UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND FABRICATE A PROTOTYPE OF FIRE SAFETY WINDOW GRILLE FOR RESIDENTIAL UNIT

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours.

by

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DECLARATION

I hereby, declared this report entitled “Design and fabricate a prototype of fire safety window grille for residential unit” is the results of my own research except as cited in references.

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Date : 11/1/2018

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirement for the Degree of Engineering Technology (Maintenance Technology) with Honour. The member of the supervisor is as follow:

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(Project Supervisor)

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ABSTRACT

Fire is a chemical reaction involving the rapid oxidation or fuel burn. In case of fire on building, mostly resident being trap inside their house is due to the window or door grille installed permanent fixed on the wall. They have struggle and difficulties to open the window or door causes by the grille and cause the people drowned and burned to death. Helpers also struggle to rescue the victims because most of the grilles are locks from inside. From this point of view, this project is to fabricate a prototype of a window grille that can be unlocked or open easily when detecting a temperature of 70ºC and above. Furthermore, this project is to facilitate the victims getting out from house easily in the event of fire and to ease rescuers to enter the house. To fabricate the prototype of a fire safety window grille for residential unit, this project has been constructed a new design of window grille according to the appropriateness of the use of complementary features as fire safety equipment. The limitation of this project is to design and fabricate safety window grille for residential building only and the design specification is only for window grille and its sensors. Furthermore, the window grille will be unlock when the fire reach the temperature 70ºc and above. Lastly, the physical properties of window grille will be tested for failure analysis.

ABSTRAK

Api adalah tindak balas kimia yang melibatkan pengoksidaan yang pesat atau bahan api yang terbakar. Sekiranya berlaku kebakaran pada bangunan, kebanyakanya mangsa kebakaran terperangkap didalam bangunan adalah disebabkan oleh jeriji tingkap dan pintu yang dipasang tetap dan kekal di dinding. Mereka menghadapi kesukaran dan bergelut untuk membuka dan tingkap disebabkan oleh jeriji yang telah dipasang dan menyebakan mangsa lemas dan teribakar hingga mati. Penyelamat juga bergelut untuk menyelamatkan mangsa kerana sebahagian besar jeriji telah dikunci dari dalam. Dari sudut pandangan ini, projek ini adalah untuk merekabentuk prototaip jeriji tingkap yang boleh dibuka atau terbuka dengan mudah apabila mengesan suhu sebanyak 70ºC dan ke atas. Tambahan pula, projek ini adalah untuk memudahkan mangsa keluar dari rumah dengan mudah sekiranya berlaku kebakaran dan untuk memudahkan penyelamat untuk masuk ke rumah. Untuk merekabentuk prototaip keselamatan kebakaran jeriji tingkap bagi unit kediaman, projek ini akan membina reka bentuk yang baru bagi jeriji tingkap mengikut kesesuaian penggunaan ciri-ciri pelengkap peralatan keselamatan kebakaran. Skop untuk menghasilkan projek ini adalah untuk merekabentuk dan fabrikasi tingkap jeriji keselamatan bagi bangunan kediaman sahaja dan spesifikasi reka bentuk adalah hanya untuk jeriji tingkap dan sensornya. Tambahan pula, jeriji tingkap akan terbuka secara automatik apabila api mencapai suhu sebanyak 70ºc dan ke atas. Akhir sekali, sifat fizikal jeriji tingkap akan diuji untuk analisis kegagalan.

DEDICATION

To my beloved parents Md Ilias Bin Abd Jalal and Tuminah Binti Sakik.

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First of all, I am very grateful to Allah S.W.T for His blessing I was able to complete the bachelor degree project report 1 with successfully. Despite the fact that there are some problems and difficulties that I faced while completing this report, I was able to fulfil my responsibility as a student to complete this work.

Besides that, I would like to thank my supervisor Mr. Khairil Amri Bin Kamaruzzaman on cooperation and effort he provided to complete this report. All suggestions and guidance that he provided has been making it easier to complete the work to achieve the objectives in this study. I greatly appreciate the efforts and the assistance he provided to me and I'm very thankful to him.

