



Iván Moreno

Supervisor: Tim Tudor

Wales Institute for Science & Art

MSc Automotive Engineering

Vertical strakes design & simulation on a Mygale F4 open-Wheel Racing vehicle

BACKGROUND & RESEARCH GAP

The underbody is a major source of racing-car downforce. Existing research is strongly focused on diffuser development, while the leading edge of the floor has received comparatively limited attention.

- 52% of overall downforce attributed to floor & diffuser in the cited F1 reference [1].
- Limited research on vertical strakes at the floor entrance.
- Straight and curved geometries show different flow-control behaviour.
- Limited parametric work on individual strake variables.

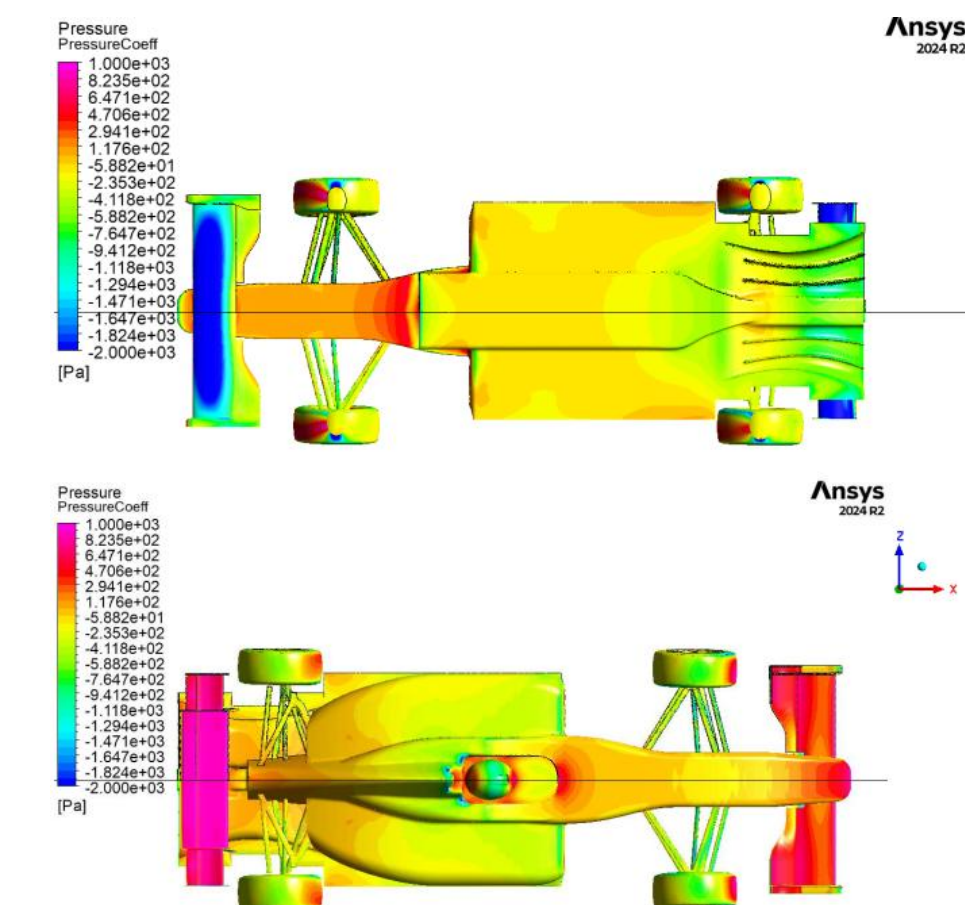


Figure 1. Benchmark results of Mygale F4. (Tudor and Bull, n.d)

OBJECTIVES

- Improve vehicle aerodynamic performance using leading-edge vertical strakes.
- Investigate the influence of strake geometry on underbody flow and diffuser feeding. Providing new data on strakes positioned at the floor entrance.
- Assess interaction with a separate bargeboard development.

