

**FACTORS AFFECTING THE IMPLEMENTATION
OF THE SAUDI BUILDING CODE**

BY

Ali Abdurahman Al-Mudhei

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This thesis, written by Ali Abdurahman Yahya Al-Mudhei under the direction of his thesis advisor and approved by his thesis committee, has been presented to and accepted by the Deanship of Graduate Studies, in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE IN ARCHITECTURAL ENGINEERING.

Thesis Committee



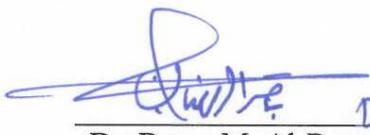
Dr. Mohammad A. Hassanain (Thesis Advisor)



Dr. Ali A. Shash (Member)



Dr. Mohammed S. Al-Homoud (Member)



DEC-16, 2009

Dr. Baqer M. Al-Ramadan
Chairman, Architectural Engineering Department



Dr. Salam A. Zummo
Dean of Graduate Studies

27/12/09
Date

DEDICATION

To my Parents and Wife

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I am most grateful to ALLAH, the almighty for providing me with time, health and ability to finish this research work.

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THESIS ABSTRACT

NAME OF STUDANT : Ali Abdurahman Yahya Al-Mudhei
TITLE OF STUDY : Factors Affecting the Implementation of the Saudi Building Code
MAJOR FIELD : Architectural Engineering
DATE OF DEGREE : June 2009

The objectives of this thesis are to assess the current practice of building authorities and design offices toward the enforcement of building codes and regulations in Saudi Arabia, to assess and rank factors affecting the implementation of the Saudi Building Code, to develop a plan of action to facilitate the implementation of the Saudi Building Code and to develop a set of guidelines to help A/E professionals implementing the building code requirements during the design stage. To achieve these objectives, literature review and interviews with building code specialists in both private and governmental sectors have been conducted. After that, a questionnaire form has been designed and addressed to 25 municipalities, 30 members of the National Committee of Saudi Building Code, 9 representatives of the General Administration of Civil Defense (GACD) and 50 A/E design offices. Moreover, two forms have been sent to the Saudi Standards, Metrology and Quality Organization and the Saudi Council of Engineers. A total of 69 completed forms have been returned and the results has been statically analyzed.

The survey showed that there is no uniform code or standards implemented in Saudi Arabia so far except some regulations issued by concerned governmental departments, and even these regulations are not thoroughly implemented. With respect to the factors assessment, the study showed that the lack of professional training is the most influential factor, followed by the public awareness of building codes or facilities insurance. The third and fourth ranks were given to the group of factors related to the current practice of the governmental departments and A/E design offices practice and to the enforcement practice respectively. The groups of technical factors related to the code text, method of construction and materials were ranked as least influential factors.

Finally, the study presents a plan of actions to facilitate the implementation of the proposed Saudi Building Code based on benchmarking with the practice of Saudi Aramco. The study also presents a set of guidelines that provides simplified methods and techniques to implement the basic requirements of the proposed Saudi Building Code during the design stage.

MASTER OF SCIENCE DEGREE
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خلاصة الرسالة

الاسم : علي بن عبدالرحمن بن يحيى آل مضحي
عنوان الرسالة : العوامل المؤثرة على تطبيق كود البناء السعودي
التخصص : هندسة معمارية
تاريخ التخرج : جمادى الأولى ١٤٣٠ هـ

تهدف هذه الرسالة الى دراسة آلية تطبيق أنظمة وكودات البناء التي تتبعها الجهات الحكومية و المكاتب الهندسية والإستشارية في المملكة العربية السعودية في الوقت الراهن . كما تهدف الرسالة الى التعريف بالعوامل المتوقع تأثيرها سلباً على تطبيق كود البناء السعودي في مراحل التصميم ومن ثم ترتيب هذه العوامل حسب أهميتها إضافة الى عرض العديد من التوصيات وتطوير آليه تساعد المهندسين والمعماريين على إدراج متطلبات كود البناء السعودي المتعلقة بالوقايه من الحرائق أثناء مرحلة التصميم. ولتحقيق هذه الأهداف تم البحث في العديد من الدوريات والكتب وكذلك إجراء العديد من المقابلات مع المختصين في مجال كود البناء في القطاعين الخاص والحكومي.

وقد تم تصميم إستبانة للبحث عن آراء المختصين العاملين في الجهات ذات العلاقة بتشريع أو تطبيق كود البناء حيث وزعت ١١٦ إستبانة على ٢٥ بلدية و ٣٠ عضواً من أعضاء اللجنة الوطنية لكود البناء السعودي و ٩ من ضباط الدفاع المدني و ٥٠ مكتباً هندسياً وإستشارياً بالمنطقة الشرقية. فيما أرسلت إستبانتين الى كل من الهيئة السعودية للمواصفات والمقاييس والهيئة السعودية للمهندسين. وفي نهاية مرحلة الإستبيان تم الحصول على ٦٩ إستبانة مكتملة تمثل الحد الأدنى المطلوب عن كل شريحة. ومن خلال تحليل النتائج تبين أنه لا يوجد نظام بناء موحد ومطبق في الملكة العربية السعودية عدا عن بعض اللوائح الصادرة من جهات حكومية تشريعية مع وجود قصور في تطبيق هذه اللوائح . وفيما يتعلق بتقييم العوامل المؤثرة على تطبيق الكود السعودي تبين أن قلة التدريب والتأهيل تعد العائق الأقوى ، يليه وعي المجتمع بثقافة نظام البناء أو تأمين الممتلكات. فيما حلت ثالثاً العوامل المندرجة تحت كيفية ممارسة الجهات الحكومية والمكاتب الهندسية تطبيق وتشريع أنظمة البناء . وحلت رابعاً العوامل المتعلقة بطرق التطبيق كالمخالفات والغرامات وما الى ذلك. أما العوامل الأكثر تقنية كذلك المتعلقة بطرق الإنشاء أو مواد البناء أو طريقة كتابة الكود فقد تم تصنيفها على أنها الأقل تأثيراً.

وأخيراً تقدم الدراسة العديد من التوصيات بناءً على دراسة تجربة أرامكو السعودية وتقدم ملحقاً مكوناً من ثلاثة فصول تحتوي على العديد من الخطوات المشروحة لأفضل الطرق لإدراج متطلبات الكود الأساسية أثناء مرحلة التصميم

درجة الماجستير في العلوم
جامعة الملك فهد للبترول والمعادن
الظهران ، المملكة العربية السعودية
جمادى الأولى ١٤٣٠ هـ

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Man's concern for the safety of his buildings has been recorded in the laws of some of the most ancient civilization such as King Hammurabi who codified many laws of the lands he conquered in approximately 16 B.C. In 1189, Lord Mayor of London, Henery Fitz-Elwyne promulgated a building code known as the Assize of Buildings which set forth the methods of approved party walls that act like fire stop (Sanderson, 1969).

In the countries of the Gulf Cooperation Council (GCC), there is no unified set of building codes that combine all building requirements. However, there are some building regulations and specifications which focus on the building's architectural requirements and urban context planning and basic, but not comprehensive, fire protection and prevention requirements. These regulations are issued by different building authorities in each country. In 1997, the Ministers of Interiors of the GCC asked the technical committee of the Council Secretariat General to prepare a comprehensive document containing all requirements and regulations for safety and fire protection to regulate the construction and operation of all type of facilities in the GCC countries. In 2003, the document was introduced, approved and named as the "Buildings Fire Protection Requirements". This document basically combined and revised the fire protection

regulations in Saudi Arabia, Kuwait, Oman and UAE. In addition, the document adapted the National Fire Protection Association life safety code requirements (GCC, 2003).

In Saudi Arabia, there was no comprehensive Building Code prior to the Building Fire Protection Requirements developed by the GCC Secretariat General. However, some fire protection and prevention regulations established by the General Administration of Civil Defense (GACD) and the Ministry of Municipal and Rural Affairs (MMRA) were utilized to regulate the construction and operation of buildings in Saudi Arabia. These regulations are generally adopted and modified from National Fire Protection Association (NFPA) standards. On the other hand, industrial facilities are governed by the fire protection directives issued by the Saudi High Commission of Industrial Security (HCIS). Major organizations in Saudi Arabia such as Saudi Aramco and the Royal Commission of Jubail and Yanbu have independent building codes and standards which govern their own constructions. These codes are basically adopted from the Uniform Building Code (UBC) and International Building Codes (IBC).

Nevertheless, there was an effort exerted by the Saudi Standards, Metrology and Quality Organization (SASO) since 1982 (1402-H) to develop the Saudi Building Code; unfortunately, nothing has been achieved since then. Later, In June 2000 (1421-H), the National Committee of the Saudi Building Code (NCSBC) was formed according to a ministerial resolution (Al-Naghady, 2005). One year later the budget and the plan for NCSBC were approved by the Council of Ministers. NCSBC formed the technical and consulting committees in April 2003, which then started to prepare the general framework for the code. The framework of the Saudi Building Code was approved in December 2004 by the Saudi Council of Ministers (SBC, 2007).

1.2 STATEMENT OF THE PROBLEM

The construction industry in Saudi Arabia developed rapidly to meet the increasing demand of population, industrial and economic growth. As a result, buildings were constructed on a rapid basis without considering the short and long-term impact of violating building standards for life safety and business continuity. In addition, there was no proper revision or enforcement of building regulations (AL-Amro, 2004). The safety regulations that have been developed by the General Administration of Civil Defenses and the Ministry of Municipal and Rural Affairs are not being successfully implemented and enforced (Al-Swat, 2004). These safety regulations and standards are not implemented for all types of facilities and the responsibility of enforcing these requirements overlap between the GACD and the municipalities (Mousa, 2004).

Accordingly, the Saudi Standards, Metrology and Quality Organization has been working to prepare the Saudi Building Code since 1982. However, the actual process started in early 2005 when the National Committee of the Saudi Building Code was founded. Implementing the new Saudi Building Code in the building industry in Saudi Arabia will face many challenges. One of the major challenges is the absence of qualified professionals to design in accordance with the code requirements. The success of implementing the requirements of building codes is subject to how far the concerned professionals are qualified and trained to use it. Many professionals are involved designing, issuing permits and inspection of buildings. Those professionals received their building code knowledge through practice only because they came from different engineering backgrounds and the majority did not receive previous training or education in the building codes. Lack of knowledge in building codes will have an impact on its successful implementation and will cause an impact on the building cost and durability (Khalifah, 2005). In Saudi Arabia, there are many building authorities. This diversity of

building and construction legislation is considered to be one of the major challenges for the Saudi Building Code during the phase of implementation. On the other hand, the code development and update are other future challenges for the National Committee of the Saudi Building Code (AL-Tassan, 2007).

1.3 RESEARCH OBJECTIVES

The objectives of this thesis are as follow:

1. To assess the current practice of A/E design offices and building authorities in addressing and enforcing the building codes and safety regulations in building design in Saudi Arabia.
2. To assess and rank the factors which adversely affect the implementation of the Saudi Building Code.
3. To develop a plan of action to overcome these factors based on benchmarking with best practice.
4. To develop and assess a guidelines for the fire protection requirements of the Saudi Building Code.

1.4 SCOPE AND LIMITATIONS

Literature survey revealed that there are few studies in the field of building safety regulations in Saudi Arabia, the Saudi Building Code development, and the current practice of design processes, the building permits process, the safety regulations enforcement process and detailed incident statistics. In addition, previous studies

indicated that 80% of the constructions conducted in Saudi Arabia are totally separated from the design phases (Arain, 1997). Accordingly, the scope of this study is limited to the following:

1. Fire safety requirements of the Saudi Building Code. However, the results of this study will contribute to the implementation of other code requirements such as mechanical, electrical or structure.
2. Implementation of the code requirements at the design phase of the project.

Fire protection requirements of the Saudi Building Code are comprehensive and related to different types of construction and design process. Therefore, there are some requirements excluded from the guidelines because of one or more of the following reasons:

1. The non-design related requirements which are of operational, maintenance or housekeeping nature.
2. The unique requirements which are rarely used.
3. The requirements of a significant use or hazard that requires special investigation and analysis by specialists in certain field and that are not normally conducted by building design professionals on a regular basis.
4. The requirements that are related to existing structures.

1.5 SIGNIFICANCE OF THE STUDY

This study is developed simultaneously with the development of the Saudi Building Code and therefore, it investigates challenges that might face its enforcement and will provide recommendations that might facilitate its successful implementation. Introducing the Saudi Building Code to the buildings industry in Saudi Arabia will make this study a basis for future studies related to building regulations in Saudi Arabia. The developed

guidelines to be used by the design professionals in Saudi Arabia will facilitate the implementation of code requirements during the design stage. Therefore, the guidelines have the potential to significantly reduce the amount of training needed. In addition, it might be used as a reference for the Saudi Building Code training and development of related courses. Finally, the study has the potential to be a basis for the Saudi Building Code automation.

1.6 RESEARCH METHODOLOGY

This section presents the research methodology through which the objectives of the study have been achieved. The methodology is described in the following subsections as follows:

1.6.1 Domain Analysis and Description

The domain analysis and description phase in this research include:

1. Conducting an extensive literature review for the following:
 - I. Local building regulations issued by the General Administration of Civil Defense (GACD) and the Ministry of Municipal and Rural Affairs (MMRA).
 - II. International codes such as International Building Code (IBC), International Fire Code (IFC) and International Mechanical Code (IMC).
 - III. National Fire Protection Association codes and standards such as Life Safety Code (NFPA-101) and Building Construction and Safety Code (NFAP-5000).
 - IV. Various articles related to the philosophy, history and importance of building codes.
2. Conducting various interviews with members of the National Committee of the Saudi Building Code, representative of Dammam Municipality, representative of the

- General Administration of Civil Defense, Owners of Design offices, consultants and engineers in the field of building code administration and enforcement.
3. Utilizing personal experience with the requirements of International Building Code and International Fire Code.

1.6.2 Assessment of the Current Practice of A/E Design Offices and Building Authorities

The first objective of the study is to assess the current practice of the Civil Defense, the Municipalities and A/E design offices in controlling, enforcing and addressing the requirements of building codes. This objective has been achieved through two phases:

Phase-I, Questionnaire and Interviews: a combination of questionnaire survey (Appendix-A) and interviews have been conducted. The questionnaire forms have been distributed to a random sample of A/E design offices in the Eastern Province of Saudi Arabia to assess their current practice. In addition, two interviews have been conducted with representatives of the General Administration of Civil Defense and Dammam Municipality to assess their current practice in enforcing and controlling building codes and regulations.

Part-I and Part-III of the questionnaire form (Appendix-A) were designed to achieve this objective as follows:

Part-I: Contains general questions about the respondent background, experience and design office description.

Part-II: this part of the questionnaire is related to the second objective of the study as discussed in Section 1.6.3.

Part-III: Contains nineteen questions about the practice of the A/E design office.

Phase-II, Findings: The results of the questionnaire survey and interviews have been analyzed and the findings are presented in chapter three.

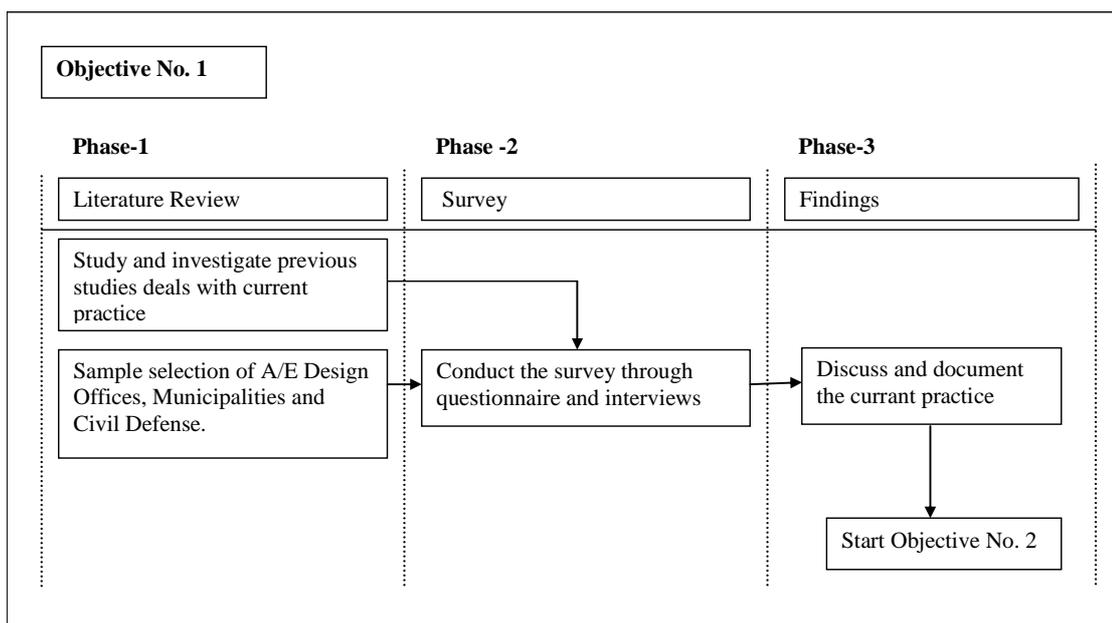


Figure 1.1: Methodology Chart for Achieving the First Objective

1.6.3 Assessment of the Factors Affecting the Implementation of the Saudi Building Code

The second objective of the study is to assess and rank the factors that affect the implementation of the Saudi Building Code. This objective has been achieved through survey questionnaire (Appendix-A). The questionnaire design, sample description, scoring and result analysis are described in the following subsections:

A. Questionnaire Design

Part-I and Part-II of the questionnaire (Appendix-A) were designed to assess the adverse influence of predetermined factors on the implementation of the Saudi Building Code as follows:

Part-I: Contains general questions about the respondent background, experience and his organization.

Part-II: Contains twenty six factors where the respondent is requested to assess how each factor would adversely affect the implementation of the Saudi Building Code using one of five possible options as extreme effect, strong effect, moderate effect, slight effect or does not affect.

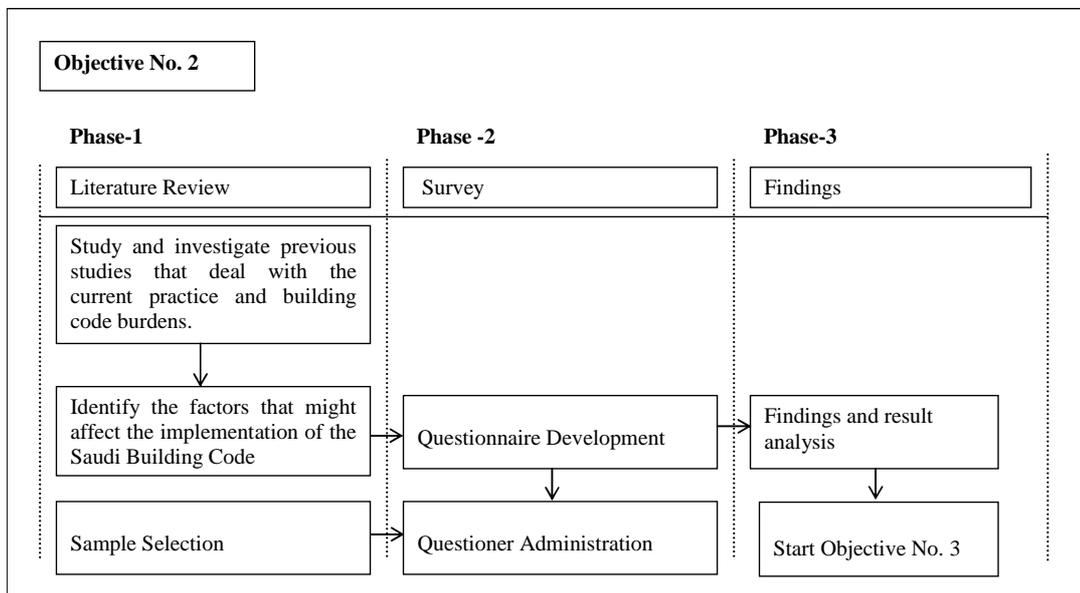


Figure 1.2: Methodology Chart for Achieving the Second Objective

B. Scoring

The respondent to the questionnaire can evaluate the adverse effect of each factor as either extreme effect, strong effect, moderate effect, slight effect or does not affect. These responses are weighted in a four point scale as follow:

Extreme effect = **4**, Strong effect =**3**, Moderate effect=**2**, Slight effect=**1**,
Does Not affect=**0**

The factors were ranked in an order based on the weight of each factor importance index

C. Data Analysis

This section describes the methods which have been used to analyze the data collected from the responses to the questionnaire. The importance index for each factor has been calculated using the following equation (Dominowski, 1980):

$$Index = \left(\frac{\sum_{i=0}^4 a_i x_i}{4 \sum_{i=0}^4 x_i} \right) \times 100 \% \dots\dots\dots (1.1)$$

Where:

- i = Response category index where $i= 0,1, 2, 3, 4$
- a_i = Wight given to i response where $i= 0, 1, 2, 3, 4$
- x_i = Frequency of the i given as a percentage of the total response for each factor where:
 - x_0 = frequency of Extreme effect
 - x_1 = frequency of Strong effect
 - x_2 = frequency of Moderate effect
 - x_3 = frequency of Slight effect
 - x_4 = frequency of Does not affect

D. Questionnaire Administration and Distribution

There are multiple stakeholders involved in this survey as follows:

1. Design/consultant offices that conduct the building design and material specifications.
2. Building authorities who published or enforced the building code and regulations including:
 - National Committee of the Saudi Building Code.
 - General Administration of Civil Defense.
 - Saudi Standards, Metrology and Quality Organization
 - Saudi Council of Engineers.
 - Municipalities.

E. Population

The sample size was determined using the following equations (Kish, 1995)

$$n_0 = \frac{(p*q)}{v^2} \dots\dots\dots(1.2)$$

$$n = \frac{n_0}{(1 + (n_0 / N))} \dots\dots\dots(1.3)$$

Where:

- n_0 = Sample Size from infinite population
- P = Proportion of the characteristics Being Measured in the Target Population.
- q = Complement of P , $1-P$
- V = Maximum standard error allowed (10% for this study)
- N = Population size
- n = Sample Size

To maximize the sample, both p and q are each set at 0.5.

1.6.4 Recommended Plan of Actions

The third objective of this study is to develop a recommended plan of action to facilities the implementation of the Saudi Building Code. This objective has been achieved through benchmarking with the practice of Saudi Aramco. A list of criteria about how building codes are implemented successfully by Saudi Aramco has been identified, and then the plan of actions has been developed based on these criteria.

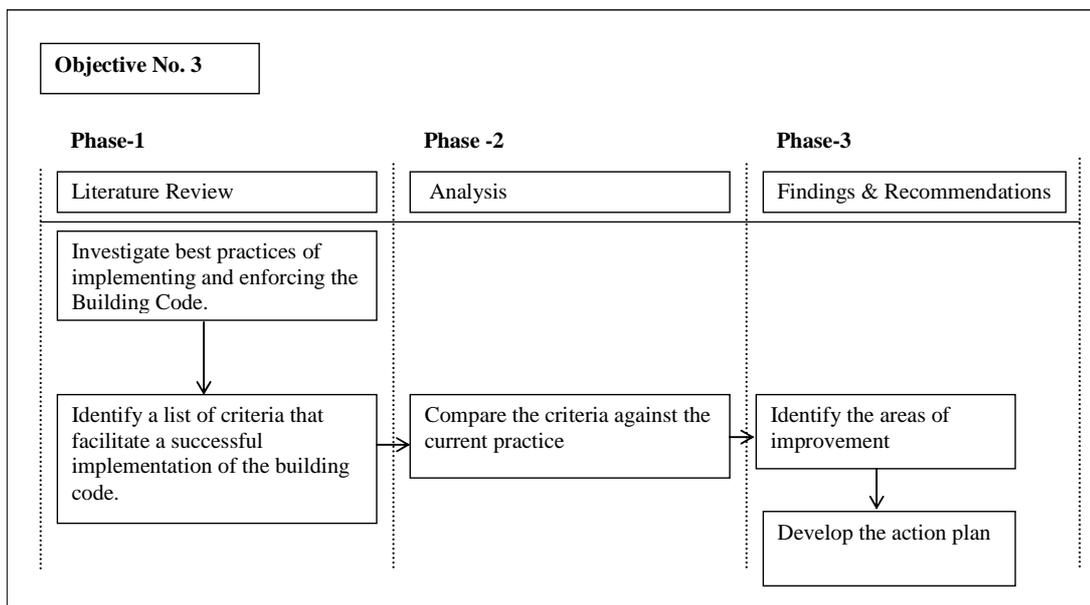


Figure 1.3: Methodology Chart for Achieving the Third Objective

1.6.5 Development and Assessment of the Saudi Building Code Guidelines

The fourth objective of this study is to develop and assess a set of guidelines for the fire protection requirements of the Saudi Building Code to be used by A/E professionals during the design stage. The guidelines were developed using a simplified statements, diagrams, tables and flowcharts without compromising the integrity and intent of the original code requirements. Moreover, the guidelines were assessed by six building code

specialists working for Saudi Aramco in term of clarity, simplicity, consistency, comprehensiveness and the methodology.

1.7 ORGANIZATION OF THE THESIS

The main objectives of this study are to assess the current practice of A/E design offices and building authorities toward implementing the building codes and regulations in Saudi Arabia and to identify and rank the factors affecting the implementation of the Saudi Building Code. The study also aims at developing a plan of action to overcome these factors. And finally, the study developed and assessed a set of guidelines for the fire protection requirements of the Saudi Building Code. The thesis has been organized into five chapters to achieve the main objectives in accordance with the developed research methodology as follows:

- **Chapter One: Introduction**

This chapter provides general background about the development of international and regional building codes and standards. This is followed by a brief introduction about the building regulations in Saudi Arabia and the processes of developing the Saudi Building Code. In addition, it includes the thesis objectives, scope, limitations, significance and the methodology followed to achieve the study objectives.

- **Chapter Two: Literature Review**

This chapter summarizes the literature related to the development and enforcement of building codes in North America, the techniques of building codes enforcement followed by Saudi Aramco and the current practice of local A/E design offices and building authorities. In addition, this chapter presents the development process of the Saudi Building Code and discusses existing building codes handbooks and guidelines.

Finally, this chapter lists and discusses twenty-six factors that might adversely affect the implementation of the Saudi Building Code.

- **Chapter Three: Assessment of the Current Practice of A/E Design Offices and Building Authorities**

This chapter presents and discusses the methodology and findings of the survey related to the current practice of A/E design offices and building authorities pertaining the implementation and enforcement of the current building regulations in Saudi Arabia.

- **Chapter Four: Factors Affecting the Implementation of the Saudi Building Code**

This chapter presents the methodology and findings of the survey related to the assessment and ranking of the twenty six factors that might adversely affect the implementation of the Saudi Building Code.

- **Chapter Five: Recommended Plan of Action**

This chapter presents the proposed plan of action that aims to facilitate and enhance the successful implementation of the Saudi Building Code. The chapter also includes the recommended fire protection guidelines for the Saudi Building Code.

CHAPTER TWO

LITERATURE REVIEW

2.1. BUILDING CODES AND STANDARDS

Building codes can be classified based on the method of development, the methodology used to achieve their intent or based on the developing organizations as follows:

1. National Codes (adopted codes), which have been developed by governmental agencies or governmental standards developing organizations.
2. Model Codes, which have been developed by private sector standard developing organizations. In the United States, model codes do not regulate building construction unless adopted or accredited by governmental agencies. The government agencies tend to adopt model codes to avoid the cost and effort associated with the development of new codes. After the model code is adopted it becomes the National Code.

The other type of building codes classification is based on the methodology in which objectives and intents of the codes are achieved. In this regard, the building codes can be classified into two types (Kenneth, 1999):

1. Performance-based Building Codes: this type specifies a set of objectives and allows the design team to figure out how to achieve these objectives.

2. Prescriptive Building Codes: this type offers a prescribed and specific criteria and guidelines based on which the codes' objectives must be achieved.

The contents of the building codes cover a variety of building related subjects, such as architectural, structural, mechanical, electrical, plumbing, fire safety and energy conservation.

2.1.1 Building Codes and Standards in the United States

The regulations of building construction in the United States date back to over 350 years ago (Ghosh, 2002). In 1905, the National Board of Fire Underwriter, and the American Insurance Association published the recommended National Building Code to guide municipalities concerned with reduction of fire hazard in and about buildings. This code was drafted by engineers of the American Insurance Association and takes into account the experience of men familiar with the phenomena of fire and their spread in buildings. The recommendations of this code were the only nationally recognized model building code until 1972 (O'Bannon, 1973).

As of 2002, there are around 93,000 standards in the United States which are developed by private organizations and federal government. The private sector standards are coordinated and harmonized by the American National Standards Institute (ANSI) which was founded in 1917. In order for standards or codes to be designated as the American National Standards, they must first be reviewed and approved by ANSI. In the private

sector, there are three types of standards developing organizations in the United States (Arther and Gasy, 2002):

1. Standards Developing Organizations: the development of codes and standards is the mission of an organization such as American Society for Testing and Materials (ASTM) which was founded in 1902 or the National Fire Protection Association (NFPA).
2. Scientific and Professional Societies: this type supports the practice and advancement of particular profession, yet it has not represented the sponsoring organization or industry. An example of this type is the Institute of Electrical and Electronic Engineers (IEEE) and the American Society of Mechanical Engineers (ASME).
3. Industry Associations: this type includes manufacturers, service providers, suppliers and others who develop technical standards that are in the interest of their particular products such as American Petroleum Institute (API).

Three model codes have been developed and practiced in all regions of the United States. The National Building Code (NBC) was developed by Building Official and Code Administrators International (BOCA) which was founded in 1945 and acquired the right to use the name of NBC after the American Insurance Association stopped publishing their National Building Code in 1976. The Uniform Building Code (UBC) was developed by International Conference of Building Code (ICBO) which was founded in 1922. The Standards Building Code (SBC) was developed by the Southern Building Code Congress International (SBCCI) which was founded in 1940 (Gosh, 2002).

The National Building Code by BOCA was published in 1950 and used on the Northeast and Great Lakes portion of the United States. The Uniform Building Code by ICBO was published in 1927 and used in the western United States. The Standard Building Code by SBCCI was published in 1945 and used in the southern United States. In 1994, the International Code Council (ICC) was established to combine these three traditional regional models into a single national model. The founders of the ICC are the Building Officials and Code Administrations International (BOCA), the International Conference of Building Officials (ICOB) and the Southern Building Code Congress International (SBCCI). In 1997, a new code based on the Uniform Building Code series, BOCA and SBCCI standards was drafted. In 2000, the International Building Code (IBC) was published as a single code by the ICC and an updated version is issued every three years (Arthur and Gasey, 2002).

ICC codes include International Building Code, International Fire Code, International Mechanical Codes, International Fuel Gas Code, International Existing Building Code, International Electrical Code, International Plumbing Code, International Energy Code, International Private Sewage Code, International Performance Code, International Property Maintenance Code, International Residential Code, International Urban Wildfire Interface Code and International Zoning Code. In addition to these codes, there are codes and standards published by the National Fire Protection Association (NFPA) such as the Uniform Fire Code, National Electrical Code, Life Safety Code, Building Construction and Safety Code and National Fire Alarm Code.

2.2. BUILDING CODES ENFORCEMENT STRATEGY

Previous studies have created different strategies about the efficiency of different approaches to enforce building codes. There has been some confusion on the classification of building codes enforcement strategies because of the disagreement over terminologies, the level of enforcement or researchers assumptions and whether such a concept applies to agencies, to inspectors or to both. Unlike the confusion found in the literature, May and Burby (1998) suggested a useful distinction with respect to the style of the enforcement strategies. The first style is related to the enforcement agency practices as inspections, technical assistance, and publicizing rules. The second is the action taken by the enforcement agency such as incentive or sanction. The practice of Building Codes enforcement can be summarized as follows (May and Burby, 1998).

A. Deterrent Enforcement Practices:

- Notice of violation.
- Notice of corrective action
- Stop-work order
- Revocation of building permit.
- Revocation of certificate of occupancy.
- Temporary restraining order.
- Preliminarily injunction.
- Permanent injunction.
- Infraction field citation/fine.

- Misdemeanor prosecution/fine.
- Fine levied for working without permit in the past 12 months.
- Fine levied for not following approved plan in the past 12 months.
- Fine levied for not following approved code provisions in the past 12 months.

B. Discretionary Enforcement Practices:

- Inspectors authorized to bluff to attain compliance.
- Inspectors allowed being lenient when life safety is not threatened.
- Inspectors can spend extra time on site to develop good relations with construction contractors.
- Inspectors can badger contractors who are chronic violators.
- Inspectors can relax standards based on extenuating circumstances.

C. Incentive Practices:

- Prior record of violator taken into account in decision to prosecute.
- Attitude of violator taken into account in decision to prosecute.
- Less frequent inspections.
- Bend over backward to be cordial.
- Modify standards for firm with good records with approval from higher authority.
- Other incentives.

D. Technical Assistance Practice :

- One-on-one technical assistance during plan review.
- One-on-one technical assistance at construction site.
- Booklets describing code enforcement procedures and policies.
- Workshops to explain code provisions.
- Newsletters and bulletins.
- Self-contained slide, audio or video cassette module.

E. Standardization and Supervision of Field Inspectors:

- Inspection checklists and forms.
- Agency policy or procedure manual.
- Periodic review of inspectors work.
- Inspector required consulting supervisor/building official on different decisions.
- Rotate field inspector's territories.
- Intensive training of inspector in agency policy and procedures.
- Annual performance evaluation of inspector's work.
- Follow-up field inspection of inspector's work.
- Productivity measures used to evaluate inspector's work.

There are two critical choices based on which building authorities could improve the compliance of building codes. The first choice is the enforced compliance through the

staff of the enforcement authority who should detect violations. This choice requires authorities to have more trained personnel who should expend more effort to issue and review building permits, review building design packages, conduct site inspections and provide technical assistance. The second choice is the voluntary compliance through emphasizing strict enforcement of rules and regulations or through staff coordination with regulated firms and individuals. This choice can be met either by following a systematic approach or facilitated approach. The systematic approach requires careful monitoring of compliance, uniform strict application of code permit requirements and use of sanctions such as stop work orders and fines to deter violations. The facilitative approach needs relaxing requirements when the goals of regulations can't be compromised, and use incentives to establish good relationship with firms and individual who should implement the regulations. This approach requires verbal negotiating with contractors, builders and developers to persuade them to comply with the building code (Burby, 1998 ; O`bannon, 1989).

The enforcement strategies are what code enforcement agencies and inspectors tend to do to enforce code provisions. These strategies can be summarized as follow:

- Strict enforcement consisting of strong systematic enforcement and limited facilitation of compliance.
- Creative enforcement consisting of a high degree of each component.
- Facilitative enforcement consisting of high degrees of facilitation and less rigidity.
- Accommodative enforcement consisting of low degrees of each component.

2.3. ENFORCEMENT OF BUILDING CODES IN THE UNITED STATES

Each state government in the United States has the power to enforce the health and safety regulations. The methodology based on which each state handles and promulgates building and fire regulations varies widely. This variation creates a problem as some local city governments are adopting one or more model codes. The building code applies to new buildings and major alterations. Occupancy is not permitted prior to issuing the occupancy permit or certificate of occupancy by the building official (Arthur and Gasey, 2002). In most states, like Louisiana they have their own fire marshal that is required by the state law to review all buildings for the private sector, governmental sector and the federal government. Review comments on the federal government are treated as recommendations and are not compulsory. On the contrary, one and two family dwelling units are reviewed by the city mayor's department (Carter, 2008). The building process in the state of Louisiana was investigated through interview with Jean C. Carter, Jr. a former architect supervisor in the Louisiana State Fire Marshal Department. The interview revealed that Louisiana had many codes and standards prior to year 2007. However, in January 1, 2007, the state started the enforcement of the International Building Code. There are many departments and individuals involved in the construction process at the state level depending on the size and type of each project. The general practice of building code enforcement is handled by the State Fire Marshal Department who is involved in reviewing projects design packages and conducting final inspections for each construction project. As a courtesy to the construction industry, the Fire Marshal

conducts interim inspections during the construction process as a rule of practice which is not required by the state law. The design packages are reviewed by the Fire Marshal Department in addition to the city Commercial Plan Review Department which is administered by the city mayor. Once the project meets the code requirements, the Fire Marshal Department notifies the City Plan Review Department to issue the building permit. Once the construction is completed, the contractor obtains a certificate of completion signed by the architect who designed the building. Then the contractor schedules a final inspection from the state Fire Marshal Department. The fire marshal inspector conducts the final inspection to ensure compliance with the building code requirements based on the stamped drawings and the review letter from the state Fire Marshal plan review department. Once the building meets the code requirements, the fire marshal notifies the city commercial plan review department to issue the certificate of occupancy.

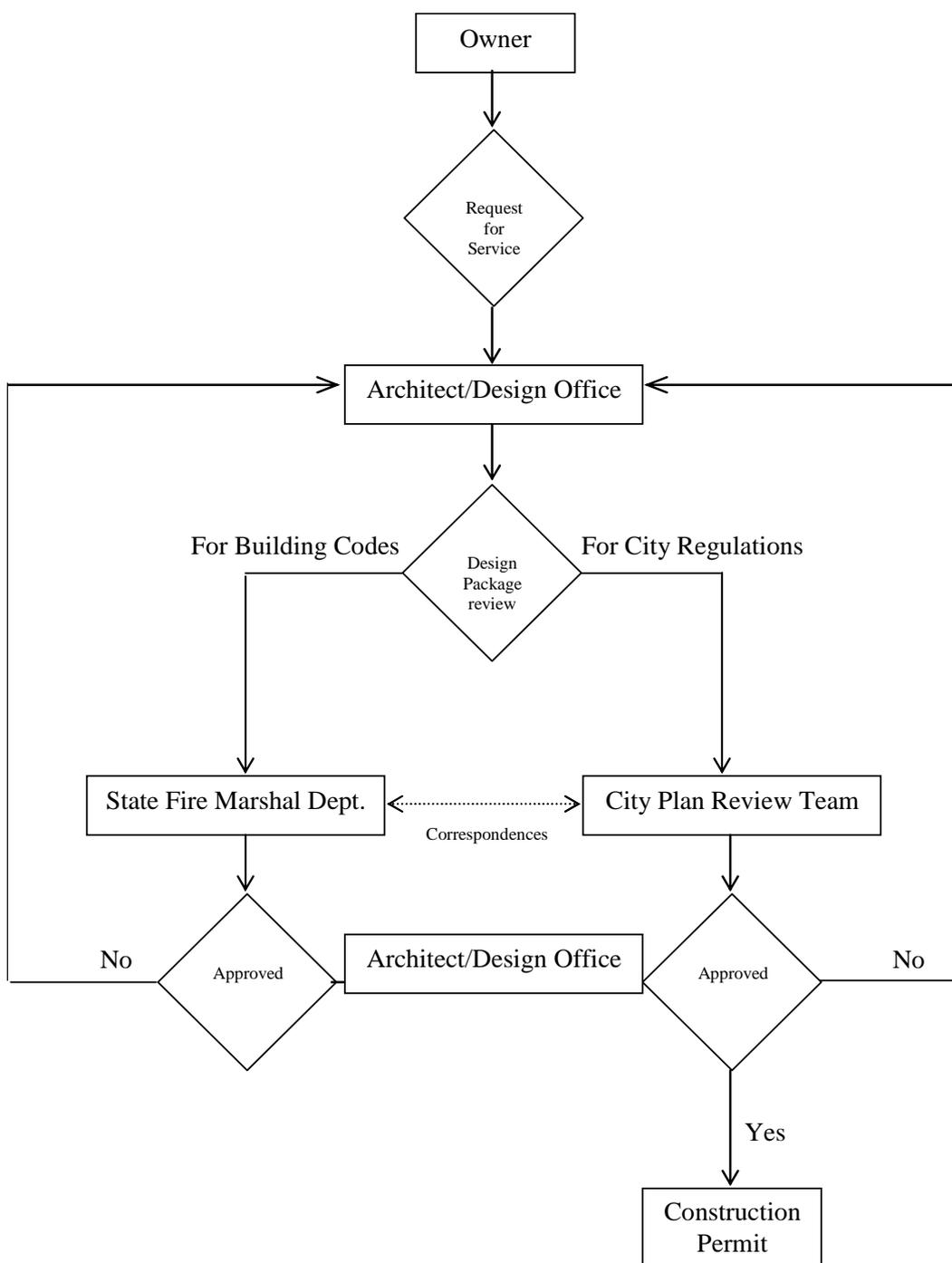


Figure 2.1: Building Permit Process in the State of Louisiana, U.S.A (Carter, 2008).

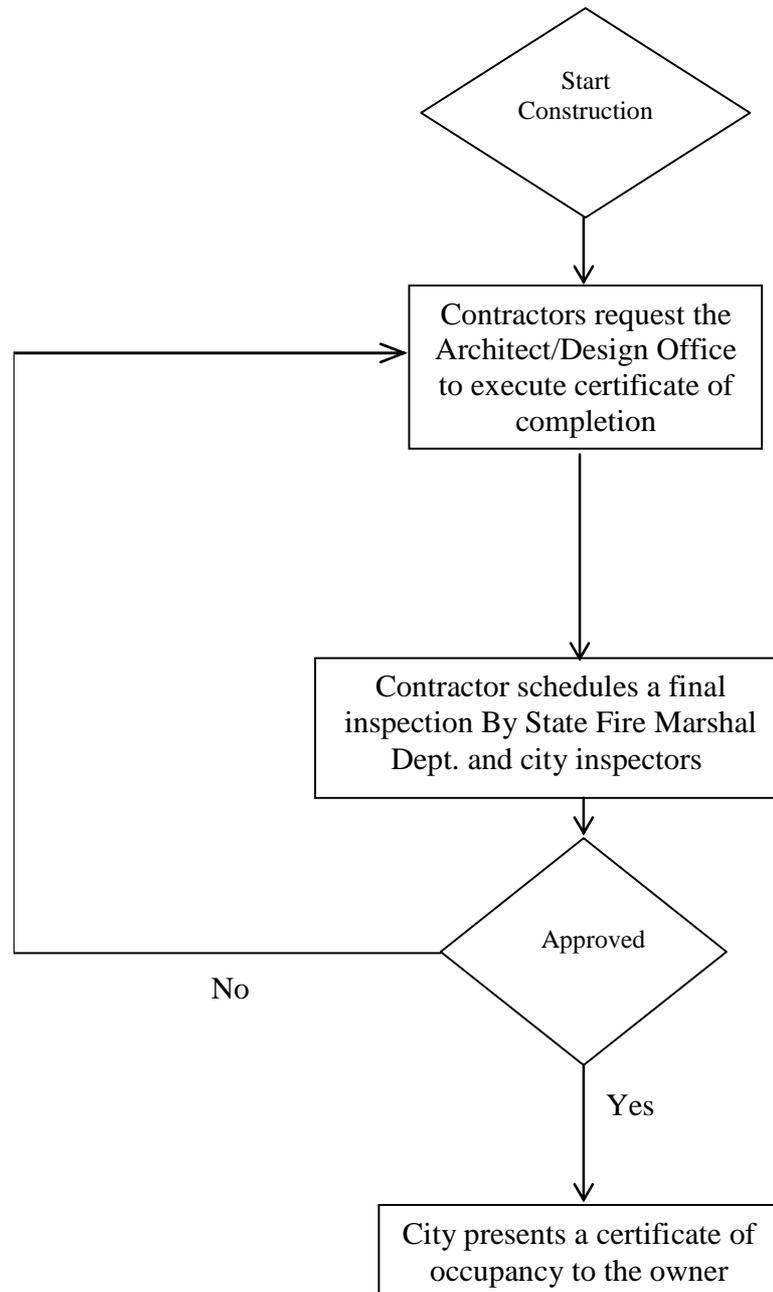


Figure 2.2: The Process of Certificate of Occupancy in the State of Louisiana, U.S.A (Carter, 2008).

2.4. THE PRACTICE OF SAUDI ARAMCO

Saudi Arabian Oil Company (ARAMCO) is considered one of the best local organizations in adopting, implementing and enforcing building codes and standards. The company adapted the Uniform Building Code many years ago. In Saudi Aramco, there are different departments involved in the building construction process. The Loss Prevention Department is considered the primary Code official for all works related to fire safety and fire protection. Within the Loss Prevention Department, there is a group specialized in the building code which reviews building design packages, inspects buildings under constructions and provides code consultations to other departments. The success of building code enforcement and implementation in Saudi Aramco results from the clear and successful safety policy followed strictly in the company through adopting a successful systematic building approval processes. These processes can be divided into five stages:

1. Design Basics Scoping Paper (DBSP) stage: at this stage, a general description of the building to be constructed is forwarded to different departments including for their review and comments to ensure major code requirements are addressed.
2. Project Proposal stage: at this stage, three reviews are conducted. The level of enforcing the code requirements at this stage is increasing according to the progress of the design.
3. Detailed Design stage: at this stage three reviews are conducted. All code requirements are addressed at this stage.

4. Construction stage: at this stage, the inspection of the project site and the Mechanical Completion Certificate (MCC) walkthroughs are conducted.
5. Life Cycle stage: at this stage, periodic safety inspections are conducted for the facility to ensure compliance with safety measures.

These stages are preset guidelines but it might be reduced or increased depending on the size and nature of the project. All five stages are illustrated briefly in Table 2.1 (AL-Sultan, 2008):

Project Management Team (PMT) is responsible for administering and coordinating the project during design and construction stage. PMT facilitates meetings and reviews throughout the project cycle between all parties and play a primary role to ensure the quality and durability of the project.

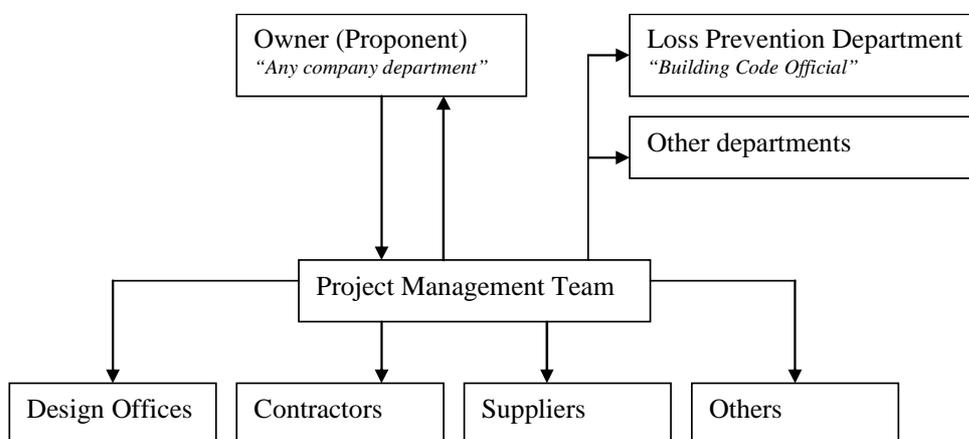


Figure 2.3: The concept of Project Management Team at Saudi Aramco

TABLE 2.1: Saudi Aramco Building Code Enforcement Process

Stage	Name	Major Activities
Stage-1	Design Basic Scoping Paper (DBSP)	The general building code requirements and company safety special requirements are addressed
Stage-2	30 % Project Proposal	Review for basic code requirements such as occupancy classification, type of contraction, site layout, and provision of fire protection systems requirement and means of egress.
	60% Project proposal	Review for compliance with the 30 % comments and check number of exits, location of exits, location of fire barriers, site layout and special case studies.
	90 % Project proposal	Review for compliance with the 60 % comments. If the project meets the code requirements, the project proposal is approved.
Stage-3	30 % Detailed Design	Review for basic detail requirements related to means of egress, fire protection systems, type of construction, code analysis and special case studies.
	60 % Detailed Design	Comprehensive review for all code provisions, specifications and installation methods.
	90 % Detailed Design	Final Review to ensure compliance with all previous comments and to review further details and special case studies.
Stage-4	Periodic field inspection	Scheduled and non-scheduled site inspections to the building during construction to ensure compliance with code requirements and approved drawings.
	Pre- MCC walkthrough	At this stage, the major code violations are addressed to the project management to rectify it before the final walkthrough to avoid time or cost impact.
	Final MCC walkthrough	At this stage, final walkthrough is conducted by many departments including the loss prevention department to ensure compliance with code requirements. If the building complies with all code requirements, it is then approved for occupancy.
Satge-5	Quarterly Safety Inspection	Each facility during its life cycle is subject to safety inspection each four months to ensure compliance with safety and fire prevention measures.

2.5. CURRENT SAFETY REGULATIONS IN SAUDI ARABIA

In Saudi Arabia, there was no comprehensive Building Code prior to the Building Fire Protection Requirements developed by the GCC secretarial General. However, some fire protection and prevention regulations established by the General Administration of Civil Defense and the Ministry of Municipal and Rural Affairs were utilized to regulate the construction and operation of buildings. In addition, major organizations in Saudi Arabia such as Saudi Aramco, Jubail and Yanbu Royal Commission have their independent building Codes that regulate the design and construction of their buildings. These building codes are based on the Uniform Building Code and the International Building Code.

As of year 2000, Mousa surveyed most of the well known design offices in the cities of Riyadh, Dammam, Makkah, Jeddah and Taif. The study indicated that 70 % of the design offices follow the local regulations issued by the Department of Safety and Industrial Security of the GACD, 17% don't follow any written safety code and 13 % follow Uniform Building Codes and NFPA codes (Al-Homoud and Mousa, 2000). Reviewing the regulations published by the Ministry of Municipal and Rural Affairs and the General Administration of Civil Defense and comparing them to model codes such as International Building Code, International Fire Code, Life Safety Code (NFPA-101) and Building Construction and Safety Code (NFPA-5000) reveals that these regulations do not meet the minimum requirements established by the model codes.

2.5.1. The Regulations of the Ministry of Municipal and Rural Affairs

The regulations established by the Ministry of Municipal and Rural Affairs do not primarily focus on building safety. Safety requirements are not unified and include minor requirements such as the provision of emergency exits, emergency lights and evacuation plans. The regulations are not classified based on the occupancy and do not provide the minimum requirements highlighted in the International Building Codes. Moreover, the safety regulations depend on the review and approval of the Civil Defense. The regulations published by the Ministry of Municipal and Rural Affairs are classified into four major categories:

1. **Health Regulations:** these regulations focused mainly on the health requirements for food service occupancies and production including regulations for restaurants, snack bars and fast food occupancies.
2. **Municipal Regulations:** these regulations are related to reuse or removal of untreated sewage water, pest control and landscaping such in public spaces and beaches.
3. **Technical Regulations:** these regulations address technical requirements for certain type of occupancy such as the regulations of malls.
4. **Construction Regulations:** these regulations are related to the requirements and procedures of permits such as building permit and demolition permit.

