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Motorcycle Technology Report
ACHA 4003

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11/2023

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Introduction

This report will show geometric data and talk about how they were acquired and what affects they have on the bike and how they translate to the bikes characteristics. There will then be researched data of 2 bikes and a direct comparison between them all how the different settings and geometric data differs between them leading to the significant differences. An excel sheet will show all data gathered with equations and full workings to show the reader clear solutions.

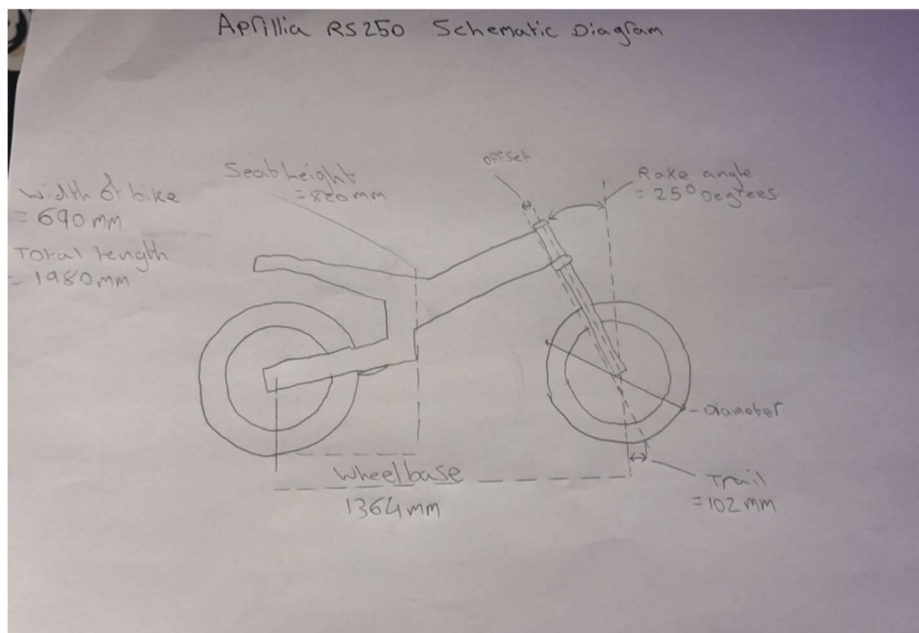
Geometric Data for Aprilia RS250

	RS250			Theta	27.46093
Weight	(Kg)	Gemoterty	(mm)		
Front	69.45	Wheel Base	1364		
Back	63.7	Front wheel radius	285		
Front (rider)	98.3	Back wheel radius	300		
Back (rider)	115	Average radius	292.5		
Lifted	54.5	Lift height	629		
Lifted (rider)	87.8				

(figure 1)

	Bike Only	Bike + Rider		Rake angle	25 degrees
X CoG	652.5483	735.3961556		Trail	102mm
Y CoG	473.8459	627.1871916			
weight split front	52.15922	46.08532583			
Weight split rear	47.84078	53.91467417			

(Figure 2)



(Figure 3)

These pieces of data have been accurately measured 3 time each to make sure that the measurements are correct. All these measurements on a motorcycle play a big role in the characteristics of the bike for example, a longer bike doesn't handle as well as a shorter bike as its turning circle is much larger, but it is much more stable under braking and acceleration than the shorter bike.

The X Centre of Gravity and the Y Centre of Gravity has been worked out as well to provide a specific centre of gravity for the RS250, the weight split for front and rear was also included to show the affect of a rider sitting on the bike in terms of centre of gravity. The centre of gravity affects stability, manoeuvrability, and handling of the motorcycle. A lower centre of gravity makes the bike feel lighter

and more stable whilst a higher centre of gravity makes the bike feel heavier and less stable. For most bikes a lower centre of gravity is more desirable as it makes the bike easier to handle and feel more stable, therefore making the bike more comfortable to ride long distances. However, sport bikes desire a higher centre of gravity as it makes the bike more agile and responsive throughout cornering. The centre of gravity can easily be affected by the riders position on the bike, for instance on a sports bike the rider will try to position his body slightly towards the back of the bike so that more weight is supported by the bigger rear tyre. When cornering the weight distribution tends to be very central as the rider will usually hang his body off the side of the bike to assist in cornering and effectively pull round the corner. Under braking the rider has to counteract the weight transfer from the rear tyre to the front by sitting up and putting weight on the rear to stop the back of the bike lifting and losing traction.

