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The Use of the C-70 Electric Motorcycle and Its Performance

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Abstract. Electric motors are one of the more environmentally friendly transportation alternatives, which can be a problem solution to reduce pollution. Besides that, electric motors have become a necessity in the future. Opportunities to accelerate automotive electrification come from motorcycles. Motorcycles are not as complicated as developing electric cars. In this paper, the C-70 bike is a preferred target for driving force because it has a slim body, a lightweight, is not too large construction, and is still fashionable. In this paper, some steps are being taken to its manufacture. The first one, calculating the required electric motor power requirements. The second, to design and assembly the C-70 motorcycle frame with BLDC dynamo. The third is the C-70 motorcycle performance test inside and outside the Town, and the last one, the C-70 motorcycle painting as the final process. The electric motor's design results can cover 49 km with an average speed of 30-40 km/hour while out of Town with roads up and down mountains. At the same time, this electric motor can cover 50.23 km with an average speed of 30-40 km/hour from a fully charged battery condition in urban areas. So that's roughly 97.5 per cent of the distance travelled within the Town. So, this electric motor is more suitable in urban areas because there are many places to charge the battery, and it is more efficient to use when inside the Town. Besides that, the process of assessing the battery in this electric motor design takes 4 hours 30 minutes from the battery condition 0% (0 Volt) to 100% (81.5 Volt). In addition, the cost required to be very economical compared to motor fuel.

INTRODUCTION

The C-70 motorcycle is one of the legendary motorcycles in Indonesia because the C series motorcycle with this variant is the best-selling in the Indonesian market. C-70 motorcycle began to enter and in production in Indonesia in 1971. C-70 motorcycle is only armed with machine motor fuel with a volume of 72 ccs; therefore, the development time of the C-70 motorcycle's engine is increasingly outdated. However, many C-70 motorcycle users change or replace the engine using a motorcycle engine with a newer brand of its product. Electric motorcycles will gradually become a trend, given the increasingly widespread environmental issues and fuel prices that continue to soar, in some areas of the world already heading there. However, it is still a work in progress.

The increase in motorcycles will be in line with the rise in air pollution through the residue released. However, air pollution will not occur when switching to an electric bike. An electric motor can be the right choice [1]. Nevertheless, many motorcycles in the region will affect the area's air quality because of pollution produced. The Republic of Indonesia has opened up the potential for conversion of ICE motorcycles that already exist and are registered into electric vehicles through the minister of transportation regulation concerning the conversion of motorcycles with fuel motors into electric motorcycles battery-based. In principle, transforming ordinary vehicles into electricity is more easily done than designing from the beginning. Designing and assembling the C70 into the electric bike is environmentally friendly to everyday life in many different cities and conduct performance testing that includes testing the track and charging systems.

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METHODS

Power Requirements

The need for an electric motorcycle can be known based on its specifications, at the maximum speed and weight, so that the C-70 motorcycle can run well. These parameters calculate the number of analytical power requirements formula (P) using a free body diagram of the C-70 motorcycle original and are explained in equation (3) below [2].

Design and Assembly

Chassis selection still maintains the pressed steel type because it has a simple construction. The shock breaker uses a telescopic front shock breaker belonging to other variants. This selection is because the front shock breaker built by the C-70 electric motorcycle still uses the leading link type, which has a level of comfort below the telescopic shock breaker and upsides down in Fig. 1(a). The swing arm uses the swing arm from other variants. However, the swingarm has construction on the wheel axle better for inserting a BLDC electric motor than the C-70 motorcycle's default swing arm. Besides that, the other variant's swingarm has a more extended swingarm than the swing arm of the C-70 electric bike, thus avoiding the risk of the wheelie on this electric motorcycle, according to Fig. 1(b).

