

**DESIGN AND ANALYSIS OF INDUSTRIAL SECURITY DOOR**

**MUHAMMAD SYAMIL BIN RUSDI**

**This report is submitted  
in fulfillment of the requirement for the degree of  
Bachelor of Mechanical Engineering (Design and Innovation)**

**Faculty of Mechanical Engineering**

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## DECLARATION

I declare that this project report entitled “Design and Analysis of Industrial Security Door” is the result of my own work except as cited in the references.

Signature : .....

Name : Muhammad Syamil bin Rusdi

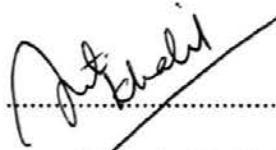
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## APPROVAL

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

Signature

..



Name of Supervisor : Dr. Siti Nurhaida binti Khalil

Date : 16 December 2016

## **DEDICATION**

To my beloved parents, lecturers, and friends.

## **ABSTRACT**

Creating a reliable and robust security system has become one of the main concerns of the global community in this modernization era which is congested with threats. In industrial sectors, roller shutter is widely used as primary entryway for various purposes such as loading or unloading goods. This study can help to solve some of the security issue concerning the roller shutter as well as the safety of its surroundings. Therefore, this thesis is carried out to design a conceptual door security system using Computer Aided Design (CAD) software which will undergo several analysis tests to determine the strength of the design. The design is then to be equipped water-film system to combat accident that involves fire. Material testing is also included in this study to determine the best material to be assign to the computer generated design. However, the design only limited to certain amount of security measure which is thought to be adequate to prevent intrusion. According to Information Security Principles, there is no such thing as absolute security (J. Breithaupt, 2014).

## **ABSTRAK**

*Mencipta satu sistem keselamatan yang teguh dan dipercayai sudah menjadi salah satu keutamaan dalam masyarakat global dalam era permodenan ini yg mana sesak dengan ancaman. Dalam sektor perindustrian, pengatup gulung digunakan secara meluas untuk pintu utama untuk pelbagai tujuan seperti memunggah masuk dan keluar barang. Kajian ini diharap boleh membantu untuk menyelesaikan masalah keselamatan berkenaan dengan pengatup gulung serta keselamatan di kawasan persekitarannya. Untuk itu, tesis ini dijalankan dengan merekabentuk sistem keselamatan pintu menggunakan perisian Computer Aided Software (CAD) yang akan melalui beberapa ujian analisis untuk mengenalpasti keteguhan rekabentuk tersebut. Rekabentuk ini juga akan dilengkapi dengan sistem lapisan-air untuk menangani kemalangan yang melibatkan kebakaran. Ujian bahan juga akan disertakan dalam kajian ini untuk mengenalpasti bahan terbaik untuk ditetapkan kepada rekebentuk yang dijana oleh komputer. Bagaimanapun, rekebentuk ini hanya terhad kepada beberapa langkah pencegahan yang difikirkan mencukupi untuk mengatasi pencerobohan. Berdasarkan kepada buku Information Security Principles, keselamatan yang mutlak adalah mustahil (J. Breithaupt, 2006)*

## **ACKNOWLEDGEMENT**

I would like to express my deepest appreciation to my supervisor Dr.Siti Nurhaida binti Khalil for giving me this opportunity to conduct and complete my final year project. She never hesitated to give me advice and guidance whenever I was confronted by problems. Furthermore, I am extremely thankful for his patience and advice while leading me in this project.

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## LIST OF ABBREVIATIONS

CAD	Computer Aided Design
CATIA	Computer Aided Three-Dimensional Interactive Application
DFMA	Design for Manufacturing and Assembly
GSM	Global System for Mobile Communications
ARL	Alarm Reminder Locking
SMS	Short Message Service
FAR	False Acceptance Rate
FRR	False Recognition Rate
AFRS	Automated Fingerprint Recognition System
MOFSET	Metal–Oxide–Semiconductor Field-Effect
PDS	Product Design Specification
QFD	Quality Function Development
HOQ	House of Quality

## LIST OF SYMBOLS

$\alpha$	=	Alpha
$^{\circ}\text{C}$	=	Degree Celsius
$K$	=	Kelvin

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 BACKGROUND**

Door security has been considered a basic necessity either in residential, commercial or industrial buildings. Lack of security can result in great damage (e.g. burglary, accidental damage, fire, espionage, natural phenomena and etc.) (Safaa A. Mahdi, 2013). Therefore with a befitting security device installed, it can ensures the safeguard of ones' privacy, treasured properties and also lives against any threat for instance, an armed burglary. A report shown in 2014 indicates there were 23,317 cases of break-ins in Malaysia by Crime Prevention and Community Security Department (Utusan Malaysia, 2015). Therefore, a door security device is designed to scale down the break-in substantially against any act of thievery or further damages that might occur to the properties and building's infrastructures. Such device will be design to be unyielding for guaranteed safety and privacy by blocking the entryway from unwelcomed intruders. Several selected material will be tested with stress and Von Misses analysis using 3D Computer Aided Design (CAD) software such as CATIA in order to determine the toughest substance for the pulmonary product. Alarm and sensors will also be electronically connected to the device's design in hope it will deter the criminal simultaneously alerted nearby guards. It will be tested and analyze with various analysis for example stress analysis to determine its quality as well as reliability.



