MSc. Salih Kuriş, Dr. Barış Aykent
Hexagon Studio

MSC Software

DELIVERING
CERTAINTY

2016 VEHICLE DYNAMICS CONFERENCE
OCTOBER 25 - 26 | MUNICH, GERMANY

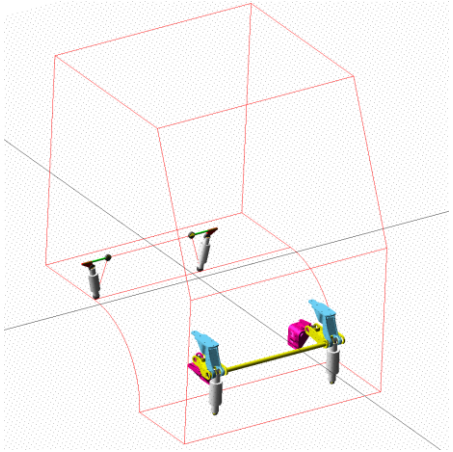
A Four Point Truck Cabin Suspension Development using ADAMS

Table of Contents

A PROTOTYPE TRUCK CABIN SUSPENSION DYNAMICS MODEL

A Prototype Truck Cabin Suspension Dynamics Model

- A cab suspension prototype model was established in MSC. Adams / Car program.
- The hardpoints were taken from CAD data.
- The stiffness values of the bushings and the air spring, the cabin weight, center of gravity and moment of inertia were entered into the mathematical model.



MEASUREMENT OF BUSHING STIFFNESSES

Measurement of Bushing Stiffnesses

- Stiffness values of the bushings of the cab suspension used in the system were tested and measured in Hexagon Studio.
- Then, the data were inserted in the mathematical model prepared in MSC Adams/Car.

	Axial	Radial	Cardanic
Front cab bushing	327 N/mm	1518 N/mm	3624 Nmm/deg
Rear cab bushing	-	932 N/mm	1841 Nmm/deg
Front swing arm bushing	961 N/mm	6085 N/mm	-