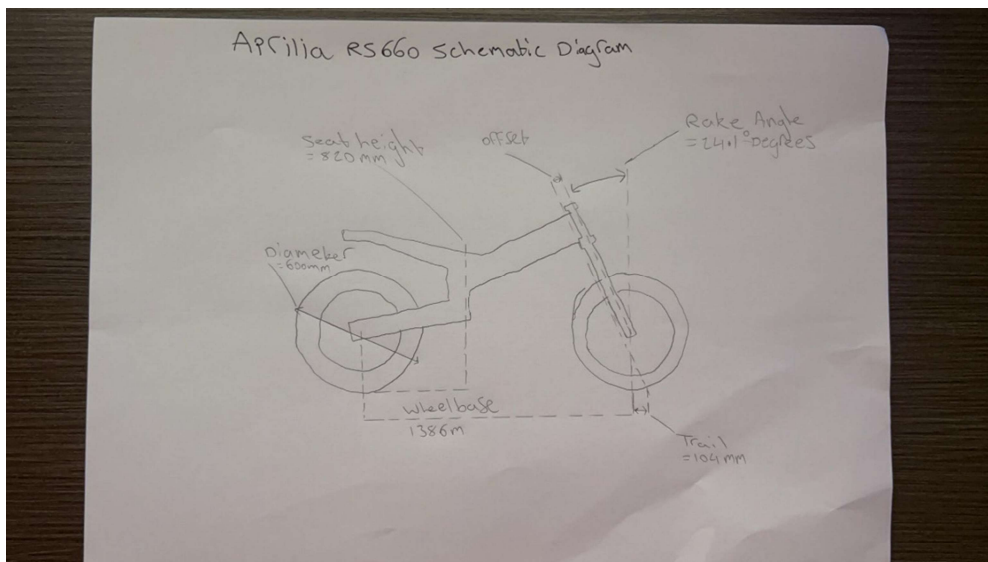
Geometric Data for Aprilia RS660

RS660				Theta	26.98929
Weight	(Kg)	Gemoterty	(mm)		
Front	84.35	Wheel Base	1386		
Back	74.5	Front wheel radius	295		
Front (rider)	114.6	Back wheel radius	305		
Back (rider)	125.6	Average radius	300		
Lifted	62	Lift height	629		
Lifted (rider)	93				

(Figure 4)

	Bike Only	Bike + Rider		Rake angle	24.1 degrees
X CoG	650.0283	724.7360533		Trail	104.6mm
Y CoG	514.1514	669.3538641			
weight split front	53.10041	47.71024147			
weight split rear	46.89959	52.28975853			

(Figure 5)



(Figure 6)

All the data for the RS660 was collected with the same principles as the RS250 and the calculations followed the same theoretical processes.

These 2 machines were built for the same purpose so both these bikes will follow very similar theories for centre of Gravity as their purpose is to be very agile and fast.

Gear Ratios for the RS250

Rs250 set up		Rpm	11000		
Gear Ratios				Top speed	
				km/h	MPH
1st	11	27		57.284573	35.80286
2nd	16	26		86.527747	54.07984
3rd	17	21		113.82519	71.14074
4th	22	23		134.49422	84.05888
5th	24	22		153.3901	95.86881
6th	25	21		167.38999	104.6187

(Figure 7)

Primary Reduc Ratio		Secondary Reduc Ratio			Rolling resistance with rider
23	59	14	42		
					$F_w = 0.02 \cdot m \cdot g$
					41.84946

(Figure 8)

Resistane due to gradient at 10 degrees	
$F_p = m \cdot g \cdot \sin \theta$	
	164.0996264
this is amount of N to reach top speed at 10 degree incline	
Amount of N to reach 167kmh	
	46.38888889

(Figure 9)

			inch	
	Tyre Dimensions			17 Dia
Front	110	70		
Rear	150	60		0.5218

(Figure 10)

These are the Gear ratios and the effective maximum speed per gear, if there is no resistance these are the speeds the bike should be able to reach.

A rolling resistance was calculated with the rider on the bike so give a direct view of the effective resistance when riding.

Then a Resistance due to gradient was calculated to see whether the bike has enough power to reach the desired speeds when going up a 10% incline.

Finally, the amount of power needed to reach its expected top speed was calculated to show whether the bike is capable of the speeds calculated.

Analysis of characteristics

The RS250 is a sports bike that was built to be a very agile lightweight sports bike. With the average rider the bike comes in at a weight of just over 200kg which is light for a stock sports bike making it very easy to handle and not tiring for the average user to ride. The short trail distance makes the bike very responsive to the inputs from the rider and very agile in the corners whilst keeping a lot of stability at lower speeds. The centre of gravity is high and positioned favouring the rear of the bike further enhancing the bikes agility and responsiveness. The rake angle on this bike is a median between keeping the bike very agile whilst keeping it very stable under various amounts of stress. As this is a sports bike the suspension will be much stiffer than what could be seen on a dirt bike as a stiffer suspension allows for more grip and stability under weight transfer whilst also keeping the distance of the wheel to the steering axis shorter to enhance the agility of the motorcycle.