## **1.2 PROBLEM STATEMENT**

Security without quality cannot assert high assurance. The main drawback from the current security door devices has not being properly analyzed in term of quality may be encounter with failure and malfunction. Other than that, the manufacturing of standard security door device generally use substandard materials which can lead to vulnerability to the products.

## **1.3 OBJECTIVES**

1. To design a conceptual door security system using Computer Aided Design (CAD) software.
2. To analyze the designed product using several analysis methods.
3. To identify the most suitable material for the roller shutter using CES EduPack Software.

## **1.4 SCOPE OF PROJECT**

The scopes of the project are:

1. The design of the product can be design and tested in 3-D modeling software.
2. The device is designed specifically for several types of industrial doors.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 INTRODUCTION**

Literature review is an inquiry that evaluates the available published resources on a given subject or topic for example door security system. The objective of literature review is to survey and gather information to form a summary. By reviewing a collective form of information on the door security system, it will provide insight as to importance of achieving the objectives of this study. The literature review will be focusing on certain areas, such as background, types and development of industrial security doors.

#### **2.2 HISTORY OF DOOR SECURITY**

The need of security has been in high demand ever since the world has moved towards industrial and technological advancement, thus showing an increase in services for personal protection. In 18<sup>th</sup> century, the Industrial Revolution has sparked rapid development of security system in order to protect goods and properties from thievery. Since then, private security evolved from need for additional, individual protection for humans and their property. One of the earliest modern security inventions was created by Reverend Augustus Russell Pope in 1853 which include an electro-magnetic alarm.

A. R. POPE.  
BURGLAR ALARM.

No. 9,802.

Patented June 21, 1853.

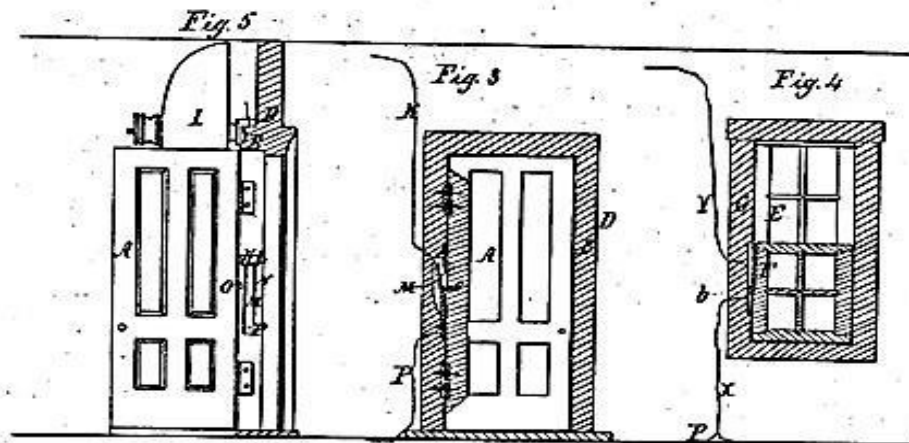


Fig. 2.1: Outside view of the improvement in electro-magnetic alarm device patented (A.R. Pope, 1853).

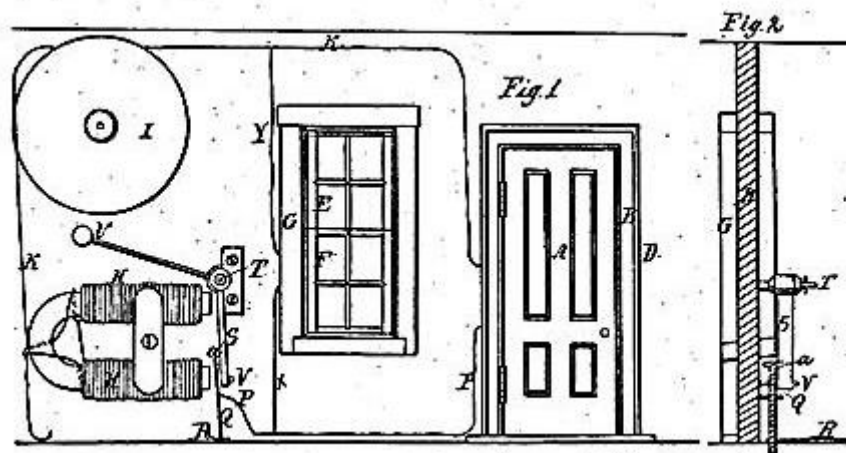


Fig. 2.2: Detailed view of the improvement in electro-magnetic alarm device patented (A.R. Pope, 1853).

