Engineering Analysis

Team 14A

November 18, 2013

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Overview

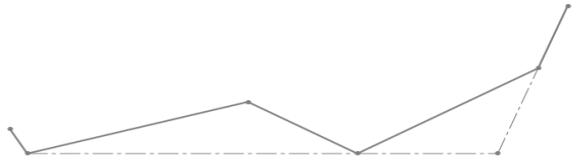
- Problem Statement
- Chassis Analysis
- Braking Analysis
- Steering Analysis
- Project Plan
- Conclusion

Problem Statement

- Design a vehicle that maximizes fuel efficiency for the Shell Eco-marathon competition.

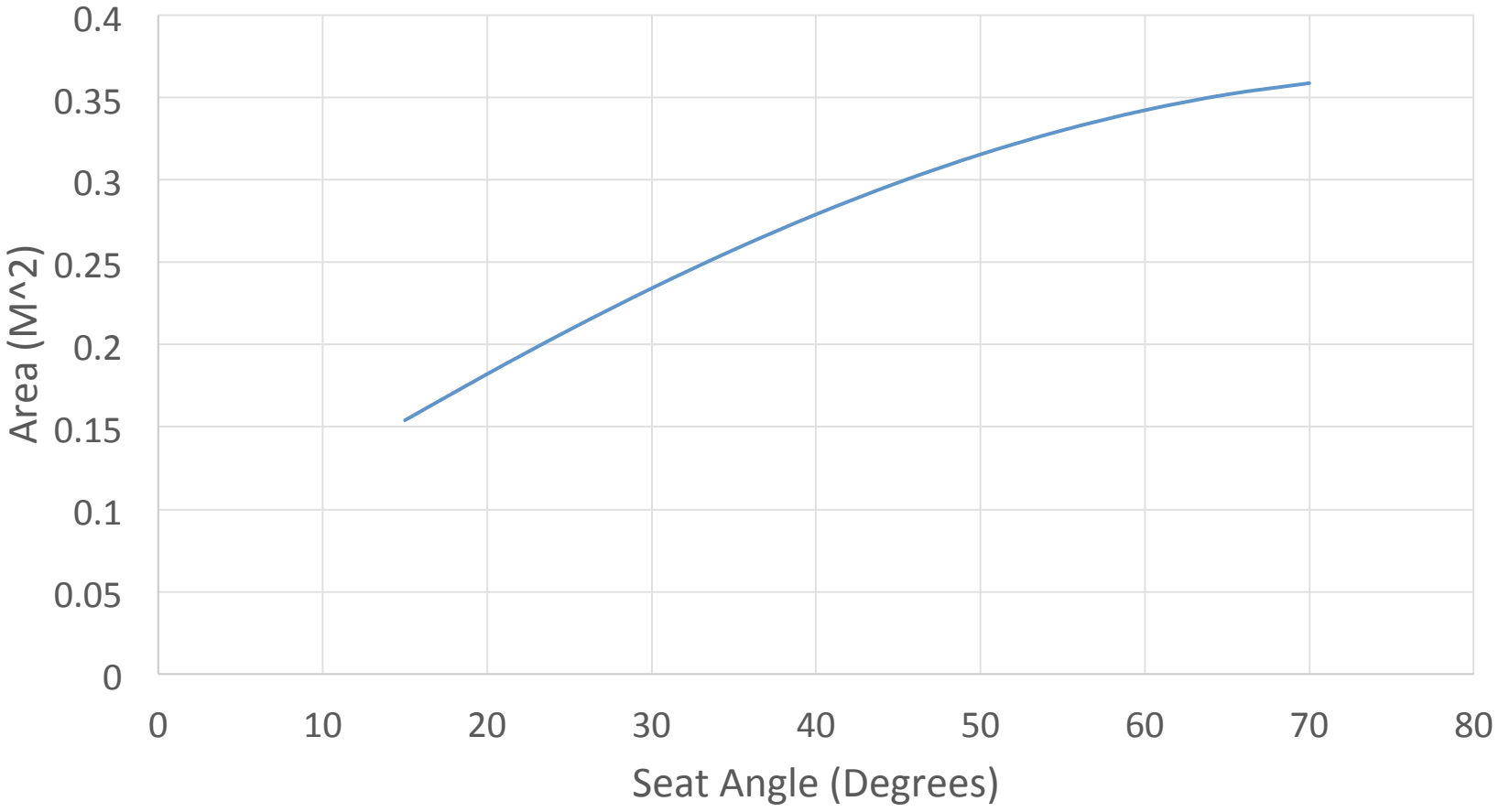
Chassis Analysis

-Minimize vehicle frontal area while maintaining a comfortable driving position and adequate driver visibility.