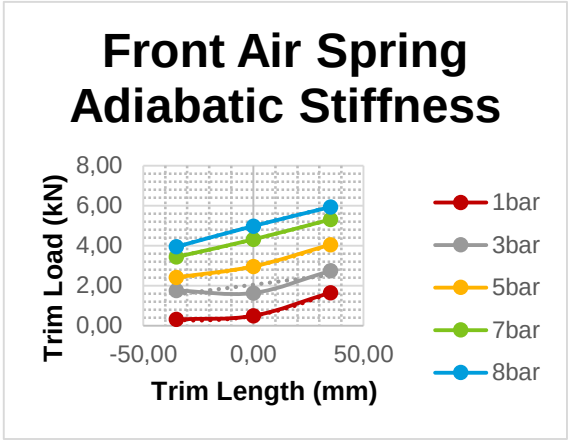
Axial measurement test rig

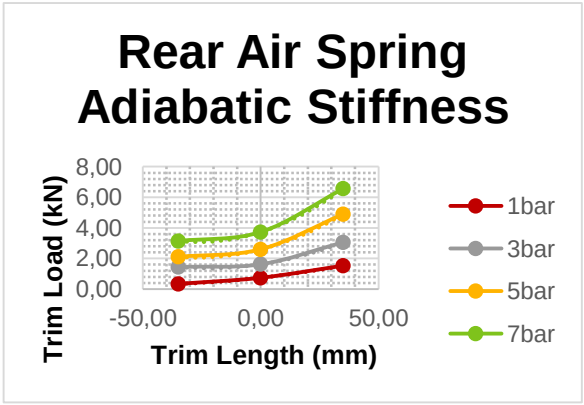
Radial measurement test rig

ADIABATIC STIFFNESS CHARACTERISTICS OF AIR SPRINGS

Adiabatic Stiffness Characteristics of Air Springs

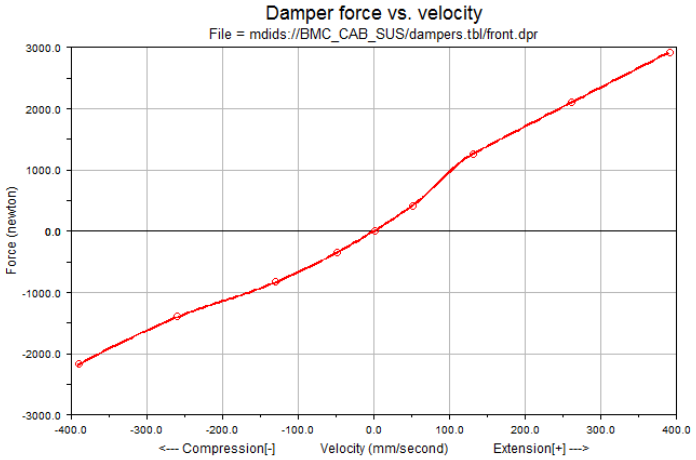
- The adiabatic stiffness characteristics were obtained from the supplier.
- Then, it was entered into the mathematical model by using curve fitting method for the cabin suspension comfort analysis.

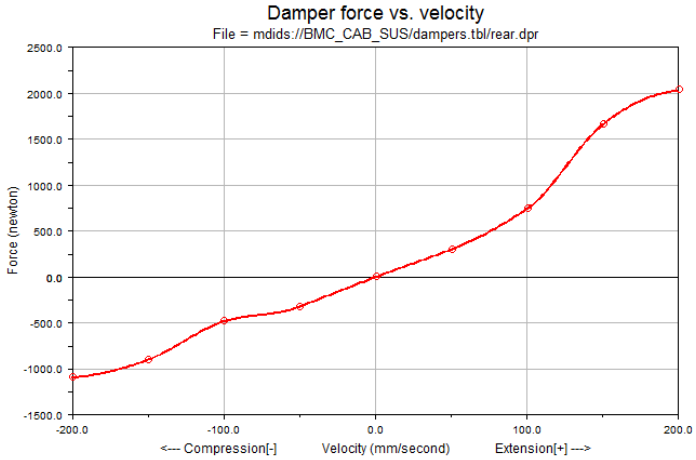




DAMPER CHARACTERISTICS

Damper Characteristics



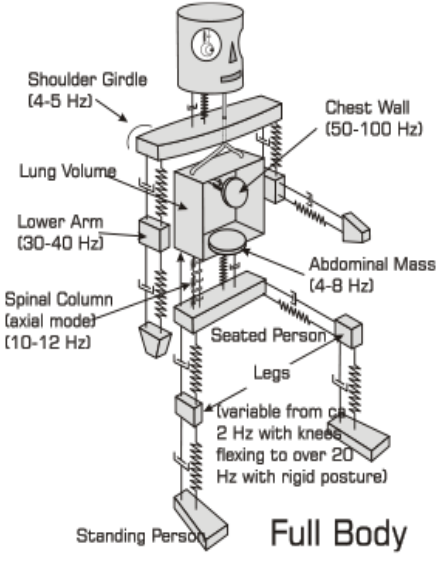


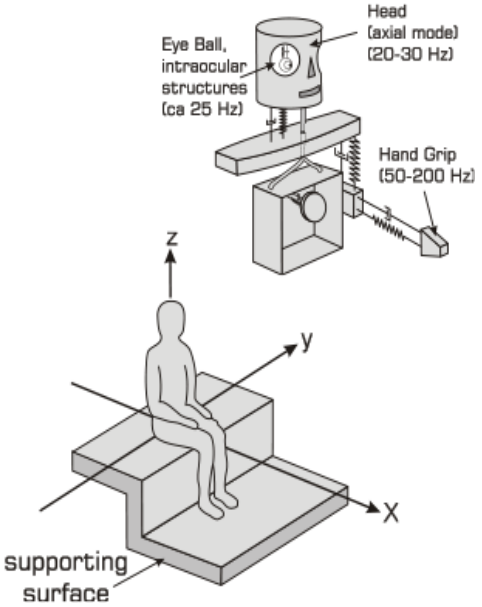
The front and rear damper characteristics were provided by the supplier and added to the model.

