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بِوَسِيْلَةِ سُنَّتِيْ اِسْلَامِيَّةٍ اِنْجَارًا يَجْتَنِبُ مَلِيْسِيَا

THE CYCLIC PERFORMANCE OF FIRE RESISTANT
DOORSET IN SELECTED SHOPPING CENTERS,
MALAYSIA

BY

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requirements for the degree of Master of Building
Services Engineering

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ABSTRACT

Fire and smoke are major risks to life and property in buildings. As such, fire and smoke have to be controlled and prevented with whatever means and methods that is available in order to keep it out of its destructive and lethal propensity. The concept of keeping the occupants of buildings safe in case of fire relies upon separating whole building into smaller “compartments”. Compartmentation is a concept in fire protection whereby a building or part of a building, comprising one or more rooms, spaces or stories, constructed to prevent the spread of fire to or from another part of the same building, or adjoining building. This is done by making compartment boundaries which consists of walls, ceilings, and floors to be fire rated. The objectives of the research are to investigate the actual open-closed cyclic performance of fire resistant doorset in shopping centers and to compare the actual open-closed cyclic performance of fire resistant doorset with the benchmark set by Malaysian Standard. In order to investigate the actual performance on open-closed cycle of fire resistant doorset, tabular form was designed to record the measurement as a primary tool to conduct the survey. The research was conducted at two selected shopping centers in Kuala Lumpur, Malaysia i.e., Sungai Wang Plaza and Low Yat Plaza. The units of the doors were selected based on the building management’s suggestion based on the frequent door usage. The actual counting was carried out by filling the table in survey form. A Video Camera Recorder (VCR) was used as a back-up, especially on the doors in the area with heavy traffic flow. The measurement taken from the four selected fire resistant doorsets of two selected shopping centers showed that the actual number of Door Cyclic Movement (DCM) is higher than the number of DCM stipulated in the Malaysian Standard.

ملخص البحث

إن الحريق والدخان يُعدّان أشد المخاطر التي تهدّد الأنفس والممتلكات في المباني، لذا ينبغي اتخاذ كل الوسائل والأساليب المتاحة للتخفيف من أثرهما أو منع حدوثهما، وفكرة الحفاظ على سلامة سكان المباني في حالة نشوب الحريق تعتمد على تجزئة المباني إلى أجزاء أصغر، بحيث يتمّ بناء فواصل قادرة على صدّ الحريق من الجدران والأسقف والطوابق، فبهذه الفكرة يتمّ منع انتشار النار بين مرافق المبنى وغرفه أو إلى المبنى المجاور له. إن الهدف من هذه الدراسة هو التحقق من فاعلية الأبواب المقاومة للحريق الموجودة في مباني بعض الأسواق، من ناحية حركتها وإحكام إغلاقها، ومقارنة نسبتها بالموصفات المعمارية الماليزية للأبواب المقاومة للنار. وقد أجريت الدراسة على مبنين تجاريين في كوالالمبور وهما المجمع التجاري سونجاي وانج (Sungai Wang Plaza) والمجمع التجاري لوي يات (Low Yat Plaza). وكان اختيار عدد الأبواب في المبنين مبنياً على ما اقترحت إدارة المبنين لمعرفة ارتفاع نسبة المارين فيها. تمّ إحصاء حركة الأبواب من خلال تعبئة الاستبانات في الموقع، كما استُعين للإحصاء بأجهزة تصوير الفيديو عند الأبواب التي تكثُر فيها حركة المارين. وكانت النسبة التي أخذت من أربعة أبواب مختارة في المبنين التجاريين أثبتت أن نسبة الحركة الدورية للسلامة فيها أعلى من النسبة المحددة لدى المواصفات المعمارية الماليزية.

APPROVAL PAGE

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DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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**THE CYCLIC PERFORMANCE OF FIRE RESISTANT DOORSET IN
SELECTED SHOPPING CENTERS, MALAYSIA**

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Dedicated To

My dearly loved father, mother, brothers and sister

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CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

Fire is the most important discovery of human civilization. The discovery of fire is one of the greatest findings of mankind. Flame and fire have been playing a major role in shaping the lives of human beings on our globe since the time immemorial.

It is now an established fact that the man's subsequent mastery over the fire has made all the developments in science and technology that we enjoy today. Mainly our modern civilization is built upon the combustion of fuels both for heat and electrical power. In recent times, combustion has also played a very important role in driving the human race towards the path of prosperity and progress as around 80% of our worldwide energy demand is met by the combustion of fuel (Mishra, 2008).

