ÉCOLE CENTRALELYON — EPSA ECURIE PISTON SPORT AUTO

OPTIMUMG OPTIMUM TIRE - FORMULA STUDENT

Wheel configuration choice for the vehicle Invictus (2020 season)

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no decimal places for this model, numbers are qualitative

Tx	Ty	p	skidpad mean radius	smallest endurance mean radius		usd2€	0,9
mm	mm	mm	m	m		in2mm	25,4
1650	1250	1035	9	3		lbs2g	453,592

tyre	model	outer radiu	width	mass	Iy	Iz	price	TTC data	
code	str	mm	mm	g	kg m^2	kg m^2	€ HT sans sped.	cornering	drive/brak
1	Hoosier 20,5/7 - 13	260	178	4990	60	30	205	y	y
2	Hoosier 16/7.5 -10	203	191	3402	27	13	180	y	n
3	Hoosier 18/7.5 - 10	229	191	4536	45	23	180	y	y
4	C19 205/470 r13	235	205	3924	44	22	183	y	y
5	Avon 16/7-10	203	178	3266	24	12	104	y	n

rim	model	radius	width	mass	Iy	Iz	price	notes
code	str	mm	mm	g	kg m^2	kg m^2	€ HT sans sped.	
a	OZ 13 Mg	165	178	2450	12	6	250	not center lock
b	OZ 10 Mg	127	178	1660	5	2	250	center lock
c	keizer 10i Al	127	178	2041	6	3	248	$265 8 pieces
d	keizer 13 Al	165	178	2835	14	7	338	
e	Oz 13 Al	165	178	3400	16	8	260	sa coute au moins com

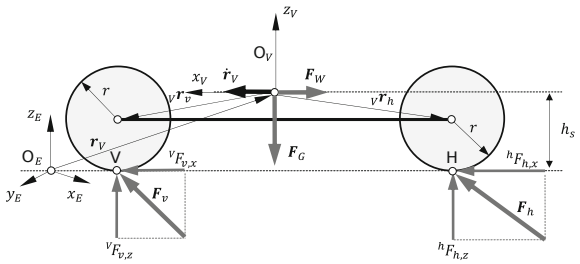
a = m +Iyy/r^2 --> wheel contribution to the y-rotation energy
b = m+Iz_G/R^2 --> wheel contribution to skidpad z-rotation energy
c = m+Iz_G/R_min^2 --> wheel contribution to smallest turn z-rotation energy

config	outer radius	mass	Iyy	Izz	Iz_G	price	a	b	c
rim tyre	m	g	kg m^2	kg m^2	kg m^2	€ HT sans	param	param	param
a1*	0,260	7440	72	36	44	205	8502	7440	7444
a4 *	0,235	6374	56	28	35	183	7393	6374	6377
d1	0,260	7824	74	37	45	543	8914	7825	7829
d4	0,165	6759	58	29	36	521	8892	6759	6762
b2	0,203	5062	32	16	21	430	5825	5062	5064
b3	0,229	6196	50	25	32	430	7151	6196	6199
b5	0,203	4926	29	14	20	354	5622	4926	4927
c2	0,203	5443	33	16	22	428	6233	5443	5445
c3	0,229	6577	51	26	33	428	7553	6577	6580
c5	0,203	5307	30	15	21	351	6029	5307	5309
c5 *	0,203	5307	30	15	21	104	6029	5307	5309
e1	0,260	8390	77	38	47	465	9520	8390	8394
e4	0,235	7324	61	30	38	443	8426	7324	7327

