MAK-Corp Group-C MOD

General

These amazingly fast cars, were made to achieve the fastest speeds using the lowest amount of fuel possible, which was key to success in that era. The Group C Mod was conceived for endurance races and for sprint races of at least one hour (one full tank). We have had the help of a former Porsche 962C driver throughout the development process and been given a lot of technical information about the car and the different tyres used.

Simulation Vs Reality

As the real cars changed from race to race and at every qualification, we had to make some directional choices, and that's why the cars match the historical final speeds and lap times at some tracks, but not in others. The main focus has been put into handling, braking distances, tyres , fuel consumption, and the driving style needed to achieve the best performance from them. These cars produced a large amount of ground effect, and over 180 km/h the ground effect pushes the car into the ground producing a huge amount of grip. Under braking this effect is reduced while the car loses speed, and needs attention to avoid locking the tyres. Below the speed of the ground effect activation, the cars rely on their tyres, and the ability of the driver to manage the power output on corner exit as they navigate the circuit. The turbo lag can also be a problem if it isn't carefully matched with the right moment, but it could be helpful in other situations.

The Cars

Mazda 787B:

Physics: Damian Baldi

This is an 850Kg car, with a carbon fiber chassis, a rotary engine and a gearbox with Porsche internal components. It's an easy car to drive, very stable and with low fuel consumption. It has very good braking thanks to carbon fiber disks. Handling is neutral and it has very good cornering behaviour thanks to the short wheelbase.

It uses Dunlop tyres fitted on 18 inches rims. Two compounds are available, medium for sprint races and hard for endurance races and a third compound for the rain.

Aerodynamics can be set for high speed tracks or high downforce changing the front wing setting to 1 (low downforce, low drag) or 2 (high downforce, high drag). The rear wing works as a balancer of the front wing, because rear downforce comes from the ground effect's tunnel. The recommended setting for high speed tracks is 1-1, while for high downforce is 2-5.

The engine have two boost settings that can be changed on the garage or on the steering wheel while driving, "Fast" (position 1/2) and "Save" (position 2/2). "Fast" mode allow full usage of the RPM range and all the power of the engine, while "Save" mode cuts the RPM range by 500 while it saves near 8% of fuel.

Specification

Weight: 850Kg
Chassis: Carbon Fiber
Brakes: Carbon Fiber
Front wheels: 300x640mm Rim: 18 inches
Rear wheels: 360x710mm Rim: 18 inches
Engine: Rotary 2.6 litre ~700HP @ 9000RPM

Porsche 962C:

Physics: Damian Baldi

This 900Kg car is the most iconic from this era. The 962C set the benchmark for years, but by the late 80’s and early 90’s it was starting showing it’s age. The Aluminium chassis had many upgrades and modifications to keep it competitive, including several different engines, aero modifications and electronics changes. It has Iron brake disks, so this car has a longer braking distance than the Mazda. For this Mod the 962C is offered with two engines, a 3 litre twin turbo engine used as C1 class in WSC, and a 2.8 litre single turbo version as used in IMSA. The 3 litre version develops power in a gentle manner, making it easy to drive and oriented to endurance races, while the IMSA version with a huge single turbo is more aggressive and more fuel hungry.

The turbo boost setting has 15 positions in total. 1 to 7 are fuel saving settings. Position 7 (1.1 bar) is the recommended setting for endurance races with the best power/consumption ratio, and matches the Mazda's fuel consumption (in “save” mode). Positions 7 to 10 (up to 1.25bar) are used for sprint races, increasing the power output but with a higher fuel consumption and higher engine wear (not recommended for endurance events). Lastly, Position 15 is only recommended for qualification stints. This setting has ridiculously high fuel usage, and the health of the engine would be affected adversely under race lengths/conditions and prone to failure. A button for temporary boost could be added too, providing full boost while pressed.

There are two different brands of tyres, Goodyear (R500 and R600, similar to the Dunlop of the Mazda) and Yokohama. The Yokohama compound is a hard and very stable tyre with behaviour similar to the Goodyear R600 compound. The Yokohama compound has lower grip than the Goodyear R600, but it's performance is comparable through an entire stint and could last longer if well managed.

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Specification

Weight: 900Kg
Chassis: Aluminium
Brakes: Iron, ventilated
Front wheels: 300x650mm Rim: 17 inches
Rear Wheels: 365x720mm Rim: 19 inches
Engine WSC: Flat-6 3.0 litre twin turbo 650-800HP @ 8200RPM
Engine IMSA: Flat-6 2.8 litre single turbo 650-800HP @ 8200RPM

Sauber C11:

Physics: Alvaro Perez

After the success of the C9 in 1989, Sauber still evolved the car and improved aerodynamics, ventilation, fuel consumption… Also a new carbon fibre chassis would embrace the formidable Mercedes engine and its twin KKK turbochargers.

10 turbo positions are available on the simulation, with the most conservative already offering 730hp and pushing hard from a very low 3500rpm. At the highest turbo settings more than 900hp explode at the wheel, but abuse will overheat the engine and harm tyres prematurely.

