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FABRICATION OF MULTI TERRAIN FIREFIGHTER VEHICLE WITH SLEWING AND TILTING NOZZLE

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Abstract: Fire accidents and wildfire spread occurs in many places across the globe. Several lives, properties and resources get converted into ashes due to fire accidents / wildfires every day. Apart from the loss of lives and property, fire accidents will also damage environment by releasing huge amounts of pollutants into environment. As a one-step solution to above problem, we are planning to fabricate a prototype multi-terrain fire fighting vehicle that can travel on flat as well as in rough terrains and quinch the fire with least human efforts.

Index Terms **– Mild steel; Electric Motor; Gears and Bearings.**

I. INTRODUCTION

Firefighters often face challenges when handling high-pressurized nozzles during firefighting operations. The force exerted by these nozzles can be substantial, making it physically demanding for firefighters to maintain control. The water stream's powerful recoil can lead to fatigue, affecting their ability to effectively manage the nozzle and direct the water flow accurately. In addition, the high-pressure environment adds an element of danger, requiring skilled and experienced personnel to handle the equipment safely. The proposed firefighting machine incorporates motors for tilting and gears for rotating the nozzle head platform. This design allows for precise control over the direction and angle of the water stream, providing firefighters with a tool that is not only powerful but also highly maneuverable.

II. LITERATURE REVIEW

2.1 Firefighting Truck

The present-day firefighting truck is commonly equipped with flashy illuminations, deafening alarm bell, and a water tank. one among the most important, most outstanding indications of a fireplace scene is the top-notch massive size and red colored firefighting truck. An ancient age water pump carrying trolley is transformed as an appropriate automobile carrying all the critical gadgets including ladders, electricity tools and rescue tools as the car moves from the fireplace station to the fireplace scene.

2.2 History

There is no doubt approximately the fact that fires are as vintage because the complete human civilization which is why groups and societies have continually felt the want to give you organized ways to guard themselves from unpredictable fires Also, considering how the world itself and populations have improved so swiftly with rural regions and concrete regions becoming so densely-packed the want to give you fire protection strategies at a civic stage had multiplied an excellent deal.

2.3 Water Pumps on Wagon Wheels

The primary ever fireplace apparatus that came into lifestyles changed into the pumps-on-wheels gadget which basically included a water supply pump that became established on to a wood chassis there has been additionally a huge lever connected to this framework whose fundamental purpose became to offer an area to the firefighters to rest their toes

III. RESEARCH METHODOLOGY

The methodology section outline the plan and method that how the study is conducted. This includes Universe of the study, sample of the study, Data and Sources of Data, study's variables and analytical framework. The detailsare as follows;

3.1 Part Design

We have drawn 2 squares of width 25mm which are 250mm distance apart from each other and we have used pad command to generate 3D of the sketch for length 350mm with thickness 2mm and we have used pad command to generate 3D of the given sketch for length 180mm and we have drawn a profile of width 25mm, length 273mm and another length 248mm and we have generated rotation mechanism base support plate for length 2mm and we have generated motor support plates using pad command for length 2mm and we have generated motor support plates using pad command for length 2mm.

3.2 Rocker

We have drawn a square sketch of width 20mm using rectangle command and we have given pad command to the sketch to develop a square pipe of length 200mm and we have drawn circle of diameter 6mm at distance 10mm from one edge and we have used pocket command to make a hole of 6mm on the pipe and we have developed another 20m square pipe perpendicular to the given pipe and we have developed motor support plates on the ends of rocker.

3.3 Rotation Mechanism

We have developed rotation mechanism by using various commands and we have developed the wheel of diameter 70mm and 40mm with shaft diameter 6mm.

3.4 Assembly Design

We have assembled all the parts together using various methods as shown in Figure 3.1.

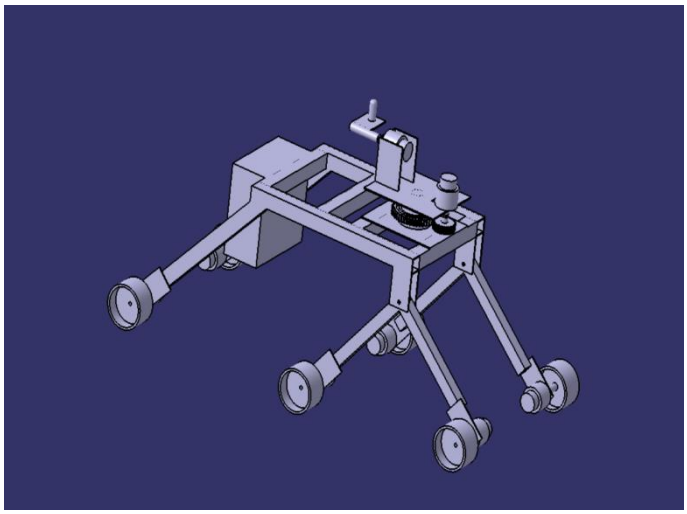

Fig. 3.1 Design of Multi-Terrain Fighter vehicle

3.4 Parts Preparation

We have marked the plate at a distance 60 mm from its edge and 55 mm from previous point using measuring and marking tools and we have performed drilling operation on the MS plate with the help of using radial arm drilling machine with 6 mm drill bit and gradually increased drill sizes to form 13 mm diameter hole and we are slightly cutting marked plate for bending into C- shape and grinding the drill surface part and we have obtained Motor case by cutting and bending at specified dimensions and it is checked by Tri square measuring tool.

