

**DESIGN AND ANALYSIS OF MECHANISM USED IN A FIRE FIGHTING
MACHINE**

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“I hereby declared that I have read through this thesis and found that it has comply the partial fulfillment for awarding the Degree of Bachelor Mechanical Engineering (Design & Innovation).”

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With the name of Allah, The Most Gracious and Most Merciful

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ABSTRACT

Fire fighting machine is a machine used to help fire fighters to extinguish fire especially when faced with the critical situation where fire fighters are unable to carry out the duty effectively. By using the fire fighting machine to extinguish fire, the risk of injuries and death of the fire fighters on the duty line can be reduced. The design of the machine enables it to operate in any state of topography features. The machine is equipped with portable fire extinguisher which is provided in the machine and enables it to operate without using supplies from outside. The machine is also providing water supply which is achieved from hose reel system that is installed in the most of building. Besides, the fire fighting machine is equipped with remote control device which is enables it to control the fire safely without needs to enter the flammable areas. The machine is powered by rechargeable battery. FEA software is used to analyze the final design to ensure that the structure of the machine can withstand load experienced by the machine. The machine is fabricated and tested to ensure that the machine is complied the specifications and able to operate effectively.

ABSTRAK

Mesin memadam kebakaran adalah mesin yang digunakan untuk membantu ahli bomba memadamkan kebakaran dengan segera terutamanya pada keadaan kritikal yang mana ahli bomba tidak dapat menjalankan tugas dengan berkesan disebabkan oleh kebakaran yang serius. Dengan menggunakan mesin memadam kebakaran ini, kadar kecederaan dan kematian ahli bomba semasa bertugas dapat dikurangkan. Rekabentuk mesin ini membolehkan ia beroperasi dalam ape jua keadaan bentuk muka bumi. Ia dilengkapi dengan sistem pemadam kebakaran mudah alih yang telah disediakan di dalam mesin memadam kebakaran dan membolehkan ia beroperasi tanpa menggunakan sumber bekalan dari luar. Selain itu, mesin ini juga menyediakan sumber bekalan pemadam api dari luar yang disalurkan melalui sistem gelung hos yang telah dipasang di dalam sesebuah bangunan. Mesin memadam kebakaran ini juga dilengkapi sistem kawalan jauh yang membolehkannya mengawal kebakaran pada jarak yang jauh dengan selamat tanpa perlu memasuki kawasan kebakaran. Sistem bekalan kuasa mesin memadam kebakaran ini pula diperolehi dengan menggunakan bateri. Perisian FEA digunakan untuk menganalisis rekabentuk akhir bagi memastikan struktur mesin memadam kebakaran ini kuat dan kukuh. Langkah terakhir adalah mengfabrikasikan dan menguji mesin memadam kebakaran ini untuk memastikan ia mengikut spesifikasi yang telah ditetapkan dan beroperasi dengan baik.

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ANNOTATION

USFA	= United State Fire Administration
NFPA	= National Fire Protection Association
CAD	= Computer Aided Design
FEA	= Finite Element Analysis
PDS	= Product Specification Design
HoQ	= House of Quality
FDNY	= New York City Fire Department
WTC	= World Trade Centre
NYS	= New York State
ROV	= Remotely Operated Vehicles
GPRS	= General Packet Radio Service
LODD	= Line of Duty Deaths
USDL	= United State Department of Labor
CATIA	= Computer Aided Three Dimensional Interactive Application

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CHAPTER 1

INTRODUCTION

1.1 Background

As we had known, fires and emergencies cases are increasingly day-by-day and these occurrences have been sacrificing lives and destroy property for every year. To confront this situation, fire fighters are responsible to protect the public by responding against this situation immediately. There are a lot of risks should be taken by fire fighters while extinguishing the fires. They exposed to danger situation such as building collapsed, high heat rate areas and poisonous smoke.

This project is to tackle the problem and a research has been carried out to help fire fighters to put out the fire by using remotely controlled machine to danger area. As a result, the risks of injuries or fatalities for fire fighters in the line duty could be reduced.

1.2 Problem Statement

Fire fighting is risky profession. This is because, fire fighters are not only have to drag heavy hoses, climb high ladders and carry people from building but they also must face with critical situation such as exposed to the hazard while preventing and clean-up of hazardous materials and entered aflame building which risky exploded caused by combustible material. Besides, not for all burns can be put out immediately because of the difficulties for the fire fighters to approach the areas of the fire with extreme temperature. Furthermore, their equipments such as their clothing not fully protect them to face with this situation. Because of that, they have to risk themselves by exposing to the danger situation which could caused injuries and lose their lives in the line of duty.

