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Effect of Changing Primary Fixed Sheave Angle and Roller Weight on Torque, Power, Top Speed, and Acceleration on Matic Motorcycles

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Abstract

This study aimed to determine the effect of angle changes on the primary fixed sheave and roller mass on torque, acceleration, engine power, and top speed of automatic motorcycles. This type of research is experimental research. The subjects in this study were 125 cc automatic motorcycles modified at the angle of the primary fixed sheave and the mass of the rollers. The angles of change were 14.5˚, 13.5˚, and 12.5˚, while the change in roller mass was 14, 13, and 12 grams. The testing began with tuning up the motorbike, then installing the fixed sheave and roller primary units that have been modified to the CVT (Continuously Variable Transmission) primary drive for further testing, and collecting the data using a dyno test tool. The results of this study show that: 1) Changes made to the primary drive pulley, especially to changes in the angle of the Primary fixed sheave and the weight or mass of the roller with the application simultaneously affect the torque, acceleration, engine power, and top speed of automatic motorbikes; 2) changing the angle of the primary fixed sheave (13.5˚) with the application of a roller weight of 13 grams can increase the maximum speed (top speed) by 0.4 (Kph) compared to the standard ones; 3) the increase in power and torque resulting from changes in the primary fixed sheave and the weight of the rollers applied at the same time do not significantly increase top speed and acceleration. Conversely, low power and torque do not necessarily reduce the top speed and acceleration of automatic motorcycles.

Keywords: Torque, Acceleration, Power, Top speed

Abstrak

Penelitian ini bertujuan untuk mengetahui pengaruh ubahan sudut pada primary fixed sheave dan masa roller terhadap torsi, akselerasi, tenaga mesin, dan top speed sepeda motor matic. Jenis penelitian ini adalah penelitian eksperimen. Subjek dalam penelitian ini adalah sepeda motor matic 125 cc yang dilakukan ubahan pada sudut primary fixed sheave dan masa rollernya. Besar sudut ubahan adalah 14.5˚, 13.5˚, dan 12.5˚, sedangkan ubahan masa roller adalah 14, 13, dan 12 gram. Langkah pengujian diawali dengan melakukan tune up pada sepeda motor, selanjutnya dilakukan pemasangan unit primari fixed sheave dan roller yang telah dilakukan ubahan pada primary drive CVT (Continuously Variable Transmission) untuk selanjutnya dilakukan pengetesan dan pengambilan data menggunakan alat dyno test. Hasil dari penelitian ini menunjukan bahwa: 1) Ubahan yang dilakukan pada primary drive pully khususnya pada ubahan sudut Primary fixed sheave dan bobot atau masa roller dengan aplikasi secara bersamaan berpengaruh pada torsi, akselerasi, power mesin, dan top speed sepeda motor matic; 2) ubahan sudut primary fixed sheave (13,5˚) dengan aplikasi bobot roller 13 gram dapat menaikkan kecepatan maksimal (top speed) sebesar 0,4 (Kph) dibandingkan dengan yang standar; 3) kenaikan power dan torsi hasil ubahan pada primary fixed sheave dan berat roller yang diaplikasikan secara besamaan tidak secara signifikan dapat meningkatkan top speed dan akselerasi. Sebaliknya, power dan torsi yang rendah belum tentu menurunkan top speed dan akserasi sepeda motor matic.

***Kata-kata kunci**: Torsi, Akselerasi, Power, Top speed*

1. Introduction

The development of motorcycle technology today has undergone many rapid changes. This is an effort to fulfill the needs of consumers who use motorbikes for better design, comfort and motorcycle performance. Motorcycle vehicles are divided into two types based on the propulsion system, namely manually driven motorcycles and automatic driven motorcycles [1]. Automotive manufacturers have produced vehicles that use an automatic transmission system called the CVT (Continuously Variable Transmission) system. This transmission system does not use gears but utilizes a pulley and belt system to transfer engine power known as CVT (Continuous Variable Transmission) [2].

CVT (Continuous Variable Transmission) is a power transmission system from the engine to the rear wheels via a V-belt that connects the drive pulley (primary pulley) to drive the driven pulley (secondary pulley) using the centrifugal force that occurs in its components [3]. Changes in speed on the CVT are very smooth, and there is no pounding like in a manual transmission. The mechanism that transfers power is the crankshaft directly coupled to the drive pulley (primary pulley Sheave and drive belt) used to rotate the secondary pulley (driven pulley) [4].

