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Analysis of Motorcycle Geometry and Handling Characteristics

Motorcycle Technology

(ACHA4003)

Finn Flye

2304833

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Table 1 Abbreviation Table (Finn Flye, 2024)

Abbreviations	Meaning
CDA	Drag Coefficient * Frontal Area
P	Density of Air
FD	Aero Drag Force
Fw	Rolling Resistance
Fp	Resistance Due to Gradient
Ft	Total Force
W/o	Without Rider
W/R	With Rider
XCoG	X Center of Gravity
YCoG	Y Center of Gravity

1 Introduction

This report conducts the importance and understanding of a motorcycle's geometry and dynamic's, this process was conducted onto four different motorcycles to understand the handling qualities that each motorcycle emits and why these characteristics make certain bikes more capable than others. The purpose of this report is to indulge in the influences of outside forces or parameters that affect the maximum speed at which the bike can travel while outputting its maximum power.

Furthermore, the lower segments of this assignment will include a comparison between the bikes that have been physically measured to high performance bikes that have competed within competitions to understand what characteristics they vary in and how this improves their overall performance compared to the other bikes.

2 Objective

To complete the research for this assignment, four various motorcycles were chosen to offer a variety of specifications. The two motorcycles were chosen to be physically measured those being:

1.Ducati Panigale S 1199

2.Bucci 140 Pit Bike

Then two motorcycles were chosen to be compared to the previous bikes through research to find the data required, those motorcycles being:

1.WorldSBK Ducati Panigale V4 R

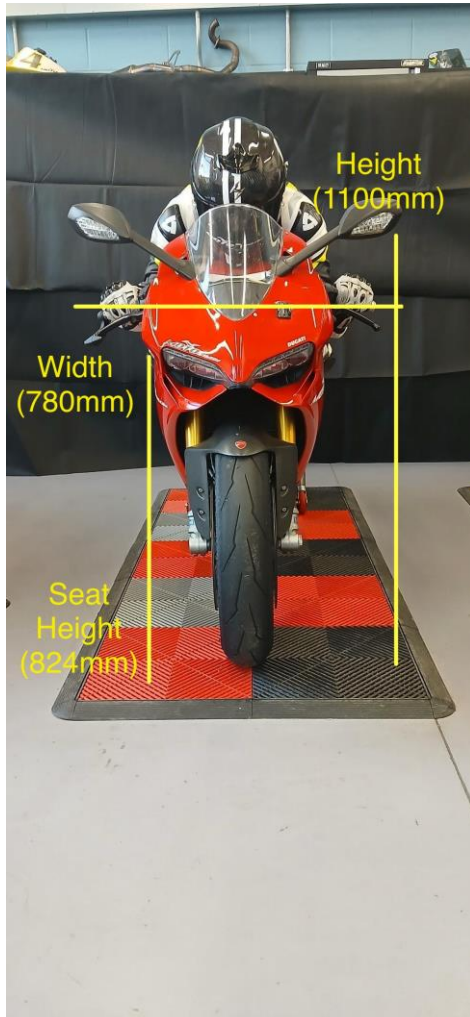
2.BMW R100GS Paris Dakar

The Calculations for center of gravity that were conducted on the Panigale and Bucci using the weight of a rider, the rider for this experiment was Finn Flye.

Furthermore, the values recorded were documented within Microsoft Excel and used to calculate the values for each of the segments of this report.

3 Ducati Panigale S 1199

The Ducati Panigale S 1199 was a revolution within the Ducati scene as it was nothing alike with previous models due to 'the chassis being 'frameless'', with the new generational engine of that of the 'superquadro (MCN, 2022)', The name of this engine derives from 'it's very high bore to stroke ratio that enables the bike to achieve stupendous levels of Horsepower (Ducati, 2024)'



This Figure shows the Dimensions that were gathered while in the workshop and for the overall height of the bike and the height of the seat was sourced from '(MotorcycleSpecs, 2024)'.

Figure 3-1 Schematic of Panigale Height, Seat height and Width (Finn Flye, 2024)

3.1 Rake and Trail

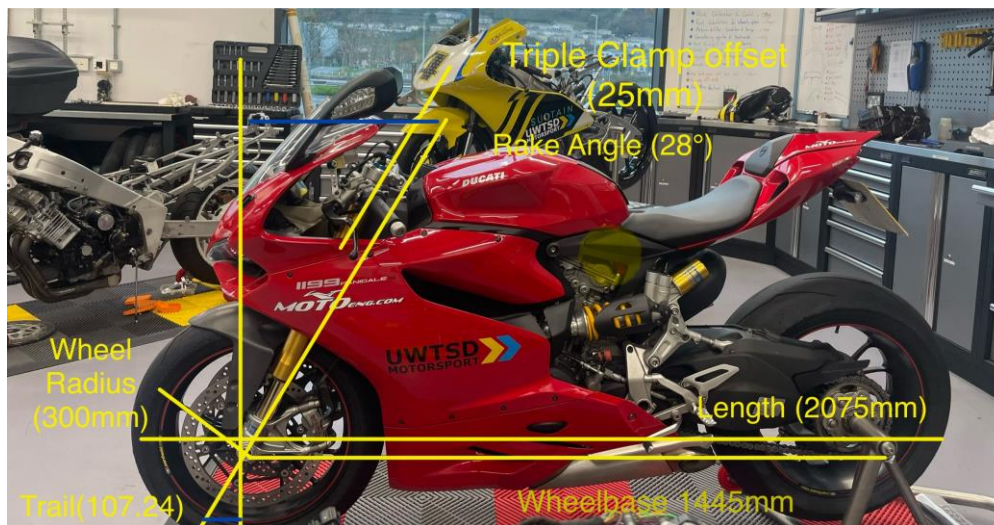


Figure 3-2 Schematic for the Panigale Dimensions (Finn Flye, 2024)

The figure above shows the physically measured dimensions for both the wheelbase and the wheel radius. While also conveying the calculated Rake angle and Trail value. The dot placed in the schematic is the location of center of gravity.