COMFORT ANALYSIS

Comfort Analysis

- Primary ride (0.5-4 Hz: high amplitude, low frequency) consists of the frequency range that motion sickness can be susceptible.This can provoke nausea.
- Choppiness (3-7 Hz) can cause discomfort mostly to shoulder and abdominal regions of the human body.
- Secondary ride (8-20 Hz: low amplitude, high frequency) can be felt as vibration at leg level.





Comfort Analysis – Air Suspension Cab Actual Condition

AIR SUSPENSION CABIN ACTUAL CONDITION (Vehicle A1)		Primary Ride [0.5-4Hz]			Choppiness [3-7 Hz]			Secondary Ride [8-20 Hz]		
		Surge	Sway	Heave	Surge	Sway	Heave	Surge	Sway	Heave
Asphalt	*Mechanic Suspension (Vehicle A2)*	105%	-1.5%	16%	367 %	65%	52%	2002%	88%	11%
	Mechanic Suspension (Vehicle B)	74%	-2%	2%	476%	117%	113%	2940%	203%	46%
	Air Suspension Recommendation (Vehicle A3)	-5%	-15 %	3%	-6%	-46%	1%	-10%	-39%	-29%
Cross Bump	*Mechanic Suspension (Vehicle A2)*	260%	168%	23%	199%	26%	59%	1165%	80%	62%
	Mechanic Suspension (Vehicle B)	252%	155%	11%	364%	63%	108%	1500%	107%	63%
	Air Suspension Recommendation (Vehicle A3)	1%	-9%	3%	-3%	-42%	-3%	-3%	-23%	-4%

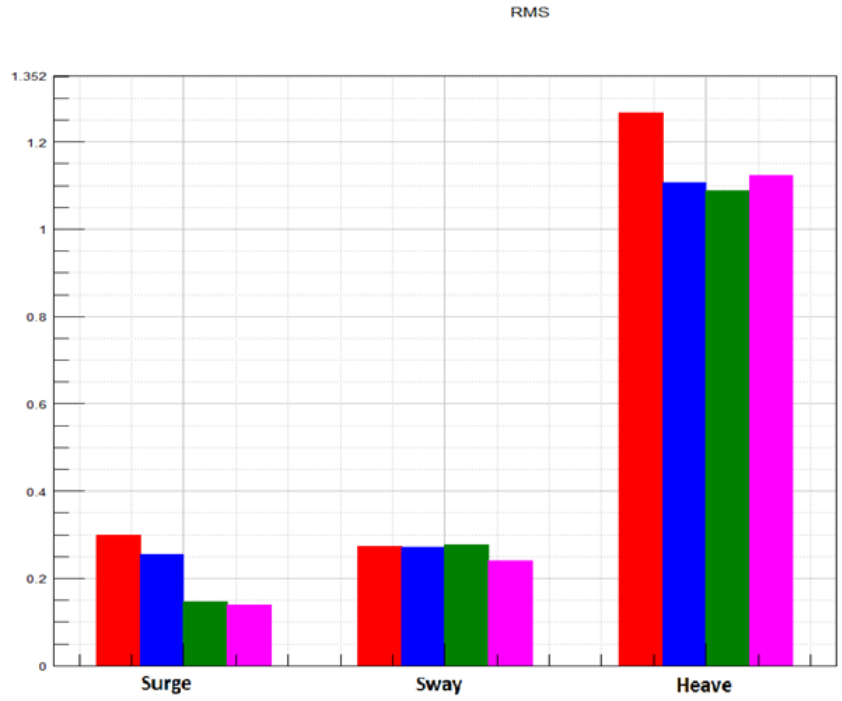
Comfort Analysis – Comparison of Vehicle A2 and Vehicle B

Comparison of Vehicle A2 and Vehicle B									
	Primary Ride [0.5-4Hz]			Choppiness [3-7 Hz]			Secondary Ride [8-20 Hz]		
	Surge	Sway	Heave	Surge	Sway	Heave	Surge	Sway	Heave
Asphalt	-15%	-1%	-13%	23%	31%	40%	45%	61%	32%
Cross Bump	-2%	-5%	-11%	35%	23%	24%	21%	13%	1%