Based on initial observations made on automatic motorbike users, several comments and responses from automatic motorbike users were obtained. Some of them gave satisfied responses, while others responded in the form of complaints about the motorcycle's performance that should have been increased. In particular, it came from automatic motorbike users who are young people. They stated that increasing the performance of motorcycles by making a number of changes were necessary. This is because the terrain traveled by the rider is not always straight, flat, but occasionally uphill and so forth. This is one of the things behind making changes or modifications adapted to the terrain conditions or the travel area to get better performance.

Several ways and changes can be made to improve the performance of automatic motorbikes. Changes that are often made are changes in the CVT section, especially in the angle of the primary pulley or primary fixed shaft and roller weight [5]. The primary pulley is directly connected to the crankshaft, while the secondary pulley is connected to the final gear and directly to the rear wheel. The diameter of the two pulleys can vary. Primary pulley changes according to engine speed based on centrifugal force. The higher the engine speed, the greater the centrifugal force on the roller, and causes the diameter of the primary pulley to increase. Meanwhile, the change in the secondary pulley is based on the pull of the primary pulley with the intermediary of the V-belt. The smaller the diameter of the primary pulley, the larger the

diameter of the secondary pulley, and vice versa: the larger the diameter of the primary pulley, the smaller the diameter of the secondary pulley. The diameter of the secondary pulley changes based on the pull of the V-belt from the primary drive pulley [6].

In the Honda Vario 125 specifications, the standard primary fixed sheave tilt angle is 15º with a roller weight of 15 grams [7]. These specifications are determined by the manufacturer based on research results for the best engine performance. This is undoubtedly related to the maximum torque or power that can be produced by the engine so that it still gets the best performance on certain road terrain, driver load, and by all means, related to fuel efficiency [8]. Even though motorcycle manufacturers have standardized the best specifications for each motorcycle variant, some consumers still complain about the manufacturer's standard specifications, so several attempts were made to find and make changes to improve the best engine performance. This was the background or basis for researchers to seek information and prove the effect of changes in the angle of the primary fixed sheave and roller weight on maximum torque and engine power.

2. Method

The method used in this study is an experimental research method. According to Sugiyono [9], the experimental research method refers to a research method used to look for the effect of certain treatments on others under controlled conditions. An experimental research method is designed in which variables can be selected, and other variables that can affect the experimental process can be controlled carefully [10]. The research was conducted at the Mototech workshop that is located at Jl. South Ringroad, Singosaren III, Banguntapan District, Bantul Regency, Yogyakarta. The implementation time was in September 2022. The subject in this study was a 125cc automatic motorcycle unit that has been modified to the primary fixed sheave angle and roller mass. The angles of change are 14.5˚, 13.5˚, and 12.5˚, while the change in roller mass was 14, 13, and 12 grams. The testing began with tuning up the motorbike, installing the fixed sheave and roller primary units modified to the CVT (Continuously Variable Transmission) primary drive for further testing, and collecting data using a dyno test tool. The description of the testing stages is presented in **Figure 1**.

