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THE MECHANICAL SYSTEM DESIGN IN TACTICAL GROUND VEHICLE (TGV) FOR AKSUS TEAM PASKHAS COMMAND BATTALION

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ABSTRACT

One of the tasks of the PDR Team (Indoor Combat) is to become the Matan Team (Security and Rescue) which has special duties in daily operations, including the task of security operations for VIPs/VVIPs who are in ring one security. From this task, the PDR Team needed an infiltration tool that was used closer to the target to get the latest visual image information and was able to carry weapons that could paralyze the enemy if needed. Therefore we need a design method to make a tool using a remote control. The mechanism of this tool frame is designed using hollow stainless steel pipe with a size of 1.5 cm x 1.5 cm and a thickness of 1 mm. The tool body uses an iron plate with a thickness of 1 mm for the placement of the driving components, namely the DC electric motor, pillow block holder, and other supporting components. The operation of the tool uses a chain and sprocket transmission system with a 12 V battery energy source using 2 DC motors with a power specification of 110.74 watts, 2000 rpm, obtained a speed of 1.84 m/s. From the DC motor to the axle (16 mm diameter) connected by a chain that is used to drive the wheels, this tool is able to withstand and support the entire load on the TGV with a total load of 50.6 kg. From the testing of the tool that has been carried out for approximately 6 months, it has succeeded in moving as expected, namely being able to shoot at targets using a 9 mm caliber short-barreled weapon effectively in the implementation of exercises and operations of the Matan/PDR Team. This tool is equipped with a camera that is connected to a remote monitor screen, so that the Operations Commander can make faster, more precise and accurate decisions according to field conditions.

Keywords : *Camera, Chain and Sprocket, DC Motor, Short Barrel Weapon, Remote.*

1. INTRODUCTION

1.1 Background

The Paskhas Command Battalion has the main task of carrying out operations for the seizure and defense of strategic objects of the Air Force in military operations. In the organization in the Paskhas Command Battalion unit there are 3 Rifle Companies, 1 Assistance Company and 1 Headquarters Company. Every soldier in the Rifle Company must always hone land, sea and air combat skills, including Raid, Indoor Combat (PDR), infiltration (infiltration into the opponent's area), Purbangkota, TPRAG, and so on. So that the operational tasks can be carried out properly as expected by the top command and can reduce losses both personnel and material.

In addition to the standard equipment used by the PDR Team, the need for information in the form of visual data about the layout, buildings and positions of the enemy as well as hostages is very important in planning and carrying out this operation. With the visual data displayed on the display screen on the controller, the Team Commander can plan PDR troop movement tactics that are adapted to real conditions in the field. If the enemy is too strong/many, then the PDR Team commander can immobilize him so as to reduce the enemy's combat power. And if the operation carried out is a destruction raid, this tool can also easily infiltrate the enemy's vital objects and blow them up.

At this time, the PDR Team only gets data from intelligence which only provides the location/place of the enemy without knowing the enemy's strength, weaponry, layout/layout and the position of the hostages, so that in carrying out PDR operations it is still very difficult to carry out and can also endanger the personnel in the team, especially first person (pioneer) because the enemy's position is unknown. And if in a raid raid operation, the PDR Team must infiltrate directly into the enemy's vital areas/objects that must be destroyed so that the confidentiality and security of PDR personnel is not guaranteed.

The previous research has its own advantages and disadvantages. Because there is no such tool in the Paskhas Command Battalion unit whose function can be controlled remotely using a remote, the author wants to make a tool that functions for reconnaissance/seeking visual data and can paralyze the enemy when carrying out special operations tasks. Therefore, it is necessary to design a tool called "Tactical Ground Vehicle (TGV) for the Paskhas Command Battalion". This tool is expected to be able to infiltrate buildings without the enemy knowing so that confidentiality is maintained and can provide visual data in the room that is displayed on the display screen, and is equipped with a short-barreled weapon with a 9 mm caliber that is controlled remotely that can paralyze the enemy without having to make contact. directly with PDR troops and equipped with explosives (handak) and triggers (detonators) if needed in raid operations the destruction can be used remotely so that the confidentiality and security of the PDR Team can be guaranteed and operations can run smoothly and successfully.

On this occasion the author wants to create a tool that can support the PDR Team to be more secure and on target in carrying out the operations carried out. The function of this tool is to send visual data to the display screen mounted on the remote control, to immobilize the enemy with a short-barreled weapon and to detonate vital enemy objects using the explosives (handak) contained in this tool with remote control so that speed and accuracy in operation are carried out. PDR can be carried out well and get success without endangering the troops themselves.

2. LITERATURE REVIEW

2.1 Past Research

Previous research has become one of the references for researchers to conduct research on the design of the framework design on the Tactical Ground Vehicle (TGV) prototype that the researchers collected from international journals that have been published widely and researchers did not find any similarities in the system that will be made in this study. , previous studies are internationally recognized references which are very useful in enriching knowledge for writers.

