

Continuously Variable Transmission Roller Mass Analysis with Drive Pulley Angle Variations of 13.5° and 12° on a 150 cc V - Matic Automatic Transmission Motorcycle

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Article Information	ABSTRACT
Article History Received : June 03, 2026 Revised : July 10, 2026 Published : July 20, 2026	The Continuously Variable Transmission (CVT) system plays a crucial role in transmitting power from the engine to the drive wheels while automatically adjusting the transmission ratio according to vehicle speed and load conditions. Automatic transmissions have gained widespread attention in the automotive industry due to their high efficiency, smooth gear shifting, cost-effectiveness, and enhanced driving comfort. This study aims to investigate the effect of drive pulley angle variation and roller weight on the performance characteristics of a CVT system, particularly in terms of power output, torque, vehicle speed, and acceleration. An experimental method was employed by modifying the drive pulley angle and roller weight configurations, followed by performance testing using a dynamometer (dynotest). Several combinations of pulley angles and roller weights were evaluated to determine the optimal configuration for vehicle performance. The results indicate that a drive pulley angle of 13.5° combined with a 10-gram roller produced the most stable torque and power characteristics across low to high engine speeds. This configuration also provided superior acceleration performance and smoother power delivery under urban driving conditions. The findings offer practical insights for optimizing CVT design and tuning to improve vehicle efficiency, responsiveness, and overall driving performance.
Keywords: <i>Automatic Transmission; Drive Pulley; Roller; Continuously Variable Transmission.</i>	

INTRODUCTION

System in a vehicle functions to transmit power from the vehicle's drive source to the front wheels by regulating the rotation according to the desired speed level (Tseng, 2015) . Based on statistical data from the Indonesian Motorcycle Industry Association (AIS, 2021) , it shows that the number of motorcycle sales reached 608,244 units in January 2023. This number increased by 25.86% per month compared to motorcycle sales in December 2022 which reached 483,254 units. Sales of automatic motorcycles still contributed the largest, reaching 90.1% of total domestic sales in January 2023. This greatly influenced the level of automatic motorcycle users in Indonesia. One of the parts that underwent modifications was the transmission part which functions to convert torque and speed (rotation) from the engine into different torque and speeds to be transmitted to the final drive (Prasetyo, 2014) .

Continuously Variable Transmission (CVT) automatic transmission is that it does not require shifting gears and is very practical in traffic jams because you only need to play the throttle

to increase or decrease engine speed without having to shift gears (Subagya & Atmika, 2009). Automatic motorcycles use an automatic transmission system called Continuously Variable Transmission. CVT tries to create a rotational ratio by utilizing a v-belt and pulley (Komaladewi et al., 2010). The primary pulley and secondary pulley generate centrifugal force to press the double clutch lining against the clutch housing, thereby generating power output to rotate the rear axle (Ilham et al., 2021). Another important component in the CVT system is the roller, a material composed of Teflon as the outer surface and copper or alloy as the inner layer (Nofendri & Christian, 2020). The working principle of the roller is almost similar to the pressure plate on a centrifugal clutch. When the engine speed increases, the roller will be thrown outward and push the pulley part that can slide closer to the stationary pulley so that the pulley gap will narrow (Jama, 2008).

Based on observations of automatic motorcycle users, many complaints are often made, including a lack of responsiveness. When cornering, climbing, and stopping, automatic motorcycles require significant power and torque, ensuring optimal performance. There are many ways to improve performance on CVT-equipped motorcycles, including by narrowing the contact angle of the primary pulley (Harsanta & Parta, 2020). If the contact angle slope is narrowed, the v-belt will be squeezed by the fixed pulley and the pulley will shift, causing the v-belt to quickly be in the outermost position of the pulley and the resulting torque and power will be greater (Wibawa, 2018). In addition to changing the contact angle slope of the standard primary pulley by 15 degrees, changing the appropriate roller size will also improve the performance of automatic motorcycles. Changes in roller size are changes in the mass of the roller, namely with a different mass from the standard roller, either larger or smaller. The lighter the mass of the roller, the faster it will be thrown to press the sliding sheave on the primary pulley so that the motorcycle's performance is more optimal. However, so that the v-belt can be pressed properly, it requires a roller with the appropriate mass, because if the roller mass is too small, the resulting pressure is also small and cannot press the v-belt properly (Yamin & Widyarso, 2012).

The manufacturer's standard angle of 15° was chosen as the baseline. The angles of 13.5° and 12° were chosen based on studies by greater Wibawa (2018) and Harsanta & Parta (2020) which showed that narrowing the primary pulley contact angle increases the v-belt's compressive force against the sliding sheave, accelerating the movement of the v-belt to the outermost position of the pulley, thereby increasing the torque and power generated. The range of 12°–15° was chosen to remain within the component's geometric tolerances without changing the pulley diameter. Due to the relationship between problems or issues with automatic motorbikes, researchers are interested in conducting further research and testing the results of changes in the size of the roller and drive. Pulley contact angle variation on Continuously Variable Transmission (CVT) with variations of 13.5° and 12° to determine the level of performance and engine acceleration at low rpm to high rpm using dyno test to achieve optimal results.