(a) (b)

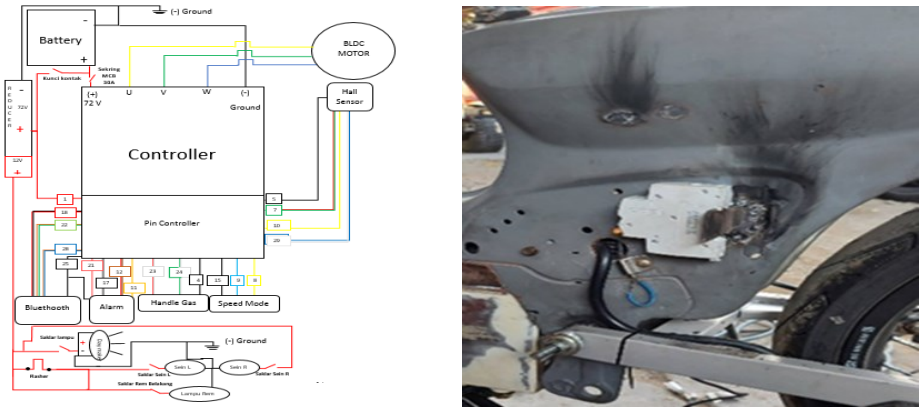
FIGURE 1. The pressed steel frame used in the C-70 motorcycle (a), BLDC motor fitting on the swing arm (b)

In Fig. 2(a), the rear shock absorber uses a double suspension from the aftermarket brand "ride it" with type 811 length 340 mm. In addition, there is an adjustable shock absorber at the bottom to adjust the severity of the shock absorber. The battery in the electric motor is suitable to the overall electrical power requirements of the electric motor. However, due to the limited dimensions of battery storage space, the battery selection on the C-70 electric motorcycle uses 72 Volt 20 A in Fig. 2(b). The specifications of the 72 Volt 20 A battery have a max voltage of 82 volts when fully charged.

(a) (b)

FIGURE 2. The rear shock absorber (a), the battery in the electric motor (b)

In Fig. 3(a), the controller on the C-70 electric motorcycle is the Nanjing ND72240 brand controller. The function of the controller as a control system for the BLDC motor [3]. The controller will read each gas opening from the throttle and distribute it to the BLDC motor according to the reader's throttle opening. This controller has a signal wave in the form of a sine signal so that the initial gas opening is much smoother than a controller that does not have a sine wave. The controller can handle various functions and accessories, such as headlights, brake lights, indicators, horns, etc. Connections are provided to connect the battery to the controller. In addition, a voltage regulator that regulates system voltage is also connected to the controller [4]. The cable original body's innate controller directly moves from the current + 72 Volt battery to the controller. In this Design, to prevent an electric short circuit is given a 30 A MCB in Fig. 3(b) below; when a short course occurs in the battery, the MCB will first cut off the electric current from the battery to the controller.

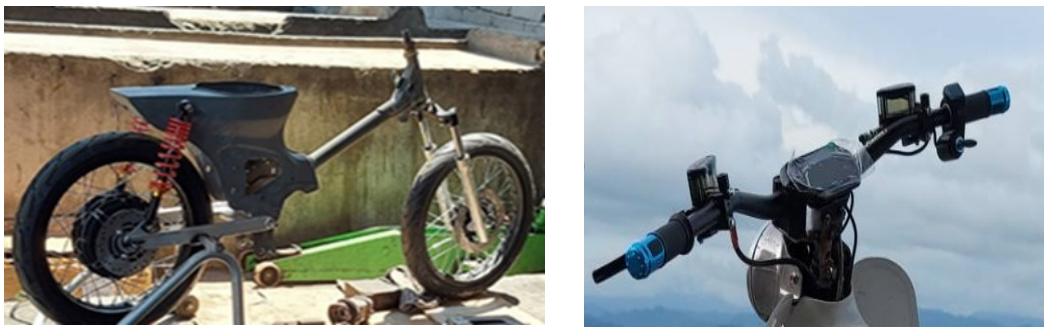


(a) (b)

FIGURE 3. Controller on the C-70 electric motorcycle (a), circuit safety system with MCB (b)

The C-70 motorcycle's engine room dimension has a volume size of 38 cm x 18 cm x 15 cm. The 72 Volt 20 A battery on the C-70 electric bike is designed to have dimensions with length 35 cm x width 15 cm x height 12 cm. Dimensions of the battery adjust the engine room of the C-70 motorcycle so that it looks proportional according to Fig. 4(a).

