

DESIGN OF TRANSPORT TRAILER FOR FIRE FIGHTING ROBOT

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DESIGN OF TRANSPORT TRAILER FOR FIRE FIGHTING ROBOT

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SUPERVISOR'S DECLARATION

I have checked this report and the report can now be submitted to JK-PSM to be delivered back to supervisor and to the second examiner.

Signature :

Name of Supervisor :

Date :

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor Of Mechanical Engineering (Design & Innovation).

Signature :

Supervisor Name :

Date :

DEDICATION

To my beloved parents (Mr. Sayoti bin Sanuri & Mrs Jamiah bt Mustam)

Supervisor (Ir. Dr. Tan Chee Fai)

Friends and housemate

ABSTRACT

Fire fighters always exposed to danger during their duty in order to save peoples live. Invention of fire fighting robot was a big helps to them as they could avoid danger during the duty. Several countries had participated in the invention of fire fighting robot during the last decade. Each country has developed their own robot with various specifications and their own specialty. Major problem encountered by the fire fighters regarding the robot is their lack of speed. With average speed of 10 km/h, it became a big problem during emergency cases. Thus, a transport trailer were needed to bring the robot to the fire scene. This research present about developing a transport trailer for the fire fighting robot. The content of this research is about choosing suitable design, size and material. Basically, the design was developed suitable with size of fire fighting robot in Malaysia. As for the material of the design, two type of material which is aluminium alloy and structural steel is compared to find the most suitable type of material for the trailer. Then, the design of the trailer is developed and 3D modelling is done by using SOLIDWORK software. Next, analysis of the design is done by using ANSYS software.

ABSTRAK

Ahli bomba sentiasa terdedah kepada bahaya semasa tugas mereka untuk menyelamatkan orang-orang hidup. Ciptaan memadamkan api robot adalah besar membantu untuk mereka kerana mereka boleh mengelakkan bahaya semasa duti. Beberapa negara telah mengambil bahagian dalam penciptaan memadamkan api robot sepanjang dekad yang lalu. Setiap negara telah membangunkan robot mereka sendiri dengan pelbagai spesifikasi dan khusus mereka sendiri. masalah utama yang dihadapi oleh anggota bomba mengenai robot adalah kekurangan mereka kelajuan. Dengan kelajuan purata 10 km / h, ia menjadi satu masalah besar semasa kes-kes kecemasan. Oleh itu, sebuah treler pengangkutan diperlukan untuk membawa robot ke tempat kejadian api. Kajian ini ini kira-kira membangunkan treler pengangkutan untuk robot memadam kebakaran. Kandungan kajian ini adalah tentang memilih reka bentuk yang sesuai, saiz dan material. Pada asasnya, reka bentuk telah dibangunkan sesuai dengan saiz memadamkan api robot di Malaysia. Bagi bahan reka bentuk, dua jenis bahan yang adalah aloi aluminium dan keluli struktur berbanding untuk mencari jenis yang paling sesuai bahan untuk treler. Kemudian, reka bentuk treler dibangunkan dan pemodelan 3D dilakukan dengan menggunakan perisian SOLIDWORK. Seterusnya, analisis reka bentuk dilakukan dengan menggunakan perisian ANSYS.

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LIST OF ABBEREVATIONS

JPJ	Jabatan Pengangkutan Jalan
CATIA	Computer Aided Three-dimensional Interactive Application
IAFF	International Association of Fire Fighters
USA	United States of America
PDS	Product Design Specification
ASF	Audi Space Frame

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Fire fighting is a risky works which is involving act of extinguishing fire in order to save life and prevent destruction of property. This works are done by fire fighters that were trained technically to perform the job. Fire fighters are exposed to danger during performing their job as they need to go near to the fire scene. Example of the hard that they need to face are toxic environment created by combustible materials, falls and structural collapse. Many accidents involving fire fighter during performing their job has been reported throughout the years.

In order to prevent accidents and injuries, a fire fighting mobile robot has been designed. This robot was able to reduce the direct contact of the fire fighters to the fire scene as it was remotely controlled. It is widely used nowadays as it is very effective in extinguishing fire and can be handled easily. There were various type of the robot has been developed in many difference countries.

Example of fire fighting robot is MVF-5 and LUF 60 as shown in figure 1.1 and figure 1.2. Fire fighting robot comes with difference specifications that make them able to perform fire fighting job. For example, LUF 60 is diesel powered and equipped with air blower and rubber

track system. The rubber track system enables the robot to climb the stair. The monitor nozzle has a flow rate up to 800 GPM and it can blow the water beam as far as 80m. As for MVF-5, it is equipped with high-pressure cannon on a hydraulic arm that pumps water up to 55 m away. The MVF-5 has a high-temperature-resistant fire protection shield. The protection shield is able to withstand 700 C for 15 minutes or 400 C for 30 minutes. The MVF-5 can spray 2000 liters of water per minute.