RESEARCH METHODS

Research using experiments with dynotest, research was conducted to determine the effects of a treatment given intentionally by researchers (Ilmy & Sutantra, 2018). The experimental research method is a way to find a causal relationship (causal relationship) between two factors that are intentionally caused by researchers by eliminating or reducing or setting aside other disturbing factors (Arikunto, 2006). The research was conducted on a Vario 150 cc automatic motorcycle with modifications to the CVT components). The dynotest can also be used to determine the power and torque needed to operate an engine (Aditya & Darlis, 2015). Through the dynotest, accurate data will be obtained and the results of the test tests carried out will be known.

The research was conducted by changing standard components into modified components so that the resulting research data could be known. Changes were made to two important CVT components, namely the drive pulley and roller mass. In the drive pulley modification, there are two variations of the pulley tilt angle that will be tested on a 150 cc automatic motorbike, namely

variations of 13.5° and 12° , so that from the results of the tests carried out, researchers can determine the difference in power and torque on acceleration and performance produced by the automatic motorbike using changes in the drive pulley tilt degree from 15° to 13.5° and 12° (Wibawa, 2018 and Harsanta & Parta 2020) to determine the comparison of test results that affect the level of power efficiency and torque produced (Towijaya & Iskandar, 2022). In the roller modification used in the study, 10 grams for a 13.5° pulley tilt degree and 12 grams for a 12° pulley tilt degree. The roller is a gravity balance bearing that is useful for pressing the inner wall of the drive pulley when rotation occurs (Nofendri & Christian, 2020). The weight of the roller greatly influences the low to high rpm.

The analysis uses an experimental concept by transforming standard components into modified components to achieve the desired results. Research involves a conceptual framework that aims to provide an overview of the research concept to be conducted, making it easier for researchers to conduct research from the beginning to the end of the discussion.

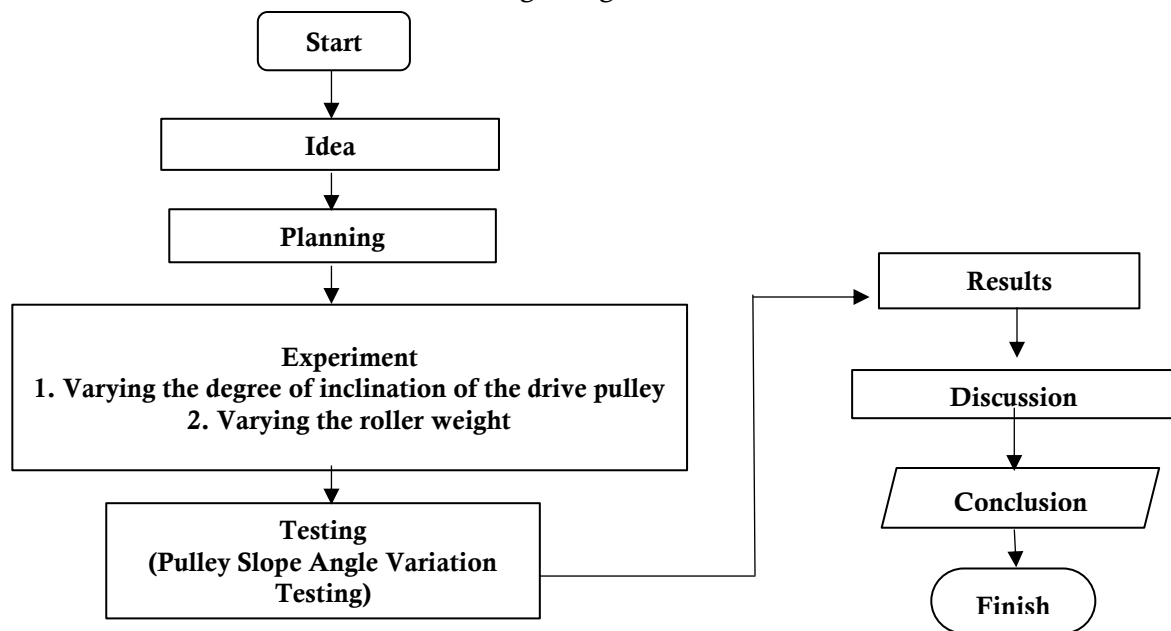


Figure 1. Research Flowchart

The CVT component system consists of two parts, the primary pulley or called the drive pulley and the secondary pulley or called the driven pulley. In the driven pulley there is a component that greatly influences the acceleration level and performance of the automatic motorbike called the CVT roller (Kholi, 2013). In this test there is a component that will be replaced on a 150 cc automatic motorbike, namely the roller section and changes in the degree of inclination of the CVT pulley angle. On the pulley with an inclination angle of 13.5° using a roller with a mass of 10 grams and on the pulley with an inclination angle of 12° using a roller with a mass of 12 grams to find out the difference in power and torque levels of a 150 cc automatic motorbike.