CFD METHODOLOGY

- ANSYS Fluent RANS CFD methodology.
- 40 m/s inlet velocity with moving ground and rotating wheels.
- k- ω SST turbulence model and coupled solver.
- Domain independence: 10 m upstream / 20 m downstream / 3 m sides / 1.5 m top.

Ride height study of the baseline & with strakes implemented

5.44 M

selected fine mesh

Ride Heights Configurations						
		FRH (mm)				
		30	35	40	45	50
RRH (mm)	70					
	75					
	80					
	85					
	90					

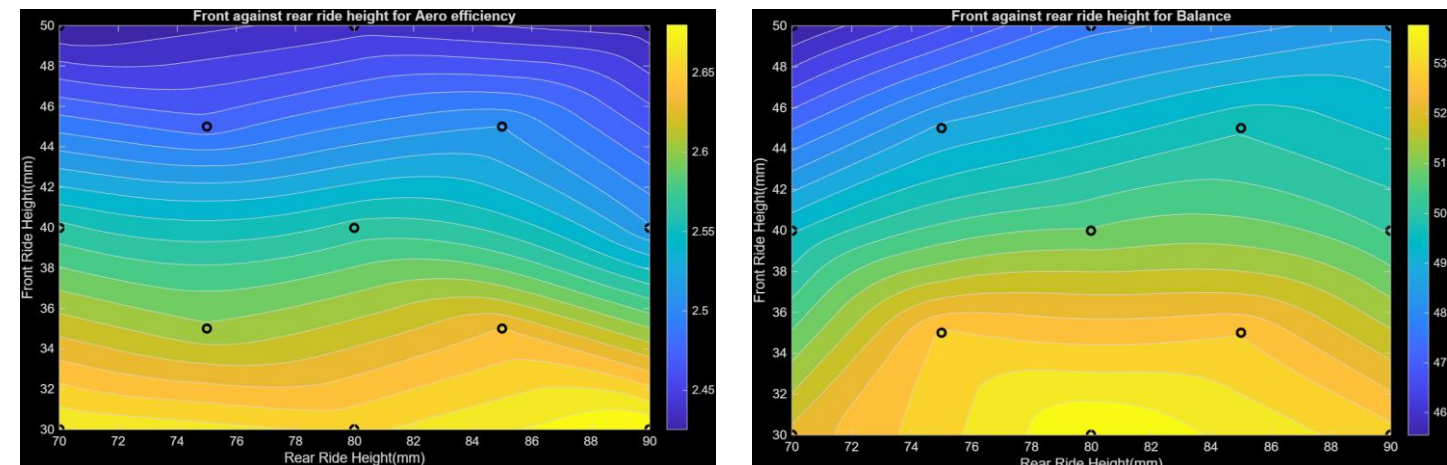


Figure 2. Aerodynamic efficiency map.

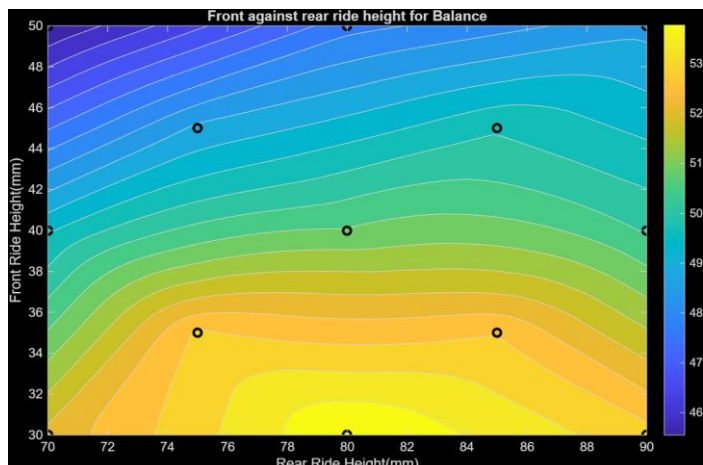


Figure 3. Forward balance percentage aerodynamic map.

