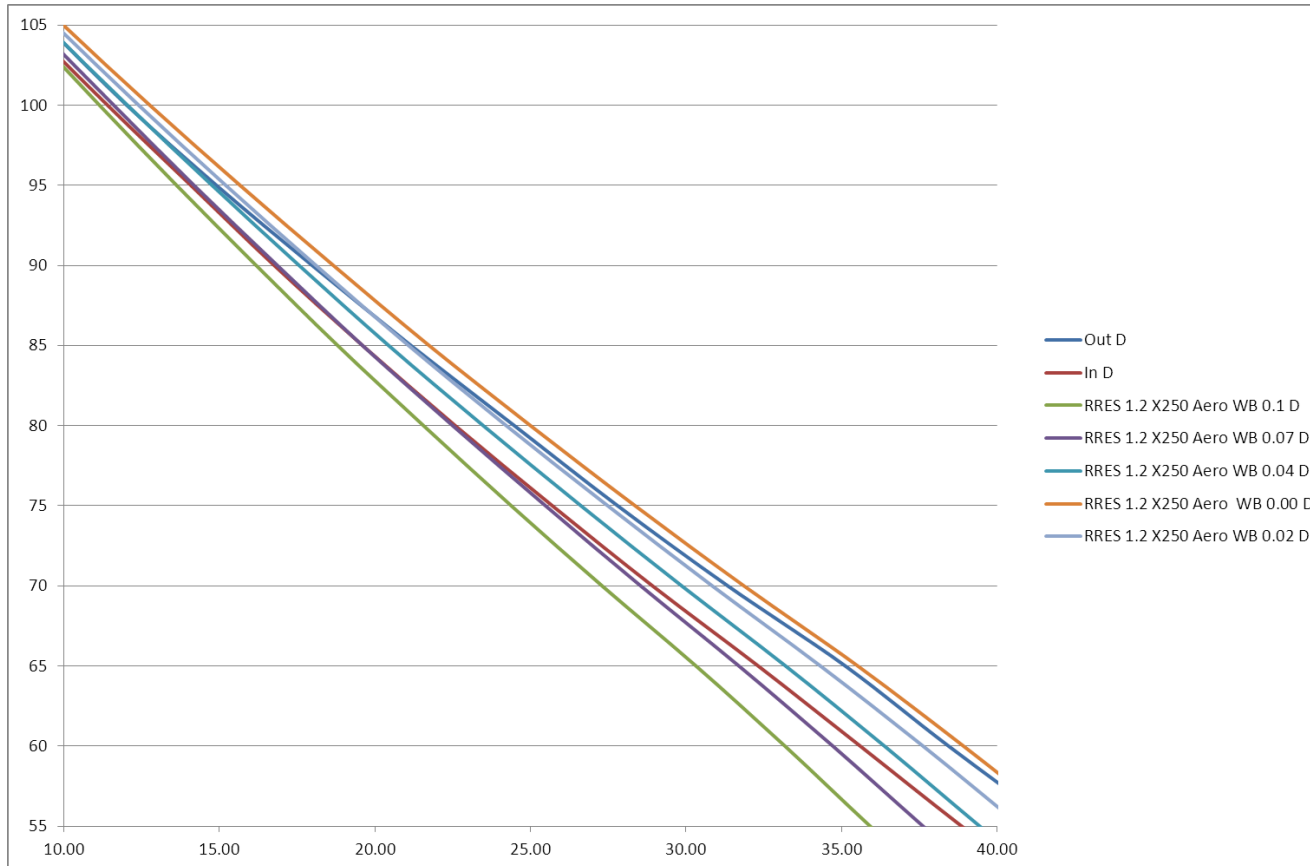
Effects of Aerodynamic data



Once the tyre rolling resistance is confirmed it is important to use aerodynamic data which is as close as possible to the physical vehicle. Again this is compared in a coast down from 125km/h in N. Unfortunately no aerodynamic data exists for the M1 vehicles, as can be seen from the 3 sets of aerodynamic data we have, the X250 data is closest, however it can also be seen there is still a large difference in the coast down between the model and the physical vehicle.

