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Rise.



Brake-Performance prediction

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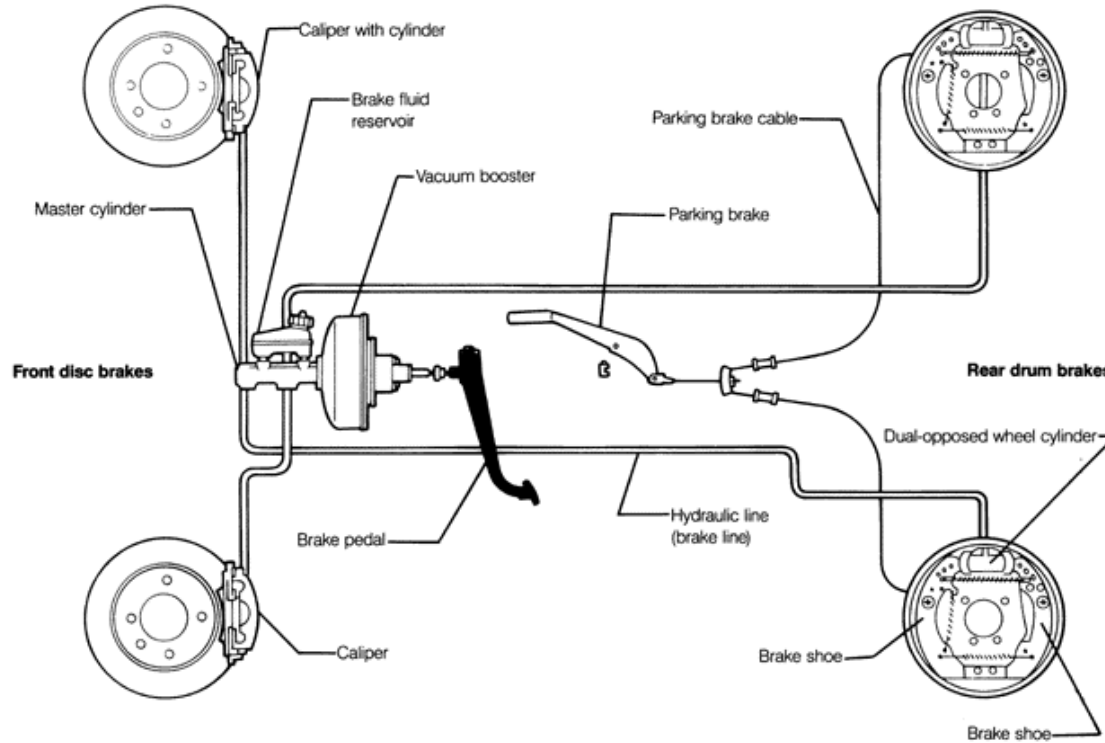
Agenda

- Objective of the application
- How does the brake system in your cars work?
- Performance curves
- MATLAB application
- Problems resolved

Objective

- To create a standalone application for predicting the brake performance curves.
- This application will:
 - Take input vehicle parameters from the user
 - Process the data and generate performance graphs
 - Tabulate the data against regulations
 - Generate a final report of the system
- Decide the brakes system design parameters