2.2 Theoretical Foundation

The theoretical basis is the theory that is used as a foundation to provide a systematic view of the variables so that it can provide an overview of the research concept in making the framework design design for the Tactical Ground Vehicle (TGV) prototype for the Special Task Force Battalion Team, the theory used is not only the opinion of the author. , but the correct theory has been tested. The theoretical foundations that support the making of the framework design on the TGV prototype for the Special Task Force Battalion Team of the Paskhas Command include:

2.2.1 Gear Ratio, Torque and Speed

The calculation of this gear is sometimes quite confusing because there are many factors that we must pay attention to. This of course presents its own challenges for anyone involved in the world of mechanical engineering. Gear calculation affects many things, from travel speed, acceleration, deceleration, torque or gear thrust, to the cost of producing gears. Gears are part of many things in this world, from big things to small things like the movement of a watch. This article will not be far from discussing gear ratios, torque from gear couplings, and speed, both the rotational speed of the wheels and the speed of the reach of the wheels.

2.2.2 Shaft

The shaft is one of the most important machine elements because almost every machine has a shaft. In planning the transmission system for the Tactical Ground Vehicle (TGV) gear, it is not only the gear itself that the researcher has to plan, but many things related to the gear transmission, which the researcher also has to plan, among others, the shaft that rotates the gear. the spie (pegs), and bearings.

2.2.3 Sprockets

A sprocket is a toothed wheel attached to a track chain, or other long, serrated object. Sprockets are different from gears. Sprockets never come into contact with other sprockets and never match. Sprockets are also different from pulleys in that sprockets have teeth while pulleys generally do not have teeth. Sprockets used in bicycles, motorcycles, cars, chainwheel vehicles, and other machines are used to transmit rotary force between two shafts where the gears cannot reach them. Gears function to continue or reduce rotation. Gears consist of at least one or more pairs of gears. Drive gear (drive gear) and drive gear (driven gear). The number of teeth on the gear affects the number of turns and the torque produced. If the driven gear is larger than the drive gear then the number of revolutions is reduced (smaller) but the torque produced is greater, on the contrary if the driven gear is smaller then the number of revolutions is greater but the torque is smaller. So the torque produced is inversely proportional to the size of the rotation produced (Dianmotorcell, 2013)

2.2.4 Roller Chain Transmission

Power transmission chains are usually used where the shaft distance is greater than in gear transmissions but shorter than in belt transmissions. The chain attaches to the spoket teeth and provides slip resistance so as to ensure constant rotation. The chain as a transmission has advantages such as: capable of transmitting large power due to its great strength, does not require initial stress, small wear on the bearings, and is easy to install. Because of these advantages, chains have a wide range of applications such as gears and belts. (Sularso, 1997)

2.2.5 Metal

Metal is a material or engineering material that is widely used in various fields. In the world of engineering, metal is the most dominating material from other engineering materials as the most important material in the manufacture of machines. (Setiawan, 2019)

2.2.6 DC Motor

DC electric motor or DC motor is a device that converts electrical energy into kinetic energy or motion. This DC motor can also be referred to as a Direct Current Motor. As the name suggests, DC motors have two terminals and require direct current (DC) to drive them. This DC Electric Motor is usually used in Electronic and electrical devices that use a DC power source such as Mobile Phone Vibrators, DC Fans and DC Electric Drills. DC or DC Electric Motor This motor produces a number of revolutions per minute or usually known as RPM (Revolutions per minute) and can be made to rotate clockwise or counterclockwise if the electrical polarity given to the DC motor is reversed. DC Electric Motors are available in various rpm sizes and shapes. Most DC Electric Motors provide a rotational speed of around 3000 rpm to 8000 rpm with an operating voltage from 1.5V to 24V. Examples of drawings of DC motor shapes and symbols. Finding DC motor torque is related to motor power and acceleration.

2.2.7 Rivets

Rivets or rivets are a type of cylindrical nail with a short rod whose head is half-round, rectangular, trapezoidal. Rivet joints are generally applied to bridges, buildings, boilers, tanks, ships and aircraft. This connection with rivets is generally permanent and difficult to remove because at the end of the base it is larger than the stem of the rivet, several common shapes are often used, type A is the easiest to rivet and is the most numerous, cylindrical stem with a radius of circle 0, 5. (Zainudin Ahmad, 2006)

3. RESEARCH METHOD

3.1 Types of Research

This research is an experiment that the author did where this research aims to develop and make innovations that are more modern than before. To become defense equipment in the TNI, especially the Paskhas Command Battalion. In this research, the design of the mechanical system on the Tactical Ground Vehicle (TGV) will be carried out for the Special Task Force Battalion Command Team.