In testing, researchers will be guided by the standard specification values for the CVT drive pulley tilt angle and the standard roller weight as reference for comparing the value of the research results produced. Therefore, the researcher has prepared a table of the specification values for the standard drive pulley tilt angle and the standard roller weight values that will be used in the testing process for the torque and power values produced. The following is a table of specifications for the Honda Vario 150 cc.

Table 1. Specifications of Honda 150cc automatic vehicles (Astra, 2020).

Specification	Date
Diameter x Stroke	57.3 x 57.9mm
Stroke Volume	149.3cc
Compression Comparison	10.6 :1
Your Maximum Power	9.3 kW / 8500 rpm
Maximum Torque	12.8 Nm/ 5000 rpm
Starter	Pedal & Electric
Fuel System	Injection (PGMI-FI)
Engine Type	4-Step SOHC
Tank Capacity	5.5 liters of fuel
Final Drive Ratio	10.6 :1
Transmission	Automatic, V-matic
Electricity	12 V-5 Ah battery (MF type)
Ignition System	Full transistorize, battery
Length x Sheet x Height	1,921 x 683 x1,096
Wheelbase	1,280 mm
Lowest Distance to Ground	135 mm
Curb Weight	109 kg
Frame Type	Backbone
Front suspension type	Telescopic
Front Tire Size	80/90-14M/C 40P <i>Tubeless</i>
Rear Tire Size	90/90-14M/C46P <i>Tubeless</i>
Front Brake	Hydraulic disc, Single piston

The table above is very useful during the testing process of the effect of variations in spring compressive strength on the acceleration level of automatic motorbikes which will be carried out using a dynotest so that the tester can compare the test result data with the prepared specification data. The following is a design image of the standard drive pulley contact angle (15°) which will be applied and then analyzed as a research reference standard. The primary sliding sheave (moving pulley) which is part of the standard primary pulley on the CVT (Continuously Variable Transmission) will be changed in the contact angle slope section (drive pulley) from an angle of 15° to 13.5° and 12° through a turning process.

Power is the amount of work done per unit of time. The power measured in a machine is called *brake power* (BP), with units of Watts (W) or HP. The amount of power can be formulated using the following equation (Towijaya & Iskandar, 2022).

$$P = \frac{T.N.2\pi}{60} \quad (1)$$

Torque is the ability of a machine to perform its work (Aditya & Darlis, 2015) . Torque is a derived quantity used to calculate the amount of energy produced by an object rotating on its axis. If an object rotates and has a centrifugal force (F) and the object rotates on its axis with a diameter or distance of (d), then the torque of the object can be calculated using the following equation.

$$T = F \times d \quad (2)$$

In this study, the dependent variables are determined, namely power and torque, as a reference for test results using a dynotest . The experimental results were obtained from measuring the output of a 150 cc Honda Vario motorcycle that had been installed with a modified 13.5° and 12° drive pulley installed alternately with the standard factory drive pulley condition of 15° at different rotational speeds (rpm).