2.5.2. The Regulations of the General Administration of Civil Defense

The regulations established by the civil defense are not unified except for the fire protection requirements of buildings issued by the technical committee of GCC, which is an Arabic translation of NFPA-101 with minor modifications. Unlike the regulations issued by MMRA, the regulations issued by GACD are classified based on building occupancy. However, it is not as comprehensive as the occupancy classification found in model codes.

2.6. THE DEVELOPMENT OF THE SAUDI BUILDING CODE

Initiatives to develop the Saudi Building Code were started by the Saudi Standards, Metrology and Quality Organization (SASO) in 1982 (1402-H) but no modifications have been achieved since then. Later, in June 2000 (1421-H), the National Committee of the Saudi Building Code (NCSBC) was formed according to a ministerial resolution (Al-Naghady, 2005). One year later, budgets and plans for NCSBC were approved by the Council of Ministers. The NCSBC formed the technical and consulting committees in April 2003, which started to prepare the general framework for the Saudi Building Code. The framework of the Saudi Building Code was approved on December 2004 by the Saudi Council of Ministers (SBC, 2007).

The National Committee of the Saudi Building Code (NCSBC) chose the International Codes by the International Code Council (ICC) as the base for the Saudi Building Code with addition and modification to suit the use within Saudi Arabia. In addition, the NCSBC endorsed the use of additional Codes and Standards such as the International

Electro-technical Commission (IEC) for electro-technical regulations and requirements, the American Concrete Institute (ACI) for concrete and masonry construction, the American Society of Civil Engineers (ASCE) for loading and force and the American Institute for Steel Construction (AISC) for steel structure (SBC-2007).

The development methodology of the Saudi Building Code took several stages in which the NCSBC conducted several meetings, workshops and symposiums with participation of experts in building and construction industry, government and private sectors and universities and research centers (SBC, 2007). The methodology can be summarized into three major stages. The first stage is the formation of the NCSBC and its subcommittees as discussed earlier. The second stage is the literature survey a select the base code. At this stage, the NCSBC reviewed several International and Arab codes, international practices, local building regulations and standards and other related researches. The third stage is the selection and modification of the base code where new chapters, subsections and Figures were added and others were deleted. The modification of the base code was a result of the outcome of the literature survey in addition to local requirements such as environmental conditions, social requirements, seismic provisions, materials, measurement units and terminologies (Al-Naghady and Bin-Hisain, 2005).

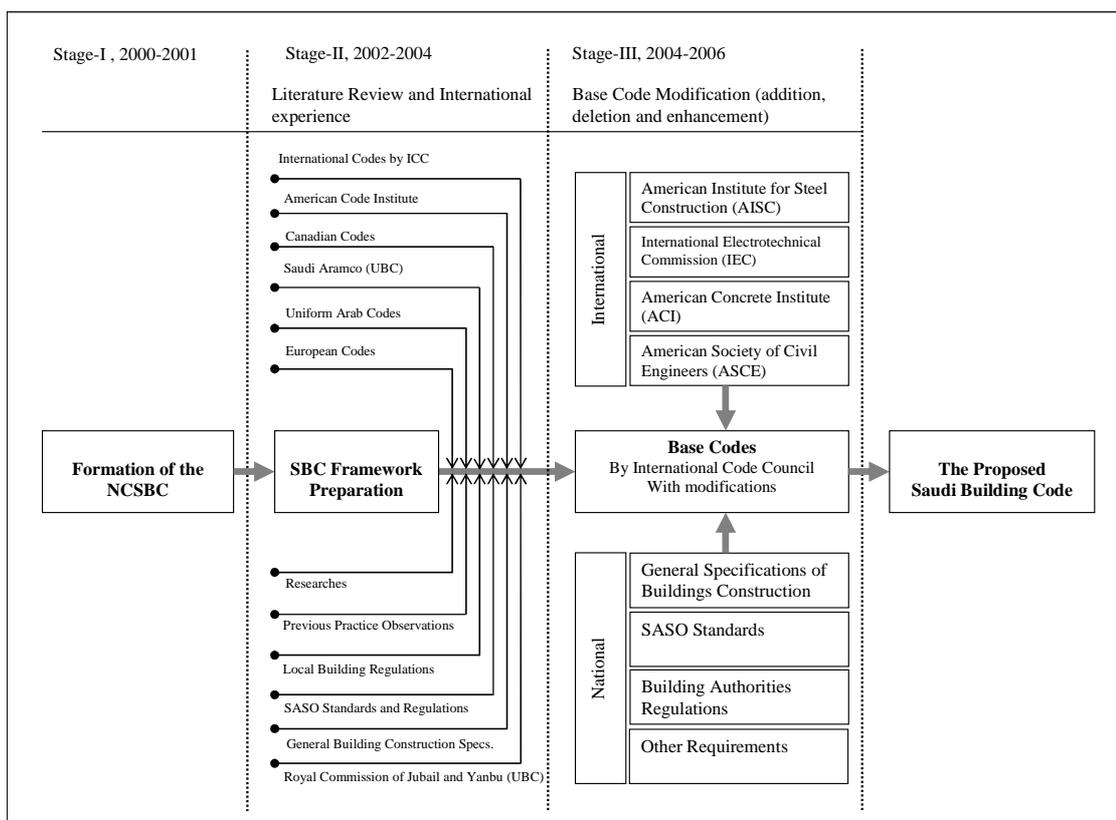


Figure 2.4: The Saudi Building Code Development Framework (Al-Zade, 2005)

The Saudi Building Code is composed of the following volumes and (Al-Zade and Al-Naghady, 2005):

- **SBC-101:** this volume includes the legal and administrative requirements, such as tasks and responsibilities of building officials and authorities, building permits, building use and occupancy, building officials' qualifications, violations, stop of work orders and others.
- **SBC-201:** this volume includes the proposed Architectural requirements, such as the detailed architectural provisions that are related to building

occupancy classification and use, building height , building area, types of construction, interior finishes, design of means of egress, handicapped provisions, indoor environmental requirements, building exterior environment, roof construction, pest control provisions and instruction signs. It also, includes architectural requirements such as materials specifications and requirements of wood and requirements of glass and gypsum boards.

- **SBC-301, SBC-302, SBC-303, SBC-304 and SBC-306:** these volumes include the proposed structural requirements such as structural design, structural inspection and tests, soil, foundations, retaining walls, scaffolding and construction safety, concrete structures, construction with brick and masonry and steel structures.
- **SBC-401:** this volume includes the proposed electrical requirements such as provisions for the electrical wiring, interior and exterior lighting, panel boards, fire alarm systems, lighting protection, elevators and escalators and standby power.
- **SBC-501:** this volume includes the proposed mechanical requirements, such as provisions for air conditioning, heating, ventilation, ductwork, water heaters, solar energy, elevators and escalators and HVAC maintenance.
- **SBC-601:** this volume includes the proposed energy and water conservation requirements, such as provisions for energy and water conservation.

- **SBC-701:** this volume includes the proposed sanitary requirements, such as provisions for the water supply, draining and sewer, rain draining, fire water, sewer treatment and gas piping.

- **SBC-801:** this volume includes the proposed fire protection requirements, such as provisions for building classifications, fire resistance constructions, and fire protection systems, means of egress and fire zoning and compartmenting.

- **SBC-901:** this volume includes the proposed existing buildings requirements, such as provisions alteration, modification, reconfiguration, changing the occupancy, enhancing seismic and fire protection performance.

2.7. DESIGN PROCESS PARTIES

Many studies listed different phases of the building construction process. These phases can be subjectively broken into three main phases of a project life cycle which are the planning phase (feasibility study, design), the construction phase (bidding, construction) and the utilization phase (occupancy and maintenance) (Arain, 2002). The design process of a project is the period started when a client hires a design office to design the project. The design process consists of four sub-phases: the conceptual design phase, the schematic design phase, the design development phase and the construction documents and specifications phase (Al-Saaty and Krawczyk, 2004). The development of

construction methods and the use of new materials urge the involvement of “multiple clients who employ multiple design teams for designing and construction which will be carried out by multiple contractors and sub-contractors” (Al-Rugaib, 1996).

There are three groups involved in the construction process based on their objectives. The first group is the investment oriented group who plan to invest in the final product of the construction process including the developer, owner and investor. The second group is the profit oriented group who profited from their contribution in the construction process including design offices, construction contractor, materials supplier, construction materials manufacturers and insurance companies. The third group is the regulatory group who has special purposes and involvement in the construction process such as building authorities (Scodek and Gauchat, 1978).

This classification of the participant’s involvement in the construction process is crucial to discuss the role of each participant in the implementation of building code and standards. The following sections highlighted briefly the role of each participant in the construction industry in Saudi Arabia.

2.7.1. Involvement of the Owner

Involvement of the owner in the construction process differs as some owners choose to be closely involved, whereas others prefer to be remotely involved. The quality of any project is affected by the involvement and contribution of the owner. The owner involvement in the design phase is the lowest during the entire construction process (Al-Musaid, 1990). The owners are viewed in previous studies as being responsible for the

completeness and adequacy of the design documents. Usually, time allowed by the owner for design and construction process is not planned. In addition, the owner level of engagement in the design process, the changes he makes or the amount of fund he secures for the design and his belief in the role of building authorities have an impact on the quality of the design documentations (Al-Darwish, 2005). Accordingly, this will affect the level of design completeness and the details that are necessary to facilitate the construction without misinterpretation of design documentations.

2.7.2. Involvement of A/E Design Offices

Design offices play a major role in the construction process, through design and construction phases in some cases. Design and consultant offices are responsible for preparing design packages of any project which include structural design drawings and calculation, HVAC design drawings and calculations , electrical design drawings and calculations, plumbing design drawings and calculations, architectural drawings and specifications. Consequently, excluding any of these documents would make the construction difficult or impossible (Al-Ghamdi, 1999). In 2006, there were around 2200 design and consultant offices, 64 % of which are engineering offices (Al-Rabiyah, 2006). Offices that practice engineering and architectural designs in Saudi Arabia are divided into two categories (Al-Rugaib, 1996), the Architectural or engineering office and the Consulting offices.

These design offices are required to be licensed by the Ministry of Commerce. Many stipulations are considered for licensing those design offices including qualifications, nationality, and number of engineers from different disciplines and years of experience

for the office founder. These stipulations have been established prior joining the World Trading Organization (WTO) and are summarized in Table 2.2.

TABLE 2.2 : License Requirements for Design and Consultant Offices

Category	Sub-category	License Requirements
Architectural or Engineering offices	Engineering Services Support Office	<ul style="list-style-type: none"> ▪ Saudi nationality ▪ High diploma or equivalent degree in engineering branches. ▪ Documented experience of not less than five years.
	Engineering or Architectural Office	<ul style="list-style-type: none"> ▪ Saudi nationality ▪ Bachelor degree in engineering from a university or institution recognized by the Ministry of Higher Education. ▪ Documented experience of not less than five years.
Consultant Offices	Engineering Consultant Office “in one field of engineering”	<ul style="list-style-type: none"> ▪ Saudi nationality ▪ Bachelor degree in engineering from a university or institution recognized by the Ministry of Higher Education. ▪ Documented experience of not less than eight years. ▪ Has been licensed as an engineering office of not less than three years.
	Engineering Consultant Office “in more than one field of engineering”	<ul style="list-style-type: none"> ▪ Saudi nationality ▪ Bachelor degree in engineering from a university or institution recognized by the Ministry of Higher Education. ▪ Documented experience of not less than fifteen years. ▪ Has been licensed as consultant engineer office for not less than three years. ▪ The office has two engineers in different fields of engineering, other than the office founder’s major, with not less than twelve years of experience.

2.7.3. Involvement of Construction Contractors

The traditional procurement method, whereby the design is totally separated from construction is the most common method in Saudi Arabia except for large governmental and municipal projects (Al-Rugaib, 1996). A study conducted in 1997, showed that around 80 % of contractors in the Kingdom of Saudi Arabia are involved only in the construction phase, whereas only 20% are involved in the design-construction phase. The construction contractors' misunderstanding of drawings and specifications is a vital factor which leads to some deficiencies from the original drawings as the contractor continues the project according to the wrong interpretations (Arain, 1997).

The contractors execute projects in accordance with the design drawings and the specifications, if there are violations to the code or the regulations in the design or the specifications, the contractors would apply the violations without identifying them or notifying the building owner or the design office. The miscommunication or low coordination between the contractors and the design offices is considered one of many factors that affect the project cost in Saudi Arabia especially for a traditional type of procurement (Al-Juwairah, 1997).

2.7.4. Involvement of Building Authorities

Building authorities who have direct involvement in the construction process in Saudi Arabia include the General Administration of Civil Defense (GACD) and the Ministry of Municipal and Rural Affairs (MMRA). There are additional governmental departments which have indirect involvement in issuing and monitoring the building regulations such

as Saudi Standards, Metrology and Quality Organization (SASO), The Ministry of Health which establishes regulations for hospitals, clinics and pharmacies and the Ministry of Education which establishes a set of regulations for schools. Other indirect involvement of government authorities includes the Ministry of Commerce which licenses design and consultant offices, Saudi Council of Engineers who administers the engineering and architectural careers. In addition, there is a proposed role for the NCSBC in future including updating the Saudi Building Code.

I. **Ministry of Municipal and Rural Affairs:** there was a distinguished development in the municipal services over the past decades. The early development of municipal services in Saudi Arabia started in 1926 (1345H), this was followed by the establishment of the Ministry of Municipal and Rural Affairs in 1975 (1395H). Over 187 municipal services sectors have been founded since then all over the kingdom. They have many roles in cities development and urban planning but their roles in the construction industry can be summarized as follows (Al-Futaimah and Amod, 2004):

- Select and plan proper land for urban development with proper zoning to prevent the spread of fire by segregation of community uses from industrial uses, and to reduce risks of earthquakes, flooding and pollution.
- Issue several regulations to control building construction, zoning, safety and sanitary.
- Coordinate and participate with other governmental departments to issue or modify building regulations.

- Enforce building regulations issued by the Ministry of Municipal and Rural Affairs or by other governmental departments.
- Issue building permits for new buildings and alteration, addition, demolition and renovation of existing buildings. In some cases those building permits are issued with coordination of other governmental departments.

II. General Administration of Civil Defense: the civil defense witnessed a gradual development in Saudi Arabia since its early development in 1927 when the first fire fighting team was founded. General Administration of Civil Defense is represented by a regional General Administration in each region which administers all Civil Defense Departments in that region. GACD's roles in the construction industry can be summarized as follows (GACD, 2001)

- Issue safety regulations for different type of occupancies, building systems and equipment.
- Issue building permits for a certain type of occupancy and activities depending on the nature of the facility or when requested by the municipality.
- Conduct preventive and supervisory inspections for the fire protection systems and equipments in existing facilities.
- Coordinate and participate with other governmental departments in issuing or modifying safety regulations.
- Educate the public on fire safety and safety behavior and enhance the practice of safety through media, publications and conferences.

Safety and fire protection regulations are issued by the Safety and Industrial Security Department of the General Administration of Civil Defense (Mousa,

2000), and approved by the Council of Civil Defense which was founded in 1985 (1406H). Additionally, the General Administration of Civil Defense (GACD) participated in the development of Building Fire Protection Requirements for Gulf Countries, which have been adopted in 2003 according to Ministerial Resolution (GACD, 2001).

III. Saudi Council of Engineers: the development of engineering and architectural career is administered by the Saudi Council of Engineers (SCE) which previously was known as the Engineering Consultancy Committee that was founded in 1982 (1402H) under the Ministry of Commerce. In 2002 (1423H), the Engineering Consultancy Committee (ECC) was changed to the Saudi Council of Engineers. The role of the Council in the construction process can be indirectly viewed through the accreditation programs and the development of A/E professionals. As of year 2008, the Saudi Council of Engineers has three branches in the central, eastern and western regions. The role of the Saudi Council of Engineers in the construction industry can be summarized as follows:

1. Establish the basis and criteria for practicing and developing the engineering careers.
2. Establish the rules for engineering accreditation.
3. Prepare studies, research and statistics related to different branches of engineering and published related scientific journals.
4. Organize courses, seminars, conferences and exhibitions related to the engineering career.

5. Offer suggestions and technical recommendations to other governmental departments.

IV. National Committee of the Saudi Building Code (NCSBC): the National Committee of the Saudi Building Code (NCSBC) was formed in 2000 to create the Saudi Building Code as a primary objective. The general secretariat of the committee is permanently formed in the Saudi Standards, Metrology and Quality Organization to organize and administers the committee and the subcommittee activities. The strategic goals of NCSBC are as follow:

1. Prepare a building code for the Kingdom of Saudi Arabia.
2. Assess buildings that are currently exposed to the risks of the earthquake.
3. Prepare the appropriate measures to implement the proposed building code.

2.8. SAFETY MEASURES IN BUILDINGS DESIGN IN SAUDI ARABIA

In May 2000, a study conducted by Mousa Khan to assess the safety measures in the design of residential buildings in Saudi Arabia surveyed 102 of the most well known design offices in the cities of Riyadh, Dammam, Khobar, Makah, Jeddah and Taif. The major findings of the study can be summarized as follows:

- The consideration of safety issues by the designers and building authorities are ineffective.
- About 70% of the design offices followed local safety requirements, 17 % followed no written codes, and 13 % followed Uniform Building Code and National Fire Protection Association standards.

- About 58% agreed that both municipality and civil defense are responsible for reviewing and approving safety issues, 28 % confirms that the civil defense is responsible and 14% confirms that the municipality is responsible.
- The review of the drawings is subject to the experience of the municipality engineers.
- Buildings of four or more stories are reviewed by civil defense.

There is a shortage of studies related to the local building regulations and enforcement practice in Saudi Arabia and there is a lack of documented procedures of the building permit process. In addition, most of the studies are focused on one type of occupancy such as residential, or office buildings. Accordingly this study emphasizes the building permit procedures and investigates the practice of the design office and building authorities toward addressing the safety requirements in different occupancies.

2.9. EXISTING CODE ILLUSTRATION STUDIES

Many books and handbooks were published to discuss the building code requirements in detailed and illustrative manners and provide practical interpretations for the code requirements. The most important books in code interpretation are the Code Commentaries published by the International Code Council, which provide explanation with examples for each code requirement. Another good example is the Illustrated 2003 Building Code Handbook by Terry L. Patterson which clarifies the sections of the 2003 edition of the international building code (Patterson, 2004). Additionally, the Building Code Illustrated by Ching, F.D. and Winkel, S. R., is another book that offers Building Code Illustration (Ching and Winkel, 2006).

This section presents some of the best studies that offer guidelines and illustrations on how to use the building codes and conduct code analysis based on the uniform Building Code and International Building Codes. Unlike the published building code and commentaries, these studies provide code navigation techniques that help the user to utilize the code properly. The most important existing code analysis and user-interface studies that are investigated in this study are highlighted and discussed briefly in the following sections. Most of the published studies and code illustrations are either provide explanation of each section of the code or provide explanations for the steps required to implement the code requirements following the same sequence of the code sections and chapters. The proposed guidelines of this study provide structured procedures based on the sequence of the requirements and not the sequence of the code sections and chapters.

2.9.1. ICBO/Sheedy Tables

Paul Sheedy and the International Conference of Building Official (ICBO) published a quick reference guide to the Uniform Building Code (Patterson, 1993). Although, the Tables do not provide the designer with clear approach of how to conduct code analysis or how to comprehend the sequence of the code requirements, the Tables grouped a great deal of information arranged based on the occupancy classification. Each Table includes different requirements based on each type of construction such as:

- Allowable area and height
- Location on property.
- Exterior and interior fire-rating and openings protection.
- Occupancy separation.
- Construction assemblies, such as shafts, floors, walls and roof.

2.9.2. Simplified Design for Building Fire Safety by James Patterson, 1993

One of the most interesting and comprehensive books that investigates the issue of fire safety from building designer point of view is the *Simplified Design for Building Fire Safety* by James Patterson (Patterson, 1993). The book was published in 1993 based on the 1991 edition of the Uniform Building Code, which aims to enable building designers to conceptualize a complete fire safety strategy. The book is divided into three parts. The first part explores the phenomena of fire, the second part examines the principles of design which are developed to defend against fire catastrophes and the third part deals with the fire control and extinguishing. Patterson classified the methods and techniques for configuring buildings to optimize fire safety into two categories. First, *Soft Technology* which include occupancy selection, compartmenting, containment, geometry of the building envelop, the arrangement of vertical shafts, means of egress and areas of refuge. Second, *Hard Technology* which has construction components including fire barriers, smoke barriers, smoke curtains, and the active equipment dealing with fire such as alarm and communication systems and automatic fire extinguishing systems (Patterson, 1993). Petersons discussed three approaches available to building designers to address the issue of fire safety: first, fire safety design strategy based on goal and objective, second, fire safety design strategy based on system concept, third, fire safety design strategy based on the building code. Although all design strategies are of relevant use, the third strategy will be highlighted as it is related to the scope of this study. Patterson identified the major sequence of events to design for building fire safety as highlighted in Figure 2.6. The book discussed the major occupancy classifications which are groups A, B, E, H, I, M and R and their major requirements based on the tabulated

occupancy construction requirements of the UBC by the International Conference of Building Code. As part of the soft technologies, Patterson provides detailed illustrations with code cross-reference about the design details for means of egress components.

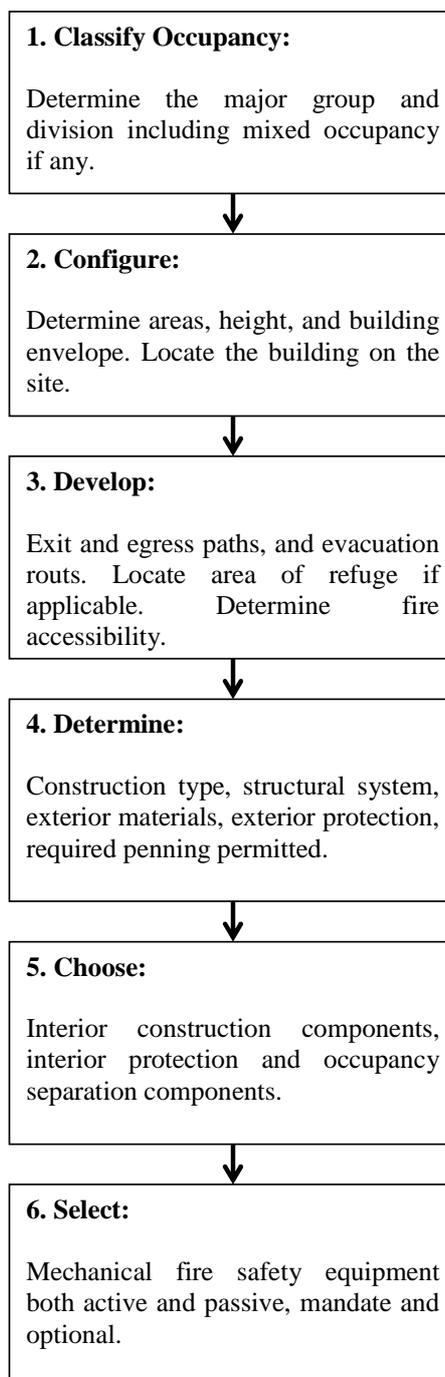


Figure 2.5: Sequence for Design Events for Fire Safety (Patterson, 1993)

2.9.3. The User's Guide to the 1997 Uniform Building Code by Catherine Houston, 1998

Houston conducted quite an important study to provide a user guide to the Uniform Building Code-1997 which acts like an interface between the architect and the building code. Houston came up with a document called the CodeMaster, which “provides a sequential structure for professionals to follow while performing a code analysis for a new or existing project “. The CodeMaster has been organized in eight sections with color coded and code cross-references that covers the non-structural requirements of volume one of the Uniform Building Code -1997. Each section of the CodeMaster has been reviewed and briefly discussed as follow:

▪ Occupancy Classification

The methods of how the occupancy classification can be established are highlighted in the CodeMaster as follow:

1. Compute the actual floor areas of the building, or portion thereof.
2. Determine the occupant load of the building.
3. Determine the occupancy group which the building or portion thereof most nearly reassembles.
4. Determine whether the building has mixed use or single occupancy.

This section of the CodeMaster provides guidelines for occupancy classification. Occupant load according to the CodeMaster can be achieved through dividing the actual area by an occupant factor. However, the influence of the type of occupancy and the exceptions of accessory spaces is not presented. The occupant load is a crucial factor in determining the occupancy classification and fire protection requirements. Overlooking

the right techniques of determining the occupant load will increase the project cost by providing unnecessary protection or will lead to wrong classification. CodeMaster does not offer users with the techniques required to determine the occupant load of mixed occupancy.

▪ **Type of Construction**

The methods of classifying the type of construction are highlighted in the CodeMaster as follows:

1. Determine the type of construction of the building materials used and the fire resistance rating of different parts of the building.
2. Determine whether all parts of the building confirm to the requirements for the materials and the fire resistance of a specific building type.
3. Determine if the building has more than one type of construction.

This section of the CodeMaster provides guidelines for determining the type of construction. However, there are no explicit explanations or considerations of how the building area or type of occupancy would influence the selection of the type of construction. In addition, there are no clear guidelines to determine the factors influencing the selection of the type of construction.

▪ **ICBO/Sheedy Tables**

International Conference of Building Code (ICBO) and Sheedy Tables as discussed in previous sections are included at this section of the CodeMaster where it recommends using the ICBO/Sheedy Tables to determine type of occupancy and type of construction with their corresponding requirements.

▪ **Location on Property, Allowable Floor Area , Height and number of stories**

The methods of locating the building on the property land are highlighted in the CodeMaster as follows:

1. Determine the location of the building on site from the plot plan as well as clearance to the property lines and other buildings.
2. Use the ICBO/Sheedy Tables for the applicable occupancy group and division to determine the required exterior wall and opening protection.

The methods of determining the allowable floor area are highlighted by Houston as follows:

1. Determine the basic allowable floor area, of one story building, by using the appropriate ICBO/Sheedy Table.
2. Determine the allowable increase due to the yard size and installation of sprinkler systems.
3. Determine the area of buildings over one story in height.
4. Determine the allowable floor area of mixed occupancies.
5. Determine the allowable increase of area by using separation walls.

The methods of determining the allowable height and number of stories are highlighted in the CodeMaster as follows:

1. Compute the height of the building in accordance with code requirements.
2. Determine the number of stories in the building as defined in the code.
3. Determine the maximum height and number of stories permitted based on the occupancy group and type of construction using the ICBO/Sheedy Tables.

This section of the CodeMaster provides guidelines for determining the allowable floor area and height. Although the key factors are highlighted, the floor area or height is subjected to code analysis techniques that are more detailed than what Houston stated and of a more simplified and flexible way than what the ICBO/Sheedy Tables highlighted. In the other hand, the allowable floor area is related to the type of construction and occupancy classification.

▪ **Egress and Exit**

The methods of designing the means of egress components including the exit, exit access and exit discharge are highlighted in the CodeMaster as follows:

1. Determine the occupant load based on dividing the building area over the occupant load factor.
2. Determine the width of the means of egress based on the calculated occupant load.
3. Determine the requirements of doors, gates , stairways and ramps

This section of the CodeMaster provides guidelines for determining the design of means of egress components but not all key factors are highlighted in this section. In addition, there is an absence of methodical approaches that will help the designer to comprehend the means of egress requirements with respect to the occupancy classification. Generally, this section provides the code requirements rather than providing effective guidelines for the designers.

▪ **Fire Resistance , Fire Protection**

The method of providing fire-resistance for the construction elements are highlighted by Houston as follows:

1. Utilize the code Tables to establish the minimum rating of fire-rated assemblies.
2. Qualification of materials by testing.
3. Calculating the fire resistance of the materials or assembly.

This section of the CodeMaster provides guidelines for determining the fire-resistance rating of the construction assembly; however, there are no useful guidelines for the key requirements such as materials testing and calculation the thickness of the fire-resistance. Other parts of this section provide code references for selecting and installing fire protection systems rather than providing the designer with comprehensive guidelines.

In conclusion, CodeMaster is a good attempt to familiarize and enable designers to work with the Uniform Building Code requirements. However, it does not provide a comprehensive method to navigate the code requirements.

2.9.4. Building Codes Illustrated by Ching, F.D. and Winkel, S. R

This is considered to be very useful guide to the international Building Code. The book discusses building code requirements that are required by the architect through providing a simplified interpretation and illustrations. The authors recommend including the code analysis with code cross-references as a part of the building permit. Code analysis format include the occupancy classification, type of construction, building height and building area. The procedures of using the International Building Code proposed by this book are indicated in Figure 2.4.

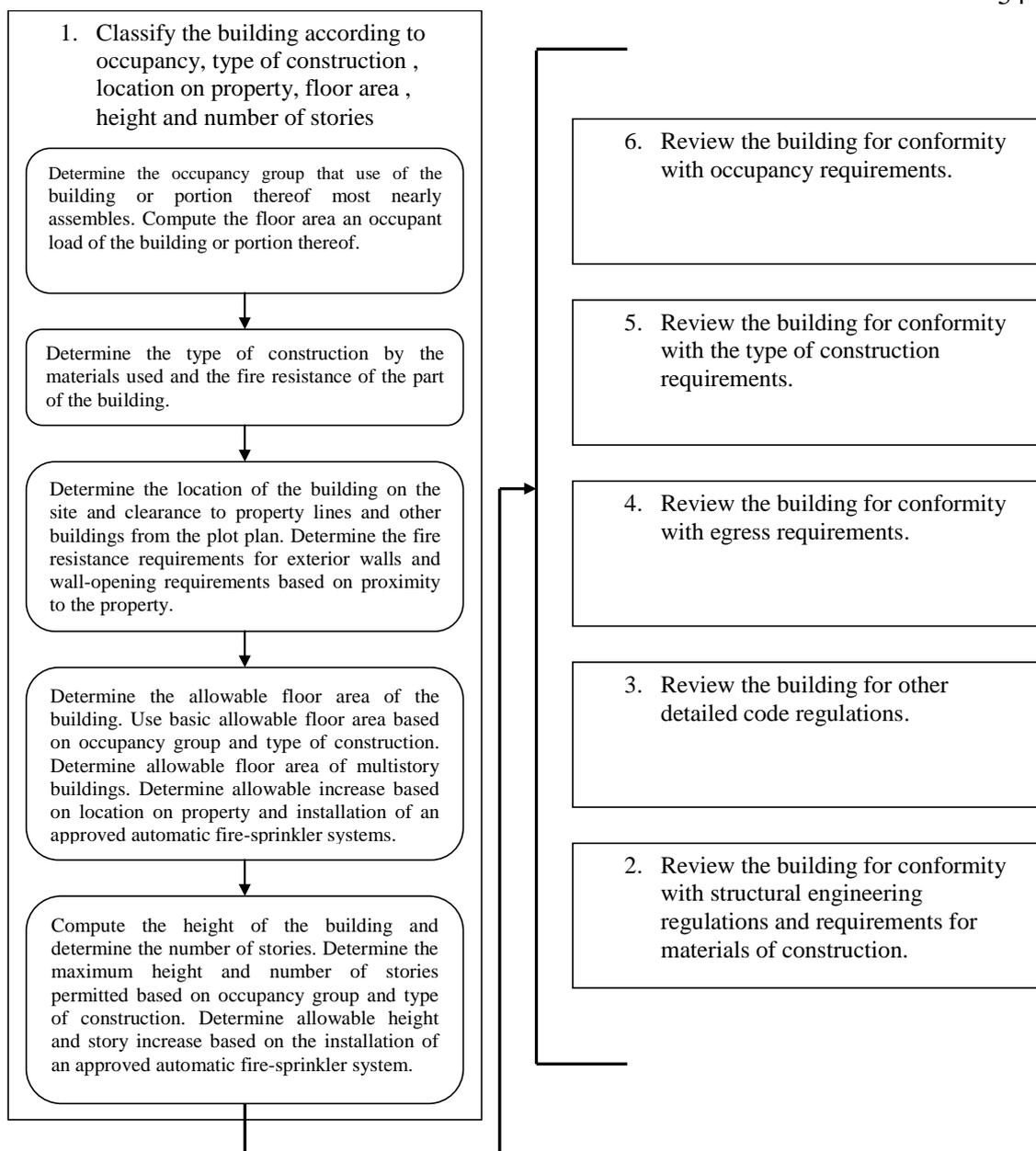


Figure 2.6: Code Navigation Sequence (Ching and Winkel, 2006).

The building code requirements illustrated are composed of 18 chapters in which the sequence of all chapters follows the same sequence of the International Building Code.

2.10. FACTORS AFFECTING THE BUILDING CODE IMPLEMENTATION

The following subsections discuss the possible factors that might affect the implementation of the Saudi Building Code. These factors are subjectively categorized into major sections. These sections include the building code text and language, the building code enforcement techniques, the code authority practice, the design office practice, the professional training and education, materials and method of constructions and finally the awareness of the public.

2.10.1. Building Codes Text and Code Language

Code text is written in such a language that minimizes variations in interpretations which affect the clarity of the code to people who are not specialized in the codes and therefore increases the number of different interpretations (Patterson, 2003). Despite the building code handbooks and illustrated books, the numerical order of the code has nothing to do with the logical order of the code requirements during code analysis (Houston, 1998). This fact is overlooked by the code users when dealing with the code requirements and find difficulty in understanding the logical sequence of the code even if the handbooks or commentaries are utilized. Each section of the building code is developed to solve a certain problem and is arranged in multiple sections and chapters that are isolated from each other with little attention to the continuity of the entire document. Moreover, the building code provides exceptions and alternatives for most of its requirements, which might be utilized and well interpreted by some designers while other designers might neglect them.

2.10.2. Building Codes Enforcement Practice

There is an impact of building code regulations upon technological innovation and industrialization. The code structure imposes additional cost and limits the flexibility and innovative design because of the stringent and complex requirements. In 1975, Field and Rivkin discussed four building code burdens that are of an impact on the housing innovations. These burdens can be summarized in the following categories (Field and Rivkin, 1975):

1. Code regulations are perceived as a problem by housing innovators as it resists design flexibility of buildings.
2. The 70s patterns of building code result in unnecessary higher price and housing cost.
3. Innovation in the housing industry is resisted by the building code.
4. Social problems due to the increased cost of municipal fees and housing costs for low income families.

Building code contributes into two types of costs; first, cost that is associated with disruption of free market and cost that is related to administrative inefficiency in implementing codes. The cost impact of standards or codes is related to product cost (materials, labors), processes cost (planning development and execution), users cost (life cycle cost), industries cost (compliance costs) (Arlani and Rakhra, 1988). The impacted groups of building code include all stakeholders involved in the building projects as individuals such as builder, owner, labor, developer, designer and regulator or industry sectors such as real estate, manufacturing and insurance. The field consequences of building code are illustrated in Table 2.3.

TABLE 2.3: Code Technical and Socioeconomic Consequence Breakdown
(Arlain and Rakhra, 1988)

Technical Consequences		
Building Process	Planning /projection design	Limitation of choices Engineering design Architectural design
	Construction	Productivity Equipment Material Safety/protection
	Operation and maintenance	Energy conservation Operating policy Maintenance policy Safety Health Comfort
Material / Equipment	Raw material	Material limitation Availability
	Manufacturing	Standards performance
	Distribution	Availability Design information
Quality/ Safety assurance	Warranty	Demand of new warranties
	Certification	Demand for standards Demand for testing procedure
	Code enforcement	Demand for inspection policy
Socioeconomic consequences		
Economic	Design Phase	Design fee Plan approval cost (government) Plan approval cost (owner)
	Construction Phase	Material Cost Labor cost Equipment cost Building inspection cost Certification cost Financing cost Administration cost
	Occupancy phase	Operating cost Maintenance cost Upgrading cost Insurance cost Taxes
Social		Environment Employment Distribution impact Accessibility Energy conservation

2.10.3. Building Authorities Practice

Despite the efforts of the General Administration of Civil Defense in controlling and promoting the safety in buildings through its potential roles, the outcome of these efforts are still less than what they should be. This is due to the absence of effective methodology for enforcing the current safety regulations, the absence of public awareness toward safety and the absence of effective coordination between Civil Defense and other governmental departments.

During the design reviews and the process of issuing the construction permits, municipalities do not consider electrical, mechanical and safety requirements of projects. Instead, the architectural requirements and urban planning requirements are considered, such as land uses, building setbacks and numbers of stories. The coordination between the building authorities, mainly between the municipalities and Civil Defense is one of the key factors for successful enforcement of safety regulations or building codes. However, the coordination between them is still less than what it should be, because their regulations are not uniform and their visions toward building safety are not unified. In the other hand, there is no clear policy that distinguishes responsibilities and resolves overlapping of duties.

Civil defense reviews and approves only the buildings and facilities that are forwarded to them by municipalities such as commercial buildings, buildings of four stories and more , fuel stations and factories. This indicates that the fire protection and safety requirements for other facilities are ignored (Al-Swat, 2004). In addition, there is no written policy or

procedure based on which building inspection and reviews are conducted by building authorities. In addition, building authorities do not have a violation tracking system classified based on type or nature of the violation or violators.

2.10.4. Professional Education and Training

Engineering education in Saudi Arabia started in 1962 when the first college of engineering was established. Today there are more than ten universities, eight of them offer engineering education in different engineering majors. The latest statistics of numbers of engineers in Saudi Arabia indicate that there is around 106, 713 engineer and architect, 20 % of them are Saudis as highlighted in Table 2.4.

TABLE 2.4 : Engineering Force in Saudi Arabia up to 2004
(AL-Amro, 2004)

	Saudis	Non-Saudis	Total
Public /Government sectors	5777	1856	7633
Private sector	16028	83052	99080
Total	21805	84908	106713

Saudi Engineers work in private and government sectors directly after graduation without undergoing any professional or special training or take any written exams like in other countries. Many studies indicate that there is a gap between engineering education and the market's needs and practices. This gap is because of most professionals view engineering as a degree not as a career. In addition, the engineering curriculum in many universities focus on theoretical material more than the field requirements and conditions which affect development of engineering careers. A survey that was conducted in 2006 shows that around 63 % of the engineers working in Saudi Arabia do not have on-Job training (AL-Amro, 2004). On the other hand, the architectural engineering curriculum

that being taught Saudi colleges like King Fahd University of Petroleum and Minerals, King Faisal University and King Saud University don't offer any courses on Building Codes or Building Safety for undergraduate students. In addition, none of the Saudi universities offer a degree in Fire Protection Engineering or Safety.

The building code qualifications for A/E professionals are not considered during the license of design and consultant offices in Saudi Arabia. In Saudi Arabia, there is no firm or design office specialized in building code or building safety in general. GACD issued a regulation that allows some design or consultant offices or companies to design, review and approve the fire protection systems and studies in the field of safety and provide safety consultations (GACD, 2001). Although the Eastern Province has no design offices that are allowed by GACD to review, design or approve drawings, some of those offices offer safety design approval, review and design which mean the following (Al-Swat, 2004):

- This regulation aims to classify A/E design offices into specialized and non-specialized offices in safety designs.
- The safety requirements are viewed as something extra to the design rather than a part of it.
- The design and engineering offices who currently offer safety consultation and fire protection systems design are not licensed and therefore, they violate the GACD regulation which stated :

“No design offices or engineering companies are allowed to review , approve or provide design or studies in the field of safety unless it has been reviewed and approved by a design office or an engineering company that is licensed in the field of safety systems engineering”.

In reality, there is no effective coordination between the General Administration of Civil Defense who issued this regulation and the Ministry of Commerce who licenses the A/E design offices.

2.10.5. Construction Methods and Construction Materials

The requirements of the building code are based on specific types of construction methods and materials. Some of these construction methods and materials are rarely used in Saudi Arabia, such as wooden construction and heavy timber construction. In addition, the building code lists a specific requirement for construction elements and assembly that required testing and labeling by a recognized testing agency. The only recognized and trusted testing agency in Saudi Arabia is the Saudi Arabian Standards Organization. As a result, the availability of approved construction materials will affect the construction of projects , local material suppliers and local manufacturers.

2.10.6. Public Awareness

There are factors that are related to the public awareness of how the building code would enhance the durability, safety and the life cycle of the facility. However, project owners tend to resist the cost associated with the implementation of the building code. Project owners are not interested in knowing the technical requirements of the building code. Therefore, they rely on the design offices to ensure compliance with engineering requirements. In addition, the facility insurance is one of the key factors that will participate in the successful implementation of the code. The perception of the owner toward the safety of the facility is subject to different criteria such as the size, purpose and the invested capital.

2.10.7. List of Factors Included in this Study.

This section lists the factors that might adversely affect the implementation of the Saudi Building Code. The factors are classified into five main categories as follows:

A. Building Code Text and Language:

- 1) The original version of the Saudi Building Code is written in English Language.
- 2) The Translation of the Saudi English version to Arabic version.
- 3) The code requirements are subjected to different interpretations among the A/E professionals.

B. Building Code Enforcement Practice:

- 1) Mixing of old regulations or other standards requirements with the Saudi Building Code requirements.
- 2) Lack of written building inspection policy and procedures by the building authorities.
- 3) The tendency of using restrictive implementation policy such as violations, fees, and stop work order.
- 4) Lack of a violation tracking system.

C. The Practice of Building Authorities and A/E Design Offices:

- 1) Implementing the Saudi Building Code increase the work load in building authorities departments and design offices.
- 2) Lack of continuous coordination between the building code authorities
- 3) Lack of continuous coordination between the design offices and building authorities.
- 4) Overlapping of responsibilities between building authorities.

- 5) Lack of A/E Design Offices classification.

D. Public Awareness of Code and Insurance:

- 1) The low awareness of the public about importance of building code.
- 2) Lack of effective role of insurance companies.

E. Construction Methods and Construction Materials:

- 1) The type of construction methods specified in the Saudi Building Code.
- 2) The type of materials and equipment specified in the Saudi Building Code.
- 3) Lack of authorized testing agencies to test and certify building products.
- 4) Lack of listed and classified building products in the local market.
- 5) The code requirements limit the flexibility of architectural design.
- 6) Implementing the Saudi Building Code will increase the project cost.

F. Professional Training and Education:

- 1) Lack of specialized training center in the field of building codes.
- 2) Lack of professionals accreditation programs.
- 3) Lack of effective and on-job training for engineers and inspectors.
- 4) Lack of skilled and certified laborers.
- 5) Lack of certified and trained engineers in the field of building code.
- 6) Lack of certified and trained building inspectors.

CHAPTER THREE

ASSESSMENT OF CURRENT PRACTICE OF A/E DESIGN OFFICES AND BUILDING AUTHORITIES

3.1. INTRODUCTION

The first objective of this study is to assess the current practice of A/E design offices and building authorities in addressing and enforcing building codes and safety regulations in building design in Saudi Arabia.

This objective has been achieved through administering a questionnaire (Appendix-A) addressed to 27 design offices in the Eastern Province and multiple face-to-face interviews with building authorities representatives and owners of A/E design offices. The results of the questionnaire survey and interviews are discussed in the following sections.

3.2. THE PRACTICE OF CIVIL DEFENSE AND MUNICIPALITIES

The main building authorities involved in design review and approval of building projects are City Municipalities and Civil Defense Departments. Two interviews were conducted to assess their current practice implementing and enforcing building codes and regulations:

1. Interview with the Manger of the Safety Department at the General Administration of Civil Defense (Eastern Province).
2. Interview with the Manger of Building Permits Department at the Eastern Province Municipality (Al-Dammam Municipality).

The results of both interviews have been utilized to assess the current practice of both authorities as follow:

I. Current Code and Standards Used by Building Authorities

Previous studies stated that there are no unified building codes followed by building authorities (Al-Homoud and Mousa, 2004), this issue has been raised during the interviews with building authorities representatives and they confirmed that there is no unified Building Code followed by Municipalities or Civil Defense Departments. The only unified standard is the Building Fire Protection Requirements issued by the technical committee of the GCC. However, this standard is not implemented thoroughly and is used as a supportive document to other regulations issued by the General Administration of Civil Defense (Al-Qahtani, 2008).

Unlike the model codes, the current regulations issued by the General Administration of Civil Defense and the Ministry of Municipal and Rural Affairs are not interrelated, are implemented independently, are not revised or modified periodically and are not communicated effectively to A/E design offices. The level of compliance with these regulations depends usually on the qualifications of the engineer in charge of reviewing and approving the design packages.

II. Level of Cooperation between Building Authorities

There is no effective communication between building authorities during the design phase of a project. Their comments on the design packages are addressed individually, as a result there is a potential for contradiction and deficiency. The prime link between the concerned building authorities is through the client or the A/E design offices.

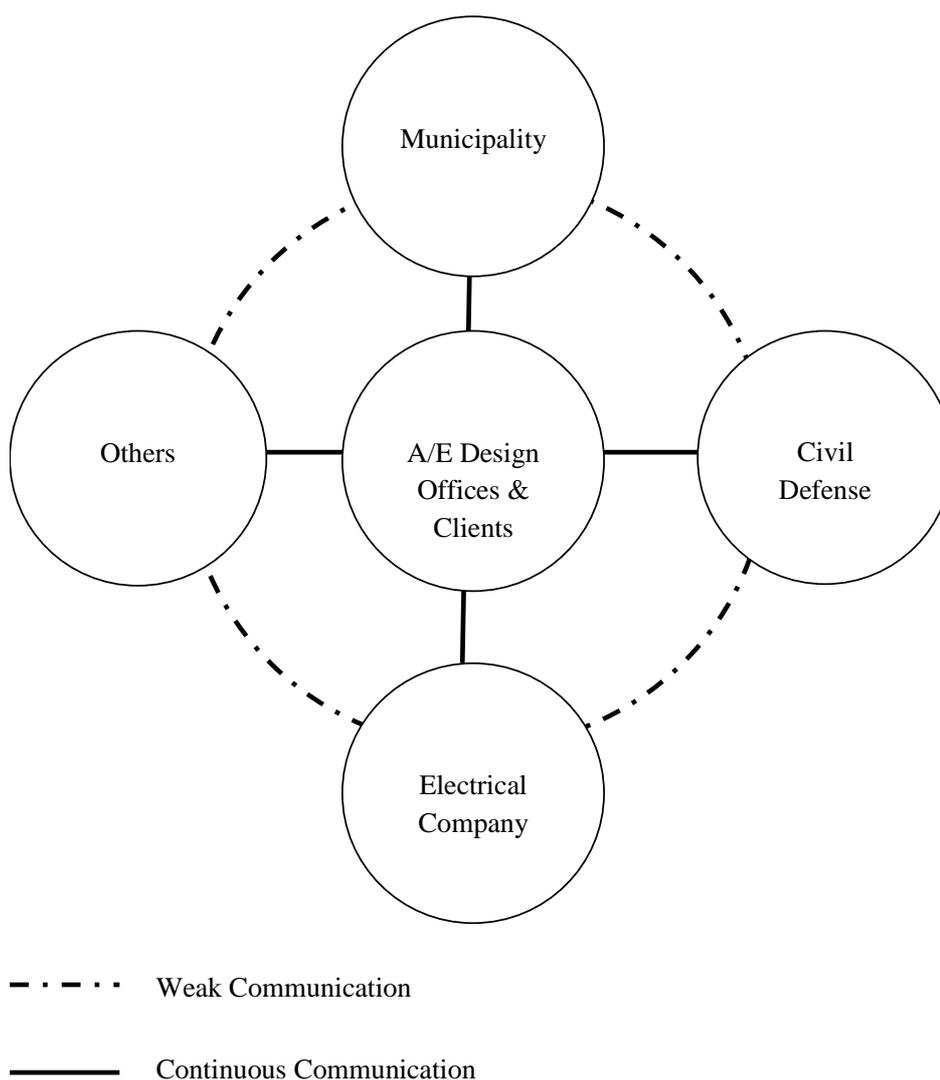


Figure 3.1: Communication Level between Building Authorities and Design Offices

III. Professionals Qualifications and Training

There is a shortage of qualified professionals in the departments of building authorities. The current manpower has no effective knowledge of building codes. Moreover, there is no planned or continuous training conducted for those professionals, instead they gain the knowledge from their day to day job.

IV. Responsibilities of Building Authorities

Neither the civil defense nor the municipalities have written procedures or checklists summarizing their responsibilities or used by A/E professionals to review design packages or to conduct site inspections. In this regard, the role of both the Civil Defense and Municipalities has been assess in and summarized in previous studies (Al-Homoud and Mousa, 2004),. This study re-assessed their responsibilities for any changes over the past years and found no significant changes. Accordingly, the current practice of both authorities can be summarized as follows:

- **Civil Defense** enforces the fire protection regulations issued by the General Administration of Civil Defense. These regulations are supported by the document issued by the technical committee of GCC named as “Building Fire Protection Requirements”. Civil defense is involved in reviewing and approving the following facilities:
 - Buildings four stories or more
 - Large Public Buildings
 - Industrial Facilities

- **Municipalities** enforce the architectural and planning regulations issued by the Ministry of Municipal and Rural Affairs. Municipalities are not involved in

reviewing and approving the electrical, civil or structural requirements and delegate this responsibility to the design offices. The municipalities issue building permits for all new buildings within its jurisdiction excluding those facilities within the jurisdiction of governmental sector such as the Ministry of Defense or Saudi Arabian Oil Company.

As summarized in Figure 3.2 and Figure 3.3. The process of building permit can be divided into two stages, preliminary process stage and final process stage.