3.2 Research Procedure

In this research procedure will be discussed about the time and place of research as well as the tools and materials that will be used in making this tool, then designing, collecting data and processing data.

a. Draw the design of the base tool on the TGV which will be made using the Solidworks program. This design describes some of the basic looks of the tool to be made.

b. Making the base of this tool is done manually. Starting from making the base tool using stainless steel and aluminum materials. Next do the merging of materials by welding. Assemble tool parts such as gears, chains, pulleys, motors to become one of the base units of the tool. After that, install the need for electrical energy sources, namely batteries as a source of DC motor energy.

3.3 Time and Place

The time for the final project research is starting in July 2021, while the place for conducting research is at the 464th Wing II Paskhas Command Battalion, which is in Malang and STTAL in Surabaya.

4. ANALYSIS AND DISCUSSION

4.1 System Design

System design is the stage of the design process to design a system or improve an existing system so that the system becomes better and can do the job effectively and efficiently. Design is a process carried out on a project that will be worked on, starting from the research design, to the finished product that will be used. In principle, good design and systematics can provide convenience in the manufacturing process so that it becomes a tool or application system that actually functions as it should. This chapter will describe the design of a system consisting of hardware aimed at realizing the idea into a series of prototype designs on a Tactical Ground Vehicle (TGV) as a gun and camera carrier that aims to immobilize the enemy and seek visual data on the training and operations of the Aksus (Action) team. Special) Paskhas in the area/target that has been determined.

4.1.1 Discussion of the Tool to be Designed

The discussion of tools is the most important part in making the TGV designed in this final project. This design is designed with concepts based on theory and related references to tools that will be designed to facilitate the work and analysis of TGV.

Then this scheme was created with the intention of facilitating the design of components and supporting tools so that they can move the TGV series of tools. The shape of this tool is designed to resemble a war vehicle in this case is a tactical vehicle (rantis). This tool is driven by a remote control that is expected to be more efficient and wide range.

4.1.2 Design of 3-Dimensional TGV

Broadly speaking, there are several stages carried out in this research, namely:

a. 3D TGV frame and body design

The installation drawing on the tool is intended to get the dimensions and shape of the tool to be made, making it easier for researchers to make this tool with the right dimensions. The design stages of making the frame and propulsion equipment as well as the TGV body are designed in the form of a three-dimensional image using a solidwork design application.

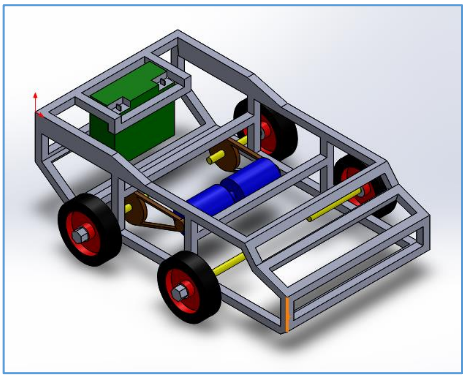

Figure 1. Wireframe and 3D TGV drive tool

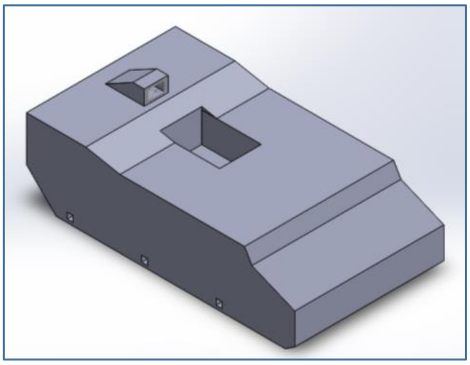

Figure 2. 3-Dimensional TGV body drawing

a. TGV base manufacture

The TGV base is the main part of the Tactical Ground Vehicle (TGV) device in which a propulsion is installed. The second stage of TGV mechanical manufacture consists of:

1) TGV base frame (hollow staenless size 1.5 cm x 1.5 cm thickness 1 mm)

2) TGV body base (1mm thickness iron plate)

3) Chain and sprocket as TGV . drive tool

4) DC motor as TGV . drive motor

5) 12 volt battery as a power source

4.1.3 2-Dimensional TGV Design

The installation drawing on the TGV frame is intended to obtain more precise dimensions and shapes of the tool, making it easier for researchers to make this tool with the right dimensions. The design stages of the TGV frame are designed in the form of two-dimensional drawings with complete sizes that are scaled by the solidwork design program, which can be seen in Figures 4.3, 4.4, and 4.5.