Remember that these Goodyear tyres (2 hard compounds) must also bear with one of highest downforce levels of the grid. Harder tyres might be better choice when there are many fast kinks and long straights.

Choose your aerodynamic setting to obtain more traction and stability. The sacrifice of some turn-in response will be a reward when exiting the corner. Using same number for front and rear is a good way to start with a balanced chassis . After that, engine brake and differential settings can help you more than you expect to find your taste on corner entry and handling reactions.

Using soft springs can lead to aerodynamic issues, so it is recommended to go with the unconfortable rock hard suspension that doesn't let you bite kerbs and spite at every bump.

Specification

Weight: 905Kg
Chassis: Carbon fibre
Brakes: Carbon, ventilated
Front wheels: 324x648mm Rim: 16 inches
Rear Wheels: 368x720mm Rim: 18 inches
Engine V8 5.0 litre twin turbo 720-940HP @ 7000RPM

Which car is best for me?

The Mazda with just one brand of tyres and management of fuel consumption in the hands of the driver, it's a great safe choice for the race. On the Porsche's side, you have different options. You could use Goodyear tyres and a higher turbo pressure to go as fast as you can, but bear in mind that tyres will last less, and pit stops will be longer due to the amount of fuel needed. A more conservative choice could be to use the Yokohama tyres with a lower turbo pressure. The C11 is heavier, it doesn't turn in so fast on twisty circuits. But it has good traction, and lots of power to reach high speeds. All cars have the same chance to fight for wins, it all depends on the driver to choose the right combination that matches their driving style to get the best performance from the chosen car.

Pit Stop Time: Tyres take 20 seconds to be changed and is the only action with a separated time. Fuel takes 1 second per litre (100 seconds for the entire tank). All the other actions are shared with the fuel time (driver change, repairs, settings changes). The amount of time that appears as fuel time, is the total time for the pit stop.

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Mulsanne's Corner group.

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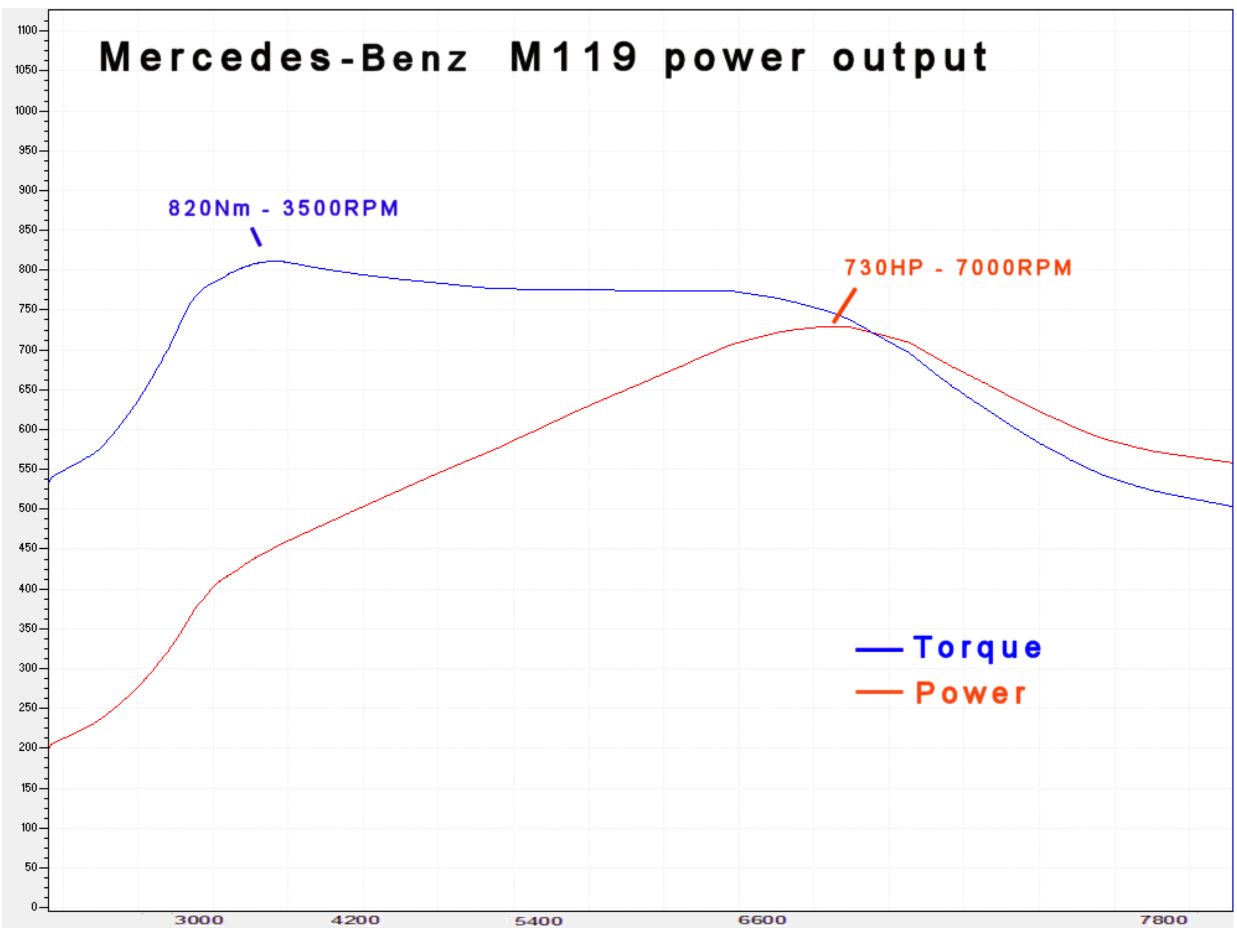
SAUBER MERCEDES C11