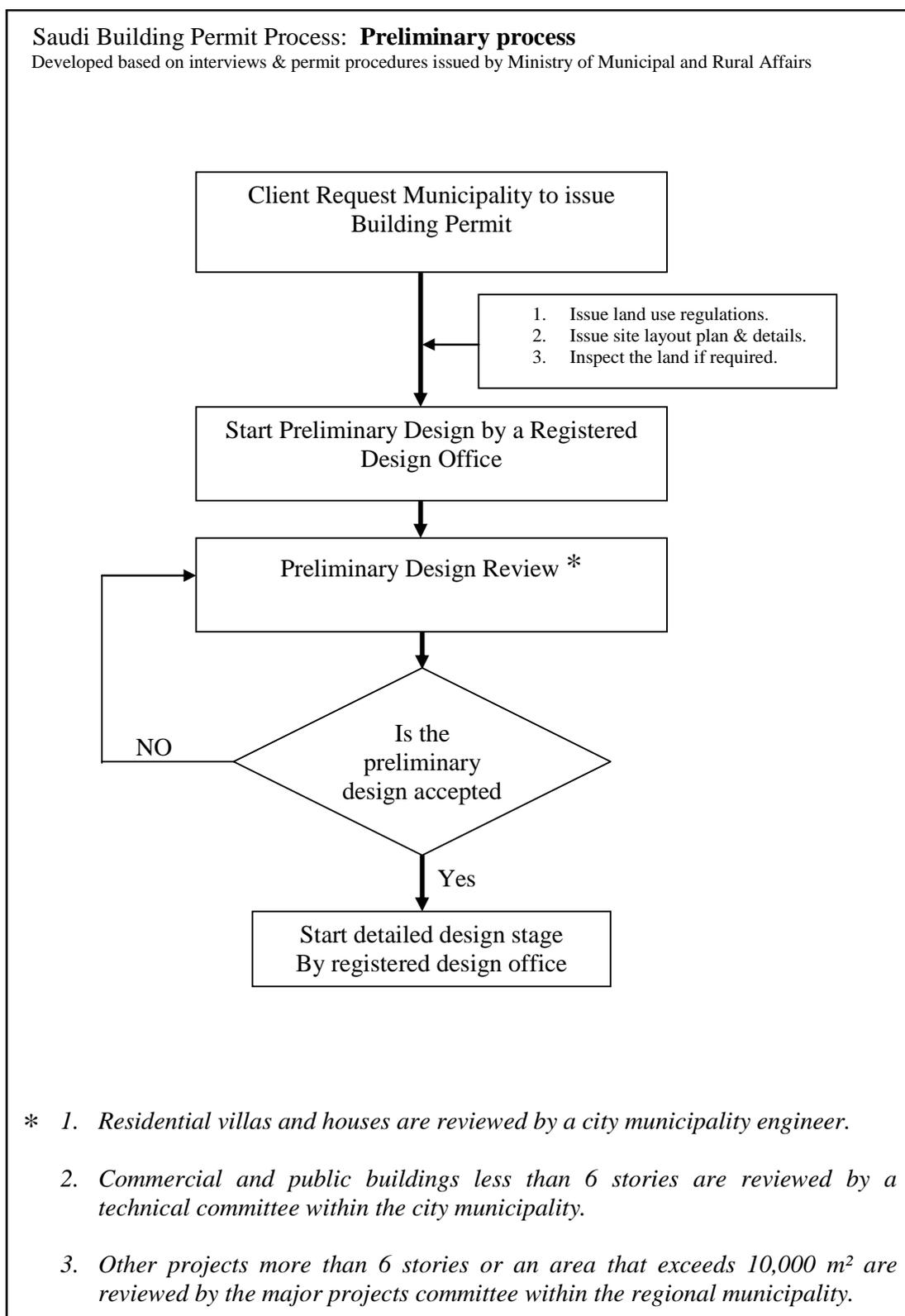


Figure 3.2: Saudi Building Permit Process (Preliminary Stage)

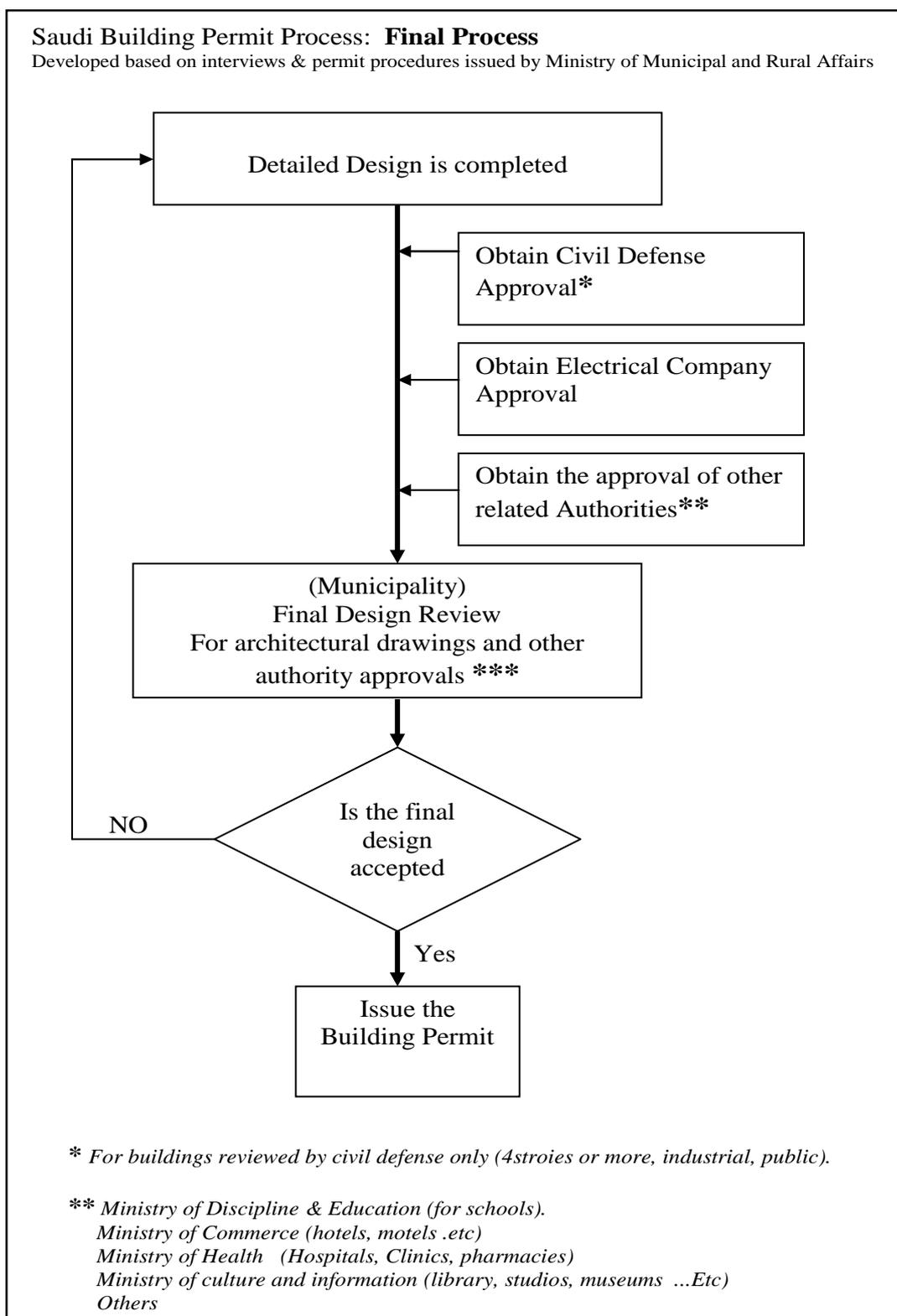


Figure 3.3: Saudi Building Permit Process (Final Stage)

3.3. THE PRACTICE OF A/E DESIGN OFFICES

In this section, the methodology and results of the assessment of the practice of A/E design offices are discussed.

3.3.1. Data collection

Two types of data were collected using the questionnaire (Appendix-A). The first type of data is about the general information of A/E design offices such as size and experience. The second type of data is about their practice related to the utilization and implementation of building codes and regulations during the design stage. The questionnaire has been developed based on literature review and owners of A/E design offices and contains two parts as follows:

Part-I: This part contains two questions about the respondent, including their years of experience and their role in the A/E design offices.

Part-II: This part is related to the second objective of the study as discussed in chapter four.

Part-III: This part contains nineteen questions about the practice of the A/E design offices. The nineteen questions are designed to assess three type of practice as follows:

- 1.**General Practice:** the general practice of the A/E design office such as the type of building code used, experience and type of projects.

2.**Positive Practice:** that have the potential to facilitate the implementation of the building Code.

3.**Negative Practice:** that have the potential to adversely affect the implementation of the building Code.

3.3.2. Population and Sample

The study population is limited to registered A/E design offices working in the Eastern Province of Saudi Arabia with an experience of five years or more. A list of 145 registered A/E design offices was obtained from the Chamber of Commerce and Industry for Eastern Province. Substituting the number of registered A/E design offices into equation 1.2 and 1.3 highlighted in chapter one, the minimum sample was calculated to be 21.31. Various techniques were used to distribute fifteen forms of questionnaire forms including fax, e-mail and personal visits. A total of 27 completed responses were received.

3.3.3. Data Analysis

The data obtained from the responses to Part-I and Part-III of the questionnaire was analyzed using percentage and average values. The results are presented using simple descriptive techniques such as graphics and Tables. In addition to these techniques, the responses related to the positive and negative practices of A/E design offices were calculated using equation 1.1. The ranges of important indices (I) are classified into positive category and negative category as presented in Table 3.1 (Al-Homoud and Mousa, 1994).

TABLE 3.1: Importance index Ranges for Positive and Negative Practice

Importance Index Range	Positive Category	Negative Category
$87.5 \leq I \leq 100$	Excellent	Extremely poor
$75.0 \leq I < 87.5$	Very Good	Very Poor
$62.5 \leq I < 75.0$	Good	Poor
$50.5 \leq I < 62.5$	poor	Slightly poor
$0.0 \leq I < 50.5$	Extremely poor	Good

3.3.4. Results

In this section, the assessment results of the practice of A/E design offices are presented and discussed. This section contains assessment for three types of practice: general, positive and negative.

A. Characteristics of the Respondents

This section presents general information about the respondents including work experiences and role in the organization.

1. Respondents Experience in the A/E Design Office

The results indicated that 49% of the respondents have been working for their A/E design offices for more than 10 years which was reflected in the level of completeness and precision of the information provided. The respondents were asked to select their years of experience in the design office. Each respondent had the option to select one of five categories: one to five years, five to ten years, ten to fifteen years, fifteen to twenty years and more than twenty years. As illustrated in Figure 3.4, 19% of the respondents have more than twenty years of experiences, 10% have fifteen to twenty years of experience,

and 19% have ten to fifteen years of experience, 33% have five to ten years of experience and 19% have an experience of less than 5 years.

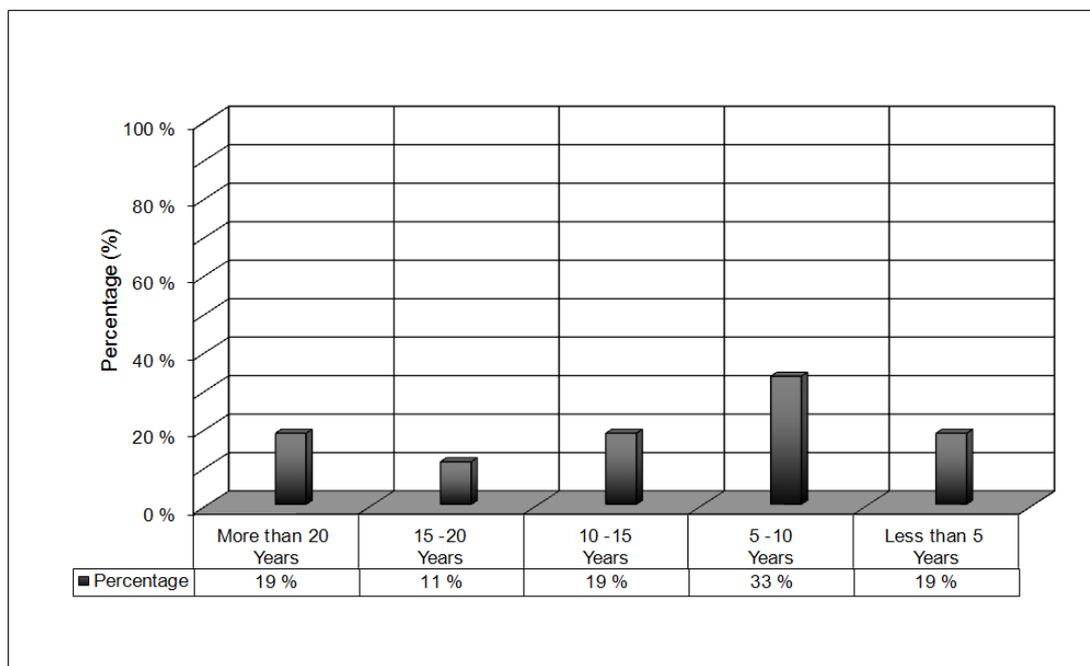


Figure 3.4 Respondents Years of Experience

2. Respondents Role in the A/E Design Office

The results indicated that 48% of the respondents are either the department manager or the owner of the A/E design office which adds more validation to the information obtained. The respondents were asked to select their role in the A/E design office. As illustrated in Figure 3.5, 26% of the respondents are the owner of the A/E design office, 22% are department managers, and 22% are architects, 15% are engineers and 15% are project engineers. The respondents did not select any of the other roles as specified by the questionnaire.

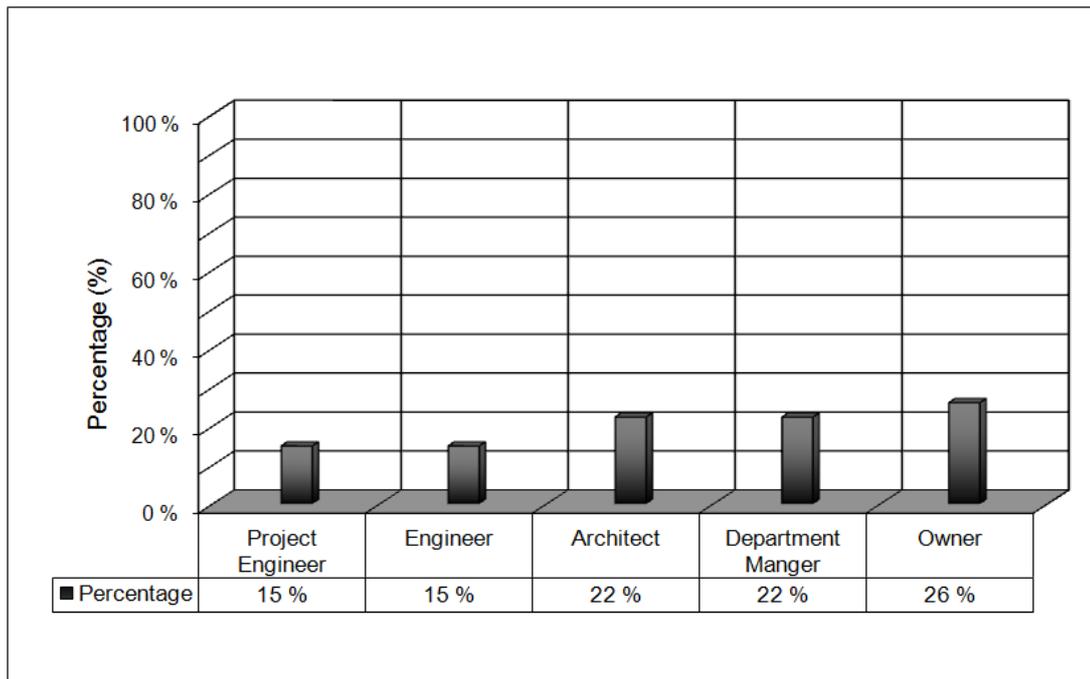


Figure 3.5: Respondents Role in the A/E Design Office

B. General Practice of the A/E Design Office

This section presents general information about the A/E design office such as experience, number of engineers, type of projects, type of clients, type of codes and regulations.

1. A/E Design Offices Years of Experience

The experience of the A/E design offices which participated in this study is limited to five years and more. The results indicated that 63% of the A/E design offices have been in business for more than 15 years which are reflected in the precision of the collected data. The respondents were asked to specify the A/E design office years of experience in one of five possible categories: one to five years, five to ten years, ten to fifteen years, fifteen to twenty years and more than twenty years. As illustrated in Figure 3.6, 44% of the A/E design offices have more than twenty years of experiences, 19% have fifteen to

twenty years of experience, 11% have ten to fifteen years of experience, and 26% have five to ten years of experience.

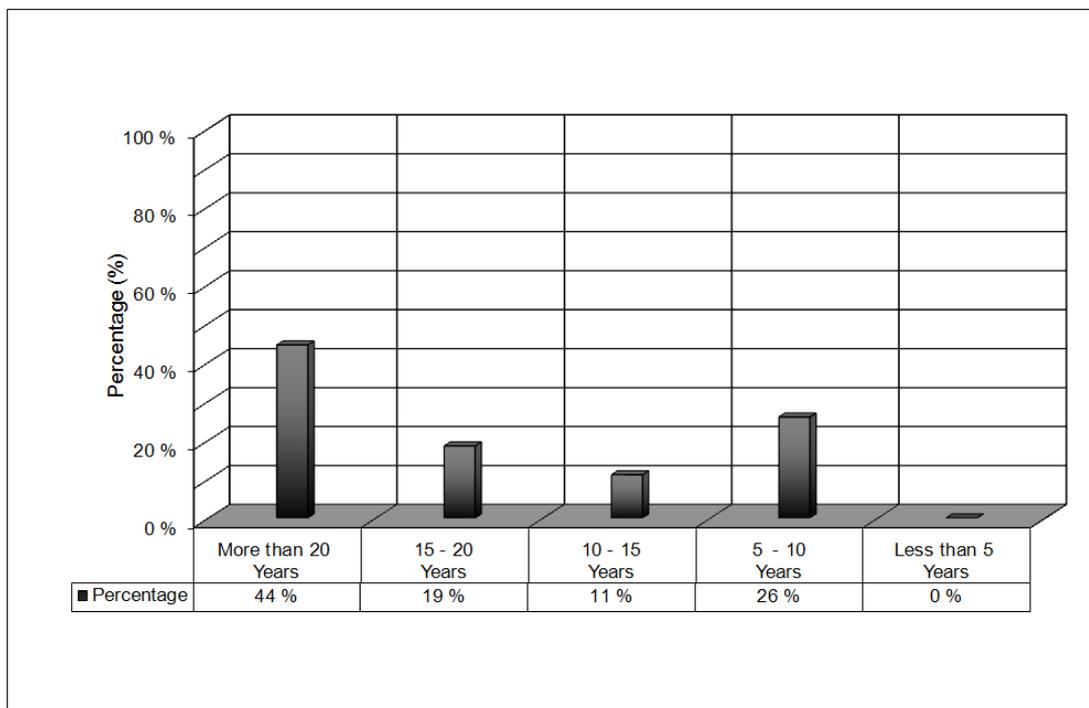


Figure 3.6: A/E Design Office Experience

2. A/E Design Office Number of Engineers

The size of A/E design offices has been classified in terms of number of engineers. The respondents were asked to specify the number of A/E professionals in the A/E design office in one of five possible categories: one to five engineers, five to ten engineers, ten to fifteen engineers, fifteen to twenty engineers and more than twenty engineers. As illustrated in Figure 3.7, 44% of the design offices has more than twenty engineers, 7% of A/E design offices have fifteen to twenty engineers, 15% of A/E design offices have ten to fifteen engineers, 30% of A/E design offices have five to ten engineers.

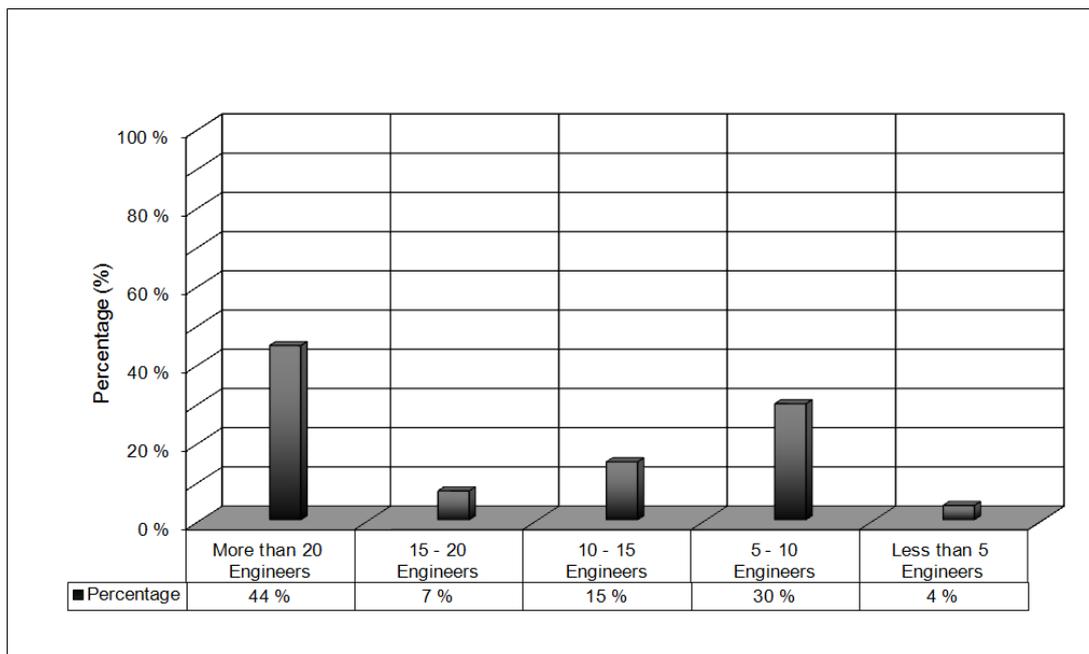


Figure 3.7: Number of Engineers Working for the A/E Design Office

3. *Type of Projects carried out by the A/E Design Offices*

Almost 93% of the A/E design offices which participated in this study carrying out multiple projects including civil, electrical, mechanical, architectural, and industrial. This variety is reflected in the experience of the A/E design offices and adds value to the information obtained. The respondents were asked to specify the type of projects handled by A/E design offices in one of five possible categories: multiple projects, industrial projects, electro-mechanical projects, civil projects and architectural projects. As illustrated in Figure 3.8, 93% of the A/E design offices handle multiple projects (all types) and only about 7% of A/E design offices handle architectural projects only.

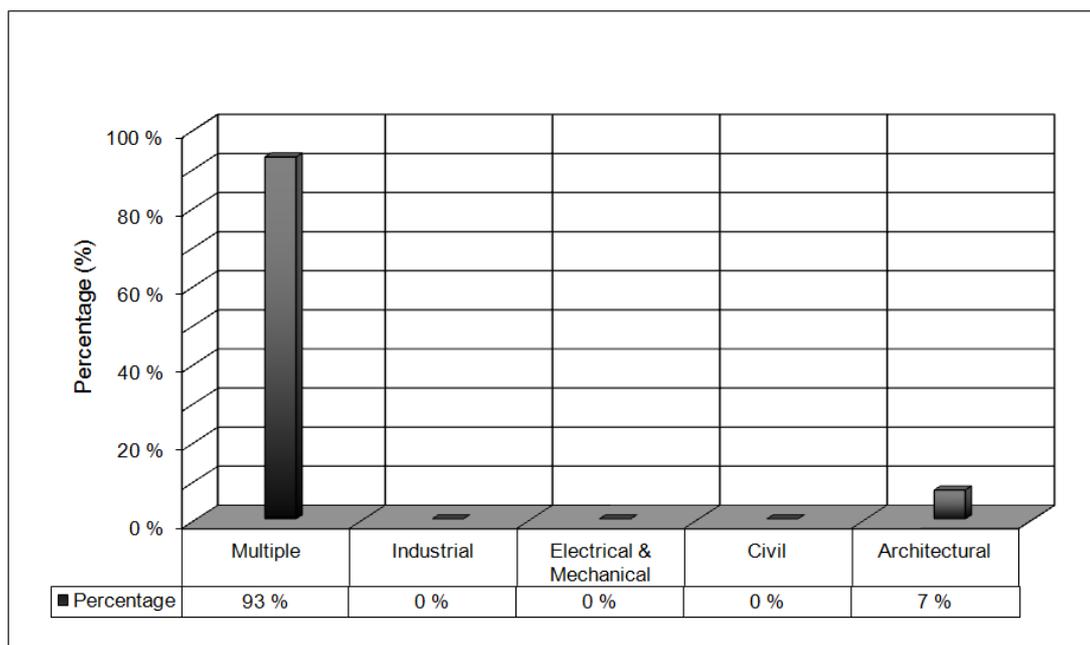


Figure 3.8: Type of Projects Carried out by A/E Design offices

4. A/E Design Offices Clients

The results showed that none of the A/E design offices which participated in this study are working for governmental sector alone, however, more than 50% of them are working for private sector alone. The respondents were asked to specify the type of their clients in one of three possible categories: governmental sector, private sector and multiple (governmental and private). The questionnaire form allows the respondent to select and specify other owners. All other owners specified by the respondents can be classified as either governmental, private sectors or semi-governmental which are partially owned by the government. As illustrated in Figure 3.9, 48% of the A/E design offices works for both governmental and private sectors, 52% of the A/E design offices work for private sector.

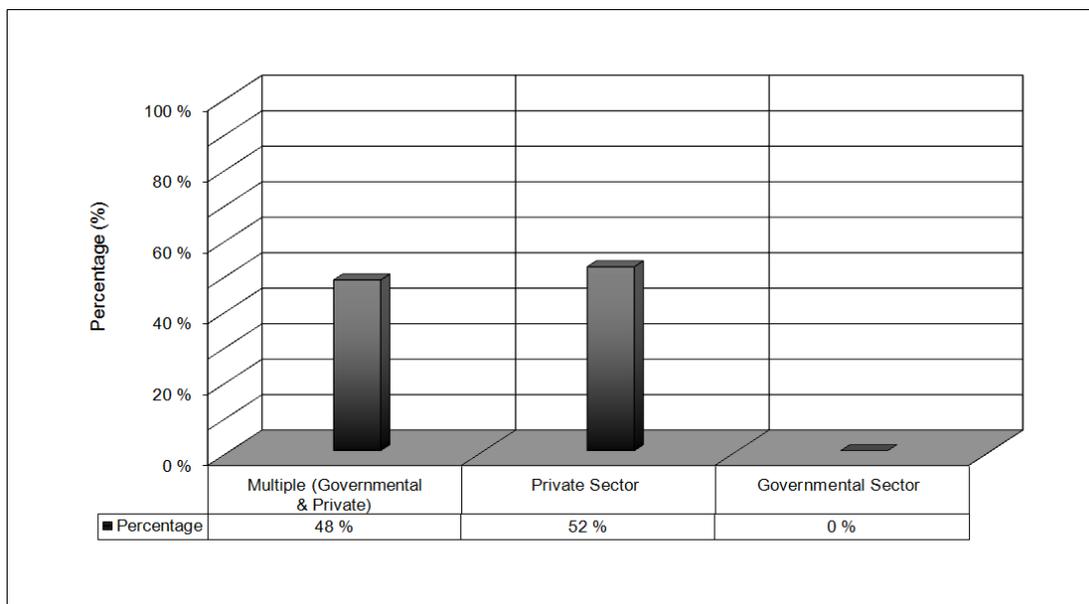


Figure 3.9: A/E Design Offices Clients

5. *Building Codes and Regulations used by A/E Design Offices*

The results indicated that all design offices use multiple international codes and standards along with local regulations. There is no building code or standard found to be used by all offices. However, around 80% of A/E design offices are using the regulations issued by MMRA because the building permits are issued through the municipalities. On the other hand, 70% of A/E design offices followed the regulations issued by the GACD. This lower value is due to the fact that not all projects are reviewed by the civil defense. The results showed that more than 50% of A/E design offices are not using ICC codes such as International Building Code or NFPA standards and Codes, which might affect the Implementation of the Saudi Building Code.

The respondents were asked to specify one or more of following code, standards or regulations utilized by their A/E design office:

1. The codes and standards issued by the American National Fire Protection Association (NFPA).
2. The codes issued by International Code Council such as International Building Code (IBC), International Fire Code (IFC), International Mechanical Code (IMC).
3. The regulations issued by Saudi General Administration of Civil Defense.
4. The regulations issued by the Ministry of Municipal and Rural Affairs (MMRA).

As illustrated in Table 3.2, out of the 27 design offices which participated in this study, 44% of the design offices are using NFPA codes and standards, 48% use ICC codes, 70% use GACD standards and about 81% of A/E design offices use MMAR regulations. No other code or standard is specified by the respondents except the standards of American Concrete Institute (ACI). In fact no significant changes have happened over the past 10 years (Al-Homoud and Mousa, 1994).

TABLE 3 .2: Codes and Standards used by A/E Design Offices in Saudi Arabia

Code and Standards		Number of A/E design offices using it (out of 27)	Percentage
1	NFPA standards & Codes	12	44%
2	ICC Codes	13	48%
3	The regulations of GACD	19	70%
4	The regulations of MMRA	22	81%

6. *The Influence of the Type of Project on the Code Requirements*

The type and size of projects would influence the level of compliance with building codes and building regulations. In this regard, the respondents were asked to specify which type of buildings is considered the most important when addressing the code requirements during the design stage. The respondents can select one or more of six possible categories as follows: commercial, industrial, multistory, residential, large storage, and public buildings. As illustrated in Table 3.3, the commercial, industrial and high rise buildings are considered the most important; this is because the building authorities focus on the safety of these facilities.

TABLE 3.3: Building Types and its Importance

Building Type		Number of A/E design offices consider it the most important (out of 27)	Percentage
1	Commercial	21	78%
2	Public	9	33%
3	Multistory	20	74%
4	Large Storages	10	37%
5	Industrial	20	74%
6	Residential	14	52%

7. *Qualifications of A/E Professionals*

The results showed that 74% of A/E design offices have building code specialist. The respondents were asked to specify if the A/E design offices have a building code specialized engineer or not. As illustrated in Figure 3.10, about 74% of the A/E design offices have a building code specialist.

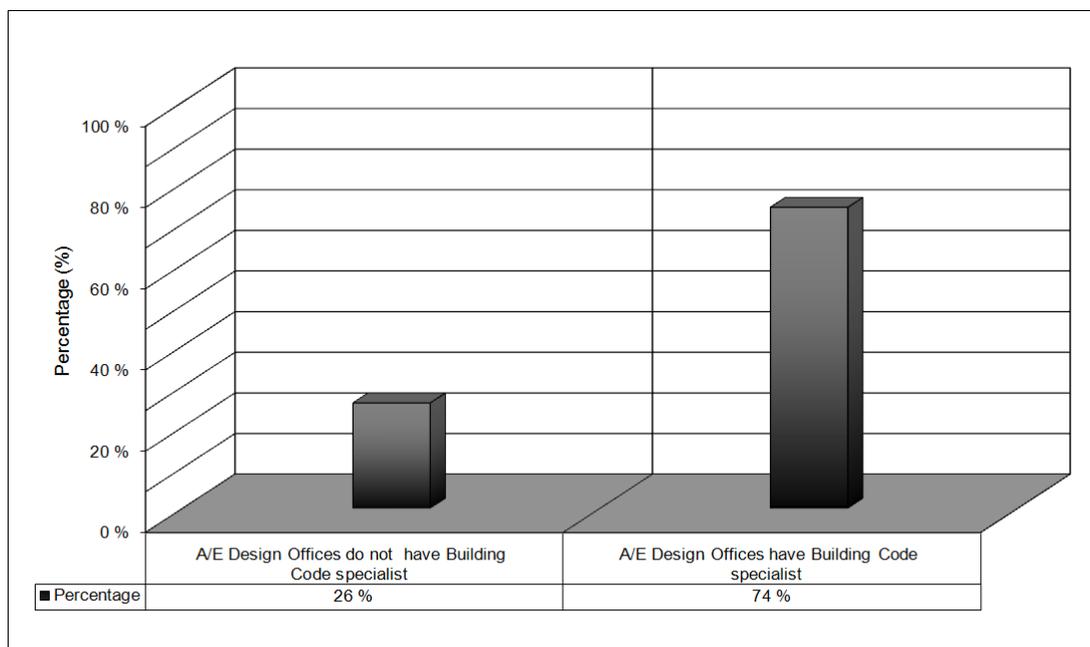


Figure 3.10: Percentage of A/E Design Offices that have Code Specialist

C. Positive Practice

The following sections present the assessment of the positive practices of A/E design offices. The study presents eight practices that are considered a positive and might enhance the code implementation. A summary of the responses and importance indices of all positive practices is illustrated in Table 3.4(1)

TABLE 3 .4 (1): Assessment of the Positive Practice of A/E Design Offices

A/E design office Practice Description		Always	Sometimes	No Answer	Rarely	Never	Importance Index	Importance Category
Positive Practice								
1	Charging the project owners for additional changes to the approved design packages.	1	7	4	7	8	34.78	Extremely Poor
2	Reviewing the drawings for compliance with current building regulations before sending it for review.	22	4	1	0	0	94.87	Excellent
3	Conducting Building Code analysis at the early stages of the project.	9	10	5	2	1	74.24	Good
4	Suggesting additional measures which are not specified in the current building regulations.	3	7	8	1	8	42.10	Extremely Poor
5	Considering experience with building code prior to hiring new engineers.	5	10	2	7	3	56.00	Poor
6	Obtaining the approval of building authorities for the changes occurs on the approved design packages.	9	3	1	1	3	70.83	Good
7	Receiving frequent updates of the regulations issued by General Administration of Civil Defense.	2	9	6	4	6	44.44	Extremely Poor
8	Receiving frequent updates of the regulations issued by Ministry of Municipal and rural Affairs.	4	8	4	5	6	47.82	Extremely Poor

1. Design Changes Fee

Changes on the approved design are one of the major causes of conflict during construction and might affect the code compliance (Arian, 2002). One of the solutions to overcome this issue is to charge the project owner for any changes that occur after the design package is approved. The study results indicated that most of the A/E design offices provide this service for their clients without fees which are considered extremely ineffective practice with an importance index of 34.78 %. In this regard, the respondents were asked how often A/E design offices request additional fees to execute changes on the approved design. As illustrated in Figure 3.11, there is only 4% of A/E design offices

always requested additional fees whereas 35% of the design offices participated in the study never request such fees.

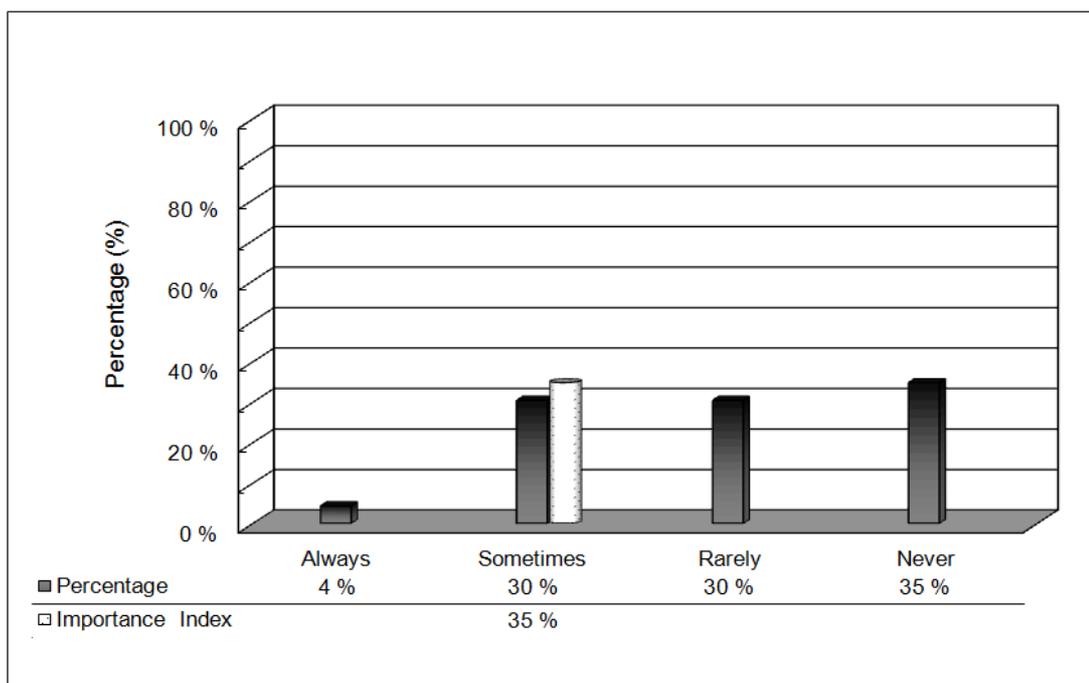


Figure 3.11: The Frequency for Requesting Fees for Additional Design Changes

2. Reviewing the Design Packages Prior to Requesting Authorities Approval

Design packages need to be reviewed for completion, consistency and compliance with building authorities regulations to minimize the review period and deficiencies. The study showed that almost all A/E design offices review the packages for compliance with building authorities regulations which are considered to be an extremely effective practice with an importance index of 94.87 %. This practice has been assessed through asking the respondents how often A/E design offices review and implement code requirements before submitting the design packages for final approval.

As illustrated in Figure 3.12, 85% of A/E design offices always review the design packages with respect to building authorities regulations before applying for final approval.

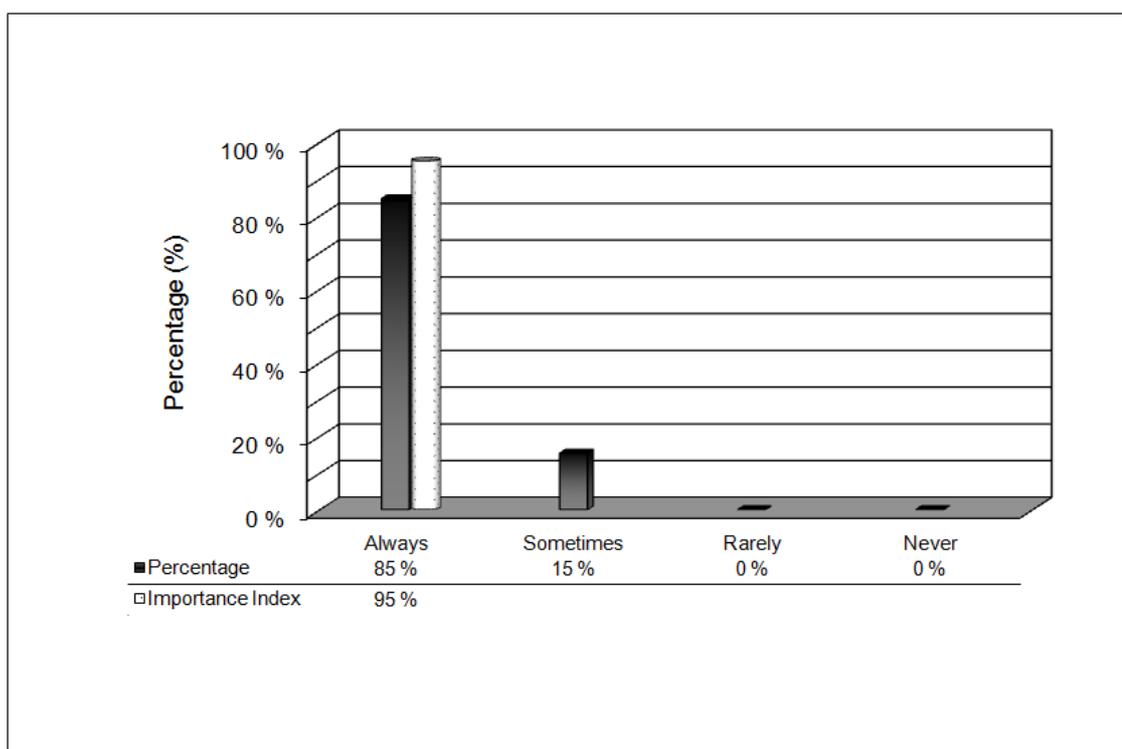


Figure 3.12: The Frequency of Reviewing Design Packages Prior to Authorities Approval

3. Implementing Code Requirements at Early Design Stage

The building code requirements need to be addressed at the early stage of the design process. This is to avoid major changes during the detailed design process which might have significant design reconfiguration and cost impact. Accordingly, the respondents were asked how often A/E design offices consider the building code requirements at the early design stage. As illustrated in Figure 3.13, only 41% of A/E design offices always consider the code requirements at the early design stage. When the importance index of all responses was calculated in accordance with equation 1.1, the result was 74%, which

classified as a good practice. This high percentage is due to the permit process which requires the approval of a preliminary design by municipalities. Although, the code requirements perceived by the respondents are not necessarily similar to those required by the model building codes, it is obvious that linking the design process with the permit process has the potential to facilitate the implementation of the Saudi Building Code.

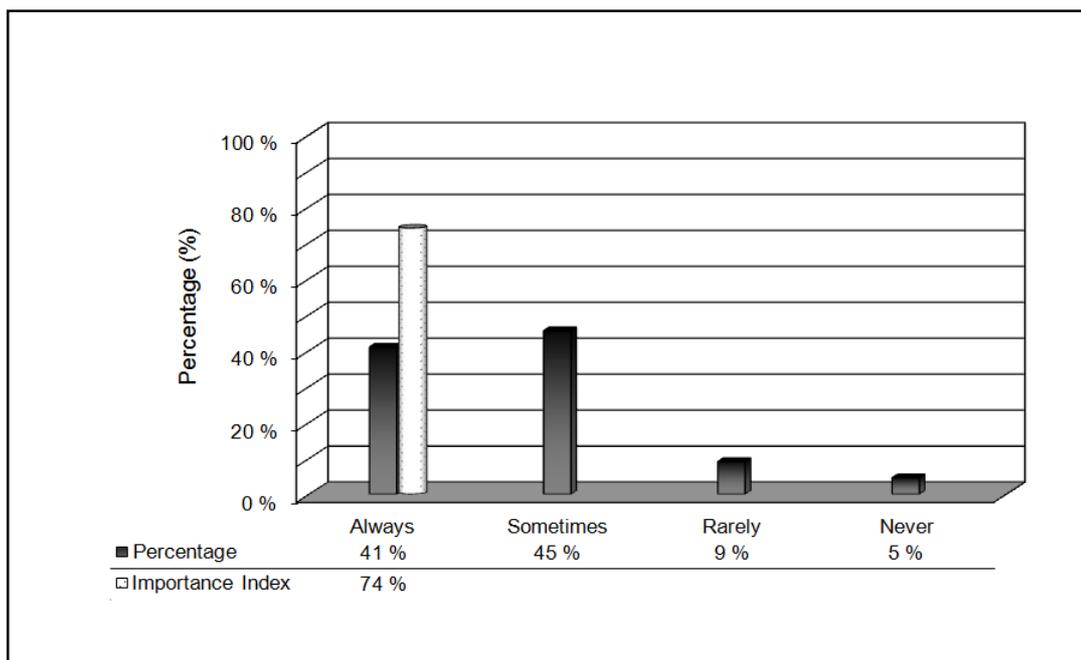


Figure 3.13: The Frequency of Considering Code Requirements at Early Stages of the Design Process

4. Additional Code Requirements during Design Stage

The current building regulations issued by building authorities are not comprehensive when compared to international building codes. Therefore, A/E design offices are expected to consider major code requirements that are not reflected in the current regulations. However, the study results indicated that most of A/E design offices that participated in this study never consider or recommend additional code requirements. The importance index of this practice is 42.10%, which implies that this practice is extremely

poor. In this regard, the respondents were asked how often A/E design offices recommend additional code requirements during the design stage. As illustrated in Figure 3.14, there are only 16% of A/E design offices always recommend such requirements, whereas 42% of A/E design offices never offers their clients such recommendations.

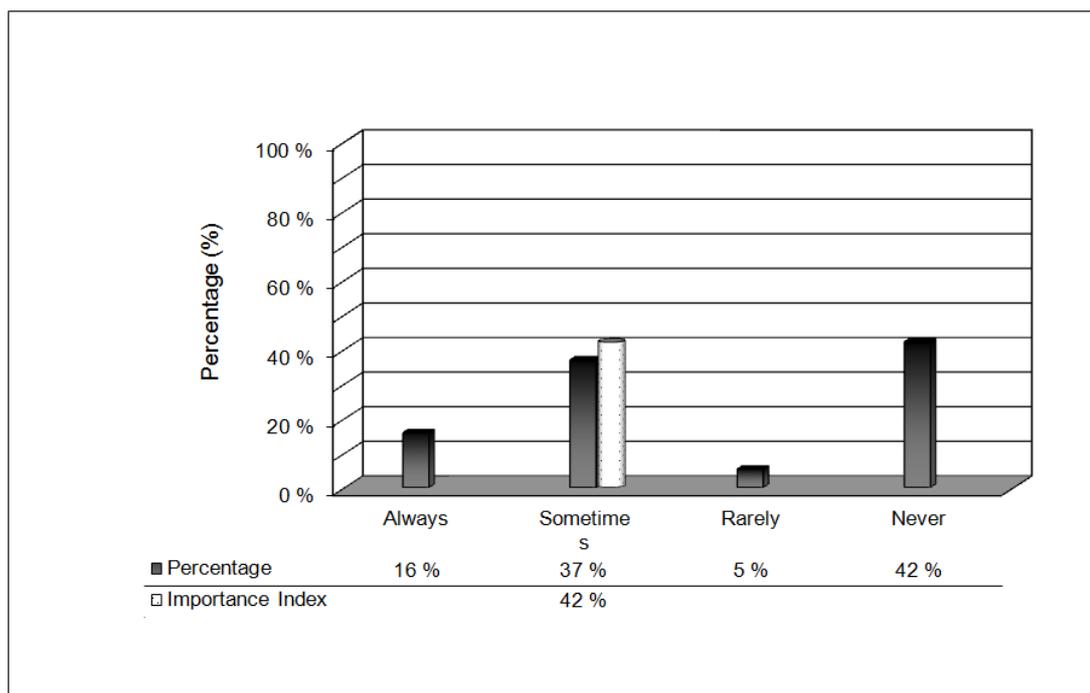


Figure 3.14: The Frequency of Recommending Additional Code Requirements during Design Stage

5. A/E Professionals Building Code Experience

Considering the A/E professionals experience with building codes prior to recruiting is an effective approach to have qualified staff. The study results showed that the practice of A/E design offices in this regard is poor with an importance index of 56.00%. The respondents were asked how often such experience is considered by A/E design offices. As illustrated in Figure 3.15, only 20% of A/E design offices consider the building code experience of their A/E professionals.

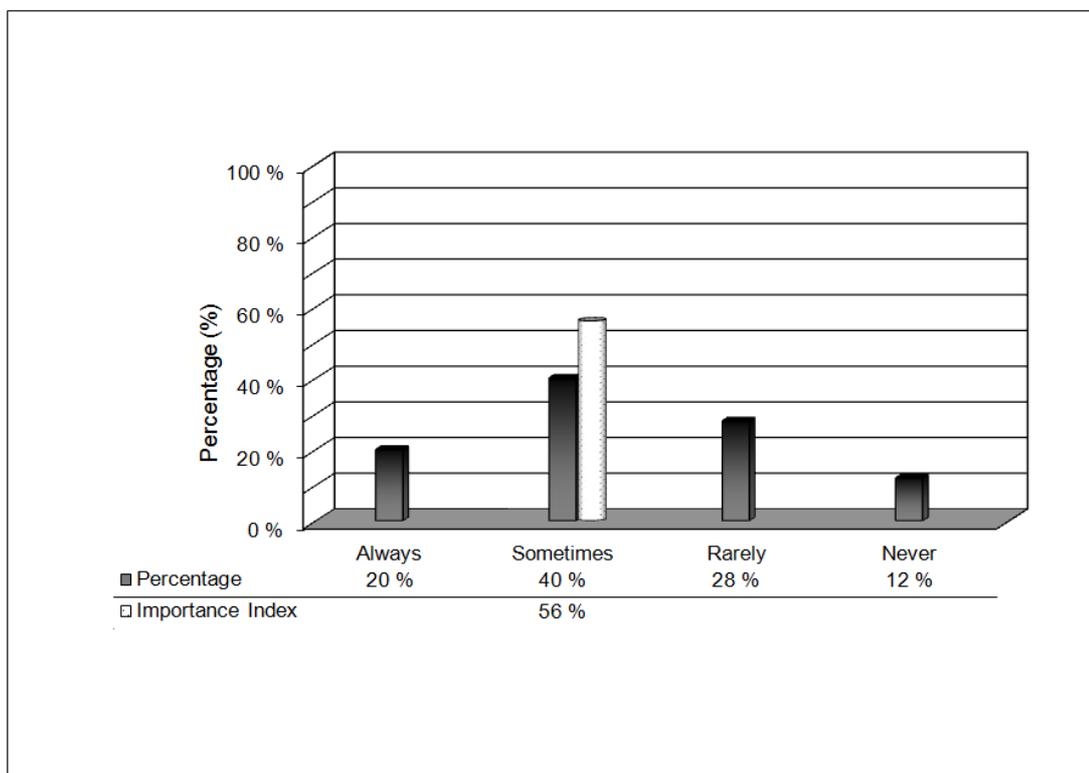


Figure 3.15: The Frequency of Considering the Experience of A/E Professionals Prior to Hiring

6. Obtaining Building Authorities Approval for Changes on the Approved Design

The study results showed that 63% of the project owners request additional changes on the approved design. Most of the A/E design offices that had experienced these changes resubmit the packages for building authority approval which is considered a good practice with an importance index of 70.80 %. As illustrated in Figure 3.16, 56% of the A/E design offices always resubmit the design packages to the building authorities, whereas 20% did not as the requested changes might occur after the design phase.

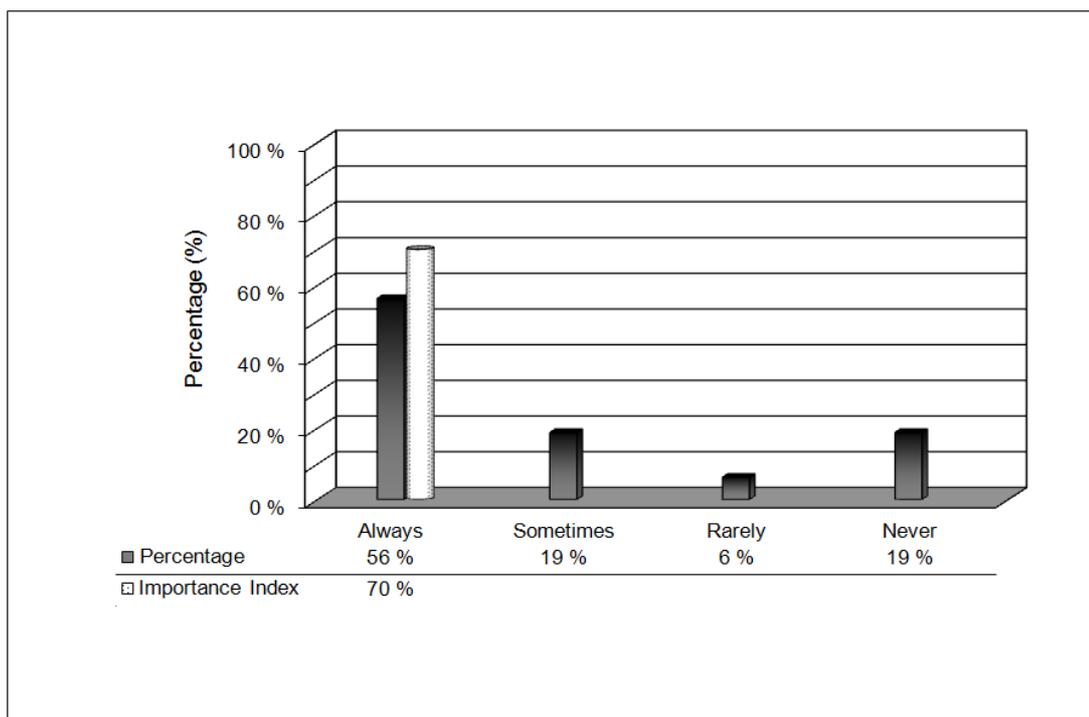


Figure 3.16: The Frequency of Re-submitting Design Packages for Re-approval

7. Receiving Frequent Updates from Building Authorities

The results showed that buildings authorities do not update A/E design offices about new or existing building regulations because the existing regulations are not updated on a regular basis. This is extremely poor practice and might influence the successful implementation of the Saudi Building Code. In this regard, the respondents were asked how often the civil defense and the municipality update A/E design offices about the changes of existing regulations or applying new one. As illustrated in Figures 3.17 and 3.18, the civil defense and municipality update less than 18% of A/E design offices on frequent basis. Both authorities did not communicate any update on a frequent basis to 48% of A/E design offices.