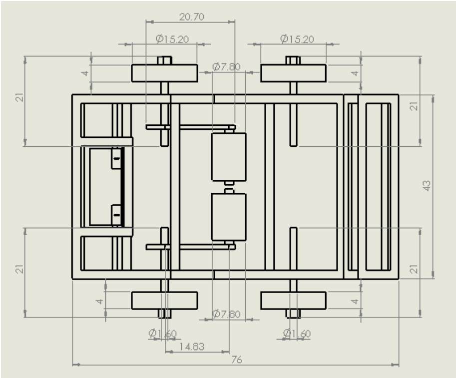

Figure 3. Figure 2 D TGV top view (in cm)

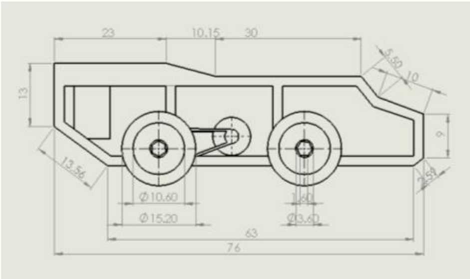

Figure 4. Figure 2 D TGV side view (in cm)

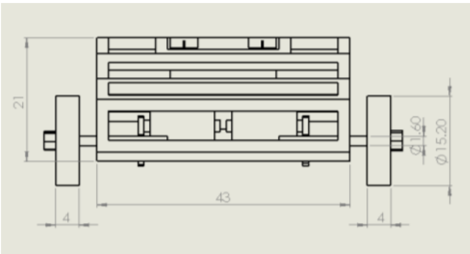

Figure 5. Figure 2 D TGV front view (in cm)

The material used in the manufacture of the TGV base for the main frame is made of hollow stainless measuring 1.5 cm x 1.5 cm with a thickness of 1 mm. The main frame is 76 cm long, 43 cm wide and 21 cm high. The researcher aims to use stainless steel in selecting the TGV frame, which is corrosion-resistant. The main inner frame has a holder made of iron plate which is made of a rectangle with a length of 63 cm, width 43 cm, and thickness 1 mm, for the placement of the driving components, namely the DC electric motor and 12 volt battery with holes to bind the electric motor so that it does not move when operating. . The back is made of a chain drive holder and a pillow block holder to run the tool base made of iron plate. In driving the sprocket, the author uses an axle with a diameter of 16 mm and a length of 21 cm. The driving motor that the researcher uses is the power steering motor on a car with a rotation of 2000 rpm. To drive the TGV, the researchers used a chain and used wheels with a diameter of 15.2 cm.

The TGV transmission system is by using a small sprocket found on a DC motor to move a chain connected to a large sprocket located on the rear axle so that the rear wheel can rotate. The researcher used two DC motors to rotate the right and left sprockets on the TGV. The rotation of the sprockets was carried out by continuing the rotation of the middle sprocket using a chain transmission for movement of the tool base. The author arranges the motor and chain so that it can rotate the sprocket that is on the DC motor as a driver, then the sprocket rotation is forwarded to the rear sprocket by using the chain as a successor to the rotation of the motor. The research power source uses a 12 volt battery.

4.2 Tool Assembly

The following is the process of assembling the TGV tool including making the tool frame, installing the body on the tool, and installing the chain.

4.2.1 Framework of the tool

In the process of making the framework researchers used electric welding. Welding amperage is one of the important factors in welding technique, because an increase in current will affect the increase in heat entering the weld area. So use amperes that are not too high, which is around 40 A - 60 A, so that holes in the workpiece can be avoided and the results are good.

The electrode diameter is a welding parameter that also needs to be considered, this is because the smaller the diameter of the welding wire used, the smaller the current used. If welding thin plates, it is recommended to use an electrode diameter of 1.2, 2.0 mm or 2.6 mm, the diameter selection can also be adjusted to the desired weld deposit. The following is table 4.1 selection of electrode diameter and welding current.

Table 1. Table of electrode diameter selection and welding current

Diameter Elektroda (mm)	Arus Las (Ampere)
1,5	20-40
2,0	30-60
2,6	40-80
3,2	70-120
4,0	120-170
5,0	140-230

4.2.2 Mounting the body on the tool frame

Mounting the body (1 mm thick iron plate) to the tool frame using rivets. After making holes in the frame and body, then proceed with inserting rivets into the holes. The loose head part of the rivet is also inserted into the same hole. The next process is to press the head of the rivet to the tail. You can use a press machine or a special pressing machine with hydraulic power to support the pressing process. For small nails, you can use a hand riveter or you can also use a hammer.

4.2.3 Mounting the chain and sprocket on the tool

Installation of chains and sprockets on the tool is carried out in the following way:

a. Locate the chain link for easy removal of the chain.

b. After the chain is removed, connect the small sprocket (on the DC motor) and the large sprocket (on the axle) using the prepared chain.

c. Don't forget that after installing all the sprockets and the chain, don't forget to adjust the chain tension. Make sure the chain is not too loose or tight for chain adjustment.

4.2.4 Mechanical System on Short-barreled Weapons

The mechanical system on the short-barreled gun and its mount mounted on the TGV is by installing a DC servo motor drive with specifications for an operating voltage of 5.0 – 6.8 DC V, Torque 21 kg.cm (5V) or 25 kg.cm (6.8V) , and a speed of 0.15 sec/60° (5V).