To solve this problem, a research has been executed which can help to reduce the risk that faced by the fire fighter and also help to control and extinguishing fires process. Machine systems are already identified as appropriate system to help fire fighters to face with this critical condition. By applying this system to the danger situation, the risk of injuries and death can be reduced and also can controlling the fire in the safe distance. This is because the operator of the machine is able to control the machine in the long distance without entered the flammable building or near to the fires. Besides, the machine is able to enter the narrow areas because of the compact design.

1.3 Objective

There are three objectives of this project:

- To design mechanism for existing fire fighting machine in other to help fire fighters to put out the fire effectively.
- To analyze the designed mechanism by using *Cosmosworks* software.
- To fabricate and install the mechanism to the existing fire fighting machine.

1.4 Scope of Study

The scope of the study that consisted in this thesis accomplishment is:

- To identify the weaknesses of existing fire fighting machine and improved it so that it can be operate more efficiently.
- To determine the appropriate method and mechanism and this is used to help fire fighters to put out the fire effectively.
- To analyze and predict the constraint and limitation of the design by using *Commosworks* software.
- To perform hands on job modification/improvement and installation of mechanism to the existing fire fighting machine.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

As we had known, fire fighting is a dangerous profession. For every year, the number of death due to fires is at a high level. The fire fighters are responsible to protect the public from this danger and needs to be more alert with the critical situation. The duty for fire fighters is flexible and may change several times depend on the emergency situations. Sometimes, they have to work days and nights to prepare themselves before any incidents or emergencies occurs. They also have to enter the flammable building to save the victims who are unable to leave the building safely. Sometimes, they also exposed to the hazard because they also have to extinguish fires occurred by hazardous materials. Therefore, a research needs to carry out to reduce the number of death among the fire fighters and also protect them from this danger. This chapter also covers about statistic of fire fighter fatalities and the existing product for the fire fighting machine.

2.1 Statistic of Fire Fighter Fatalities

There are many fire fighters are lose their lives in the line of duty each year throughout the world. The statistics of the fire fighter fatalities are still maintain at high level every year and it will continue to increase over the next decade. In this chapter, there are attached three statistics of fire fighter facilities in United State, Netherlands and New York.

In the USA, the traumatic death rate amongst firefighters shows that 1.9 firefighters are killed per year, per 100,000 structure fires which is the rate only slightly lower than that obtained in the early 1980s. However, this rate increasing to 3.0 per 100,000 structure fires across a thirty year period which is peaking in the 1990s. There are many causes for Line of Duty Deaths (LODD) such as smoke inhalation, burns, crushing injuries and related trauma. All this statistics above are strictly related to firefighting operations and exclude all other causes of death, such as heart attacks and road accidents en-route etc [1].