The braking system for the front and rear wheels uses a hydraulic/disc braking system. The braking section uses a lot of other variants. The show and rear brake masters use an axial brake master type with a diameter of 14 mm with the RCB brand. The position of the rear brake on the C-70 motorcycle is on the right leg; because this Design already uses a BLDC electric motor dynamo, the rear brake position is moved to the left handlebar like an automatic motor in general, according to Fig. 4(b). The rear brake hose length by moving the part to the left of the steering handlebar; the size of the brake hose used is 155 cm.

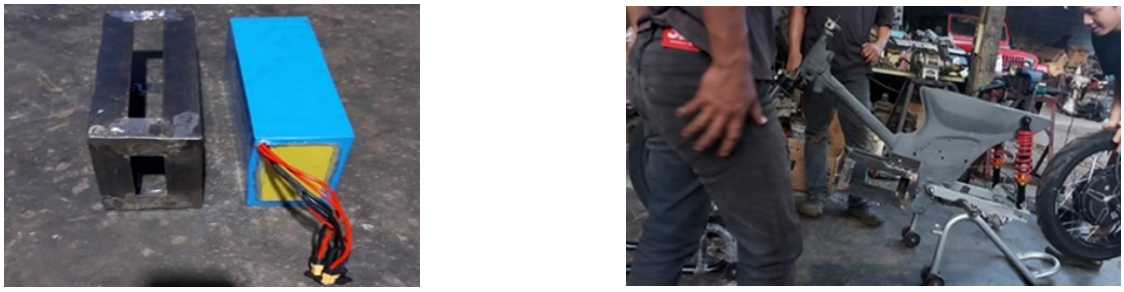


(a) (b)

FIGURE 4. The dimensions of the engine room (a), the brake master and brake lever position of the C-70 motorcycle (b)

In Fig. 5(a), the battery frame uses elbow iron thickness of 3 mm, and it is shaped according to the dimensions of the battery [5]. Manufacture of the battery is done by cutting the angle iron, then doing the SMAW welding process on the pieces of the angle iron.

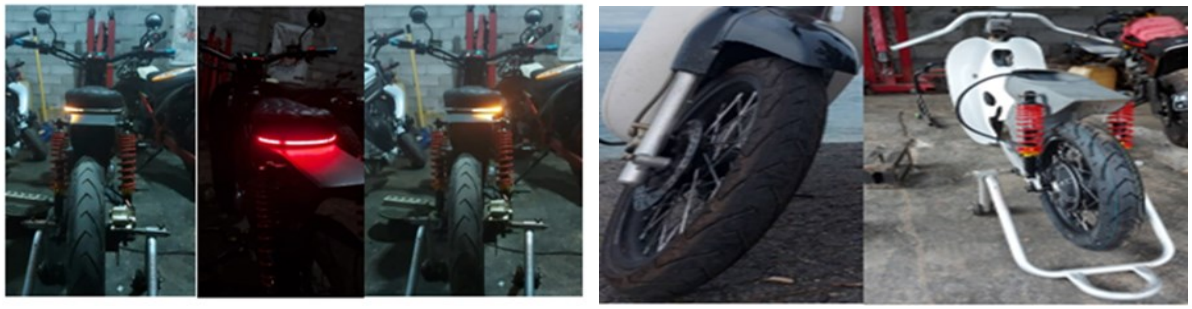
After completing all the design processes and modifications to the battery housing frame, we have to do the fitting process again. So that the battery compartment is avoided inaccuracies after the welding process so that it could fit and look proportional in Fig. 5(b).



