

Friction, Speed and Stopping Distance

The distance that a car will travel to stop depends on the driver's alertness and the roadway conditions. **Friction** is the force that is developed between roadway surfaces and the locked tires of a skidding car. Friction is responsible for stopping a skidding automobile. Roadway surfaces are typically rated with a friction coefficient (μ) that serves as an indicator of the amount of friction the surface provides. The friction coefficient is the ratio of the friction force to the load (vehicle weight) as measured on a level surface. Friction coefficients are dependent upon the tire and the nature of the roadway surface.

Table 1

Surface	μ
Asphalt	0.75
Concrete	0.90
Gravel	0.50
Snow	0.30

Table 1 estimates the friction coefficient for good tires on varying road surfaces.

Knowledge of a friction coefficient allows one to predict the distance that a vehicle skids when the brakes are fully locked. This skid distance is dependent upon the original speed of the vehicle prior to braking. **Figure 1** illustrates the dependence of skid distance upon vehicle speed for varying friction coefficients. The distances are based on locked brakes and do not account for anti-lock brakes.

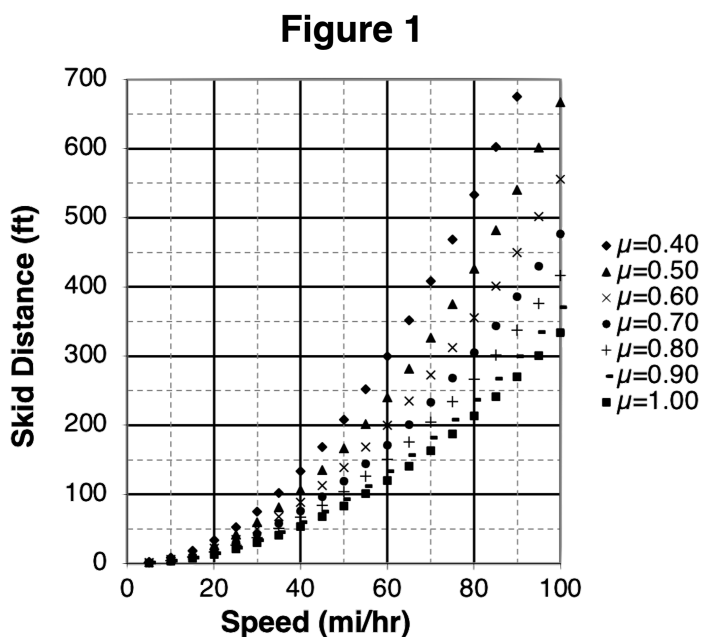


Figure 1 represents the skid distance. The total stopping distance of an vehicle also includes the distance the vehicle travels before the brakes are applied. When the driver perceives a situation that demands braking, the driver must react to the stimuli, lift the foot off the gas pedal and fully engage the brake pedal. During this *reaction time*, the car is traveling at a constant speed and covering distance. The total stopping distance is the sum of this **reaction distance** plus the skid distance. **Table 2** demonstrates the dependence of reaction distance (in feet) upon vehicle speed and reaction time.

Table 2: Reaction Distance (feet)

v (mi/hr)	$t_{rxn}=$ 0.60	$t_{rxn}=$ 0.70	$t_{rxn}=$ 0.80	$t_{rxn}=$ 0.90	$t_{rxn}=$ 1.00
	s	s	s	s	s
40	35	41	47	53	59
50	44	51	59	66	73
60	53	62	70	79	88
70	62	72	82	92	103
80	70	82	94	105	117
90	79	92	105	119	132