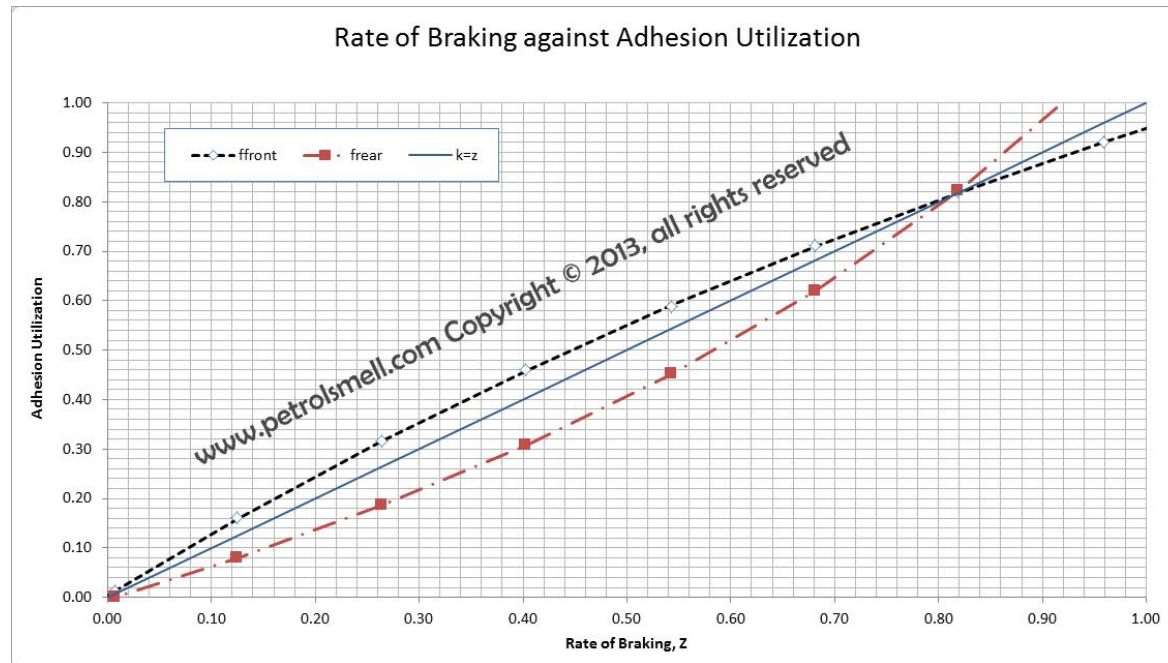
How does the brake system in your cars work?



- Energy source - muscular effort vacuum booster
- Modulation system - to control brake force
- Transmission system - brake tubes, brake hoses(flexible tubes)
- Foundation brakes – calipers, drums