Engine: Mercedes-Benz M119 HL - V8 Turbo

Output:

<u>Torque</u>: 820Nm at 3500rpm (low boost)

<u>Power</u>: 730hp at 7000rpm (low boost) ; 944hp at 7000rpm (full boost)



Engine telemetry at minimum boost pressure

Max. recommended **rpm**: 7300rpm (at 7500 engine life is halved)

Recommended **radiator** setting: 3 (Endurance)

Recommended **oil temperature** range: 112 – 130ºC (at 123ºC life is halved)

Recommended **boost** position:

Endurance: 6 Qualifying: 9

Recommended **mixture** map use:

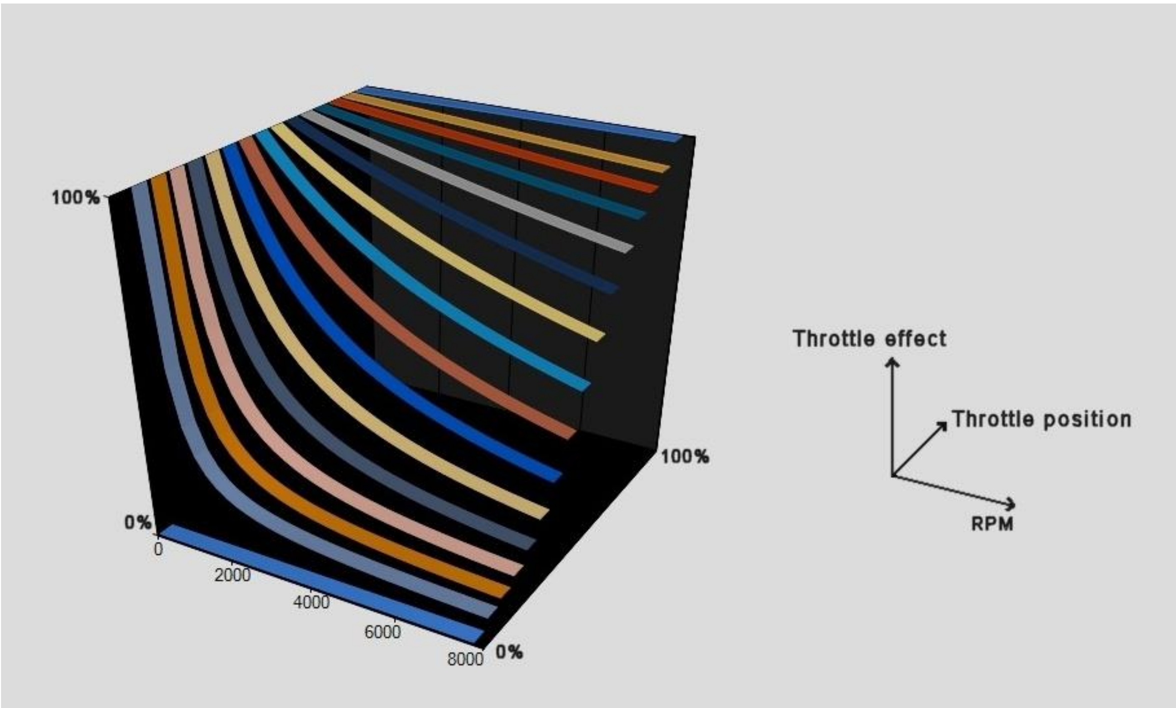
Lean (rain/save fuel): 1 Rich (maximum power): 2

Recommended **engine brake** setting:

Short braking distance : 1

Keep corner speed: 4

Other info:



Throttle map effect depending on pedal position and engine RPM (created and shown by Engine Easy Create)

Tyres:

Compounds:

Goodyear R500 (medium)

Goodyear R600 (hard)