4.3 Calculation

4.3.1 Calculation of Total Load on Equipment

In this discussion, the author has calculated the total load on the Tactical Ground Vehicle using digital scales. From the results of data collection, it is obtained:

- Total weight of TGV equipment : 50.6 kg,
- TGV body weight : 29.7 kg
- Supporting equipment weight : 20.9 kg, with details:
  - DC Motor Weight : 4 kg
  - Battery weight : 5 kg
  - Chain and sprocket weight : 0.6 kg
  - Pillow block bearing weight : 5.6 kg
  - Weapon mount weight : 1 kg
  - Weight of 4 wheels : 4.2 kg
  - Weight of electrical components: 0.5 kg

Armed with this data, the researcher will get a reference as a basis for designing the motor power system, calculation of transmission, and the strength of the axle shaft.

4.3.2 Calculations in the Selection of the Motor Drive

The motor is the main component that functions to drive the sprocket and chain transmission system in the movement on the ground of the Tactical Ground Vehicle. Calculations are carried out to get the desired motor according to the existing load. In the calculation of the load has a weight (m) of 50.6 kg, so the speed on the ground for the vehicle's function as a troop guide is planned to have a speed of (V) 2 m/s. Power requirement is the amount of power needed to move the tool. The amount of power required is influenced by the weight of the tool, the coefficient of friction of the wheel/tire with the ground, and the rolling resistance of the wheel/tire.

a. Friction on wheels/tyres

The frictional force in the form (N) can be obtained from the total load (N) multiplied by the coefficient of friction (μ). Then the coefficient of friction can be searched by using the rolling resistance coefficient graph.

The coefficient of friction on a grooved tire (μ) is assumed to be 0.012. The coefficient of friction (Fs) can be calculated by the formula:

$$\begin{aligned} Fs &= W \,.\, \mu \\ &= m \,.\, g \,.\, \mu \\ &= 50{,}6\ kg \,.\, 9{,}8\ m/s \,.\, 0{,}012 \\ &= 5{,}95\ N \end{aligned}$$

b. Rolling prisoner

Rolling resistance is the force that restrains the rotational speed of an object due to the force absorbed on the road surface. The following is a table 4.2 coefficient of overturning resistance (c).

The coefficient of rolling resistance (c) is 0.004

Rolling resistance (Fr) can be calculated by the formula:

$$\begin{aligned} Fr &= c \,.\, W \\ &= c \,.\, m \,.\, g \\ &= 0{,}004 \,.\, 50{,}6\ kg \,.\, 9{,}8\ m/s^2 \\ &= 1{,}98\ N \end{aligned}$$

c. Acceleration Style

The acceleration force (F.aks) is the force that occurs when the wheelchair starts to move assuming acceleration (a) = 0.5 m/s².

The acceleration force (F.ax) can be calculated by the formula:

$F.aks = m . a$
$= 50{,}6 \text{ kg} . 0.5 \text{ m/s}^2$
$= 25{,}3 \text{ N}$

d. Calculating the incline force (F.hill)

Calculating the incline force (F.hill) can be calculated by the formula:

$F.hill = m . g . \sin 15°$
$= 50{,}6 \text{ kg} . 9{,}8 \frac{m}{s^2} \; 0{,}26$
$= 128{,}93 \text{ N}$

e. Total load

The total load is the sum of the frictional force (Fs), rolling resistance (Fr), acceleration force (F.aks), incline force (F.hill). The total load (F) can be calculated by the following formula:

$F = Fs + Fr + F.aks + F.hill$
$= 5{,}95 \text{ N} + 1{,}98 \text{ N} + 25{,}3 \text{ N} + 128{,}93 \text{ N}$
$= 162{,}16 \text{ N}$

Jadi beban total (F) yang diperoleh adalah 162,16 N.

The desired vehicle power is obtained by multiplying the total load (F) by the speed (V). Speed is obtained from the desired assumptions. For the Tactical Ground Vehicle the desired speed is 2 m/s.

The formula can calculate the desired motor power:

$P = F . V$

$= 162{,}16 \text{ N} . 2 \text{ m/s}$
$= 324{,}32 \text{ watt}$
$= 0{,}43 \text{ HP}$ (Dimana 1 HP = 745,7 watt)

Because the Tactical Ground Vehicle uses two DC motors, the power is divided by 2, so each DC motor carries a power of 162.16 watts (0.162 kW) or 0.22 HP.

4.3.3 Motor Torque Calculation

Finding the torque required for a DC motor, using the formula

$T = 9{,}55 \text{ P/nrpm}$
= 9,55 (162,16 watt)/2000
= 0,774 Nm

So it can be concluded that the minimum torque DC motor required for TGV at 2000 rpm is 0.774 Nm.

4.3.4 Motor Selection

Based on the consideration of choosing a DC motor, the author determines the choice of DC motor specifications that can support the TGV device's performance, as shown in Figure 4.12 below.