3.5 Rotating Plates

We have taken a mild steel (MS) plate of width 150 mm and thickness 2mm and we have marked the plate at a distance 150 mm from its edge using measuring and marking tools and we have performed a cutting operation using an angle grinder with respect to the markings and we grinded the plate using an angle grinder to remove cutting chips and better surface finish and we have marked the plate at a distance 55 mm from its edge using measuring and marking tools and we have performed a cutting operation using an angle grinder with respect to the markings.

We have marked a rectangular slot of 13 x 40 mm(s) from one side plate and cutting to obtain the rectangular slot and for another plate we have marked centre and made a square hole of dimensions 25 x 25 mm(s) and cut the square part and we have taken a hollow pipe for rotating operation and a sleeve of 20 mm long ,50 mm internal diameter of 3mm thickness and Deep groove bearing of inner diameter 25 mm and outer diameter 52 mm as shown and we are Chamfering the hollow pipe using Angle grinder at an angle to attain the requirements of chamfer.

We have performed welding operation of sleeve over square plate, and hollow pipe over another square plate and we have marked the pipe at a distance 55 mm from its edge and 10 mm from the same edge for a hole of 3mm diameter using measuring and marking tools and we have taken a plate and marked the plate as 40 x 55 mm(s) from one side plate and making a drilling operation of 13 mm diameter from a distance 10 mm from on edge of plate and we have taken plastic spur gear 75 and 25 teeth’s i.e., in 1:3 and M-Seal and attached to the sleeve for rotation mechanism.

3.6 Chassis Fabrication

We have taken a square pipe of thickness 25 mm long and we have marked on the square pipe of distance 200 mm from its edge using measuring and marking tools and we have performed a cutting operation using an

angle grinder with respect to the markings and we grinded the pipe using an angle grinder to remove cutting chips and better surface finish and we obtain four square pipes by cutting the pipe by following above mentioned process and we have performed drilling operation on the square pipe with the help of using radial arm drilling machine with 6.2 mm drill bit.

We have performed welding operation of square pipe at an angle of 45 degrees using tri square and we grinded the plate using an angle grinder to remove cutting chips and better surface finish and we have taken a mild steel (MS) plate of width 100 mm and thickness 2mm and we have marked the plate at a distance 55 mm from its edge and 6mm drill bit from 10 mm from the same edge using measuring and marking tools.

We have performed a cutting operation using an angle grinder and radial arm drilling machine with 6 mm drill bit with respect to the markings and obtain the four plates and we have marked the square pipe at a distance 180 mm from its edge of 3 units, 350 mm of 2 units and 238mm of 2 units using measuring and marking tools and we have performed welding operation on joining square pipes to form chassis and joining with the square plate.

We have taken a mild steel (MS) plate of width 40 mm, thickness 2mm and respective drilling operation of 13mm diameter drill bit and we have marked the plate at a distance 70 mm from its edge using measuring and marking tools and we have performed a cutting operation using an angle grinder with respect to the markings and obtaining six pieces of plates and we have marked the MS plate of thickness 5 mm at a distance 7.5 mm from its edge and by drilling operation on MS plate with the help of using radial arm drilling machine with 3 mm drill bit a hole is made from 3 mm from its edge.

We have performed a cutting operation using an angle grinder by obtaining 2 plates with respect to the markings and we have obtained the plates, and the tank of 1½ litre capacity is fixed to it by screw and nut and welding operation is performed.

3.7 Wiring, Motors, And Wheel Assembly

We have taken remote with respective switches and wiring of 5 meters long and we have joined wiring as per vehicle requirements of movement and spraying of water switch and we have performed wiring to the remote controller and we have taken a positive displacement diaphragm pump of 12 volts and pipe of thickness 3mm and we have taken six drive wheels of 3.0 rpm, and another two for rotation and tilting of 3.5 rpm with wheels of 70 mm diameter and joining them and we have taken a brass nozzle and performed drilling operation of drill 1.5 mm and arranging the wire in proper order by taping.

We have obtained the prototype of wired-remote for better assistance of vehicle as shown in Figure 3.2.