The events of the World War I (1914) and the Great Depression (1930) have also played an important role as catalyze to increase operation of security doors and device not only to major countries but also to all countries worldwide. The fear of sabotage, espionage, riot has helped significantly in security advancement either by the governments or private sector.

Today, most threats are ranging from armed burglary to terrorism. Both threats are considered highly dangerous for either occupants of residential or industrial building to ignore. Some security services companies also have incorporated to prevent other unwanted scenarios such as fire and collision as part of their system.

### **2.3 DEVELOPMENT OF DOOR SECURITY**

In the early 20<sup>th</sup> century, amass of technological inventions has flooded the market affecting various sector including the safety and security sector. Both residential and industrial door security have been revolutionized by integrating mechanical and electrical component together. For example, biometric recognition device was connected to the auto-deadlocking and alarm to ensure any attempt of access by unrecognized personnel will be directly alerted to the person in charge. High standard security companies usually offer various options that not only insure protection but also simplified sophisticated systems.

### **2.4 GUIDES TO SECURITY DOORSETS AND LOCKING HARDWARE**

Door comes in several of designs from standard hinged door to military grade vault door. Both types included with a locking mechanism for privacy and security purposes. The main objective of this guide is to introduce important security features to certain door sets to avoid intrusion.

The material selected to construct a door is as paramount as how it is configured by additional security aspects to prevent forced entry. The table below illustrates on relative effect that different features of a door sets' construction can have resistance on forced entry.

Resistance	Mode of Opening	Number of Leaves	Leaf	Bolting Points	Bolt Engagement	Dead-lockable Operation	Vision Panel
More secure	Inward	Single	Solid	Multipoint deadbolt	Small gap between frame and door and good bolt throw	Deadlock by key on inside only (single cylinder on inside only)	None
	Outward		Framed of paneled	Single point deadbolt		Non-lockable (thumb turn)	Laminated security glass containing polycarbonate Laminated security glass containing PVB interlayers
Less secure	Bi-directional	Double		Single point latch bolt	Large gap and minimal bolt throw	Non-lockable (lever handle)	Toughened or wired glass

Tab. 2.1: Relationship between a doors set's design and its resistance to forced entry (CPNI, 2013)

## 2.4.1 POSSIBLE THREATS

In order to offer solutions, the problems must first be identified which in this particular study is the threats that any infrastructures especially in industrial sector may encounter. These are the possible threats that might occur in these present days. (Centre for the Protection of National Infrastructure, 2013)

1. Accidental damage
2. Espionage
3. Fire
4. Natural phenomena (e.g. flood, high winds)
5. Opportunistic crime
6. Organized crime
7. Protestors

8. Terrorism
9. Vandalism
10. Use (e.g. wear and tear)

The frequency of occurrence of these threats however will depend on other aspect for example the location on site and other security measure which are implemented in the surrounding area of the building.

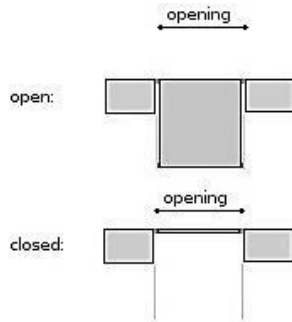
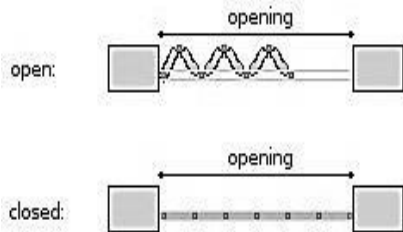
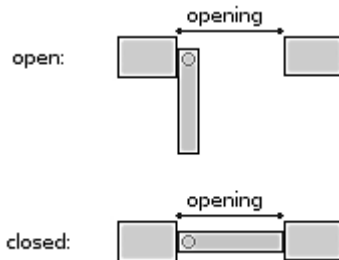
#### **2.4.2 METHODS OF LOCK OPERATION**

Considering there are thousands of alternatives of lock operation to a door, the list in the figure below will only covers general type of the operation. The effectiveness will depend on the quality of the materials, reliability of the components and combination of multiple security devices (CPNI, 2013).

