Faculty of Mechanical and Manufacturing Engineering Technology

DESIGN AND FINITE ELEMENT ANALYSIS OF FIRE SMOKE DAMPER

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Bachelor's Degree in Mechanical Engineering Technology (Refrigeration and Air-Conditioning Systems) with Honours

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DECLARATION

I declare that this project report entitled "Design and Finite Element Analysis of Fire Smoke Damper" is the result of my work except as cited in references.

Signature :_____

Name :_____

Date :_____

APPROVAL

I at this moment declare that I have read this project report. In my opinion, this report is enough in term of scope and quality for the award of bachelor's degree in Mechanical Engineering.

Signature :_____

Name :_____

Date :_____

DEDICATION

To my beloved mother and father

ABSTRACT

A good and effective fire safety of ventilation systems can prevent heat and smoke from spreading through the ventilation system. The combination of fire smoke damper can provide a greater efficiency of fire and smoke prevention compare to fire and smoke damper. Thus, the aim for this project is to improve the structural design of Fire Smoke Damper and reduce the cost of material by design a conceptual body structure of frame casing of Fire Smoke Damper in 2 differences geometry design with 3 differences surface thickness of damper frame and to determine the material strength develops in Fire Smoke Damper for each differences design surface thickness of damper frame in Case 1 (Geometry 1) and Case 2 (Geometry 2) by using by CATIA Finite Element Analysis. Moreover, aluminium material was selected as primary material for the design by Morphological Chart and Pugh Method in materials selection and sizing of Fire Smoke Damper structural design. Thus, the maximum Von Mises Stress, equivalent strain and total deformation rate in both cases will be compared and discussed.

ABSTRAK

Keselamatan kebakaran sistem pengudaraan yang baik dan berkesan boleh menghalang haba dan asap daripada menyebarkan melalui sistem pengudaraan. Gabungan penyadap asap api dapat memberikan kecekapan kebakaran dan pencegahan asap yang lebih besar berbanding kebakaran dan peredam kebakaran. Oleh itu, matlamat projek ini adalah untuk meningkatkan reka bentuk struktur Pemadam Asap Kebakaran dan mengurangkan kos bahan dengan merangka struktur badan konseptual rangka selongsong Damper Kebakaran Asap dalam 2 reka bentuk geometri perbezaan dengan 3 ketebalan permukaan ketebalan peredam dan untuk menentukan kekuatan bahan yang terbentuk dalam Damper Kebakaran Asap bagi setiap perbezaan ketebalan permukaan reka bentuk ketebalan peredam dalam Kes 1 (Geometri 1) dan Kes 2 (Geometri 2) dengan menggunakan Analisis Elemen CATIA Finite. Selain itu, bahan aluminium dipilih sebagai bahan utama untuk reka bentuk oleh Morfologi Carta dan Kaedah Pugh dalam pemilihan bahan dan saiz reka bentuk asap Kebakaran Merokok. Oleh itu, Tekanan Von Mises maksimum, ketegangan yang sama dan kadar ubah bentuk dalam kedua-dua kes akan dibandingkan dan dibincangkan.

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LIST OF SYMBOLS AND ABBREVATION

AFP	Active Fire Protection
PFP	Passive Fire Protection
FSD	Fire Smoke Dampers
FEA	Finite Element Analysis
NFPA	National Board of Fire
CFD	Computational Fluid Dynamics
HVAC	Heating Ventilation Air-Conditioning
FEM	Finite Element Method
ρ	Density
Pa	Pascal
Kg	Kilogram
V	Volume
D	Diameter
Mm	Millimetre
A	Area
σ	Stress
ε	Strain
E	Young's modulus
τ	Shear Stress
F	Force
m	Mass

CHAPTER 1

INTRODUCTION

1.0 Introduction

Nowadays, in this modern generation era, the fire prevention system is a need and vital piece of a building's infrastructure to secure valuable inventory and lives (Mattel Johnson, 2017). An effective fire prevention system can help extinguish the fire or control the fire, help in tenant departure, and protect property from harm. These systems can be isolated into two classes: active fire protection (AFP) and inactive or passive fire protection (PFP). However, like active fire protection require a trigger activity to work, and incorporate things like fire extinguishers, fire/smoke alerts, and sprinkler system. Passive fire protection frameworks can incorporate structure components, for example, fire and smoke appraised dividers and floors that are utilized to isolate portions of the structure.

As a component of the passive fire prevention system, fire/smoke appraised allotments and obstructions compartmentalize the building and forestall the spread of flame and smoke to the whole building. While infiltrating these obstructions with ventilation work ought to be maintained a strategic distance from if conceivable, at times it is fundamental. In these entrances, fire or potentially smoke dampers can be used to keep up the control of imperviousness to fire rating. There are three kinds of these dampers: fire dampers, smoke dampers, and new innovation of combination of fire/smoke dampers (FSD).