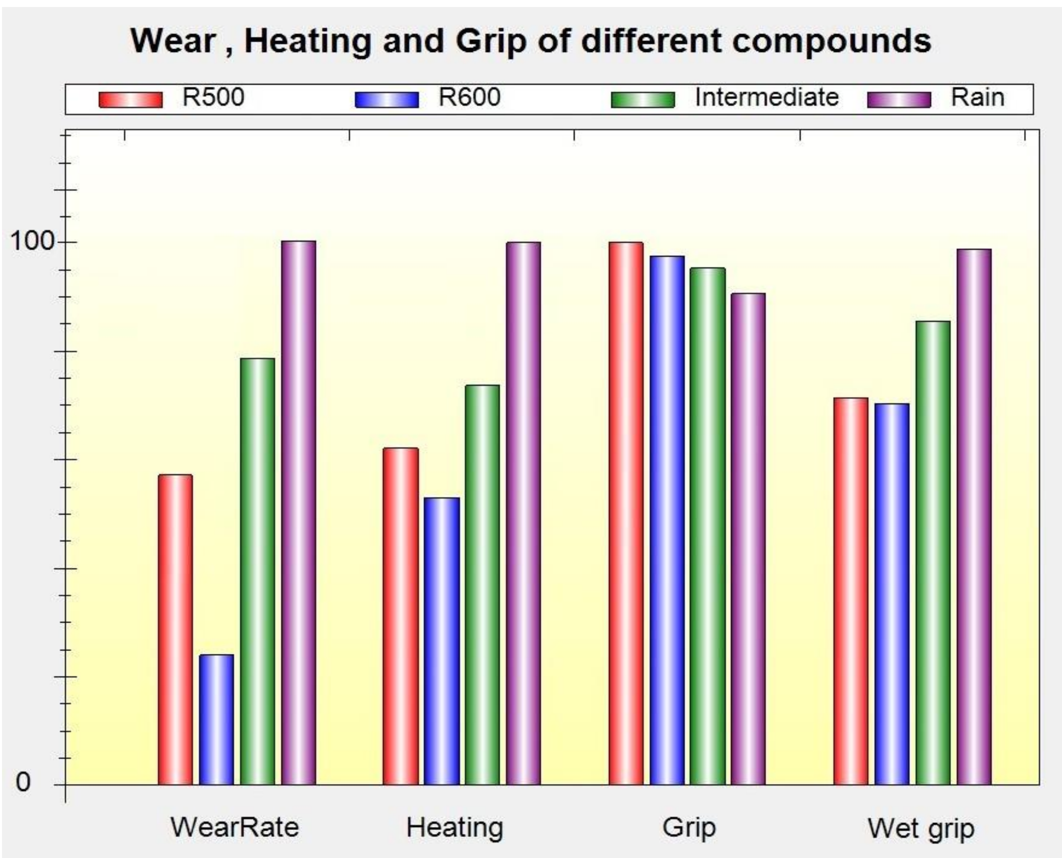
Intermediate

Rain

-Dimensions:

Front: 25.5/13 x 17 ; Rear: 28.5/14.5 x 18

-Performance comparison (based on CarStat):



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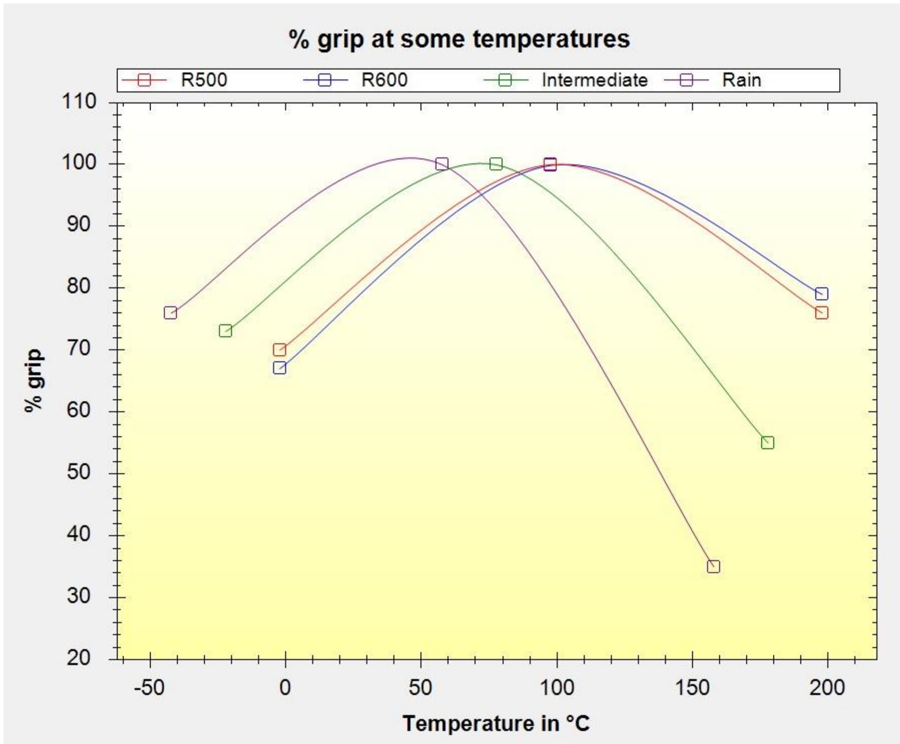
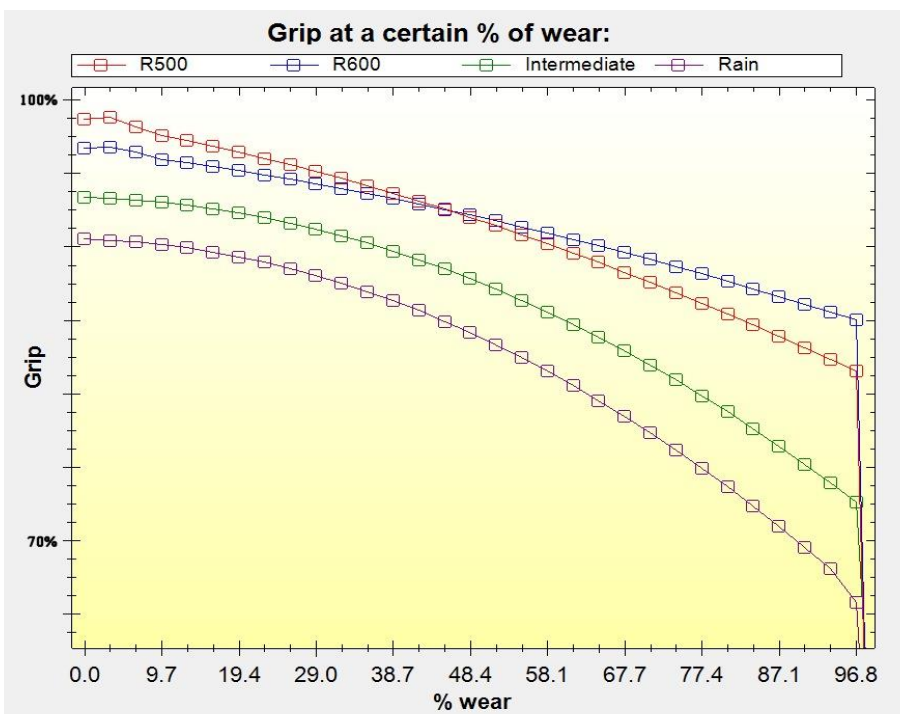
-Optimum temperatures:

R500: **100ºC** ; R600: **103ºC** ; Intermediate: **78ºC** ; Rain: **58ºC**



-Abrasion degradation :



-<u>Thermal degradation</u>:

R500 thermal degradation starts at: 109^{o}C

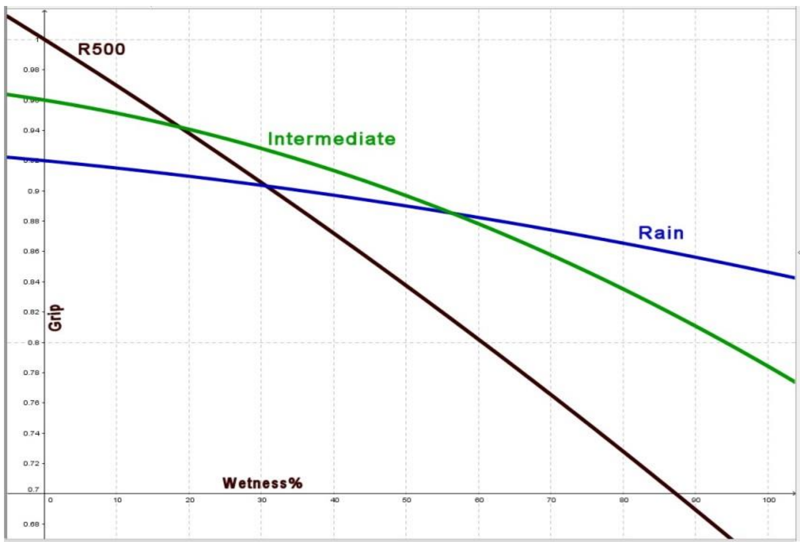
R600 thermal degradation starts at: 112^{o}C

Intermediate thermal degradation starts at: 104ºC

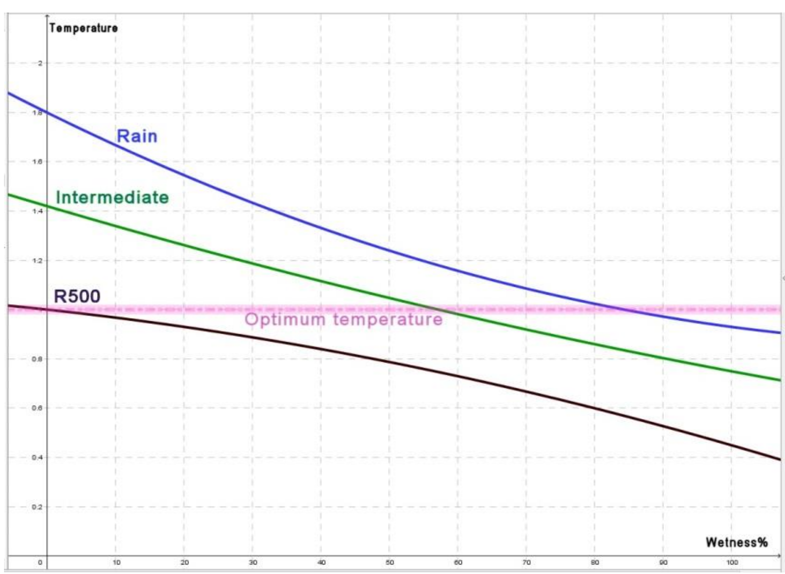
Rain thermal degradation starts at: 100ºC

