Concept Development: Drive System & Power Requirements

Prof. R. S. Shaefer

TA: Han Wang, Aziz Alawadhi, and Lily Clay

Kian Mohseni

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Mechanical & Aerospace Engineering Department
HS School of Engineering & Applied Science
University of California, Los Angeles (UCLA)
Los Angeles, CA. 90095-1597

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1. Determine the Optimum Drive System

Description	Symbol	Variable Name	VALUE	UNITS
Vehicle/Hill Parameters:				
Mass	**m**	**mass**	**2.12**	kg
Wheelbase	**L**	**L**	**0.35**	m
CoM distance from Rear Wheel	L_c	**Lc**	**0.25**	m
CoM Height from ground	h_c	**hc**	**0.09**	m
Force (weight)	F_{mg}	**Fmg**	**20.80**	N
Normal Wheel Forces and Tipping Angle:				
Incline Angle (Hill)	θ	**theta**	**12.00**	deg
Normal Force on Both Front Wheels	N_f	**Nf**	**13.42**	N
Normal Force on Both Rear Wheels	N_r	**Nr**	**6.92**	N
CoM Tipping Height	h_{max}	**hmax**	**1.18**	m
Tipping Angle	θ_{max}	**theta_tip**	**70.20**	deg
Minimum Required Friction Coefficient:				
Minimum Friction Coefficient for FWD	μ_f	**mu_f**	**0.32**	-
Minimum Friction Coefficient for RWD	μ_r	**mu_r**	**0.62**	-
Minimum Friction Coefficient for AWD	μ_{awd}	**mu_awd**	**0.21**	-
CoM distance for $\mu_f = \mu_r$	**Lc-equal**	**Lc-eq**	**0.19**	m
Optimum Drive System - FWD or RWD:		**FWD**		
Check which has the lowest required friction coefficient (FWD or RWD): μ_f or μ_r				