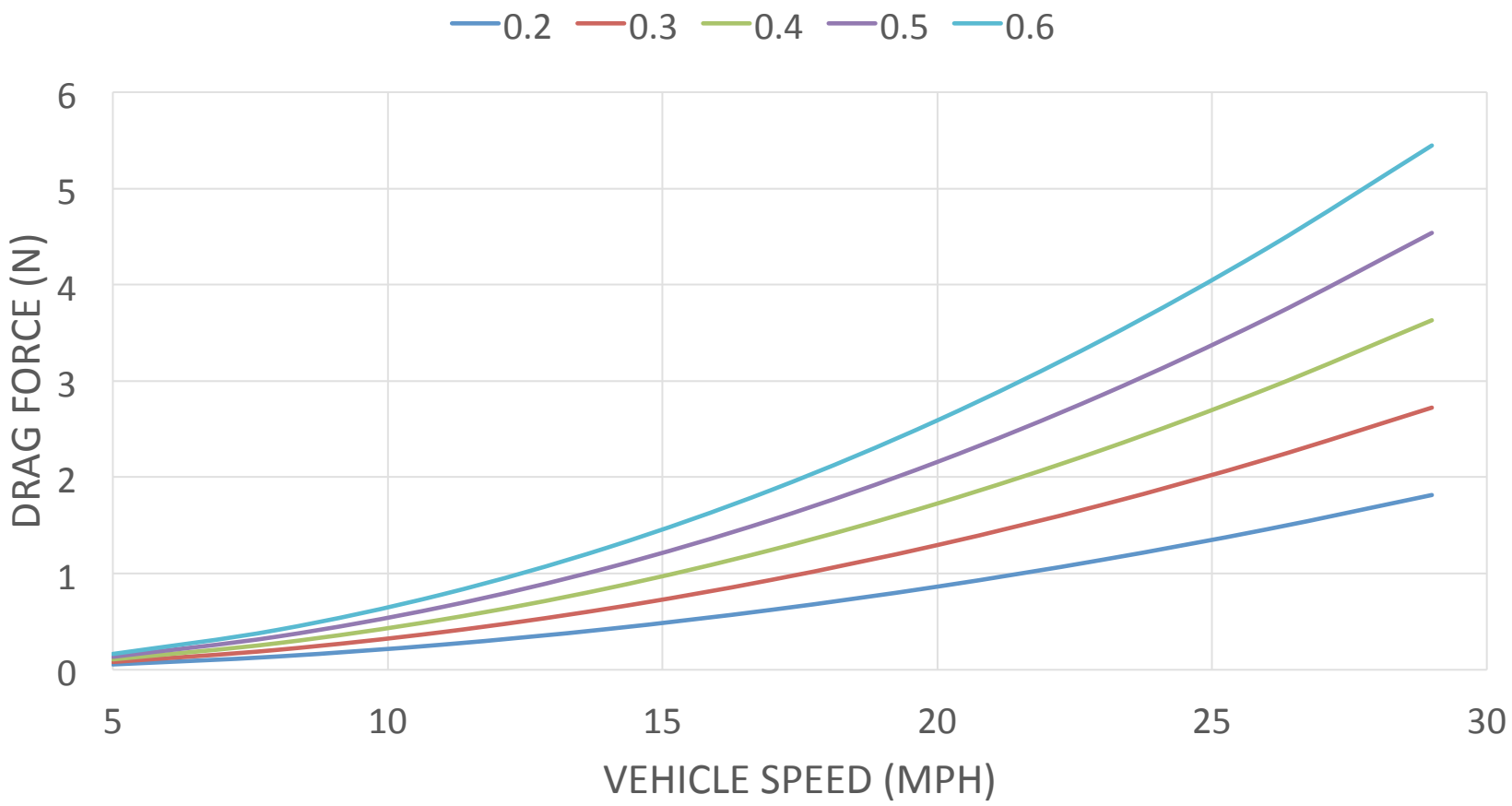


-Fairing tail section reduction should not exceed 22 degrees in the YZ or XZ plane to ensure flow separation does not occur.
-Chassis floor should taper between 3-4 degrees towards the rear of the vehicle to reduce turbulence of the merging flow paths coming from above and below the vehicle.