-<u>Wet tyres</u>:

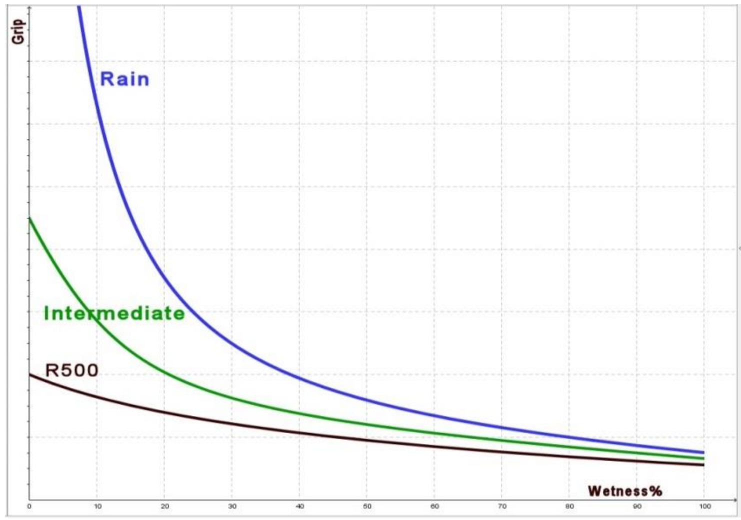
Tyre grip comparison depending on wetness (no wear or heat effects)



Tyre temperature comparison depending on wetness (approximated)



Tyre wear comparison depending on wetness (approximated)



These are ideal representations on uniform constant wetness levels. However, road state usually evolves depending on rain amount and cars on track, so that wetness levels are usually dynamic and tarmac is often a mix of damp patches, dry paths, puddles, etc,…

-Tyre characteristics and recommendations:

Tyres are very sensitive to **slip angle**. This means using excessive steering angles may induce quick overheating on tyres surface, losing grip prematurely while cornering. Sliding and going sideways may harm rear tyres.

Tyres are also sensitive to **load** and **speed**. They are not so effective at the fastest corners, where sliding speed is higher and downforce increases tyre deformation, so they lose grip and suffer faster overheating and wear.

Soft compounds are more sensitive to load, so probably you will notice that they are much more grippy than hard compounds at low speed corners, but grip difference is not so big at high speed corners.

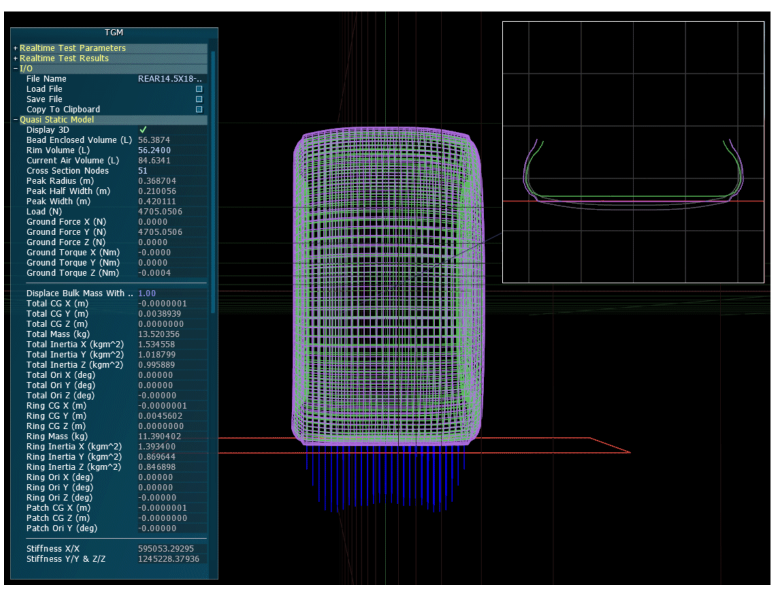
Different compounds need different driving style according to their **temperature characteristics**. Soft compounds are not very efficient when overheated, while hard compounds are not efficient when cold. Probably hard compounds admit a more aggressive style, which helps to reach optimum temperatures, while soft compounds need to be gentle to not exceed them.

Chosen tyre compound must fit with ambient conditions and required task. Soft tyres fit better with low fuel loads, high turbo positions and more oversteering chassis. These are the typical conditions on short race stints and qualifying laps. It's not recommended to use soft tyres with high fuel loads, very hot ambient temperatures, etc,... In the other hand, it is not recommended to use hard tyres with highest turbo positions.

Never use rain tyres in a dry track. They will overheat and wear quickly, making impossible to drive safely.

Also, do not use slick tyres in the wet since they are easily affected by aquaplanning.

