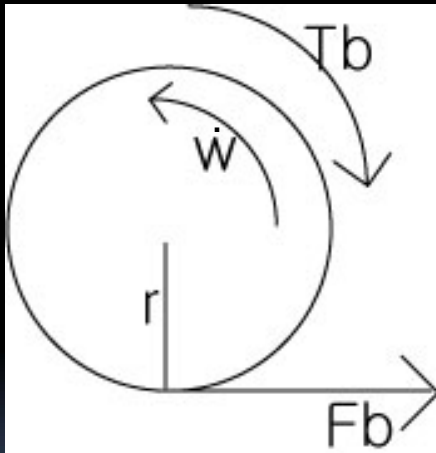


Team : The Best Circle
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Sungwon Lee

THE OPTIMUM DESIGN OF THE ALUMINUM WHEEL'S SHAPE

Introduction

- **Wheel Dynamics**



$$T_b = rF + I\dot{\omega}$$

Similarly ,

$$T_a = rF - I\dot{\omega}$$

If $\dot{\omega}$ is increased, $I\dot{\omega}$ term cannot be ignored.



Formulate

- Step 1 : Project/Problem Statement
The goal of this project is to determine shape of an aluminum wheel.
- 

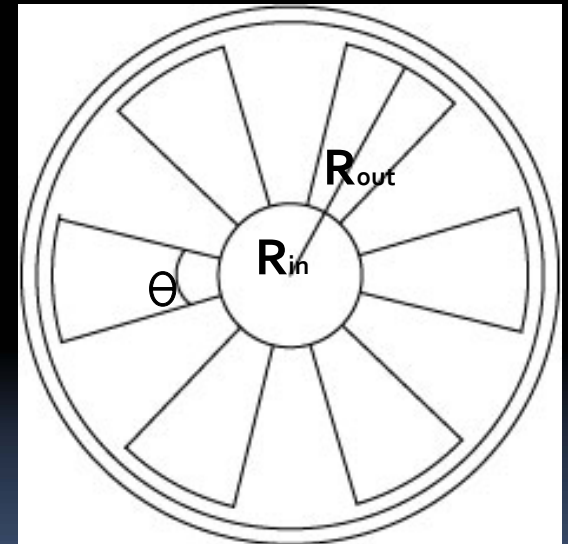
Formulate

- Step 2 (1) : Data and Information Collection.

16'' Wheel

Mass Inertia Moment :

$$J = \frac{1}{2} m_1 r_{in}^2 + \frac{1}{2} m_2 (r_{out}^2 - r_{in}^2) \frac{6\theta}{2\pi}$$

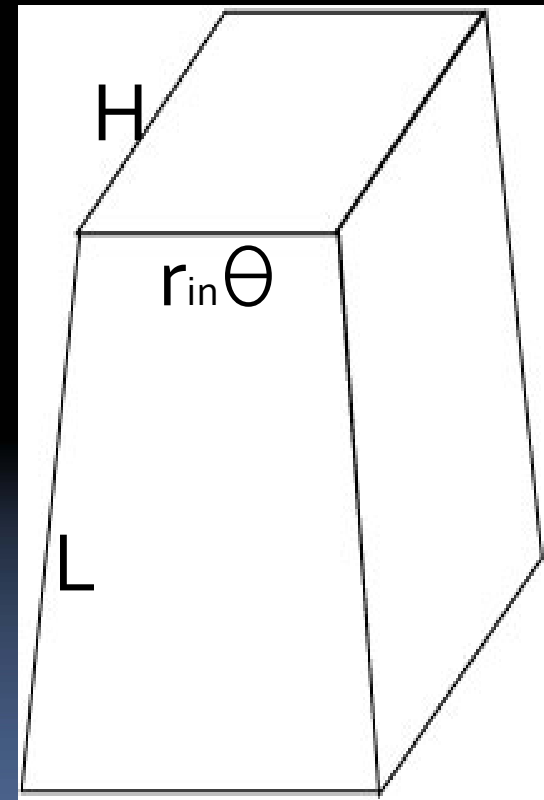


Formulate

- Step2 (2) :
Column Buckling :