Figure 1.1 : MVF-5 Autonomous Fire Fighting Machine



Figure 1.2 : LUF60

Example of other robot specifications is shown below:

Table 1.1 : Fire Fighting Robot Specifications

Model	Weight(kg)	Length(m)	Width(m)	Height(m)	Speed(km/h)
Firemote 4800	450	1.40	0.70	1.14	4.5
FFR-1	940	1.14	1.62	1.38	3 - 4
Service Robot FIREROB	250	1.30	0.69	0.39	3
JMX LT50	1500	2.40	1.44	1.56	12

There are different specifications of different model fire fighting robot. All the specifications and features for the robot make the job to extinguish fire easier and safer. However, this robot has one crucial problem which is mobilizing. Although it is equipped with tracks and wheels, this robot speed is only between 3km/h to 10km/h which make it very slow.

That speed would be sufficient for the robot to mobilize at the fire scene but not for the robot to move from the fire station to the scene.

Thus, this research was done in order to give a solution to this problem. The main purpose of this research is to design and develop a transport trailer for the fire fighting robot to help it to reach the fire scene as soon as possible. However, the design of the transport trailer must be following Department of Road Transportation Malaysia. Details such as safety sticker and reflector must be included on the trailer to follow the road safety. Besides that, the design parameter such as shape, weight, size and type of material must suitable with the robot. This is to ensure the smoothness of the work to be done and as safety precautions.

1.2 PROBLEM STATEMENT

Fire fighting is a risky work as fire fighters are exposed to many dangerous situation and fire hazard in order to save life and property. There were many accidents that had happened to fire fighters whether or not involving their life. Although they are equipped with safety suit, helmet and tools, they are still exposed to danger as they need to go near to the fire scene.

Recently, an automatic fire fighting robot was developed in order to reduce loss of lives and risk of danger to fire fighter during fire incident. Fire fighting robot is a mobilize remote controlled machine that can that replace fire fighter to extinguish fire. This robot was able to reduce the direct contact of the fire fighters to the fire scene as it was remotely controlled. This fire fighting robot is widely used nowadays. Although the robot can be mobilize, but the speed is very slow which is from 3km/h to 10km/h as it is mainly using steel track or rubber track.

Thus, it becomes the main problem for the robot as it needs to travel from the fire station to the scene as fast as possible.

The solutions that can be suggested is by design and build a transport trailer for the fire fighting robot to travel from the fire station to the scene. The design of the transport trailer must following specifications that had been drafted by Department of Road Transportation in Malaysia (JPJ). Besides that, type of material that will be use also important for the trailers. The material must have characteristic that suitable to transport the heavy robot. Characteristic that need to be consider is strength and ductility. This properties is very important for the trailer to avoid accident and mishap during the travelling of the robot. Other than that, the design of the trailers must be suitable with the specifications of the robot. The trailer must be wide and long enough for the robot to be place.

1.3 OBJECTIVE

The objective of this research is :

1. To design a transport trailer for mobilizing a fire fighting from fire station to fire scene.
2. To choose a suitable material that will be used for the transport trailer.
3. To design a transport trailer for fire fighting robot based on suitable specifications and pass Jabatan Pengangkutan Jalan's(JPJ) law.
4. To develop prototype of the transport trailer for the fire fighting robot from the research that had been done.

1.4 SCOPE OF PROJECT

1. To do a research about fire fighting robot specifications in order to design a transport trailer for the robot.
2. To do a research about JPJ's law involving transport trailer specifications.
3. To design the trailer from the research that has been done by using drawing software such as SOLIDWORK.
4. To analyze the design's structure stress analysis by using Finite Element Analysis in ANSYS software.

CHAPTER 2

LITERATURE REVIEW

2.1 Fire Fighting Mobile Robot

In order to reduce the risk of injuries to the fire fighters, mobile fire fighting robot was used to replace the fire fighter at the fire scene. IAFF (2000), state that: “There are 1.9 firefighters are killed per year in the USA, per 100,000 structure fires”. Thus, the research and developing fire fighting robot project has been done by a few country such as U.S.A and China over the past few years. There are various types of fire fighting robot that produced by different countries. Each robot has different specs. We can see the specs of the different type of robot at **table 2.1:**

Table 2.1 : The comparison of current fire fighting robot from the source (Fire Fighting Mobile Robot: State of the Art and Recent Development, Tan, C.F., and H.F. Kong, 2013)

Specification	LUF60	FFR-1	FIREMOTE-4800	MVF5	JMXLT50	SACI	ArchiBot	Thermite	FFM3000
Size (L x W x H)	2.3 x 1.35 x 2 m	1.62 x 1.14 x 1.38 m	1.4 x 0.7 x 1.14 m	3.8 x 2.18 x 2.1 m	2.44 x 1.44 x 1.56 m	1.8 x 1.5 x 1.6 m	1.4 x 0.8 x 0.65 m	1.88 x 0.89 x 1.4 m	1.5 x 1.0 x 1.3 m
Speed (km/h)	6	4	4.5	12	12	12	20	20	2.36
Power source	Diesel engine	Battery	Battery	Diesel engine	Diesel engine	Battery	NA	Diesel engine	Battery
Control	Radio control	Wireless control	WiFi	Remote control	Radio control	Radiocontrol	NA	Radio control	Radio control
Weight (kg)	2000	940	450	9274	1500	NA	450	744	910
Price (USD)	200,000	NA	NA	NA	49,000	NA	NA	98,000	40,000
Origin	Austria	US	UK	Croatia	China	Brazil	Korea	US	Malaysia