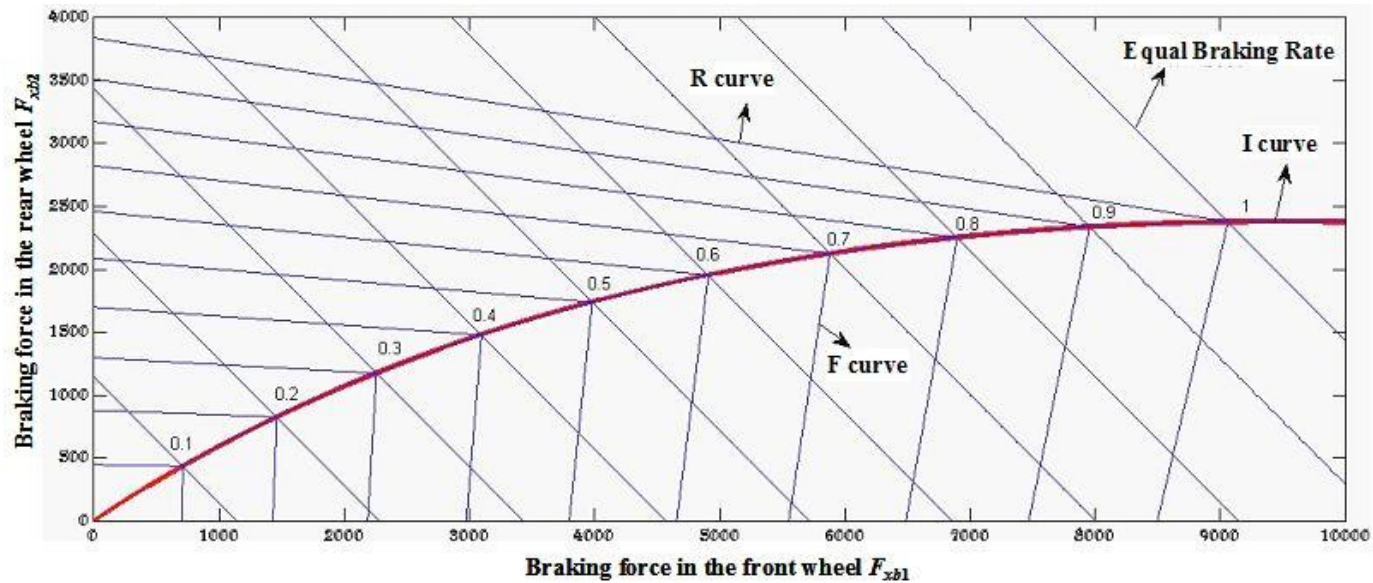
Performance curves

1. Adhesion utilization vs deceleration



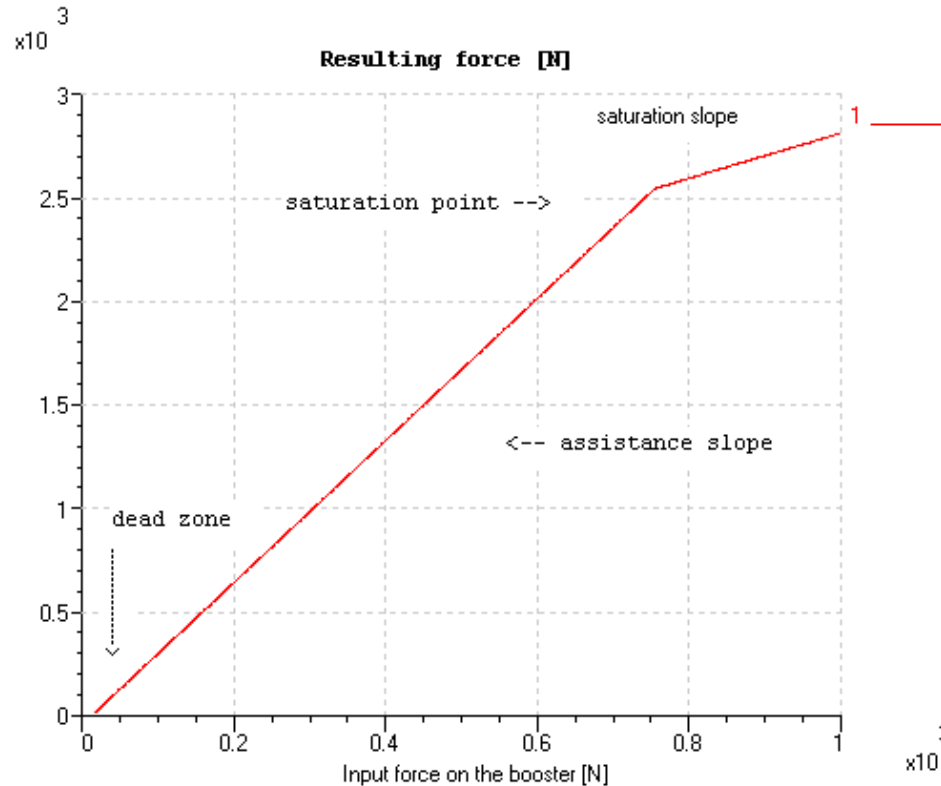
- Adhesion utilization is equivalent to coefficient of friction
- Relates the maximum wheels-unlocked deceleration to the lowest tire-road friction coefficient with which the deceleration can be achieved without locking of any brakes.

2. Braking forces diagram



- Relates the braking forces on the front and rear wheels
- Ideal braking curve
- Actual braking curve
- Constant deceleration lines