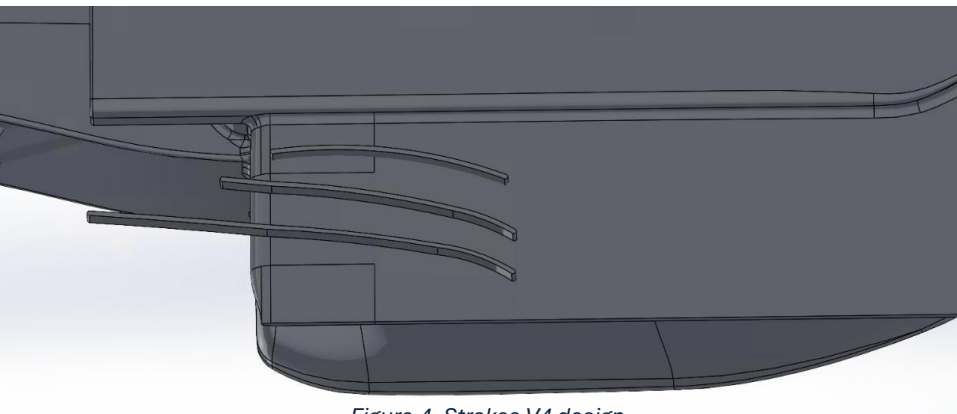


Figure 4. Strakes V4 design.

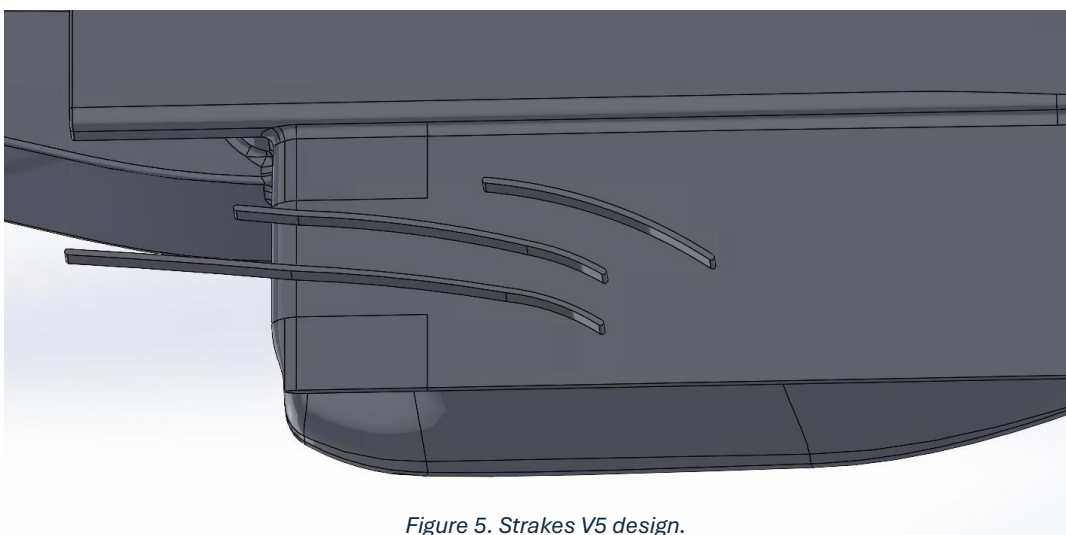


Figure 5. Strakes V5 design.

- V1 – curved concept: acceleration and low-pressure generation.
- V2 – straight concept: improved front-wheel wake separation.
- V3 – curved concept: improved flow distribution to the diffuser.
- V4 – hybrid: stronger vortex generation and floor sealing.
- V5 – hybrid + stagger: rearward low-pressure region and improved diffuser flow.

DESIGN SELECTION

Table 2. Results from Vertical strakes designs.