Table 2 Table Showing the Values of Rake and Trail for the Panigale (Finn Flye, 2024)

Rake	28	Degrees
Trail	107.24	mm
Wheel Rad	300	mm
Offset	25	mm

In the table above are the calculated figures of the Rake and Trails using the wheel radius and the offset of the triple clamp on the motorcycle's forks. Rake is 'the measurement from the steering axis angle to the vertical axis (Siahaan, 2020)' using this information and the schematic produced the rake angle could be recorded. The value of Trail is 'the distance from where the front wheel encounters the ground and the line drawn from the angle of the steering head (Lindemann, 2015).

To calculate the value of Trail the equation:

$$(\text{Radius} \times \sin(\text{Rake angle}) - \text{Offset}) / (\cos(\text{Rake Angle}))$$

Was used.

So to Calculate the value of Trail for the Panigale this formula was used:

$$\text{Trail} = (300 \times \sin(28) - 25) / (\cos(28))$$

$$\text{Trail} = 107.24\text{mm}$$

3.2 Centre of Gravity

Table 3 Table showing the Measured Values of the Panigale (Finn Flye, 2024)

W/o			W/R	
Rear Wheel	89.35	Kg	131.7	kg
Front Wheel	97.9	Kg	129.3	kg
Bike Weight	187.25	Kg		
Rider Weight	75.1	Kg		
Total Weight	262.35	Kg		
Front Wheel Rad	300	Mm		
Rear Wheel Rad	320	Mm		
Wheelbase	1445	Mm		
Rav	310	Mm		
Lift				
Front Weight lifted	110.1	Kg	158.85	kg
Rear Weight Lifted	76.9	Kg	102.1	kg
Stool H	600	Mm		
Wheelbase	1.445	M		

Using the measured values from the motorcycle with no rider and a rider, both the values for the weight of the front and rear wheels were able to be recorded, enabling the center of gravity and the Percentage load to be calculated.

The data collected found above Enabled the center of gravity for both x and y axis to be calculated as shown in this table below.

Table 4 Table showing the calculated values of x and y axis center of gravities of the Panigale (Finn Flye, 2024)

	W/o		W/R
XCoG	0.69		0.73
Angle L	24.53	%	
YCoG	0.31		0.33

To calculate the XCoG value without a rider the formula:

$$XCoG = (\text{Rear Wheel Weight Level} \times \text{Wheelbase (mm)}) / (\text{Total Weight of the Bike}) / 1000$$

Was used. The formula to calculate the XCoG with the rider is the same as the previous, however adding the weight value to the total bike weight.

To be able to calculate the value of the y axis the angle of lift had to be calculated first using the formula: Angle of Lift $^{\circ} = (\sin^{-1}(\text{Stool height} / \text{Wheelbase(mm)}))$

So using the value of the angle the value of YCoG without a rider can be measured using the equation:

$$YCoG = (\text{Wheelbase(mm)} \times (\text{Rear Wheel Level} - \text{Rear Wheel Lifted}) / (\text{Bike Weight} \times \text{Angle of lift}) + (\text{Rav})) / 1000$$

For YCoG with a rider the weight of the rider needs to be added to the Bike weight.

Table 5 table showing the value of Percentage Load for the Panigale (Finn Flye, 2024)

	Percentage Load	
W/o	47.72	%
W/o	52.28	%
W/R	50.20	%
W/R	49.80	%

To calculate the Percenatge Load two equations were used:

$$(\text{Wheelbase (m)} - Xcog) / (\text{Wheelbase (m)}) \times 100$$

$$\text{And: } (Xcog) / (\text{Wheelbase (m)}) \times 100$$

For the values using the rider, substitute the XCoG values with that from the rider's values, for example: Percentage Load W/R = $(1.445 - 0.73) / (1.445) \times 100$

$$\text{Percenatge Load W/R} = 49.80 \%$$

3.3 Resistance to Motion

Table 6 Table showing the values needed to calculate the forces acting upon the Panigale (Finn Flye, 2024)

Mass	262.35	kg
CdA	0.95	m^2
Velocity	72.88	m/s
P	1.167	kg/m^3
Gravity	9.81	m/s^2

The value of drag coefficient at 0.663 was collected from the dyno data on the Panigale that was sourced from Mark Fall. To calculate the value of A the frontal area was used, which the image was supplied by Ian Henshaw.



Figure 3-3 Frontal Area Photo (Ian Henshaw, 2024)