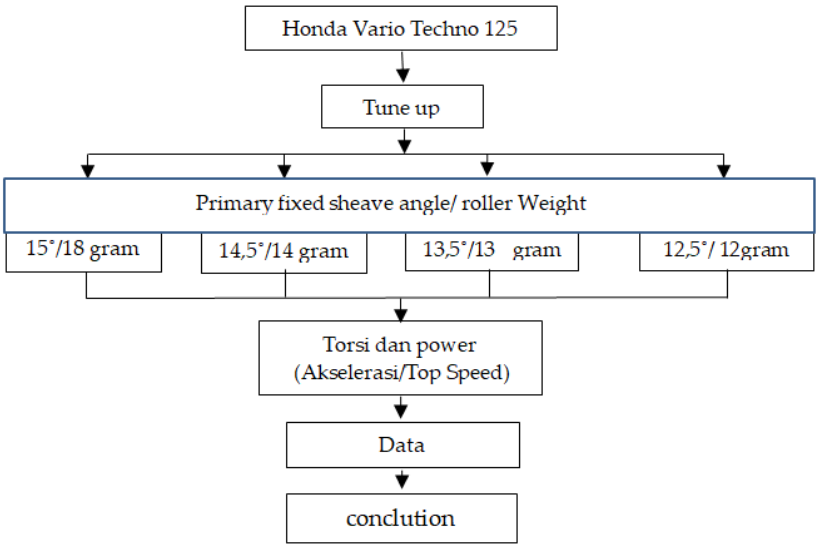


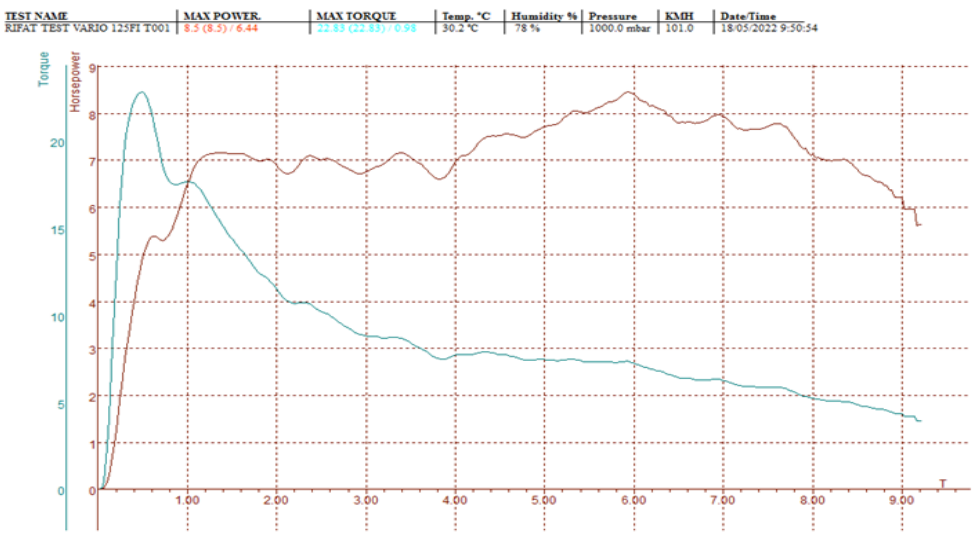
Figure 1. Stages of Research Implementation

The data collection technique in this study was carried out by documenting the results of documents or printing a dyno test tool in the form of test data and graphs. The data obtained from the test results were then analyzed using descriptive analysis techniques. Then, it was presented in the form of tables and graphs **[11].**

3. Results and Discussion

The results of the research data were obtained from tests carried out using a dyno test tool. Test data includes torque, maximum power, top speed, and acceleration. The test data for each change is shown in the figure and table below.

a. Presenting Result Primary fixed sheave angle 15 ° and roller weight 18 gram (standard)



Comments
ROLLER STD // PULLY STD

T	HP (HP)	Q (N*M*M)	Engine RPM
0,20	0.0	0.00	3788
0,40	0.0	0.10	3870
0,60	0.3	4.10	3992
0,80	3.0	20.67	4218
0,98	4.8	22.83	4436
1,00	5.1	22.69	4544
1,20	5.3	18.58	4980
1,40	6.0	17.56	5362
1,60	7.0	17.34	5484
1,80	7.2	15.73	5638
2,00	7.1	14.22	5700
2,20	7.0	12.92	5730
2,40	7.0	12.00	5816
2,60	6.7	10.81	5844
2,80	7.1	10.74	5812
3,00	7.0	10.14	5782
3,20	6.9	9.52	5906
3,40	6.7	8.91	6042
3,60	6.9	8.76	6202
3,80	7.1	8.75	6312
4,00	7.0	8.34	6400
4,20	6.7	7.73	6542
4,40	6.7	7.52	6684
4,60	7.1	7.73	6862
4,80	7.5	7.89	6992
5,00	7.5	7.75	7144
5,20	7.5	7.53	7306
5,40	7.6	7.45	7446
5,60	7.8	7.41	7598
5,80	8.0	7.49	7750
6,00	8.0	7.32	7892
6,20	8.2	7.32	8054
6,40	8.4	7.36	8200
6,44	8.5	7.34	8214
6,60	8.3	7.06	8326
6,80	8.1	6.78	8456
7,00	7.8	6.43	8586
7,20	7.8	6.31	8730
7,40	8.0	6.32	8868
7,60	7.8	6.07	8982
7,80	7.7	5.91	9114
8,00	7.7	5.87	9218
8,20	7.7	5.79	9340
8,40	7.2	5.36	9440
8,60	7.0	5.13	9552
8,80	7.0	5.07	9646
9,00	6.8	4.87	9746
9,20	6.6	4.65	9834
9,40	6.2	4.36	9626
9,60	6.0	4.18	9806