Fire dampers are designed and intended to forestall the spread of blazes over an appraised hindrance. A flame damper is installed inside the duct where the duct intersects

the obstruction. They work utilizing a heat sensitive device that, when actuated, melts and makes the damper segments close. A smoke damper can likewise be introduced inside the duct, and is enacted by a sign from a smoke locator inside the damper. Endless supply of smoke, the actuator will consequently close the damper segments. A combination of fire smoke damper are fordable to support prevent smoke and fire. Thus, it closes the damper segments upon detection of flame or smoke. A combination of fire/smoke damper can likewise contain an electric heat release device, which can be reset, and enables the damper to shut in an increasingly controlled manner, as opposed to pummelling shut when the electric heat release device dissolves. A combination of fire/smoke damper will likewise close upon the failure of electrical power, as they are held open by a fuelled actuator. This implies they can be interlocked with the structure fire caution framework to such an extent that they close in the wake of getting a sign from the fire alarm system.

1.1 Problem Statement

In this advanced generation with full of high rise buildings, an effective and pragmatic the ventilation systems of fire safety of was important to secure valuable inventory and lives, and to provide and ensure a safety working conditions for the rescue team. A fire occurrence must be limited before it develops into a disaster. Foremost to save lives, but also significant values may be lost. The requirements for personal safety and the emergency response capacity are very closely linked to the risk of fire spreading and stability of the building. A good and effective fire safety of ventilation systems can prevent heat and smoke from spreading through the ventilation system. Fire safety in ventilation plants is thus necessary in modern buildings.

According to the examination of National Board of Fire (NFPA) data in the 1930s, in 1939 the National Board of Fire Underwriters proposed that the dampers been selected and installed in HVAC systems must able to interrupt the passage of smoke, flame, and heat during a fire. Since that time, numerous experts in the field of the fire sciences have substantiated the effectiveness of automatic closing fire or smoke dampers and automatic fan shutdown in HVAC systems in preventing the migration of smoke, flame, and heat to areas of a building remote from the area of origin. Thus, John Knapp (2015) stated the limitation of the current Fire Damper is only operating to close the damper once the fusible link of fire damper is melt or the thermal sensor detected high rise temperature occurs in the ducting system. Thus, the smoke damper is operating due to the smoke detector once the smoke concentration is over the safety rate according to the standard of National Board of Fire (NFPA). To overcome the current limitation of fire and smoke damper, an improvement and modification is needed and necessary; the best solution to overcome the problem is through the use of the combination of fire smoke

damper. Thus, the combination of fire smoke damper can provide a greater efficiency during operation which it closes not only upon high duct temperature but also upon the detection of smoke. It is UL leakage-rated to stop smoke in its tracks, which is the main difference from the current fire dampers and smoke dampers. Moreover, the improvement of design geometry of past fire and smoke damper is needed, to improve the material efficiency in term of weight, damper sizing, and damper frame thickness to reduce the cost of material thus provide a greater efficiency than past fire and smoke damper.

1.2 Objective

The main objectives of this project are:

1. Designed a conceptual body structure of frame casing of Fire Smoke Damper in differences geometry with differences surface thickness of damper frame.
2. Determined the material strength develops in Fire Smoke Damper for differences geometry and differences surface thickness of damper frame.

1.3 Scope of Work

Scopes are recorded to guarantee the venture will be inside its expected limit. The scopes will be functional to guarantee those project is heading in the right course with attaining the objective. In this project, there are several scopes to be considered in order to achieve the objective. Which is designed a conceptual combination Fire Smoke Damper (FSD) in differences design geometry with differences thickness of damper frame surface thickness by using SOLIDWORK according the specifications standard of UL 555 (Standard for Safety/Fire Dampers and Ceiling Dampers) and UL 555S (Standard for Leakage Rated Dampers for Use in Smoke Control Systems) to improves the limitation of current Fire Damper. Thus, the structural design of the Fire Smoke Damper (FSD) in this

project is only applicable to the rectangular duct in Heat Ventilation Air-conditioning (HVAC) system with a Single duct Section size in 18" W x 18" H Vertical Mount and up to the body structure design of the fire smoke damper which including the materials use of fire smoke damper and the geometry design of damper frame, blade and blade linkage rod.

Moreover than that, this project also applied the optimization design technique to optimize the body structure design of Fire Smoke Damper (FSD) into 2 differences damper frame design geometry which is geometry 1 the ordinary design of past fire damper (without Cut Edged from side) and geometry 2 the new innovation Fire Smoke Damper Frame (cut edged 20mm from both side) on 3 differences thickness parameter of FSD damper frame on each geometries. Thus, Finite Element Analysis (FEA) of CATIA was applied for determined the material strength of selected material that develops in Combination of Fire Smoke Damper for differences geometry with different thickness of damper frame to produce a better design structure of fire smoke damper and to improve the material efficiency in term of weight, damper sizing, and damper frame thickness to reduce the weight of fire smoke damper frame and material cost to fulfil the objective of the project.

1.4 Thesis Structure

In Chapter 1, it will be explained briefly about the possibility of the project. Tasks background will be discussed in this part. This part will concentrate on the outline of the undertaking, specifying the objective, the issue articulation, and the scope of the project.

In chapter 2, this section is about the idea, hypothesis, and some characteristic of equipment and component that utilized as a part of this task. This part also contains a meaning of term used as a part of this undertaking and furthermore discusses about the idea of the research and how it identified with the theory.