Comfort Analysis – Comparison of Vehicle A1 and Vehicle B

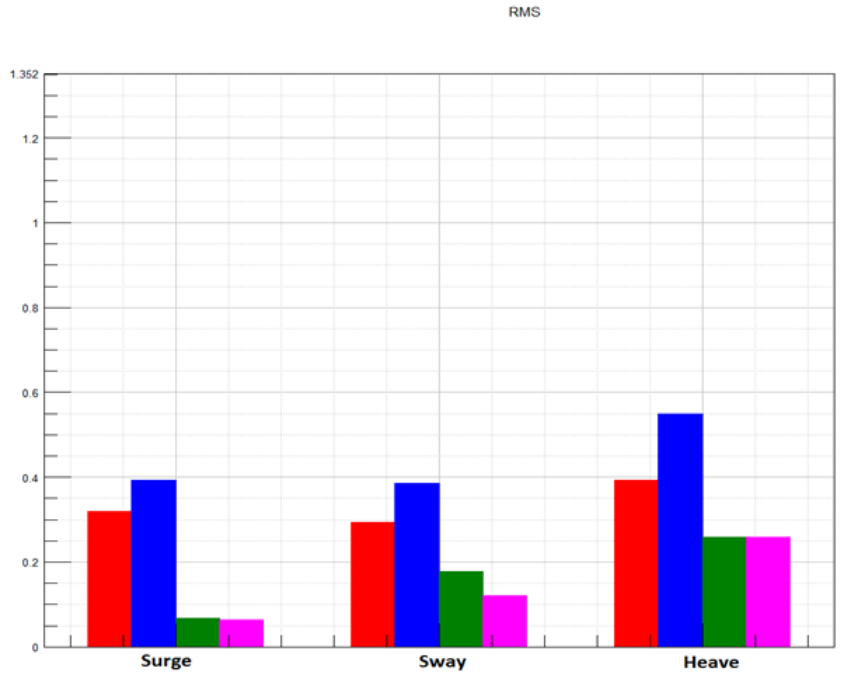
Comparison of Vehicle A1 and Vehicle B									
	Primary Ride [0.5-4Hz]			Choppiness [3-7 Hz]			Secondary Ride [8-20 Hz]		
	Surge	Sway	Heave	Surge	Sway	Heave	Surge	Sway	Heave
Asphalt	74%	-2%	2%	476%	117%	113%	2940%	203%	46%
Cross Bump	252%	155%	11%	364%	63%	108%	1500%	107%	63%

Comfort Analysis – Primary Ride RMS Comparison (Asphalt)



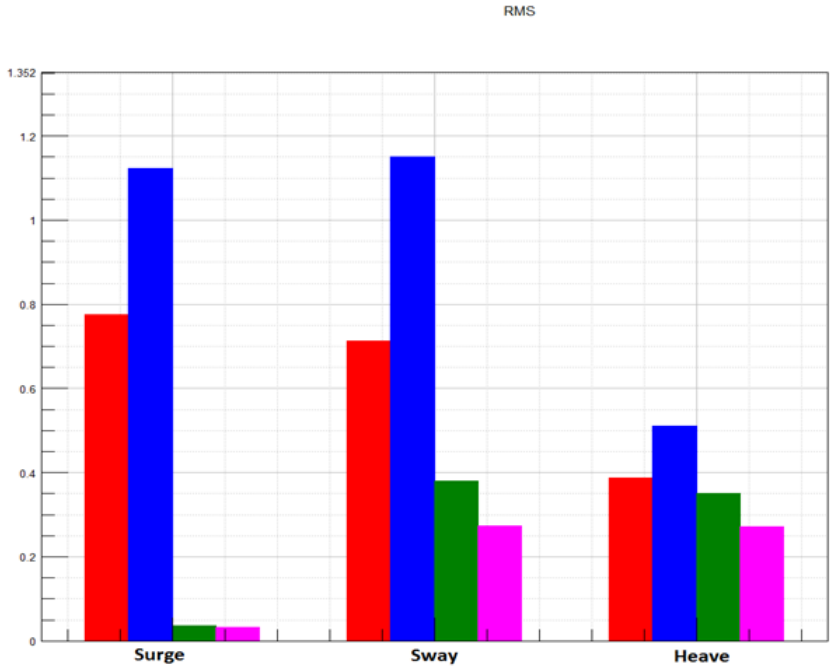
Red:Vehicle A2
Blue: Vehicle B
Green: Vehicle A1
Pink: Vehicle A3