2. Friction Coefficients

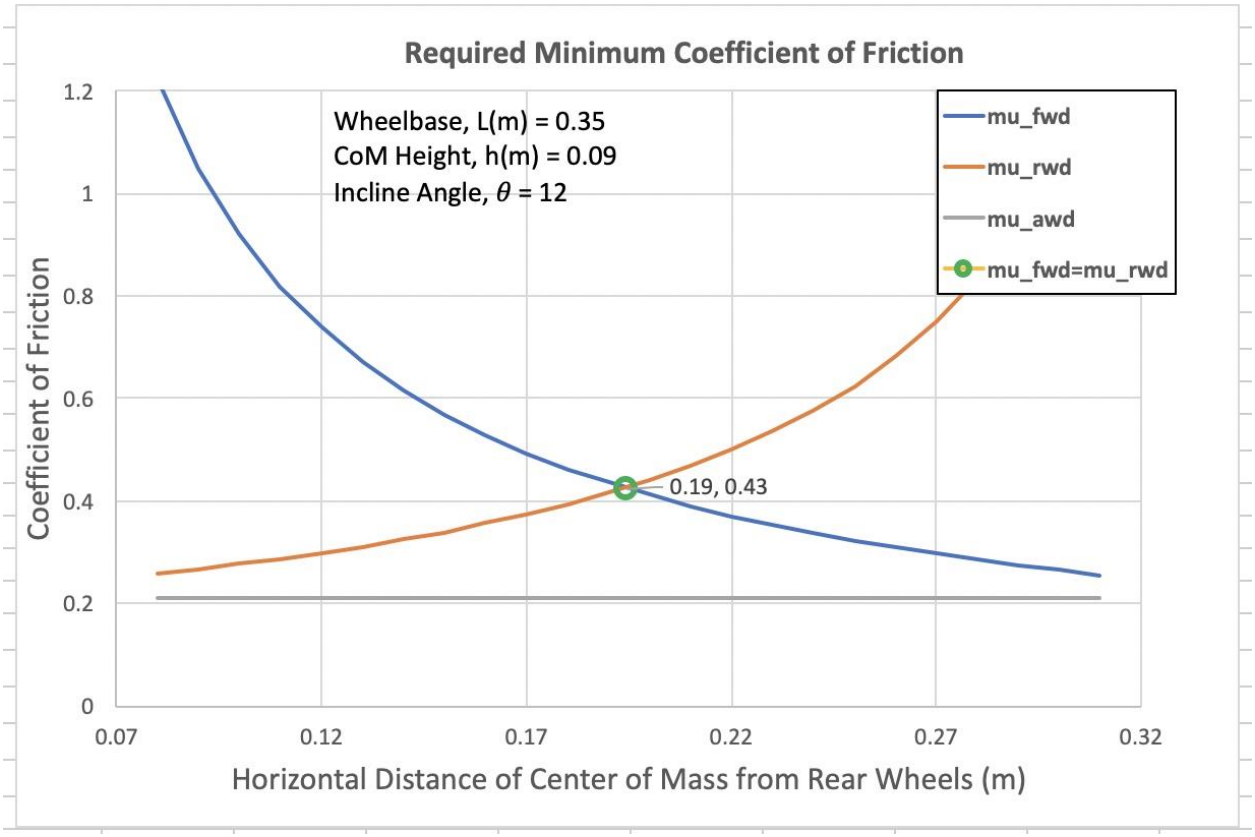

Figure 1: Comparison of minimum required friction coefficients for AWD, FWD, and RWD systems, as a function of distance of CoM from rear wheels.

3. Estimate Minimum Torque and Power to Move Uphill

Minimum required Tractive Force for estimated μ:				
Friction coefficient at $\mu_f = \mu_r$ from **your μ-graph** (Fig.1)	μ_W	**mu_W**	**0.425**	
Rolling friction coefficient	μ_{ROL}	**mu_rol**	**0.003**	-
Front Wheel Drive Tractive Force (Traction)	F_{TF}	**F_Tf**	**0.0403**	N
Rear Wheel Drive Tractive Force (Traction)	F_{TR}	**F_Tr**	**0.0208**	N
All Wheel Drive Tractive Force (Traction)	F_{Tawd}	**F_Tawd**	**0.0610**	N
Minimum required Wheel Torque based on Tractive Force:				
Front Wheel Diameter	D_{fw}	**Diam_fw**	**0.05**	m
Rear Wheel Diameter	D_{rw}	**Diam_rw**	**0.025**	m
Front Wheel Torque	T_{fw}	**T_Fw**	**0.00101**	N-m
Rear Wheel Torque	T_{rw}	**T_Rw**	**0.000260**	N-m
All Wheel Torque	T_{aw}	**T_Aw**	**0.001144**	N-m
Propulsion Power based on Tractive Force:				
Drive System Efficiency	η	**eta**	**0.7**	-
RMS Velocity up the ramp	V_{rms}	**v_rms**	**0.2**	m/s
FWD Power	P_{FWD}	**P_FWD**	**0.00564**	W
RWD Power	P_{RWD}	**P_RWD**	**0.00291**	W
AWD Power	P_{AWD}	**P_AWD**	**0.00961**	W
Checking Propulsion Power using Weight Distribution on Wheels (β):				
Fraction of weight on Front wheel	β_f	**betaf**	**0.660**	-
Fraction of weight on Rear wheel	β_r	**betar**	**0.340**	-
FWD Propulsion Power based on Weight Distrib. (β):	$P_{\beta\text{-FWD}}$	**P_b-FWD**	**0.00372**	W
RWD Propulsion Power based on Weight Distrib. (β):	$P_{\beta\text{-RWD}}$	**P_b-RWD**	**0.000990**	W
AWD Propulsion Power based on Weight Distrib. (β):	$P_{\beta\text{-AWD}}$	**P_b-AWD**	**0.00859**	W