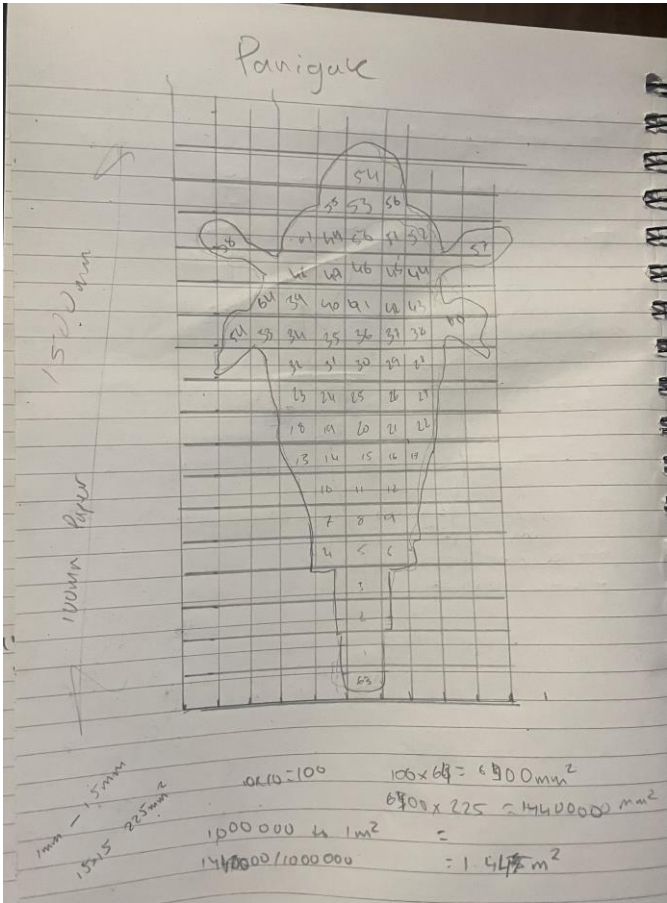


Figure 3-3 Frontal Area Calculation (Finn Flye, 2024)

Using the method found from ‘(Harrison, 2024) using the boxes as $10\text{mm}^2 \times 10\text{mm}^2 = 100\text{mm}^2$ ’ The value of frontal area was calculated using a drawing and setting the boxes to a value to use as reference for the scale of the actual frontal area and using the drawing of the frontal area being 1500mm total meaning each 1mm^2 would be 15mm^2 , thus meaning $15 \times 15 = 225\text{mm}^2$ which is then multiplied by the number of boxes within the drawing so, $225 \times 6400 = 1440000\text{mm}^2$. Thus, meaning the area is 1.44 m^2

Table 7 Table showing the forces calculated for the Panigale (Finn Flye, 2024)

FD	2958.52	N
Fw	51.47	N
Fp	256.09	N
Ft	3266.08	N
Road Angle	5.71	Degrees
Power	219353.00	W
	219.35	kW
Power	238015.42	W
	238.02	kW

To calculate FD: $FD = (1/2 \times P) \times (CDA) \times (V^2)$

To calculate the value of Fw: $Fw = (0.02 \times \text{Mass} \times \text{Gravity})$

To calculate Fp: $Fp = (\text{Mass} \times \text{Gravity} \times \sin(\text{Road angle}))$

To calculate the value of Ft: $Ft = (FD + Fw + Fp)$

Two Calculations were used to calculate the power using the value of $FD + Fw = 3009.99\text{N}$

And Ft: $\text{Power} = (Ft \times V)$

$$\text{Power} = (3009.99 \times V)$$

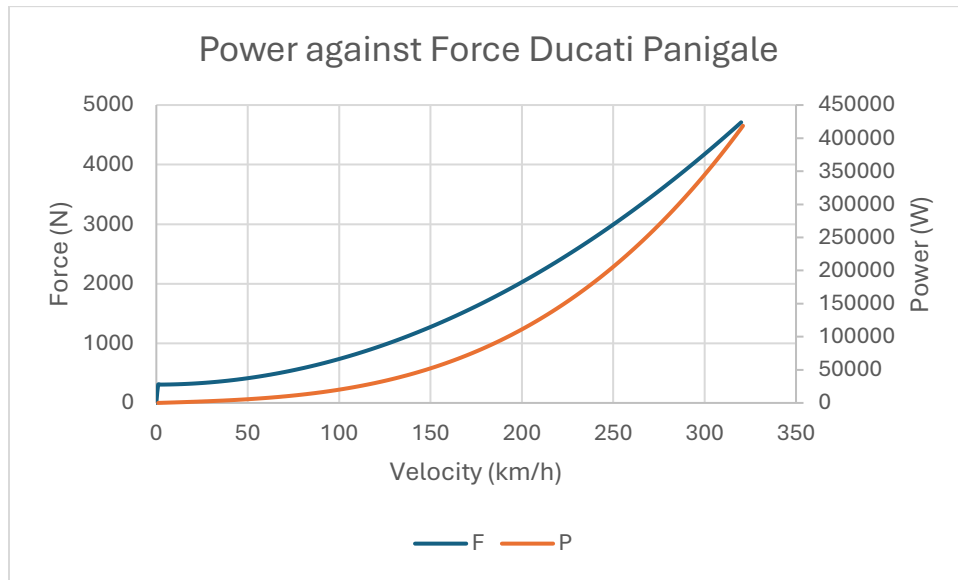


Figure 3-4 Graph showing Powe against force for the Panigale (Finn Flye, 2024)

Using the values calculated against a steady Velocity up to 320 km/h a graph was plotted showing the Power against the opposing Forces. As the value of force increases the value of power increases at gradual concavely rate, however the power will exceed the rate at which the force increases meaning that eventually it will be able to reach its maximum velocity.

3.4 Gearbox

Table 8 Table showing the Gearbox values for the Panigale (Finn Flye, 2024)

Primary	30	53					
Final	15	39					
Diam		0.64	m				
Rpm	10500		rev/min				
		Main	Counter	Ratio	Speeds	Revs	Falls
1st		15	37	0.405	112	10500	
						7981	2519
2nd		16	30	0.533	147	10500	
						8400	2100
3rd		18	27	0.667	184	10500	
						8750	1750
4th		20	25	0.800	221	10500	
						9164	1336
5th		22	24	0.917	253	10500	
						9224	1276
6th		24	23	1.04	288	10500	

The values for Primary and final and including the main and counter values were sourced from Ian Henshaw from the specifications on the Panigale.