Specifications of DC motor ex power steering

- DC Motor 12 V 2000 rpm 10 A
- Overall motorcycle length 14 cm
- Body diameter 7.3 cm
- Diameter of axle 19 mm
- Length of axle 2.3 mm
- Weight 2 kg

4.3.5 Sprocket Transmission Ratio Calculation

With this data, researchers can determine the driving motor with power above 162.16 watts, the researchers choose a motor with the following specifications: The motor that researchers use is a power steering motor in a car. Researchers used two motors that were used to rotate the sprocket attached to the DC motor on the left and right with a radius (Rinput) of 1.45 cm and the number of teeth (Zinput) 14. To rotate the rear sprocket (Zoutput) with a radius (Zoutput) (Routput) 4.25 cm and the number of teeth (Zoutput) 41, the researchers took advantage of the rotation of the sprocket on a DC motor by using a roller chain transmission to the rear sprocket mounted on the axle with the axle radius (Ras) 8 mm continuing the rotation of the rear wheel with a wheel radius of 7.6 cm.

Then the chain speed ratio (i) is obtained from the following calculations:

Number of teeth of small sprocket Zin = 14

Number of teeth of large sprocket Zout = 41

$$i = \frac{Zin}{Zout} = \frac{14}{41} = 0{,}341$$

For the calculation of the output round, the researcher uses the following formula:

Calculating the circumference of the wheel in use

$Kroda = 2 . \pi . Rroda$

$= 2 . 3{,}14 . 0{,}076\text{m}$

$= 0{,}477 \text{ m}$

Because the wheels and rear gears are mounted on axles, one rotation of the wheel is equal to one rotation of the rear gear, so next Calculating the circumference of the back teeth in use

$KZout = 2 . \pi . RZout$
$= 2 . 3{,}14 . 0{,}0425\text{m}$
$= 0{,}267 \text{ m}$

Menghitung keliling gigi pada motor yang di pakai

$KZin = 2 . \pi . RZin$
$= 2 . 3{,}14 . 0{,}0145\text{m}$

$= 0{,}091\ \mathrm{m}$

Because the force acting on the TGV is 162.16 N, then the next author will look for the value of the torque that works on the motor (drive torque) using the existing gear ratio, then

$\frac{\mathrm{Zout}}{\mathrm{Zin}} = \frac{\mathrm{Fout}}{\mathrm{Fin}}$

$\frac{41}{14} = \frac{162{,}16\ \mathrm{N}}{\mathrm{Fin}}$

$\mathrm{Fin} = \frac{14\,.\,162{,}16\ \mathrm{N}}{41}$

$\mathrm{Fin} = \frac{2270{,}24\ \mathrm{N}}{41}$

$\mathrm{Fin} = 55{,}37\ \mathrm{N}$

Calculating the DC motor power used to drive the TGV, assuming a speed (v) of 2 m/s, then

$\mathrm{Pin} = \mathrm{Fin}\,.\,\mathrm{v}$

$\mathrm{Pin} = 55{,}37\ \mathrm{N}\,.\,2\ {}^{\mathrm{m}}/_{\mathrm{s}}$

$\mathrm{Pin} = 110{,}74\ \mathrm{watt}$

Because the author uses two motors, the DC motor power is divided into 55.37 watts. For the calculation of the output round, the researcher uses the following formula:

$i_1 = \frac{\mathrm{Zin}}{\mathrm{Zout}} = \frac{14}{41} = 0{,}341$

$i_2 = 1$

$n_2 = n_1\,.\,i_1$

(Where n1 = motor speed = 2000 rpm)

$= 2000\ \mathrm{rpm}\,.\,0{,}341$

$= 682\ \mathrm{rpm}$

$n_3 = n_2\,.\,i_2$

$= 682\,.\,0{,}341$

$= 231{,}88\ \mathrm{rpm}$

$= 3{,}86\ \mathrm{rps}$

$V = \pi\,.\,d\,.\,n_3$(diameter roda 15,2 cm = 0,152 m)

$= 3{,}14\,.\,0{,}152\mathrm{m}\,.\,3{,}86\ \mathrm{rps}$

$= 1{,}84\ \mathrm{m/s}$

Then the speed value after being given additional reduction gear is 1.84 m/s.

4.3.6 Chain Selection

This chain number is selected based on the corrected power of 55.37 watts or 0.055 kW and rpm (n) of 2000 rpm.

From the available data, it can be concluded that the chain number that matches is the chain with the number 25.

4.3.7 Determining the Diameter of the Wheel Shaft

Armed with the existing calculation data, the author will use it as a reference for calculating the wheel axle to be able to withstand the overall load of the tool, and be able to move stably. With the results of weighing the equipment obtained a total weight of 50.6 kg, so the author can determine the axle or axle. Next is to do the calculation using the following formula

Where : $W = 50{,}6\ \mathrm{kg}$

$g = 3{,}4\ \mathrm{cm}$

$j = 4\ \mathrm{cm}$

$h = 7{,}6\ \mathrm{cm}$

$V = 1{,}84\ {}^{\mathrm{m}}/_{\mathrm{s}} = 6{,}62\ {}^{\mathrm{km}}/_{\mathrm{h}}$

$\alpha = 3\ \mathrm{mm}$

For the overall load of the tool (W) divided by 4 equally because this design uses 4 wheels