1. Keys (e.g. pin tumbler lock key, lever lock key, tubular key)
2. Locks (e.g. padlocks, deadbolts, smart locks)
3. Reinforcement (e.g. strike plates, chains, hinge screw, internal lock)
4. Security code
5. Alarms (e.g. smoke alarms, burglary alarm, sensor alarm)
6. Biometric recognition (e.g. thumbprint, facial, retina)

#### **2.5 INDUSTRIAL DOORS AND TYPES OF INDUSTRIAL DOORS**

Industrial doors have distinctive aspect in terms of overall design, security, functions, mechanism and etc. compared to residential doors. However, the most common doors are divided into 3 basic type of mechanism that is suitable to be implemented in industrial infrastructure according Wessex Industrial Door Ltd. Website.

Type of Door Mechanism			
Ref.	Type of Mechanism	Diagram of Mechanism	Application
2.5.1 and 2.5.2	Up and Over / Rolling Mechanism	 <p>The diagram shows two states of a door mechanism. In the 'open' state, a door panel is rolled up into a compact box above the opening. In the 'closed' state, the door panel is lowered to form a barrier across the opening. Arrows indicate the vertical movement of the door panel.</p>	Used in roller shutter door, sectional overhead door in garage or commercial buildings
2.5.3	Sliding/Folding	 <p>The diagram shows two states of a sliding or folding door. In the 'open' state, the door is composed of multiple panels that have folded together and are positioned to the side of the opening. In the 'closed' state, the panels are extended across the opening. Arrows indicate the horizontal movement of the door panels.</p>	Used mostly in residential building and few industrial building.
2.5.4	Hinge	 <p>The diagram shows two states of a hinged door. In the 'open' state, the door is swung outward from its frame. In the 'closed' state, the door is swung inward, flush with the frame. Arrows indicate the rotational movement of the door around its hinges.</p>	Widely use in almost all type of buildings

Tab. 2.2: Type of common door mechanisms (Industrial Doors for All Types of Businesses and Buildings, 2016)

### 2.5.1 ROLLER SHUTTER DOORS

One of the earliest improved roller shutter invention was patented in 1929 by B. Negrini and its constructed rectangular metal sheets that is connected to each other by inter-engaging spirally formed beadings constructed along their longitudinal edges so as to allow the coupling of the slats and the shutter being wound up on a roller (United State Patent Office, 1929). Since then, similar contraptions have been an ideal choice for factories and other business outlet.

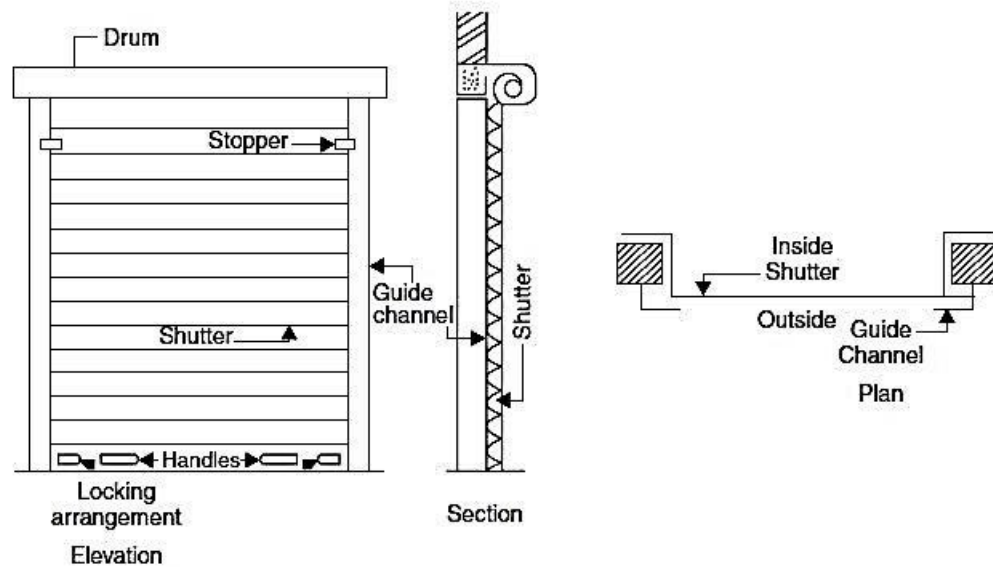


Fig. 2.3: Roller shutter component description (Type of Doors, 2014)

There is a wide range of product regarding roller shutter from security, fire-resistant or insulated that currently available in the market. Most are which have the synonymous mechanism with a few upgrades to accommodate the client's requirement. The operations only compose of manual operation and a single phase electric which are required to lift the shutter upward. It consists of a frame, a drum and a shutter made of thin steel plates. The width of the door may vary from 2 to 3 m. The shutter moves on steel guides provided on sides and can easily roll up. For this counterbalancing is made with helical springs on the drum. The shutter can be easily pulled down. This type of door is commonly used as additional doors to shops, offices, banks, factory, and buildings from the point of safety.