To Calculate the Speeds the equation: $(\text{RPM} \times 60 \times (\text{Main}/\text{counter}) \times (\text{Primary in}/\text{Primary out}) \times \text{Diameter} \times \text{PI})/1000 \times (\text{Final in}/\text{Final out})$

So, Speed = $(10500 \times 60 \times (15/37) \times (30/53) \times 0.64 \times \text{PI})/1000 \times (15/39)$

Speed = 112 km/h

To calculate the RPM for the next gear is:

Next gear RPM = $(\text{RPM} \times (\text{Main}/\text{counter}) \times (\text{Next gear counter}/\text{Next gear main})$

Table 9 Table showing the Chain Dimensions gathered from measuring the Panigale (Finn Flye, 2024)

Chain size	Front Sprocket	Rear Sprocket	Chain	Distance From Sprocket to Pivot	Swing Arm Length
5/8"	15	39	104	73	538

To calculate the Dimension for the swingarm length the formula:

Swingarm Length = $(0.5 \times ((\text{No.Chain links} - 0.5 \times (\text{Front sprocket} + \text{Rear sprocket})) \times 25.4 \times (\text{Chain size})) - \text{Distance from Sprocket to Pivot}$

So, Swingarm Length = $(0.5 \times ((104 - 0.5 \times (15 + 39)) \times 25.4 \times (5/8)) - 73$

Swingarm length = 538mm

L	M	N	
Rpm	BHp	Power (KW)	
3000	25	18.65	
3500	49	36.55	
4000	58	43.27	
4500	63	47.00	
5000	67	49.98	
5500	76	56.70	
6000	85	63.41	
6500	93	69.38	
7000	105	78.33	
7500	121	90.27	
8000	143	106.68	
8500	157	117.12	
9000	166	123.84	
9500	174	129.80	
10000	183	136.52	
10500	185	138.01	

Figure 3-5 Data Showing RPM, BHp and Power For the Panigale (Finn Flye, 2024)

Using the Data collected for the RPM and BHp from the Dyno that was supplied by Mark Fall the Power was able to be calculated using the equation:

$$\text{Power (kW)} = (\text{BHp} \times 0.746)$$

For example, Power = 49×0.746

$$\text{Power} = 36.55 \text{ kW}$$

Then using the equation for Speed using the RPM the road speed for each gear and RPM could be calculated as shown in the figure below.

Road Speed 1st	2nd	3rd	4th	5th	6th	
	32	42	53	63	72	82
	37	49	61	74	84	96
	43	56	70	84	96	110
	48	63	79	95	108	123
	53	70	88	105	120	137
	59	77	96	116	132	151
	64	84	105	126	144	164
	69	91	114	137	156	178
	75	98	123	147	169	192
	80	105	131	158	181	206
	85	112	140	168	193	219
	91	119	149	179	205	233
	96	126	158	189	217	247
	101	133	166	200	229	260
	106	140	175	210	241	274
	112	147	184	221	253	288

Figure 3-6 Data showing the Road Speeds for each gear (Finn Flye, 2024)

Once the Road speed was calculated the Driving Force of the motorcycle could be calculated using the values of power and the values of road speed, using the equation:

$$\text{Driving Force (N)} = (\text{Power} \times 1000) / (\text{Roadspeed} / 3.6)$$

So, the initial driving force would be $DF = (18.65 \times 1000) / (32 / 3.6)$

$$DF = 2102 \text{ N}$$

Driving Force 1st	2nd	3rd	4th	5th	6th	
	2102	1598	1278	1065	930	817
	3531	2684	2147	1789	1562	1372
	3657	2780	2224	1853	1618	1421
	3531	2684	2147	1789	1562	1372
	3380	2569	2055	1713	1495	1313
	3485	2649	2119	1766	1541	1354
	3573	2716	2173	1811	1580	1388
	3609	2743	2195	1829	1596	1402
	3783	2876	2301	1917	1673	1470
	4069	3093	2475	2062	1800	1581
	4509	3427	2742	2285	1994	1752
	4659	3541	2833	2361	2060	1810
	4652	3536	2829	2358	2058	1807
	4620	3512	2809	2341	2043	1795
	4616	3509	2807	2339	2041	1793
	4444	3378	2702	2252	1965	1727

Figure 3-7 Data Calculated for Driving Force for each gear on the Panigale (Finn Flye, 2024)

From the established data a graph was produced showing the Driving force against the Road speed and as seen below the higher the driving force the slower the road speed of the motorcycle is. The values for the Panigale are lower than expected as it was found that it was conducted using rain mode on the motorcycle, so the full power had been restricted. Meaning that the motorcycle wouldn't be able to reach maximum speed due to the restrictions and the forces acting against the bike.