The discovery of fire has made life easier, yet uncontrolled fire poses serious problems to man since time immemorial. It can cause colossal damage to life and property. Fires occur frequently and destroy life and property in buildings. In the United Kingdom, for example, public fire brigades attend more than 400,000 fires every year in which about 800 people are killed and 15,000 sustain non-fatal injuries (Ramachandran, 1998). In his article, Karter also wrote that U.S. fire departments had responded to an estimated 530,500 structure fires occur in the U.S. during 2007.

Fire resistant doorset is an integral component of any passive fire-protection design in the built environment as it serves a very important purpose of restricting fire to one area. In the event of fire, fire resistant doorset can minimize the loss of life and

property if they are properly used and designed. Thus, it is very important in providing assurance for fire resistant doorset in performing its intended use.

The findings of the research are expected to give contributions in getting better design strategies for fire safety on fire resistant doorset. It will be beneficial to the fire safety institution in Malaysia particularly and all over the world generally.

1.2 BACKGROUND OF STUDY

Uncontrolled fire is a uniquely, deadly, and destructive occurrence in human civilization and it can occur at anytime and anywhere. In designing against fire in buildings, the first aim is to reduce the risk of human injury or death to as low level as possible. Simultaneously, is to minimize fire damage to the building and its contents and to prevent fire, smoke, and heat spreading from floor to floor or from compartment to compartment. In larger buildings, compartmentation becomes increasingly important, both to protect the large numbers of people inside and to prevent the unchecked spread of fire.

Compartmentation of fire is used to either contain fire or occupants within a protected area in an attempt to achieve a level of safety in buildings. This is done by making compartment boundaries which consists of walls, ceilings, and floors to be fire rated. The construction of fire resistant walls, floors, and ceilings help in stopping the spread of fire and smoke and compartmentalized fire to a particular part of the building. Bush et al. (1994) and Shapiro et al. (1987) who studied medical center and hotel fires found that the fire damage and fire death were large because of ineffectiveness of compartmentation. The doors (as part of the compartmentation) to the rooms of origin were left open and stairwells were not enclosed or were inadequately enclosed which allow smoke and heat to spread through the areas. Kay,

(2008) also wrote article about a fire that broke out in Düsseldorf airport in April 1996. A welder had set fire to some polystyrene insulation and the resultant blaze led to 17 deaths. Eight people were killed in a VIP lounge, several hundred metres from the seat of the fire. Smoke and noxious gasses had spread uncontrollably through the ventilation ducts and caught the occupants of the lounge unawares. Had the compartmentation within the building been adequate, these deaths may not have occurred.

Fire resistant doorset which served a protection for openings of compartmentation walls or fire rated partitions has become important as it preserves the integrity of the said element. It allows people to evacuate safely from a building along with limiting the spread of fire and smoke to other areas. This proves to be very helpful at the time of criticality in the area of multi-storey apartments and buildings. Therefore just installing the fire resistant doorset is not enough; the occupants of the buildings should be educated about the safe use of fire doors and fire code compliance should be ensured. Fire resistant doorset has to be carefully and precisely designed, engineered, and tested in accordance with standards to ensure that it performs its functions effectively.

To understand the scope of fire resistant doorset, it is important to know its definition. According to Malaysian Standard MS 1183: Part 2: 1993, it is a door or shutter provided for the passage of persons, air or things which, together with its frame and furniture installed in a building, is intended, when closed, to resist the passage of fire and/ or gaseous products of combustion and is capable of meeting specified performance criteria to those ends.

The implementation of codes and standards is seen in many aspects of day-to-day life. The adoption of codes and standards, along with increased public awareness

of fire safety practices, has resulted in significant reductions in the loss of life and property damage due to the effects of fire. By continuing to use codes and standards that are readily accepted and followed, the world will be safer from fire and related hazard. Today's model building codes establish minimum requirements for construction and design, and fire protection codes and standards play an important part in community development (Daniel, 2003).

Malaysia as a developing country has already applied the fire safety design strategies for buildings by using Malaysian Standard, Uniform Building By-law 1984, and Fire Services Act 341 as a base. Malaysian Standards are consensus documents developed by Industrial Standards Committees (ISCs) within the Malaysian Standards Development System and approved by the Minister of Science, Technology and Innovation in accordance with the Standards of Malaysia Act 1996 (Act 549). A Malaysian Standard is a technical document that specifies the minimum requirements of quality and safety for voluntary use by the public. A standard becomes mandatory when a regulatory agency enforces its use through the relevant Acts and Regulations. The policy in developing Malaysian Standards is to adopt International Standards wherever appropriate.