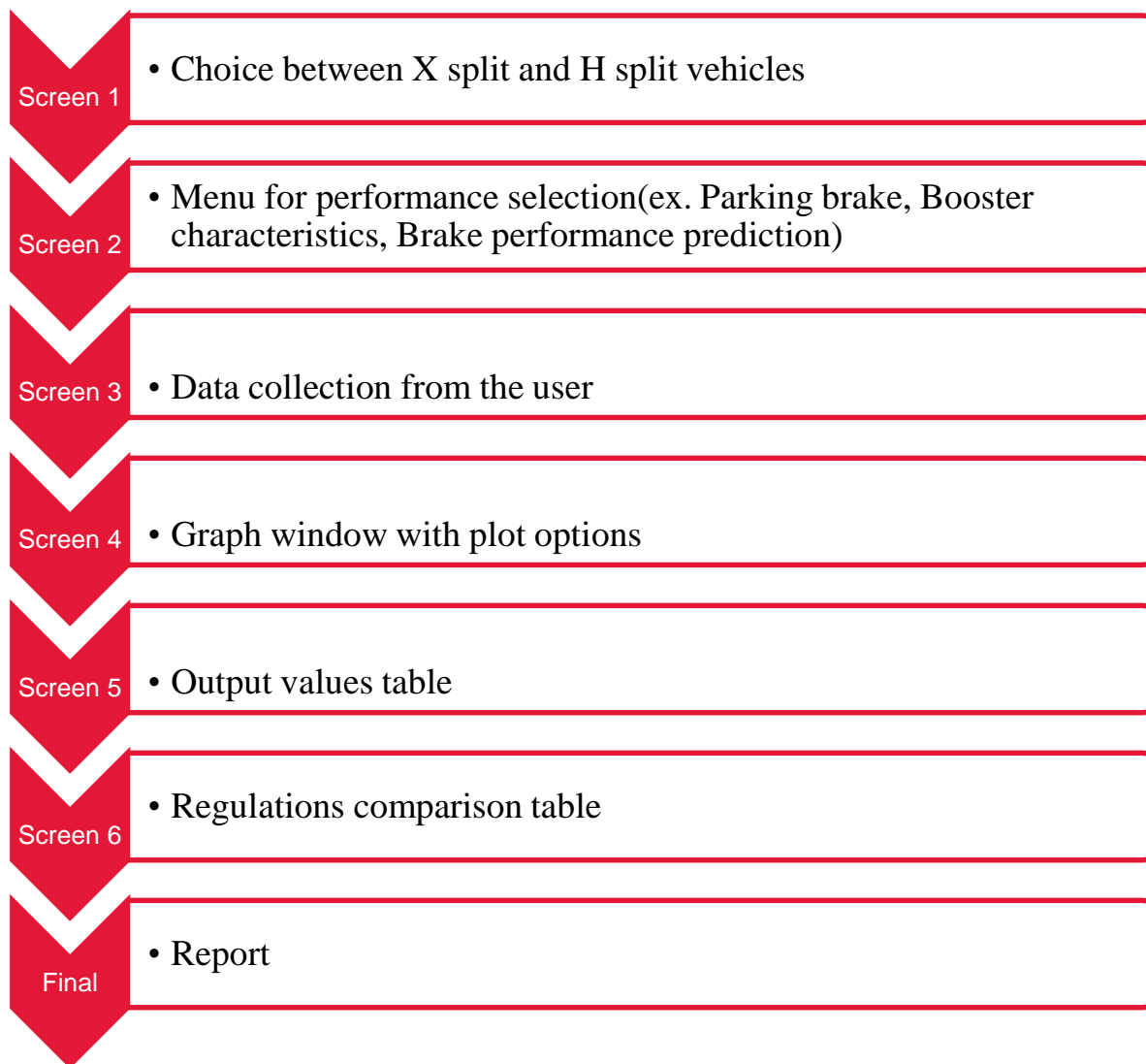
3. Booster characteristics curve



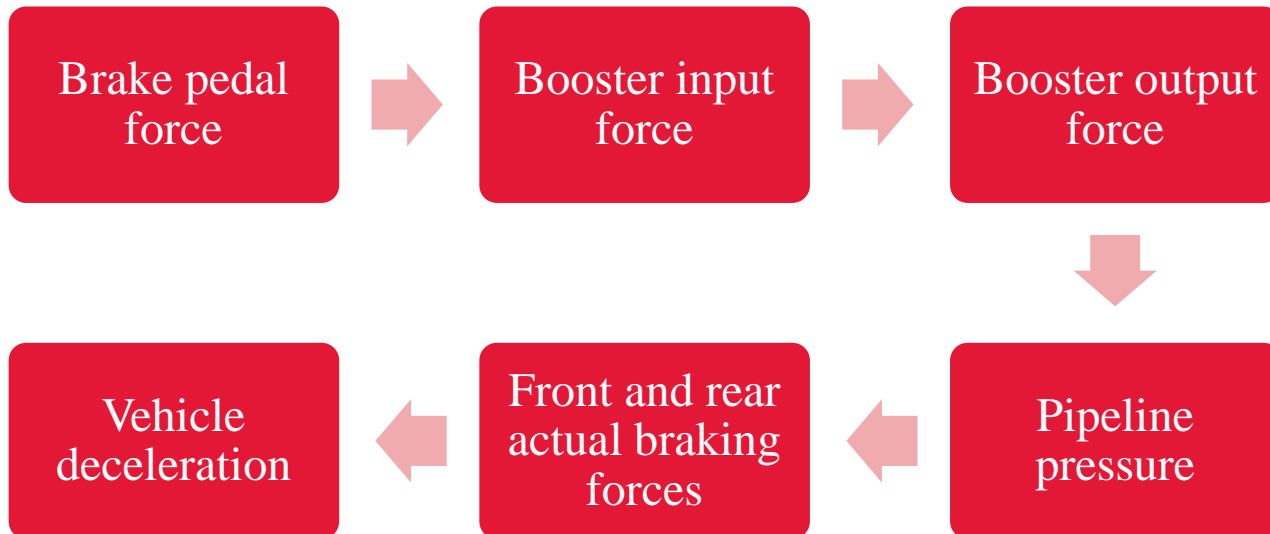
- Relates output force from booster with the input force
- Key points in booster:
 - Jump-in pressure
 - Boost ratio
 - Knee-point pressure