Configuration	CL	CD	Balance	Efficiency
Baseline	2.5064	0.9755	49.60%	2.5694
V1	2.5465	0.9767	50.31%	2.6072
V2	2.4979	0.9690	51.02%	2.5777
V3	2.5491	0.9731	50.74%	2.6197
V4	2.5588	0.9770	50.91%	2.6191
V5	2.5727	0.9768	49.96%	2.6337

V5
selected design

+2.50%
aero efficiency

49.96%
forward balance

FLOW MECHANISM

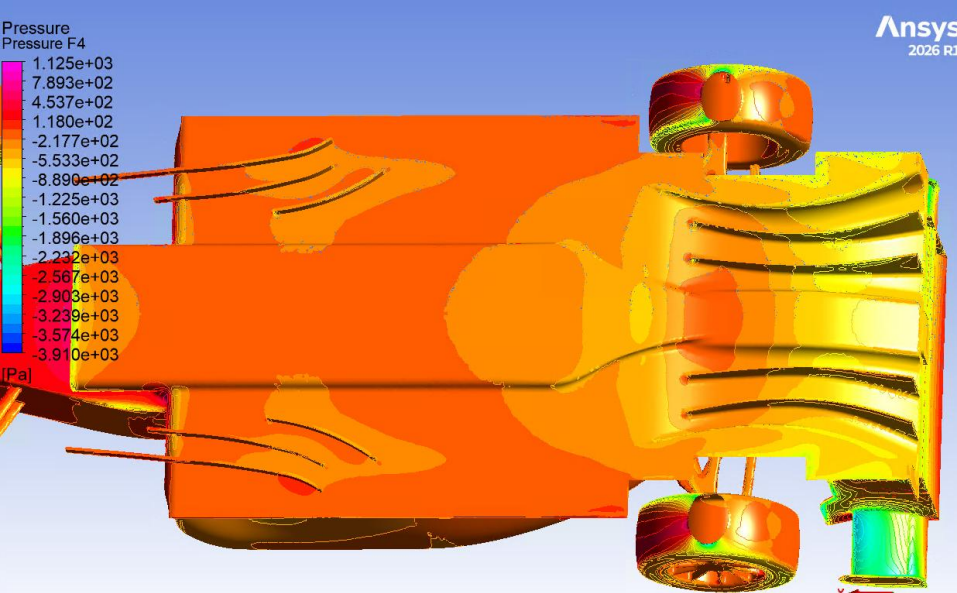


Figure 6. Strakes V5 design pressure distribution.