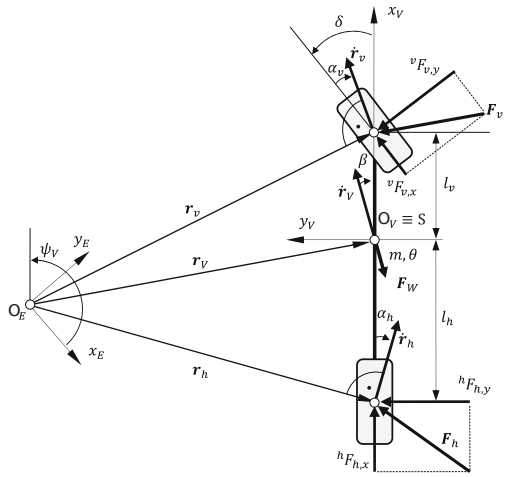
* use old rims

5 Concept selection: a dynamic model

5.1 A nonlinear single track model



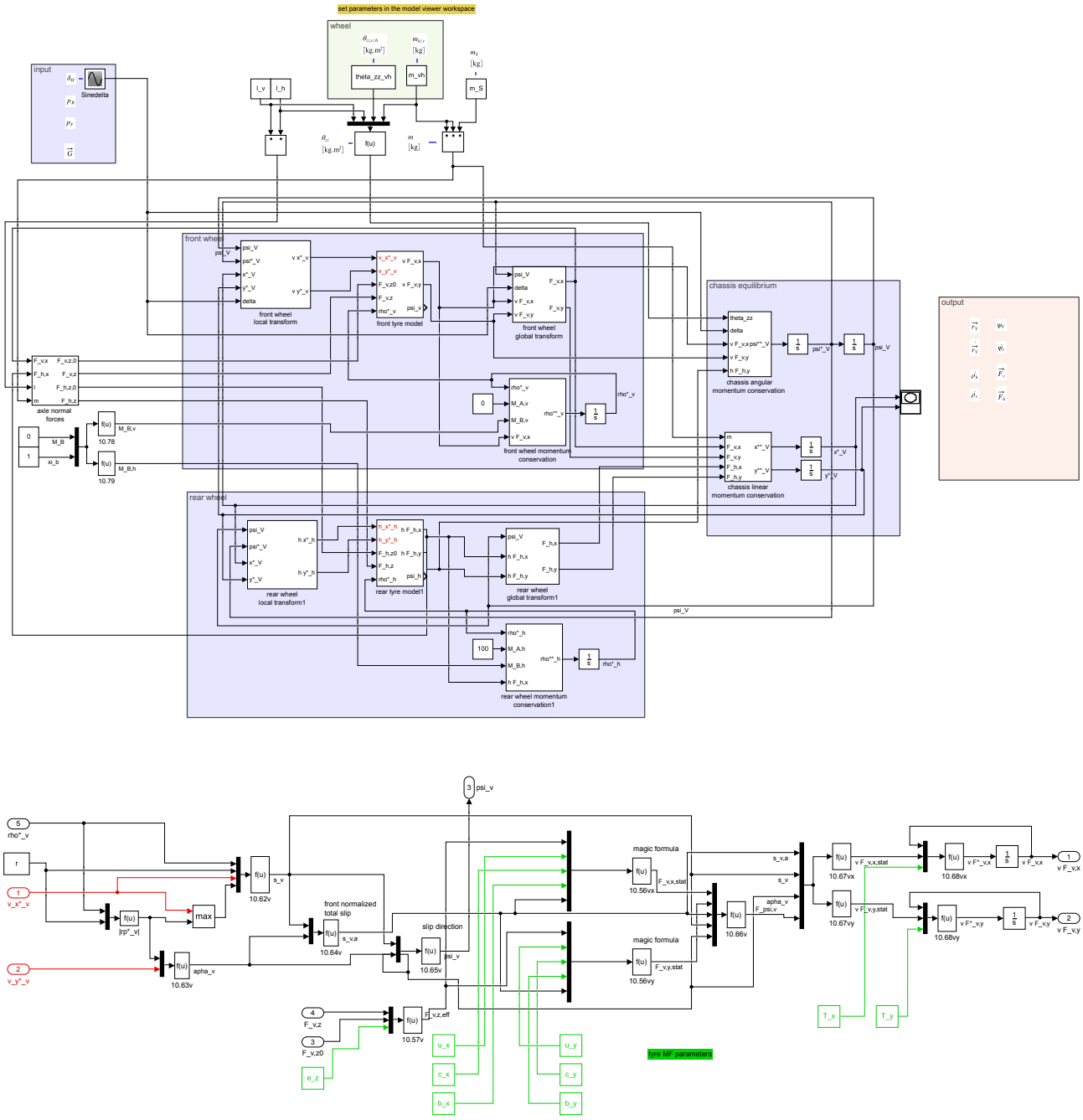
Nonlinear single track model—side view



Nonlinear single track model–top view

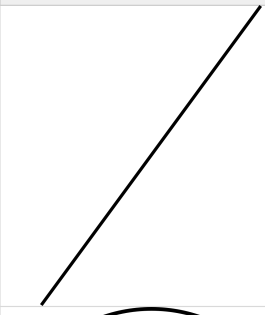
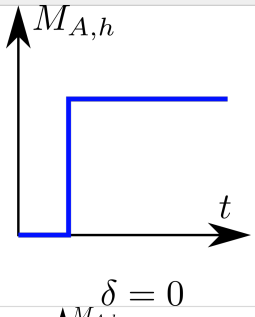
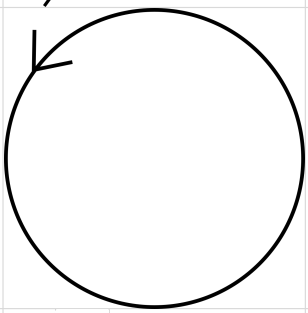
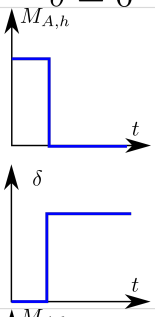
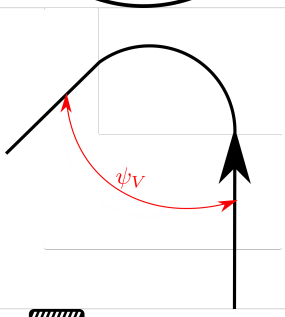
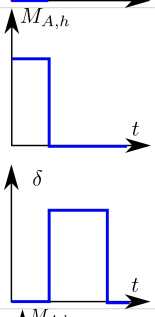
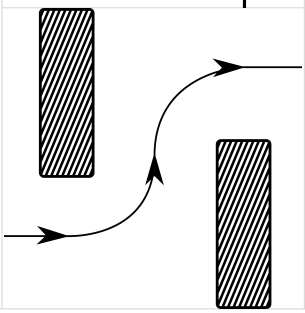
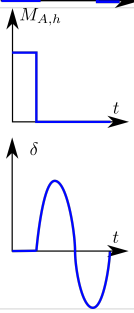
constant	unit	description
l_v	m	distance between S and the front axle (vehicle reference frame)
l_h	m	distance between S and the rear axle (vehicle reference frame)
h_S	m	height of S (ground reference frame)
m_vh	kg	wheel mass
m_S	kg	suspended mass
r	m	tyre outer radius
theta_vh	kg.m^2	tyre rolling inertia
theta_zz_vh	kg.m^2	tyre z inertia
u_x		tyre MF model
u_y		
c_x		
c_y		
b_x		
b_y		
e_z		
T_x		
T_y		
g	m/s^2	acceleration of gravity

non linear single track model schema from cap 10.3 of [1]



MATLAB Simulink realisation of the non linear model. The Tyre model is expanded in a second view for more detail

5.2 Test cases list

test	event	schema	input	output to analyse
T1 straight line	acceleration			elapsed time
T2 circle	skidpad			time to become staic
T3 U inversion	autocross / endurance			change in vehicle direction
T4 slalom				pic variation in vehicle direction

5.3 Results

6 Conclusion

6.1 Wheel configuration choice

6.2 Future work

References

[1] Bardini Schramm, Hiller: *Vehicle Dynamics: Modeling and Simulation*. 2018, ISBN 9783662544822.