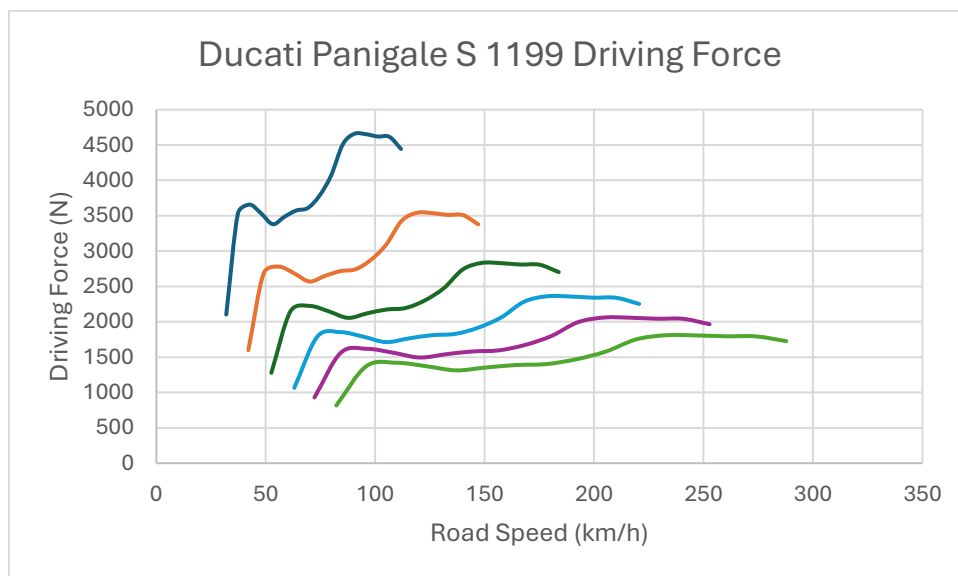
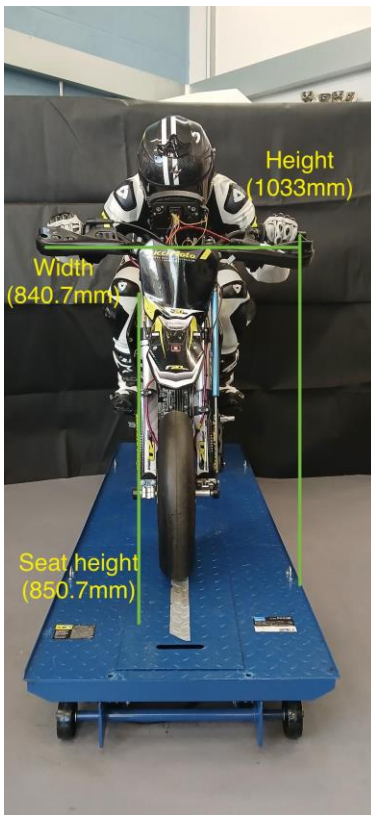


Figure 3-8 Graph Plotting the Driving Force against the Road Speed for the Panigale (Finn Flye, 2024)

4 Bucci Pit Bike 140

The Bucci is a powerful pit bike that has made progress through the years as the model that was used for this assignment has a ‘high-resistant frame that comes with a subframe with a motor support box (BucciMoto, 2022)’ making it substantially more lightweight while keeping all the components protected from any damage.



This Schematic shows the overall dimensions of the Bucci pit bike having gathered the measurements while in the workshop.

Figure 4-1 Schematic showing the Height, Seat height and Width of the Bucci (Finn Flye, 2024)

4.1 Rake and Trail



Figure 4-2 Schematic showing the Dimensions and Rake and Trail values (Finn Flye, 2024)

This Schematic shows accurately the value of Rake and Trail of the Bucci Pit Bike while giving the values for the other dimensions needed to calculate the value of trail that was implemented into the Schematic as shown in the table below. The dot indicated on the Schematic is the point of center of gravity.

Table 10 Table showing the Rake and Trail for the Bucci (Finn Flye, 2024)

Rake	19.3	Degrees
Trail	86.6	mm
Offset	20	mm
Radius	250	mm

4.2 Centre of Gravity

Table 11 Table showing the Measured Dimensions of the Bucci (Finn Flye, 2024)

W/o			W/R	
Rear Wheel	36.8	kg	86.2	kg
Front Wheel	38.1	kg	63	kg
Bike Weight	74.9	kg		
Rider Weight	75.1	kg		
Total Weight	150	kg		
Front Wheel Rad	250	mm		
Rear Wheel Rad	250	mm		
Wheelbase	1160	mm		
Rav	250	mm		
Lift				
Front Wheel W/R	46.2	kg	101.3	kg
Rear Wheel W/R	26.75	kg	45.5	kg
Stool Height	600	mm		
Wheelbase	1.16	m		

Using the same rider the values produced from the table above enabled the values of both x and y center of gravities to be calculated with both the rider and without.

Table 12 Table showing the values of both x and y center of gravities for the Bucci (Finn Flye, 2024)

	W/o		W/R
XCoG	0.57		0.67
Angle L	31.15	Degrees	
YCoG	0.25		0.27

Table 13 Table showing Percentage Load values for the Bucci (Finn Flye, 2024)

	Percentage Load	
W/o	50.87	%
W/o	49.13	%
W/R	42.53	%
W/R	57.47	%

In the table above you can see the calculations of percentage load that have been calculated using the x axis center of gravity and the wheelbase.

4.3 Resistance to Motion

Table 14 Table showing the calculated opposing forces (Finn Flye, 2024)

Mass	150	kg
CdA	0.9	m ²
Velocity	41.67	m/s
P	1.167	kg/m ³
Gravity	9.81	
FD	884.83	N
Fw	29.43	N
Fp	146.42	N
Ft	1060.68	N
Road Angle	5.71	Degrees
Power	38094.28	W
	38.09	kW
Power	44195.10	W
	44.20	kW

The value for Drag coefficient at 0.876 was sourced from the Dyno from Mark Fall.