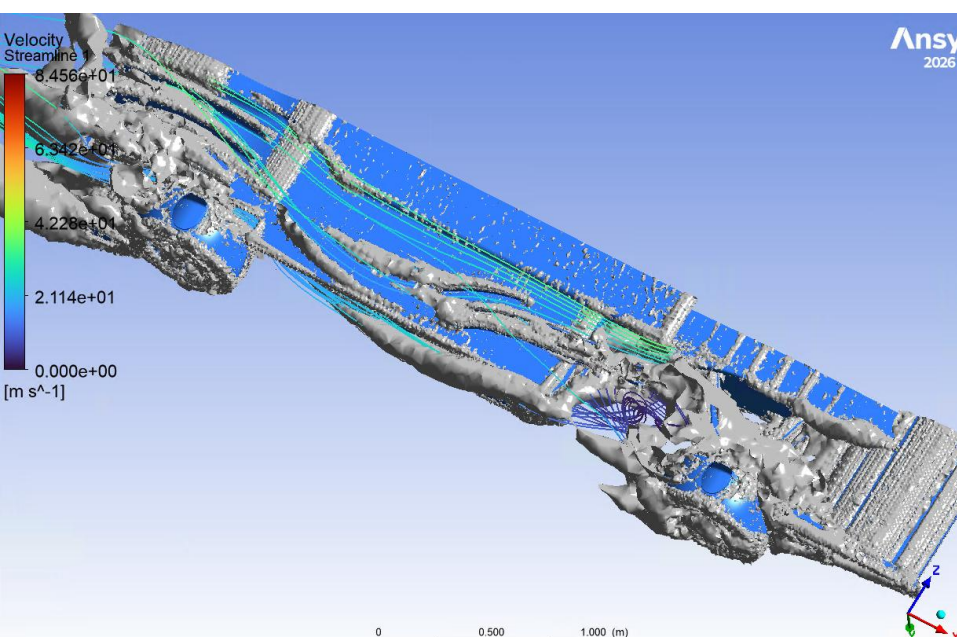


Figure 7. Strakes V5 design vorticity and streamlines

PARAMETRIC STUDY – STRAKE HEIGHT

V5 was investigated for six heights while keeping the third-strake X-position at 340 mm.

Table 3. Results from parametric study of the height.

Strakes V5 Height Parametric Study						
Height (mm)	20	30	40	50	60	70
Drag Coeff.	0.9779	0.9708	0.9768	0.9715	0.9763	0.9765
Drag Force (N)	625.95	621.37	625.26	621.83	624.95	625.0300
Lift Coeff.	2.5296	2.5136	2.5727	2.5742	2.6660	2.7314
Lift Force (N)	1619.17	1608.89	1646.76	1647.72	1706.49	1748.37
Forward Balance %	50.74%	50.72%	49.96%	51.36%	51.19%	51.89%
Aero Efficiency	2.5867	2.5892	2.6337	2.6498	2.7306	2.7973
% improvement	-1.7838%	-1.6902%	0.0000%	0.6102%	3.6785%	6.2094%

- Lift increased consistently with strake height, while drag remained relatively stable.
- 70 mm achieved the highest efficiency: +6.21% vs the 40 mm reference.
- Forward balance exceeded 50% for every height except 40 mm.
- 40 mm was therefore selected as the best compromise between performance and balance.

40 mm SELECTED

best compromise: performance + balance

LEADING-EDGE POSITION & RIDE-HEIGHT ROBUSTNESS

- X-position investigated: 240–490 mm.
- Global aerodynamic performance showed limited sensitivity to position.
- Position mainly changed where the final vortex and low-pressure region developed.
- With V5 installed, efficiency improved across most ride-height configurations.
- Forward balance shifted approximately 1–2% towards the front.

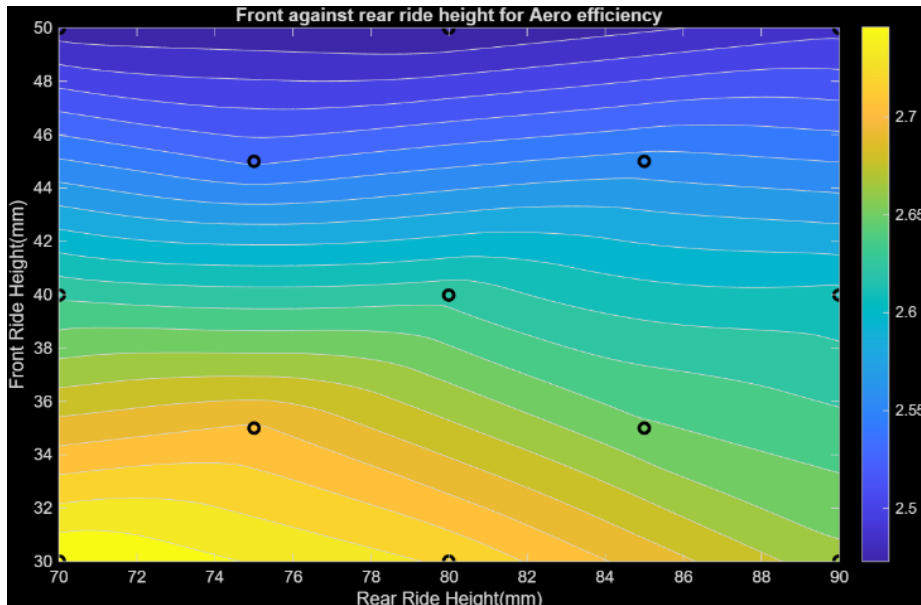


Figure 8. Aerodynamic efficiency map with strakes.