$\frac{W}{4} = \frac{50{,}6}{4} = 12{,}65\ \mathrm{kg}$. This load will be used to find the diameter of the axle

$M_1 = \frac{j-g}{4}\,.\,W$

$= \frac{(40-34)^{\mathrm{mm}}}{4}\,.\,12{,}65\mathrm{kg}$

$= \frac{6\ \mathrm{mm}}{4}\,.\,12{,}65\ \mathrm{kg}$

$= 18{,}9\ \mathrm{kgmm}$

$\propto_v = 0{,}4, \propto_L = 0{,}3$

$M_2 = \alpha\,.\,M_1$

$= 0{,}3\,.\,18{,}9\ \mathrm{kgmm}$

$= 5{,}7\ \mathrm{kgmm}$

$\mathrm{Pr} = \propto_L\,.\,W$

$= 0{,}3\,.\,12{,}65\ \mathrm{kg}$

$= 3{,}8\ \mathrm{kg}$

$Q_o = P\,.\,\frac{h}{j}$

$= 3{,}8\ \mathrm{kg}\,.\,\frac{76\mathrm{mm}}{40\mathrm{mm}}$

$= 7{,}22\ \mathrm{kg}$

$R_o = P\,.\,\frac{(h+r)}{g}$

$= 3{,}8\mathrm{kg}.\,\frac{(76+18)^{\mathrm{mm}}}{40\mathrm{mm}}$

$= 3{,}8\mathrm{kg}\,.\,2{,}35$

$= 8{,}93\ \mathrm{kg}$

$M_3 = \mathrm{Pr} + \mathrm{Qo}\ (a+1) - \mathrm{Ro}.\left[(a+1) - \frac{(j-g)}{2}\right]$

$= 3{,}8\mathrm{kg} + [7{,}22.\,(3{,}65+1)\mathrm{mm}] - 8{,}93\mathrm{kg}.\left[(3{,}65+\ 1) - \frac{(40-34)}{2}\right]$

$= (3{,}8\mathrm{kg} + 32{,}5\mathrm{mm}) - 8{,}93\mathrm{kg}.\,((4{,}65\mathrm{mm}) - 3\mathrm{mm})$

$= 36{,}3\mathrm{kgmm} + 14{,}7\mathrm{kgmm}$

$= 51\ \mathrm{kgmm}$

Class 3 axle axle assumption with

$\sigma_{wb} = 11$ axle for axle $m = 1$

$d_s \geq \sqrt[3]{\frac{10{,}2}{\sigma_{wb}}\ m(M_1 + M_2 + M_3)}$

$\geq \sqrt[3]{\frac{10{,}2}{11\,{}^{\mathrm{kg}}/_{\mathrm{mm}^2}}\,1\ (18{,}9\mathrm{kgmm} + 5{,}7\mathrm{kgmm} + 51\mathrm{kgmm})}$

$\geq \sqrt[3]{0{,}93\ {}^{\mathrm{mm}^2}/_{\mathrm{kg}}\,.\,(75{,}6)\mathrm{kgmm}}$

$\geq \sqrt[3]{70{,}3\mathrm{mm}^3}$

$\geq 4{,}13\ \mathrm{mm}$

Then the minimum diameter of the axle on the wheel is 4.13 mm to be able to withstand the total load on the tool.

$$\sigma_b = \frac{10{,}2.m\,(M_1+M_2+M_3)}{d_s^3}$$

$$= \frac{10{,}2\,.1\,(18{,}9kgmm+5{,}7kgmm+51kgmm)}{(4{,}13mm)^3}$$

$$= \frac{10{,}2\,.75{,}6\;kgmm}{70{,}44\;mm^3}$$

$$= 10{,}9\,{}^{kg}/_{mm^2}$$

$$n = \frac{\sigma_{wb}}{\sigma_b} \geq 1$$

$$n = \frac{11}{10{,}9} = 1{,}009\;(baik)$$

4.4 Implementation

The implementation of the tools and systems that have been planned in this final project is adjusted to the needs of the work area, the plan has been prepared, calculated carefully and in detail as it should be. The application of the tool is carried out in order to get results in accordance with the plans and expectations of researchers. As in the base tool drive system, there are two DC motors as a power source. DC motor is as a mover forward, backward, turn right and left. Furthermore, the installation of the axle as a support for the base load of the TGV tool.

4.4.1 Drive System Implementation

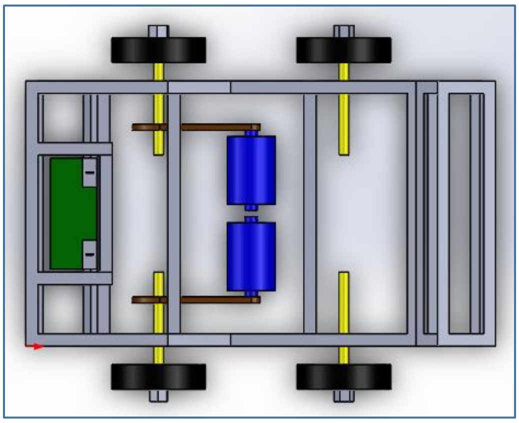

Figure 6. Schematic of the drive system

Caption :

- 12 volt battery: green color
- DC motor: blue color
- Chain and Sprocket: brown color
- Axle: yellow color
- Wheel: black color

As shown in Figure 4.16 in the drive system there are two DC motors that are used as a source of propulsion.