MATLAB application

Process workflow



Calculation methodology



- Tools used: MATLAB, GUI, Report Generator toolbox
- For LSPV vehicles, cut-in point taken as input from user
- For ABS vehicles, actual forces follow optimal curve after critical deceleration

Data screen of the application

Brake performance prediction

Vehicle data

	Unladen	Laden
Mass(kgs)	1855	2610
Front axle weight(kgs)	1094	1275
Rear axle weight(kgs)	761	1335
Height of CG(mm)	680	720

Project name: Vehicle category:

Wheelbase(in mm): Dynamic rolling radius(mm):

Engine type:

Coeff. of friction b/w. tyre and ground:

Maximum speed of vehicle:

Maximum engine power:

Brake data

	Front-disc	Rear-disc
Number of pots in caliper	2	1
Disc rad./Drum eff. rad.(mm)	138	131
Friction coeff. / Brake factor	0.4200	0.4200
Diameter of first pot	45	38
Diameter of second pot	45	0
Caliper efficiency	1	1
Percentage fade speed	90	90
Percentage fade temperature	90	90
Percentage fade pressure	90	90

Fluid volume displaced

Pressure(bar)	FVD front(cc)	FVD rear(cc)
10	0.8806	0.1765
20	1.1468	0.2214
30	1.3729	0.2663
40	1.5591	0.3112
50	1.7452	0.3562
60	1.9313	0.4011
70	2.0975	0.4460
80	2.2536	0.4909
90	2.4098	0.5358
100	2.5759	0.5807
110	2.7320	0.6256
120	2.8882	0.6705
130	3.0343	0.7154
140	3.1905	0.7604
150	3.3166	0.4026

Pedal data

Pedal ratio:

Pedal efficiency(0-1):

Clearance between clevis pin and shank hole(in mm):

Actuation data

Diameter of master cylinder(in mm):

Booster threshold load with no vaccum(in kgs):

Booster threshold load with vaccum(in kgs):

Booster data

Type of booster:

Booster diameter(inches):

Tandem booster diameter(inches):

Jump in pressure(in bar):

Vacuum available(mm of Hg):

Boost ratio:

Hydraulic efficiency:

Booster efficiency:

Kneepoint pressure(bar):

Kneepoint load (kgs):

Valve data

Type of Valve:

Slope of LSPV:

Dynamic LSPV cut-in(unladen):

Dynamic LSPV cut-in(laden):

- Default values in the window
- Drop-down menu for LSPV and ABS modules
- Dynamic GUI based on option selection from drop-down menu