(a) (b)

FIGURE 5. The battery frame (a), fitting process (b)

In Fig. 6 (a), we use LED lights with the type of "day maker" 4.5-inch. The leading light has three paralleled points, which can operate far and near lights. The high beam is yellow, and the low beam is white.

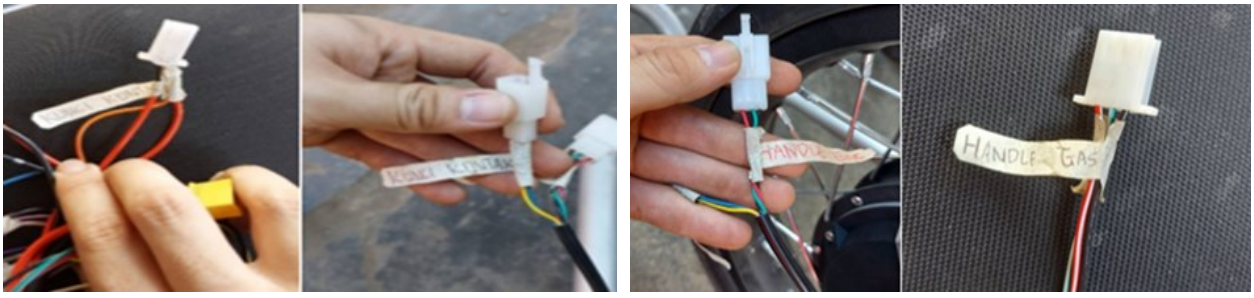


(a) (b)

FIGURE 6. The turning and braking signal light (a), the front and rear tires of the C-70 motorcycle (b

In Fig. 6(b), the front and rear wheels use a spoke type with a diameter of 17 inches and have a width of 1.85 inches at the show and 2.15 inches at the back with a matte black or fuzzy black colour. These wheels use TDR brand spokes with a length of 184 mm at the front and 120 mm. The front and rear tires use the Corsa brand with type R26 with sizes 80/90-17 at the front and 90/80-17 at the rear. The reason for choosing this tire size is so as not to overload the BLDC motorcycle when running.

In Fig. 7(a), the ignition key on this electric motor works to disconnect the current (+) 72 Volt from the battery to the controller pin one and reducer. The ignition key installation process is from socket to socket. Socket from the ignition to the socket on the battery (+)72 Volt.



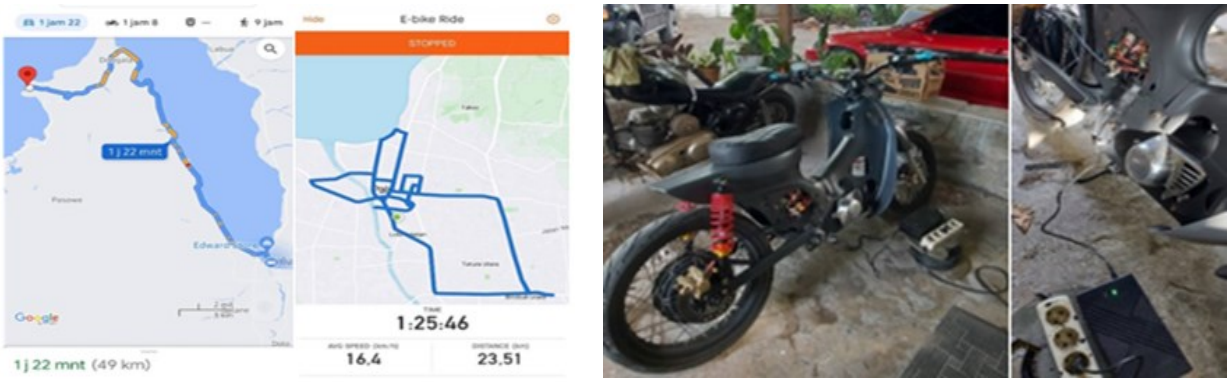
a) (b)