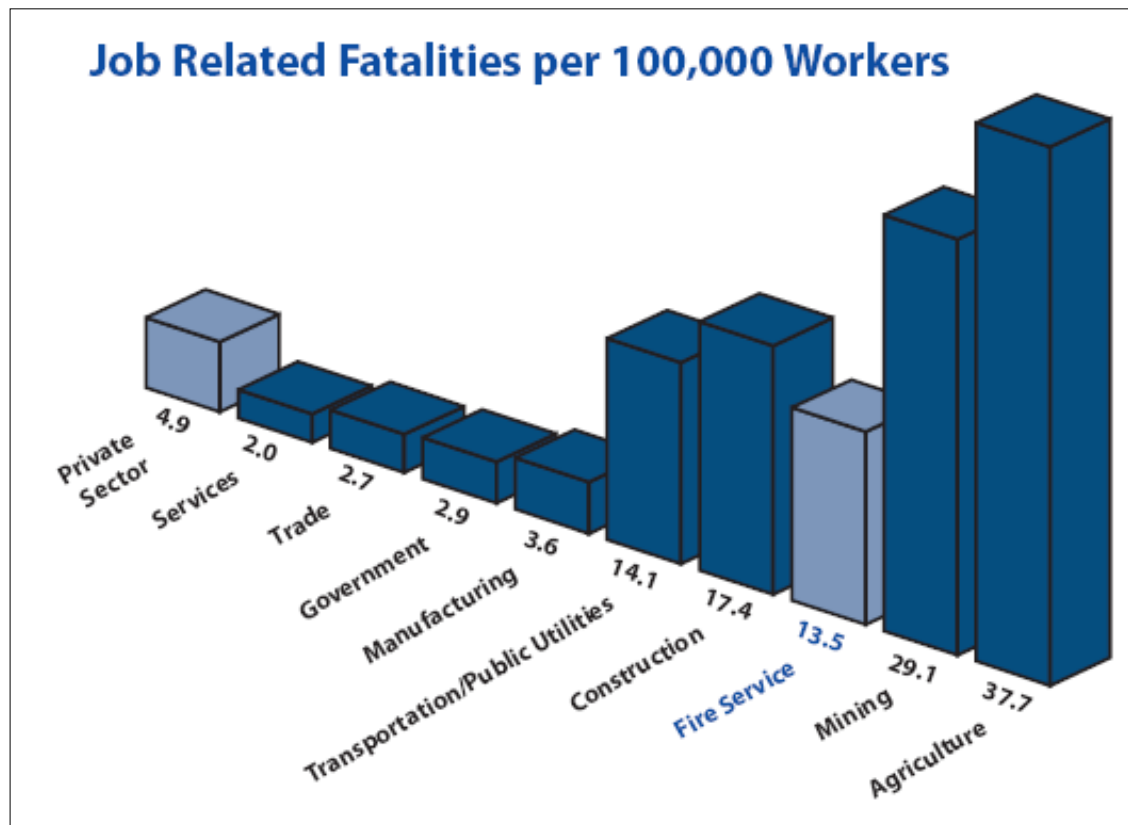


Figure 2.1: Statistic of Job Related Fatalities per 100,000 Workers

(Source: National Census of Fatal Occupational Injuries, 1998; USDL 99-208, U.S. Bureau of Labor Statistics; Public Safety Officers' Benefit Program; U.S. Fire Administration; and U.S. Bureau of Census.)

Based on the bar chart above, we know that the fire service is 13.5% of the job related fatalities which is the fifth higher percentage from this statistic. So, we can conclude that fire fighter occupation is one of the dangerous professions.

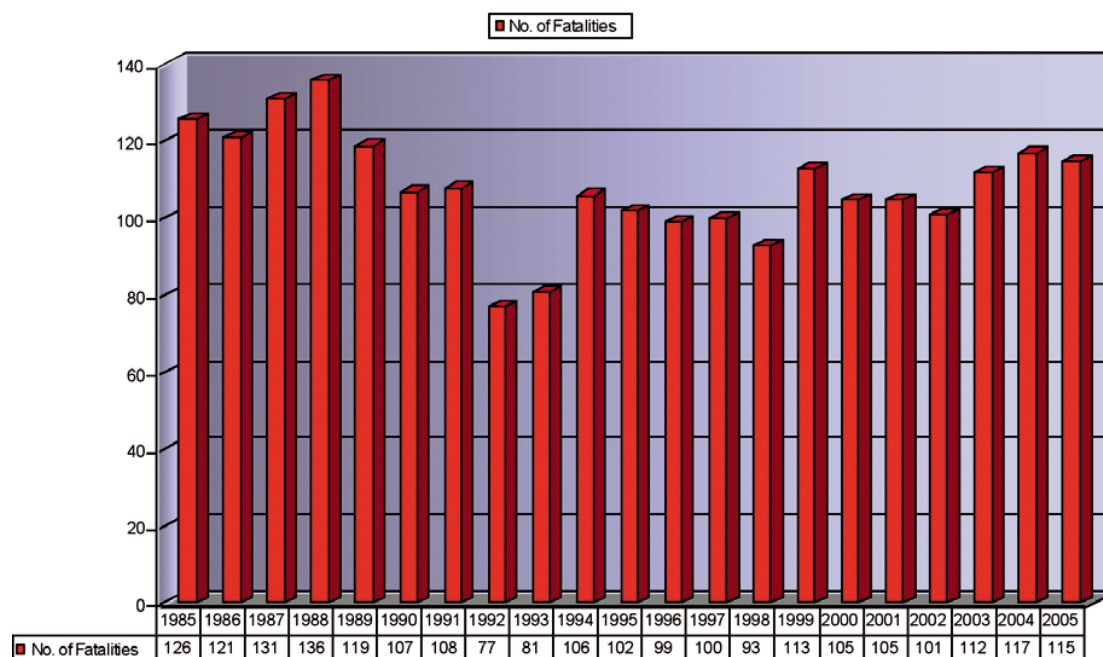


Figure 2.2: Firefighter Fatalities in the United States 1985–2005

(Source: Firefighter Fatalities, USFA, 2006)

Based on the statistic above we know that, the highest number of fire fighter fatalities was in year 1988 which involved about 136 people in this year while the lowest number of the fire fighter fatalities was in year 1992 which involved about 77 people. For another year shows that the statistic are remain the same at the high level. The statistic above achieved from the investigating those carried out from year 1985 until 2005.