Figure 4-4 Image of Frontal area (Ian Henshaw, 2024)

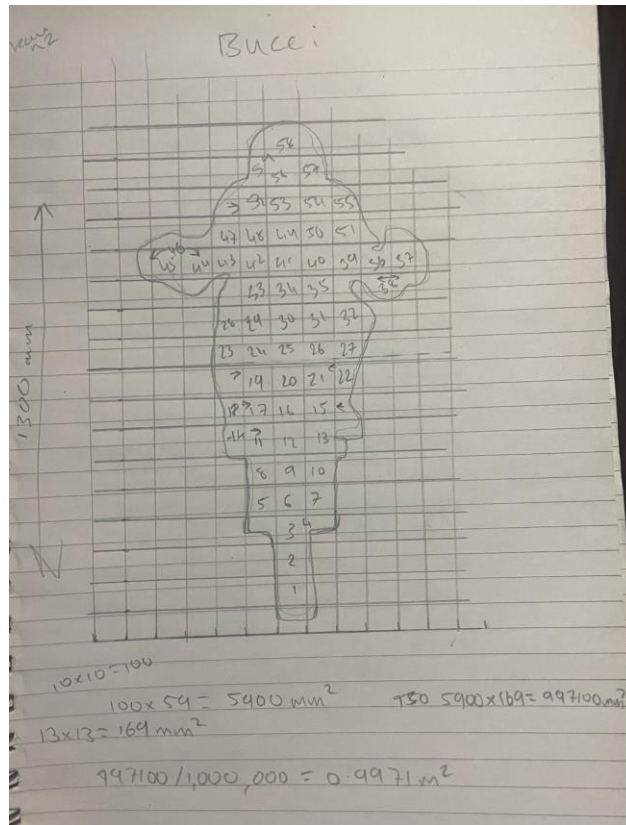


Figure 4-3 Image of calculations of the Frontal area (Finn Flye, 2024)

The figures above show the Calculations to understand the Frontal area of the Bucci using the same method previously used, However the height of the Bucci differs from the Panigale so each 1mm^2 is 13mm^2 instead of 15mm^2 , meaning that the frontal area on paper is $13 \times 13 = 169\text{mm}^2$ then $169 \times 5900 = 997100\text{mm}^2$. Then when transferred to the actual motorcycle the frontal area is $997100/1000000 = 0.9971\text{m}^2$.

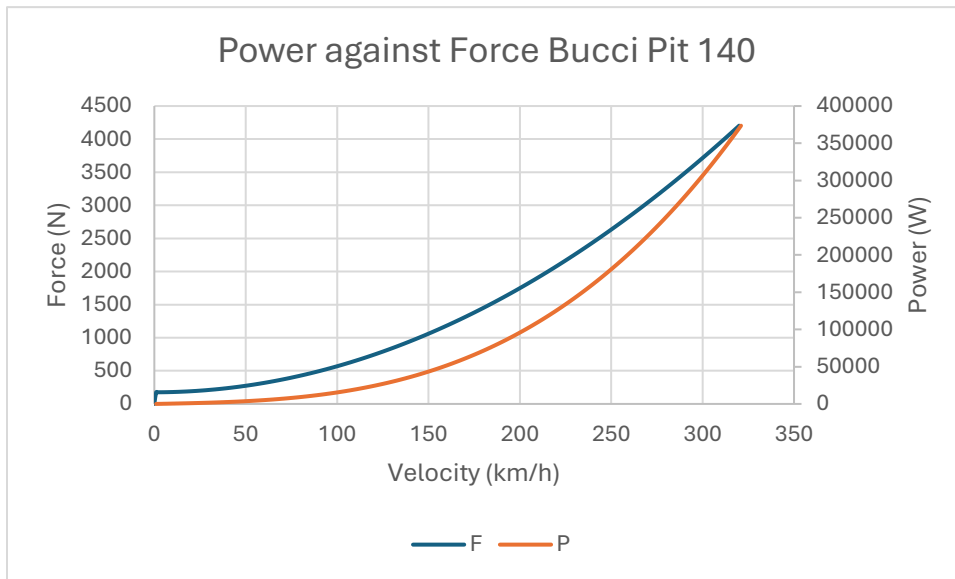


Figure 4-5 Graph Plotted showing the Power against Force for the Bucci (Finn Flye, 2024)

As shown in the graph the relationship that is shared between force and power is that as they both increase, they both increase at a gradual concave curve. However, the Bucci doesn't emit enough power to outweigh the opposing forces as the body isn't built for aerodynamics, so the overbearing height of the rider increases the amount of drag force.

4.4 Gearbox

Table 15 Table showing the values of the Bucci Gearbox (Finn Flye, 2024)

Primary	18	67				
Final	17	31				
Diam		0.5	m			
RPM	7500		rev/min			
	main	counter	ratio	Speeds	RPM	Fall
1st	11	36	3.27	32	7500	
					4440	3060
2nd	16	31	1.94	54	7500	
					5237	2263
3rd	17	23	1.35	77	7500	
					5821	1679
4th	20	21	1.05	99	7500	

In the table above the information regarding primary and final drive as well as the main and counter teeth count were sourced from searching the engine online and finding specifications on eBay. Using this information the Speeds and Next gear RPMs were able to be calculated using the formulas previously stated.

Table 16 Table showing the dimensions of the chain for the Bucci (Finn Flye, 2024)

Chain size	Front Sprocket	Rear Sprocket	Chain	Distance From Sprocket to Pivot	Swingarm Length
1/2"	17	41	108	54.8	446.85

The data was gathered while measuring within the workshop, using the data recorded the swingarm length was able to be calculated.