FIGURE 7. The ignition key (a), the speed mode of the C-70 motorcycle, (b)

In Fig. 7(b), the speed mode consists of 3 wires: negative (black), red, and white (5V), green and white (data). The installation process is also socket to socket. Connect the socket of the gas handle and the gas handle socket to the controller. Speed mode in this Design consists of three settings, namely low, medium, and high. In addition, speed mode consists of 3 cables: black, blue, and yellow, with socket-to-socket installation. This speed mode serves to change the speed settings of the controller.

Testing and Performance Evaluation

The first test was a test of the distance travelled on a C-70 electric motorcycle. This test is divided into two types: testing when out of Town and testing when in Town. In Fig. 8(a) below, both tests were carried out at fully charged.



(a) (b)

FIGURE 8. The Route Testing at outside and inside Town (a), the battery charging of the C-70 motorcycle (b)

The risks related to lithium-ion batteries are as follows: When a lithium-ion cell reaches high temperatures or experiences overcharging, the physical composition of metal oxides is destroyed. This damage is exothermic and results in increased energy release and the production of oxygen. Consequently, the electrolyte fluid will boil, producing highly flammable gas. If the temperature rises to the flashpoint, a thermal runaway takes place (defined below). Extinguishing such fire is difficult because the lithium-ion cells produce oxygen by themselves. When combined with water, lithium has an aggressive acid that is hazardous to the environment [6]. The battery selection in this C-70 electric motorcycle design uses a battery capacity of 72 Volts 20 A, with a peak voltage of 84 Volts. The charger from this electric motor must be suitable for the storm, namely by using an 84 Volt 5A charger. The 84 Volt 5 A charger requires 430 Watts of A.C. power, according to Fig. 8(b).

Finishing and Painting

Finishing is done when all of the design process and the welding process has been completed. The finishing process is the process of meeting and perfecting a design that is made. In Fig. 9, this process includes the putty process, levelling the object's surface, and the painting process.

FIGURE 9. The finishing and painting of the C-70 motorcycle

Coating of paint on the frame and the whole body aims to strengthen the paint colour on the body and frame. The primary colour uses a dark grey colour using the same brand on the chassis and body whole.

RESULTS AND DISCUSSION

Electric Motor Power Calculation

Using road load model calculations from inputs of the motor's horsepower and torque capabilities and the battery's voltage and current capabilities, expected values for top speed, acceleration, and other performance measures were estimated. The power needed so that the electric motorcycle can run, calculations are carried out using the C-70 motorcycle technical specifications that have been designed.

$$\sum M_{total} = Mass_{motor} + Mass_{\ battery} + Mass_{Driver} \quad (1)$$

$$= 174 \text{ kg}$$

The total weight of the electric motorcycle can be calculated as follows.

$$W_{Total} = \sum M_{total}\ x\ g \quad (2)$$

$$= 174 \text{ kg x } 9.81 \text{ m/s}^2$$

$$= 1706.94 \text{ N}$$

Electric motor power (P) that must be required at velocity 40 km/h = 11.1 m/s; friction coeficient (μ) = 0.2 ; energy efficiency (η) = 0.85; wheel diameter (d) = 0.22 m. The value of electric motor power can be calculated as follows.

$$P = g\ x\ \mu\ x \sum M_{total}\ x\ V\ x\ \eta \quad (3)$$

$$= 9.81 \text{ m/s}^2 \text{ x } 0.2 \text{ x } 174 \text{ kg x } 11.1 \text{ m/s x } 0.85$$

$$= 3221 \text{ Watt}$$

Then,

$$V = \Pi\ x\ d\ x \frac{n}{60} \quad (4)$$

So,

$$n = \frac{60\ V}{\Pi\ xd}$$

$$= \frac{60x\ 11{,}1}{\Pi x\ 0{,}22}$$

$$= 964 \text{ rpm}$$

Then the required torque can be calculated as follows.