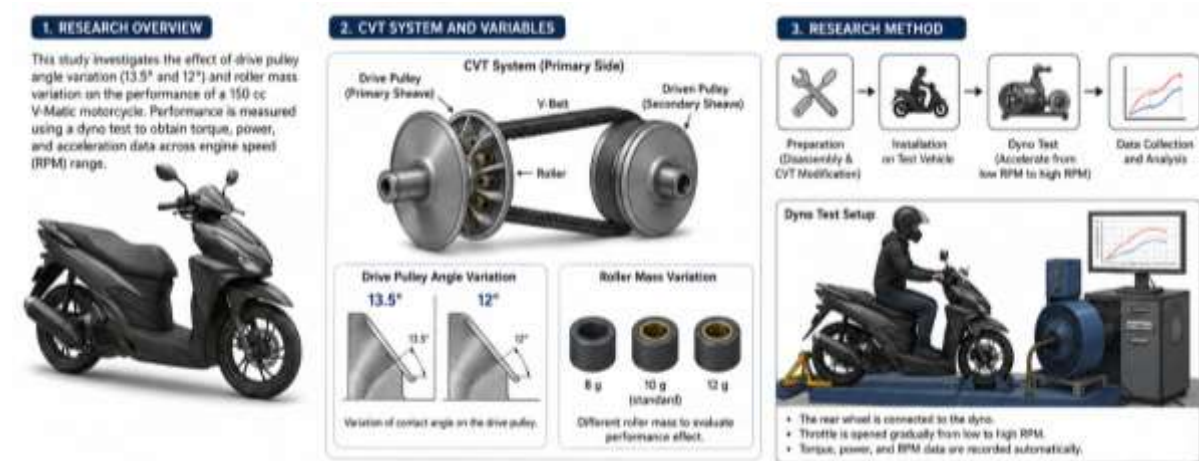


Figure 2. Illustration of the Research

RESULTS AND DISCUSSION

The results discussed in this study examine the influence of pulley tilt angle and variations in roller mass on changes in engine performance. The engine performance indicators in question are horsepower and torque. Horsepower is defined as a unit of power equivalent to horsepower, and therefore can be described as horsepower. One horsepower is equivalent to 735.5-745.7 watts. Horsepower plays a crucial role in enabling a vehicle to move even when carrying a heavy load. Torque is the cumulative amount of horsepower generated by a given engine. Engine torque can be defined as the force generated by an engine.

Dynotest Test Results for Engine Torque and Pure Power

Forget data results torque from vehicle, researchers conducted testing using a dynotest on a 150cc Vario, thus obtaining data on engine power and torque values at each engine speed. Testing was carried out at each multiple of engine rpm, namely at each increase in engine speed of 250 rpm up to the highest engine rpm, namely at a peak rpm of 9,500 rpm. The test results are presented in table form, which includes the power and torque of each different tilt angle variation and the use of different roller masses.

Table 2. Dynotest results of power and torque of the Vario 150cc engine with three variations of driver pulley angle and three variations of roller mass

RPM	<i>Drive pulley 15°</i> m/r 18 g		<i>Drive pulley 13.5°</i> m/r 10 g		<i>Drive pulley 12°</i> m/r 12 g	
	Hp	Tm (Nm)	Hp	Tm (Nm)	Hp	Tm (Nm)
2500	3.90	11.12	3.10	8.88	4.10	11.76
2750	4.90	12.82	5.10	13.23	5.10	13.13
3000	5.70	13.54	6.20	14.92	6.30	14.95
3250	6.40	14.12	7.10	15.83	7.40	16.36
3500	7.10	14.59	8.00	16.40	8.10	16.73
3531	7.20	14.61	8.20	16.45	8.20	16.72
3750	7.60	14.33	8.50	16.10	8.50	16.15
4000	8.00	14.27	8.50	15.23	8.70	15.67
4250	8.30	13.78	8.60	14.49	8.70	15.38
4500	8.60	13.57	8.60	13.66	8.20	13.67
4750	9.00	13.40	8.70	13.56	8.00	12.58
5000	9.30	12.95	8.50	12.70	7.80	11.70
5002	9.60	12.59	8.10	11.50	7.70	10.96
5250	8.90	12.02	7.90	10.70	7.60	10.30

5500	8.60	11.07	7.90	10.22	7.50	9.63
5750	8.10	10.01	7.90	9.68	7.00	8.54
6000	7.90	9.28	7.50	8.85	6.70	7.93
6250	7.50	8.44	7.20	8.22	6.80	7.70
6500	7.40	8.05	7.60	8.24	6.70	7.32
6750	7.60	8.00	7.70	8.04	6.60	6.87
7000	7.70	7.78	7.30	7.42	6.50	6.57
7250	7.90	7.69	7.30	7.10	6.30	6.17
7500	7.80	7.36	7.30	6.86	6.40	6.00
7750	7.70	7.03	7.20	6.53	6.40	5.80
8000	7.50	6.59	6.80	6.04	6.10	5.40
8250	7.20	6.13	6.50	5.60	5.70	4.89
8500	6.80	5.65	6.20	5.19	5.00	4.17
8750	6.00	4.81	5.60	4.50	4.20	3.40
9000	5.30	4.13	4.70	3.68	3.40	2.64
9250	5.30	3.46	3.90	2.98	2.60	1.97
9500	3.90	2.88	3.40	2.49	2.00	1.46

The experimental results indicate that the combination of a 13.5° drive pulley angle and 10 g roller mass produced a more stable torque distribution from low to high engine speeds. This condition suggests that the transmission ratio changed more progressively, enabling efficient power transfer and reducing torque fluctuations throughout the operating range. Similar findings have been reported by researchers who concluded that optimizing CVT geometric parameters can enhance engine performance and drivetrain efficiency (Harsanta & Parta, 2020). Furthermore, the torque behavior observed during testing confirms the important role of CVT tuning in improving vehicle drivability and acceleration performance. Stable torque across a broad rpm range allows the engine to operate closer to its optimum efficiency region, resulting in smoother vehicle response and reduced energy losses during power transmission. The results support previous studies indicating that proper selection of roller mass and pulley geometry can improve acceleration characteristics without requiring modifications to the engine itself. In practical applications, the identified configuration may be particularly suitable for urban driving conditions, where frequent acceleration and deceleration require consistent torque availability. These findings contribute to the growing body of knowledge regarding CVT optimization and provide useful guidance for automotive engineers and vehicle tuners seeking to enhance scooter performance through transmission modifications rather than increasing engine displacement or fuel consumption. The results also reinforce the principle that transmission parameter optimization is a cost-effective approach for improving overall vehicle performance and rider comfort.