RPM	BHp	Power (kW)
3750	1.781	1.328626
4000	2.658	1.982868
4250	3.552	2.649792
4500	4.376	3.264496
4750	4.817	3.593482
5000	5.059	3.774014
5250	5.764	4.299944
5500	6.554	4.889284
5750	7.34	5.47564
6000	8.082	6.029172
6250	8.66	6.46036
6500	9.218	6.876628
6750	9.518	7.100428
7000	9.859	7.354814
7250	10.187	7.599502
7500	10.465	7.80689

Figure 4-6 Data showing the RPM, BHp and Power of the Bucci (Finn Flye, 2024)

Road Speed 1st	2nd	3rd	4th
16	27	38	50
17	29	41	53
18	30	44	56
19	32	46	60
20	34	49	63
21	36	51	66
22	38	54	69
23	39	56	73
24	41	59	76
25	43	62	79
27	45	64	83
28	47	67	86
29	48	69	89
30	50	72	93
31	52	74	96
32	54	77	99

Figure 4-7 Data showing the calculated Road speed (Finn Flye, 2024)

Driving Force 1st	2nd	3rd	4th
5872	9918	14204	18302
9348	15789	22611	29135
13272	22419	32105	41368
17313	29244	41880	53963
20117	33980	48661	62701
22239	37565	53796	69317
26605	44940	64357	82925
31692	53533	76662	98781
37106	62678	89759	115656
42634	72015	103130	132884
47586	80380	115110	148320
52678	88982	127428	164192
56485	95411	136635	176057
60676	102490	146772	189118
64933	109682	157072	202389
69005	116560	166922	215082

Figure 4-8 Data showing the calculated Driving Force values for the Bucci (Finn Flye, 2024)

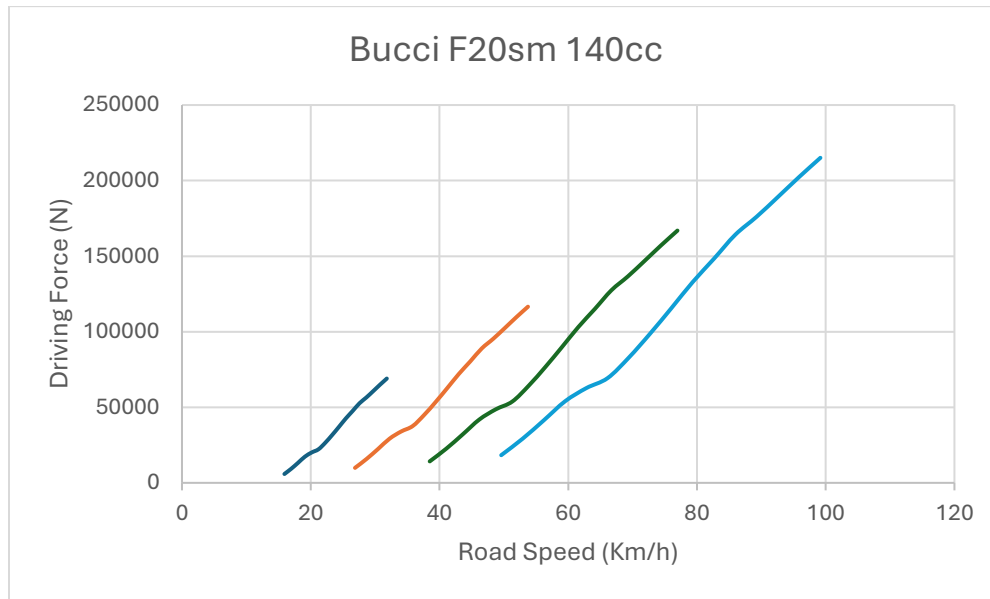


Figure 4-9 Graph Plotted showing the Driving Force against the Road speed for the Bucci (Finn Flye, 2024)

As Shown in the graph plotted above shows that the Bucci has a linear correlation between the driving force and the road speed as they both increase with each other at a linear rate meaning they'll never meet. This shows the Bucci won't be able to reach maximum output due to the additional weight caused by the rider and the height of the rider increasing the forces applied.

5 Panigale S 1199 Vs WorldSBK Ducati V4 R



Figure 5-1 Image of Ducati Panigale V4 R (WorldSBK, 2023)

The WorldSBK Ducati Panigale V4 R is a high-performance superbike like no other former Ducati reaching a maximum speed of '315 km/h (Ducati, 2024)' whereas the Panigale in the workshop tops out at around 288 km/h this is due to the tuning that is done to the engine to receive the maximum power available under the circumstances within the track or racing guidelines. The information used in the created schematic above was sourced from '(Motorcycle News, 2024)' and '(AutoX, 2024)' showing the overall dimensions of that years bike as it has a more compact build compared to that of the Panigale S being both shorter and smaller in width to help minimize the air resistance as the motorcycle and the rider has a smaller surface area as the seat has a higher angle to lower the tuck of the rider to enable then to become more slipstream.

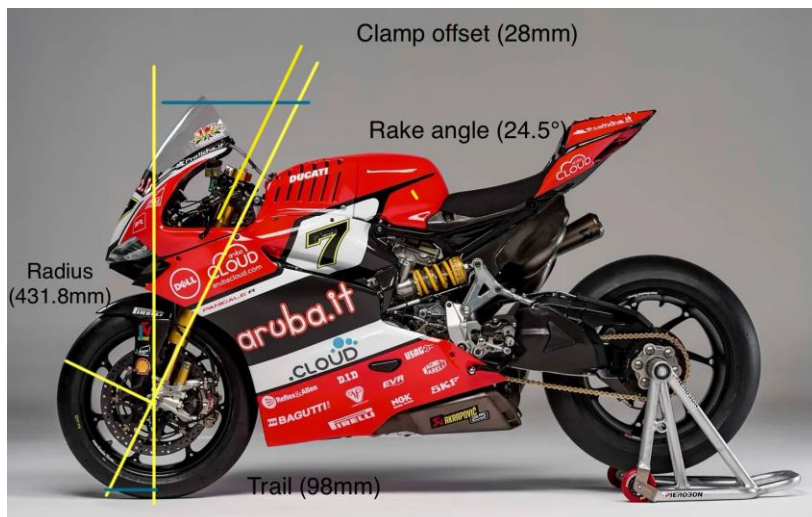


Figure 5-2 Image of Ducati Panigale V4 R found on Asphalt and Rubber (Jensen Beeler, 2016)