LOSSES:	0.0 HP	0.0N*M*M
TOTAL ENGINE:	8.5HP	22.83N*M*M

Figure 2. Unmodified test graph

Based on **Figure 2** above, the results of testing the torque and power using the primary fixed sheave and roller without changes show that the amount of torque produced is 22.83 (Nm) and the maximum power that can be achieved is 8.5 (HP). The highest speed that can be achieved is 101(Kph) and acceleration is 4391 m/s2, as presented in the **Table 1**.

Table 1. Unmodified Test Data

Primary fixed sheave angle and standard roller (15°, 18 gram)			
Acceleration (m/s²)	Top Speed (Kph)	Torque (Nm)	Max Power (HP)
4391	101	22,83	8,5

b. Primary fixed sheave angle 14.5 ° and roller weight 14 gram

DATA FOR TEST: RIFAT TEST VARIO 125FI T026

Comments
ROLLER 14GRAM//PULLY 14.5

T	HP (HP)	Q (N*M*M)	Engine RPM
0,20	0.3	4.57	4648
0,40	0.5	6.60	4648
0,60	1.5	14.98	4840
0,80	4.3	23.19	5202
1,00	6.7	25.72	5516
1,00	6.9	25.66	5618
1,20	7.6	22.14	5836
1,40	8.2	20.10	5834
1,60	8.0	17.22	5842
1,80	7.9	15.28	5830
2,00	7.5	13.46	5934
2,20	7.4	12.28	5938
2,40	7.2	11.38	5930
2,60	7.5	11.05	5972
2,80	7.8	10.99	5964
3,00	7.7	10.34	6014
3,20	7.4	9.57	6042
3,40	7.4	9.10	6142
3,60	7.4	8.84	6238
3,80	7.3	8.40	6436
4,00	7.4	8.24	6580
4,20	7.3	7.90	6802
4,40	7.8	8.22	7020
4,60	8.3	8.48	7186
4,80	8.4	8.41	7386
5,00	8.6	8.37	7564
5,20	8.5	8.05	7758
5,40	8.6	7.90	7924
5,60	8.8	7.95	8110
5,64	8.9	7.93	8154
5,80	8.8	7.72	8290
6,00	8.6	7.43	8470
6,20	8.6	7.23	8618
6,40	8.5	7.07	8766
6,60	8.5	6.87	8934
6,80	8.3	6.64	9066
7,00	8.0	6.27	9210
7,20	7.8	6.00	9322
7,40	7.8	5.93	9460
7,60	7.7	5.82	9568
7,80	7.2	5.37	9676
8,00	6.9	5.08	9778
8,20	6.8	4.93	9822
8,40	6.5	4.69	9750

LOSSES: 0.0 HP 0.0N*M*M
TOTAL ENGINE: 8.9HP 25.72N*M*M

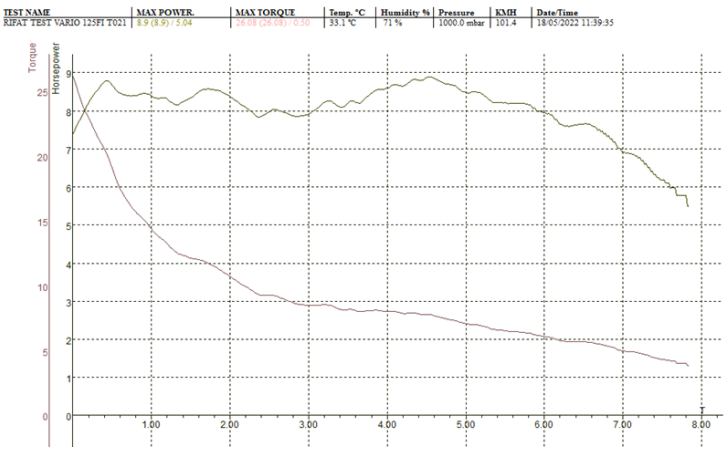
Figure 3. Primary fixed sheave angle 14.5 ° and roller weight 14 grams test graph