Uniform Building By-laws and Fire Services Act are included in the building regulations. Building regulations are basically rules, laws, ordinance, statutes, regulations, or codes passed by the highest law making body of the country or parliament pertaining to building development. These rules or regulations are carefully compiled and tailored in written documents and editorially structured for easy reference for those involved in the building industry and mandatory to be applied. These laws are standardised and rationalised as the minimum standard for health and safety particularly in regulating issues related to fire, structural ability,

health, security, and energy conservation. Building codes or regulations are intended to protect the public by establishing minimum standards of safety i.e. by providing minimum guideline for construction and inspection of a structure to prevent fire, structural collapse, electrical wiring, heating equipment, ventilation, day-lighting, sanitary facilities, care for the disable and general deterioration. Building regulations are intended to protect others or consumers from short sighted individuals whom as clients, they often assume they can build whatever they wish on their property (Norwina Mohd Nawawi, 2003).

Malaysian Standard MS 1073: Part 3: 1996 stipulates testing requirements of fire resistance and cyclic endurance for up to 100,000 cycles for all fire resistant doorsets to be marketed in Malaysia. The second half of the laboratory test i.e. the cyclic endurance test is to gauge the performance of fire resistant doorset. The objective of this research is to determine the actual cyclic performance of the fire resistant doorset through actual field data collection and to ascertain the adequacy of laboratory cyclic endurance bench marking as stipulated by the Malaysian Standard.

1.3 RESEARCH QUESTIONS

This research is focused on performance of cyclic movement of fire resistant doorset in selected shopping centers, Kuala Lumpur, Malaysia. Hence, several research questions have been made to guide the study. The major research questions are as follows:

1. What is the actual cyclic performance of fire resistant doorset in the field?
2. What is the basis of cyclic endurance test bench mark set forth by the Malaysian Standard on fire resistant doorset?

3. Does the cyclic movement of fire resistant doorset influence the durability of fire resistant doorset in Malaysia?

1.4 RESEARCH AIM

The central aim of this study is to ascertain whether the actual performance of cyclic movement of fire resistant doorset is apt to the standard on cyclic movement of fire resistant doorset specified by Malaysian Standard.

1.5 RESEARCH OBJECTIVES

The objectives of the research are as follows:

1. To understand the scope of regulations and standards on fire resistant doorset in terms of door cyclic performance
2. To investigate the actual cyclic performance of fire resistant doorset in shopping centers
3. To compare the actual performance of fire resistant doorset with the benchmark set by Malaysian Standard

1.6 SCOPE AND LIMITATIONS

There are several key limitations for this research due to its focus on the examining the factors contributing to the performance of fire resistant doorset. Conducting the experiments within Klang Valley is one of the limitations due to financial and resources constrain. But even though it may not be able to give a better spectrum through averaging from the statistic perspective, nonetheless it gives an inside to the cyclic performance of the fire resistant door set within KL City that serves as an indication. There are many different types of building categories, due to time and

resources constrain, data were gathered from one specific occupancy category – shopping complex, as this is a public assembly category. The focus of the research is on two selected shopping centers that have different characteristic of human traffic flow as a comparison. The doors selected varied from heavy traffic to light traffic both on weekdays and weekends. The category of multiply occupancy was selected as the research priorities on public assembly due to public safety with large volume of people.

The findings of this research cannot be generalized to other type of buildings usage such as hospitals, schools, hotels, office buildings, etc. Even for the same type of building occupancies of shopping centers, because the research was only focused on two selected shopping centers i.e., Sungai Wang Plaza and Low Yat Plaza.

1.7 SIGNIFICANCE OF STUDY

The findings of this research will contribute to the development of Malaysian Standards and SIRIM in terms of performance of fire resistant doorset. It will also benefit the fire resistant doorset manufacturer in terms of future design. Not forgetting the architects and Fire Authority will all benefit from these findings. It will also help the building management in doing a priority to repair and what steps need to be taken to handle the problems occurred.

CHAPTER TWO

LITERATURE REVIEW

2.1 FIRE

A fire is essentially a chemical reaction known as combustion. Fire triangle is a well-known representation of three variables needed to initiate a fire (see Figure 2.1). The three sides of the fire triangle are heat, fuel, and oxygen (Diamantes, 2003). To prevent a fire from occurring, it is easier to segregate heat source since fuel and air is present most of the time (Tay, H.G., 2007). Modern fire research led to the update of the fire triangle. An extra element, the molecular chemical chain reaction, was discovered which completes the fire tetrahedron. Once a fire begins, it requires four variables to sustain the combustion reaction (Daniel, 2003). With the new element came another method of fire extinguishment; interruption of the molecular chemical chain reaction.