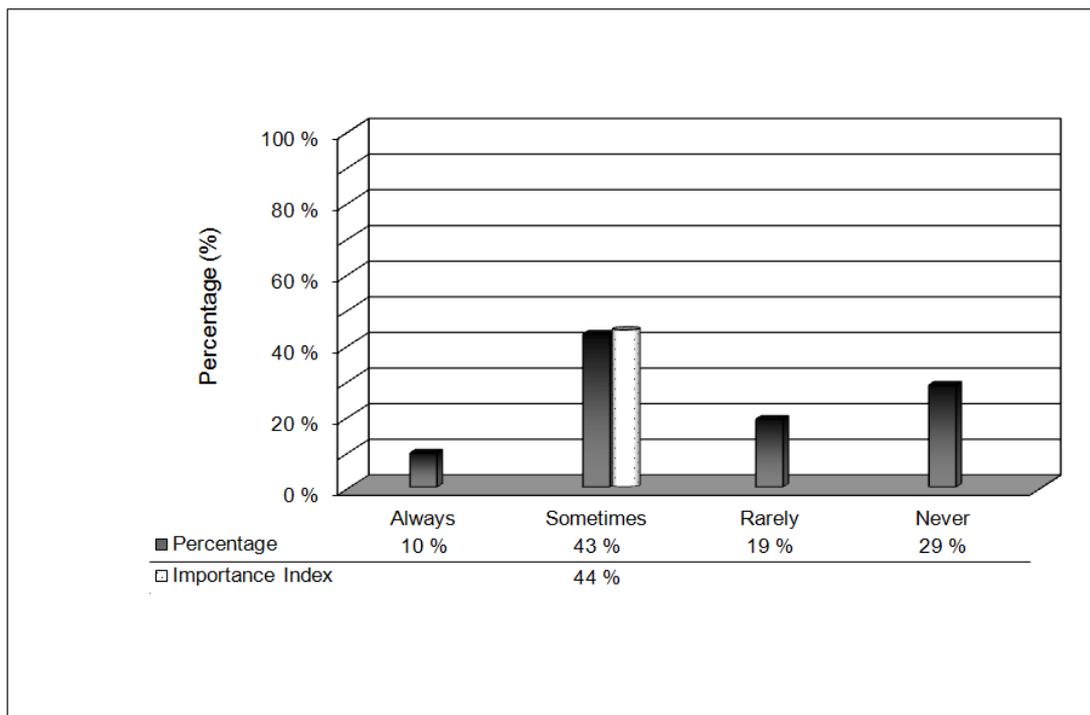


Figure 3.17: The Frequency of Updating A/E Design Offices by the Civil Defense

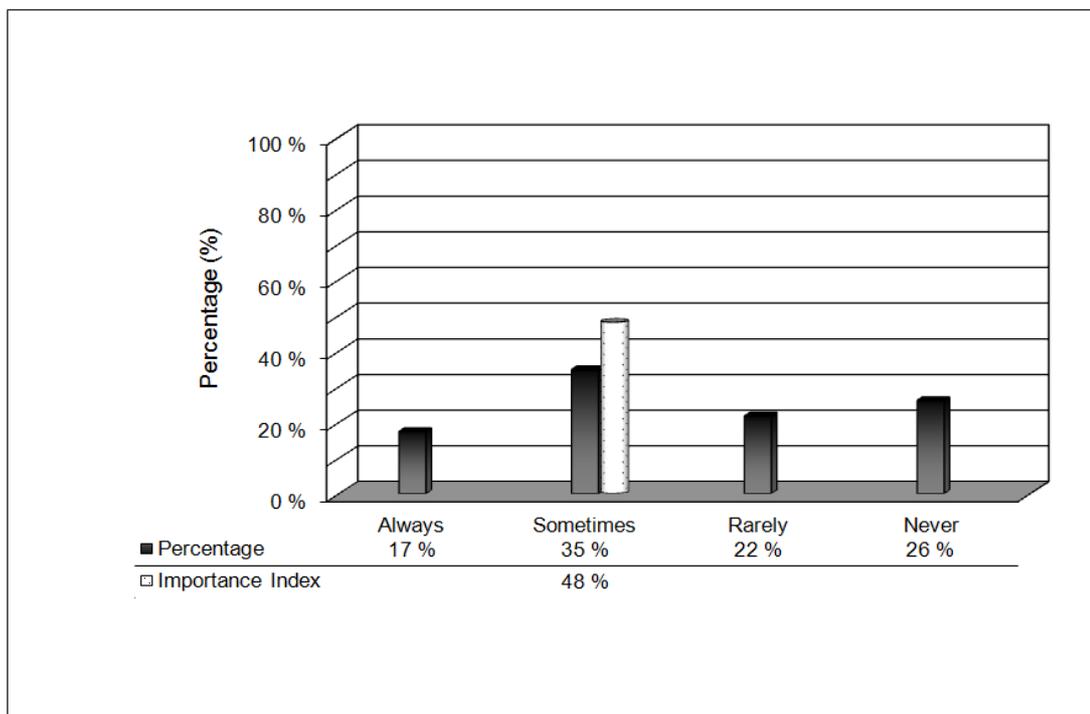


Figure 3.18: The Frequency of Updating A/E Design Offices by the Municipality.

D. Negative Practices

Two practices are considered as negative practices and have the potential to affect the implementation of the Saudi Building Code. These two practices are the weak experience of Saudi young professionals and the building owners resistance to the implementation of the building code. The following sections discuss the results of the assessment for both practices. A summary of the responses and importance indices of negative practices is illustrated in Table 3.4 (2).

TABLE 3 .4 (2): Assessment of the Negative Practice of A/E Design Offices

A/E design office Practice Description		Always	Sometime	No Answer	Rarely	Never	Importance Index	Importance Category
Negative Practice								
1	Facing a problem with young Saudi engineers with no background in building codes.	9	9	6	1	2	73.01	Poor
2	Resisting the implementations of building code requirements by project owner for cost reasons.	4	10	4	4	4	54.54	Good

1. Building Code Experience of Saudi A/E Professionals

The curriculums of architectural and engineering colleges in the major universities in Saudi Arabia do not include any course related to the building code or regulations, which affects the qualification of graduated engineers. The respondents were asked how often A/E design offices face a problem with the level of code experience of Saudi young engineers. The results indicated that their experience with building codes is poor with an important index of 73.01%. As illustrated in Figure 3.19, 43% of A/E design offices face this problem, 43% sometimes face this problem and only 15% of A/E design offices rarely or never face this problem.

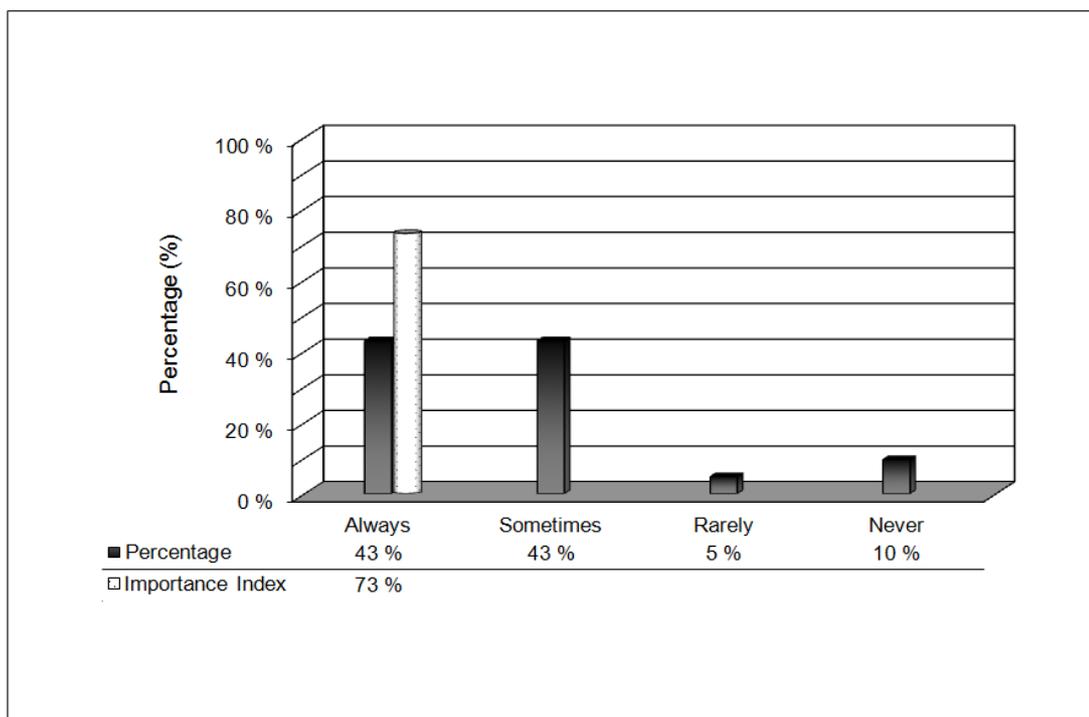


Figure 3.19: The Frequency of Improper Building Code Experience of Young Saudi A/E professionals

2. *Project Owner Resistance to Code Requirements*

The results indicated that there is noticeable resistance from the project owners to certain regulations or code requirements for cost reasons. The overall importance index of this behavior is 54.54% which is considered to be slightly poor practice and requires extensive awareness of the important of the code. In this regard, the respondents were asked how often the project owners resist implementing building code requirements for cost related reasons. As illustrated in Figure 3.20, 18% of A/E design offices always experience resistance from the project owner and 45% of A/E design offices sometimes have the same experience, whereas 18 % of A/E design offices rarely or never experience the owner's resistance.

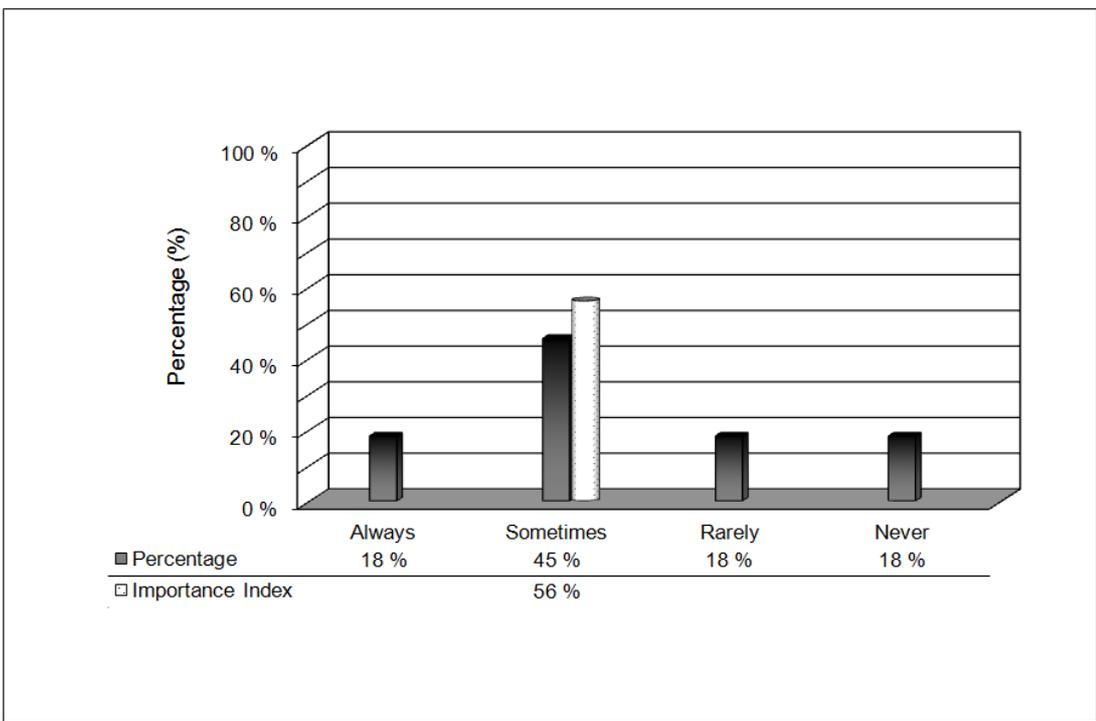


Figure 3.20: The Frequency of the Resistance by Project Owner to the Building Code Requirements

3.4. SUMMARY OF FINDINGS

The following is a list of findings obtained from the interviews and the analysis of the responses to the questionnaire:

1. There is no unified building code enforced by the building authorities. Instead, Civil Defense enforces the regulations issued by the GACD and the Municipalities enforce the regulations issued by the Ministry of Municipal and Rural Affairs.
2. Civil Defense reviews and approves only industrial facilities such as gas stations and workshops, buildings with a floor area more than 10,000 square meters and buildings with four stories and more.

3. Municipalities review only the architectural requirements of the buildings and delegate the responsibility of structural, mechanical and electrical requirements to the A/E design offices.
4. Building Authorities have an extreme shortage of qualified A/E professionals with appropriate building code experience. In addition, there is no effective training for building authorities professionals.
5. The processes of building permit are not optimized as it has multiple stages and requires multiple reviews and approvals.
6. There is no code or standards that are commonly used by all offices. Instead, each office uses one or more of the code and standards specified by this study.
7. About 56% of A/E design offices do not use the National Fire Protection Associations (NFPA) code and standards, which are fundamental for the design and installation of fire protection systems.
8. More than 50% of the design offices are not familiar with ICC codes which are the foundation of the Saudi Building Code. This percentage is reduced because most of the design offices work for Saudi Aramco or the Royal Commission of Jubail and Yanbu which enforce the Uniform Building Code and ICC codes as well.
9. About 30% of the A/E design offices are not following the GACD regulations and around 20% are not following the Municipalities regulations.
10. Buildings are not treated the same during the design stage when it comes to safety. Large commercial buildings, industrial buildings and multistory buildings are considered the most by both A/E design offices and Building authorities. This

is because the building authorities give these building a higher importance level during the process of issuing the building permit.

11. About 74% of the design offices have building code specialists trained to enforce code requirements.
12. A/E design offices do not always consider the code experience prior to hiring new A/E professionals. Only 20% of the A/E design offices consider such experience.
13. A/E design offices always face problem with the building code experience of young Saudi A/E professionals. Only 10% of the A/E design offices never face such a problem.
14. More than 40% of the design offices do not recommend additional code requirements that are not required by the current regulations even if such requirements are critical.
15. More than 60% of the A/E design offices admit that building owners request changes to the approved design where most of these changes happens during the construction phase. Only about 50% of these design offices re-submit the changes to building authorities for re-approval. Design offices sometimes request additional fees for such changes.
16. Project owners sometimes resist the implementation of certain code requirements especially when it increases the project cost. Only 18% of the A/E design offices don't experience such resistance.
17. Both Civil Defense and Municipality are not frequently updating the A/E design offices about their new regulations or the changes to the existing ones. Almost 30% of A/E design offices are never provided with such information.

18. The overall relationship between both the project owner and the A/E design offices and the building authorities and A/E design offices is a good relationship in accordance to the ranking of the design offices.

This chapter does not provide recommendations to overcome these findings. However, all of these findings have been considered during the development of the plan of actions to implement the Saudi Building Code, as presented in chapter five.

3.5. CONCLUSION

This chapter presents an assessment of the current practices of the A/E design offices and building authorities during the design stage with regards to the implementation of building codes and regulations. The results are presented in three sections as follows:

1. Section one presented the Building authorities practice obtained from interviews conducted with the manger of Safety Department at the Eastern Province GACD and the manger of Building Permits Department at Dammam Municipality.
2. Section two presented the practice of A/E design offices that has been obtained from analyzing the results of 27 A/E design office responses to the questionnaire (Appendix-A).
3. Section three presented the overall findings of the assessment followed by the conclusion.

CHAPTER FOUR

FACTORS AFFECTING THE SAUDI BUILDING CODE

4.1. INTRODUCTION

The second objective of this study is to assess and rank the factors that adversely affect the implementation of the Saudi Building Code. This objective has been achieved through two phases as follows:

Phase-I: Extracting twenty six factors from literature review, interviews with code experts and members of the National Committee of the Saudi Building Code, design offices owners and personnel experience. All factors are discussed in chapter two.

Phase-II: Assessing and ranking the factors through analyzing the responses of the questionnaire (Appendix-A)

4.2. DATA COLLECTION

The data were collected via questionnaire forms (Appendix-A) addressed to twenty seven design offices in the Eastern Province, eighteen members of the National Committee of the Saudi Building Code, Nine Managers and engineers in the General Administration of Civil Defense, thirteen municipalities, the chief of Saudi Engineer Council of the Eastern

Province, and a representative of the project department at SASO. The questionnaire consists of two parts as follows:

Part-I: three questions about the respondent, including his organization, his years of experience, his role in the organization and his experience with the building code.

Part-II: contains twenty six factors which might have adverse affect on the implementation of the Saudi Building Code.

4.3. POPULATION AND SAMPLING

The study population consists of six different stakeholders who have direct and indirect relation with the development or implementation of the Saudi Building Code. The minimum sample of each stakeholder has been determined using equations 1.2 and 1.3 highlighted in chapter one. The population and sample sizes are described as follows:

I. The National Committee of the Saudi Building Code (NCSBC):

Referring to the latest editions of the Saudi Building Code volumes, there are eleven members representing the NCSBC. However and in order to ensure variety of responses, the population size has been extended to the members of subcommittees including the consultative committee and technical committees. As a result, the total population has been determined to be 65 members. Substituting in equation 1.2 and 1.3 highlighted in chapter one, the required minimum samples is 18 members. Accordingly, 30 questionnaire forms have been addressed to different members of the NCSBC. After four months, 18 samples were received.

II. General Administration of Civil Defense (GACD)

The response of the GACD was determined to be through the chief of the Safety Department of the Eastern Province due to the similarity of the GACD roles over the Kingdom. However, the sample size has been increased in order to increase the accuracy of response. The samples extend to the Central Region and Makkah Region where total of nine questionnaire forms have been distributed to the GACD in Dammam, Jubail, Riyadh, Makah and Jeddah. All nine forms were received within one month.

III. Municipalities

Referring to the Public Relation Department at the Ministry of Municipal and Rural Affairs, there are over 170 municipal sectors kingdom wide. However, the study is restricted to large municipalities, in which case the population size was determined to be 25 municipalities regarded as regional municipalities or Class-A municipalities. Substituting in equation 1.2 and 1.3, the required minimum sample is 12.5 municipalities. Accordingly, a total of 25 questionnaire forms have been distributed to Eastern Province, Central Region, Makkah region, Madinah Region, Qasim Region, Tabuk Region, Asir Region, Jazan Region, Najran Region and Northern Border Region. Two months later, 13 forms were received.

IV. A/E Design offices

The study restricted the sample of A/E design offices to the Eastern Province of Saudi Arabia with five years of experience as minimum. Referring to Eastern Province Chamber of Commerce and Industry, there are around 145 A/E design offices in the Eastern Province. Applying Equation 1.2 and 1.3, the required

minimum sample is 22.13 A/E design offices. However, the sample has been extended to 27 A/E design offices.

V. Saudi Standards, Metrology and Quality Organization (SASO) & Saudi Council of Engineers (SCE)

One sample for both SASO and SCE was determined to be the minimum required sample due to their unique roles. The questionnaire forms have been addressed to the chief of both organizations and received two months later. The questionnaires were answered by the chairman of the SCE for the Eastern Province and the Project Department Representative from SASO. However, their responses have been used as points of reference during the discussion and analysis of the factors and are not included in the statistical analysis or ranking.

Various techniques were used to distribute the questionnaire forms to each one of the stakeholders including fax, e-mail and personal visits. Table 4.1, summarize the sample size, population, distributed and received forms for each stakeholder.

TABLE 4.1 Summary of Sample Size and Population

	Stakeholder	Population Size	Minimum Sample Size	Distributed Forms	Returned Forms
1	NCSBC	65	18	30	18
3	Municipalities	25	12.5	25	13
4	A/E Design offices	145	22.13	50	27
2	GACD	1	1	9	9
5	SASO	1	1	1	1
6	SCE	1	1	1	1

4.4. DATA ANALYSIS

This section discusses the two types of data obtained from the responses to the questionnaire as follows:

4.4.1. PART ONE: Respondent General Information

Simple descriptive statistics techniques including simple graphics, percentages and simple summaries of the findings are utilized to summarize and present the data obtained from the responses to Part-I of the questionnaire (Appendix-A) which includes general information about the respondents such as experience and job title.

I. Respondent's Experience

The results showed that more than 60% of the respondents have been working for their organizations for more than 10 years. All sixty-nine respondents, representing six different stakeholders, were asked to specify their work experience in one of five categories as follows: one to five years, five to ten years, ten to fifteen years, fifteen to twenty years and more than twenty years. As illustrated in Figure 4.1, the overall experience of the sixty-nine respondents representing all stakeholders shows that 29 % of the respondents have more than twenty years of experiences, 22 % have fifteen to twenty years of experience, 10 % have ten to fifteen years of experience, 20% have five to ten years of experience and 19 % have an experience of less than 5 years.

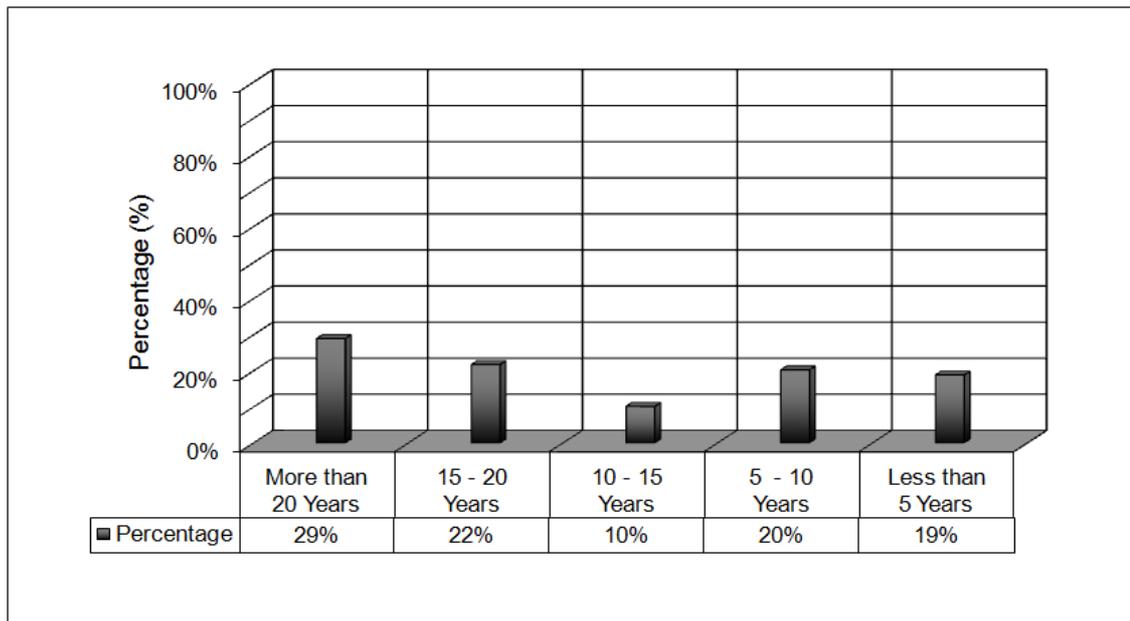


Figure 4.1: Respondents Work Experience

II. Respondents Roles in their Organizations

All sixty-nine respondents, representing six different stakeholders, were asked to specify their role in the organization they work for. Each respondent had the option to select one of eight possible roles: Owner, Department Manger, Architect, Project Engineer, Engineer, Consultant, Building Code Specialist and Manger. As illustrated in Figure 4.2, 10 % of the respondents are mangers, 30% department manger, 9% engineers, 9% architects, 6% project engineer, 10% A/E design office owner and 26% of the overall respondents are members of the NCSBC.

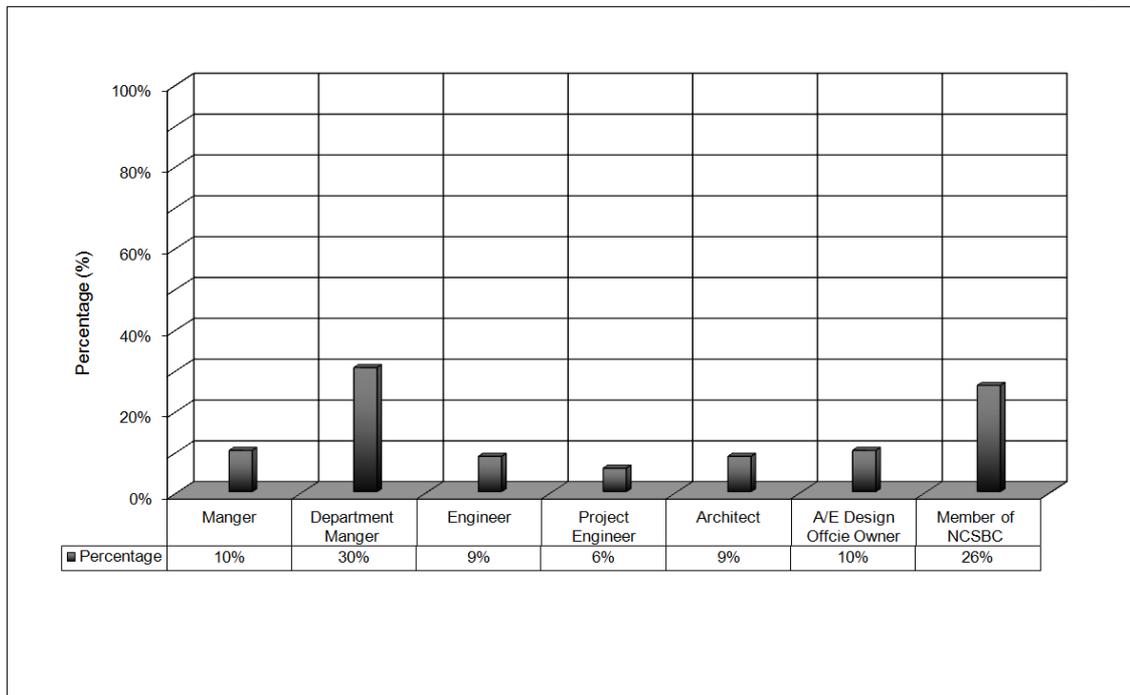


Figure 4.2: Respondents Role

III. Respondents Building Code Years of Experience

Each respondent was asked to specify his experience of building code. He had the option to select one of five categories: one to five years, five to ten years, ten to fifteen years, fifteen or more and no code experience. As illustrated Figure 4.3, 22 % of the overall respondents have more than fifteen years of experiences, 14 % have ten to fifteen years of experience, 19 % have five to ten years of experience, 25 % have less than five years of experience and 20 % have no code experience.

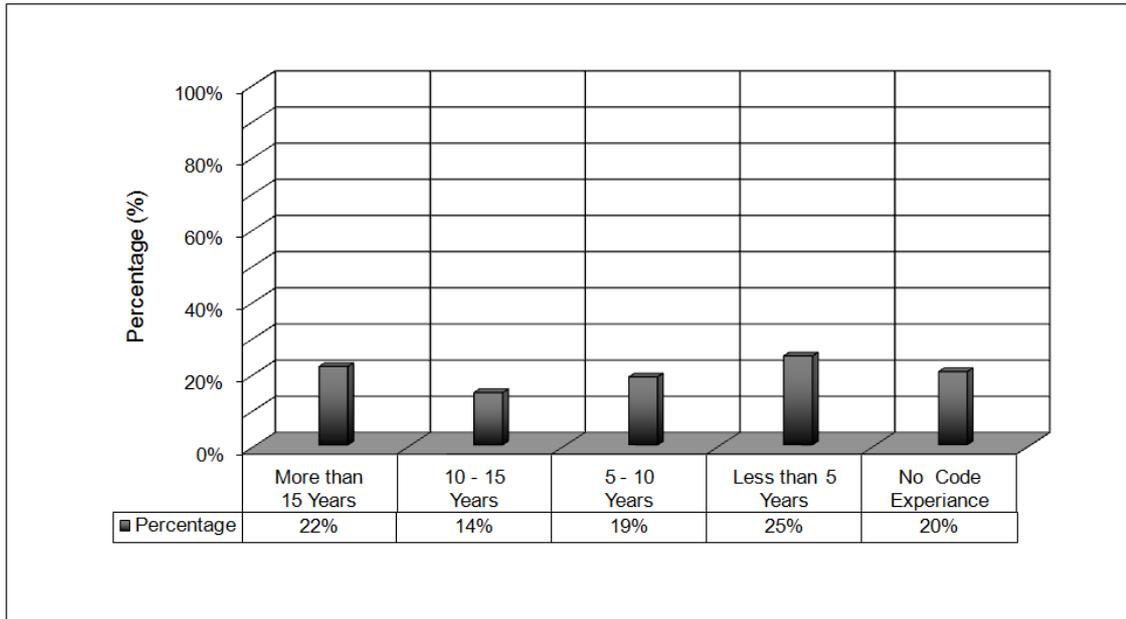


Figure 4.3: Respondents Building Code Experience

4.4.2. PART TWO: Assessment and Ranking of the Factors

The second part of the questionnaire contains twenty six factors that might adversely affect the implementation of the Saudi Building Code. The respondents were asked to describe their opinion on how would each factor will affect the implementation of the code using one of five options: Extreme effect, Strong effect, Moderate effect, Slight effect and No effect. The importance index has been calculated using equation 1.1. Accordingly, if all respondents select no effect, the importance index is =0 based on which the factor is ranked the last, but if all respondents select extremely important, then the importance index is equal to 100 % and therefore it is the most severe factor and the first in the rank. The importance indices and numerical ranking of the factors by group are shown in Table 4.2. The indices and ranking for each factor is shown in Table 4.3. The cumulative indices and ranking for each factor is shown in Table 4.4. The detailed responses, for each factor by all stakeholders are shown in Appendix-C.

TABLE 4.2: Summary of the Importance Indices and Ranking of the Factors by Group

0.1

Factors by Groups	NCSBC ¹		GACD ²		MMRA ³		A/E Design Offices		Cumulative Important Index	Cumulative Rank
	Index	Rank	Index	Rank	Index	Rank	Index	Rank		
A Code Language & Interpretation Factors	54.24	5	75.93	4	57.13	6	62.53	6	62.46	6
B Enforcement Practice Factors	66.32	3	73.61	6	69.54	4	69.46	4	69.73	4
C Building Authorities and Design office Practice Factors	62.41	4	77.50	2	78.46	3	74.27	3	73.16	3
D Public awareness and Insurance Role Factors	73.33	2	76.39	3	86.54	2	76.83	2	78.27	2
E Construction Methods and Materials Factors	53.79	6	75.46	5	61.35	5	65.24	5	63.96	5
F Professionals Training Factors	81.54	1	85.65	1	88.01	1	78.70	1	83.48	1

1 National Committee of the Saudi Building Code

2 General Administration of Civil Defense

3 Ministry of Municipal and Rural Affairs (Municipalities)

Table 4.3: Factors Indices and Ranking

Group of Factors	Sub-Factors		NCSBC		GACD		MMRA		A/E Design Offices	
			Index	Rank	Index	Rank	Index	Rank	Index	Rank
Code Text Language & Interpretation	A1	The original version of the Saudi code is written in English language	60.71	13	72.22	10	56.82	16	58.70	24
	A2	The translation of the English Version of the code to Arabic Version	53.57	16	86.11	3	64.58	12	65.91	16
	A3	The Code requirements are subject to different interpretations among the A/E professionals	48.44	18	69.44	12	50.00	18	63.00	19
Code Enforcement Techniques	B1	Mixing of old regulations or other standers requirements with the Saudi Building Code requirements	54.51	15	61.11	14	55.77	17	59.00	22
	B2	Lack of a written building inspection policy and procedures by the building authorities	70.59	8	72.22	10	67.92	8	72.92	12
	B3	the tendency of using a restrictive implementation policy(violation, fee, stop work orders)	63.89	12	83.33	5	70.45	11	64.42	18
	B4	Lack of a violation tracking system.	76.39	6	77.78	8	75.00	9	81.48	5

Table 4.3: Factors Indices and Ranking (*Contd.*)

Group of Factors	Sub-Factors		NCSBC		GACD		MMRA		A/E Design Offices	
			Index	Rank	Index	Rank	Index	Rank	Index	Rank
Building Authorities and A/E Design offices Practice	C1	Implementing the Saudi Building Code increases the working load.	46.43	20	62.50	13	61.36	14	55.95	25
	C2	Lack of continuous Coordination between the building code authorities	63.89	12	86.11	3	82.69	6	81.73	4
	C3	Lack of continuous coordination between the design offices and building authorities	70.83	7	86.11	3	84.62	5	82.69	3
	C4	Overlapping of responsibilities between building authorities	65.63	9	77.78	8	77.08	7	77.00	7
	C5	Lack of A/E Design Offices classification	65.28	10	75.00	9	86.54	4	73.96	11
Public Awareness & Insurance Role	D1	The low awareness of the public about the importance of building code	81.94	3	83.33	5	86.54	4	83.65	1
	D2	Lack of an effective role of insurance companies	64.71	11	77.78	8	86.54	4	70.00	14

Table 4.3: Factors Indices and Ranking (*Contd.*)

Group of Factors	Sub-Factors		NCSBC		GACD		MMRA		A/E Design Offices	
			Index	Rank	Index	Rank	Index	Rank	Index	Rank
Construction Methods and Materials	E1	The type of construction methods specified in the Saudi Building Code	46.15	21	81.25	6	60.00	15	65.48	17
	E2	The type of materials and equipments specified in the Saudi Building Code	48.21	19	71.88	11	50.00	18	60.23	21
	E3	Lack of authorized testing laboratories and agencies to test and certify building products	84.72	1	84.38	4	75.00	9	75.96	9
	E4	Lack of listed and classified building products in the local market	60.29	14	77.78	8	73.08	10	68.52	15
	E5	The code requirements limit the flexibility of buildings architectural design	33.33	22	56.25	15	47.50	19	58.75	23
	E6	Implementing the Saudi Building Code increases the project cost	50.00	17	81.25	6	62.50	13	62.50	20

Table 4.3: Factors Indices and Ranking (*Contd.*)

Group of Factors	Sub-Factors		NCSBC		GACD		MMRA		A/E Design Offices	
			Index	Rank	Index	Rank	Index	Rank	Index	Rank
Professionals Training	F1	Lack of specialized training centers in the field of building Codes	79.17	5	77.78	8	86.54	4	75.93	10
	F2	Lack of professionals accreditation programs	80.88	4	83.33	5	90.38	2	76.00	8
	F3	Lack of an effective and related on job training for engineers and inspectors	81.94	3	86.11	3	94.23	1	72.83	13
	F4	Lack of skilled and certified construction laborers.	81.94	3	94.44	1	73.08	10	80.77	6
	F5	Lack of certified and trained engineers in the field of building code	81.94	3	80.56	7	89.58	3	83.65	1
	F6	Lack of certified and trained building inspectors	83.33	2	91.67	2	94.23	1	83.00	2

Table 4.4: Cumulative Indices and Ranking

Group Of Factors	Sub-Factors		NCSBC	GACD	MMRA	A/E Design Offices	Cumulative Index	Cumulative Rank
Code Text Language & Interpretation	A1	The original version of the Saudi code is written in English language	60.71	72.22	56.82	58.70	62.11	21
	A2	The translation of the English Version of the code to Arabic Version	53.57	86.11	64.58	65.91	67.54	18
	A3	The Code requirements are subject to different interpretations among the A/E professionals	48.44	69.44	50.00	63.00	57.72	22
Code Enforcement Techniques	B1	Mixing of old regulations or other standers requirements with the Saudi Building Code requirements	54.51	61.11	55.77	59.00	57.57	24
	B2	Lack of a written building inspection policy and procedures by the building authorities	70.59	72.22	67.92	72.92	73.16	14
	B3	the tendency of using a restrictive implementation policy(violation, fee, stop work orders)	63.89	83.33	70.45	64.42	70.52	16
	B4	Lack of a violation tracking system.	76.39	77.78	75.00	81.48	77.66	11

Table 4.5: Cumulative Indices and Ranking (*contd.*)

Group Of Factors	Sub-Factors	NCSBC	GACD	MMRA	A/E Design Offices	Cumulative Index	Cumulative Rank	
Building Authorities and A//E Design offices Practice	C1	Implementing the Saudi Building Code increases the work load.	46.43	62.50	61.36	55.95	56.56	25
	C2	Lack of continuous Coordination between the building code authorities	63.89	86.11	82.69	81.73	78.61	10
	C3	Lack of continuous coordination between the design offices and building authorities	70.83	86.11	84.62	82.69	81.06	7
	C4	Overlapping of responsibilities between building authorities	65.63	77.78	77.08	77.00	74.37	13
	C5	Lack of A/E Design Offices classification	65.28	75.00	86.54	73.96	75.19	12

Table 4.5: Cumulative Indices and Ranking (*contd.*)

Group Of Factors	Sub-Factor		NCSBC	GACD	MMIRA	A/E Design Offices	Cumulative Index	Cumulative Rank
Public Awareness & Insurance Role	D1	The low awareness of the public about the importance of building code	81.94	83.33	86.54	83.65	83.87	3
	D2	Lack of an effective role of insurance companies	64.71	77.78	86.54	70.00	72.67	15
Construction Methods and Materials Specified by the Code	E1	The type of construction methods specified in the Saudi Building Code	46.15	81.25	60.00	65.48	63.22	20
	E2	The type of materials and equipments specified in the Saudi Building Code	48.21	71.88	50.00	60.23	57.58	23
	E3	lack of authorized testing laboratories and agencies to test and certify building products	84.72	84.38	75.00	75.96	80.01	8
	E4	lack of listed and classified building products in the local market	60.29	77.78	73.08	68.52	69.92	17
	E5	The code requirements limit the flexibility of buildings architectural design	33.33	56.25	47.50	58.75	48.96	26
	E6	Implementing the Saudi Building Code increases the project cost	50.00	81.25	62.50	62.50	64.06	19

Table 4.5: Cumulative Indices and Ranking (*contd.*)

Group Of Factors	Sub-Factor	NCSBC	GACD	MMRA	A/E Design Offices	Cumulative Index	Cumulative Rank	
Professionals Training	F1	Lack of specialized training centers in the field of building Codes	79.17	77.78	86.54	75.93	79.85	9
	F2	Lack of professionals accreditation programs	80.88	83.33	90.38	76.00	82.65	5
	F3	Lack of an effective and related on job training for engineers and inspectors	81.94	86.11	94.23	72.83	83.65	4
	F4	lack of skilled and certified construction laborers.	81.94	94.44	73.08	80.77	82.56	6
	F5	Lack of certified and trained engineers in the field of building code	81.94	80.56	89.58	83.65	83.93	2
	F6	Lack of certified and trained building inspectors	83.33	91.67	94.23	83.00	88.06	1

4.5. RESULT ANALYSIS AND FINDINGS

As detailed in chapter two, the factors that might affect the implementation of the Saudi Building Code are categorized into six groups based on its nature. Each group has several factors, and no other significant or relevant factors suggested by any of the respondents to the questionnaire survey. The important indices and ranking of each group with brief descriptions for subgroups is illustrated in the following sections.

Group –A: Building Code Text and Language.

This group of factors is related to the language of the code, translation and A/E professionals' interpretation. This group of factors comes in the sixth and last rank based on the average of importance indices of all stakeholders. The factors included in this group are as follows.

A1. The Original Version of the Saudi Building Code is Written in English Language

English language is not the primary language used by most of the stakeholders expected to enforce the Saudi Building Code including Civil Defense, Municipalities and majority of A/E design offices. Therefore, there will be a gap in the understanding and interpretation between the legislative authorities and the enforcing authorities. As illustrated in Table 4.6, this factor comes in the twenty-first rank with an overall important index of 62.11.

A2. The Translation of the English Version of the Code to Arabic Version

The translation of the code into Arabic language is subjected to variation in pure technical meaning, which requires specialized professionals and lengthy revision procedures. As illustrated in Table 4.6, this factor comes in the eighteenth rank with an overall important index of 67.54.

A3. The Code Requirements are Subject to Different Interpretation among the A/E professionals.

The majority of the codes contents are subject to different interpretations, as a result of professional experience, code language and ambiguous of some of the code statements. As illustrated in Table 4.6, this factor comes in the twenty-second rank with an overall important index of 57.72.

Group-B: Code Enforcement Techniques

This group of factors is related to the methods applied by the building authorities to enforce the code requirements during all stages of the project including building permits procedures; design reviews procedures, violation tracking, fees, and inspection methods. This group of factors comes in the fourth rank based on the average of importance indices of all stakeholders. The factors included in this group are as follows.

B.1. Mixing of old Regulations or other Standards Requirements with the Saudi Building Code Requirements

There is a chance that A/E professionals might mix the requirements of existing regulations or other irrelevant standards with the requirements of the Saudi Building

Code. As illustrated in Table 4.6, this factor comes in the twenty fourth rank with an overall important index of 57.57.

B.2. Lack of a Written Building Inspection Policy and Procedures by the Building Authorities

The written inspection procedures and checklist is an important means to facilitate thorough and unified inspection for any facility and serves as reference for A/E professionals and inspectors. As illustrated in Table 4.6, this factor comes in the fourteenth rank with an overall important index of 73.16

B.3. the Tendency of Using a Restrictive Implementation Policy

Implementing restrictive policy, including fees, stop work orders and violations are viewed by project owners and construction contractors as obstacles which will discourage their appreciation to the advantages of the code and affect the project progress. As illustrated in Table 4.6, this factor comes in the sixteenth rank with an overall important index of 70.52

B.4. Lack of a Violation Tracking System

Using a violation tracking system during the design and construction stages, will enable building authorities to keep a record of all type of violations and evaluate the contractors and A/E design offices regularly; it will also remain in the facility as-built documents as a reference in case of incidents. On the other hand, it is a major source used for the revision and development of the prescriptive codes.

As illustrated in Table 4.6, this factor comes in the eleventh rank with an overall important index of 77.66.

Group-C: The Practice of Building Authorities and A/E Design Offices

This group of factors is related to the practice of building authorities including the coordination between different departments, manpower, and the clarity of role of each department. Overlapping of responsibilities, low level of coordination and insufficient manpower will affect implementation of the Saudi Building Code. On the other hand, if A/E design offices are not classified, it will be difficult for building authorities to regulate the engineering profession, and therefore, will affect the proper implementation of the code. As illustrated in Table 4.6, this factor comes in the third rank based on the average of importance indices of all stakeholders. The factors included in this group are as follows.

C.1. Implementing the Saudi Building Code Increases the Work Load.

The current workload in all the stakeholders involved in this study is expected to be increased, and therefore, it might affect the implementation of the code especially when some organizations have existing problem with the manpower. As illustrated in Table 4.6, this comes in the twenty fifth rank with an overall important index of 56.56. When considering the individual important indices, GACD and MMRA were the highest.

C.2. Lack of Continuous Coordination between the Building Code Authorities

The coordination level between the building authorities is required to exchange expertise and unify the procedures. On the other hand, the effective coordination might improve the permit procedures significantly. As illustrated in Table 4.6, this factor comes in the tenth rank with an overall important index of 78.61.

C.3. Lack of continuous Coordination between A/E Design Offices and Building Authorities

The coordination level between the building authorities and the A/E design offices is required to establish an effective work relationship and improve the permit procedures significantly. As illustrated in Table 4.6, this factor comes in the seventh rank with an overall important index of 81.06,

C.4. Overlapping of Responsibilities between Building Authorities

Overlapping of responsibilities implies duplication of efforts and concerns and might lead to conflict as different opinions are expected. As illustrated in Table 4.6, this factor comes in the thirteenth rank with an overall important index of 74.37.

C.5. Lack of A/E Design Offices Classification

The classification of design offices is an essential means for building authorities to approve the nature and size of projects handled by them and to take legal actions in case of building code violations. As illustrated in Table 4.6, this factor comes in the twelfth rank with an overall important index of 75.19.

Group-D: The Public Awareness and Insurance Role

This group of factors is related to public and investors awareness of the importance and advantages of the building code and the role of the facilities insurance. As illustrated in Table 4.6, this factor comes in the second rank based on the average of importance indices of all stakeholders. The sub-factors included in this group are as follows.

D-1: The Low Awareness of the Public about the Importance of Building Code

If the importance and advantages of the building codes is not explained to the public especially the real-estate owners and investors, they will not support its implementation. As illustrated in Table 4.6, this factor comes in the third rank with an overall important index of 83.87.

D-2: Lack of an Effective Role of Insurance Companies

Insurance practice is one of the prime reasons for the building code development . The facility insurance will force the company that over such service to ensure compliance with the standards in order to minimize their loss in case of catastrophe. As illustrated in Table 4.6, this factor comes in the fifteenth rank with an overall important index of 72.67.

GROUP-E: Construction Methods and Martial

This group of factors is related to the construction methods and materials specified in the Saudi Building Code including type of construction methods, availability of fire resistive materials, testing laboratories, and the impact of the code requirements on the project cost and design flexibility. As illustrated in Table 4.6, this factor comes in

the fifth rank based on the average of importance indices of all stakeholders. The sub-factors included in this group are as follows.

E.1. the Type of Construction Methods Specified in the Saudi Building Code

The Saudi Building Code illustrated a unique construction method that rarely used such as wood and heavy timber construction, in addition the fire resistive construction methods and installation details are not currently practiced and would require a long time to be designed and implemented properly. As illustrated in Table 4.6, this factor comes in the twentieth rank with an overall important index of 63.22.

E.2. the Type of Materials and Equipment Specified in the Saudi Building Code

The Saudi Building Code listed a lot of requirements for finishing material specification along with the listing and testing of other equipment and construction assembly such as doors, glass, fire and smoke dampers and fire resistive materials. As illustrated in Table 4.6, this factor comes in the twenty-third rank with an overall important index of 57.58.

E.3. Lack of Authorized Testing Laboratories and Agencies to Test and Certify Building Products

The Saudi Building Code required some of the construction components to be tested for a certain functions such as fire resistivity. However, there are no sufficient approved labs to perform the test in accordance to the UL standards. As illustrated in Table 4.6, this factor comes in the eighth rank with an overall important index of 80.01.

E.4. Lack of Listed and Classified Building Products in the Local Market

The shortage of approved materials which have been tested and labeled in accordance with the Saudi Building Code will affect the project scheduling. As illustrated in Table 4.6, this factor comes in the seventeenth rank with an overall important index of 69.92.

E.5. the Code Requirements Limit the Flexibility of Buildings Architectural Design

The code requirements tend to limit the flexibility of architectural design as it limits the area of open spaces, height, shape and even finishing materials. As illustrated in Table 4.6, this factor comes in the twenty-sixth rank with an overall important index of 48.96.

E.6. Implementing the Saudi Building Code Increases the Project Cost

The code requirements will affect the initial cost of the projects as additional requirements are involved. Owners will resist such additional expense. As illustrated in Table 4.6, factor comes in the nineteenth rank with an overall important index of 64.06.

GROUP-F: Professional Training

This group of factors is related to training of professionals and inspectors including on job training, undergraduate programs, training centers and certification. As illustrated in Table 4.6, this factor comes in the first rank based on the average of importance indices of all stakeholders. The sub-factors included in this group are as follows.

F-1: Lack of Specialized Training Centers in the Field of Building Codes

There is no local accredited training center offering a specialized training courses and programs related to the building codes and standards. As illustrated in Table 4.6, this factor comes in the ninth rank with an overall important index of 79.85.

F-2: Lack of Professionals Accreditation Programs

There are no effective accreditation programs for engineers which affects the engineering practice. As illustrated in Table 4.6, this factor comes in the fifth rank with an overall important index of 82.65.

F-3: Lack of an Effective and Related on Job Training for Engineers and Inspectors

The engineering subjects and code requirements are developed and changed frequently, which requires effective and frequent on job training for engineers and professionals. As illustrated in Table 4.6, this factor this factor comes in the fourth rank with an overall important index of 83.65.

F-4: Lack of Skilled and Certified Construction Laborers

The lack of skilled and certified laborers in unique jobs that requires special skills will affect the proper construction and installation of building systems as construction contractors tends to hire labors for multiple activities. As illustrated in Table 4.6, this factor comes in the sixth rank with an overall important index of 82.56.

F-5: Lack of Certified and Trained Engineers in the Field of Building Code

The lack of trained and certified engineers in the field of building code will affect the implementation of the building code during the design stages and construction inspection. As illustrated in Table 4.6, this factor comes in the second rank with an overall important index of 83.93.

F-6: Lack of Certified and Trained Building Inspectors

The lack of trained and certified inspectors working for code enforcing authorities will affect the implementation of the building code during the construction and turn offer of the projects. As illustrated in Table 4.6, this factor comes in the first rank with an overall important index of 88.06.

4.6. CONCLUSION

This chapter presented the assessment and ranking of the factors affecting the implementation of the Saudi Building Code including the data collection methods, sampling and result analysis. Twenty-six factors were identified to affect the implementation of the Saudi Building Code and were assessed by 69 individuals representing six different stakeholders. The assessment reveals that the group of factors can be arrange according to their important indices as follows

1. Professionals and laborers training and qualification come in the first rank with an important index of 83.48.
2. Public awareness and insurance role comes in the second rank with an important index of 78.27.
3. The practice of building authorities and design offices comes in the third rank with and important index of 73.16.

4. Enforcement practice comes in the fourth rank with an important index of 69.73.
5. Construction methods and Materials come in the fifth rank with an important index of 63.96.
6. Code Texts and language comes in the sixth and last rank with an important index of 62.46.

CHAPTER FIVE

RECOMMENDED PLAN OF ACTIONS

5.1. INTRODUCTION

This chapter presents the proposed recommendations, overview of the proposed code guidelines and a conclusion of the study. Last objective of the research aims at developing a plan of actions to facilitate the implementation of the Saudi Building Code. The plan of actions is developed based on benchmarking with the practice of Saudi Aramco. A set of criteria have been determined to be the key for the successful implementation of Building Codes in Saudi Aramco. These criteria are compared to the current practice of the building authorities in order to define the area of improvement.

5.2. MAJOR BENCHMARKING CRITERIA

The practice of implementing International Building Codes by Saudi Aramco has been studied. The practice can be summarized as follows:

I. General Instructions and Engineering Procedures

The company has many standards and procedures that regulate every aspects of the construction starting from the project proposal stage until the facility is occupied.