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LIST OF ABBREVIATIONS AND NOMENCLATURES

JBPM	-	Jabatan Bomba dan Penyelamat Malaysia
PFA	-	Perfluoroalkoxy Alkane
AFP	-	Active Fire Protection
CO2	-	Carbon Dioxide
NFPA	-	National Fire Protection Association, United States of America
PFP	-	Passive Fire Protection
RTD	-	Resistive Temperature Detector
Fe	-	Iron
ASTM	-	American Society for Testing and Materials
CAD	-	Computer-Aided Design
MIG	-	Metal Inert Gas
WDS	-	Welding Data Sheet

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CHAPTER 1

INTRODUCTION

1.1 Project Briefing

Nowadays, the risk of people being trapped inside a house when the house or building is on fire is high. In the case of fire, most residents will be trapped inside their house because the window or door grille is installed permanently on the wall. This project has been constructed with new design and has been fabricated a prototype of a fire safety window grille for residential unit. The objective is to minimize the risk of people being trapped inside the house and to facilitate the victims getting out from house easily in the event of fire. The window grille has been designed to provide a safety exit for the victims in case of fire. It is also to ease rescuers to enter the house. In terms of fire protection system, this project is categorized as an active fire protection with a combination of mechanical and electrical components. A mechanical device is attached to unlock the window grille and the electrical component is set up to detect the setting temperature in the event of fire. The heat sensor has been installed at certain location inside a house that has high risk potential of a fire.

1.2 Problem Statement

Fire cases involving residential buildings recorded a sharp increase each year. Fire can occur from a variety of ways such as a short circuit, cooking gas leakage, carelessness, and others. Fire can cause physical injury and mental, death, loss of property and shelter. There will be an increase statistics of fire in buildings every year if not being prevented.

Almost all houses in Malaysia have installed window grille and door grille in order to prevent thieves from entering the house. In most reported cases, victims died because of being trapped inside their residential unit. They have difficulties to open the window or door causes by the grille. Helpers also struggle to rescue people because most of the grilles are locks from inside. Based on the data by Jabatan Bomba dan Penyelamat Malaysia (JBPM), in 2013, a total of 5,817 fires cases were reported in Malaysia for all type of buildings and incidents involving residential building recorded the highest number compared to other type of buildings with 3,235 cases were reported. Although the purpose of window grill is to avoid thieves entering the house, at the same time it pose danger to residents in the event of fire. Residents have to install a window grille even though they realise the negative impact that can occur. Based on the statistic issued by the JBPM, they prohibit the installation window and door grille inside and outside the house. This disaster can be avoided if the security measures to deal with fire are being practiced appropriately and effectively.

According to JBPM, the majority of deaths in fires are due victims being trapped and they only have 60 seconds to get out of from the building, otherwise they would have drowned and burned to death. According to Assistant Director, Division of Fire Safety of JBPM, Datuk Rusmani Muhamad (2009), JBPM discourage permanently installed grille in homes or buildings because it prevents the residents to escape. Most deaths from fires in home are caused by victims suffocating from smoke inhalation and burns while trying to escape due to these permanently installed grilles. Other factors include the delays fire fighters to put off the fire. Fire fighters need to cut the metal bars to get into the building. Parts that have been cut will be

very sharp, hot and difficult to see in the thick smoke that can expose danger to fire fighters and victims when they want to get out from the building.

Based on the previous cases, the aims of this project is to design an active fire protection system for permanent installed grille on window. In the event of fire, the window grille will be unlocked when detecting an abnormal or increase in temperature on its surrounding and it can ease the process for victims to escape from the house. The window grille will be installed with heat sensor and the temperature detector can be set based on the environment situations.

1.3 Background of Project

The main objective of this project is to produce a new design prototype or innovation on the window grille so that risk of being trapped inside the house or premise can be minimized. Appropriate window grille design is to provide a safety exit in the event of fire. Furthermore, the aim of this project is to fabricate a prototype of fire safety window grille that can be unlocked automatically when it detects a temperature around 70ºC and above.

Building owners who do not take serious note of this matter can be charged under Fire Services Act 1988, Act 341 Fire and Rescue Department. A fine not exceeding RM 5000 or to imprisonment for a period not exceeding three years or both and can also be liable to a further fine of one hundred ringgit for each day during which the offense continues after conviction. Only grille with safety feature or safety exit is accepted under this law.

Lack of attention to the rules of fire safety to save residents from being trapped inside their homes must be considered so that the safety measure can be emphasized. Window grille is usually been fabricated using mild steel as the main material because it is cheap among other materials. Window grille mostly is designed permanent fixture on the wall and it will trap people in the event of a fire.