Fig. 3.2 Fabrication of Multi-Terrain Fighter vehicle.

IV. RESULTS AND DISCUSSION

4.1 Analysis

We have applied Load 50N, Max Von-mises stress 2.4 x 105N-m2, Yield strength of MS (Mild steel) 210 to 240 x 106N-m2, max transitional displacement upon application of 50N is 0.000325mm which is negligible as shown in Figure 4.1.

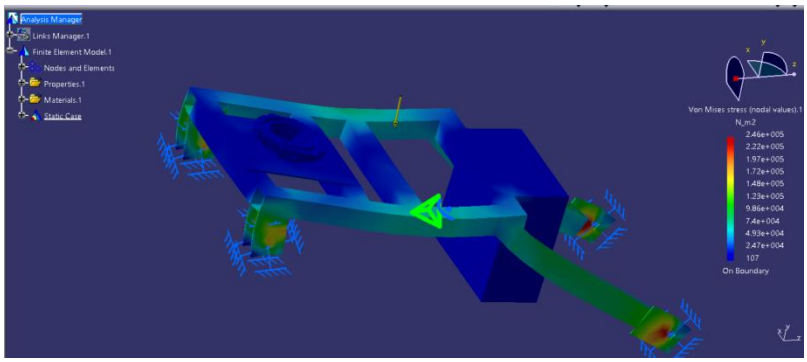

Fig. 4.1 Von-mises stress diagram

4.2 Nozzle Tilting Power Calculation

Table 4.1: Nozzle Tilting Power Calculation.

Mass of Nozzle Tilting arrangement(m_n)	=	0.75Kg
Radius of nozzle rotation(m)	=	25/1000
Force on shaft (F_n)	=	m x g
	=	0.75 x 9.81
	=	7.3575 N
Motor Speed of nozzle tilting (N_n)	=	3.5 rpm
Torque T	=	F x r
	=	7.3575 x 0.025
	=	0.1839N-m
Nozzle Tilting Motor Power P_n	=	2 x 3.14 x N x T/60
	=	2 x 3.14 x 3.5 x 0.1839/60
	=	0.068 Watts

The total power required for the nozzle tilting mechanism is 0.068 watts.

4.3 Pumping Power Calculation

Table 4.2: Pumping Power Calculation.

Flow Rate (Q)	=	1LPM
	=	1 x 60 /1000
	=	0.06 m^3 /hr
Density of water (ρ)	=	1000 kg/ m^3
Head of the pump (h)	=	1bar
		10 meters
Acceleration due to gravity (g)	=	9.81 m/s2
Power (P_p)	=	Q x ρ x g x h /3.6 x 1000
	=	0.06 x 1000 x 9.81 x 10 / 3.6 x1000
	=	1.635 Watts
Total power consumption = P_n+ P_r+ P_p	=	0.068 + 0.8086 + 1.635
	=	2.511 Watts
Range of spraying water	=	10 metres.

The total power required for the pumping operation is 1.635 watts.

The total power required for tilting, rotating, pumping is 2.511 watts.

That means after charging the battery for ½ hour we can use the vehicle for (30min /1.635 Watts) = 20 minutes, which is sufficient for the vehicle to spray water at the fire.

4.4 Conclusion

Through direct contact with firefighters, it was possible to acquire knowledge about which would be the most relevant vehicle to fight forest fires. The selection was unanimous, and the target vehicle of study was the Forest Fire Fighting Vehicle In order to study the general mechanical condition of the FFFVs, it was necessary to begin by deepening the knowledge about them, investigating their main equipment and the procedures used to maintain them in proper operating condition. It was quickly perceived that, although vehicles from different manufacturers and with different ages were being analyzed, most of the main equipment was similar and the inspections and maintenance carried out on each vehicle were the same within the same fire brigade.

When contacting different FBs, it was found that there are no standardized inspection and maintenance programmers, leaving it up to each fleet manager to execute his own plan. This way, some of the tasks that should be performed to maintain the vehicle's competence end up being neglected Research was then carried out on which failures could occur in the components of the different systems of these vehicles, what their potential causes were and what treatment action should be taken. Through the collaboration of firefighters from the different FBs, a degree of severity, probability of occurrence and detectability was assigned to each fault, thus forming a Failure Modes, Effects and Criticality Analysis.

Through the analyses carried out, it was found that many of the potential failures represent a risk, not only for the functioning of the FFFV, but also for the safety of its operators (firefighters). For these faults and for those that have a low detectability, which means that specialized personnel are needed to identify them, preventive maintenance should be carried out. On the opposite hand, when the severity of the fault is low and detectability is high, corrective maintenance can be executed. Along this study, the importance of carrying out inspections, maintenance programmers and recording the interventions carried out was proven.

V. ACKNOWLEDGMENT

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