These procedures and regulations highlight the responsibilities of each individual department involved in the construction process. These procedures manage and reduce conflicts, assign duties and control the quality.

II. Structured Organization

The company structure allows each department to be involved in the project in a specific field. The contribution of each department is administered and coordinated by a single department who has the primary responsibility to administer all projects.

III. Professionals Development

All professionals pass through a sequence of on job training courses and development assignments with prime attention to their job. The roles of each professional in any single project are assigned to him with respect to his background and previous related training.

IV. Standardize Materials & Material Supplier

The company has a list of approved construction materials and approved vendors to overcome substandard materials. Such materials and vendors are reviewed regularly.

V. Combined Facilitative and Restrictive Enforcement Practice

Besides using restrictive enforcement techniques such as violation notices, stop work order and contractor's violations penalty, there are other facilitative techniques including engorgement, awareness publications and verbal notices.

VI. Awareness of the Importance of the Code

There are strong safety awareness programs within the company which aim at reduction of injuries and major incidents. The compliance of code and standards and their importance is part of these periodical programs.

VII. Initial Violation Tracking System and Life Cycle Inspection

Projects pass through a sequence of stages; each stage needs to satisfy a certain level of code and standard compliance. During design stages the approval of project proposal depends on its compliance with code requirements. During the construction stages no facility is allowed to be occupied unless it complies with code and standard requirements. The Mechanical Completion Certificates (MCC) is signed by different departments. Prior to signature, each department provides a list of exception items which must be corrected prior to their signature. Failure to implement any exception leads to rejection of the MCC and the operation of the facility. On the other hand, and during the life cycle of the facility it is inspected frequently under the Quarterly Safety Inspection program (QSI).

5.3. COMPARISON BETWEEN THE PRACTICE OF SAUDI ARAMCO AND THE LOCAL BUILDING AUTHORITIES

This section includes a comparison between the practice of Saudi Aramco pertaining to the implementation of the building code and the current practice of the building authorities. As illustrated in Table 5.1, seven criteria have been determined to be the major reasons for the successful implementation of the building code by Saudi

Aramco. These criteria are compared to the practice of the local building authorities and found that they are not following the eight criteria effectively.

TABLE 5.1: Benchmarking Criteria with Saudi Aramco

	Benchmarking Criteria	Saudi Aramco	Local Authorities
1	General Instructions and Engineering Procedures to regulate the design and construction of projects.	Yes	No
2	Structured organizational hierarchy where the roles of each department are clearly identified.	Yes	No
3	Planned and continuance on-Job training for A/E professionals.	Yes	No
4	Standardized and approved construction materials.	Yes	No
5	Combined facilitative and restrictive enforcement policy.	Yes	No
6	Effective Awareness programs	Yes	No
7	Effective Violation tracking system	Yes	No

5.4. RECOMMENDED PLAN OF ACTIONS

The study's major findings indicate a lack of professional trainings and public awareness, absence of written engineering procedures and violation tracking systems and overlapping of responsibilities. Accordingly, there is a need to resolve these major items prior to or along with the implementation of the Saudi Building Code.

The recommendations are classified into long term and short term as follows:

5.4.1. Part-One: Short-Term Recommendations

1. Training:

- It is recommended to conduct temporary building code training and certification programs for the current engineering workforce in both A/E design offices and the building authorities departments. The training programs should be conducted in coordination with the Saudi Council of Engineers, the International Code Council, and the National Fire Protection Association.

2. Public Awareness :

- It is recommended to conduct awareness campaign through public media to highlight the importance of building codes and standards and for public and engineering workforce.
- It is recommended to conduct awareness workshops for A/E design offices, building authorities and A/E professionals at different locations.

3. The Practice of Building Authorities and A/E Design Offices :

- It is recommended that the municipalities and civil defense departments subcontract the building code review and approval for the government and public projects to a consultant offices or company with acknowledged experience with building code.

4. Enforcement Practice :

- It is recommended that the Municipalities implement a building certificate of occupancy program for public and governmental buildings. The certificate of occupancy should be signed by different parties including project owner, building authorities, designer and construction contractor.

5. Construction Method and Materials :

- It is recommended to assess the current market and investigate the availability verses the shortage of approved materials.

6. Code Text and Language :

- It is recommended to develop additional code volume related to the private residential villas and houses.

5.4.2. Part-Two: Long-Term Recommendations**1. Training :**

- It is recommended to develop two years Building Inspectors Diploma program within the technology or community colleges. The curriculum of such a program should include multiple field of building inspections with prime focus on the requirements of building codes and standards.
- It is recommended to develop building code and construction standards courses and add it to the curriculums of all Engineering Collages.

- It is recommended to develop Professionals Training Policy (PTP); this policy should involve the yearly on-job training requirements for each professional.

2. The Practice of Building Authorities and A/E Design Offices:

- As illustrated in Figure 5.1, It is recommended to establish a Higher Commission for Projects (HCP) to administer all governmental and public projects under the ministry of finance in order to ensure quality, durability and code compliance as follows :
 - i. Transfer the duties of all project departments within all governmental departments to the higher commission and keep a small team for maintenance and minor renovations projects.
 - ii. Transfer the major roles of building permits department within all municipalities to the commission.
 - iii. Establish a Building Code Department within the HCP to review and approve all projects.
 - iv. Establish support departments such as Material Procurement and Contracting Department ,

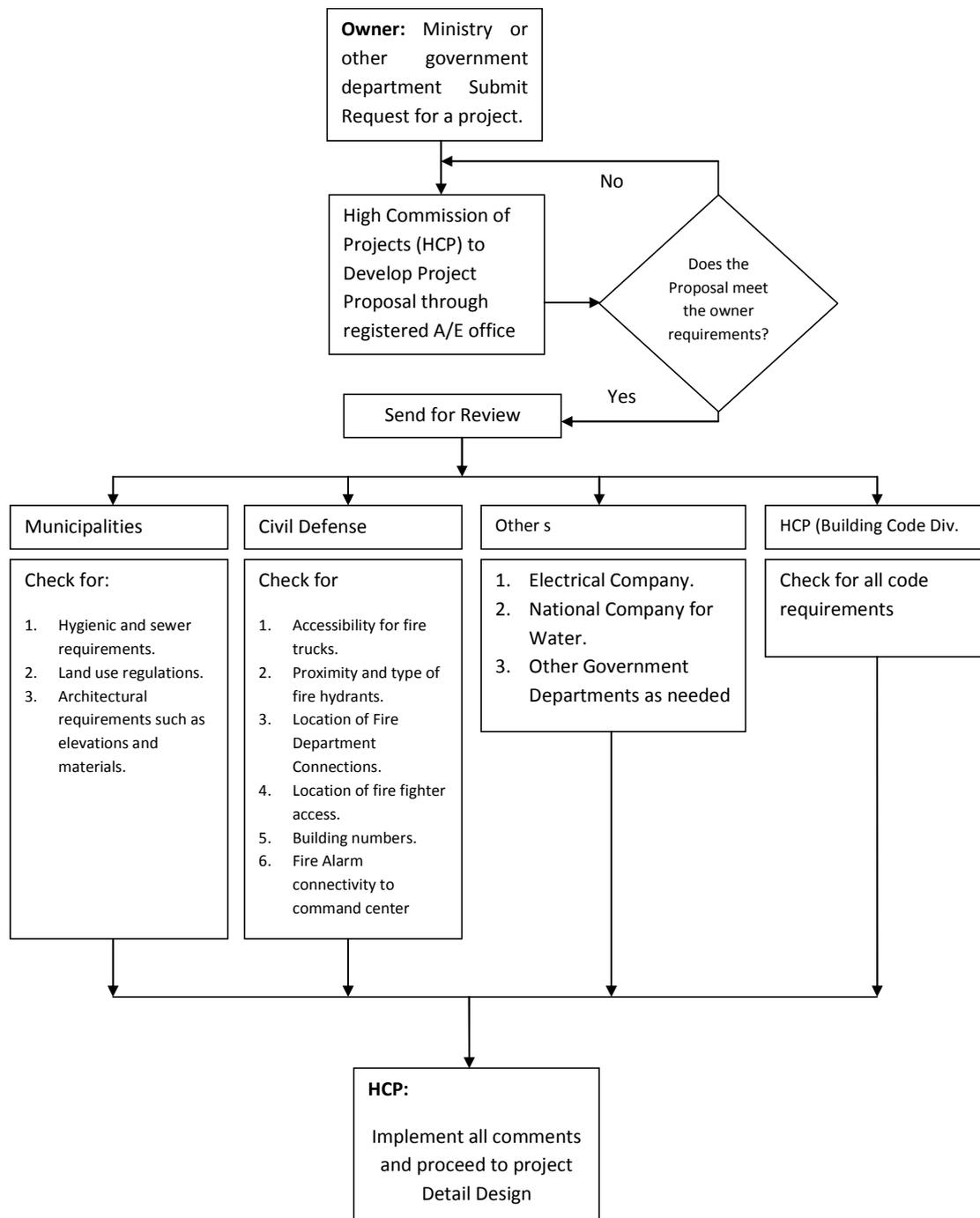


Figure 5.1: Proposed Project Process by the Higher Commission of Projects

- It is recommended to establish building insurance policy for existing and new public and governmental projects. Insurance companies should take the responsibility of the periodic inspection of such facilities.
- It is recommended to establish statistical database for building fire incidents by GACD to be utilized as reference for researches and code developments.
- It is recommended to develop Engineering Procedures in coordination with best in practice organizations , these procedures should involve the following:
 - a. Describe the role and duty of each organization in the construction industry in Saudi Arabia.
 - b. Describes the project phases and the requirements for each phase.
- It is recommended to develop A/E design offices classification program based on predetermined criteria including experiences and engineering qualification. This program should involve the following:
 - i. Specify the type of projects by nature, size and capital that each office is allowed to handle.
 - ii. Develop a Yearly Evaluation System (YES) for A/E design offices. The system should be based on positive and negative points linked to the approval of licenses renewal. Design

violations noticed by building code enforcement agencies should be added to the system as negative points.

- It is recommended to develop Professionals Accreditation Program (PAP). This program should involve a professional ranking system which specifies the role and duty of each professional, the qualification, years of experiences and training requirements. Those professional in charge of building code enforcement should obtain a related certificate to be accredited as building code officials.
- It is recommended that the Saudi Standards, Metrology and Quality Organization should invest in building materials testing laboratories in coordination with Underwriter Laboratories in order to enrich the local market with approved materials.

5.5. RECOMMENDED BUILDING CODE GUIDELINES

Objective four of this study was to develop and assess a set of guidelines to help A/E professionals interpreting the fire protection requirements of the Saudi Building Code. As detailed in Appendix-B, the guidelines include the requirements related to the design stage. The bases of the developed guidelines are summarized in Figure 5.1.

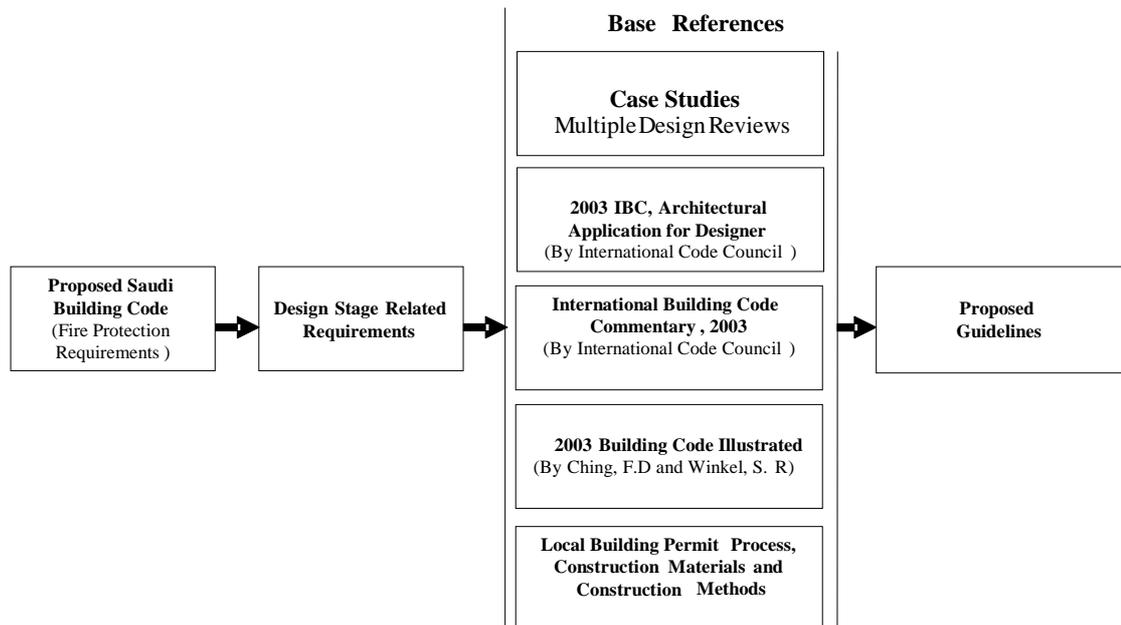


Figure 5.2: The Development Process of the Guidelines

5.5.1. Guidelines Overview

The guidelines consist of three chapters including the major and fundamental design related code requirements as follows:

I. Chapter One: Basic Code Requirements

This chapter includes step by step explanation for occupancy classification, type of construction, building area and height limitation and occupant load calculations.

II. Chapter Two: Fire Resistance Construction

This chapter includes step by step explanation for structural elements fire proofing, fire compartments, opening limitations and fire protection.

III. Chapter Three: Mean of Egress

This chapter includes step by step explanation for the design of width, length, height and other significant details of the mean of egress.

5.5.2. Guidelines Techniques

The guidelines divided the code requirements based on their sequence during design starting with the fundamental requirements that are required to navigate the code followed by other requirements that depends on the fundamental analysis. For example, to decide if sprinkler system is needed in a facility, the type of occupancy, the occupant load and building area need to be determined first. Therefore, the guidelines of determining occupancy classification, calculating occupant load and building area are presented first. Each chapter addresses a major group of code requirements organized in sections, and each section contains a group of steps. Each step is referenced in accordance with the equivalent section in the Saudi Building Code. Some Tables and Figures are developed and optimized based on the Saudi Building Code or the referenced standards and Codes.

5.5.3. Guidelines Summary

The following Figures provide illustrative summary of the content of the guidelines.

Occupancy Classification Guidelines

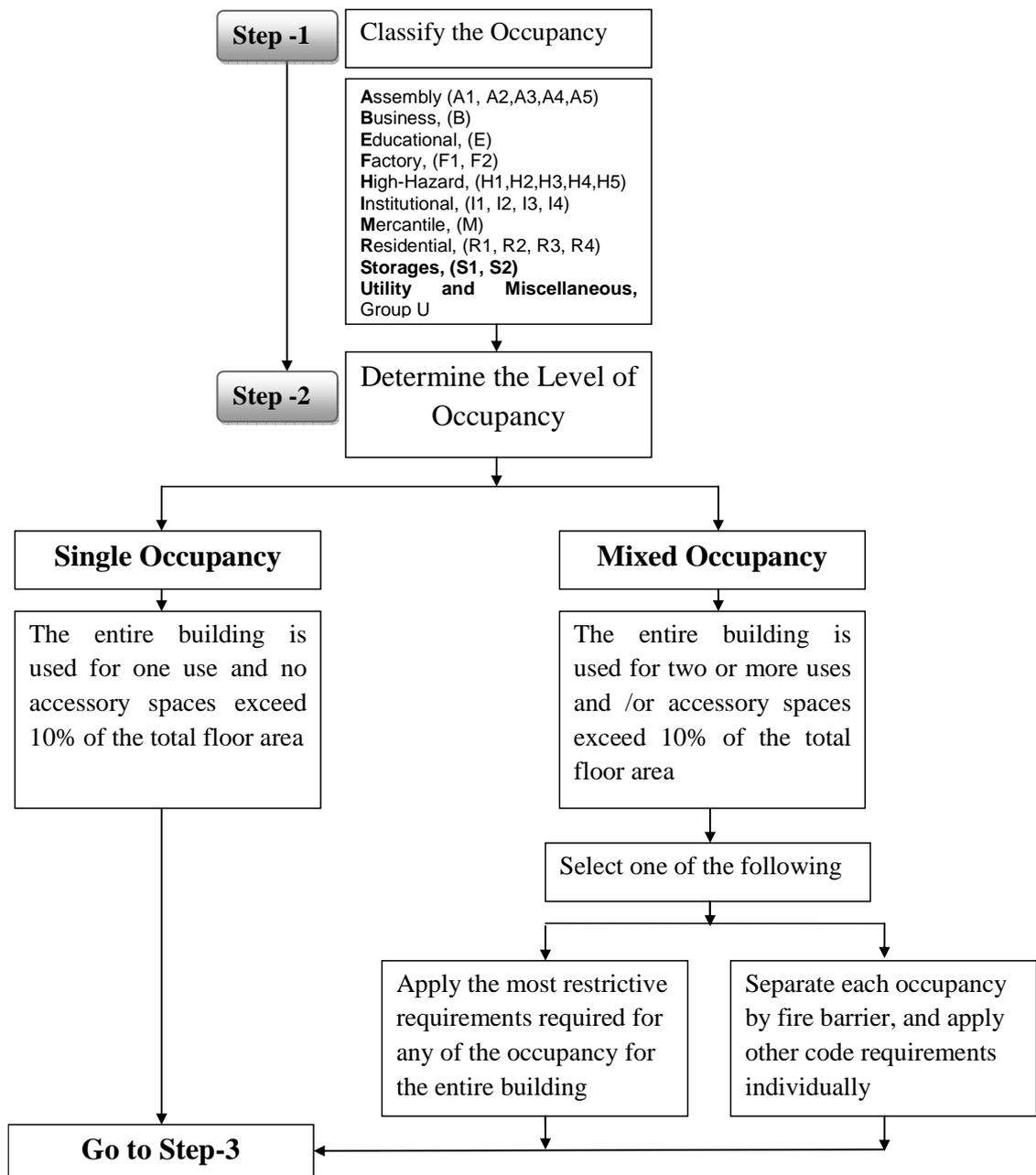


Figure 5.3: Guidelines for Determining the Occupancy Classification

Occupancy Classification

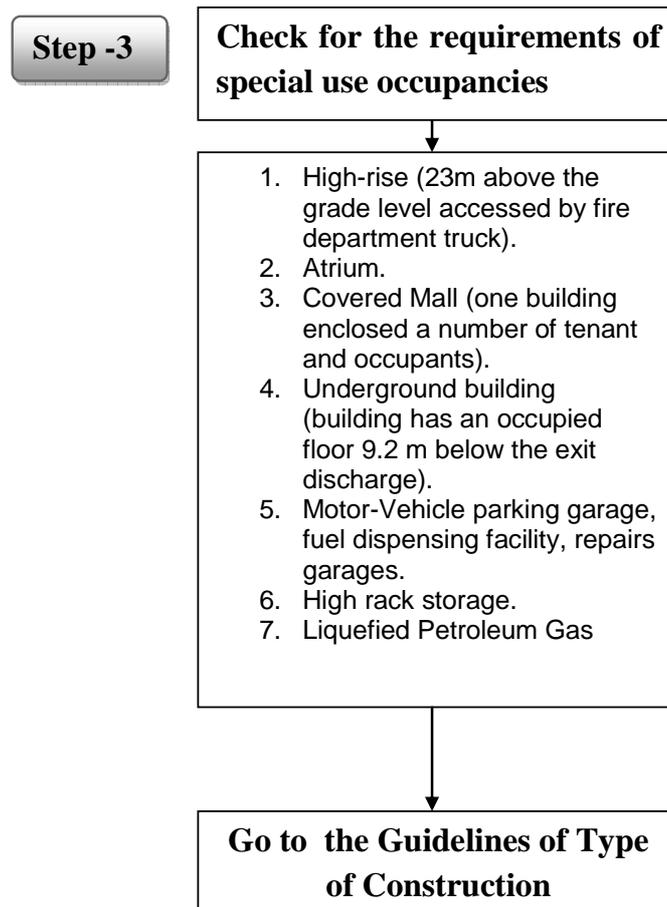


Figure 5.3: Guidelines for Determining the Occupancy Classification (*Cont.*)

Type of Construction Guidelines

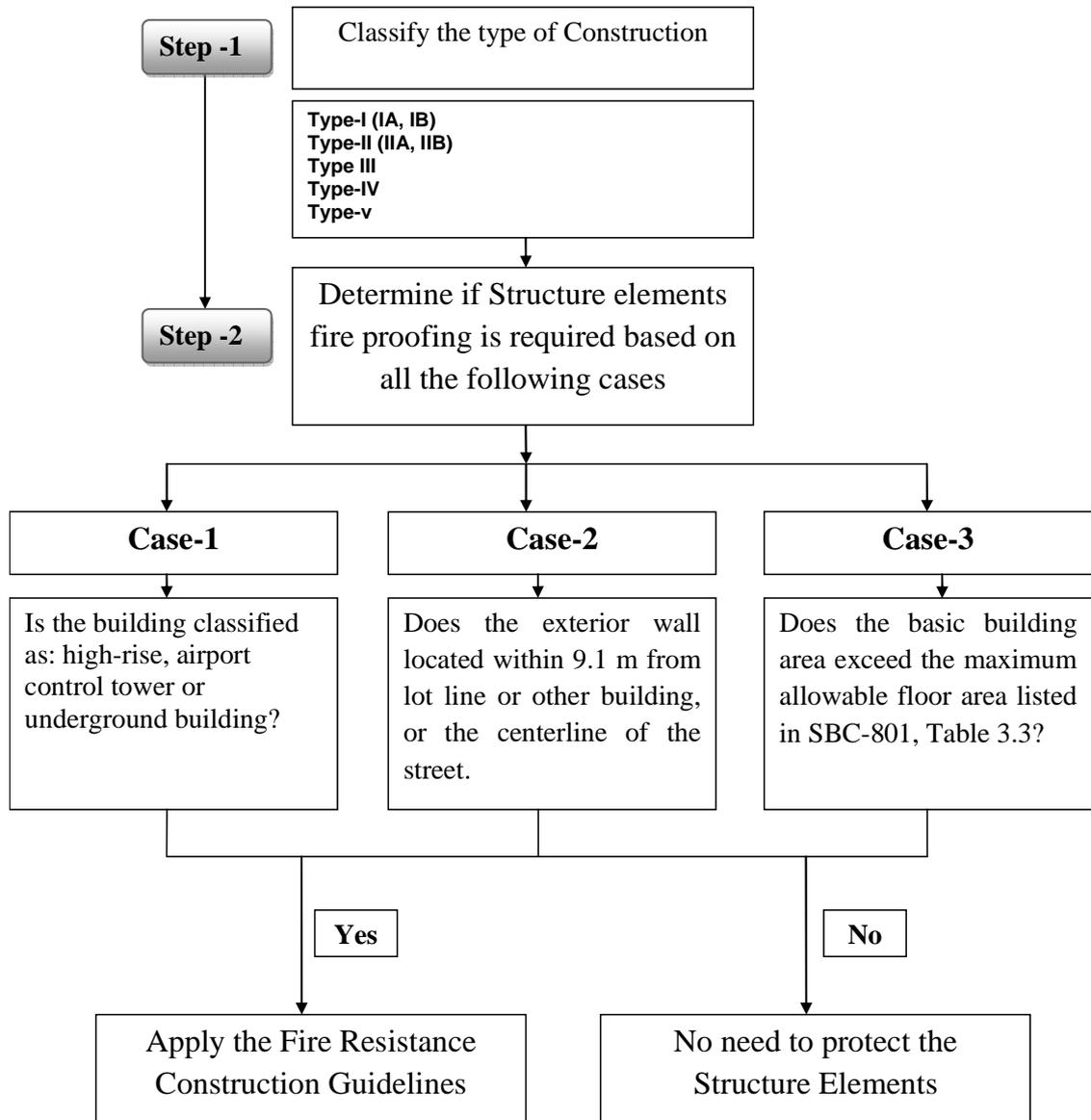


Figure 5.4: Guidelines for Determining the Type of Construction.

Building Area and Height Guidelines

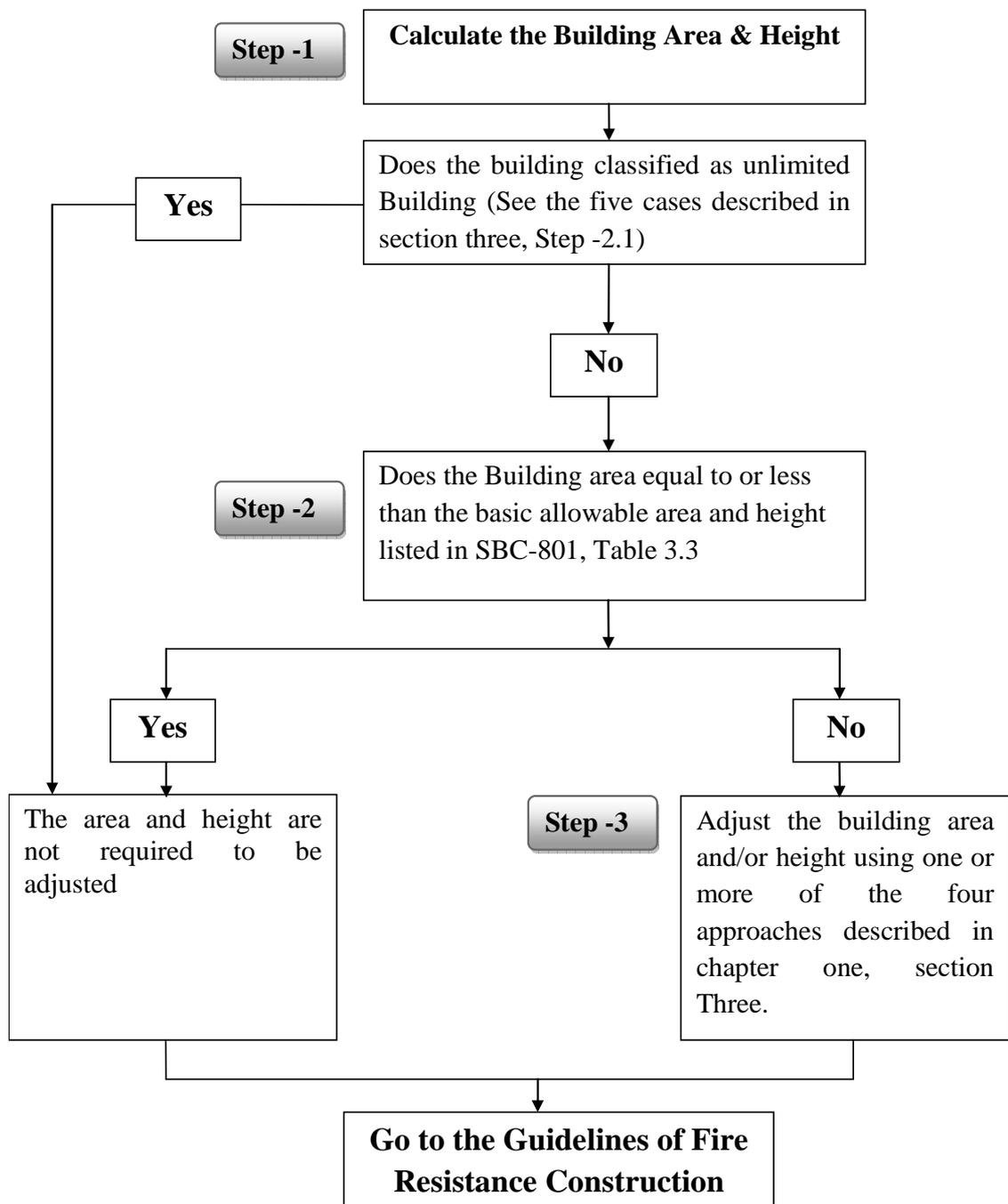


Figure 5.5: Guidelines for Determining the Building Area and Height

Fire-Resistance-Rated Construction Guidelines

A. Structural Members

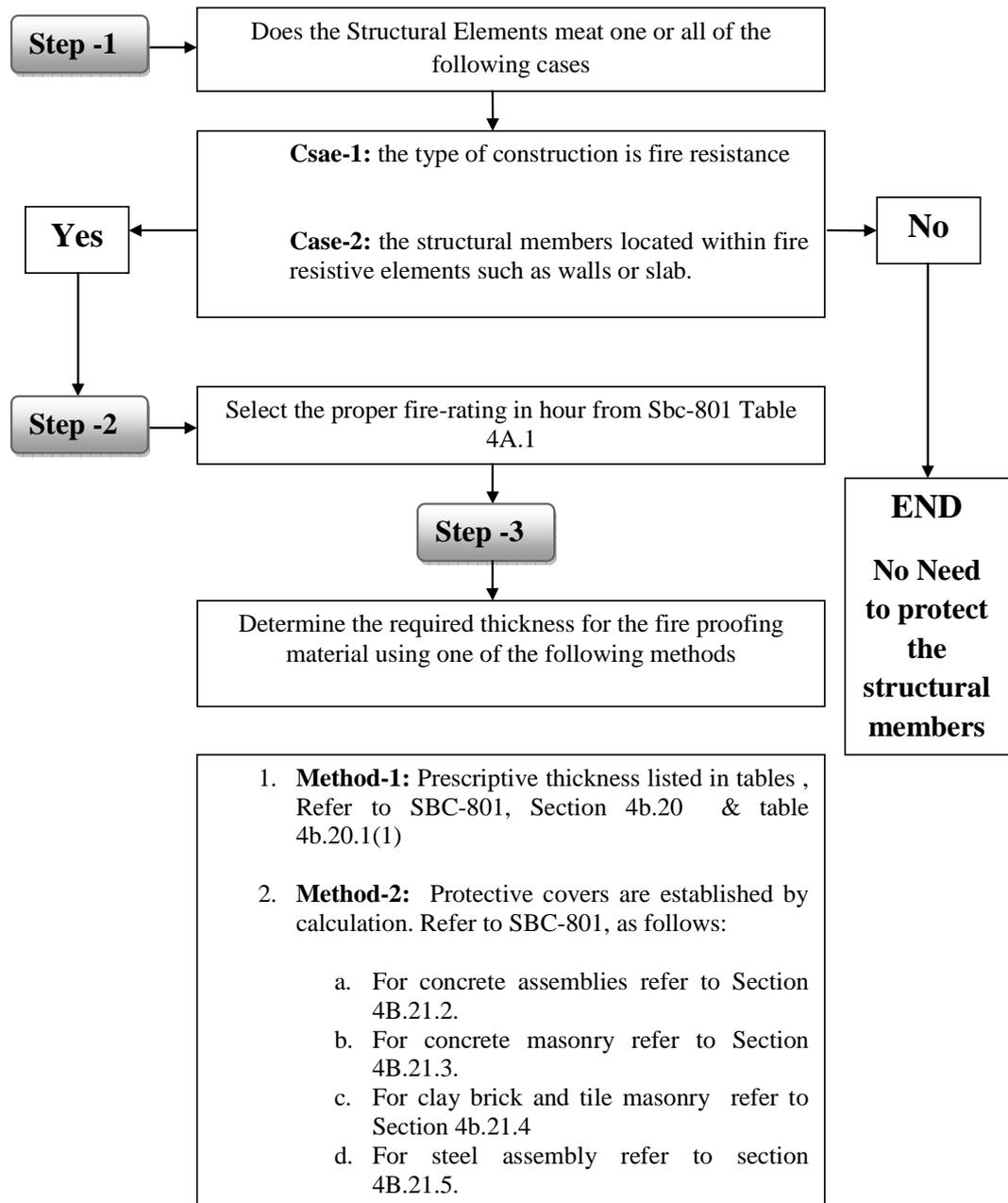


Figure 5.6: Guidelines for Determining the Fire Resistivity of Structural Members

B. Exterior Wall Guidelines

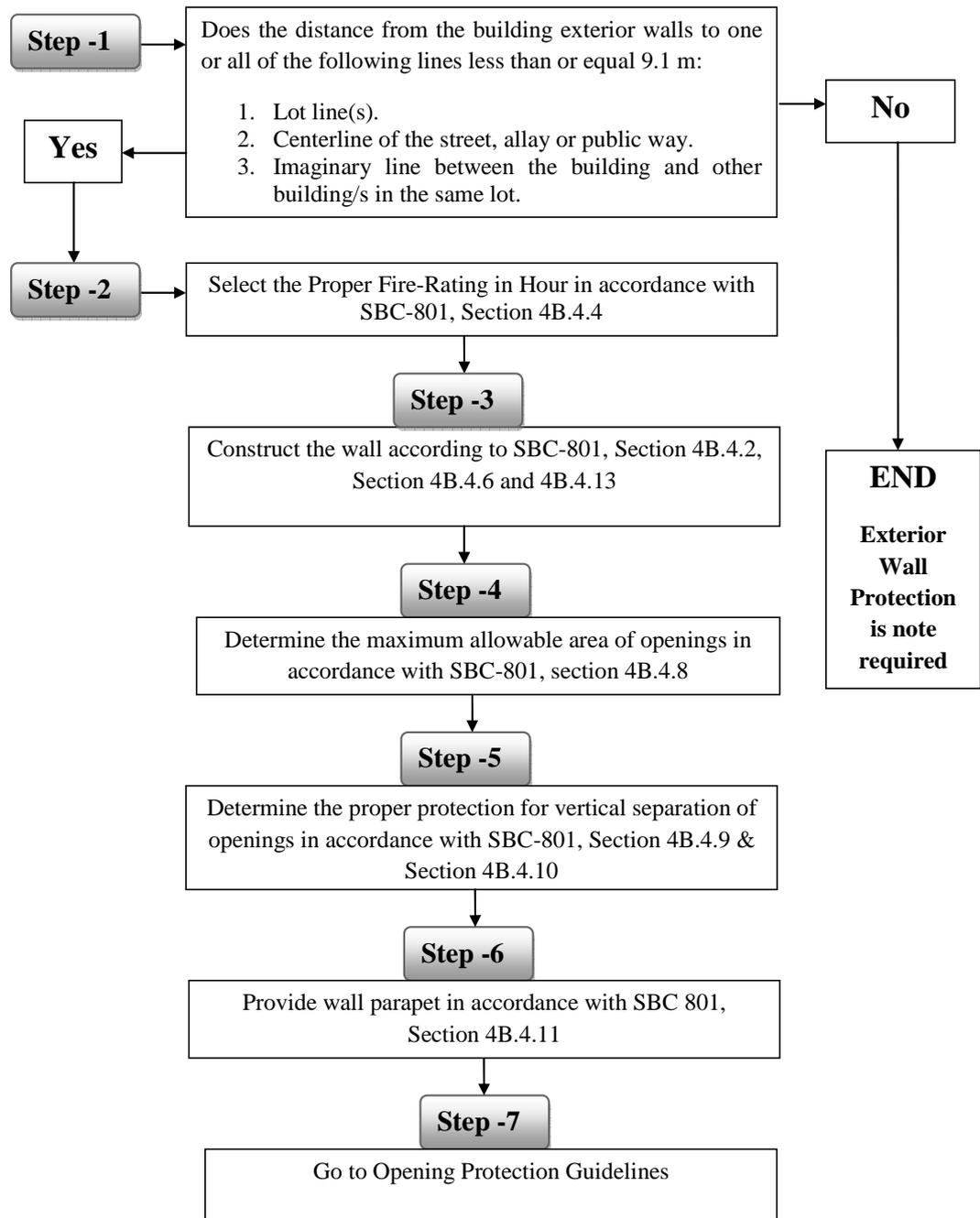


Figure 5.7: Guidelines for Determining the Fire Resistivity of Exterior Walls.

C. Fire Wall Guidelines

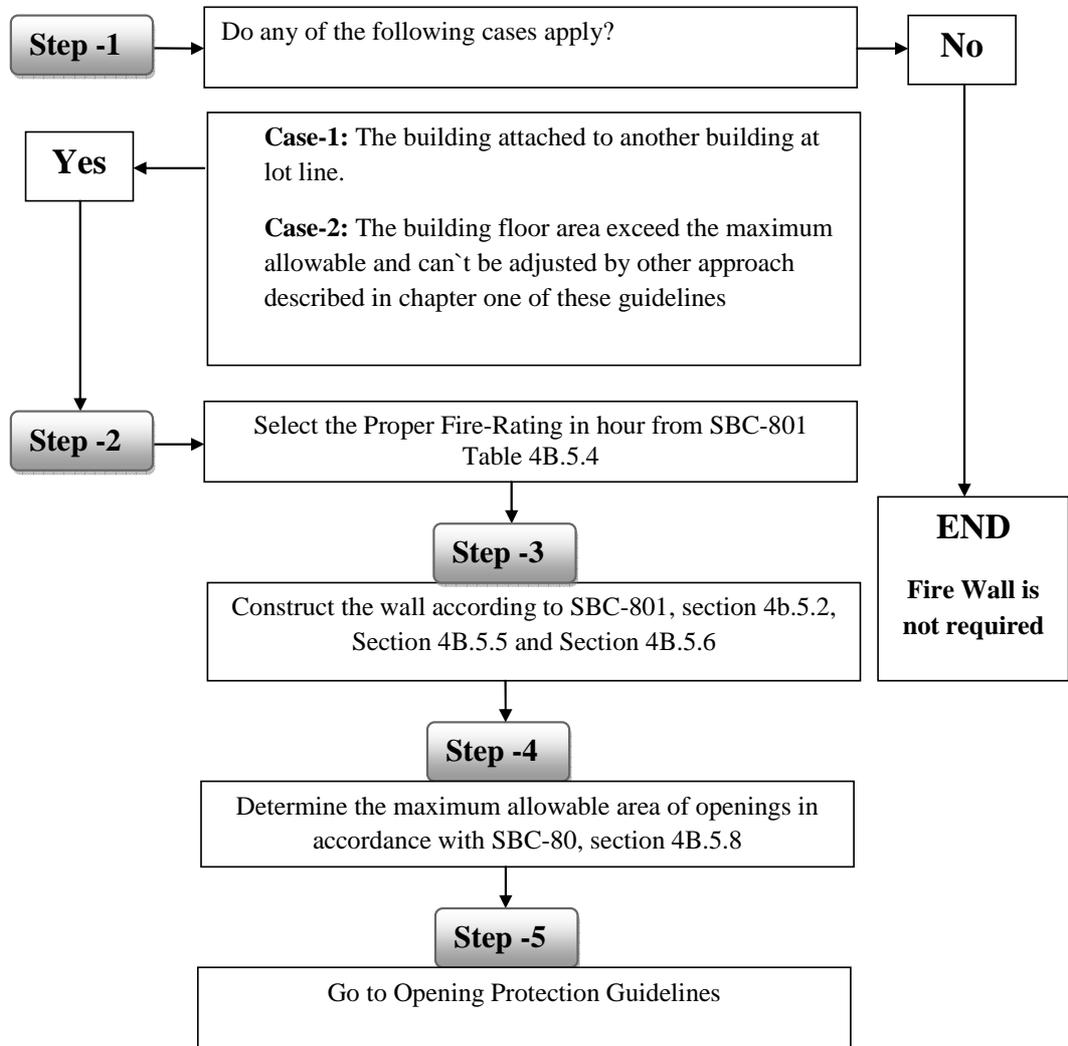


Figure 5.8: Guidelines for the Construction of Fire Walls.

D. Fire Barrier Guidelines

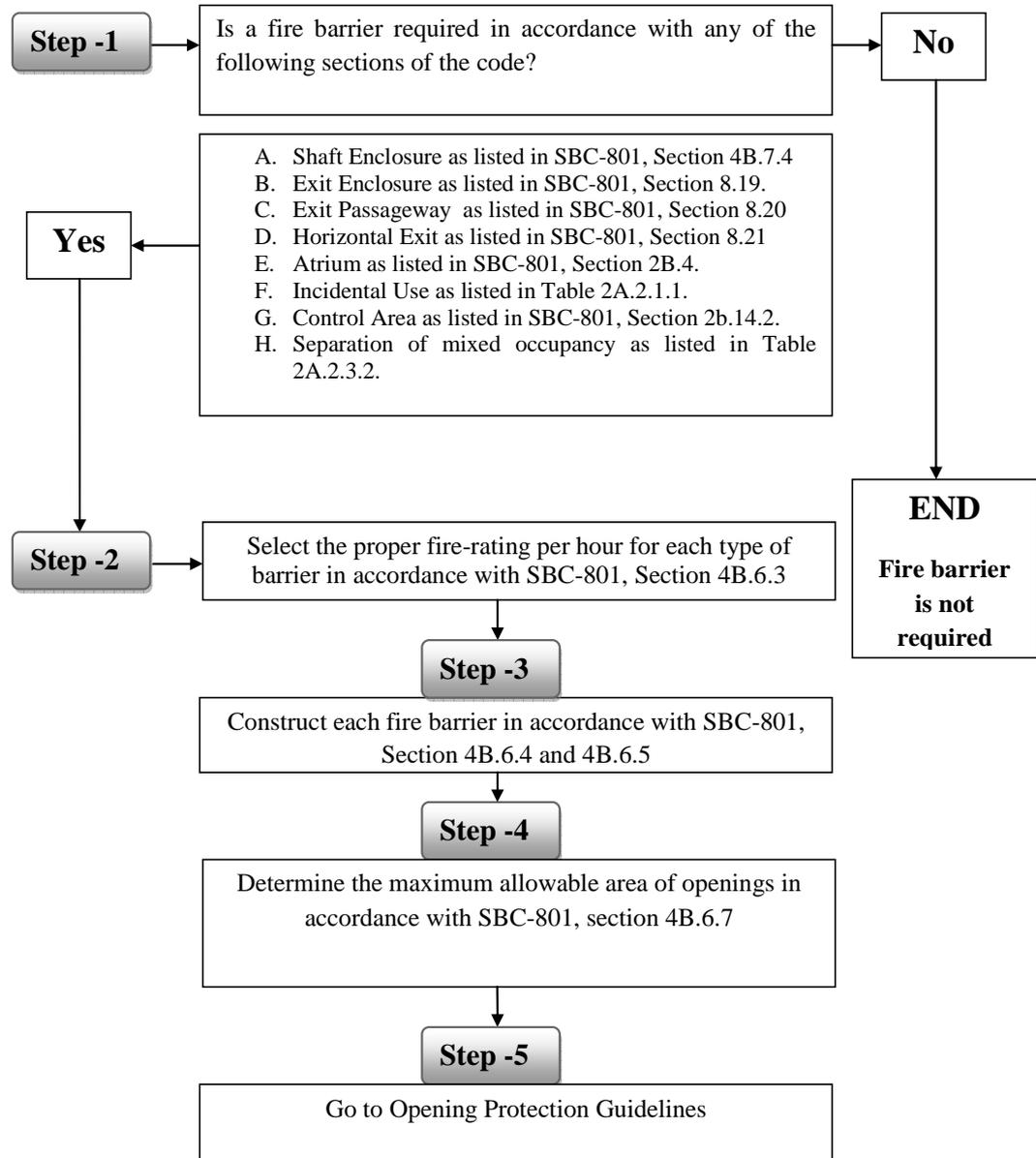


Figure 5.9: Guidelines for the Construction of Fire Barriers.

E. Fire Partition Guidelines

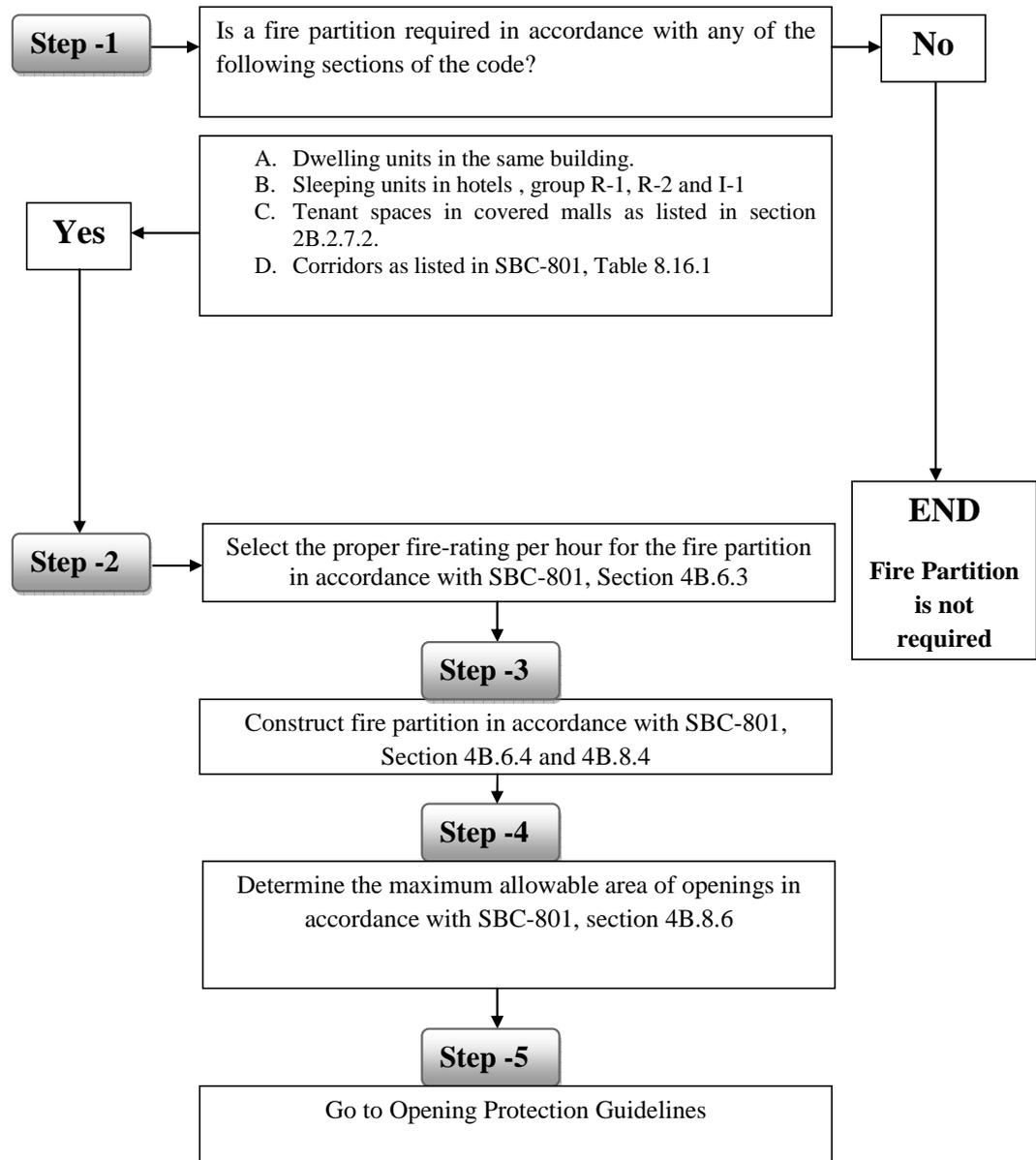


Figure 5.10: Guidelines for the Construction of Fire Partitions.

F. Smoke Partition and Smoke Barrier Guidelines

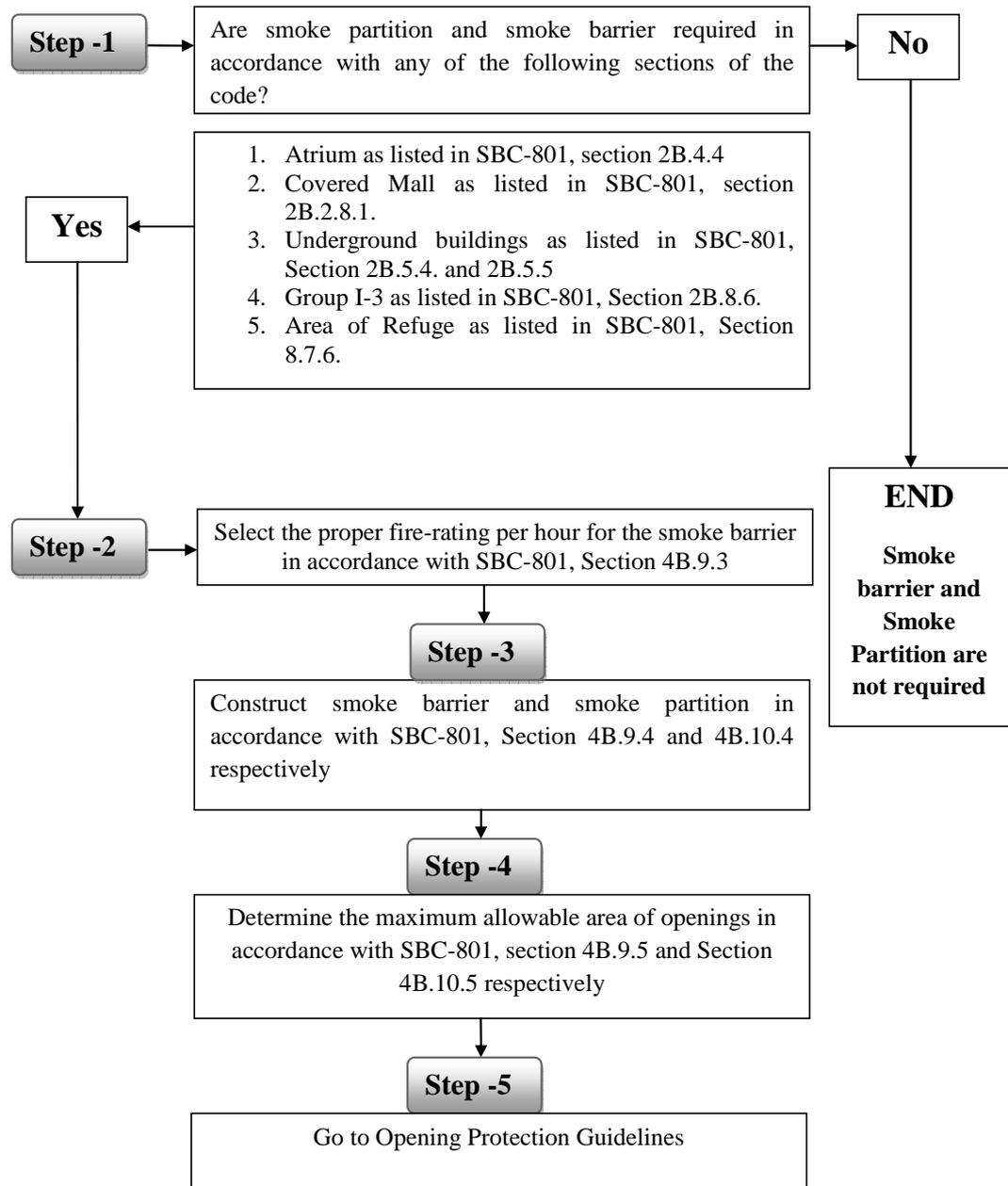


Figure 5.11: Guidelines for the Construction of Smoke Partitions and Smoke Barriers.