Dynotest Results of Roller Mass Comparison CVT Against Wheel Torque

After obtaining the results of pure power and torque testing on a Vario 150 cc vehicle with a dynotest tool as a reference for comparison for variations of 13.5° and 12° driver pulley angles, a second test was then carried out to determine the amount of power and torque of the CVT roller mass ratio produced on the wheels through the CVT transmission which then greatly affects vehicle performance. The results of the second test are presented in the form of a comparison table of dynotest results for variations in the drive pulley tilt angle with different roller weight combinations at each different drive pulley tilt angle. The test results are listed in the following table:

Table 3. Dynotest results of Vario 150cc wheel torque with three variations of driver pulley angle and three variations of roller mass

RPM	<i>Drive pulley 15°</i> m/r 18 g		<i>Drive pulley 13.5°</i> m/r 10 g		<i>Drive pulley 12°</i> m/r 12 g	
	Hp	Tr (Nm)	Hp	Tr (Nm)	Hp	Tr (Nm)
2250	3.30	243.50	0.80	58.04	2.10	161.03
2500	3.90	248.24	3.10	203.64	4.10	277.08
2750	4.90	278.17	5.10	294.65	5.10	300.31
3000	5.70	285.31	6.20	322.42	6.30	331.63
3250	6.40	288.69	7.10	331.62	7.40	351.63
3500	7.10	289.17	8.00	332.72	8.20	347.84
3750	7.60	275.04	8.50	315.99	8.50	324.85
4000	8.00	264.96	8.50	288.84	8.70	298.76
4250	8.30	247.23	8.60	265.23	8.20	256.12
4500	8.60	234.97	8.70	241.00	8.00	227.03
4750	9.10	223.64	8.50	215.67	7.80	203.08
5000	9.00	208.02	8.10	187.68	7.70	182.68
5250	8.90	185.55	7.90	167.55	7.60	164.58
5500	8.60	163.96	7.90	153.28	7.50	147.23
5750	8.10	141.99	7.90	138.78	7.00	124.68
6000	7.90	125.83	7.50	121.03	6.70	110.31
6250	7.50	109.15	7.20	106.98	6.80	101.80
6500	7.40	99.07	7.60	101.79	6.70	91.73
6750	7.60	93.45	7.70	94.00	6.60	81.36
7000	7.70	86.01	7.30	81.85	6.50	73.27
7250	7.90	80.20	7.30	73.62	6.30	64.56
7500	7.80	72.15	7.30	66.60	6.40	58.64
7750	7.70	64.51	7.20	59.07	6.40	52.69
8000	7.50	56.35	6.80	50.65	6.10	45.33
8250	7.20	48.58	6.50	43.26	5.70	37.68
8500	6.80	41.24	6.20	36.66	5.00	29.26
8750	6.00	32.09	5.60	28.81	4.20	21.51
9000	5.30	24.97	4.70	21.12	3.40	14.88
9250	5.30	18.75	3.90	15.14	2.60	9.75
9500	3.90	13.81	3.40	11.00	2.00	6.22

Based on the grouping results in the table, it can be concluded that the test produces different power and torque values based on the engine rpm rotation value. Each of these results includes; at the initial rpm rotation (2250rpm) with a pulley angle of 15 ° (18gr) a power value of 3.30, at a pulley angle of 13.5 ° (10gr) a power value of 0.80 and a torque of 58.04 Nm was obtained, for a pulley angle of 12 ° (12gr) a power value of 2.1 and a torque of 161.03 Nm was obtained. At a pulley tilt angle of 15 ° the largest power value was obtained at 5000 rpm of 9.1 and the largest torque value at 3500 rpm of 289.17 Nm. At a pulley tilt angle of 13.5 ° the highest power value is obtained at 4500 rpm of 8.7 and the highest torque value is obtained at 3500 rpm of 332.72 Nm. At a pulley tilt angle of 12 °, the highest power value is obtained at 4000 rpm of 8.70 and the largest torque value is obtained at 3250 rpm of 351.63 Nm.