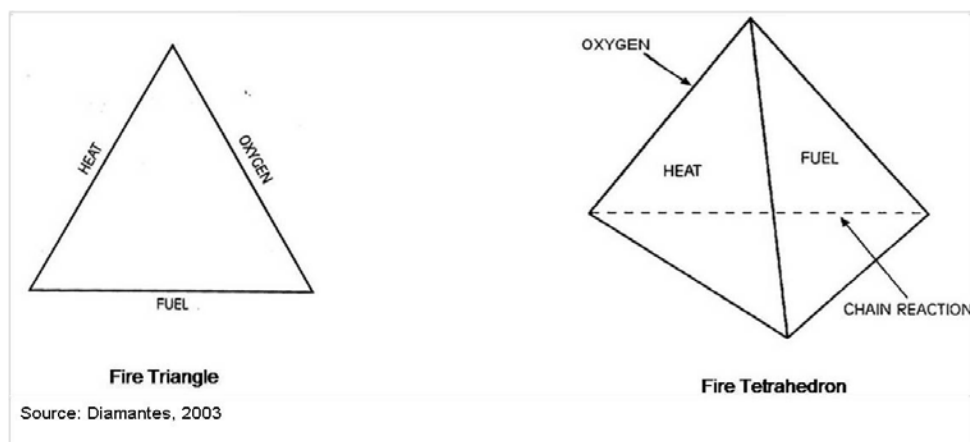


Figure 2.1: Fire Triangle and Fire Tetrahedron

2.1.1 Spread of Fire

Once “flaming combustion” has commenced, the fire must spread using one or all of the three methods of heat transfer i.e. conduction, convection, and radiation. Recent studies have shown four stages of fire development i.e. growth, flash over, fully developed fire, and decay as illustrated by the fire growth curve in Figure 2.2. The fire begins to grow in the first stage of incipient. The second stage is a transition stage from growth to fully developed stage. The fully developed stage of fire is the point where all contents within the perimeter of the fire’s boundaries are involved in fire. The intensity and the rapidity of the spread will depend on whether it is an outdoor or compartment type fire. For an outdoor fire, the spread will be dependent upon the amount and configuration of the fuel. For a compartment fire, the spread will be more dependent on the amount of oxygen the fire is receiving. Finally, the decay stage is the point where there is no more large flames, only small licks of flame and these will diminish also. The fire will burn itself out due to lack of fuel and oxygen (Flannery, 2001).

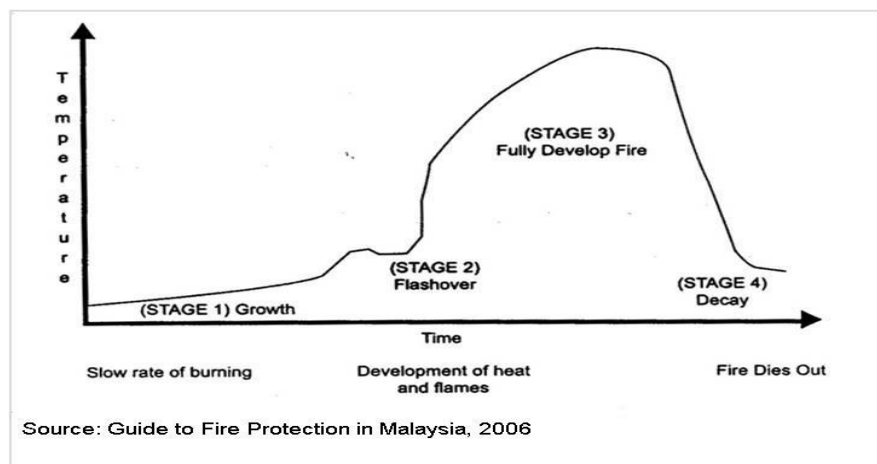


Figure 2.2: Typical Compartment Fire Developments

Harmathy (1979) noted that 80 to 90% of the combustible contents of building compartments are consumed during the period of fully developed fire. In addition, Ramachandran (1998) found that the structural elements of compartment would only be affected if fire grew into a fully developed stage defined scientifically as 'flashover'. The severe heat generated during this stage can cause structural collapse or thermal failure. Thus, the conditions that are expected to prevail during this period should be given special attention in the design of buildings.

2.2 COMPARTMENTATION

In designing against fire in buildings, the first aim is to reduce the risk of human injury or death to as low a level as possible. Simultaneously, is to minimize fire damage to the building and its contents and to prevent the fire from spreading to neighboring buildings.

The basic concept of compartmentation is to minimize or prevent fire and smoke from spreading from one compartment to another, that is, to keep the fire and its products of combustion in the area in which it started. Figure 2.3 illustrates this concept. The unenclosed shaft of building A causes hot gases spread fire to higher floors; meanwhile the enclosed shaft of building B contains the fire to one area of fire origin. Needless to say, compartmentation is an important concept in fire protection in any buildings.