In the Schematic created above the clamp offset was found on an online forum by ‘(Brad, 2021)’ where the value for trail was found on the Ducati.ms forum by (Arjay, 2013) for the Value of 98mm. The value of rake was collected from (Kevin Cameron, 2018) on cycle world at a value of 24.5 degrees. When comparing the values of rake and trail of the V4 to the S, the V4 has a smaller value for both measurements this is because a smaller rake angle means ‘the head stock angle is steeper which reduces high speed stability but increases the rate at which the rider can turn (Dowds, 2024)’. Which it has been tailored this way to improve the cornering while performing on the track. The trail value being smaller means that ‘small inputs into steering have a bigger effect (Dowds, 2024)’ this means that the ability of self-centering is reduced, thus the rider must rely more on himself to centralize after a corner, however having faster turn timings will vastly increase the rate at which the rider finishes each lap.

6 Bucci vs BMW R100GS Paris Dakar

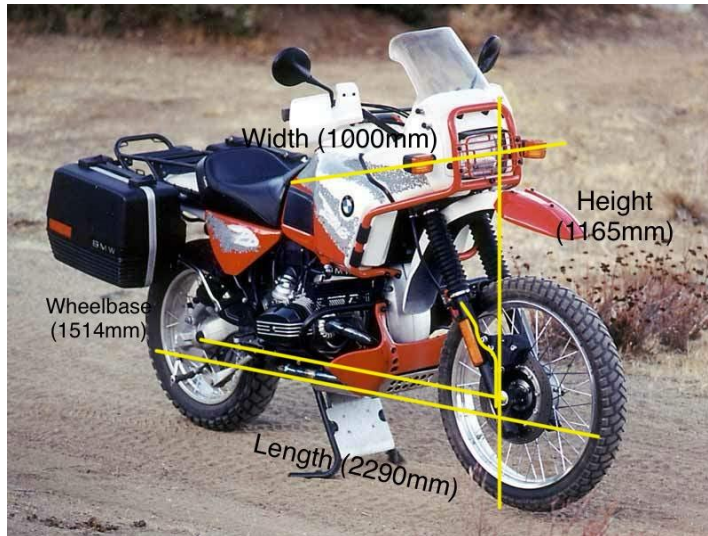


Figure 6-1 Image of BMW R100GS 1989 (MotorcycleSpecs, 2024)

The BMW R100GS is a high-performance endurance motorcycle that outputs ‘power at 60 Hp at 6,500 rpm (Gheran, 2024) making it an all-time competitor in Paris Dakar with a ‘top speed of 181 km/h (Gheran, 2024)’. The measurements gathered and plotted in the schematic above were sourced from ‘(MotorcycleSpecs, 2024)’. The build of the BMW tailors towards a more stable design and traction over performance, however its overall dimensions show that the bike is relatively heavy giving a bigger downforce with an increased friction coefficient to counter act the downforce, thus increasing the way the bike handles corners and enables for faster turning where it is lost in the angle of rake in the schematic below.



Figure 6-2 Image of BMW R100GS 1989 (Bring a Trailer, 2023)

The Schematic above shows the values gathered from an online forum '(Ducsingle, 2007)' where the wheel radius was collected from '(MotorcycleSpecs, 2024)'. The increased size of the wheel radius and tyre size supplies the bike with better traction when traversing tough terrain on the course however, heavily affecting the down force on the motorcycle. Compared to the Bucci the BMW is suited for stability rather than turning speed or lean angle as the BMW has a high Rake angle meaning that the 'head angle is lower meaning the stability of the bike increases but reduces the sharpness of its turn (Dowds, 2024)'. The Bucci has a much shorter trail length as it is suited for sharper turning whereas the BMW has a higher trail value as 'a longer trail length supplies the bike with better stability on straights but impacts the turning effort (Shazaam, 2007)' This means the rider will have to increase the force he applies into a corner to ensure the bike follows.

7 Conclusion

To Conclude the Bucci has been tailored to these values as the condition of the terrain is vastly different compared to the Panigale as the Bucci has to be able to take sharper turns around the course as this is shown with the lower rake and trail values that the Bucci offers. However, with the lower rake this means the rider must ensure his balance as the bike is very small and offers little stability. Whereas the Panigale has been tailored this way to suit street riding as the trail and rake values are at a higher number. Increasing the value of Rake supplies the bike with more stability at high speeds but reduces the sharpness of the turning. However, increasing the value of trial will improve the self-centering capabilities of the bike ensuring the biker is aligned with minimal effort.

Each Motorcycle is tailored to its specific usage and that's what determines the values of their dynamic handling and what forces they're able to overcome with their specific design and build taking into the outside parameters of the rider.

8 Additions

To improve both bikes simultaneously an Adjustable headstock should be implemented as this would vary the value of the Rake angle to either improve or reduce stability while either improving or reducing the sharpness of turning. Another key alteration would be to make the swingarm length variable as 'increasing the swingarm length, give a bigger wheelbase increasing the straight-line stability (Slo, 2012)' Whereas decreasing the swingarm length 'Shortens the wheelbase improving the handling capabilities (Slo, 2012)' thus increasing the sharpness of turning.

Furthermore, an adjustable triple clamp would greatly improve the performance of the motorcycles as the trail length will be adjustable to either improve or reduce the effects of small turning inputs, while either improving or reducing the self-centering ability.

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