These findings indicate that pulley geometry and roller mass directly affect the centrifugal force acting on the variator, thereby altering the CVT shift pattern and transmission efficiency. A smaller pulley angle tends to accelerate pulley movement and increase torque multiplication, whereas a larger angle promotes smoother ratio transitions and higher power retention at elevated engine speeds. Similar observations have been reported by Ilham et al., (2021), who found that variator geometry and roller characteristics significantly affect torque transfer efficiency and vehicle acceleration performance. Furthermore, studies conducted by

Society of Automotive Engineers reported that optimizing the balance between roller mass and pulley angle can improve power delivery, fuel efficiency, and drivability in automatic transmission systems. Therefore, the 13.5° pulley angle combined with a 10 g roller can be considered the optimum configuration because it provides a more stable distribution of torque and power across low-to-high engine speeds, making it suitable for urban driving conditions that require responsive acceleration and consistent vehicle performance.

Test Results of the Primary Pulley Tilt Angle of 15° (18gr) on Power and Torque

The drive pulley tilt angle of 15° with a roller weight of 18gr (Standard Pulley) in the form of power and torque obtained through testing using a dynotest. In this test, researchers used several variations of engine speed (rpm) to obtain the results of the cooled test values. The testing stage researchers used three variations of engine speed, namely at rpm 5500, 6000, 6500. In the initial test, researchers used the initial rotation base at 5500 rpm because at that rpm the data produced was more valid than low rpm, at rpm low yields variable test result data change. Base For data influence variation corner primary pulley researchers take engine speed in rpm 6000 due to on rpm the Already Canshows significant data. The following table shows the results of the 4 testing with corner primary pulley standard 15.5 °.

Table 4. Testing at an angle of 15° with a mass 18gr roller

RPM	Power (P) (Hp)	Engine torque (Nm)	Wheel torque (Nm)
5500	8.6	11.07	163.96
5750	8.1	10.01	141.99
6000	7.9	9.28	125.83
6250	7.5	8.44	109.15
6500	7.4	8.05	99.07
6750	7.6	8.00	93.45
7000	7.7	7.78	86.01
7250	7.9	7.69	80.20
7500	7.8	7.36	72.15
7750	7.7	7.03	64.51
8000	7.5	6.59	56.35
8250	7.2	6.13	48.58
8500	6.8	5.65	41.24
8750	6.0	4.81	32.09
9000	5.3	4.13	24.97
9250	5.3	3.46	18.75
9500	3.9	2.88	13.81

Based on the test table, it can be concluded that the standard pulley angle variation with a roller weight of 18g is only capable of producing maximum power at 5500 rpm with a power of 8.6 hp, and is only capable of producing maximum torque at 5500 rpm with a torque of 163.96 Nm. The results indicate that the standard drive pulley angle configuration combined with an 18 g roller weight produced a maximum power output of only 8.6 hp at 5500 rpm and a maximum torque of 163.96 Nm at the same engine speed. This finding suggests that the standard CVT setting tends to shift the transmission ratio more rapidly toward a higher ratio, causing the engine to operate within a narrower effective power band. Heavier roller weights generate greater centrifugal force, accelerating pulley movement and reducing the engine's ability to maintain higher rotational speeds, which consequently limits power development and acceleration performance. These results are consistent with previous studies reporting that heavier CVT rollers generally enhance transmission stability but reduce engine responsiveness and delay power

delivery at higher rpm. Conversely, lighter rollers allow the engine to remain longer within its optimal torque and power range, thereby improving acceleration characteristics and overall vehicle performance. Furthermore, the interaction between roller mass and pulley geometry significantly affects the CVT ratio transition, influencing torque multiplication and power transmission efficiency. Therefore, the standard pulley angle with an 18 g roller can be considered suitable for stable cruising operation; however, it is less effective for achieving maximum acceleration and dynamic performance compared with lighter roller configurations and optimized pulley-angle modifications (Towijaya & Iskandar, 2022).

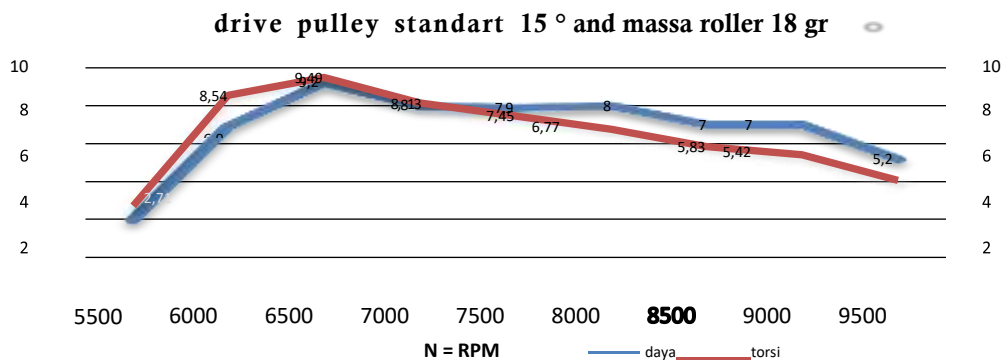


Figure 3. *Dynotest* graph with a roller mass of 18g and a drive pulley of 15° against engine torque and power

Primary Pulley Tilt Angle Test Results 13.5° (10gr) to Power and Torque

The drive pulley tilt angle variation of 13.5° with a roller weight of 10g in the form of power and torque obtained through testing using a dynotest. In this test, the researcher used several variations in engine speed (rpm) to obtain more valid test value results, namely at 5500 rpm. The power and torque obtained are data from the specifications of the primary pulley angle variation of 13.5° 10g which have been tested. The following is the test result data in Table 5.

