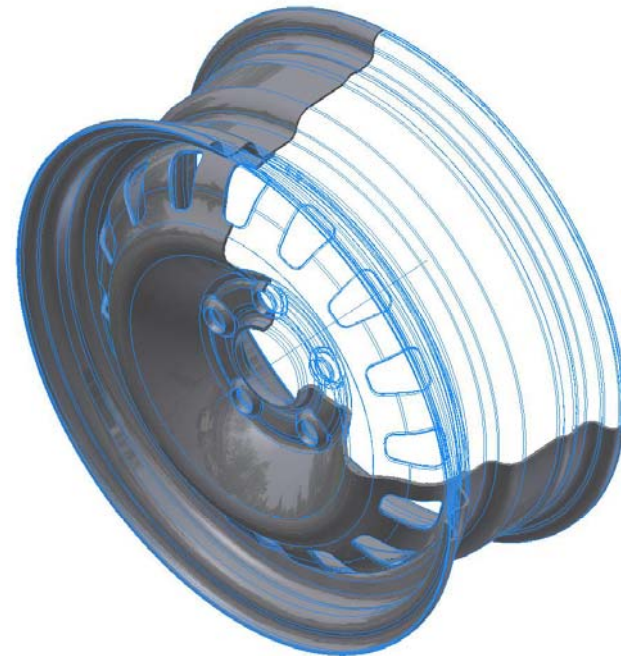


IBD Connection, Inc.

*INTERNATIONAL BUSINESS DEVELOPMENT
METAL PROCESSING & METAL FORMING*

Wheel Mass to Body Ratio

by Erik Waelchli



The Questions

One Unit of Wheel Weight is “worth” how much Body Weight?

- Internet research reveals claims of ratios from 2 to 10 times!
- Are these figures for real?
- What are the factors that influence this ratio?

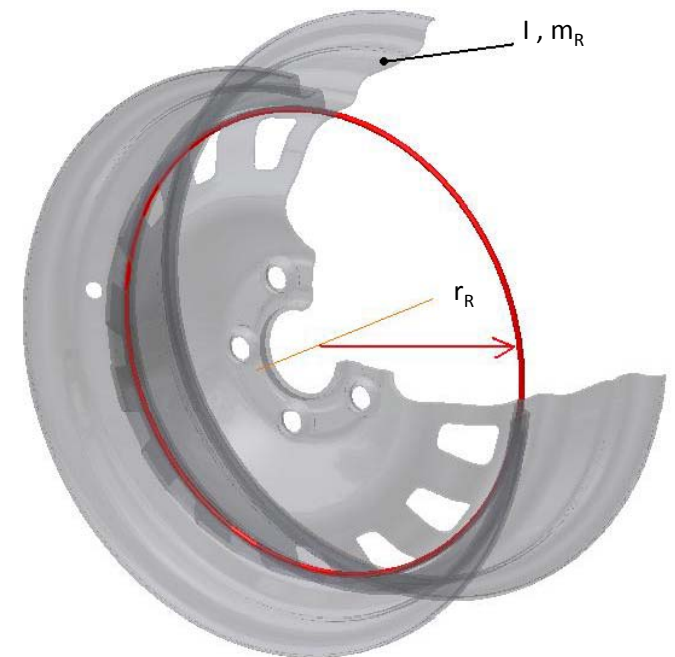
The Wheel-Rim Mass Radius

The need for a simple model

$$I = m \times r^2$$

- Concentrate the wheel mass to the “**Mass Radius**”

$$r_R = \sqrt{I_{\text{wheel}} / m_{\text{wheel}}}$$



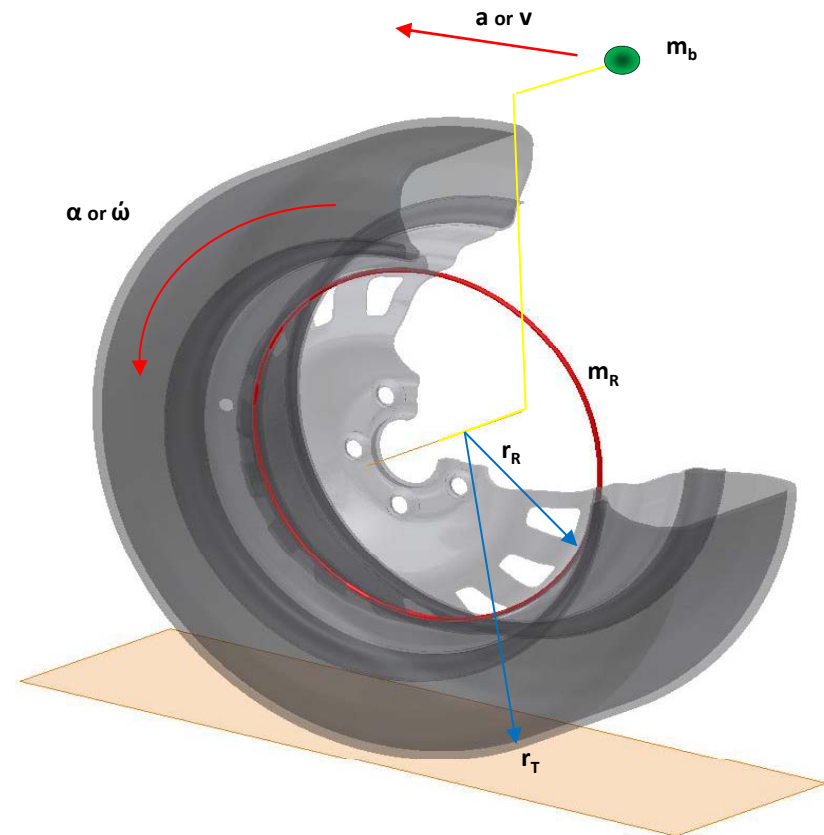
Physics & “The Relationship”

