Vehicle Inertial Measurements

SAE J182 - Motor Vehicle Fiducial Marks and Three-Dimensional Reference System

SAE J1100 - Motor Vehicle Dimensions



Scales Method

ISO 10392 - Road vehicles - Determination of centre of gravity ISO 789-6 - Agricultural tractors - Test procedures - Part 6: Centre of gravity ISO 612 - Dimensions of motor vehicles and towed vehicles - Terms and definitions ISO 3833 - Road vehicles - Types - Terms and definitions ISO 8855 - Road vehicles - Vehicle dynamics and road-holding ability - Vocabulary

Measure the force under each tire with the vehicle level using wheel scales or a platform scale. The transmission should be in neutral with brakes off

 $W = F_{RF} + F_{LF} + F_{RA} + F_{LA}$ $F_F = F_{RF} + F_{LF} \qquad F_A = F_{RA} + F_{LA} \qquad F_R = F_{RF} + F_{RA} \qquad F_L = F_{LF} + F_{LA}$ Measure ℓ = wheelbase

$$x_{CG} = \ell \frac{F_F}{W}$$

measured forward from rear a

measured forward from rear axle



Measure b = tread

$$y_{CG} = \frac{b}{2} \frac{(F_{R} - F_{L})}{W}$$

measured to right from centerline





Suspend aft of vehicle or place rear tires onto blocks at angle θ greater than 15° with transmission in neutral and brakes off

Measure the force F_F ' under the front tires. Repeat for several different angles.

$$z_{\rm CG} = \ell \frac{\left(F_{\rm F}\, - F_{\rm F}\right)}{W\, \tan\theta} + r_{\rm STATIC}$$

measured up from ground



W a sin
$$\theta = F_F \ell \cos \theta - W x_{CG} \cos \theta$$

W
$$\mathbf{x}_{CG} = \ell F_F$$
 $\mathbf{a} = \ell \frac{(F_F' - F_F)}{W \tan \theta}$

 $\begin{array}{l} HMMWV\text{-}M1025 \ \ m=5960 \ lbm=185.2 \ slug} \\ J_{xx}=1750 \ slug.ft^2, \ J_{yy}=J_{zz}=3500 \ slug.ft^2 \qquad \qquad k_{xx}=3.07 \ ft, \ k_{yy}=k_{zz}=4.35 \ ft \end{array}$

θ

F_F'

F_F'

XCG

Tilt Table Method

ISO 16333 - Heavy commercial vehicles and buses - Steady-state rollover threshold - Tilt-table test method

SAE J2180 - Tilt Table Procedure for Measuring the Static Rollover Threshold for Heavy Trucks http://www.natc-ht.com/PDF/tilt.pdf





x forward - y right - z down				J_{xx} roll – J_{yy} pitch – J_{zz} yaw				
	Front							
Vehicle Class	Sprung	Wheel	Track	Axle	CG	Jxx	Jyy	Jzz
	Mass	Base	Width	to CG	Height			
	[kg]	[m]	[m]	[m]	[m]	[kg.m ²]	[kg.m ²]	[kg.m²]
Passenger Small	969.0	2.524	1.446	1.021	0.519	392.6	1632.2	1798.8
Passenger Large	1403.0	2.679	1.468	1.277	0.585	632.3	2749.7	2893.3
Pickup Small	1409.4	2.948	1.424	1.396	0.620	571.3	3142.8	3326.3
Pickup Large	1885.8	3.425	1.619	1.581	0.684	940.5	5344.0	5642.3
SUV Small	1718.5	2.683	1.496	1.350	0.688	803.3	3367.0	3522.2
SUV Large	2251.1	3.032	1.579	1.628	0.767	1157.3	5960.8	6111.0
Van	1847.5	2.947	1.589	1.480	0.698	992.3	4410.7	4617.8
$J_{yy} \approx J_{zz} \approx 5 J_{xx}$		$4.15 \le J_{yy}/J_{xx} \le 5.68$			$4.38 \le J_{zz}/J_{xx} \le 6.00$			

Inertial Properties of American Vehicles

Heydinger GJ, Bixel RA, Garrott WR, Pyne M, Howe JG, Guenther DA (1999) Measured Vehicle Inertial Parameters - NHTSA's Data Through November 1998 SAE 1999-01-1336