Table 5. Testing at an angle of 13.5° with a period of 10gr roller

RPM	Power (Hp)	Engine torque (Nm)	Wheel torque (Nm)
5500	7.90	10.22	153.28
5750	7.90	9.68	138.78
6000	7.50	8.85	121.03
6250	7.20	8.22	106.98
6500	7.60	8.24	101.79
6750	7.70	8.04	94.00
7000	7.30	7.42	81.85
7250	7.30	7.10	73.62
7500	7.30	6.86	66.60
7750	7.20	6.53	59.07
8000	6.80	6.04	50.65
8250	6.50	5.60	43.26
8500	6.20	5.19	36.66
8750	5.60	4.50	28.81
9000	4.70	3.68	21.12
9250	3.90	2.98	15.14
9500	3.40	2.49	11.00

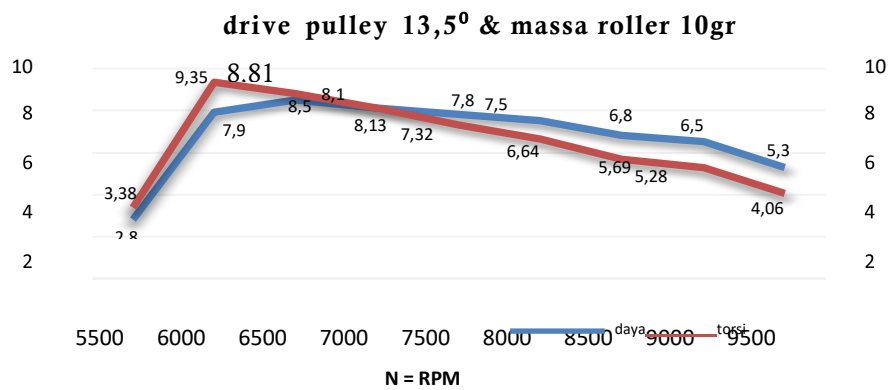


Figure 4. Dynotest graph with a roller mass of 10gr and a drive pulley of 13.5g against engine torque and power

In the dyno test results to determine power and torque using a primary pulley angle of 13.5°. Based on the graph, it is known that at 5500 to 6500 rpm there is a significant increase in power (Hp), because at that rpm the motor still has maximum power, while at 7000 rpm up to 9500 power and torque tends to experience This decrease is due to the motor power already reach the maximum limit so that power and torque motor experience decline. The dynamometer test results demonstrated that the CVT configuration utilizing a primary pulley angle of 13.5° generated the most favorable power and torque characteristics within the medium engine speed range. A significant increase in power output was observed between 5,500 and 6,500 rpm, indicating that the CVT transmission ratio at this pulley angle effectively maintained the engine within its optimal power band. This phenomenon is consistent with the fundamental operating principle of CVT systems, where efficient ratio adjustment enables improved power transfer and engine performance under varying load conditions. However, beyond 7,000 rpm up to 9,500 rpm, both power and torque exhibited a declining trend. This reduction can be attributed to the engine approaching its maximum volumetric efficiency and power limit, resulting in diminished combustion effectiveness and mechanical efficiency at higher rotational speeds. Similar findings have been reported by Towijaya & Iskandar (2022), who stated that engine performance typically increases until reaching the optimum operating range and subsequently decreases due to increased frictional losses, reduced filling efficiency, and greater thermal stresses at high rpm. Furthermore, research by Nofendri & Christian (2020) colleagues demonstrated that appropriate CVT pulley geometry significantly influences torque transmission efficiency by maintaining engine operation near the region of maximum brake power. Therefore, the 13.5° primary pulley angle can be considered an effective configuration for improving power delivery and acceleration performance, particularly in urban driving conditions where medium engine speeds dominate vehicle operation.

Test Results of the Primary Pulley Tilt Angle of 12 ° (12gr) on Power and Torque

The drive pulley tilt angle of 12° with a roller weight of 12gr in the form of power and torque obtained through testing using a dynotest. In this test, the researcher used several variations in engine speed (rpm) to obtain more valid test value results, namely at 5500 rpm. The power and torque obtained are data from the specifications of the 12° 12gr primary pulley angle variation that has been tested. The following is in Table 6 the test result data.