$$m_B / m_R = 1 + r_R^2 / r_T^2$$

i.e. the Mass-Ratio

or $m_B = m_R \times (1 + r_R^2 / r_T^2)$

or $m_R = m_B / (1 + r_R^2 / r_T^2)$



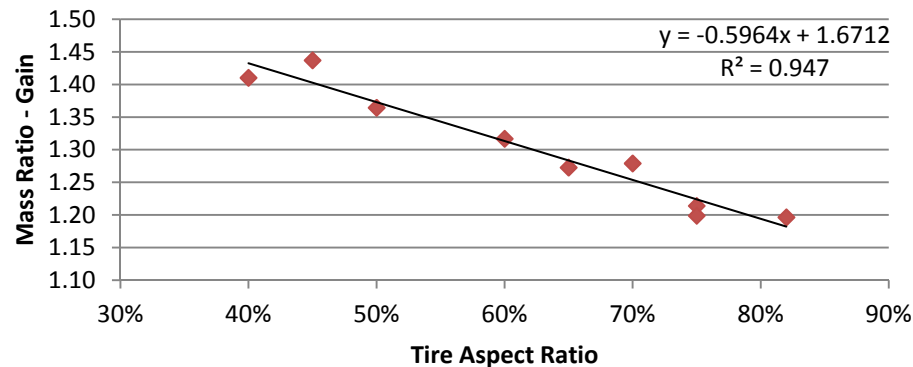
Numerical Limits and Ranges

$$m_B / m_R = 1 + r_R^2 / r_T^2$$

- **Minimum Limit** $m_B / m_R = 1.0$
- **Maximum Limit** $m_B / m_R = 2.0$
- **Typical Range for Wheels** $m_B / m_R = 1.2 \dots 1.5$
dependant on aspect ratio of tire

"Rotating-to-Body Mass Ratio" Comparison with different Tire Aspect Ratios

Vehicle		<i>Corvette</i>	<i>Camaro</i>	<i>Cadillac STS</i>	<i>Pass-Car</i>	<i>Silverado</i>	<i>Pass-Car</i>	<i>Hummer H3</i>
Rim		18 x 8.5	20 x 8	18 x 8	J14 x 5.5	J8 x 18	J14 x 5.5	16 x 7.5
Tire		P245/40ZR18	P245/45ZR20	P235/50ZR18	P185/60R14	P265/65R18	P185/70R14	P265/75R16
Aspect Ratio		40%	45%	50%	60%	65%	70%	75%
Tire Rolling Radius	mm	306.9	330.4	325.7	271.7	376.5	289.5	377.9
Wheel-Rim Mass Radius	mm	196.6	218.4	196.6	152.9	196.6	152.9	174.8
Mass Ratio = $1 + R_R^2/R_T^2$	[-]	1.41	1.44	1.36	1.32	1.27	1.28	1.21



The interesting Weight is Outside

		<i>Original</i>	<i>Outer Section</i>	<i>Inner Section</i>	
Inertia	I	138,783	128,938	137,302	kg-mm ²
Wheel Mass	m_R	5.86	5.61	5.61	kg
Delta Wheel Mass	dm_R		0.250	0.250	kg
Mass Radius	r_R	153.9	151.6	156.44	mm
Tire Radius	r_T	266	266	266	mm
Ratio	m_B/m_R	1.335	1.325	1.346	[-]
Wheel Mass refl. to Body		7.82	7.43	7.55	kg
Delta equiv. Body Mass			0.389	0.271	kg
%-age Gain to delta Wheel Mass			55.7%	8.4%	

The Answers

**How much more is One Unit of Wheel Weight
“worth” than Body Weight is influenced by:**

- **Where the Weight is on the Wheel**
 - How far away is the wheel-mass from the wheel’s rotational axis
- **Aspect Ratio of the Tire**
 - How far away is the wheel-mass from the road
- **Typical Wheel-Mass-to-Body Ratio $m_B/m_R = 1.2$ to 1.6**
 - Possible Mass Gains from 20% to 60% i.e. (factors of > 2 are false!)

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for Feedback and Questions
contact

Erik Waelchli
www.IBDConnection.com
+1 (574) 621 0096



52037 Woodridge Dr.
South Bend, IN 46635
USA

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