The RS660 is a modern sport bike, this bike is tailored to feel like a road legal race bike as it has a short wheelbase enhancing the agility and responsiveness of the machine, it shares a lot of similarities with the RS250 as both have a low rake angle to positively affect the cornering ability of the bike but keeping a stable front end when undergoing weight transfer when braking. This bike also shares a lot of similarities when talking about the centre of gravity as both bikes are aimed at race feeling bikes not comfortability. The high centre of gravity makes the bike feel heavier than a cruiser as the bike takes more effort to turn but will turn with much more agility and responsiveness making this bike much better at manoeuvring around tight and twisty roads. The seating position of this motorcycle is quite aggressive as the bike is designed to be able to attack corners naturally making the rider lean off the bike when turning as it becomes the natural position. Leaning off the bike also neutralises the centre of gravity to allow for stability for both tyres on the ground.

Geometric data for 2 modern motorcycles.

A MotoGP bike is a prototype motorcycle directly aimed at being fast around a track, but modern MotoGP bikes have turned more towards being very fast in a straight line and using rider ability and aerodynamics to pull the machine around the corner and then accelerating quickly out. Modern MotoGP bikes have a much longer wheelbase of 1420mm than they used too as they have a lot more power so to be able to use this increase in power, they lengthened the wheelbase of the bikes to reduce wheelie when accelerating (2). The centre of gravity is still high as the bike needs to be agile but modern versions of these bikes have a ride height device switch that lowers the bike when accelerating as a lower centre of gravity allows for more aerodynamic efficiency and grip of the rear tyre under stress, also a lower centre of gravity when accelerating reduces the front wheel lift allowing the traction control to have less input, therefore the bike can use all of its power much quicker leading to reaching higher speeds much faster. Most of the geometry of a MotoGP bike gets changed every track as different tracks have different feelings and rider preferences. A standard setting before the rider changes to their preference is that the Rake angle is 31 degrees, and the amount of trail is 114.3mm. this is to give the bike much more stability at faster speeds as the agility can be found using advanced aerodynamics.

MotoGP		
wheel base	1420 mm	
Rake angle	31 degrees	
Trail	114.3 mm	
wheel diameter	17"	
Front Tyre	120	70
Rear Tyre	180	55

(Figure 11) (3)

Paris Dakar bikes are big enduro off road bikes with high centre of gravity giving them good handling to navigate harsh terrain but have long and tall suspension to absorb big impacts, these suspensions have 170mm of travel making the bikes like a big, weighted pendulum over the top of the tyres. These suspensions are quite soft as the ground they ride on is very un-even. The seat height of these bikes is 860mm making them quite tall. The long wheelbase of 1500mm makes them very stable for riding on rough terrain. These bikes are not very aerodynamically efficient as they need to be able to carry large fuel loads and energizing supplies for the rider as they must do very long distances between stations (1). The front suspension is much larger than the rear with a full travel length of 270mm this allows the front wheel to bounce off the ground and absorb all terrain throughout the race.

Paris Dakar		
wheel base	1500mm	
wheel diameter	21" front	18" rear
rake angle	27.6 degrees	
trail	121.92	

(Figure 12)

A suggestion for improving the handling of a MotoGP bike could be that they reduce the amount of trail and rake on the bike to enhance the handling to assist the riders pull the bike round the corner with less stress. This change would lead to slightly less stability when at top speed but could be a risk for a much bigger rewards in the lap time achieved by being able to corner at a slightly faster speed than others.

References

- (1) Cycle World. (n.d.). *2023 Ducati DesertX*. [online] Available at: <https://www.cycleworld.com/ducati/desertx/> [Accessed 14 Dec. 2023].
- (2) Anon, (2023). What Size Bikes Do MotoGP Use? - Moto Chronicle. [online] Available at: <https://motochronicle.com/what-size-bikes-do-motogp-use/#:~:text=The%20wheelbase%20of%20a%20MotoGP%20bike%20is%20typically> [Accessed 14 Dec. 2023].
- (3) Pretorius, L. (2022). What Size Tires Does MotoGP Use? [online] One Stop Racing. Available at: <https://onestopracing.com/what-size-tires-does-motogp-use/#:~:text=All%20MotoGP%20bikes%20use%20the%20exact%20size%20tire> [Accessed 14 Dec. 2023].