Frontal Area/Seat Angle



Aerodynamic Drag



Chassis Rigidity

$$\delta_{max} = \frac{Fa(L^2 - a^2)^{3/2}}{9\sqrt{3}LEI}$$

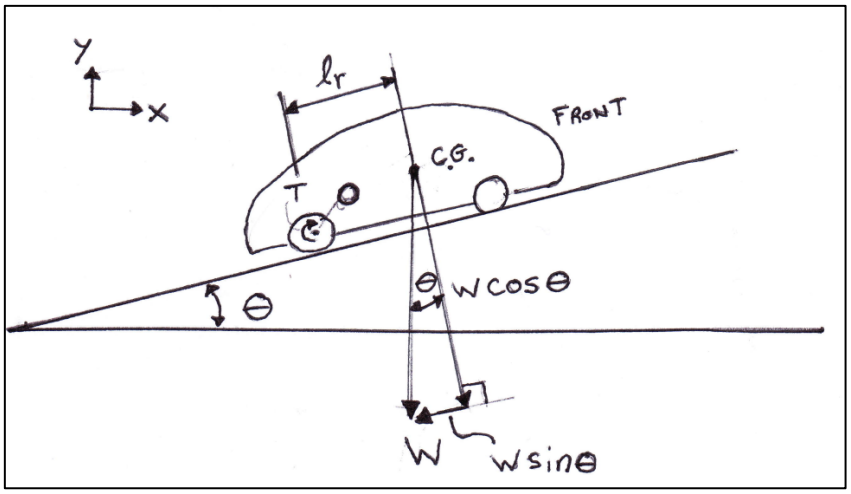
$$x_1 = \sqrt{\frac{L^2 - a^2}{3}}$$

Variable	Value
a (Load to nearest support)	.6 m
L (Wheelbase)	2.5 m
X (Point of maximum deflection)	1.484 m
E (Elastic Modulus)	141 GPa
I (Moment of Inertia)	.079 m^4

Load at a	Maximum deflection at x
60 kg	1.19 mm
90 kg	1.78 mm
120 kg	2.37 mm

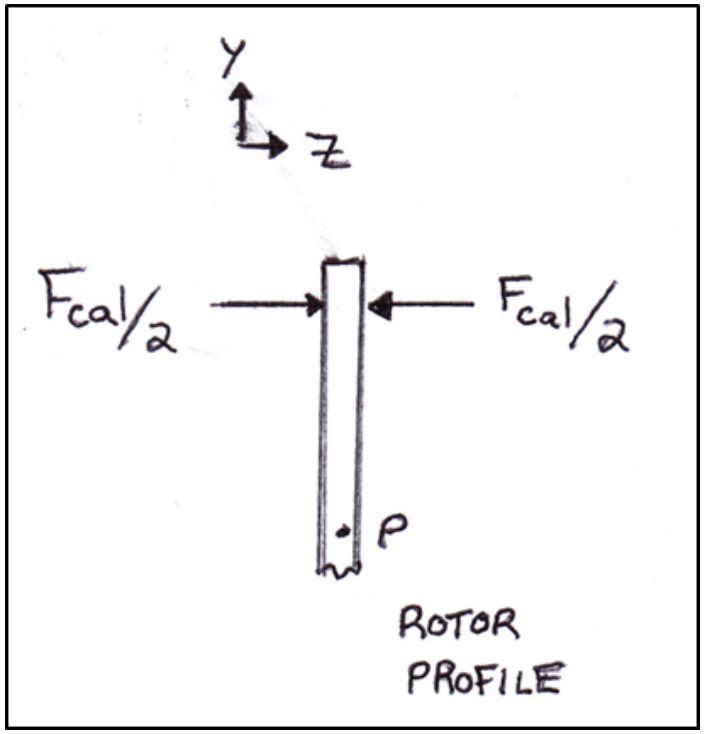
Braking Analysis

- Each braking system must hold car at 20% grade



Braking Analysis

- Most mountain bike braking systems can provide enough force.
- Brake pads range in material, cost, strength.
- Rotor sizes 160mm, 185mm, and 203mm.