Based on **Figure 3** above, the results of testing the torque and power using the Primary fixed sheave 14.5° with a roller weight of 14 grams show that the torque produced is 25.72 (Nm) and the maximum power that can be achieved is 8.9 (HP). The highest speed that can be achieved is 97.6 (Kph) and the observed and calculated acceleration results are 4000 m/s2, as presented in the **Table 2.**

Table 2. Primary fixed sheave (14,5°) and roller (14 gram) test data

primary fixed sheave (14,5°) and roller (14 gram)			
Acceleration (m/s²)	Top Speed (Kph)	Torque (Nm)	Max Power (HP)
4000	97,6	25,72	8,9

c. Primary fixed sheave angle 13.5 ° and roller weight 13 gram



Comments
ROLLER 13GRAM//PULLY 13.5

T	HP (HP)	Q (N*M*M)	Engine RPM
0,50	7.4	26.08	0
0,20	7.5	25.73	6282
0,40	7.6	25.34	6282
0,60	7.9	23.88	6326
0,80	8.6	21.38	6280
1,00	8.6	18.67	6246
1,20	8.4	16.29	6300
1,40	8.5	14.97	6330
1,60	8.3	13.66	6384
1,80	8.2	12.52	6466
2,00	8.4	12.08	6482
2,20	8.6	11.71	6408
2,40	8.5	11.01	6358
2,60	8.2	10.21	6374
2,80	7.9	9.46	6482
3,00	8.0	9.26	6574
3,20	7.9	8.86	6668
3,40	7.9	8.53	6794
3,60	8.1	8.49	6954
3,80	8.2	8.37	7090
4,00	8.2	8.17	7248
4,20	8.3	8.04	7420
4,40	8.6	8.07	7590
4,60	8.7	7.98	7766
4,80	8.8	7.90	7918
5,00	8.9	7.79	8064
5,04	8.9	7.77	8108
5,20	8.7	7.51	8228
5,40	8.6	7.25	8386
5,60	8.5	7.01	8520
5,80	8.3	6.71	8662
6,00	8.2	6.54	8796
6,20	8.2	6.41	8924

T	HP (HP)	Q (N*M*M)	Engine RPM
6,40	8.0	6.19	9042
6,60	7.9	6.01	9168
6,80	7.6	5.69	9284
7,00	7.7	5.67	9398
7,20	7.5	5.48	9506
7,40	7.2	5.19	9602
7,60	6.9	4.92	9688
7,80	6.6	4.67	9782
8,00	6.2	4.33	9748
8,20	5.8	4.03	9836

LOSSES:	0.0 HP	0.0N*M*M
TOTAL ENGINE:	8.9HP	26.08N*M*M

Figure 4. Primary fixed sheave angle 14.5 ° and roller weight 14 grams test graph

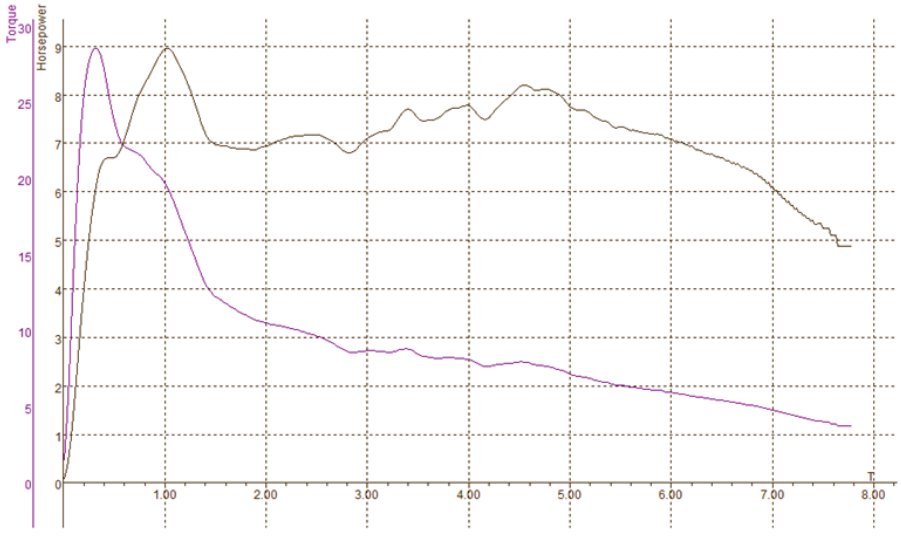
Based on **Figure 4** above, the results of testing the torque, max power, top seed using a Primary fixed sheave 13.5° with a roller weight of 13 grams obtained that the resulting torque is 26.08 (Nm) and the maximum power that can be achieved is 8.9 (HP). The highest speed that can be achieved is 101.4 (Kph) and the acceleration results from time observations and calculations are 4072 m/s2, as presented in the **Table 3.**