$$\frac{w/4}{A} \leq \frac{\pi^2 EI}{(KL)^2}$$

$$I = \frac{r_{in} \theta h^3}{12}$$



Formulate

- Step2 (3) :
- Constant & Coefficient

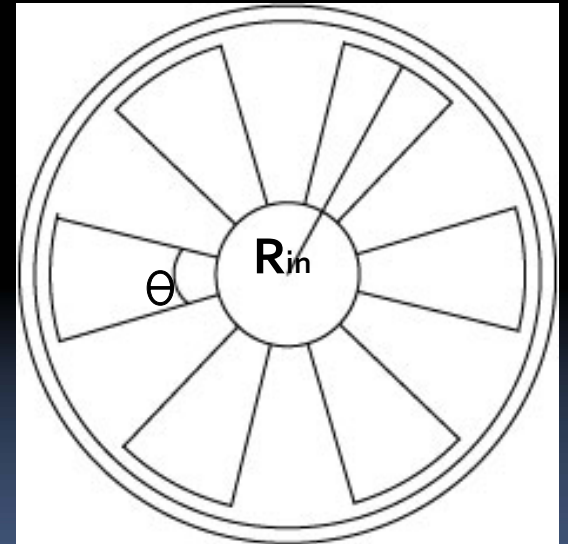
h	2in = 5.08 cm (assumption)
r_{out}	16in = 40.64cm
m1	$2.7\text{g/cm}^2 \pi \cdot r_{in}^2 \cdot h = 43.10r_{in}^2$
m2	$(20.32^2 - R_{in}^2)h \cdot \theta \cdot 2.7\text{g/cm}^2$
W	1.1ton=10.780KN
K	0.5 (Fixed-Fixed Column)
E	75Gpa (Aluminum)

Formulate

- Step 3 : Identification/Definition of Design Variables

R_{in} : Inner Radius of Wheel

θ : Angle of Wheel Frame



Formulate

- Step 4 : Identification of a Criterion to Be Optimized

Objective Function :

Minimize ,

$$\begin{aligned} J &= \frac{1}{2} m_1 r_{in}^2 + \frac{1}{2} m_2 (0.2032^2 - r_{in}^2) \frac{6\theta}{2\pi} \\ &= \frac{0.04310 r_{in}^4}{2} \\ &\quad + 0.020574 (0.2032^2 - r_{in}^2)^2 \frac{\theta^2}{\pi} \end{aligned}$$

Formulate

- Step 5 : Identification of Constraints

$$g1 : S = \pi r_{in}^2 + 6(0.2032^2 - r_{in}^2)\theta \\ \leq 3 \times 10^{-6}$$

$$g2 : \frac{10780}{4} \leq \frac{\pi^2 75 \times 10^9 \frac{r_{in} \theta 0.0508^3}{12}}{0.5(0.2032^2 - r_{in}^2)}$$

$$g3 : 0 \leq R_{in} \leq 0.2032 \text{ (m)}$$

$$g4 : 0 \leq \theta \leq 30 \text{ (deg)}$$

Analysis (Using Excel) (1)

rin	g1	g2	J	0.00001
0.025	7.674935591	0.001703025	58.23672	
0.0375	7.760830556	0.001113538	12.41329	
0.05	7.886896163	0.000812251	5.880689	
0.0625	8.05981967	0.000626244	3.478671	
0.075	8.289689263	0.000497877	2.288589	
0.0875	8.591642337	0.000402446	1.594601	
0.1	8.988764037	0.000327602	1.141629	
0.1125	9.517425682	0.000266482	0.81672	
0.125	10.23777981	0.000214968	0.55919	
0.1375	11.25626825	0.00017044	0.320246	

Analysis (Using Excel) (2)