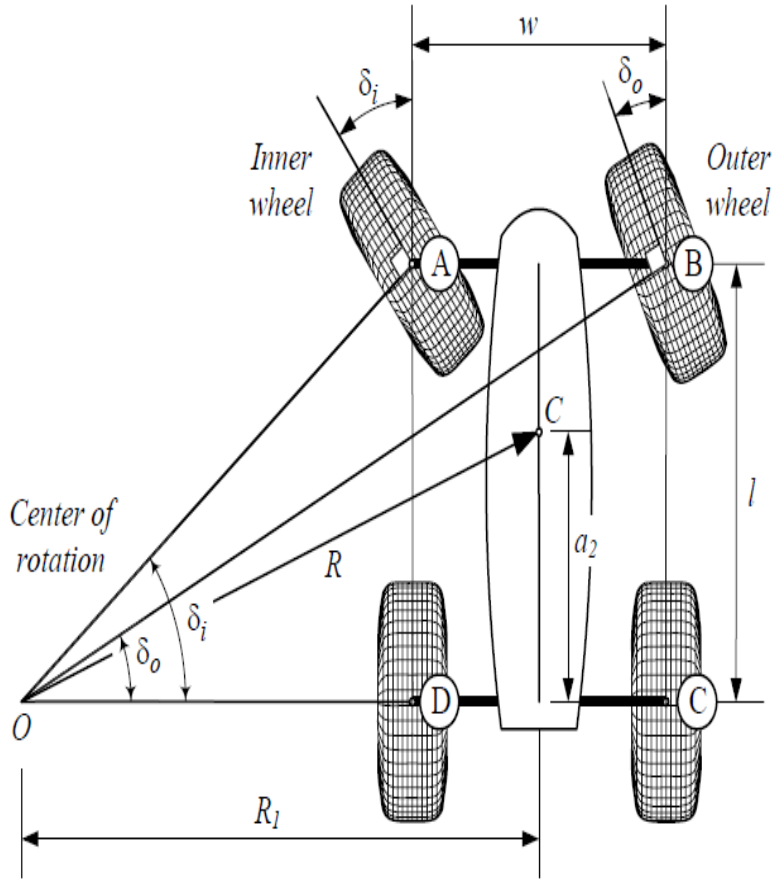


Steering Analysis

- Ackermann Steering Geometry

$$\cot \delta_o - \cot \delta_i = \frac{w}{l}$$

- Track width (w)100-130cm
- Wheelbase (l) 220-350cm



Radius (R)