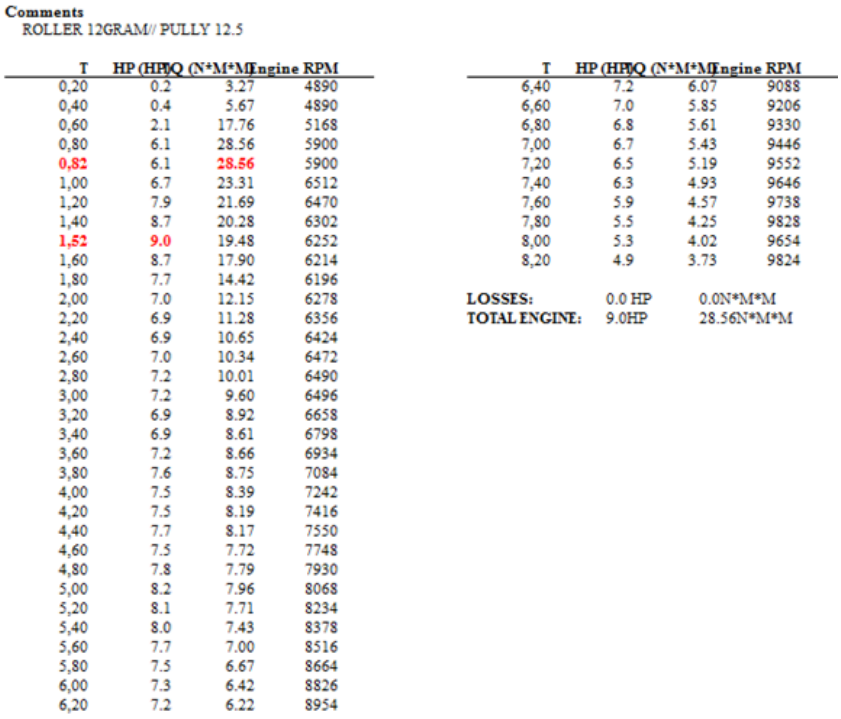
Table 3. Primary fixed sheave (13,5°) and roller (13 gram) test data

primary fixed sheave (13,5°) and standard roller (13 gram)			
Acceleration (m/s²)	Top Speed (Kph)	Torque (Nm)	Max Power (HP)
4072	101,4	26,08	8,9

d. Primary fixed sheave angle 12.5 ° and roller weight 12 gram

TEST NAME	MAX POWER.	MAX TORQUE	Temp. °C	Humidity %	Pressure	KMH	Date/Time
RIFAT TEST VARIO 125FI T011	9.0 (9.0) / 1.52	28.56 (28.56) / 0.82	32.3 °C	76 %	1000.0 mbar	92.7	18/05/2022 11:27:16





Comments
ROLLER 12GRAM// PULLY 12.5

T	HP (HP)	Q (N*M*M)	Engine RPM
0,20	0.2	3.27	4890
0,40	0.4	5.67	4890
0,60	2.1	17.76	5168
0,80	6.1	28.56	5900
0,82	6.1	28.56	5900
1,00	6.7	23.31	6512
1,20	7.9	21.69	6470
1,40	8.7	20.28	6302
1,52	9.0	19.48	6252
1,60	8.7	17.90	6214
1,80	7.7	14.42	6196
2,00	7.0	12.15	6278
2,20	6.9	11.28	6356
2,40	6.9	10.65	6424
2,60	7.0	10.34	6472
2,80	7.2	10.01	6490
3,00	7.2	9.60	6496
3,20	6.9	8.92	6658
3,40	6.9	8.61	6798
3,60	7.2	8.66	6934
3,80	7.6	8.75	7084
4,00	7.5	8.39	7242
4,20	7.5	8.19	7416
4,40	7.7	8.17	7550
4,60	7.5	7.72	7748
4,80	7.8	7.79	7930
5,00	8.2	7.96	8068
5,20	8.1	7.71	8234
5,40	8.0	7.43	8378
5,60	7.7	7.00	8516
5,80	7.5	6.67	8664
6,00	7.3	6.42	8826
6,20	7.2	6.22	8954