G. Penetration and Openings Protection Guidelines

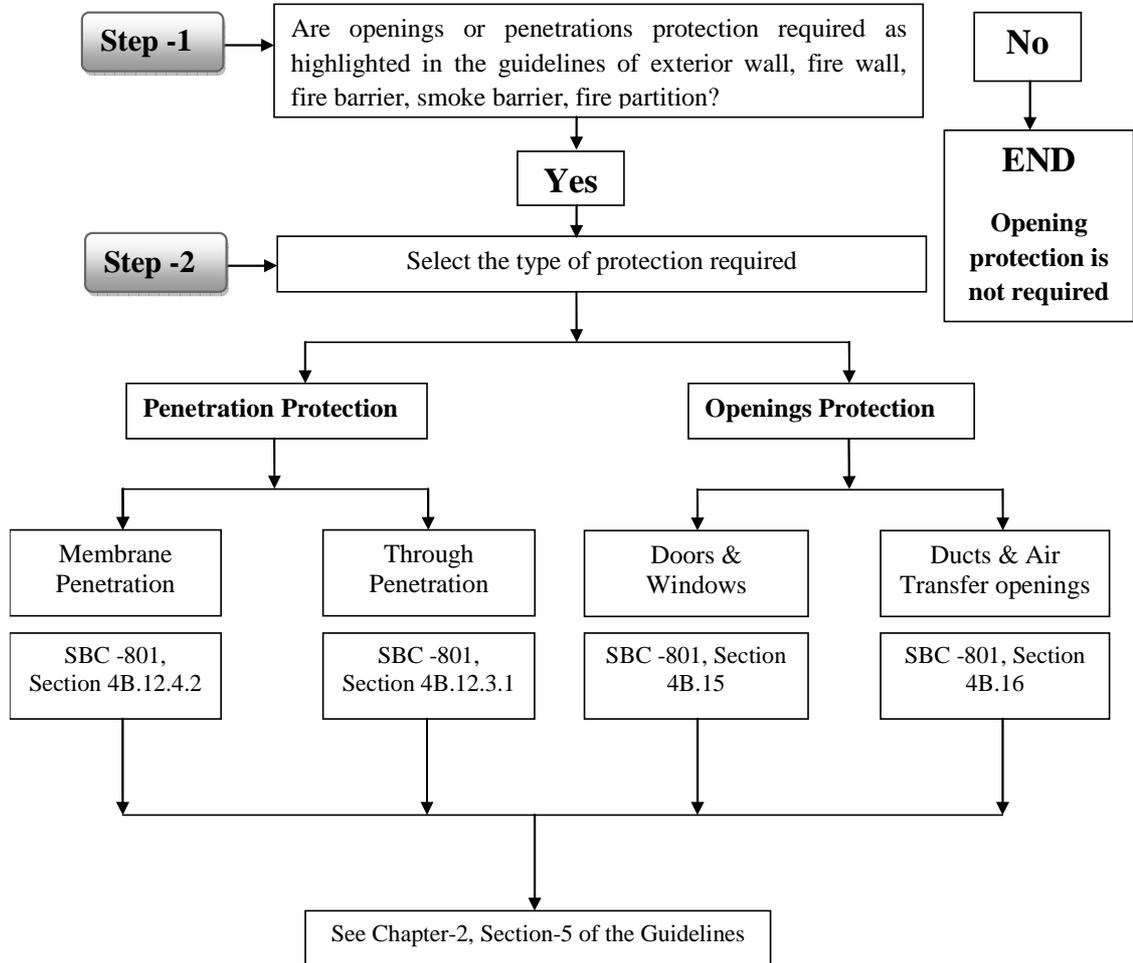


Figure 5.12: Guidelines for the Protection of Penetrations and Openings.

Means of Egress Guidelines

Step -1	Classify the building and interior spaces
Step -2	Calculate the occupant load
Step -3	Provide the right number of exit or exit access doorways for the selected space or building Reference: SBC-801, Section 8.14 and Section 8.18
Step -4	Maintain proper distance between exits, or exit access doorways Reference: Reference: SBC-801 , Section 8.14.2
Step -5	Maintain proper travel distance from the most remote point within the story to the entrance of an exit. Reference: SBC- 801, Section 8.15.
Step -6	Check exit access layout <ul style="list-style-type: none"> • Exit through intervening room (Section 8.13.2). • Common path of egress (Section 8.13.3). • Dead ends (Section 8.16.3).
Step -7	Design for the change in elevation at the means of egress Reference: SBC-801, Section 8.3.5
Step -8	Calculate the width of the required means of egress Reference: SBC-801, Section 8.5 and 8.8

Figure 5.13: Guidelines for the Construction of Means of Egress (Step-1 to 8).

Means of Egress Guidelines

Step -9	<p>Check the door clear width and door leaf size.</p> <p>Reference: SBC-801, Section 8.8</p>
Step -10	<p>Check the door height and the allowable projection into the door clear width and height.</p> <p>Reference: SBC-801, Section 8.8.1.1 and 8.1.1.1</p>
Step -11	<p>Check the swing direction of doors.</p> <p>Reference: SBC-801, Section 8.8.1.2</p>
Step -12	<p>Check the floor elevation on each side of all</p> <p>Reference: SBC-801, Section 8.8 .1.4</p>
Step -13	<p>Check the details of door landing</p> <p>Reference: SBC-801, Section 8.8 .1.5</p>
Step -14	<p>Check the details of the thresholds at doorways</p> <p>Reference: SBC-801, Section 8.8 .1.6</p>
Step -15	<p>Check the location of the door hardware</p> <p>Reference: SBC-801, Section 8.8 .1.8</p>
Step -16	<p>Check the specific details for locks, latches and panic hardwires</p> <p>Reference: SBC-801, section 8.8.1.8.1 through 8.8.1.8.9.</p>

Figure 5.14: Guidelines for the Construction of Means of Egress (Step-9 to 16).

Means of Egress Guidelines

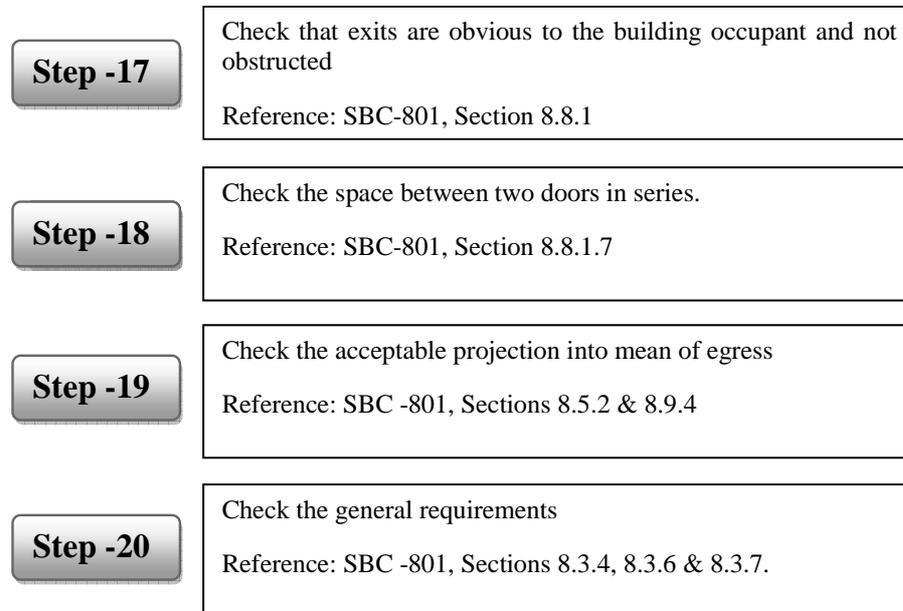


Figure 5.15: Guidelines for the Construction of Means of Egress (Step-17 to 20).

5.5.4. Experts Assessment

The developed guidelines were reviewed and assessed by six Building Code specialists working for Saudi Aramco with substantial working experience between 7 years and 20 years using an assessment questionnaire (Appendix-D). The respondents were asked to evaluate and rate the guidelines as follows:

1. **Clear:** in term of language.
2. **Simple:** effortless to comprehend by the reader.
3. **Consistent:** free from contradictory rational.
4. **Comprehensive :** content covers all cases or scenarios
5. **Methodical:** orderly displays the process followed.

The respondents have five options as follows: strongly agree, agree, disagree, and strongly disagree and no opinion. Each response is weighted on a four points scale and the importance indices for the responses were calculated using equation 1.1 and grouped to reflect the respondent rating as followed (Al-Homoud and Mousa, 2004):

Importance Index Range	Category
$87.5 \leq IE \leq 100$	Excellent
$75.0 \leq IE < 87.5$	Very Good
$62.5 \leq IE < 75.0$	Good
$50.5 < IE < 62.5$	poor
$0.0 \leq IE < 50.5$	Extremely poor

As illustrated in Table 5.1, the results indicated that the guidelines were rated as excellent in term of clarity, simplicity, consistency and methodology and rated as very good in term of comprehensiveness and that due to the limited scope of the guidelines.

Table 5.2: Results of Experts Assessment for the Guidelines

Category	No Answer	Strongly Disagree	Disagree	Agree	Strongly Agree	Importance index	Rating
Clear	-	-	-	2	4	91.66	Excellent
Simple	-	-	-	3	3	87.50	Excellent
Consistence	-	-	-	2	4	91.66	Excellent
Comprehensive	-	-	-	4	2	83.33	Very Good
Methodical	-	-	-	2	4	91.66	Excellent

5.6. CONCLUSION

This chapter presented the recommendations to facilitate the implementation of the Saudi Building Code. These recommendations are developed based on benchmarking with the practice of Saudi Aramco and based on the two assessments carried out by this study.

The recommended plan of actions is divided into short-term and long-term, the short term requirements need to be implemented as soon as possible to overcome existing obstacles and implement the code in shorter time, whereas the long term recommendations will eliminate the long term effects of existing and predicated obstacles.

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Appendix–A

Questionnaire

QUESTIONNAIRE (ENGLISH FORM)

PART-I : RESPONDENT GENERAL INFORMATION

Please answer the following questions by placing a tic (√) on the appropriate answer

1. The organization or the firm you work for is : *(chose only one answer)*

- National Committee of the Saudi Building Code (NCSBC)
- General Administration of Civil Defense (GACD)
- Saudi Council of Engineers (SCE)
- Saudi Standards, Metrology and Quality Organization (SASO)
- Municipality
- Design /Consultant Office

2. Your role in the organization /firm is: *(you may select more than one answer)*

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Owner | Manger | Consultant | Member | Department
Manger |
| <input type="checkbox"/> |
| Project Manger | Architect | Engineer | Code specialist | Other
(specify) |
| <input type="checkbox"/> |
| | | | | |

3. Your experience in the organization /firm is:

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| | | | | More than 20 |
| 1-5 years | 5-10 years | 10-15 years | 15-20 years | years |
| <input type="checkbox"/> |

4. Your experience with Building Code is:

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1-5 years | 5-10 years | 10-15 years | More than 15 years | No experience |
| <input type="checkbox"/> |

PART-II: FACTORS AFFECTING THE IMPLEMENTATION OF THE SAUDI BUILDING CODE:

This section lists many possible factors that may affect the implementation of the Saudi Building Code. You are kindly requested to place a tic (√) in the appropriate box which reflects your opinion

		Extreme effect	Strong effect	Moderate effect	Slight effect	Does not effect
1	The original version of the Saudi code is written in English language					
2	The translation of the English Version of the code to Arabic Version					
3	The type of construction methods specified in the Saudi Building Code					
4	The type of materials and equipments specified in the Saudi Building Code					
5	lack of authorized testing laboratories and agencies to test and certify building products					
6	lack of listed and classified building products in the local market					
7	The Code requirements are subject to different interpretations among the A/E professionals					
8	Mixing of old regulations or other standers requirements with the Saudi Building Code requirements					
9	The code requirements limit the flexibility of buildings architectural design					
10	Implementing the Saudi Building Code increases the project cost					
11	Implementing the Saudi Building Code increases the working load of your office					
12	Lack of a written building inspection policy and procedures by the building authorities					
13	the tendency of using a restrictive implementation policy(violation, fee, stop work orders)					
14	Lack of a violation tracking system.					
15	Lack of continuous Coordination between the building code authorities					
16	Lack of continuous coordination between the design offices and building authorities					
17	Overlapping of responsibilities between building authorities					
18	Lack of A/E Design Offices classification					
19	Lack of specialized training centers in the field of building Codes					
20	Lack of an effective role of insurance companies					
21	The low awareness of the public about the importance of building code					
22	Lack of professionals accreditation programs					
23	Lack of an effective and related on job training for engineers and inspectors					
24	lack of skilled and certified construction laborers					
25	Lack of certified and trained engineers in the field of building code					
26	Lack of certified and trained building inspectors					

PART-III: THE PRACTICE OF A/E DESIGN OFFICES

Please answer the following questions by placing a tic (✓) in the appropriate box

1. The design office years of experience is:

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1-5 | 5-10 | 10-15 | 15-20 | More than
20 |
| <input type="checkbox"/> |

2. The number of engineers in the office is :

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 5-10 | 10-15 | 15-20 | 20-25 | More than
25 |
| <input type="checkbox"/> |

3. The major type of projects the office undertaken are:

- | | | | | |
|--------------------------|--------------------------|----------------------------|--------------------------|--------------------------|
| Architectural | Civil | Electrical /
Mechanical | Industrial | Multiple |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

4. Which one of the following project owners you mostly deal with : (you may select more than one answer)

- Government.
- Private sectors.
- Other (please specify.....)

5. What are the current building code used in your office: (you may select more than one answer)

- The National Fire Protection Association codes (NFPA).
- The International Code Council Codes (Such as IBC, IFC , IMC...etc)
- Civil Defense regulations
- Municipalities Regulations
- Other, (Specify).....

6. Which type of buildings does your office, the project owner, civil defense or municipality consider the most important when dealing with building code: (you may select more than one answer)

- | | |
|---|---|
| <input type="checkbox"/> Commercial | <input type="checkbox"/> Large Storages |
| <input type="checkbox"/> Residential | <input type="checkbox"/> Multistory buildings |
| <input type="checkbox"/> Industrial | <input type="checkbox"/> Public |
| <input type="checkbox"/> other, please specify..... | |

7. How would you rate the level of cooperation between your office and the project owner during design stage to address the safety requirements?

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Very good | Good | Week | Very week | No cooperation |
| <input type="checkbox"/> |

8. How would you rate the level of cooperation between your office and civil defense and municipalities to address safety requirements?

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Very good | Good | Week | Very week | No cooperation |
| <input type="checkbox"/> |

9. Do you have specialized engineer or trained engineer to address the building code and safety regulations during design:

- Yes No

No.	Factors	Always	Sometime	No answer	Rarely	Never
10	Do you charge your client once changes are required by Civil Defense or Municipalities?					
11	Do you review drawings to ensure compliance with current safety regulations before you send it for review?					
12	Does the project owner resist implementing building code requirements once it has cost impact?					
13	Do you analyze the building code requirements at the early stages of the project?					
14	How often the Civil Defense updates your office about its regulations?					
15	How often the Municipality updates your office about its regulations?					
16	Do you suggest additional measures which are not specified in the current building code you use?					
17	Do you face a problem with young Saudi engineers who have no background in building codes?					
18	Do you consider building code experience prior to hiring new engineers?					
19	Does the project owner request changes after the drawings approved by municipality and civil defense? Yes () No () If yes , does your office obtained the approval of the code authority on the changes					
Do you Have any additional Comments						

QUESTIONNAIRE (ARABIC TRANSLATION)

القسم الأول : معلومات عامة

فضلاً أجب عن الأسئلة التالية بوضع علامة (√) للإجابة المناسبة :

١ . الجهة التي تعملون بها هي (يرجى إختيار إجابته واحده):

- اللجنة الوطنية لكود البناء السعودي
 الإدارة العامة للدفاع المدني
 الهيئة السعودية للمهندسين
 الهيئة العربية السعودية للمواصفات والمقاييس
 أمانة مدينة
 مكتب هندسي أو استشاري

٢ . ماهو منصبكم في الجهة التي تعملون بها؟ (يمكن اختيار أكثر من إجابة)

المالك	المدير	استشاري	عضو	رئيس قسم
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
مدير مشروع	معماري	مهندس	مختص في كود البناء	غير ذلك (فضلاً حدد)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
٣ . عدد سنين خبرتك في الجهة التي تعمل بها :				
٥-١	١٠-٥	١٥-١٠	٢٠- ١٥	أكثر من ٢٠ سنة
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
٤ . عدد سنين خبرتك بكود البناء بشكل عام:				
٥-١	١٠-٥	١٥-١٠	١٥ فأكثر	لا يوجد خبره
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

القسم الثاني : العوامل المؤثرة على تطبيق كود البناء السعودي

هذا القسم يحتوي على عدة عوامل من الممكن تأثيرها سلباً على تطبيق كود البناء السعودي. فضلاً قِيم العوامل التالية بوضع علامة (√) أمام الإجابة المناسبة وفقاً لوجهة نظرك :

العوامل المؤثرة على تطبيق الكود		لا يوجد تأثير	تأثير خفيف	تأثير متوسط	تأثير قوي	تأثير قوي جدًا
1	كتابة الكود السعودي باللغة الانجليزية					
2	ترجمة النسخة الانجليزية للكود السعودي للغة العربية					
3	الطرق الإنشائية التي حددها كود البناء السعودي					
4	نوع المواد التي حددها كود البناء السعودي					
5	ندرة الجهات المعنية والمرخصة بإجراء فحص وترخيص مواد البناء					
6	ندرة مواد البناء التي تم اختبارها وترخيصها في سوق مواد البناء المحلي					
7	متطلبات الكود السعودي معرضه لتفسيرات مختلفة بين المهندسين					
8	التوجه إلى الخلط بين الاشتراطات السابقة أو أنظمة بناء أخرى مع متطلبات كود البناء السعودي					
9	كود البناء يحد من حرية التصميم المعماري للمباني					
10	زيادة تكلفة المباني نتيجة تطبيق كود البناء					
11	تطبيق كود البناء سيرفع معدل ساعات العمل في مكتبكم					
12	عدم وجد سياسة وخطوات واضحة ومكتوبة والتي بالاعتماد عليها تتم معاينة المباني طور الإنشاء أو أثناء الاستخدام					
13	التوجه لتطبيق الكود باتباع أساليب تطبيق حازمه (مخالفات، غرامات، إيقاف العمل)					
14	عدم وجود آلية لمتابعة المخالفات أو تعقبها أو أرشفتها					
15	قلة التنسيق الفعال بين الجهات الحكومية ذات العلاقة بتطبيق كود البناء					
16	غياب التنسيق الفعال والمستمر بين المكاتب الهندسية و الجهات الحكومية ذات العلاقة بتطبيق كود البناء					
17	تداخل المسؤوليات بين الجهات الحكومية ذات العلاقة					
18	غياب التصنيف للمكاتب الهندسية					
19	ندرة المراكز المتخصصة في التدريب الهندسي المتعلق بأنظمة البناء					
20	غياب الدور الفعال لقطاع التأمين					
21	قلة الوعي لدى أفراد المجتمع بأهمية كود البناء					
22	غياب التأهيل و الترخيص المهني للمهندسين					
23	غياب التدريب الفعال والمتخصص على رأس العمل للمهندسين والمفتشين					
24	ندرة أعماله ذات الحرفية العالية والمرخصة					
25	ندرة أالمهندسين المدربين والمرخصين في مجال كود البناء					
26	ندرة أالمفتشين المدربين والمرخصين					

الثالث : المكاتب الهندسية

فضلاً ضع علامة (√) أمام الإجابة المناسبة وفقاً لطبيعة عمل مكتبكم الهندسي :

١. عدد سنين خبرة الكتب:				
٥-١	١٠-٥	١٥-١٠	٢٠-١٥	٢٠ فأكثر
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
٢. عدد "المهندسين" في مكتبكم :				
٥-١	١٠-٥	١٥-١٠	٢٠-١٥	٢٠ فأكثر
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
٣. المشاريع التي تصممونها بالعادة هي:				
معماريه	مدنيه	كهربائية/ميكانيكيه	صناعية	مختلفة
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
٤. غالباً المشاريع الذي يصممها أو يشرف عليها مكتبكم تتبع لـ : (يمكن اختيار أكثر من أجا به)				
<input type="checkbox"/> القطاعات الحكومية				
<input type="checkbox"/> القطاع الخاص				
<input type="checkbox"/> أخرى (فضلاً حدد)				
٥. ما هو كود البناء الذي يطبقه مكتبكم حالياً: (يمكن اختيار أكثر من إجابة)				
<input type="checkbox"/> الأنظمة الصادرة من الجمعية " الوطنية الأمريكية" للوقاية من الحرائق "NFPA"				
<input type="checkbox"/> الأنظمة الصادرة من مجلس الكود العالمي أو أحد مؤسسيه مثل UBC ,IBC				
<input type="checkbox"/> لوائح الدفاع المدني				
<input type="checkbox"/> اللوائح الصادره من وزارة الشؤون البلديه والقرويه.				
<input type="checkbox"/> أخرى (فضلاً حدد)				
٦. ماهي المياني التي تولى أهمية اكبر من قبل مكتبكم ، الدفاع المدني، المالك أو البلدية فيما يتعلق بمتطلبات كود البناء: (يمكن اختيار أكثر من إجابة)				
<input type="checkbox"/> التجارية				
<input type="checkbox"/> المخازن				
<input type="checkbox"/> السكنية				
<input type="checkbox"/> متعددة الأدوار				
<input type="checkbox"/> الصناعية				
<input type="checkbox"/> ألعامه				
<input type="checkbox"/> أخرى (فضلاً حدد)				
٧. كيف تقيم مستوى التعاون ومناقشة وجهات النظر مع العميل أثناء التصميم لإدراج متطلبات الكود :				
جيد جداً	جيد	ضعيفة	ضعيفة جداً	لا يوجد تعاون
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
٨. كيف تقيم مستوى التعاون ومناقشة وجهات النظر مع الدفاع المدني والبلدية أثناء التصميم لإدراج متطلبات الكود :				
جيد جداً	جيد	ضعيفة	ضعيفة جداً	لا يوجد تعاون
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
٩. هل يوجد لديكم مهندس مختص أو مدرب لتطبيق متطلبات كود البناء أثناء التصميم؟:				
<input type="checkbox"/> نعم				
<input type="checkbox"/> لا				

أبدأ	نادراً	لا إجابته	أحياناً	دائماً		
					هل يحاسب المكتب تكلفه إضافية على التعديلات التي تطلبها البلدية أو الدفاع المدني في حال عدم مطابقتها للأنظمة المعمول بها	١٠
					هل يقوم المكتب بتدقيق الرسومات الهندسية والتأكد من مطابقتها لأنظمة أسلامه المعمول بها قبل إرسالها للترخيص	١١
					هل يعارض مالك المشروع التقيد بكود البناء خصوصاً تلك التي تزيد عن تكلفة لمشروع	١٢
					هل تقومون باستعراض متطلبات الأنظمة المحلية أو العالمية أولاً قبل البدء في المشروع أو إنشاء المراحل الأولية من التصميم	١٣
					متى يطلعكم الدفاع المدني بالتعديلات أو التحديثات التي تطرأ على لوائحها	١٤
					متى تطلعكم الأمانة أو البلديات بالتعديلات أو التحديثات التي تطرأ على لوائحها	١٥
					هل تقترحون إضافة متطلبات لم يرد ذكرها في الكود الذي تطبقونه حالياً	١٦
					هل يواجه مكتبكم مشكله من عدم إلمام المهندسين السعوديين حديثي التخرج بمتطلبات كود البناء	١٧
					هل تشترطون قبل توظيف أي مهندس إلمامه وخبرته بكود البناء	١٨
					هل يقوم العميل بعمل تعديلات على المخططات بعد اعتمادها من الدفاع المدني او البلدية (قبل الإنشاء)؟ نعم () لا () إذا كانت الإجابة بنعم : فهل يقوم مكتبكم بإعادة اعتمادها من الجهات ذات العلاقة	١٩
هل يوجد لديكم أي تعليق :						
.....						

Appendix –B

Recommended Guidelines for Fire Protection Requirements

The Saudi Building Code Designer Guidelines ©

By: Ali A. Al-Mudhei

Preface

This document was prepared as partial requirement of master thesis presented to the Architectural Engineering Department at King Fahad University of Petroleum and Minerals in May 2009.

This document must be read in conjunction with the Saudi Building Code. It provides only a simplified approach of interpreting a specific code requirements as defined in its scope and shall not be used in whole or in portion to replace the original requirements of the building code, the author accept no liability for any misuse or misunderstanding of the scope or content of this document.

This document was prepared based on the draft edition of the Saudi Building Code issued in 2007 and the International Code Council publications and as referenced in the scope of this document.

I would like to thank my master thesis committee for their advices and valuable contribution and vision. I am grateful to Saudi Aramco and King Fahad University of Petroleum and Minerals for providing me with necessary resources and knowledge to prepare this document.

Introduction:

The scope of this document explains the major fire protection requirements addressed in the Saudi Building Code Volume # 801 and required by the designer to establish an effective code analysis during the design stage. This document does not cover all the requirements addressed in the Saudi Building Code. It consists of three Chapters as follows:

Chapter-1: Basic Code Requirements

Chapter-2: Fire Resistance-Rated Construction.

Chapter-3: Mean of Egress

Each chapter contains step-by-step guidelines to achieve the major code requirements, exceptions and other code requirements shall be obtained from the original code volume.

CHAPTER ONE

BASIC CODE REQUIREMENTS

This chapter provides fundamentals steps in which the building code requirements can be easily navigated and incorporated during the design stage. This chapter is divided into three sections where each section addresses an important issue of the code. A/E professional needs to conduct the following fundamental steps before navigating through the code.

Step One: Occupancy Classification

Step Two: Type of Construction material

Step Three: Building area and height Adjustment

SECTION ONE: OCCUPANCY CLASSIFICATION

The building code classifies a building based on the intended use (occupancy) into ten groups and some groups are subdivided into subgroups. The occupancy is classified into different types based on the function of the building, occupant nature and number of occupants. The code requirements can't be addressed or applied smoothly without classifying the building.

Step-1: Classify the Occupancy

A- Specified Building Occupancy:

Step-1.1:

Classify the building occupancy into one of the following groups which been specified in the code.

- **Assembly** , (A1, A2,A3,A4,A5)
- **Business** , (B)
- **Educational**, (E)
- **Factory** , (F1, F2)
- **High-Hazard**, (H1, H2,H3,H4,H5)
- **Institutional** , (I1, I2, I3,I4)
- **Mercantile** , (M)
- **Residential** , (R1,R2,R3,R4)
- **Storages**, (S1,S2)
- **Utility and Miscellaneous** , Group U

B. Unspecified Building Occupancy:

Step-1.2:

If the building is not specified in the code, then classify the building into a group that most nearly resembles.

Step-2: Determine the Level of Occupancy

The building occupancy need to be categorized under one of the following types:

A. Building with One

Occupancy:

Step-2.1A

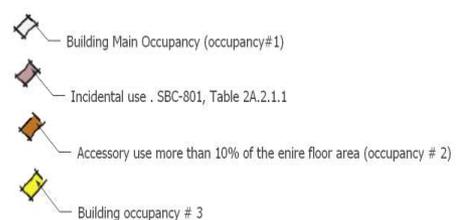
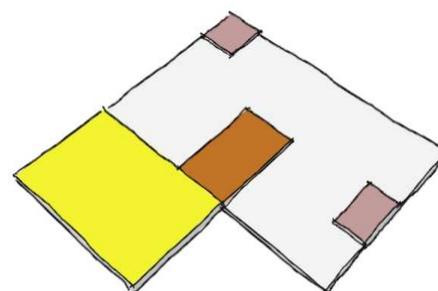
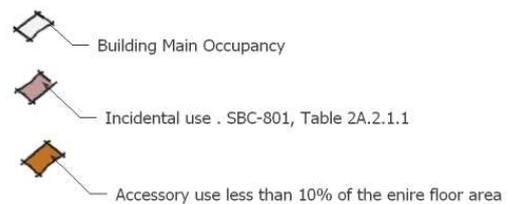
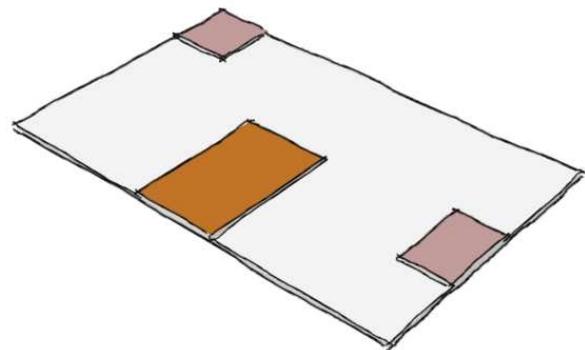
Check if the entire building is used only for one occupancy

Step-2.2A

Ensure that the aggregate area of accessory spaces is equal to or less than 10 % of the total floor area, otherwise categorize it as Building with Mixed occupancy

Step-2.3A

Classify the building as single occupancy and implement the code requirements accordingly.



B. Building with Mixed Occupancy:**Step-2.1B**

Check if the entire building is used for two or more occupancy.

Step-2.2B

Ensure that the aggregate area of each occupancy and the aggregate area of all accessory spaces are more than 10 % of the total floor area of building, otherwise categorize it as Building with one occupancy.

Step-2.3B

Select one of the following approaches:

1. Don't separate the occupancies or accessory spaces from each other by fire barrier, provided that the most restrictive type of construction and fire protection systems of any occupancy applied to the entire building, or
2. Separate the occupancy from each other by fire barriers and apply the code requirements for each occupancy individually.

Step-3: Check for Special Occupancy Requirements

The building might contain or have special use occupancy which requires a special code requirements if any of the following conditions arise:

1. High-rise (23m above the grade level accessed by fire department truck).
2. Atrium.
3. Covered Mall (one building enclosed a number of tenants).
4. Underground building (building has an occupied floor 9.2 m below the exit discharge).

5. Motor-Vehicle related occupancies
6. High rack storage.
7. High Hazard Occupancies

SECTION TWO: TYPE OF CONSTRUCTION

The type of construction is determined by the construction elements combustibility and fire proofing characteristics. The structural elements that are considered in classifying the type of constructions are:

1. Structural frame (Columns, beams, girders, trusses and spandrels having direct connection to the columns, and bracing designed to carry the gravity load).
2. Interior and exterior bearing walls (walls that carry load).
3. Interior and exterior Non-bearing walls
4. Floor construction
5. Roof construction.

Step-1: Classify the Type of Construction

The type of construction is classified based on the combustibility of the construction materials in one or more of the following types:

- **Type I and Type II:** All structural elements are noncombustible materials or have limited combustible materials as allowed in SBC-801, Section 4A.3.1.
- **Type III:** Mixed of non combustible materials on the exterior envelope and combustible construction for interior construction.

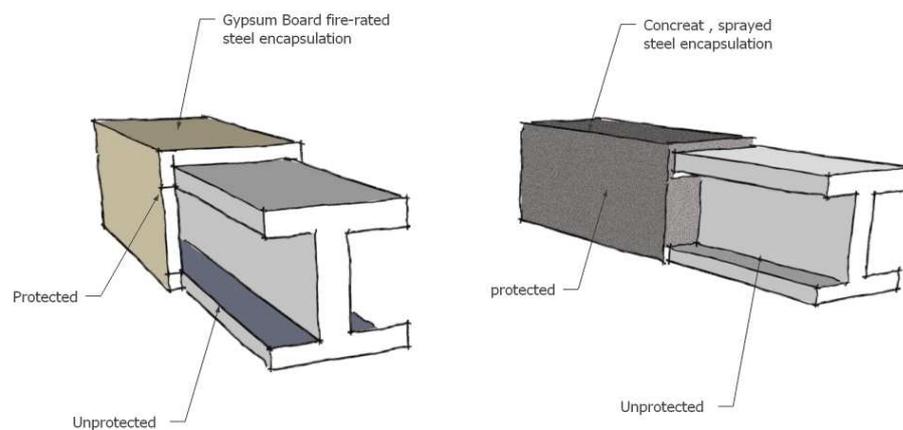
- **Type IV:** Heavy Timber structural members, wood floor decking inside noncombustible exterior walls.
- **Type V:** combustible materials, basically wood structural frame.

The building code categorized these five types of construction based on the fire resistivity of the construction elements as listed below:

- Type-IA : 3 hour fire resistive construction.
- Type-IB : 2 hour fire resistive construction.
- Type-IIA : 1 hour fire resistive construction.
- Type-IIB : not fire resistive.
- Type III, IV and V

Step-2: Determinant if the Fire Proofing of the Construction Elements is required.

The construction elements of a building are required to be protected to increase its fire resistivity and avoid building collapse during fire.



The building code requires a fire proofing of structural elements only in the following cases:

Case-1: if the building is classified as one of the following special occupancy:

- a. High rise building.
- b. Airport control tower with a height of more than 25.9 m in type I and II and of more than 19.8 m in type III.
- c. Underground buildings.

Case-2: The exterior wall need to be protected if the distance between the exterior walls and other building , lot line, centerline of street and public way is less than or equal to 9.1 m.

Case-3: if the basic building area exceeded the tabulated allowable floor area, Table 1.1 (SBC-801, Table 3.3), plus the allowable increase for non fire resistive type of construction.

SECTION THREE: BUILDING AREA AND HEIGHT

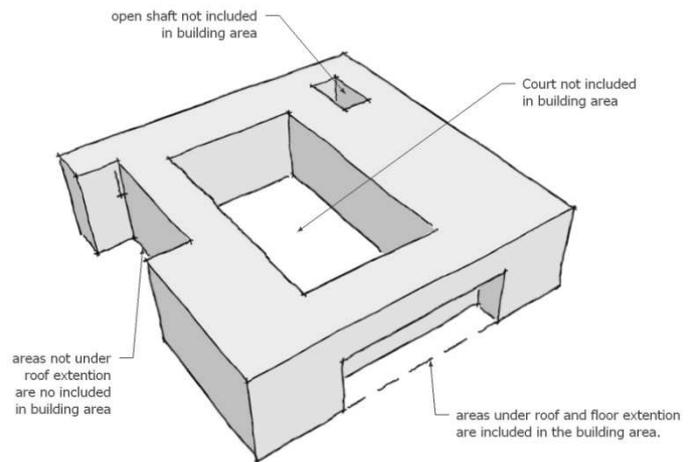
The third basic code requirement is to check the building area and height against a predetermined value.

STEP- 1: Calculate the Building Area and Height

The building floor area shall include the entire area of the building surrounded by exterior walls or fire walls or located under the projection of roof or floor above. There are special cases that are not included in the aggregate building area, height or numbers of stories, these cases are:

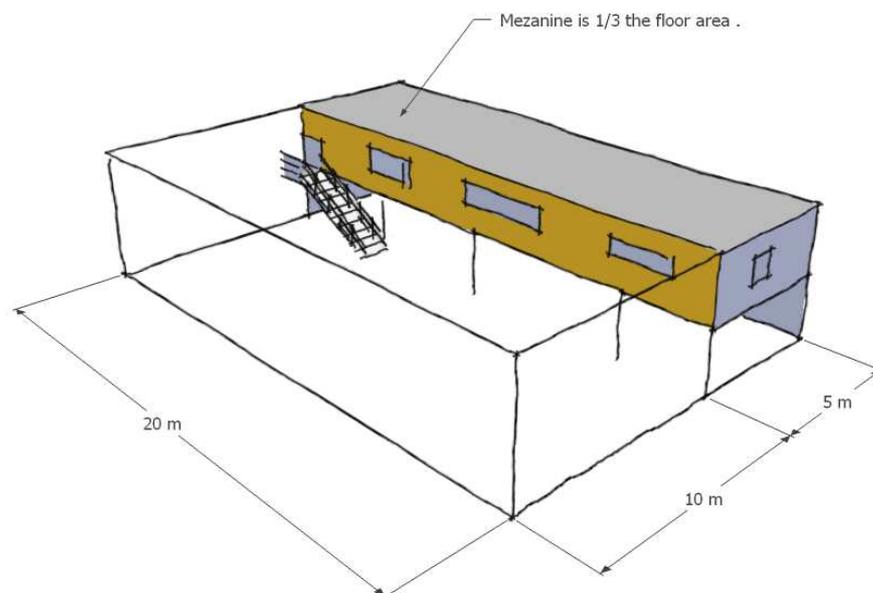
1. Open Shafts and Courts:

Courts: The area of open shafts and courts shall not be calculated as part of the building area.

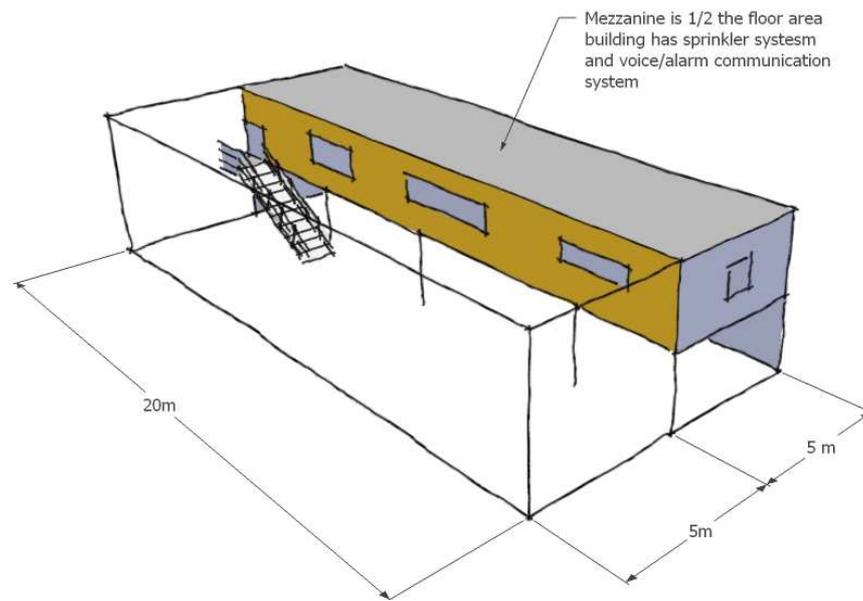


2. Mezzanine: The floor area of the intermediate level between the floor and ceiling of any story is not included in calculating the building area if the aggregate area of the mezzanines meet any of the following cases:

- I. **Case one:** if the area of the mezzanine is one-third or less of the floor area of the room or space in which they are located.

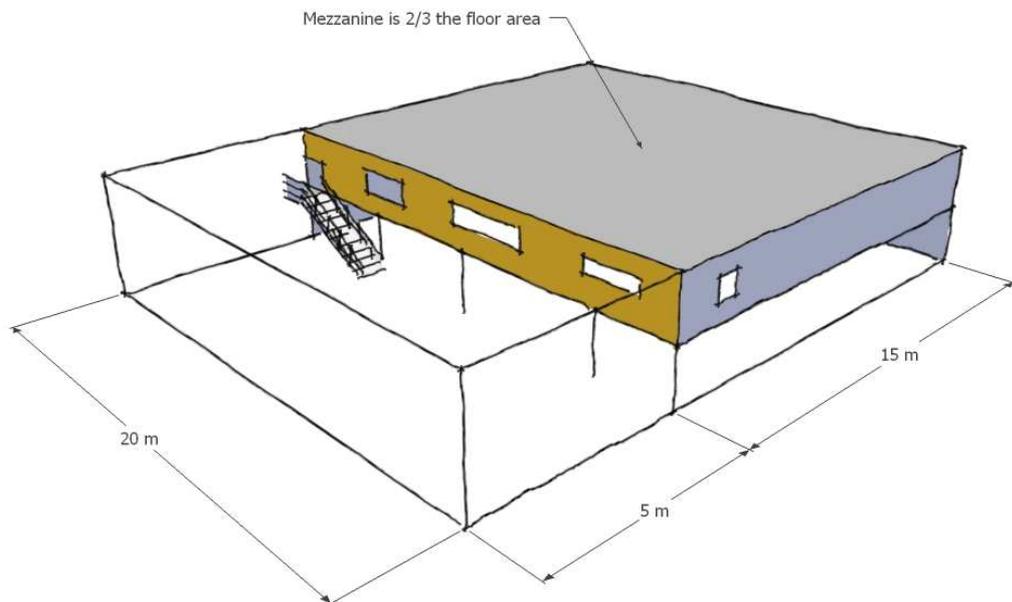


- II. **Case two:** if the mezzanine floor area is **half** of the floor area in which it is located and the building is equipped with sprinkler system and voice/alarm communication system.



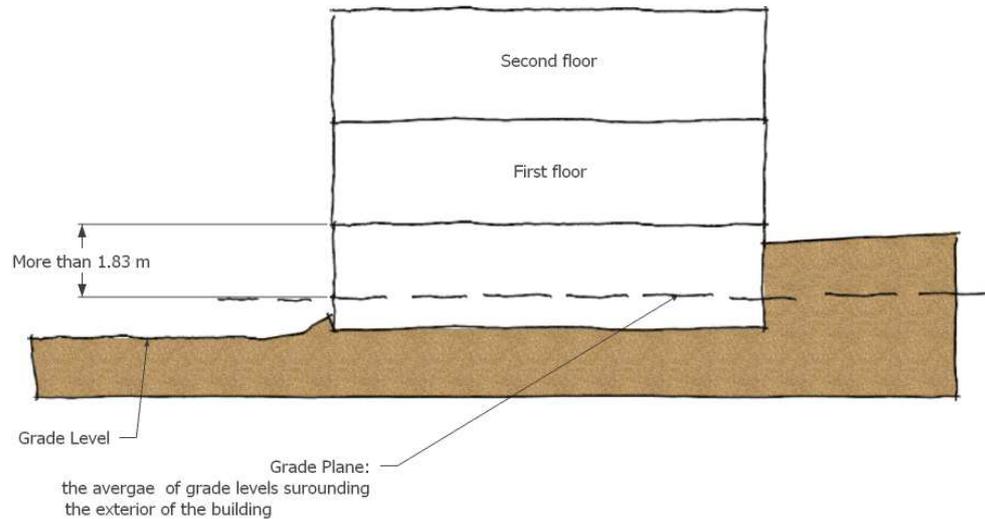
- III. **Case three:** if the mezzanine floor area is two third or less of the floor in which it is located and located in any facility designed to house low-hazard industrial processes that require large areas and unusual heights to accommodate crane ways or special machinery and equipment including, among others, rolling mills, structural metal fabrication shops and foundries, or the production and distribution of electric, gas or steam power.

- 3. Basement:** the part of the building that partially or completely below the average of the finished ground level adjoining the building at exterior walls shall not be considered a story and shall not contribute to the building number of stories or area limitation. The basement is considered a story and contribute to the number of stories and area

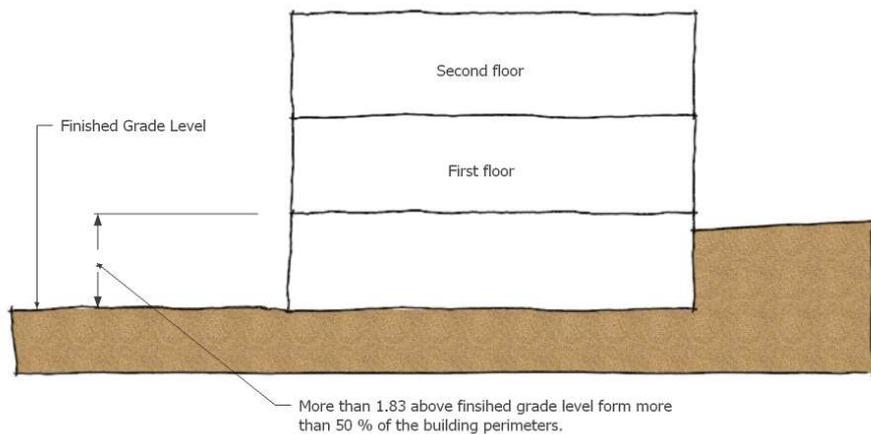


limitation of a building only if one of the following cases is arise:

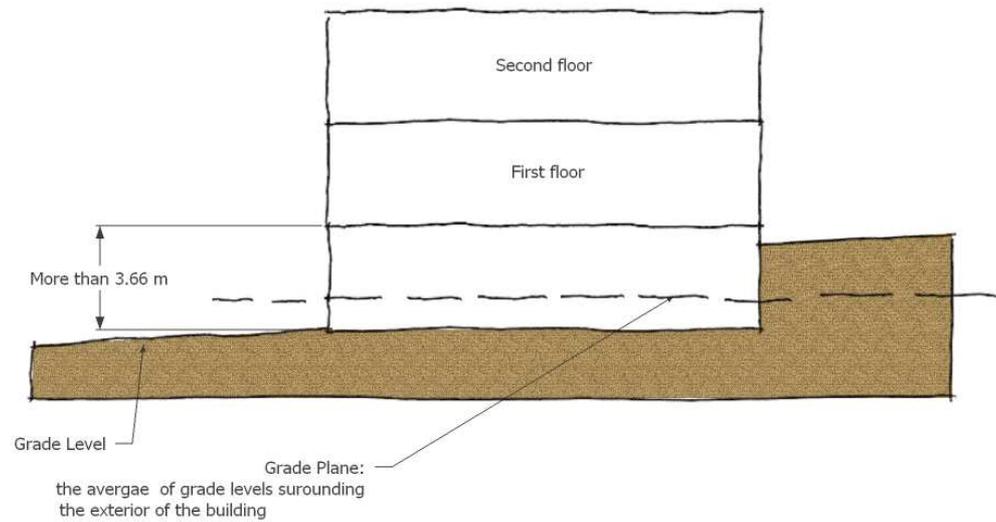
- I. **Case one:** If the finished floor of the floor above the basement floor is 1.83 m above the grade plane (average of the grade level around the building measured at 1.83 m of the exterior walls).



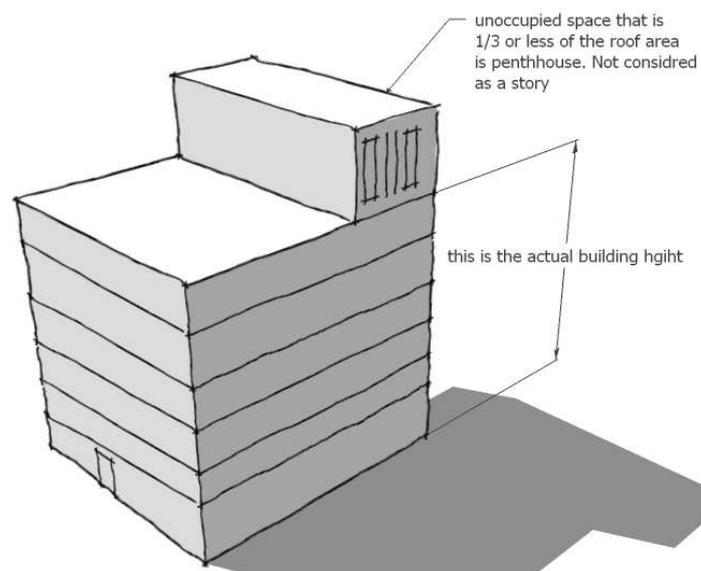
- II. **Case Two:** If the finished floor of the floor above the basement floor is 1.83 m above the finished grade for more than 50 % of the building exterior parameters.



- III. **Case Three:** If the finished floor of the floor above the basement floor is 3.66 m above the finished grade level.



- 4. Penthouse:** the unoccupied and enclosed structure above the roof of the building other than a tank, tower, spire and dome with an aggregate area of note more than one-third of the roof area does not contribute to the building height or floor area limitation.



STEP- 2: Check if the Calculated Building Area and Height is equal to or less Than the Basic Allowable Area and Height.

Step-2.1

Check if the calculated building area, height and number of stories is equal to or less than the tabulated allowable floor area, height and number of stories for the building type of construction and occupancy classification as highlighted in Table 1.1 below (*Refer Also to SBC-801, Table 3.3*).

Table 1.1: Allowable Height and Building Area

Height (m)	Type I				Type II			
	A		B		A		B	
	UL		49		19.8		16.8	
Occupancy	Area (m ²)	Story						
A1	UL	UL	UL	5	4,724	3	2,591	2
A2 , A3 , A4	UL	UL	UL	11	4,724	3	2,896	2
A5	UL	UL	UL	UL	UL	UL	UL	UL
B	UL	UL	UL	11	11,430	5	7,010	4
E	UL	UL	UL	5	8,077	3	4,420	2
F-1	UL	UL	UL	11	7,620	4	4,724	2
F-2	UL	UL	UL	11	11,278	5	7,010	3
H-1	6,401	1	5,029	1	3,353	1	2,134	1
H-2	6,401	UL	5,029	3	3,353	2	2,134	1
H-3	UL	UL	18,288	6	8,077	4	4,267	2
H-4	UL	UL	UL	7	11,430	5	5,334	3
H-5	UL	3	UL	3	11,430	3	7,010	3
I-1	UL	UL	16,769	9	5,791	4	3,048	3
I-2, I-3	UL	UL	UL	4	4,572	2	3,353	1
I-4	UL	UL	18,440	5	8,077	3	3,962	2
M	UL	UL	UL	11	6,553	4	3,810	4
R-1, R-2, R-4	UL	UL	UL	11	7,315	4	4,877	4
R-3	UL	UL	UL		UL	4	UL	4
S-1	UL	UL	14,630	11	7,925	4	5,334	3
S-2	UL	UL	24,097	11	11,887	5	7,925	4
U	UL	UL	10,820	5	5,791	4	2,591	2

UL : Unlimited

Important Notes for Table 1.1:

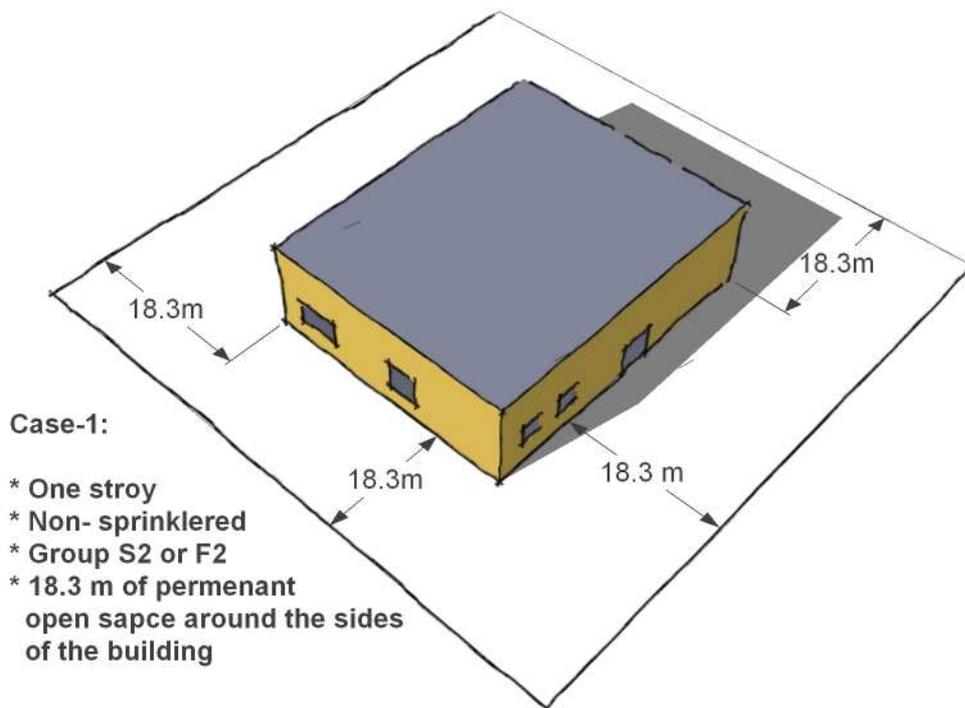
1. The maximum allowable area in the Table is per floor for up to two stories. However, if the Table allows more than two floors, then the maximum area for the building shall not exceed three times the allowable area per floor unless the building is sprinkled
2. For other types of constructions (which are rarely used in Saudi Arabia) refer to SBC-801, Table 3.3.
3. The height in stories and meters are measured above the grade plane.