Comfort Analysis – Choppiness RMS Comparison (Asphalt)



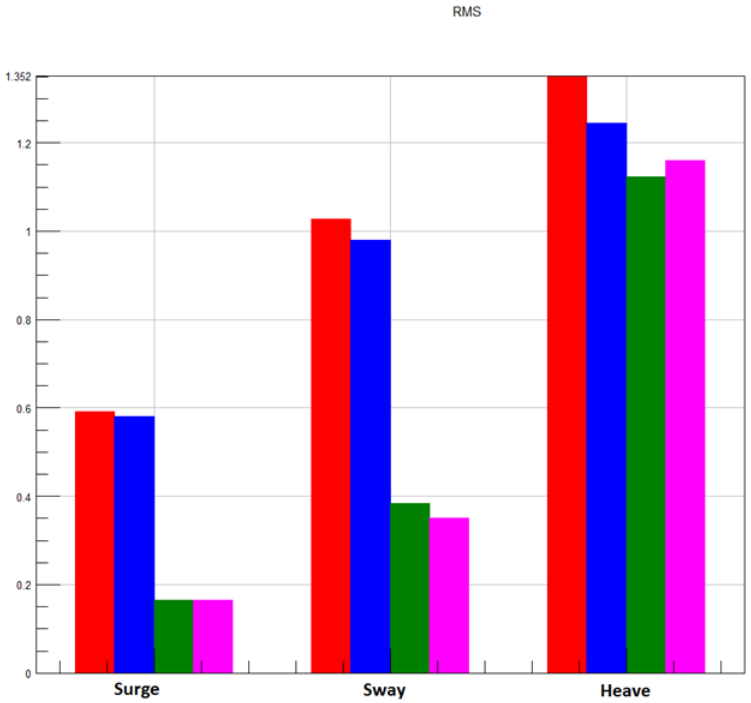
Red:Vehicle A2
Blue: Vehicle B
Green: Vehicle A1
Pink: Vehicle A3

Comfort Analysis – Secondary Ride RMS Comparison (Asphalt)



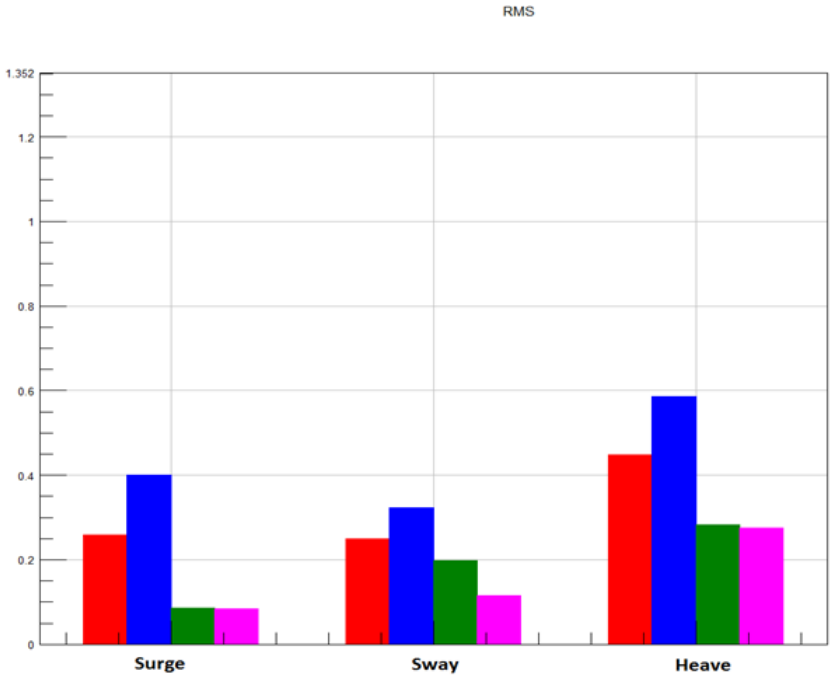
Red:Vehicle A2
Blue: Vehicle B
Green: Vehicle A1
Pink: Vehicle A3

Comfort Analysis – Primary Ride RMS Comparison (Cross Bump)