Table 6. Testing at an angle of 12° with a roller mass of 12 gr

RPM	Power (Hp)	Engine torque (Nm)	Wheel torque (Nm)
5500.00	7.50	9.63	147.23
5750.00	7.00	8.54	124.68
6000.00	6.70	7.93	110.31
6250.00	6.80	7.70	101.80
6500.00	6.70	7.32	91.73
6750.00	6.60	6.87	81.36
7000.00	6.50	6.57	73.27
7250.00	6.30	6.17	64.56
7500.00	6.40	6.00	58.64
7750.00	6.40	5.80	52.69
8000.00	6.10	5.40	45.33
8250.00	5.70	4.89	37.68
8500.00	5.00	4.17	29.26
8750.00	4.20	3.40	21.51
9000.00	3.40	2.64	14.88
9250.00	2.60	1.97	9.75
9500.00	2.00	1.46	6.22

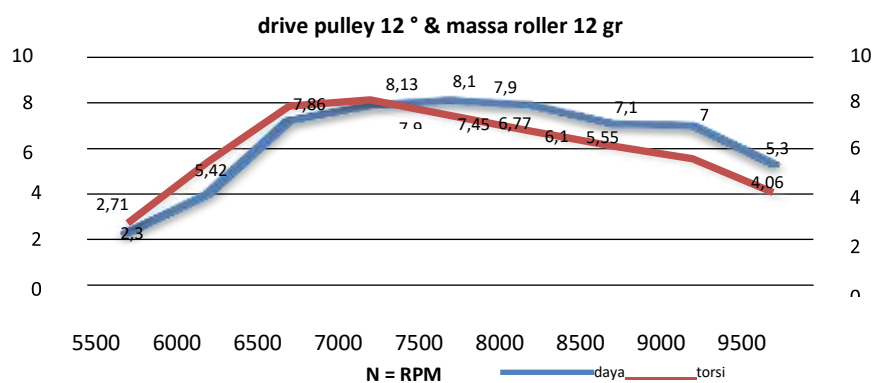


Figure 5. Dynotest graph with a *roller mass* of 12gr and a *drive pulley* of 12° against engine torque and power

In the dyno test results to determine power and torque using a primary pulley angle of 13.5°. Based on the graph, it is known that at 6000 to 7000 rpm there is a significant increase in power (Hp) and power, because at that rpm the motor still has maximum power, while at 7000 rpm up to 9500 torque tends to experience This decrease is due to the motor power already reach the maximum limit so that the power and torque motor experience decrease. At 6500 rpm, power increases, which can be said to be almost stable up to 9000 rpm. This is influenced by the mass lighter rollers and a smaller drive pulley tilt angle of 12 °.

The dyno test results demonstrated that the CVT configuration employing a 13.5° primary pulley angle exhibited superior power and torque characteristics across the tested engine speed range. A significant increase in power output was observed between 6000 and 7000 rpm, indicating that the engine operated within its optimum power band where volumetric efficiency and combustion effectiveness were maximized. Beyond 7000 rpm, both torque and power gradually decreased, suggesting that the engine had reached its peak performance threshold, leading to reduced filling efficiency and increased mechanical losses at higher rotational speeds. Furthermore, the relatively stable power curve observed from 6500 to 9000 rpm can be attributed to the use of lighter roller weights, which delayed the CVT upshifting process and maintained the

engine within its effective power band for a longer duration. The smaller pulley angle also contributed to a slower transmission ratio change, thereby enhancing torque multiplication and acceleration performance. These findings are consistent with previous studies reporting that a 13.5° pulley angle combined with lighter rollers improves power delivery, torque stability, and vehicle responsiveness by optimizing the centrifugal force acting on the variator mechanism and maintaining engine operation near peak power conditions (Towijaya & Iskandar (2022). Lighter roller masses have been shown to improve acceleration and sustain engine speed within the optimal torque region, resulting in enhanced dynamic performance of automatic motorcycles equipped with CVT systems (Nofendri & Christian, 2020).

CONCLUSION

His study confirms that the 13.5° drive pulley angle combined with a 10 g roller mass produces the most stable torque and power distribution across the 3,500–9,500 rpm range, with a maximum engine torque of 16.45 Nm and stable power output between 8.0–8.7 hp in the mid-rpm range, outperforming both the standard 15° and the narrower 12° configurations. This finding confirms the research objective of identifying an optimal CVT tuning configuration for 150cc automatic motorcycles. This study is limited to dynamometer-based (chassis dyno) testing on a single motorcycle unit and engine displacement, without validation under real road-load conditions, and each pulley angle was tested with only one corresponding roller mass rather than a full factorial combination. Future research should include road-test validation, a fuller matrix of roller mass–pulley angle combinations, durability/wear testing of the modified components, and application to different CVT-equipped engine displacements.

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