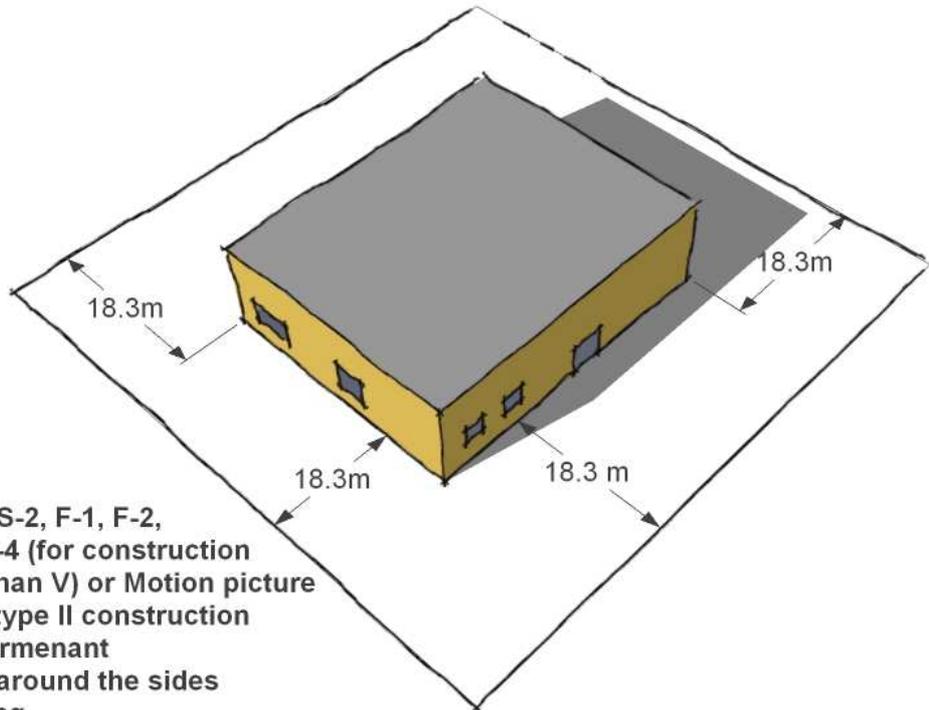
Step-2.2

If the area, height or number of stories is equal to or less than the value indicated in Table 1.1 for the selected type of construction, assume IIB, and the occupancy classification, then no need to modify the basic allowable area or height. The building area and height is within the accepted value.

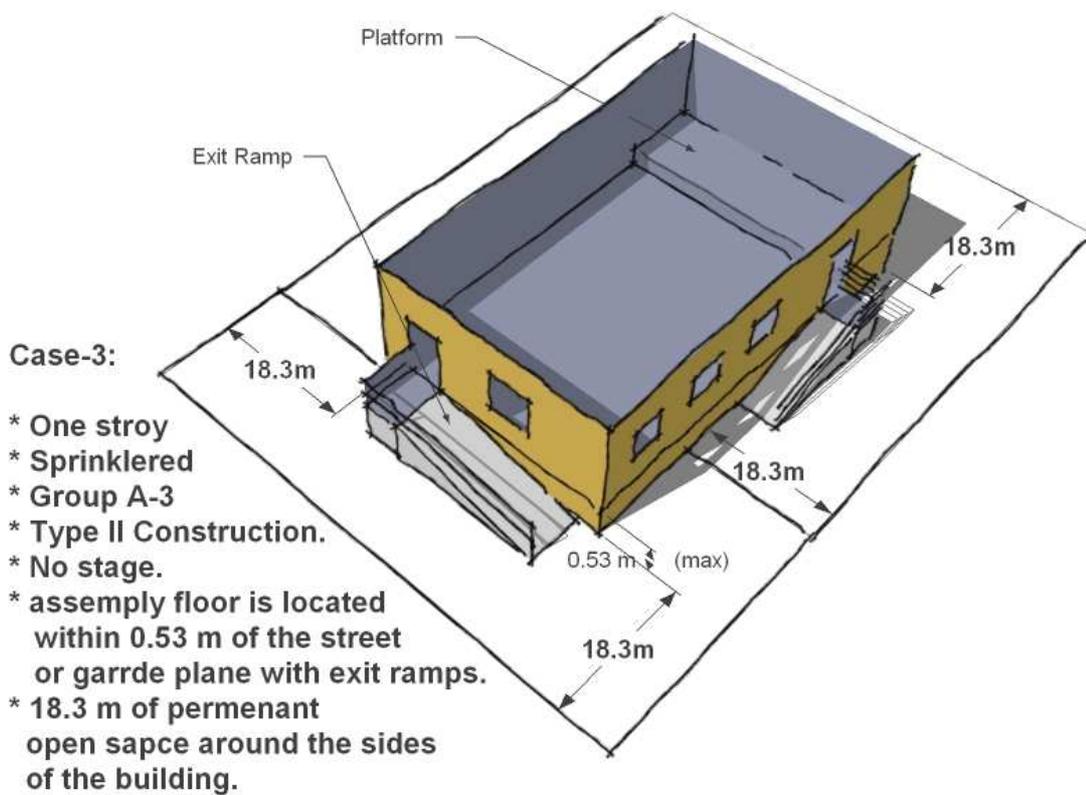
Step-2.3

Check if the building area is allowed to be unlimited if any of the following cases arise:

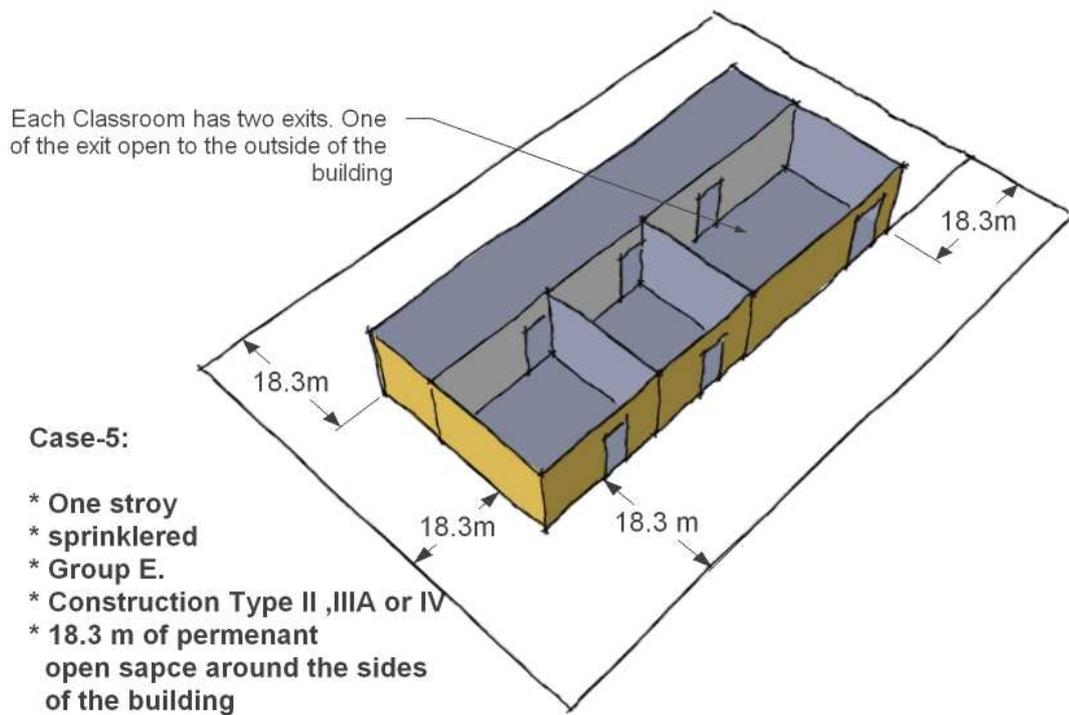
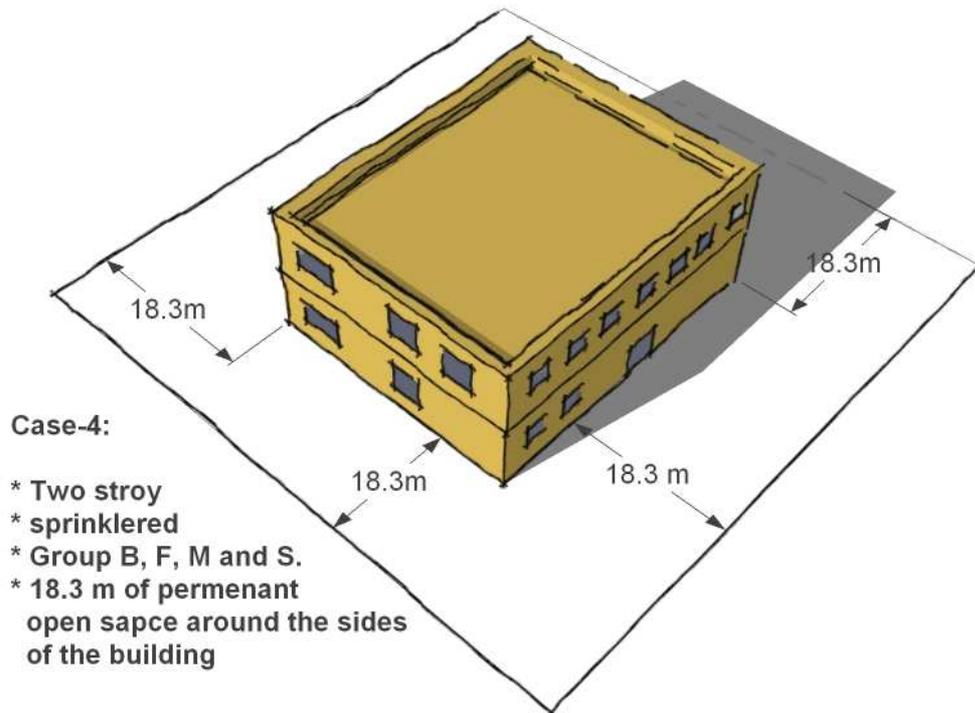


**Case-2:**

- * One story
- * Sprinklered
- * Group S-1 , S-2, F-1, F-2, M , B and A-4 (for construction type other than V) or Motion picture theaters of type II construction
- * 18.3 m of permanent open space around the sides of the building

**Case-3:**

- * One story
- * Sprinklered
- * Group A-3
- * Type II Construction.
- * No stage.
- * assembly floor is located within 0.53 m of the street or garage plane with exit ramps.
- * 18.3 m of permanent open space around the sides of the building.



Important Exceptions: The code allows for a reduction in the width of the surrounding spaces for up to 12.2m instead of 18.3 m only for 75% of the exterior parameter of the building provided that the walls and opening faced the reduced space have 3 hour fire-resistive rating.

STEP-2.4

If the building area is allowed to be unlimited because any of the above mentioned cases, there is no need to adjust the basic allowable building area or height for the selected type of construction and occupancy classification.

STEP- 3: Adjust the Basic Building Area or Height if it exceeds the Basic Allowable Value

If the basic allowable building area or height exceeds the value determined in step-2 and the building does not meet any of the exceptions described in step-2 for unlimited buildings, then one of the following approaches shall be follows:

I. First Approach: Sprinkler System Increase (SBC-801,Section 3.6.3)

A.) Area Increase:

The basic allowable building area can be increased if a sprinkler system is provided in the building unless the sprinkler system was initially provided to substitute fire proofing structural elements. Also, this approach can't be followed for building classified as group-H occupancy. Consequently, the maximum allowable area increase needs to be calculated as follow:

Area Increase due to sprinkler system:

$$A_a = A_t + (A_t \times I_s)$$

Where:

A_a = Allowable building area

A_t = the tabulated floor area Table 1.1 (SBC-801, Table 3.3)

I_s = sprinkler systems increase factor (2 for two story and more) (3 for one story)

Example

What is the basic allowable building area and height for one story building of Group A1 occupancy and type IIB construction?

Solution:

From: Table 1.1, (SBC-801-Table 3.3)

Max Building Area = 2,591, the number of story = 2, the height in meter = 16.8 m.

Providing the sprinkler system will increase these basic values to be as following:

Building Area

$$A_A = A_t + (A_t \times I_s)$$

$$A_A = 2,591 + (2,591 \times 3)$$

$$A_A = 10364 \text{ m}^2$$

B.) Height and Number of Stories:

Similarly, the basic allowable number of stories and height of the building is allowed to be increased by one story and the height in meters is allowed to be increased by 6.1 m. except for the following:

- Group I-2 in other than type-1 and IIA construction.

- Group H-1, H-2, H-3, H-5.
- If the sprinkler system is provided to reduce the required fire proofing of structural elements.
- Group- R is limited to 4 stories and 18.2m

II. **Second Approach: Frontage Increase (SBC-801, Section 3.6)**

The basic allowable building area is permitted to be increased if the building is surrounded by open accessible space of not less than 6.1 wide of at least 25 % of the exterior parameters of the building. Consequently, the maximum allowable area increase needs to be calculated as follows:

Increase due to Frontage

$$A_a = A_t + (A_t \times I_f)$$

Where:

A_a = Allowable building area

A_t = the tabulated floor area Table 1.1 (SBC-801, Table 3.3)

I_f = area increase due to frontage

$$I_f = (F/P - 0.25) \times (W/9.144)$$

Where:

F = Exterior parameters fronts on public or open space of not less than 6.1 m

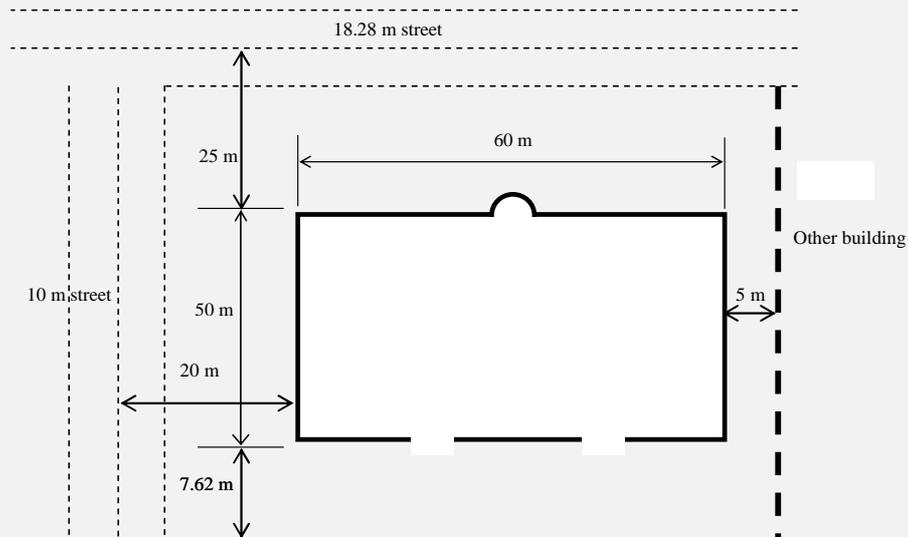
P = the entire building parameters

W = the average width of open spaces surrounding the building, where $w/9.144$ shall not exceed 1 unless it is used for an unlimited building area

Example

Calculate the allowable frontage increasing for one story mosque building of Group

A3 occupancy and type **IIB** construction as indicated in the diagram below?

**Solution:****Step-1:**

Exterior parameters

$$P = (60+50+60+50) = 220\text{m}$$

Step-2:

Exterior parameters open to open space of 6.1 m or more

$$F = (60 + 50 + 60) = 170 \text{ m.}$$

Parameters open to public and open spaces more than 6.1 m is 170 m which is 77.3 % of the parameters (more than 25%).

Step-3:

Weighted average value of exterior parameters facing open space of 6.1 m ore more is:

- (A)Parameters fronts on open space of 9.144 or more = 110 m
- (B)Parameters fronts on open space of 6.1 to 9.144= 60 m

$$W = \frac{((9.144 * A) + (7.62 * B))}{F}$$

$$W = \frac{(9.144 \times 110) + (7.62 \times 60)}{170} = 8.6$$

Step-4 :

$$I_f = (F/P - 0.25) \times (W/9.144)$$

$$I_f = (170/220 - 0.25) \times (8.6/9.144)$$

$$I_f = 0.72$$

Step-6 :

$$A_a = A_t + (A_t \times I_f)$$

$$A_a = 7,896 + (7,896 \times 0.72)$$

$$A_a = 4,981.12 \text{ m}$$

Increase for sprinkler systems and frontage is permitted to be combined using the following equation

$$A_a = \{A_t + (A_t \times I_s) + (A_t \times I_f)\}$$

If sprinkler system is provided then

$$A_a = A_t + (A_t \times I_f) + (A_t \times I_s) ,$$

$A_t \times I_s$ obtained as discussed in approach one above.

III. Third Approach: Upgrade the Type of Construction

The basic allowable building area and height can be increased if the construction type is upgraded.

Example:


Type –IA: Three Hour fire resistive	Type –IB: Two Hour fire resistive	Type –IIA: One Hour fire resistive	Type –IIB: Not fire resistive
Height: Unlimited Story: Unlimited Area: Unlimited	Height: 49 m Story: 5 Area: Unlimited	Height: 19.8 m Story: 3 Area: 4,724 m ²	Height: 16.8 m Story: 2 Area: 2,591 m ²

Table 1.1: Allowable Height and Building Area

	Type I				Type II			
	A		B		A		B	
Height (m)	UL		49		19.8		16.8	
Occupancy	Area (m ²)	Story						
A1	UL	UL	UL	5	4,724	3	2,591	2
A2 , A3 , A4	UL	UL	UL	11	4,724	3	2,896	2
A5	UL	UL	UL	UL	UL	UL	UL	UL
B	UL	UL	UL	11	11,430	5	7,010	4
E	UL	UL	UL	5	8,077	3	4,420	2

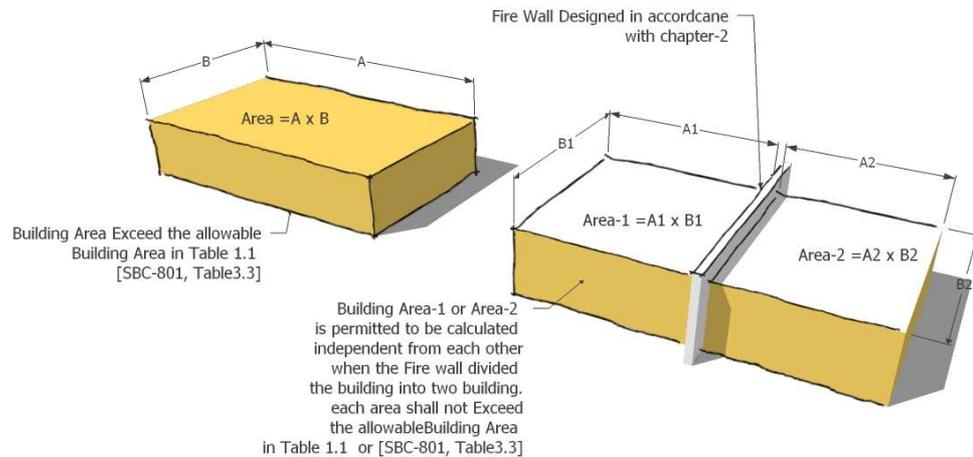
Important Note: Always assume the type of construction as IIB for new designs because it is less expensive and may be upgraded if needed in accordance to the following sequence

IIB → IB → IIA → IA

This assumption is not valid for special occupancies that require specific type of construction such as high rise buildings and malls

IV. Fourth Approach: Fire Wall

The basic allowable building area can be increased by dividing total building area into smaller areas using fire walls that are constructed in accordance with prescribed steps in chapter two:



In this case, the building area and height for each portion of the building separated by the fire wall was calculated independently and considered as separate buildings.

Important note: There is a difference between fire-wall and fire barrier. Fire barriers do not qualify the building to be considered as two independent buildings but fire walls do. Refer to chapter two to understand the difference between the two types of walls.

Step- 4: Separated Mixed Occupancy Allowable Area and height Adjustment

The basic allowable building area and height needs to be calculated for each individual occupancy. If the building is classified as mixed occupancy and separated from each other by fire barrier as discussed in chapter two, the following steps should be implanted.

Step-4.1

Calculate the building area for each building occupancy individually as indicated in step-1.

Step-4.2

Adjust the basic allowable floor area for each occupancy using step -3 for each occupancy individually.

Step-4.3

Calculates the ratio of adjusted floor area to the allowable tabulated area using the following equation:

$$A_a = \frac{A_{d1}}{A_{t1}} + \frac{A_{d2}}{A_{t2}} + \frac{A_{dn}}{A_{tn}} \leq 1$$

Where

A_a = Allowable floor area

A_{tn} = Tabulated floor area for building occupancy 1, 2, 3....n.

A_{dn} = Adjusted floor area for building occupancy 1, 2, 3....n.

Step-4.4

Determine the allowable height for each occupancy as described in step-3.

STEP- 5: Calculate the Occupant Load

The number of building occupants is an important criteria in order to address the code requirements properly.

Important Note: Do not use the actual or the anticipated number of occupants, unless the actual occupant load is more than the calculated.

Unlike the Saudi Building Code, the 2006 version of International Building Code allow the use of the actual occupants load once permitted by building authority.

STEP-5.1

Determine the proper occupant load factor from SBC-801, Table 8.4.1.2.

- Note-1: Some occupant load factors are associated with the net area and others are associated with gross area.
- Note-2: When the Table does not indicate the factor for intended use, then the most nearly resemble may be used.
- **Net Area:** The actual occupied area not including unoccupied accessory spaces such as corridors, stairways, toilet rooms, mechanical rooms and closets.
- **Gross Area:** The entire area surrounded by the exterior walls excluding vent shafts and courts.

STEP-5.2

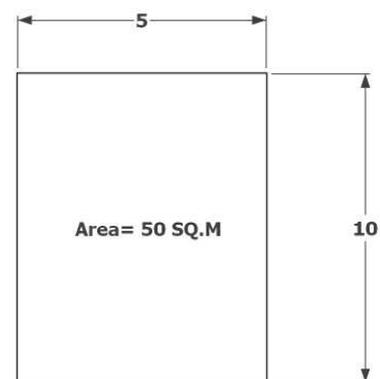
Divide the area of the space or spaces by the selected occupant load factor as follow:

$$OL = A / OLF$$

OL = Occupant Load

A = Gross or net area

OLF= Occupant load factor (SBC-801, Table 8.4.1.2)



Class Room Without Fixed Seats

$$OL = A / OLF$$

$$OL = 50 / 1.86$$

$$OL = 27 \text{ persons}$$

Exceptions:

- Occupant load for spaces with fixed seats shall be calculated as follow:

$$OL = NS + (A / OLF)$$

OL = Occupant Load

NS= Number of Fixed Seats

A = Gross or net area that not have fixed seats but intended for additional non fixed seats

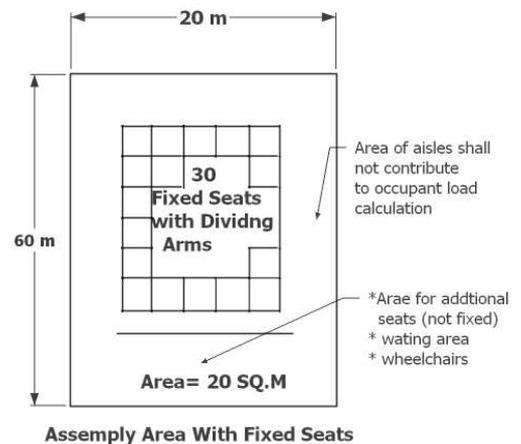
OLF= Occupant load factor (SBC-801, Table 8.4.1.2)

- Occupant load for mall building shall be calculated as follow:

$$OLF = ((0.00007) (GLA) + 25) \times 0.0929$$

Where;

GLA: Gross Leasable Area in square fee



$$OL = NS + [A / OLF]$$

$$OL = 30 + [20 / 0.65]$$

$$OL = 30 + 30$$

$$OL = 60 \text{ persons}$$

CHAPTER TWO

FIRE-RESISTANCE-RATED CONSTRUCTION

This chapter provides guidelines for the fire resistivity requirements for construction elements

1. Structural members (columns, beams, guarders)
2. Exterior walls.
3. Interior walls
4. Horizontal slabs (floor, roof).

These guidelines describe fire resistivity requirements with illustrations of construction methods, opening and penetrations protection. Accordingly, this chapter is divided into four sections:

1. Section one : Structural Members fire resistance.
2. Section two : Exterior Walls fire Resistance.
3. Section three : Interior walls fire Resistance.
4. Section four : Openings Protection.

SECTION ONE: STRUCTURAL MEMBERS

Structural Members includes the following:

- Columns
- Beams
- Girders
- Trusses
- Spandrels have direct connection with columns
- Bracing elements.

Step-1: Determine if the Structural Members are required to be Fire-Resistive or not.

The structural members are required to be fire resistive only in the following two cases:

1. If the type of construction is determined to be fire resistive as described in chapter one of this guidelines
2. If the structural members located within a required fire resistive elements such as walls or slab.

Step-2: Select the Proper Fire-Rating per hour from SBC-801 Table 4A.1.

Based on the building type of construction, determine the required rating for each structural member.

Step-3: Determine the Required Thickness for the Fire Proofing Material to achieve the Required Fire Resistance.

There are two methods which can be used to determine the required thickness of the fire proofing materials as follows:

1. **Prescriptive Fire Resistance:** Many example of the required thickness of fire-resistance materials is listed in Tables , Refer to SBC-801, Section 4b.20 & Table 4b.20.1(1)

2. **Calculated Fire Resistance:** Different procedures are listed in the code by which the thickness of the protective covers is established by calculation. Refer to SBC-801, as follows:
 - a. For concrete assemblies refer to Section 4B.21.2.
 - b. For concrete masonry refer to Section 4B.21.3.
 - c. For clay brick and tile masonry refer to Section 4b.21.4
 - d. For steel assembly refer to section 4B.21.5.

SECTION TWO: EXTERIOR WALLS

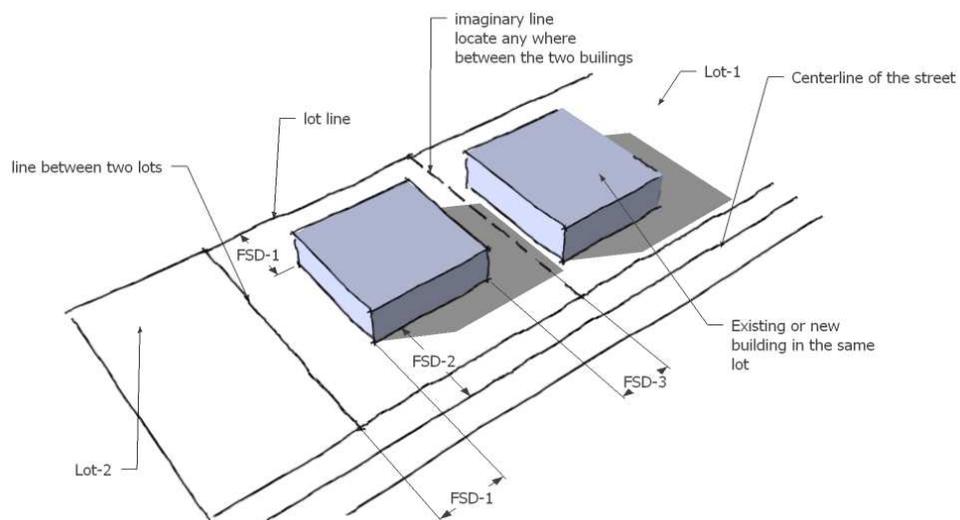
Step-1: Determine if Exterior Walls are required to be Fire-Resistive or Not

The fire resistance of exterior walls aims to protect the spread of fire from one building to another building or from one story to another story in the same building.

Step-1.1

Calculate the distance from the building exterior walls to all of the following lines as applicable:

1. Lot line(s).
2. Centerline of the street, alley or public way.
3. Imaginary line between the building and other building/s in the same lot.



Step-1.2

If the calculated distance in previous step is less than or equal 9.1 m, then fire-resistance is required based on the following step.

Step-2: Select the Proper Fire-Rating in Hour from SBC-801, Table 4a.2.

Table -2.1 : Exterior walls fire-rating in hours (based on SBC-801, Table 4A.2 and 4A.1)

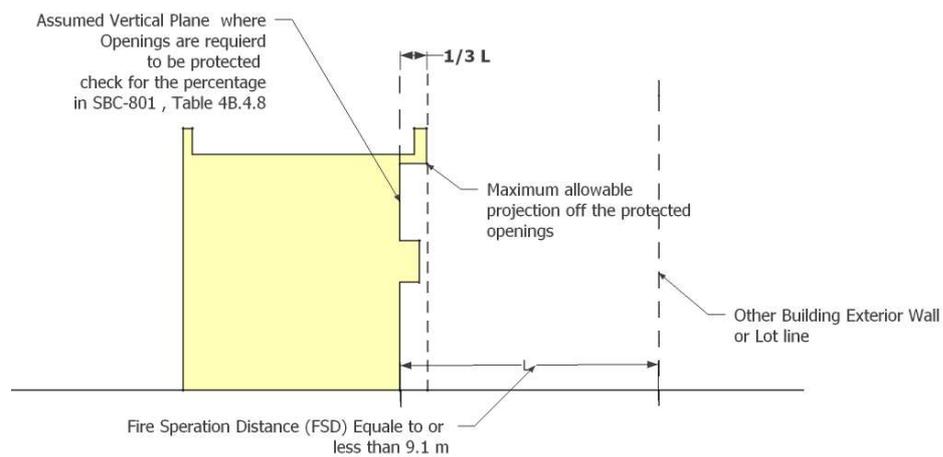
	Fire separation distance (FSD)	Occupancy classification	Type of Construction				
			IA	IB	IIA	IIB	
Exterior Bearing walls	< 1.5 m	H	3	3	3	3	
		F1, M, S1	3	2	2	2	
		others	3	2	1	1	
	≤1.5 < 3.1	H	3	2	2	2	
		F1, M, S1	3	2	1	1	
		others	3	2	1	1	
	≤3.1 <9.1	H	3	2	1	1	
		F1, M, S1	3	2	1	0	
		others	3	2	1	0	
	≥ 9.1	All	3	2	1	0	
	Exterior Non-bearing wall	< 1.5 m	H	3	3	3	3
			F1, M, S1	2	2	2	2
others			1	1	1	1	
≤1.5 < 3.1		H	3	2	2	2	
		F1, M, S1	2	1	1	1	
		others	1	1	1	1	
≤3.1 <9.1		H	2	2	1	1	
		F1, M, S1	1	1	1	0	
		others	1	1	1	0	
≥ 9.1		All	0	0	0	0	

Step-3: Construct the Wall According to SBC-801, Section 4b.5

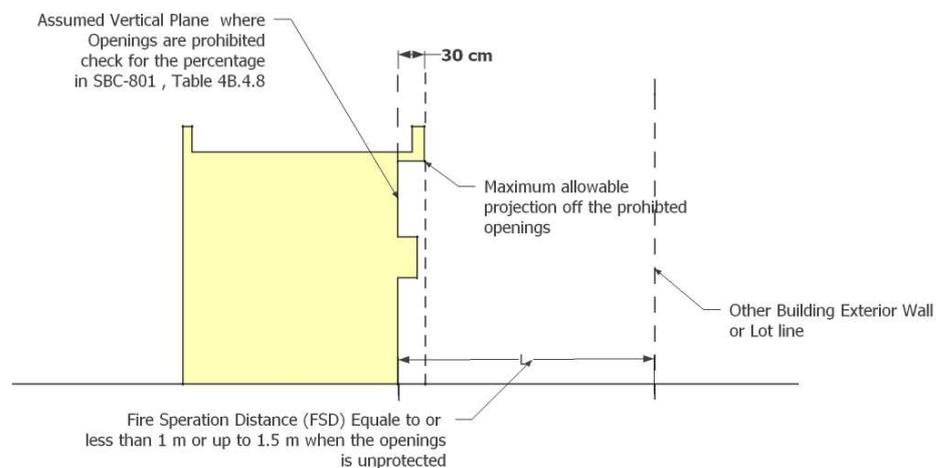
Step-3.1

Ensure that the projection extended from the building exterior walls meet the restrictions highlighted in (SBC-801, Section 4b.4.2) as follows:

- Case-1



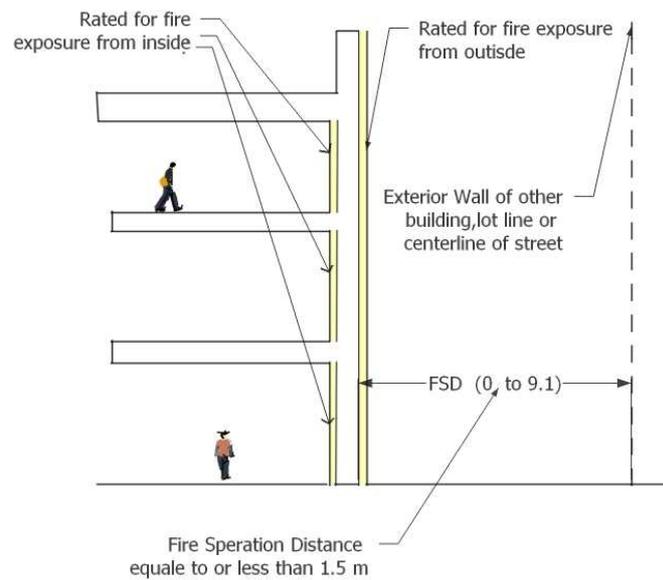
- Case-2



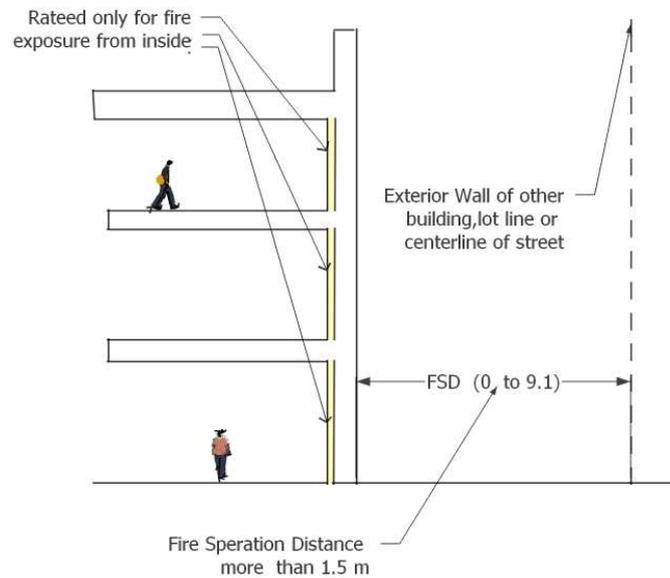
Step-3.2

Design the wall rating for fire exposure as heighted in SBC-801, Section 4B.4.5 as follows:

- Case-1 : Interior and Exterior Rating:

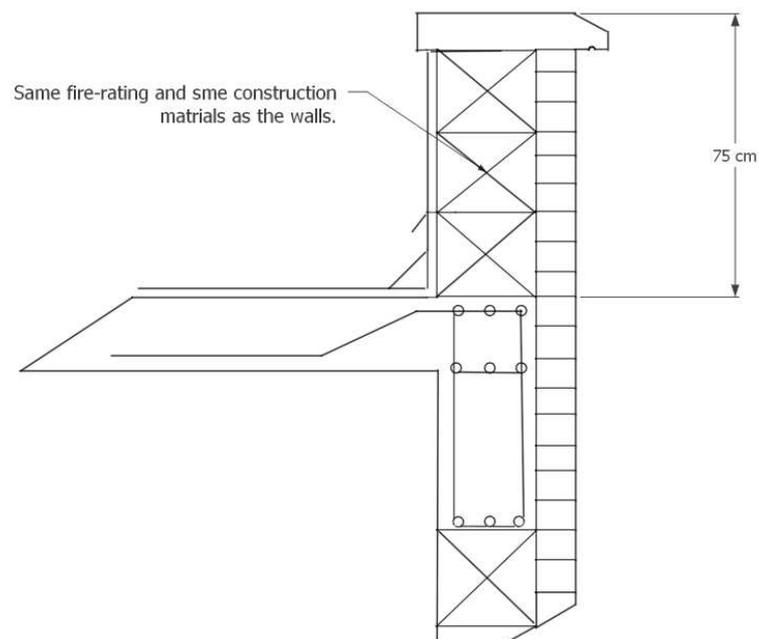


- Case-2 : Interior Rating Only :



Step-3.3

Provide wall parapets for exterior fire rated walls in accordance with the following diagrams:



Important Note: Parapets are mandatory only if:

- The exterior wall is required to be fire-resistive as discussed in step -1

- The building has an area of more than 93 m² in any floor.
- The roof is not fire rated or has openings closer than 1.2 of the exterior wall.

Step-4: Determine the Maximum Allowable Area of Openings In Accordance With Sbc-80, Section 4b.4.8.

The area of windows, doors or other openings are limited and need to be positioned in appropriate locations to limit the spread of fire from one story to another or from one building to another.

Step-4.1

Determine the allowable percentage of openings area in accordance with Table 2.2.

TABLE 2.2 : Maximum Area of Exterior Wall Openings (**Based on –SBC-801**)

Classifications Of openings	Fire Separation Distance (x) (Meter)							
	0 < x ≤ 1	1 < x ≤ 1.5	1.5 < x ≤ 3	3 < x ≤ 4.5	4.5 < x ≤ 6	6 < x ≤ 7.5	7.5 < x ≤ 9	9 < x
Unprotected (No Sprinkler)	N.P	N.P	10%	15%	25%	45%	70%	UL
Unprotected (with Sprinkler) Other than H1, H2, H3 occupancy	N.P	15%	25%	45%	75%	UL	UL	UL
protected	N.P	15%	25%	45%	75%	UL	UL	UL
<i>NP: Not Permitted, UL: Unlimited, Refer to SBC-801 for exceptions.</i>								

Example-1

A fire resistant exterior wall has an area of 300 m² and spaced 1 m from other building. What is the maximum allowable area of openings?

Solution

No openings are permitted in such wall.

Example-2

A fire resistant exterior wall has an area of 300 m^2 and spaced 4 m from other building . What is the maximum allowable area of openings?

Solution

Maximum allowable area of protected openings = $300 \times 45 \% = 135 \text{ m}^2$

Example-3

A non fire resistant exterior wall has an area of 300 m^2 and spaced 4 m from other building. What is the maximum allowable area of openings?

Solution

Maximum allowable area of unprotected openings = $300 \times 15 \% = 45 \text{ m}^2$

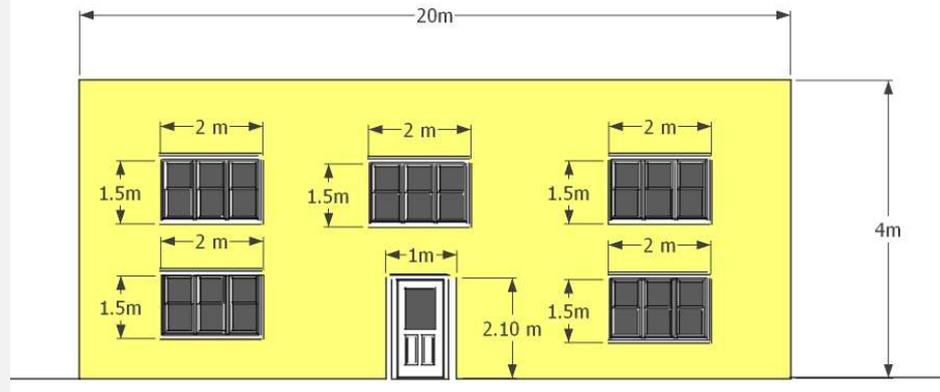
Step-4.2

Determine the allowable area of combined protected and unprotected openings in the exterior wall.

Important Note: fire resistant walls must have protected openings, whereas, exterior walls that are not required to have fire resistance construction are permitted to have a combination of protected and unprotected openings once the maximum allowable area of unprotected openings is exceeded.

Example

As indicated in the diagram below, a non fire resistant exterior wall has an area of 80 m^2 and spaced 4 m from other building with 17.5 m^2 of unprotected openings. Determine the allowable openings area.



Solution

Maximum allowable area of unprotected openings = $80 \times 15 \% = 12 \text{ m}^2$

The actual area of unprotected openings = 17.5 m^2

In this situation, the area of unprotected openings need to be reduced or a combination of protected and unprotected openings need to be calculated as follows:

1. Determine the area of openings needs to be protected

$17.5 - 12 = 5.5 \text{ m}^2$, therefore at least 5.5 m^2 need to be protected.

In this example two windows and one door will be protected. The area will be 6.10 m^2

2. Ensure that the ratio of the combination of the actual area of protected and unprotected openings to the allowable area is less than or equal to ONE:

To calculate the ratio of allowable combination of protected and unprotected openings, the following equation needs to be used:

$$\frac{A}{a} + \frac{Au}{au} \leq 1$$

Where:

A = Actual area of protected opening.

a = allowable area of protected openings per SBC-801, Table 4B.4.8.

Au

au = Allowable area of unprotected openings per SBC-801, Table 4B.4.8.

Referring to the example, the following data is determined:

$$\mathbf{A} = (2 + 2 + 2.10) = 6.10 \text{ m}^2$$

$$\mathbf{a} = 80 \times 45\% = 36 \text{ m}^2$$

$$\mathbf{Au} = 17.5 - 6.10 = 11.4 \text{ m}^2$$

$$\mathbf{au} = 80 \times 15\% = 12 \text{ m}^2$$

Substituting in the equation:

$$\frac{6.1}{36} + \frac{11.4}{12} \leq 1$$

$$0.17 + 0.95 = 1.12$$

$$1.12 > 1$$

The ratio exceeds one; therefore the ratio will be reevaluated by protecting additional window as follows:

$$\mathbf{A} = (2 + 2 + 2 + 2.10) = 8.10 \text{ m}^2$$

$$\mathbf{a} = 80 \times 45\% = 36 \text{ m}^2$$

$$\mathbf{Au} = 17.5 - 8.10 = 9.4 \text{ m}^2$$

$$au = 80 \times 15\% = 12 \text{ m}^2$$

Substituting in the equation:

$$\frac{8.1}{36} + \frac{9.4}{12} \leq 1$$

$$0.22 + 0.78 = 1$$

$$1 \leq 1$$

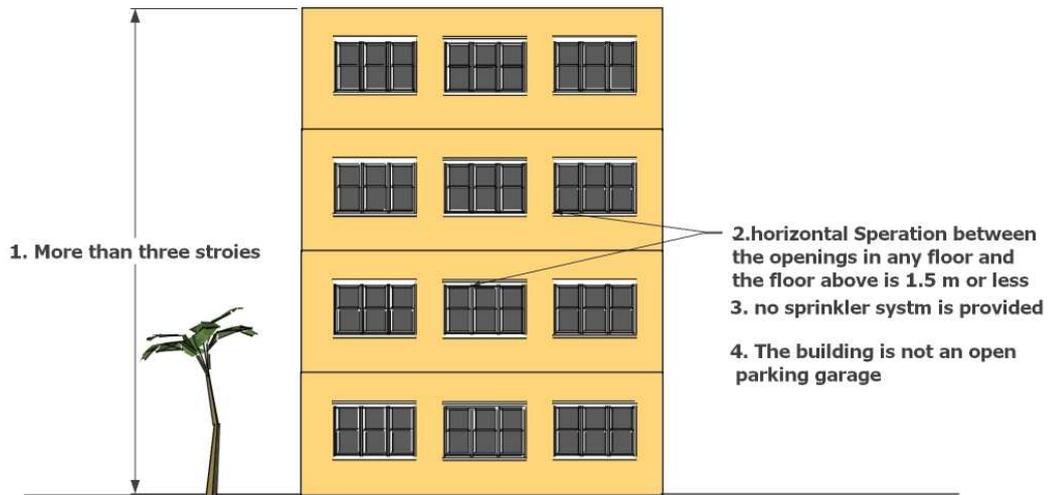
The ratio equal one which is acceptable combination.

Important Note: the equation assumed that the openings are uniformly distributed. if the openings are not distribute uniformly , then divide the area of exterior wall into uniform areas based on the distribution of the openings and apply the previous steps for each area individually.

Step-5: Determine the Proper Protection for Vertical Separation of Openings

Step-5.1

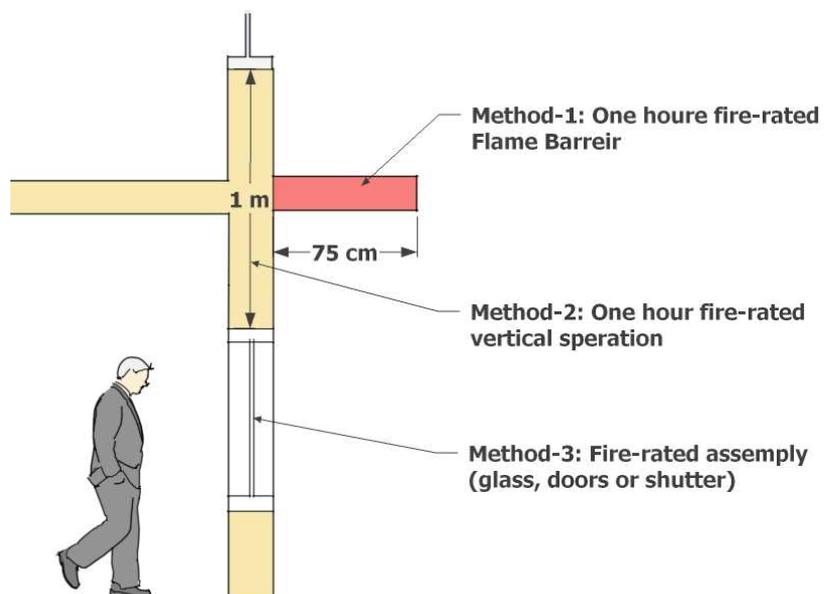
Determine if vertical separation of the openings is required if all the four conditions illustrated below arise. (SBC-801, Section 4B.4.9)



Step-4.4

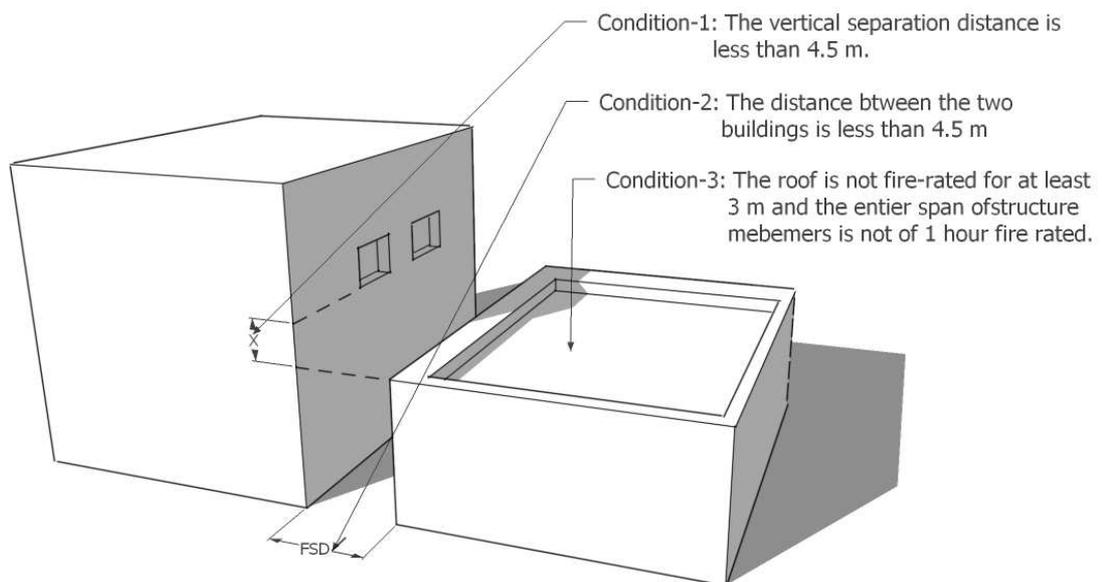
If vertical separation of the openings is required, then openings need to be protected using one of the following methods:

1. Provide a horizontal flame barrier of not less than 75 cm.
2. Separate the openings vertically by 1m fire resistance assembly.
3. Protect the windows by fire-rated Assembly.



Step-5.2

Protect any openings due to the vertical exposure to other building in the same lot if all of the conditions illustrated below arise.



Step-6: Provide Proper Fire Protection Assembly for Exterior Wall Openings as Described in Section Five.