Functions or ways of working on the components of the drive system include the following:

- The main function of the 12 volt battery is to store electrical power which will be needed by a DC motor.
- The way a DC motor works in converting energy is to take electric power through direct current (battery) which is then converted into mechanical rotation.
- The chain and sprocket are part of the power transfer system of the TGV.
- The axle has the function of running TGV, where the axle is connected to a DC motor using a chain and sprocket.
- Wheels as a support / pedestal when the vehicle is moving.

4.4.2 Axle Implementation

The load-bearing system on the Tactical Ground Vehicle is supported by 4 wheels with the same dimensions and diameter (wheel diameter 15.2 cm), while the axle used is 16 mm because the allowable diameter is 4.13 mm.

4.5 Testing

The purpose of tool testing is to determine the ability of several processes carried out in the system that has been built, tool testing is carried out to find out and prove the results of the designs that have been made. The results of testing tools are part of the success of the system that has been designed previously.

4.5.1 System Testing

System testing is a determining part for the success of the previously designed system. A system is said to be successful if the tests carried out are in accordance with what has been planned. Although in various cases of system testing often deviant results are obtained, the system is said to be quite successful if the deviation is within the allowable limits.

4.5.2 Tool Movement Test

After the manufacture of tools and materials has been completed, the next stage is the manual movement experiment, after the experiment is moved manually by being pulled and pressed by the hand successfully, the next stage is testing using a remote control, aiming to determine the workability of several components in the machine. the system, including DC motor rotation, battery, chain system movement, and axle strength. In this remote test, the TGV base movement is able to move stably, able to withstand the existing load. In the test, several parameters are used, namely range (meters), time (seconds).

a. Testing tools on asphalt roads

From the results of testing the movement of the TGV base using a remote on a paved road, the tool is able to move stably.

b. Testing on grassy terrain

Tests on grassy terrain were carried out at the shooting range of the 464th Paskhas Command Battalion.

4.5.3 Testing of Shooting Tools

The shooting test using a Glock 26 organic pistol was carried out at the firing range of the 464th Paskhas Command Battalion with live ammunition. Shooting to the body is assisted by a pointer mounted on the tool which is then directed to the axis of the shooting target. The target of the shooting used is the body with a height of 170 cm and a width of 50 cm with a shooting range of approximately 10 meters. The results of the shot at the target can be seen in the image below.

4.6 Test Results

From the results of testing using a remote control, it can be concluded that for movement with a time of 1 minute on asphalt roads the average TGV is able to walk a distance of 100 meters, the movement system of components at the base of the TGV, especially the DC motor and axles on the wheels is able to withstand and run well.

5. CONCLUSIONS & SUGGESTIONS

5.1 Conclusions

Based on the results of planning, making a prototype Tactical Ground Vehicle (TGV) obtained several conclusions in testing the tool. During a period of approximately 6 months researchers conducted research and testing tools, the products produced were as expected as follows:

a. By calculating the total weight of the TGV and its equipment and from the experiment by weighing the TGV, the overall weight of the TGV is 50.6 kg, so a DC motor ex power steering with specifications of 12 Volt, 2000 rpm, and 10 A was chosen.

b. By calculating the total weight and determining the motor torque on the TGV device, then determining the transmission using a chain and sprocket. The choice of chain used a chain with a roller chain type with chain number # 25, the number of small sprocket teeth was 14 and the large sprocket was 41, while the four axles mounted on the TGV used axles/axles with a diameter of 16 mm because the result of the allowable diameter was 4.13 mm.

c. To drive a short-barreled weapon on the TGV, that is by installing a DC servo motor drive with specifications for an operating voltage of 5.0 – 6.8 DC V, torque of 21 kg.cm (5V) or 25 kg.cm (6.8V), and a speed of 0 ,15 sec/60° (5V).

5.2 Recommendations

Based on observations of the results of the design of the prototype base for the Tactical Ground Vehicle tool regarding the movement and strength of the wheel axle, the following suggestions are given:

a. For further researchers, it is hoped that the TGV body will be reduced so that the movement when operated is lighter.

b. For the drive system on the chain to be replaced with rubber to reduce noise when walking.

c. In the future for weapons, automatic pistols are made by considering the number of bullets more and adding silencers to make them silent.

d. The front bulge on the TGV body is removed and the front wheel position is shifted forward.

e. Development is not limited to the base tool but the system in this mechanism can be implemented on other objects.

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