Mechanical thermostat has been chosen as a heat or thermal detector device and has been installed to the window grille. The function of electrical thermostat is device to detect the temperature on an element so that the system temperature is maintained close to the required set point. Perfluoroalkoxy Alkane (PFA) insulated cable and wire has been chosen for wiring circuit because it can resist operating temperatures up to 260 °C and has excellent physical strength for high temperatures condition. Mild steel material type has been selected to fabricate window grille because mild steel is malleable, ductile, tough, has good tensile strength and it is the cheapest compared to other materials. Solenoid 12V DC type has been used as a mechanical device to unlock the window grille when receiving a response from the thermostat when detecting high temperature.

1.4 Objective

From the problem statement, the objectives of the research are as follows:

1. To fabricate a prototype of a window grille that can be unlocked or open easily when detecting a temperature of 70ºC and above.
2. To facilitate the victims getting out from house easily in the event of fire and to ease rescuers to enter the house.

1.5 Scope

The scopes of this research are shown below:

1. To design and fabricate safety window grille for residential building only.
2. The design specification is only for window grille and its sensors.
3. To unlock when the fire reaches the temperature 70ºC and above.
4. To test the physical properties of mild steel for failure analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 Principle of Fire

Figure 2.1: Element of Fire (Source: www.risingleaders.weebly.com)

Fire is a chemical reaction involving the fuel burn or rapid oxidation. It only requires three elements for the fire to occur which is oxygen, fuel, and heat as shown in Figure 2.1. Fire cannot begin if any one of these factors is taken away or in case the fire already occurs extinguishment will happen.

The air for breathing contains about 21% oxygen and fire only requires an atmosphere with 16 % of oxygen at least. According to Quintiere, (2002) both heat and oxygen-restricting response process can influence fire behavior in a compartment. It means that oxygen is present in all situations especially in all type of buildings. However, if the other two elements were separated, it will have taken the first step towards for effective fire prevention.

Fuel can be any combustible material type in any state of matter which is liquid, solid, or gas. Most types of liquids and solids appear as a vapour or gas before they start to burn. Examples of possible fuel sources at the building include flammable liquids, clothing, curtains and furniture. Milke (2002) stated that, once a material is starting to burn, a fire spreads over the fuel component or object until it turns out to be completely involved.

Heat is an element that the energy requirements to increment the temperature of the fuel to a point where adequate vapour are emitted for start the ignition or spark to happen. Examples of possible heat sources include damaged electrical wiring, heating appliances, stoves and fireplaces.

2.1.1 Fire Behaviour

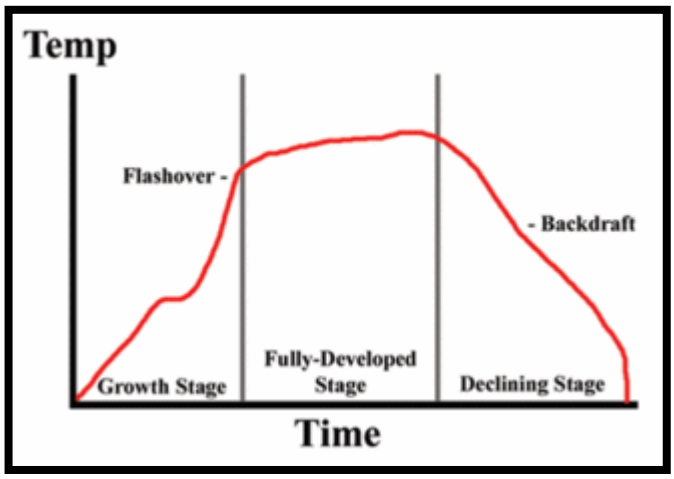

Figure 2.2: Graph of Fire Behaviour (Source: www.fireengineering.com)

According to Ashford et al., (2011) flames can happen in any setting, gave these 3 components are in nearness under the right conditions which are an oxidizer, fuel and heat or an ignition source. Fire behavior as shown in Figure 2.2 consists of three stage which is growth stage, fully developed stage and declining stage. For growth stage, it is where the fire will start to ignite with a slow rate of burning. The ignition temperature at growth stage is at lowest temperature which means that any combustible will reach fire state. Normally, it only takes at least 5 seconds to reach the flame point which is the temperature will continue to burn.