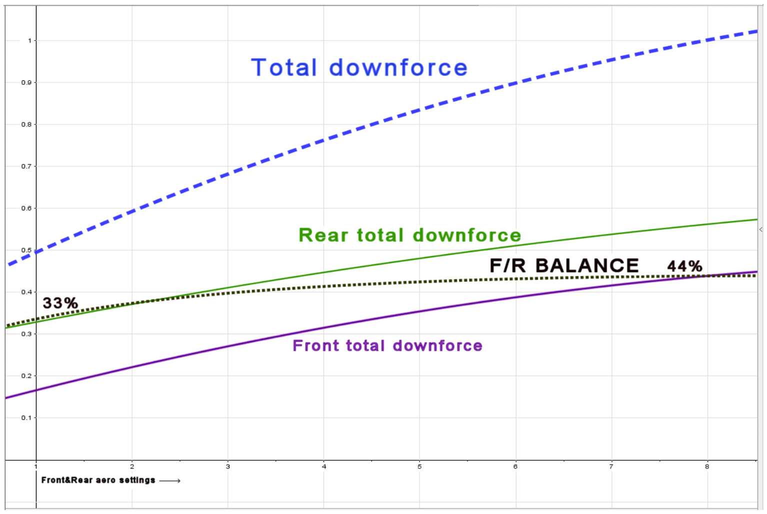
Other info:



Deflection test at 4700N (by Rfactor 2 Tyre tool)

Aerodynamics

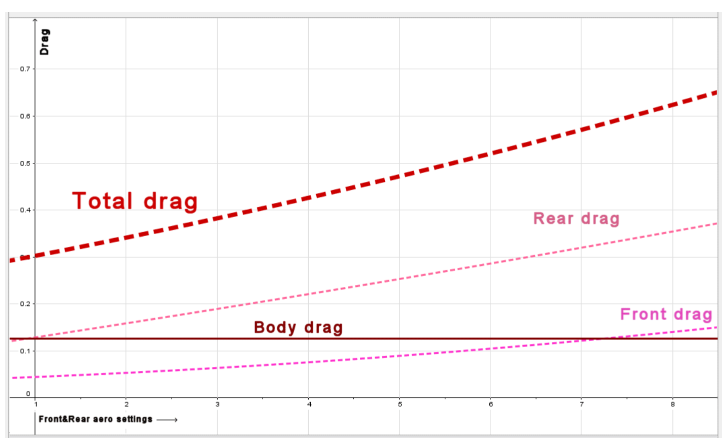
Downforce:



Total normalized downforce and aerodynamic balance depending on garage aerodynamic settings (shown by AeroGebra).

As a start point, it is recommended to use **same number** for both front and rear downforce settings (for example: front = 6 and rear = 6).

Drag:



Total drag and contributions, depending on garage aerodynamic settings.

<u>Ride height:</u>

How to choose best ride height, from aerodynamics point of view?

Ride height is dynamic, it changes all the time while driving due to different forces acting on the chassis. You should choose a static ride height that goes in favour of the optimum instant ride height on corners and straights of each track.

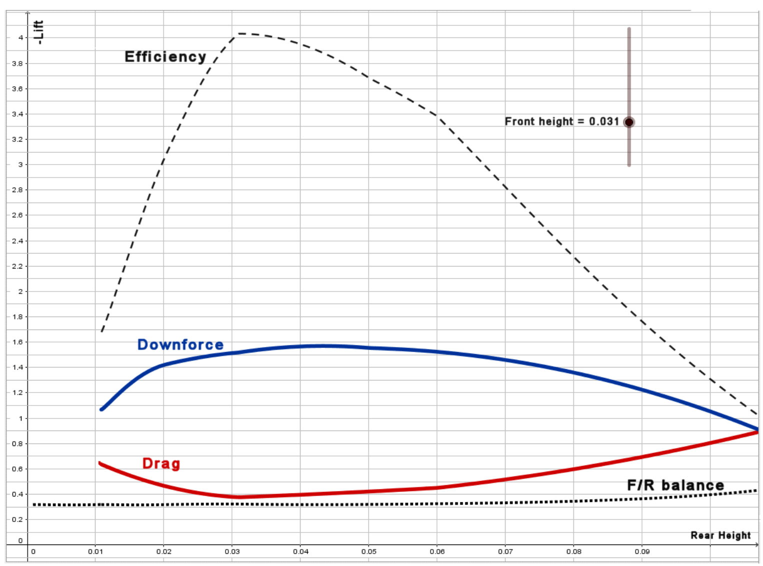
'**Static** ride height': Ride height setting. It is set on garage.

'**Instant** ride height': Actual ride height while driving. Normally, it is lower than static, because of aerodynamic downforce.

Rake is the difference between rear and front ride height. Rake is positive when rear is higher than front. Rake is negative when rear is lower than front.

