Instructor:
Anne Goodchild

Homework 1: Road Vehicle Performance

Additional Required Work

I chose a 2003 Honda Element four-wheel drive EX model vehicle for this assignment. Figure 1 is a plot of its braking distance vs. initial speed for both theoretical minimum braking distance and practical braking distance used in design. Supporting equations and assumptions are shown on the following page.

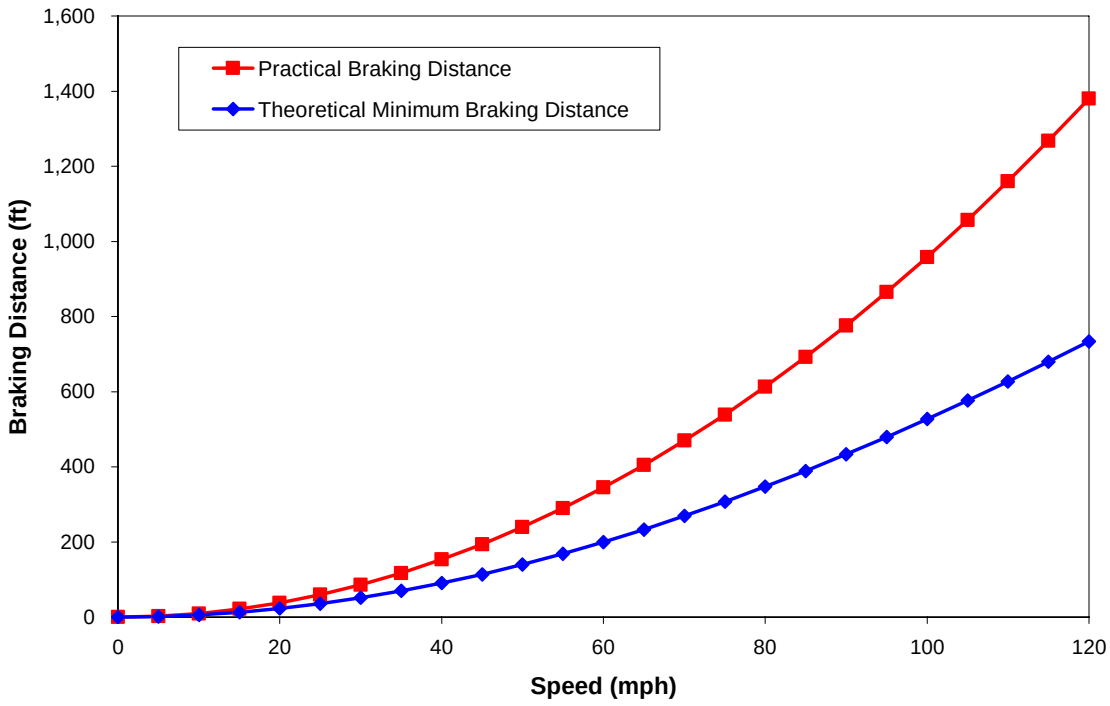

Figure 1: Comparison of theoretical braking distance for the 2003 Honda Element 4WD EX and practical braking distance used in design.

$$\text{Braking distance: } S = \frac{\gamma_b W}{2gK_a} \ln\left[1 + \frac{K_a V_1^2}{\eta_b \mu W + f_{rl} W \pm W \sin\theta_g}\right]$$

Where:
- S = theoretical minimum braking distance (ft.)
- γ_b = mass factor (given)
- W = weight of vehicle (in lbs.). Obtained from: http://www.hondacars.com/models/specifications.asp?ModelName=Element
- g = acceleration due to gravity (32.2 ft/sec^2)
- K_a = air resistance term (more below)
- V = Vehicle speed in ft/sec
- η_b = Braking efficiency (given)
- μ = Coefficient of road adhesion (given)
- f_{rl} = Coefficient of rolling resistance
- θ_g = Angle of incline (in this case, $\theta = 0$ for a flat grade)

$$\text{Air resistance: } K_a = \frac{\rho}{2} C_D A_f$$

Where:
- K_a = air resistance term (more below)
- ρ = Air density (slugs/ft^3)
- C_D = Coefficient of drag. The Honda Element value was not readily obtainable so I selected a vehicle with a similar shape, the Hummer H2, and used its drag coefficient as an estimate of the Element's. A value of 0.57 was obtained from: http://www.motortrend.com/roadtests/suv/112_0208_hummer/index1.html
- A_f = Frontal area, estimated by multiplying the vehicle width (71.5 inches) by the difference between the height (70.4 inches) and ground clearance (6.9 inches). Dimensions obtained from: http://www.hondacars.com/models/specifications.asp?ModelName=Element

$$\text{Practical braking distance for design: } d = \frac{V^2}{30\left(\left(\frac{a}{32.2}\right) \pm G\right)}$$

Where:
- d = practical braking distance for design (ft.)
- V = vehicle speed in miles/hour
- a = deceleration (given as 11.2 ft/sec^2)
- G = grade, as a decimal

Supporting Excel tables and calculations are shown on the next page.

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2003 Honda Element 4WD EX

INPUTS

Vehicle Values

height =	70.4	inches
width =	71.5	inches
clearance =	6.9	inches
W_e =	3,595	lbs
W_p =	400	lbs
C_D =	0.50	estimated from H2 C_D

Other Values

η_b =	0.85	
μ =	0.70	
grade =	0	percent
ρ =	0.0024	slugs/ft^3
g =	32.2	ft/sec^2
γ_b =	1.04	
a =	11.2	ft/sec^2

CALCULATIONS

W_f =	3,995	lbs	
A_f =	31.53	ft^2	(height - clearance) x width
K_a =	0.0189	lbm/ft	
angle =	0.00	degrees	

TABLE

Table 1: Comparison of Theoretical Braking Distance for the 2003 Honda Element 4WD EX and Practical Braking Distance Used in Design

Theoretical							Practical
Speed		f_{rl}	front	top	bottom	Braking Distance (ft)	Braking Distance (ft)
miles/hr	ft/s						
0	0.00	0.01000	3410.32	0.00	2,416.98	0.00	0.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

You get the idea

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
120	176.00	0.01599	3410.32	585.99	2,440.89	733.80	1380.00