T	HP (HP)	Q (N*M*M)	Engine RPM
6,40	7.2	6.07	9088
6,60	7.0	5.85	9206
6,80	6.8	5.61	9330
7,00	6.7	5.43	9446
7,20	6.5	5.19	9552
7,40	6.3	4.93	9646
7,60	5.9	4.57	9738
7,80	5.5	4.25	9828
8,00	5.3	4.02	9654
8,20	4.9	3.73	9824

LOSSES:	0.0 HP	0.0N*M*M
TOTAL ENGINE:	9.0HP	28.56N*M*M

Figure 5. Primary fixed sheave angle 12.5 ° and roller weight 12 gram test graph

Based on **Figure 5** above, the results of testing the torque, max power, top seed using a Primary fixed sheave 12.5° with a roller weight of 12 grams obtained that the resulting torque is 28.56 (Nm) and the maximum power that can be achieved is 9.0 (HP). The highest speed that can be achieved is 92.7 (Kph) and acceleration data from observations and calculations is 3607 m/s2, as presented in the **Table 4.**

Table 4. Primary fixed sheave (12,5°) and roller (12 gram) test data

primary fixed sheave and standard roller (12,5°, 12 gram)			
Acceleration (m/s²)	Top Speed (Kph)	Torque (Nm)	Max Power (HP)
3607	92,7	28,56	9,0

As presented in the graphics and research results tables for each change above, it can be analyzed as follows:

a. Changes made to the Primary fixed sheave angle and roller weight affect maximum power, torque, top speed, and acceleration. The test results show that the unmodified condition has a good top speed and acceleration value compared to the modified primary sheave and roller, even though the maximum torque and power values are the lowest. Thus, to get the performance of an automatic motorbike with good acceleration, there is no need to change the Primary fixed sheave or replace it with a lighter roller. This is what the manufacturer considers to determine the angle and weight of the standard roller. Without a doubt, the

manufacturer's standards applied to motorcycles are the result of research, analysis and trials. Naturally, they also take into account aspects of road conditions or terrain and fuel consumption **[8].**

b. Data from the test results on the Primary fixed sheave change with an angle of 13.5° and a roller weight of 13 grams shows the highest maximum speed or top speed value compared to other changes, even though the maximum torque and power are smaller than the change with an angle of 12.5 ° and the roller weighs 12 grams. Thus, to get a high-top speed, you don't necessarily have to have great power and torque. This is greatly influenced by the pulley angle and roller weight, all of which are related to one another.

c. Data from the test results on the Primary fixed sheave change with an angle of 12.5° and a roller weight of 12 grams shows the value of maximum power and torque at the highest value compared to other changes. Top speed/maximum speed and acceleration shows the lowest value. Thus, large torque and power are not the main factors that determine maximum speed and acceleration. It is possible that other factors outside the research variables will greatly affect the performance of motorcycles. This is due to the characteristics of automatic motorbikes that use power transfer in the form of pulleys. The size of the maximum and minimum diameter of the pulley is greatly influenced by the pulley angle and the weight of the roller. The pulley angle affects the change in the size of the pulley diameter, while the weight of the roller affects the time when the diameter of the primary drive and secondary driven is changed **[12].**

4. Conclusion

Based on the results of research, analysis and discussion, the research can be concluded as follows:

a. Changes made to the primary drive pulley, especially to changes in the angle of the Primary fixed sheave and the weight of the roller with the application simultaneously affect the torque, acceleration, engine power, and top speed of automatic motorcycles **[13].**

b. Changes to the primary fixed sheave with an angle of 13.5° and a roller weight of 13 grams applied simultaneously can increase the maximum speed (top speed) by 0.4 (Kph) compared to standard conditions. However, it tends to accelerate slower.

c. Changes made to the angle of the Primary fixed sheave and the weight of the roller with the application simultaneously affect the torque, power, acceleration, and top speed of an

automatic motorbike. Based on the research data, it can be concluded that low power and torque do not necessarily have an impact on low acceleration and top speed. Likewise, high power and torque do not guarantee top speed and high acceleration **[14].**

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