$$R = \sqrt{a_2^2 + l^2 \cot^2 \delta}$$

$$a^2 = 120cm$$

$$l = 220cm - 350cm$$

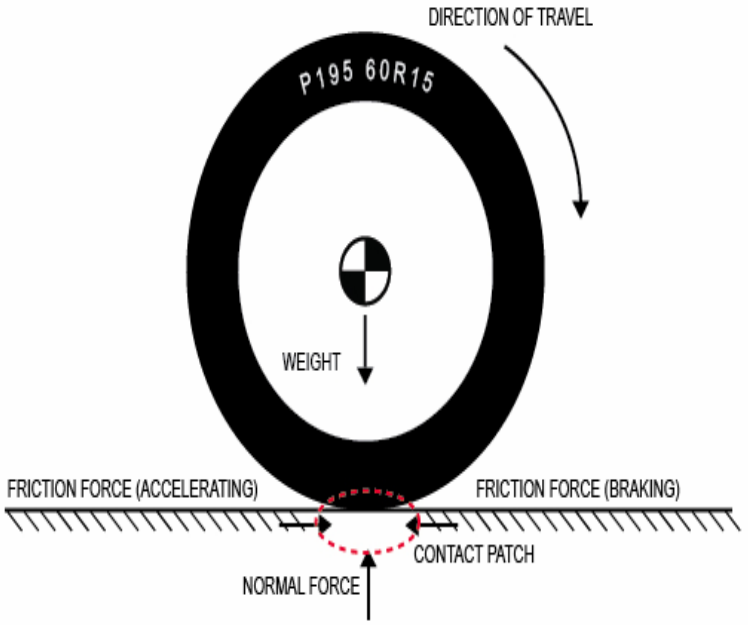
Rolling Resistance

F = CrrN =.0025x1111.5 = 2.79N

F - rolling resistance force

Crr - coefficient of rolling friction

N - normal force

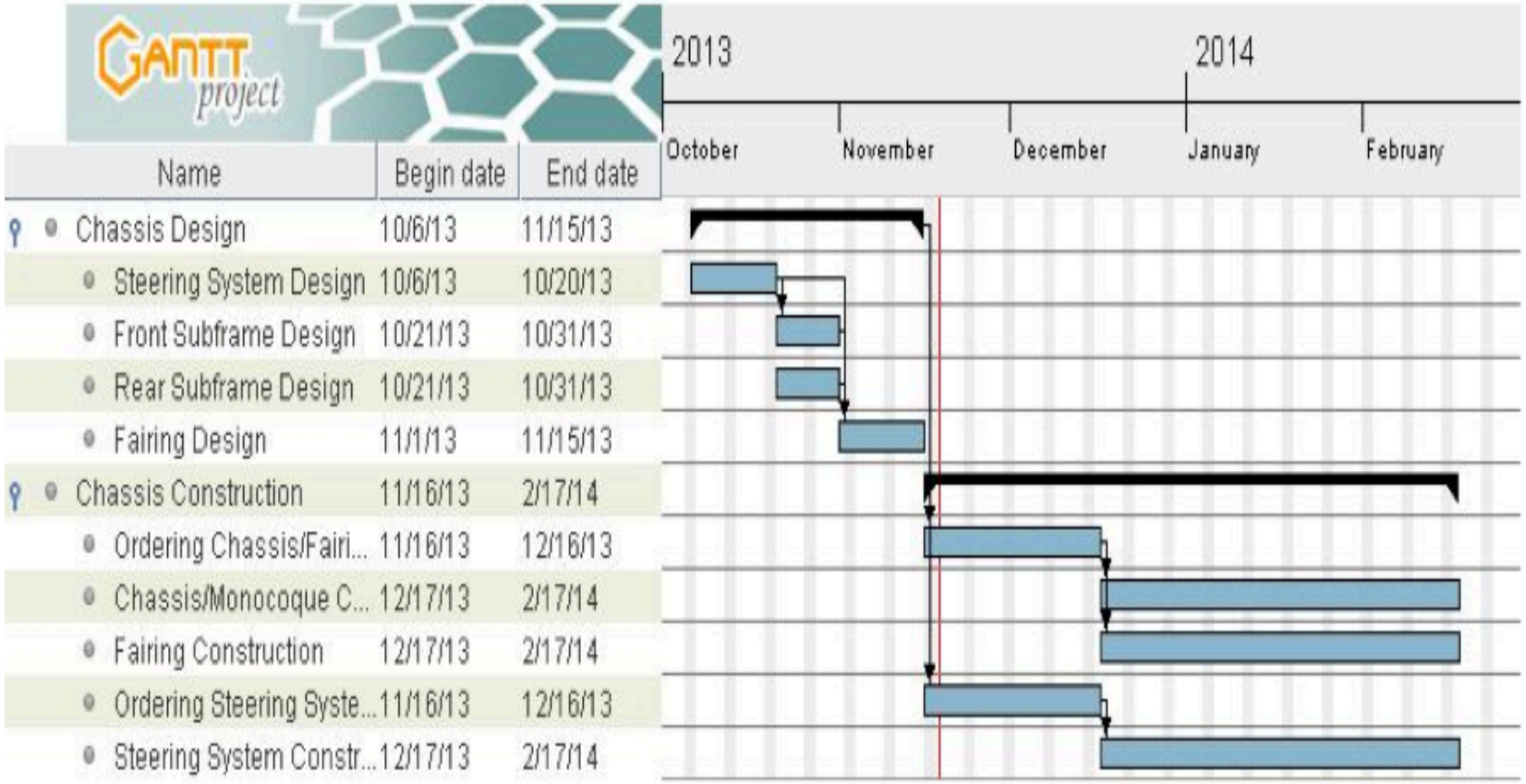


Torque

T= Fr = 2.79x.508=1.42 Nm

r - radius of the wheel

Project Plan



Conclusion

- The overall size of the vehicle fairing will be determined by the desired seating angle between 15 and 30 degrees.
- Each braking system must hold car at a 20% grade slope.
- 160mm rotors and semi-metallic brake pads are ideal for low speeds and forces.
- Nearly all disc brake systems for mountain bikes are strong enough.
- In calculating the radius, the best results are track width of 123cm, wheelbase length of 320cm, and rolling resistance of 2.79Nm.

References

- B. Jawad, E. Marck, D. Tingley, T. Salvati, J. McCoy, A. Ondes, E. Posta, V. floma. “Best Practice for an SAE SUPERMILAGE Vhicle, ” 2001-01-2469, SAE International, Costa Mesa, CA, 2001.
- J. Walker, Jr., “The Physics of Braking Systems” (1st Ed.) [tab] http://www.stoptech.com/docs/media-center-documents/the-physics-of-braking-systems, 2005.
- Department of Defense Design Criteria Standard: Human Defense, MIL-STD-1472F, 1999.

Questions?