Graph screen

Output data

Adhesion coefficients vs deceleration

Brake fail condition

TMC pressure vs pedal effort

Braking forces diagram

Representative braking forces diagram

Plot options

Deceleration vs pedal effort

Deceleration vs pedal travel

Dynamic LSPV cut-in

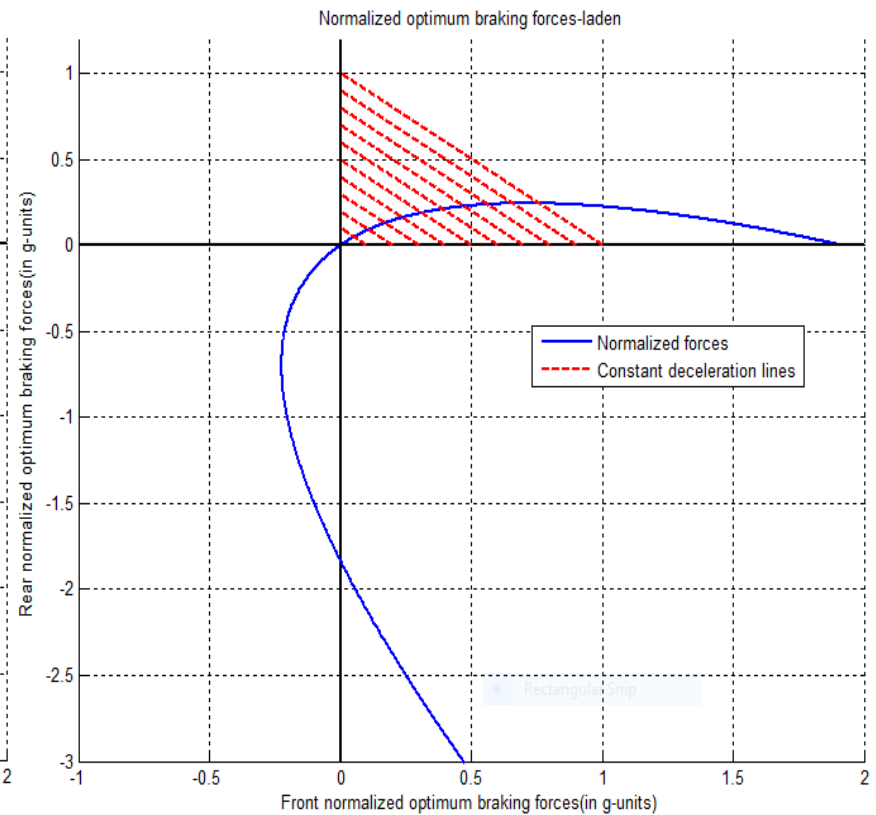
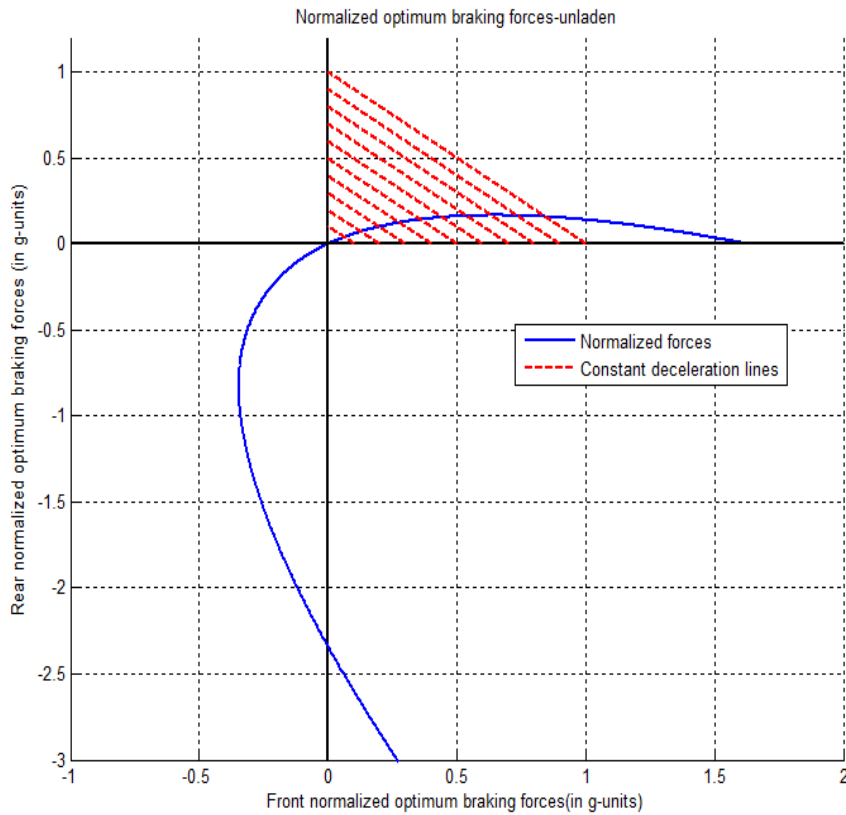
Percentage of critical deceleration