Constant Run Analysis- Vehicle Model Correlation

Effects of Wheel Bearing Friction



Once the rolling resistance and aerodynamic data has been chosen it is important to get the overall coast down to match. As the tests we want to perform with this correlated model are all in gear and between 60-100k, it is important to correlate the coast down in D. This will also include all of the drag from the drivetrain. As such the wheel bearing friction has been introduced to generate more drag on the vehicle to represent a similar level as seen in the vehicle. The friction coefficient chosen is 0.04.

Tools and Methods



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- Virtual Development of TSA using:
 - ❑ IPG Testware
 - ❑ IPG Test Manager
 - ❑ TestWare Builder GUI (Bespoke JLR)
 - ❑ Trailer Builder GUI (Bespoke JLR)
 - ❑ Matlab m-scripts in the CarMaker for Simulink Environment
 - Auto selection of Calibration files based on the vehicle selected
 - Post Process data files to generate parameters

Tools and Methods

Test Suite Creation



CarMaker for Simulink - TestWare

TestWare/SCS-1.0.5 Test ID: File Create Tests Close

Test Configuration Vehicle Configurations

Test	Results	Vehicles	Variations
TSM - Constant Run 2	6	2	3

Add
 Delete
 Info

Parameter Variations

Trigger Condition: not used s Number of Variations: 3

Variations: Combinatorial Filter After filtering: inactive

Parameter	Unit			
Test Speed	km/h	60	80	100
Constant Run Time	secs	60		
Road Friction	Mu	1.0		
Gradient	%	0		
Slope	%	0		
Gear	1	0		

CarMaker for Simulink - Test Manager constant_run_aj126.ts

Test Manager

Item Description	Par1	Par2	Par3	Par4	Par5	Par6	Criteria	Res.Date	Result
Global Settings									
T1: TSM - Constant Run 2									
V1: X761_AJ126sc_AUTO_CalSimUpdated_MF_Modded									
Info									
X761_AJ126sc_AUTO_CalSi									
Settings									
Read Info Block									
Initialize Run									
Group 0									
...01_Constant_Run									
Variation0	Test_Veloci	Test_Time	Friction	Gradient	Slope	Gear			
Variation1	60	60	1.0	0	0	6			
Variation2	80	60	1.0	0	0	7			
Variation2	100	60	1.0	0	0	8			
V2: X761_AJ126sc_AUTO_CalSimUpdated_MF_Modded									
V3: X761_AJ126sc_AUTO_CalSimUpdated_MF_Modded									
V4: X761_AJ126sc_AUTO_CalSimUpdated_MF_Modded									

About TestSeries

File constant_run_aj126.ts

Last Change 2014-05-27 10:42:01 nambady

Description / Comments

Start Stop Report

Tools and Methods

Bespoke Tools



GUI_Trailer_model

File

Description of the Trailer

Type of Axle

Single Axle Trailer Model Template

Twin Axle

Test Run

Select Vehicle Model

Same Tire for Front and Rear

Trailer Mass Location

	Left			Right		
	X	Y	Z	X	Y	Z
Front	-1.981	0.5	0.61	-1.981	-0.5	0.61
Rear	-5.249	0.5	0.61	-5.249	-0.5	0.61

Total Trailer Mass (Kg) Nose Weight(Kg) Total Trim Mass (Kg)

 Trailer Model File

testware_builder

Menu

Calibration file

Test Run

Carmaker TestRun Version:

Search Signal

Select test signals :

Output file

Output file name :

Saved Name :

Conclusions



- ❑ It is possible to tune the function to a certain degree of confidence using just Simulation
- ❑ Few Hours than weeks of physical Testing
- ❑ Understand a broader range of Trailers, Test Speeds, Loading Conditions
- ❑ Elimination of associated risks to personnel, vehicles and test locations
- ❑ Programme costs reduced due to physical prototypes not being required



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