$$Torque = \frac{60x\ P}{2\Pi\ n} \quad (5)$$

$$= \frac{60x\ 3221}{2\Pi\ 964}$$

$$= 31.92 \text{ Nm}$$

From the analysis of these calculations, selecting an electric motor dynamo that is sufficient for the C-70 electric motorcycle is the Q.S. 2000W BLDC motor. The reason for choosing this electric motor dynamo is because the Q.S. 2000W BLDC Motor has a peak power of 4000 Watt and has a peak torque of 140 Nm. In addition, electric vehicles using BLDC motors as their driving method do not have brushes because they present several advantages over D.C. brush motors [7].

Performance Testing of Mileage Outside and Inside the Town

In Fig. 10(a), from the first electric motor test results, the maximum mileage on this electric motor design outside the Town is 49 km, assuming a constant speed of 30 km/h to 40 km/h and a throttle position of about 40%-50% opening [8].

In Fig. 10(b), the total mileage obtained from the test inside the Town is 50.23 km, assuming a constant speed of 30 km/h to 40 km/h and a throttle position of about 40%-50% opening. Thus, the total distance travelled in the Town with the battery fully charged (81.5 Volt) to exhausted (0 Volt) is 50.23 km.

(a) (b)

FIGURE 10. The C-70 motorcycle performance testing when outside and inside the Town

Testing the Battery Charging Time

Battery design of the C-70 electric motorcycle using 72 Volt battery with a capacity of 20 A, with a voltage of 84 Volts peak. The charger from this electric motor must be suitable for the battery, namely by using an 84 Volt 5A charger. The 84 Volt 5 charger requires 430 Watts of A.C. power. The A.C. voltage from a residence is used to charge the batteries through the designed charge circuit—it is used to convert the A.C. voltage to the DC [9]. The battery charging time test is carried out at 0 Volt to complete the (84 Volt) requirement. It takes 4 hours and 31 minutes to charge the battery from 0 Volt to 84 Volt [10].

TABLE 1. Charging time

Index	Power	Time	Total (Power Hour)
1	430 Watt	4 hours 31 minutes	1942 Watt Hour

The traditional electrical vehicle battery charger mainly consists of DC/DC and DC/AC stages. The DC/DC converter acts as the DC/DC stage to boost the voltage towards the desired level, while the DC/AC stage is working as an inverter that changes the D.C. energy from the battery to A.C. energy various loads. A battery charger usually utilizes a boost converter at the first stage, and a DC-DC converter regulates the output voltage at the second stage as designed battery chargers. Suppose we calculate the A.C. power supply needed during the battery charging process. The entire home electrical power (A.C.) required to charge the electric motor battery from depleted to complete condition requires 1942 Watt of power. If the household electricity used is 2200 VA at IDR 1444 per kWh, then the cost of charging the electric motor battery from depleted to complete condition is IDR 2804, rounded up to IDR 3000 to cover a distance of 50 km in urban conditions.

CONCLUSION

The electric motor's Design can cover 49 km with an average speed of 30-40 km/hour while out of Town with roads up and down mountains. At the same time, this electric motor can cover 50.23 km with an average speed of 30-40 km/hour from a fully charged battery condition in urban areas. So that's roughly 97.5 per cent of the distance travelled within the city. This electric motor is more suitable in urban areas because there are many places to charge the battery, and it is more efficient to use if in the city. The process of assessing the battery in this electric motor

design takes 4 hours 30 minutes from the battery condition 0% (0 Volt) to 100% (81.5 Volt). In addition, the cost required to be very economical compared to motor fuel. This electric motorcycle only costs IDR 3000 to cover a distance of 50 km in urban conditions.

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