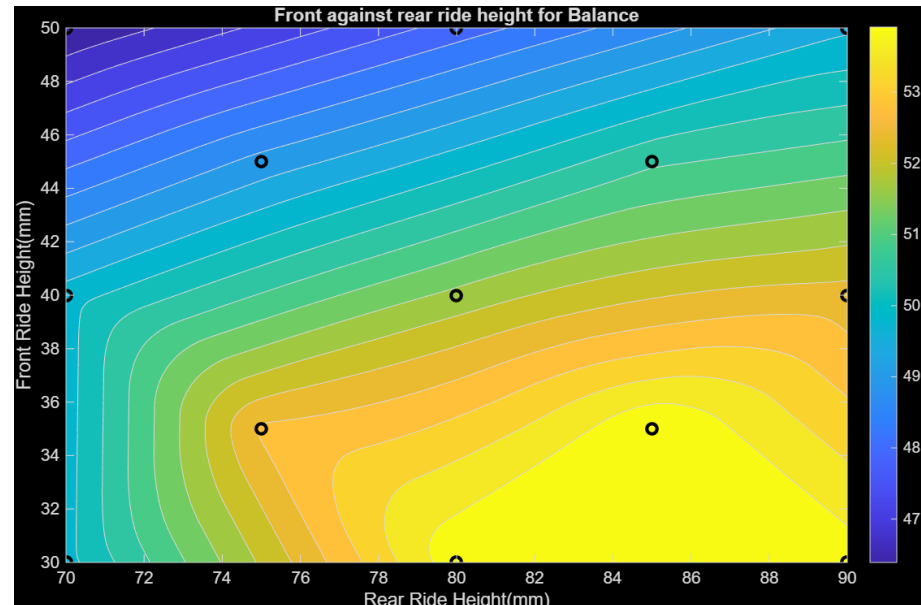


Figure 9. Forward balance percentage aerodynamic map with strakes.

BARGEBOARD INTERACTION

Combining the independently developed bargeboard with V5 caused a performance regression, reinforcing the need for co-development of interacting aerodynamic devices.

Table 4. Bargeboard and strakes combination results.

Case	CL	Balance	Efficiency
Baseline	2.5064	49.60%	2.5694
V5	2.5727	49.96%	2.6337
V5 + BB	2.5389	50.73%	2.5921

CONCLUSIONS & FUTURE WORK

- Leading-edge vertical strakes can improve underbody aerodynamic performance.
- V5 increased aerodynamic efficiency by 2.50% vs baseline.
- Strake height had greater influence than the studied X-position.
- 40 mm was selected to maintain forward balance below 50%.
- Future work: experimental validation, front-wing rebalancing and wider 3D optimization.

[1] Toet, W. (2013) 'Aerodynamics and aerodynamic research in Formula 1', The Aeronautical Journal, 117(1187), pp. 1–26.
[2] Shaalan, A. et al. (2024) 'Formula 1 Race Car Aerodynamics: Understanding Floor Flow Structures...', SAE Technical Paper, 2024-01-2078.
[3] Nebot, E.P., Gupta, A. & Mahak, M. (2025) 'Investigating the Impact of Structural Features on F1 Car Diffuser Performance Using CFD', Mathematics, 13, 1455.
[4] Zhang, G. et al. (2018) 'Application of Strake Structure in Aerodynamic design of formula racing', Lecture Notes in Electrical Engineering, pp. 107–121.
[5] Tudor, T. & Bull, C. (n.d.) CB Mygale F4. Unpublished CFD benchmark report.