'**Rake**' = 'Rear ride height' – 'Front ride height'

We need to know how downforce and drag evolve depending on ride height:



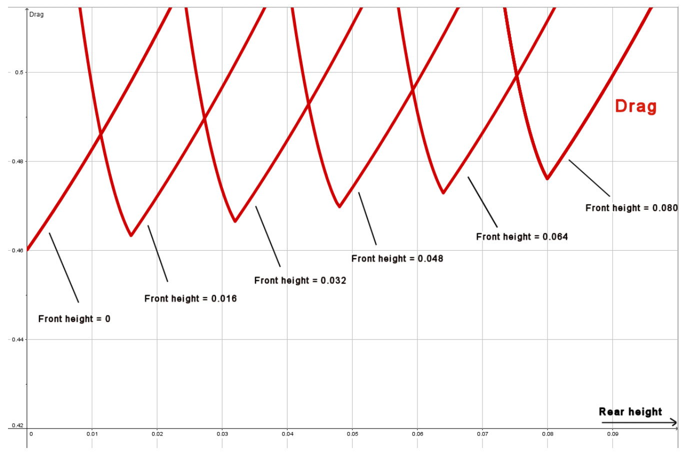
<u>Total</u> downforce, drag, efficiency and balance depending on instant rear ride height (for instant front height = 31mm, which is the optimum).

Instant ride height for maximum **downforce** : Front: **31**mm ; Rear: **43**mm

Instant ride height for maximum **efficiency** : Front: **31**mm ; Rear: **31**mm

This means we need some positive rake to maximize downforce, and no rake to minimize drag.

Let's check drag evolution for other front ride heights:



Total drag depending on instant rear ride height, for various instant front ride heights

Instant ride height for minimum aero **drag** : Front: **0**mm ; Rear: **0**mm

This confirms that:

- The lower is the car, the less aerodynamic drag there is.

- Drag also decreases when both front and rear heights are the same. That is: **Rake generates extra drag**, especially negative rake.

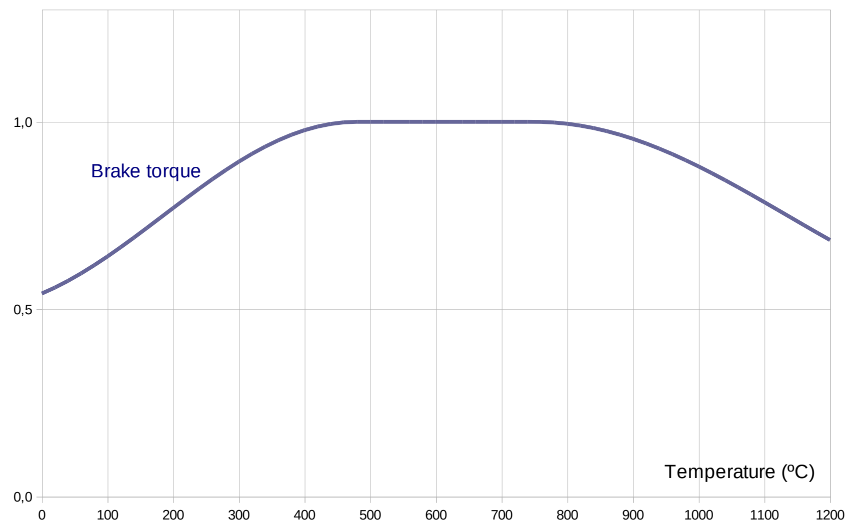
At the straights, rear height tends to go lower than front due to strong rear downforce. **Use hard rear springs** and/or **increase rear height** setting to avoid negative rake and speed loss. Avoid using too soft rear springs in combination with low rear ride heights. A change of +-1cm in rear height can make you lose 5kph of top speed.

As a conclusion, we recommend the following static ride height to obtain a balanced setup:

Recommended **front** static ride height **setting**: 45-50mm

Recommended **rear** static ride height **setting**: 60-70mm

Brakes: 35mm carbon discs, internally ventilated



Optimum **temperature** range: 450-800ºC

Recommended **brake duct** setting: 5 (Endurance)

-Other data:

-Speed statistics:

Acceleration:

0-100kph: 2.6s ; 100-200kph: 3.2s ; 200-300kph: 6.6s

Top speed:

415kph

-Driving recommendations:

- Caution! This is a 900HP machine. It is strongly recommended to carefully regulate throttle pedal when approaching corner exit, especially on low speed corners. It is possible to slide and to make opposite lock while using a portion of throttle, but never use full throttle until the car is firmly stabilized. Highest turbo positions are only recommended when riding new qualifying tyres or very good track conditions. Listen to turbo sound so that you know when the power is coming. When track is very wet, use ‘Rain’ engine mixture.

- Going sideways at high speed is not recommended. Severe grip loss can occur when trying to drift at higher speeds than 180kph.

- Stay on track limits, avoid driving over kerbs. Suspension travel is short and springs are usually very hard, so they don’t cope well with irregularities.

- After exiting pit lane or caution laps, brakes and tyres are usually cold. Avoid aggressive driving and late braking until car elements reach optimum work temperatures. Brakes can heat up after a pair of corners, but tyres may need rolling for two or more laps, depending on track and compound.

- Car settings should take in account fuel consumption and tyre wear. Car performance will change after some laps, so risky setups which are fast on new tyres can be dangerous for a long stint. Remember that car weight, balance and grip will change. For the race, choose tyre compounds which last longer in good state, and this applies also to rain tyres.