95

Update

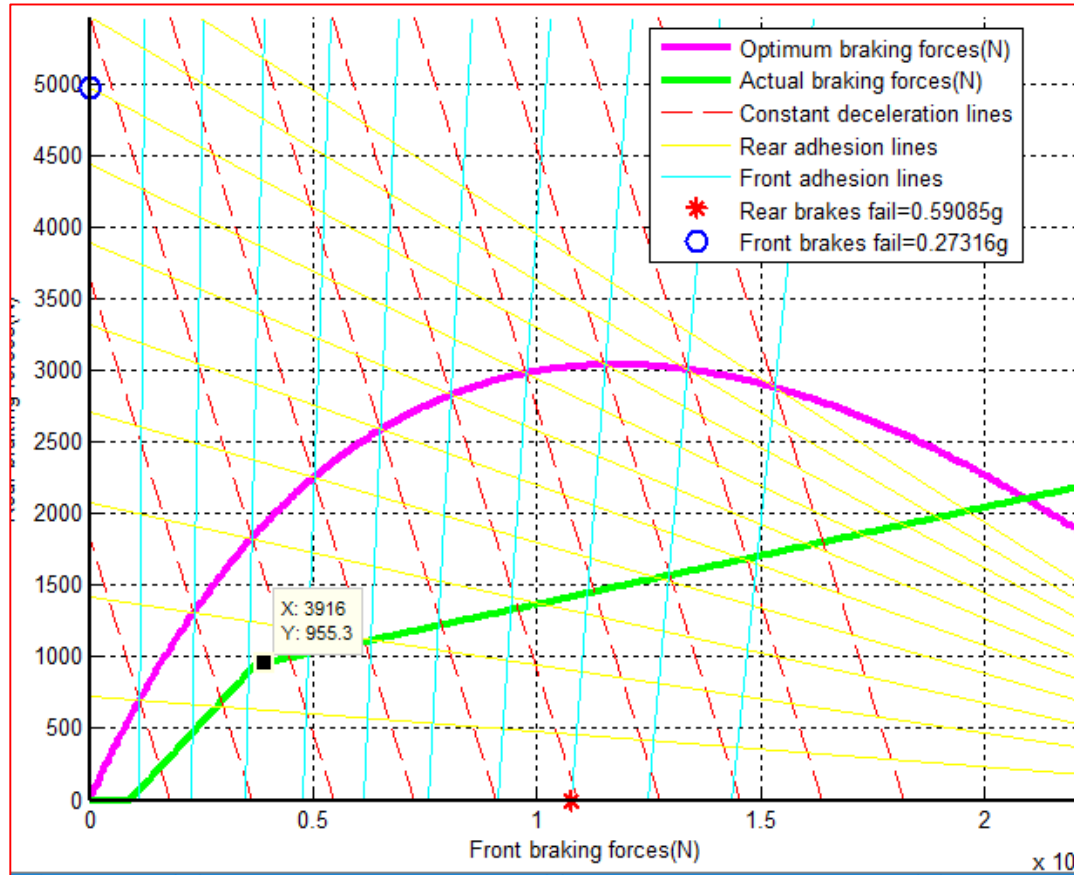
Back

Generate table



- Display of graph is instant – earlier application took 174 seconds to display all the graphs
- Comparison of data for unladen and laden conditions

Representative diagram of braking forces



- Values at particular points can be easily obtained
- Graphs can be printed from this menu

Output values screen

Output values

Vehicle values

	Unladen	Laden
Weight(N)		
Front/Rear weight ratio		
Relative height of CG(mm)		
Static axle load distribution		

Booster calculation

	Value
Booster assist force(N)	
Kneepoint deceleration-unladen(g)	

Brake failing condition

Rear brake fail

	Unladen	Laden
Maximum deceleration(g)		
Pedal effort(kgs)		

Front brake fail

	Unladen	Laden
Maximum deceleration(g)		
Pedal effort(kgs)		

Brake locking condition

Rear brake locking first

	Unladen	Laden
Maximum deceleration(g)		
Pedal effort(kgs)		
Front brakeline pressure(bar)		
Rear brakeline pressure(bar)		

Front brake locking first

	Unladen	Laden
Maximum deceleration(g)		
Pedal effort(kgs)		
Front brakeline pressure(bar)		
Rear brakeline pressure(bar)		

Display
Regulations

ECE13

	Adhesion at front	Deceleration(g)	Pedal effort requirement(kg)	Actual pedal effort(kg)
Service braking	Unladen			
	Laden			
Booster failure	Unladen			
	Laden			
Primary ckt. failure	Unladen			
	Laden			
Secondary ckt. failure	Unladen			
	Laden			

ECE13H

	Adhesion at front	Deceleration(g)	Pedal effort requirement(kg)	Actual pedal effort(kg)
Service braking	Unladen			
	Laden			
Booster failure	Unladen			
	Laden			
Primary ckt. failure	Unladen			
	Laden			
Secondary ckt. failure	Unladen			
	Laden			

Compute

Generate report

- Critical values in a tabular column
- Comparison with regulations ECE13 and ECE13H

Problems resolved

- Inclusion of ABS logic
- Fast execution time(close to 1.5 s for graph generation)
- Distribution of standalone executable files with user access
- Successful report generation
- Modules for each and every section – code modifications
- Data values at every point of the graph
- Dynamic GUI
- Easy-to-interact interface

Thank you

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