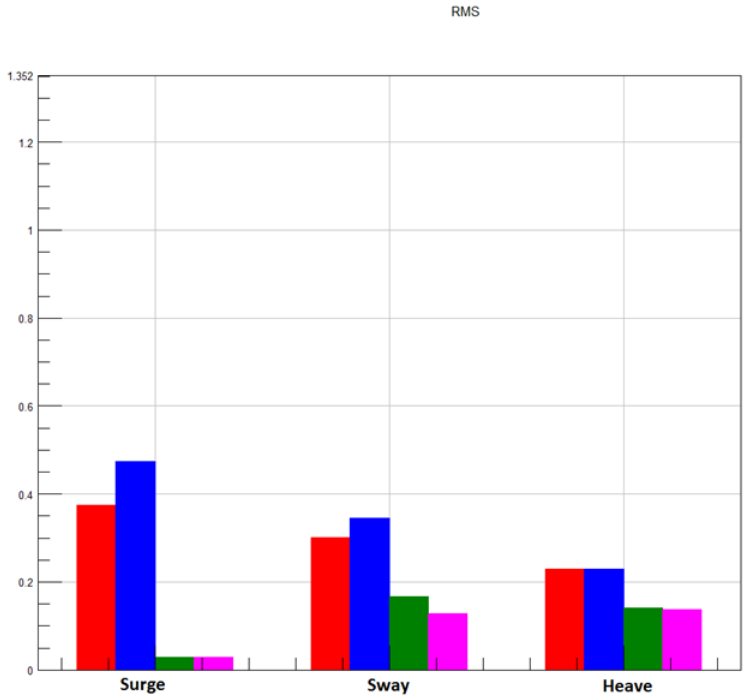
Red:Vehicle A2
Blue: Vehicle B
Green: Vehicle A1
Pink: Vehicle A3

Comfort Analysis – Choppiness RMS Comparison (Cross Bump)



Red:Vehicle A2
Blue: Vehicle B
Green: Vehicle A1
Pink: Vehicle A3

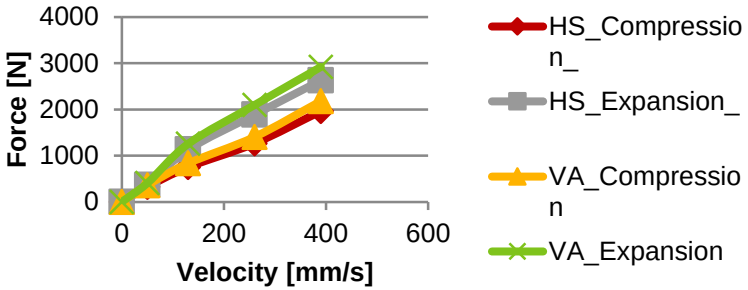
Comfort Analysis – Secondary Ride RMS Comparison (Cross Bump)



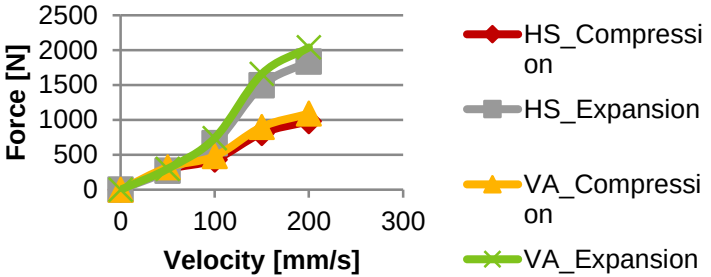
Red:Vehicle A2
Blue: Vehicle B
Green: Vehicle A1
Pink: Vehicle A3

Comfort Analysis – Part Choice

Front Damper (8956)



Rear Damper (8973)



Front cabin bushing

Radial: 607 N/mm

Axial: 130 N/mm

Rear cabin bushing

Radial: 1862 N/mm

Conclusions

- A truck cabin was modelled.
- The optimization was provided for primary ride, choppiness and secondary ride in sway on asphalt respectively as 15%, 46% and 39%.
- The improvement was provided for primary ride, choppiness and secondary ride in sway on cross bump respectively as 9 %, 42 % and 23%.

Thank You

MSC Software