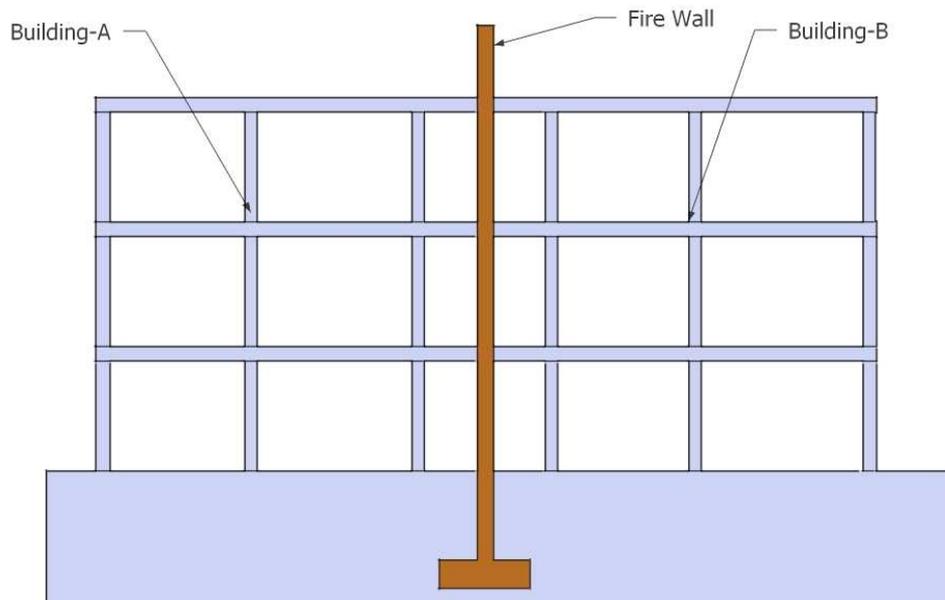
SECTION THREE: FIRE WALLS

The fire walls aims at protecting the spread of fire from one building to another building that **are attached** at the lot line or in the same lot. It also utilized as a design alternative to divided the one building large area that exceeds the maximum allowable area to a smaller areas as described in chapter one.

If the fire walls are required or utilized then it shall be designed in accordance with the following steps.

Step-1: Design the wall in Accordance With SBC-801, Section 4B.5.

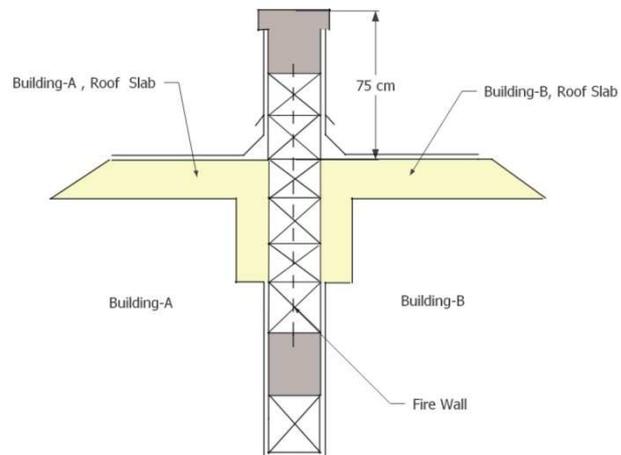
The fire wall shall be of noncombustible material and shall have a Structural stability to allow collapse of building in any side of the wall without the collapse of the wall itself.



Step-2: Extend the Wall above the Roof and beyond the Exterior Walls.

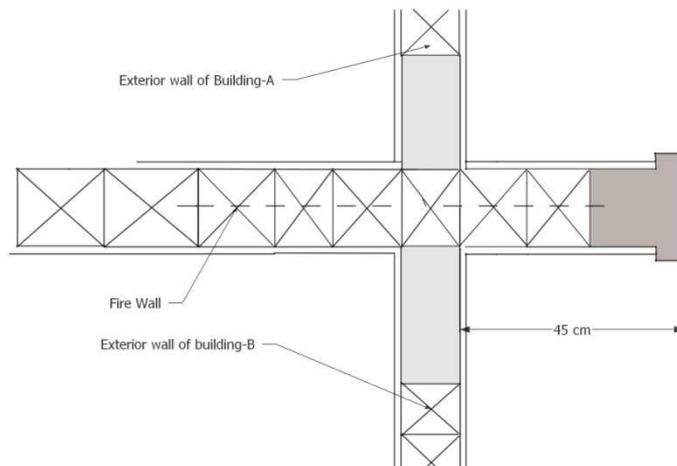
Step-2.1

Extend the fire wall 75 cm above the roof. For exceptions, refer to SBC-801, Section 4B.5.6.



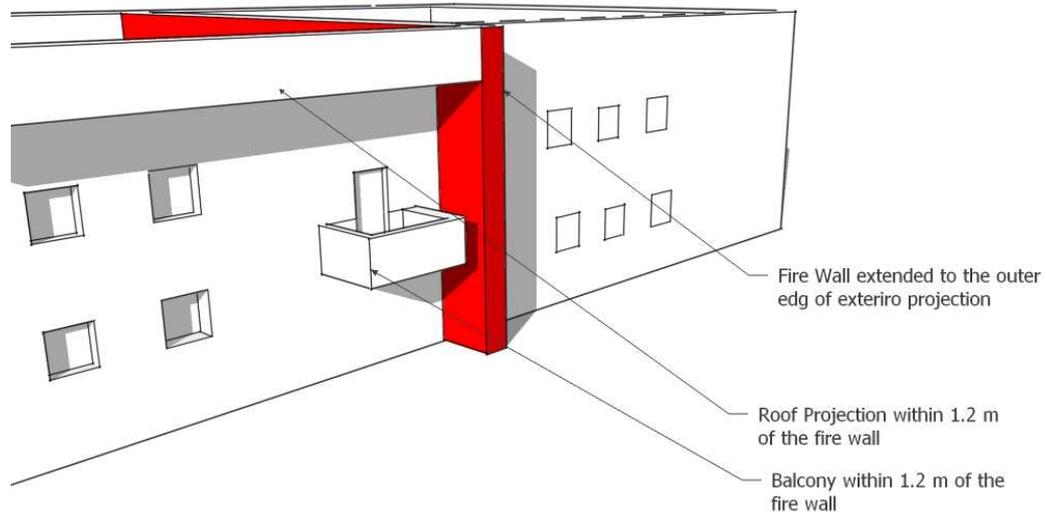
Step- 2.2

Extend the fire wall 45 cm beyond the exterior walls of the building. For exceptions, refer to SBC-801, Section 4B.5.5



Step 2.3

Extend the fire wall to the outer edge of horizontal projection of the exterior walls that within 1.2 m of the fire wall. For exceptions, refer to SBC-801, Section 4B.5.5.2

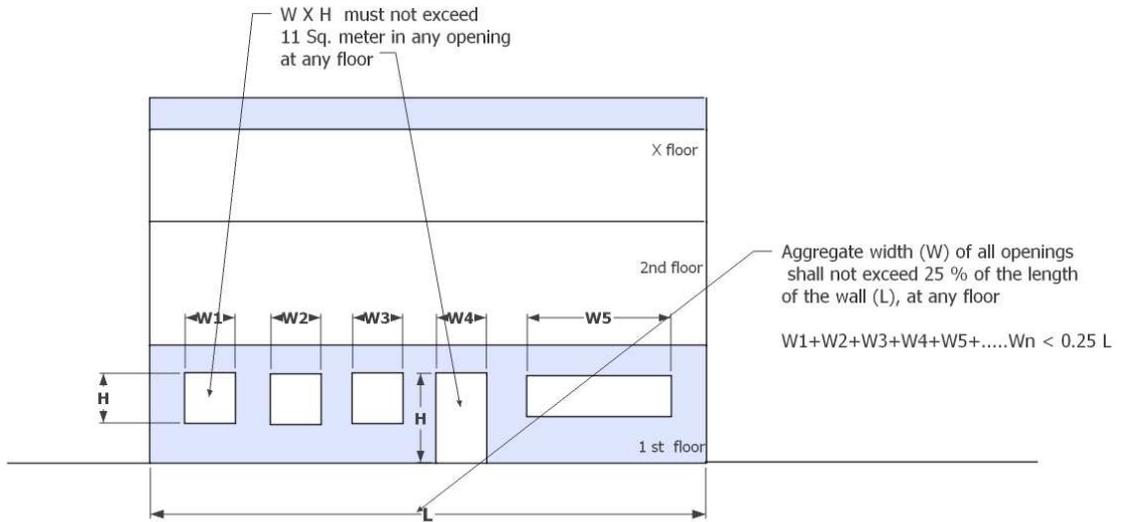


**Step-3: Determine the Maximum Allowable Area of Openings
In Accordance with SBC-801, Section 4B.4.8.**

Important Note: openings are prohibited once the fire walls act like party wall along the lot line.

Step-3.1

Determine the area of openings only in non-sprinkled buildings as indicated in the diagram below.



Step-4: Select the Proper Fire-Rating in Hour from Table 2.3 Below

TABLE 2.3: Fire Wall Fire-resistance Rating (Hour)

Occupancy Classification	Fire resistive Rating (Hour)
A, B,E, H-4, I, R-1, R-2, U	3
F-1, H-3, H-5, M, S-1	3
H-1, H-2	4
F-2, S-2, R-3, R-4	2

Important Note:

1. When the fire wall is separating one occupancy into two building area then the value in the Table need to be used.
2. When the fire wall separate the building with more than one occupancy, then the most restrictive need to be used.

Step-5: Provide Proper Fire Protection Assembly for Fire Wall Openings as Described in Section Five.

SECTION FOUR: FIRE BARRIERS AND PARTITION AND SMOKE BARRIER AND PARTITION

The fire or smoke barriers and partitions aim at preventing the spread of fire and smoke within the building between different uses and areas.

Step-1: Determinant if Fire Barrier, Fire Partition, Smoke Barrier, Smoke Partitions are required or not and Determine the Proper Fire Rating

Step-1.1

Provide **Fire barriers** to totally enclose and separate the following functions and spaces from each other and from the remainder of the building:

- A. Shaft Enclosure** as listed in SBC-801, Section 4B.7.4
- B. Exit Enclosure** as listed in SBC-801, Section 8.19.
- C. Exit Passageway** as listed in SBC-801, Section 8.20
- D. Horizontal Exit** as listed in SBC-801, Section 8.21
- E. Atrium** as listed in SBC-801, Section 2B.4.
- F. Incidental Use** as listed in Table 2A.2.1.1.
- G. Control Area** as listed in SBC-801, Section 2b.14.2.
- H. Separation of mixed occupancy** as listed in Table 2A.2.3.2.

- I. **Subdividing signal occupancy into more than one area** as listed in Table 4B.6.3.7.

Step-1.2

Provide **Fire Partition** to totally enclose and separate the following functions and spaces from each other and from the remainder of the building:

- A. **Dwelling units in the same building.**
- B. **Sleeping units in hotels , group R-1, R-2 and I-1**
- C. **Tenant spaces in covered malls** as listed in section 2B.2.7.2.
- D. **Corridors** as listed in SBC-801, Table 8.16.1

Step-1.3

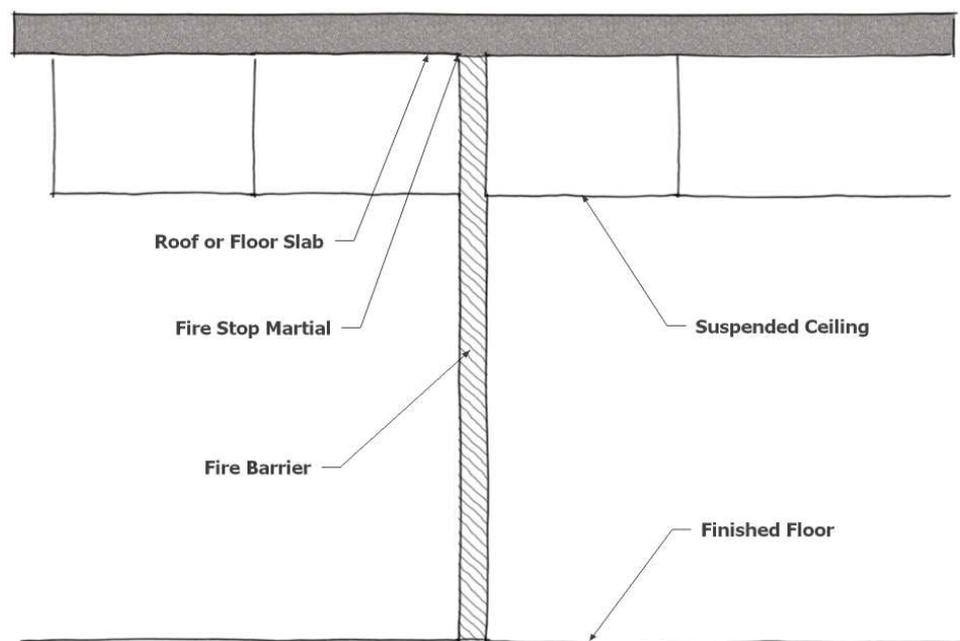
Provide **smoke barrier** or **smoke partition** for smoke compartments and smoke control as follows:

- 1. **Atrium** as listed in SBC-801, section 2B.4.4
- 2. **Covered Mall** as listed in SBC-801, section 2B.2.8.1.
- 3. **Underground buildings** as listed in SBC-801, Section 2B.5.4. and 2B.5.5
- 4. **Group I-3** as listed in SBC-801, Section 2B.8.6.
- 5. **Area of Refuge** as listed in SBC-801, Section 8.7.6.

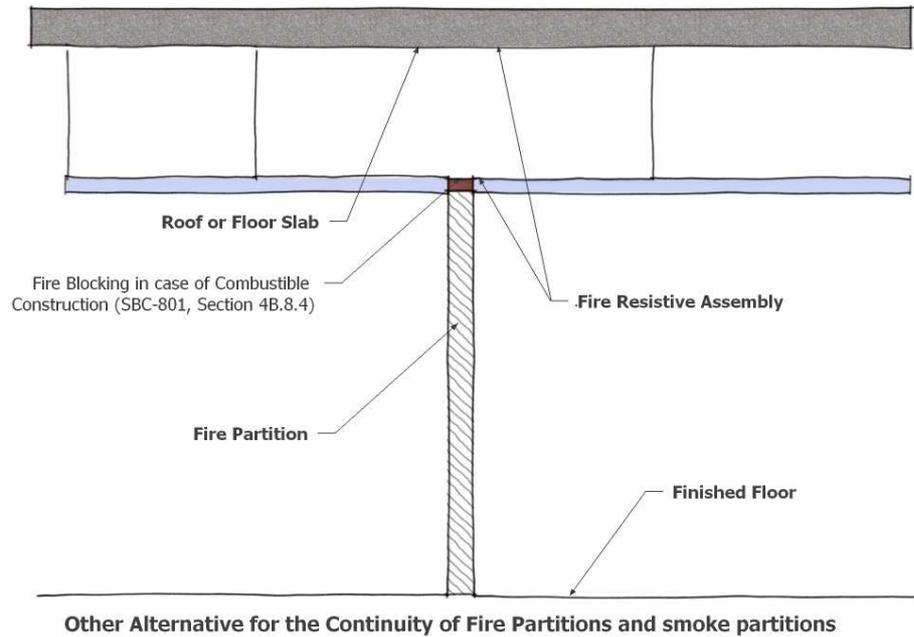
The main difference between the smoke barrier and smoke partition is that smoke barrier is required to be of one hour fire-resistive construction whereas the smoke partition is not.

Step-2: Construct The Fire/Smoke Barriers And Fire/Smoke Partitions.

Fire barrier shall be extended from the top of the finished floor to the underside of the floor or roof slab above.



Continuity of Fire Barrier , Fire Partitions ,Smoke Barrier and smoke partitions



Step-3: Determinant the Maximum Allowable Size of Openings Only In Non-Sprinkled Building, Sbc-801, Section 4b.6.7.

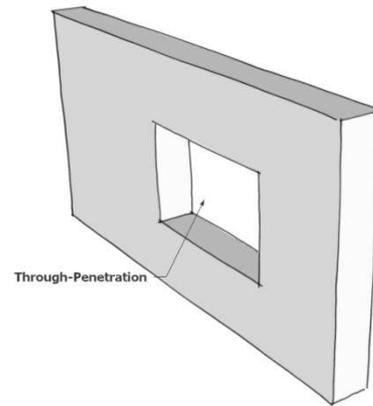
Refer to SECTION -3, STEP-3

Step-4: Provide Proper Fire Protection Assembly For Fire Wall Openings as Described in Section Five.

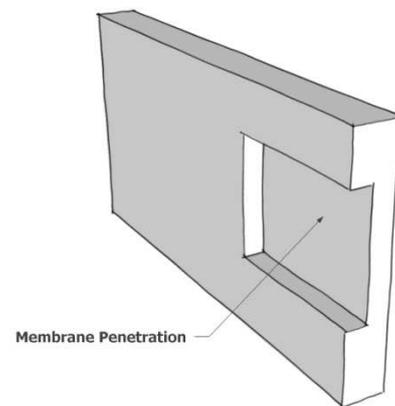
SECTION FIVE: PENETRATION PROTECTION

Penetrations in horizontal or vertical constriction elements are classified in the code into two types.

1. **Through-Penetration:** which penetrate the entire assembly (wall, floor or ceiling). Refer to SBC-801, Section 4B.12.3.1.



2. **Membrane Penetration:** which penetrate only one side of the assembly (wall, floor or ceiling), Refer to SBC-801, Section 4B.12.4.2



Step-1: Protect all Door Opening Penetrating Fire-Resistive Construction Walls, Barrier or Partition

Step-1.1

Check the proper rating of the door assembly in accordance with SBC 801, Table 4B.15.3.

Step-1.2

Check the glazed openings limitation within the doors in accordance section 4B.15.3.6.1.

Step-1.3

Provides appropriate door closer in accordance with SBC-801, Section 4B.15.3.7

Step-2: Protect All Windows Opening Penetrating Fire-Resistive Construction Walls, Barrier or Partition in Accordance With SBC-801, Section 4B.15.4.**Step-2.1**

Check the proper rating of the glazing in accordance with SBC 801, Table 4B.15.4.

Step-2.2

Check the size of glazing in accordance with SBC 801, Table 4B.15.3 and 4. The maximum area of glass per door leaf shall not exceed 0.065 m² other size shall be tested in accordance with NFPA-252.

Important Note: Wired glass with minimum thickness of 6mm and installed in steel frame is equivalent to 45 minutes, the wired glass shall not exceed the maximum limit indicated in SBC-801, Table 4B.15.4.3

Step-3: Protect All Ducts and Air Transfer Openings PENETRATING Fire-Resistive Construction Walls, Barrier Or Partition in Accordance with SBC-801, Section 4b.16.

Step-3.1

Check if smoke damper, fire damper or combination of fire/smoke damper is required in accordance with SBC-801, Section 4B.16.5, as summarized in Table 2.4.

TABLE 2.4: Fire Damper and Smoke Damper Requirements

	Saudi Building Code Reference	Wall Assembly	Fire Damper	Smoke Damper
1	SBC-801,Section 4B.16.5.1	Fire Wall	Yes	-
2	SBC-801,Section 4B.16.5.2	Fire Barriers	Yes	-
3	SBC-801,Section 4B.16.5.3	Shaft Enclosure	Yes	Yes
4	SBC-801,Section 4B.16.5.4	Fire Partition	Yes	-
5	SBC-801,Section 4B.16.5.4.1	Corridors	Yes	Yes
6	SBC-801, Section 4B.16.5.5	Smoke Barriers	-	Yes

Important Note:

- Provision of sprinkler systems and the thickness of the duct may reduce the dampers requirements (refer to the exceptions of each section).

- Opening the exit enclosures and exit passageway is limited to require for the ventilation and pressurization of these spaces. Refer to SBC-801, Section 8.19.1.2 and Section 8.20.5.

Step-3.2

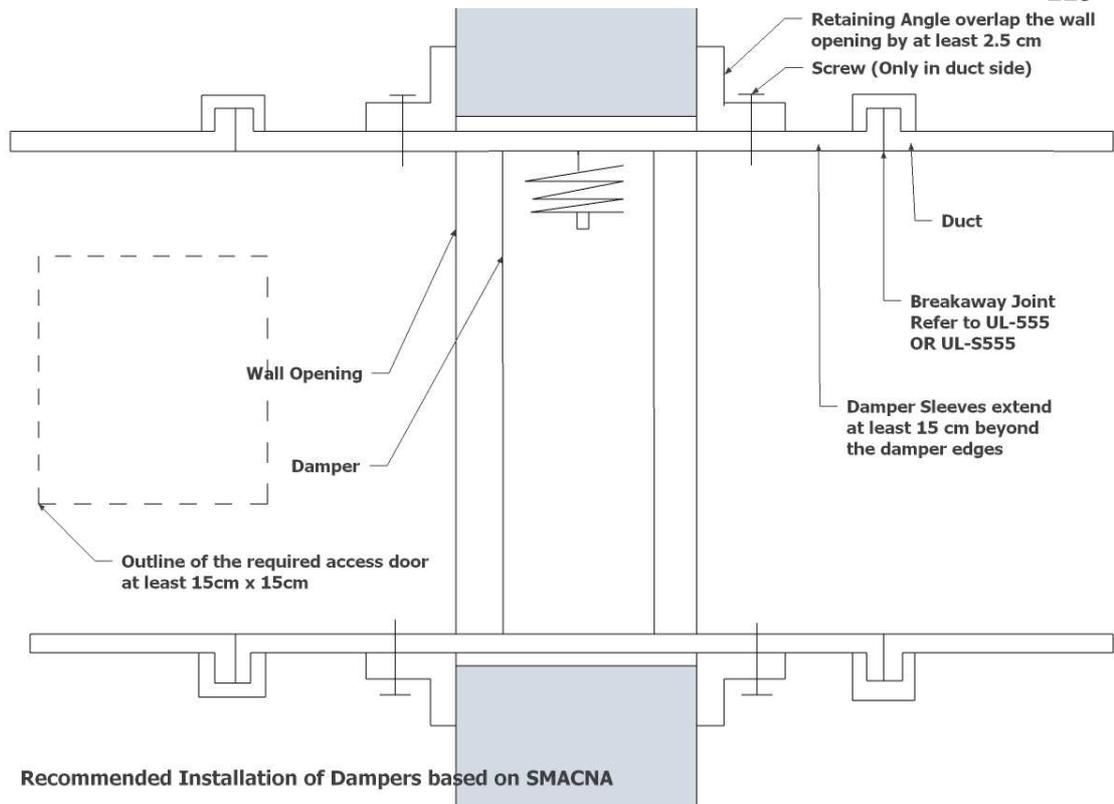
Select the proper rating of the damper in accordance with SBC-801 Table 4B.16.3.1, or Table 2.5 below.

TABLE 2.5: Fire Damper Rating

Rating of the fire-resistive assembly (fire wall, fire barrier , fire partition , smoke barrier , smoke partition)	Minimum Rating of the Damper (Hour)
Less than 3 hour	1.5
Three hour or more	3

Step-3.3

Address the damper requirements in accordance with the manufacturer recommendations, refer to SBC-801, Section 4B.16.2.



Step-3.4

Specify proper actuation method for the fire or smoke dampers in accordance with SBC-801, Section 4B.16.3.1.1 and 4B.16.3.2.1

Fire Dampers: actuated by temperate-rated fusible link that will activate the damper when it melts.

Smoke Damper: actuated by one of five means:

- Interlocked with the building smoke-detection system if required and provided.
- By the smoke detectors installed within the corridors.

- By spot type smoke detector located 1.5 horizontally of the damper for non-ducted openings.
- By spot type smoke detectors listed for door releasing services in smoke barriers.
- By listed smoke detector in the duct within 1.5 m away from the damper.

Step-3.5

Specify the proper labeling and testing of the damper in accordance with SBC-801, Section 4B.16.3

Fire Dampers: Shall be tested in accordance with UL-555.

Smoke Damper: Shall be tested in accordance with UL-555s.

Combination fire and Smoke Damper: Shall be tested in accordance with both UL-555 and UL-555s

Step-4: Protect All Thorough Penetrations around Ducts, Pipes, Conduits or Wiring in Accordance With SBC-801.**Step-4.1**

Identify the location of the openings in fire-resistive in vertical (walls) and horizontal (floor) assembly.

Step-4.2

Check the required rating of such elements, if it is not required to be rated, and then no need for fire stopping system.

Step-4.3

Select the proper and classified fire-stop systems as indicated in UL directory.

Step-4.4

Specify the UL classified fire-stopping material as follows:

- A. UL classified FS caulk, where openings is exposed to moister or severs conditions.
- B. UL classified FS collars (pipe choking) with intumecent material, around plastic pipes penetrating the fire barrier.
- C. UL classified FS pillows and putty around cable trays penetrating t he fire barrier.
- D. UL classified F.S stopping putty for sleeved and non-sleeved conduits and cables.

CHAPTER THREE

Means of Egress

The means of egress is a continuous and unobstructed path of egress (vertical and horizontal) from any occupied point within the building to a public way (exterior of the building)

The mean of egress consist of three major parts:

1. Exit access.
2. Exit.
3. Exit discharge.

Building occupant will utilize these three parts in sequence in order to reach a safe place outside the building.

The following steps provide the fundamental steps to design the means of egress properly.

Step-1: Determine the Occupancy Classification of the Building or the Space. (Reference: SBC-801, Section 2A.2.)

* Refer to chapter one of these guidelines

Step-2: Calculate the Occupant Load. (Reference: SBC-801, Section 8.4)

* Refer to chapter one of these guidelines

STEP-3: Provide the right number of exit or exit access doorways for the selected space or building.(Reference: SBC-801, Section 8.14 and Section 8.18)

Step-3.1
Section 8.14.1

Check the number of exits or exit access doorways required from each individual room and spaces within a floor as follows:

1. Based on the occupant load value as illustrated in the Table 3.1 below

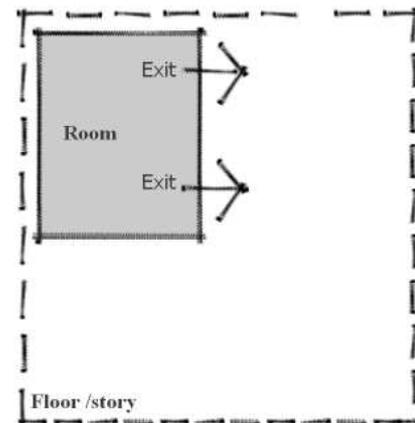


Table 3.1: Number of Exits

Occupancy Classification	One Exit	Two Exits	Three Exits	Four Exits
A,B,E,F,M,U	1-49 persons	50-500 persons	501-1000	More than 1000
H1, H2, H3	1-3 persons	4 -500 persons	501-1000	
H4,H5,I1,I3,I4,R	1-10 persons	11-500 persons	501-1000	
S	1-29 persons	30-500 persons	501-1000	
I2	Section 8.13.2.2	1- 500 persons	501-1000	
Day care	1-10 persons	11-500 persons	501-1000	

2. Common path of egress travel exceed the limitations as noted in step-5B.

3. Special use rooms :

Machinery, refrigerated room more than 93 square meter

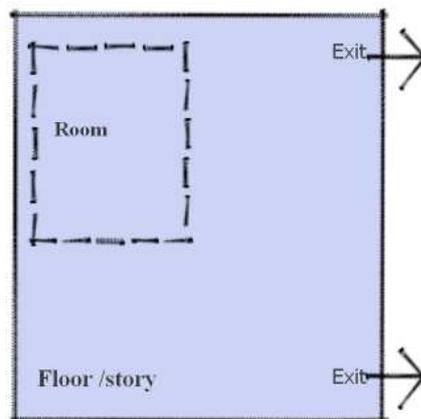
Boiler, incinerator and furnace room more than 46 square meter

Step-3.2

Section 8.18.1

Check the number of exits from each floor/story

The number of exits from each story, basement, shall be as follows:



1. **One exit:** If the conditions of Section 8.18.2 are met.(Listed Below)

2. **Two exits:** Occupant load 1-500 persons

3. **Three Exits** : Occupant load 501 -1000 persons

4. **Four Exits** : Occupant load more than 1000 persons

One Exit Conditions:

Building is allowed to be provided with one exit if any of the following conditions exists

1. In single level building with the occupant load values highlighted in

Table 3.2.

Table 3.2: Single Exit Occupant Load

occupancy	Number of occupants
A,B,E,F,M,U	1-49 persons
H1, H2, H3	1-3 persons
H4,H5,I1,I3,I4,R	1-10 persons
S	1-29 persons

2. Building of Group- R3.

3. In any building where the conditions illustrated Table 3.3 exists

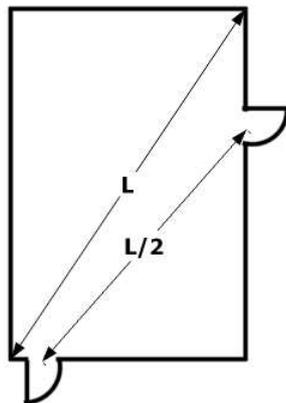
Table 3.3: One exit Conditions

occupancy	Maximum Occupant Load	Height above grade	Maximum Travel Distance
A,B,E,F,M,U	50 persons	1 story	23 m
H2, H3	3 persons	1 story	7.6m
H4, H5, I, R	10	1 story	23 m
S	30	1 story	30.5 m
B, F, M,S	30	2 stories	23 m
R-2	4 dwelling units	2 stories	15.3 m
B	50 persons	1 story & sprinkler system	30.5
R-2	4 dwelling units, Sprinkler system Escape openings	3 stories	15.3 m

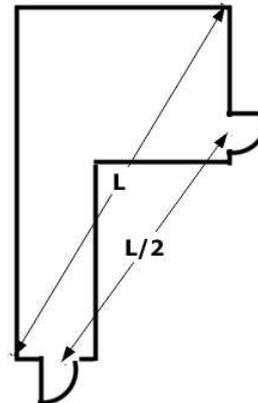
Step-4: Locate the Exits, or Exit Access Doorways as Described Below. (Reference: SBC-801, Section 8.14.2)

Check the remoteness of exits or exit access doorways based on the dimensional characteristics of the spaces. Exits or exit access doorways shall be placed a distance equal to one half the maximum diagonal dimension (L) as illustrated below:

CASE-1: Remoteness of exterior or interior exit doors in non-sprinklered Buildings.
For sprinklered Buildings " L " could be divided by 3.

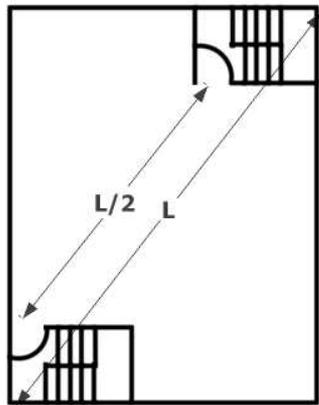


Measurement line should be within the space

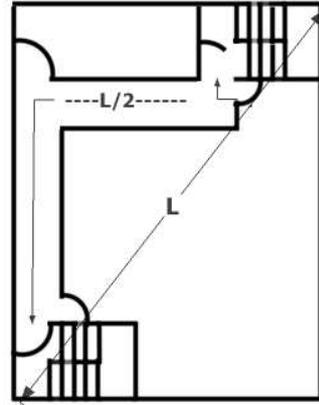


Measurement line could be go outside the space

CASE-2: Remoteness of interior exit stairways or exits in non-sprinklered Buildings.
For sprinklered Buildings "L" could be divided by 3.



non-interlocked interior enclosed stairways

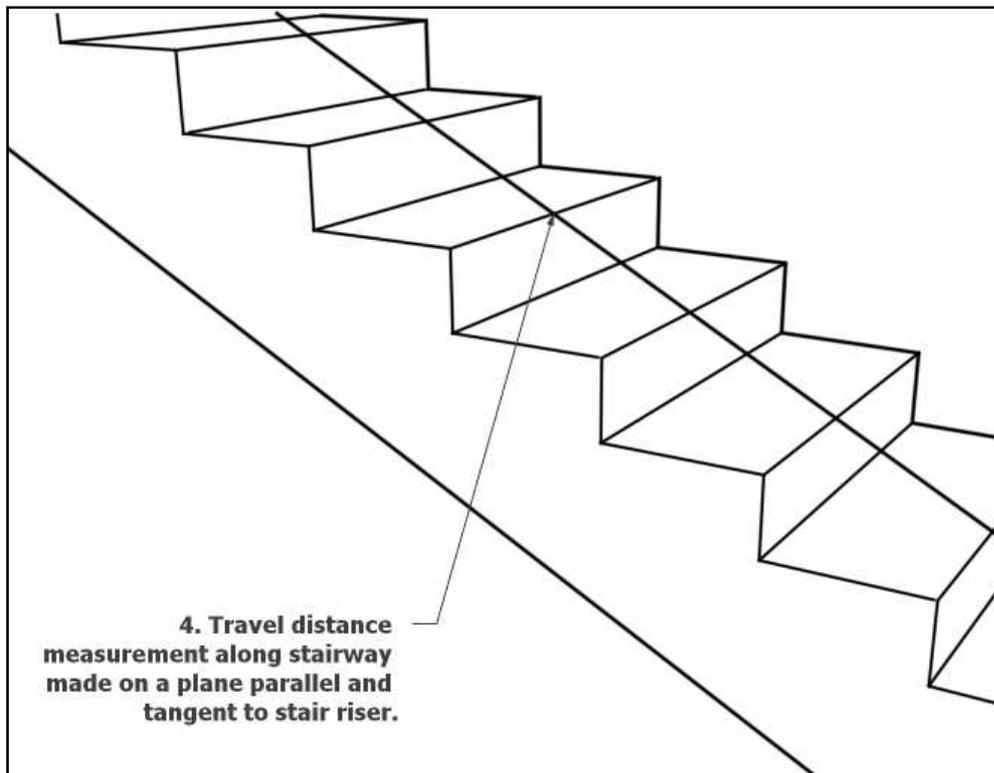
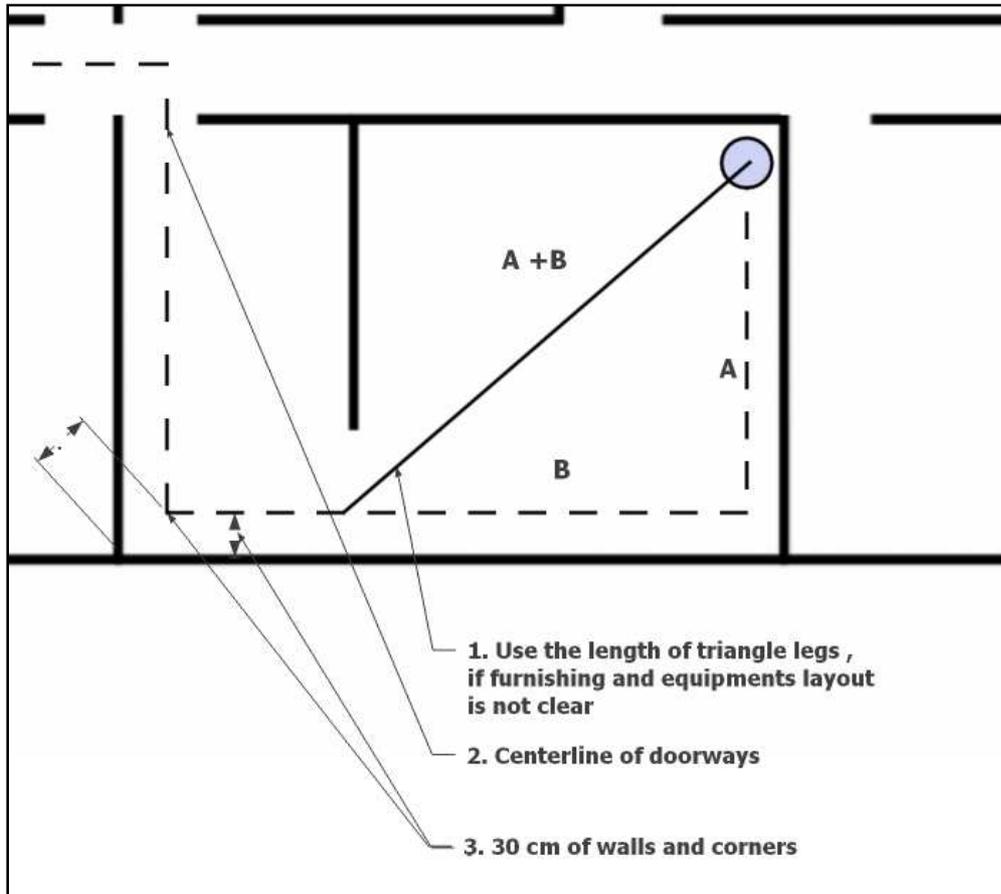


non-interlocked interior enclosed stairways or other exits connected with 1-hour corridor

Step-5: Examine the Maximum Travel Distance from the Most Remote Point within the Story to the Entrance of an Exit. The Travel Distance shall not exceed the Values in Table 3.4. (Reference: SBC- 801, Section 8.15.)

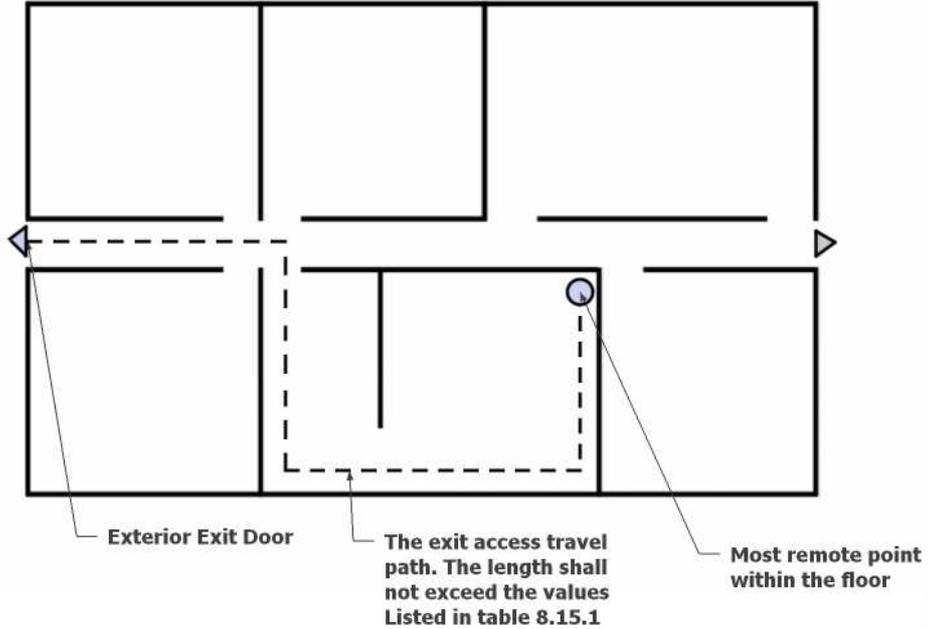
The exit access travel path shall be measured as illustrated in the diagrams below:

1. Using the legs of triangles instead of hypotenuse.
2. In centerline of door opening.
3. At least 30 cm of walls, corners columns.etc.
4. Plane parallel and tangent to stair riser.



CASE-1: Single Story:

The travel distance measured from the most remote point to the entrance of exterior exit door.



CASE-2: Multiple Stories:

The travel distance measured from the most remote point to the entrance of one of the following:

1. Door of fire-resistance exit enclosure stairway or horizontal exit.
2. exterior door at the grade level when interior exit enclosure or exterior protected stairway is not required or provided. The distance shall be measured through the stairway.

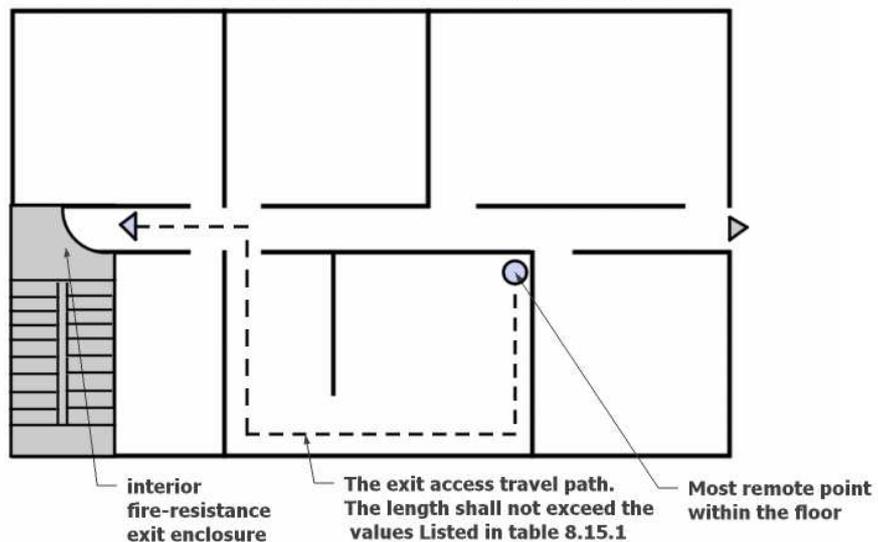


TABLE 3.4: Travel Distance

Occupancy	Maximum Travel Distance	With Sprinkler system	With exterior egress Balcony
A,E,F-1,I-1,M,R,S-1	61 m	+ 15.2 m	+30 .5 m
B	61m	+30.5 m	+30.5 m
F-2,S-2, U	91.5 m	+30.5 m	+30.5 m
I-2, I-3,I-4	45.7 m	+ 15.3	+ 30.5 m
F-1, S-1	122 m (max) if one story , heat and smoke roof vents, sprinkler throughout		
In mall building	Maximum of 61 m (Section 2B.2.4.4)		
Atrium	Maximum of 61m through the atrium (Section 2B.4.8)		
Group H	Refer to Table 8.15.1		

Step-6: Implement the Exit Access Arrangement Requirements. (Reference: SBC-801, Sections 8.13.2, 8.13.3 and 8.16.3)

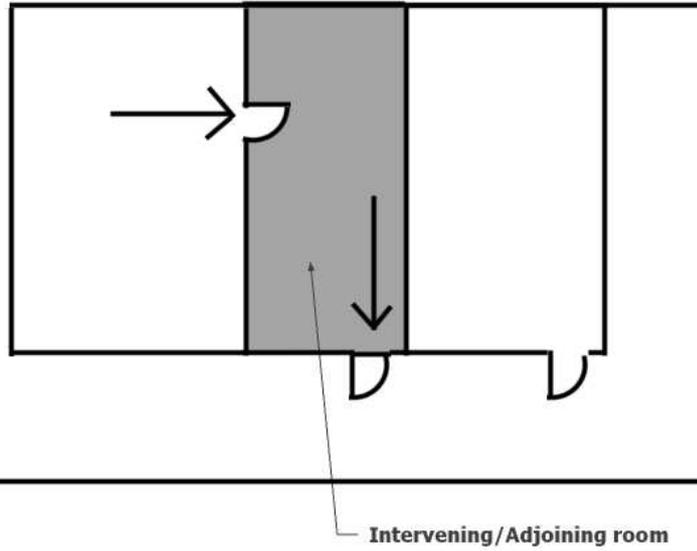
Check if any of the following cases arise within the exit access. These three cases are a limitation for the travel distance within the exit access

CASE-1:

Section 8.13.2 : Exit Through Intervening Spaces:

Exit through the following spaces or rooms is prohibited unless permitted by this section :

1. Kitchen.
2. Store
3. Closet
4. Sleeping area
5. Bathroom and toilet
6. High hazard
8. Room that can be locked.
9. Multiple tenants.
10. Habitable rooms or suites in Hospitals

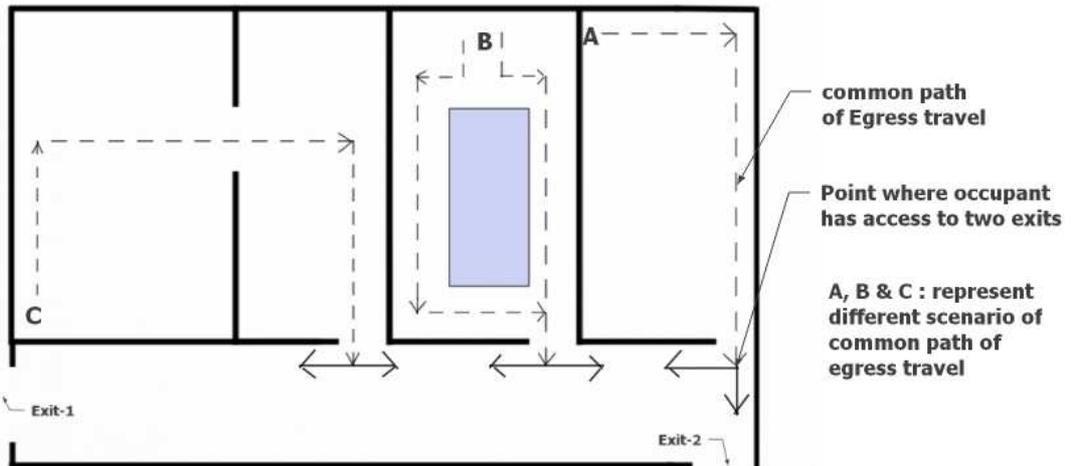


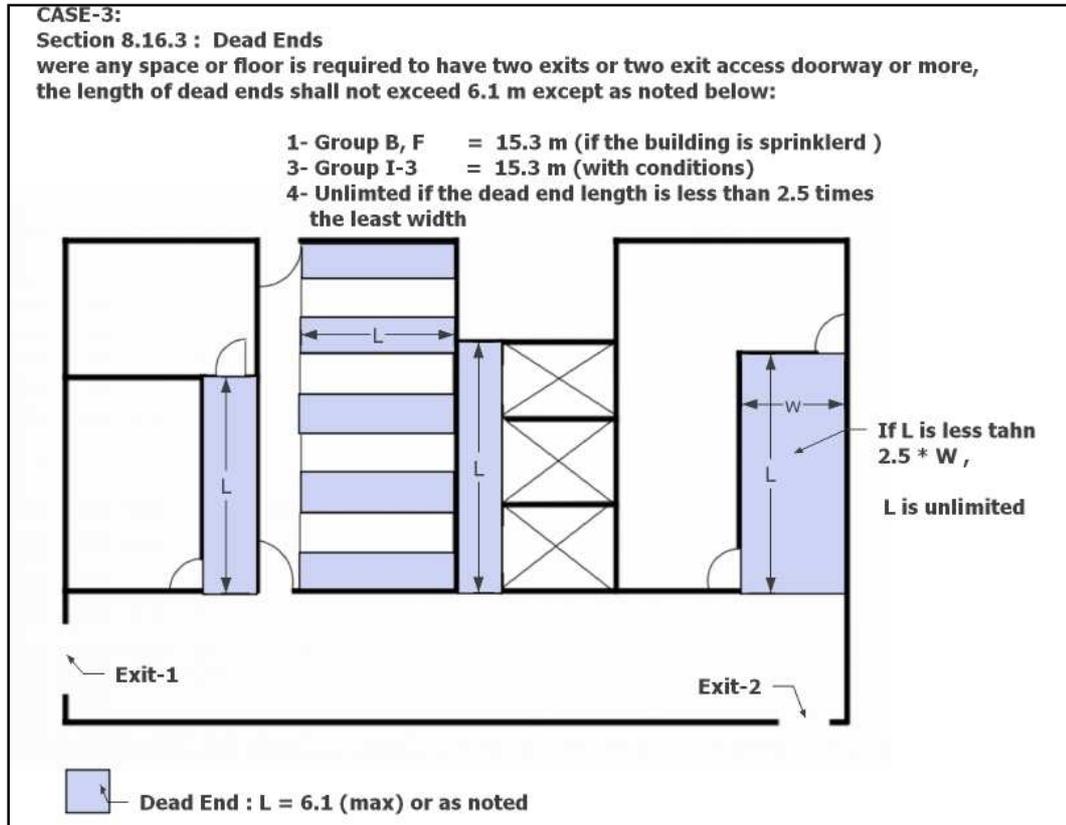
CASE-2:

Section 8.13.3 : Common Path of Egress Travel

The distance measured from the most remote point within any space to a point where the occupant has access to two required exits shall not exceed 23 m except as noted below:

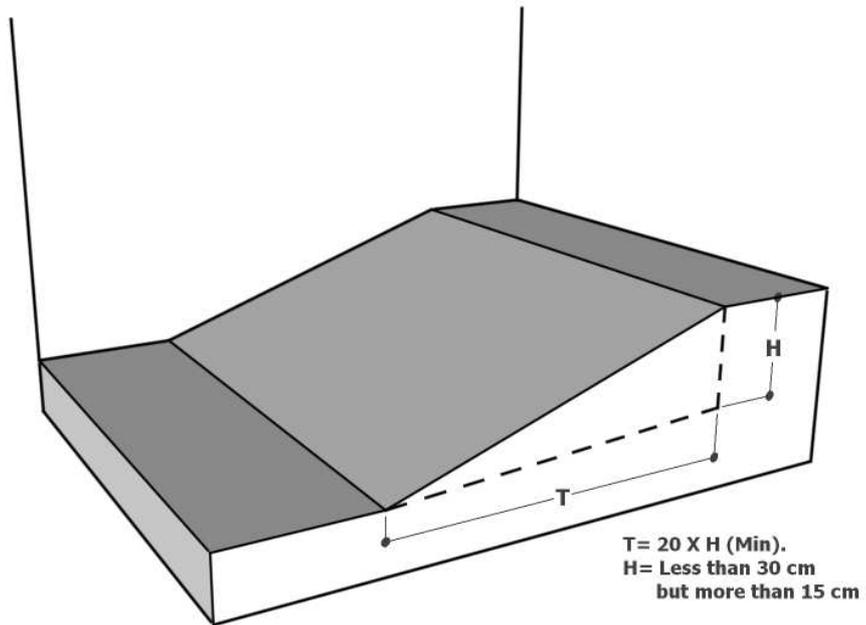
- 1- Group B, F, S = 30.5 m (if the building is sprinklered)
- 2- Group B,S,U = 30.5 m (if occupant load is less than 30 person)
- 3- Group I-3 = 30.5 m
- 4- Group H1, 2,3 = 7.6 m



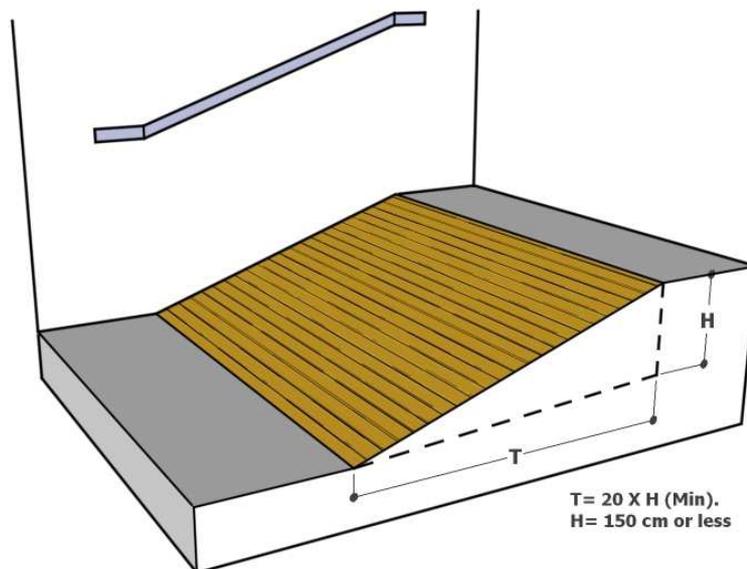


Step-7: Design the Changes in Elevation in the Mean of Egress that are less than 30 cm in accordance to one of the Following Alternatives whichever is Applicable. (Reference: SBC-801, Section 8.3.5)

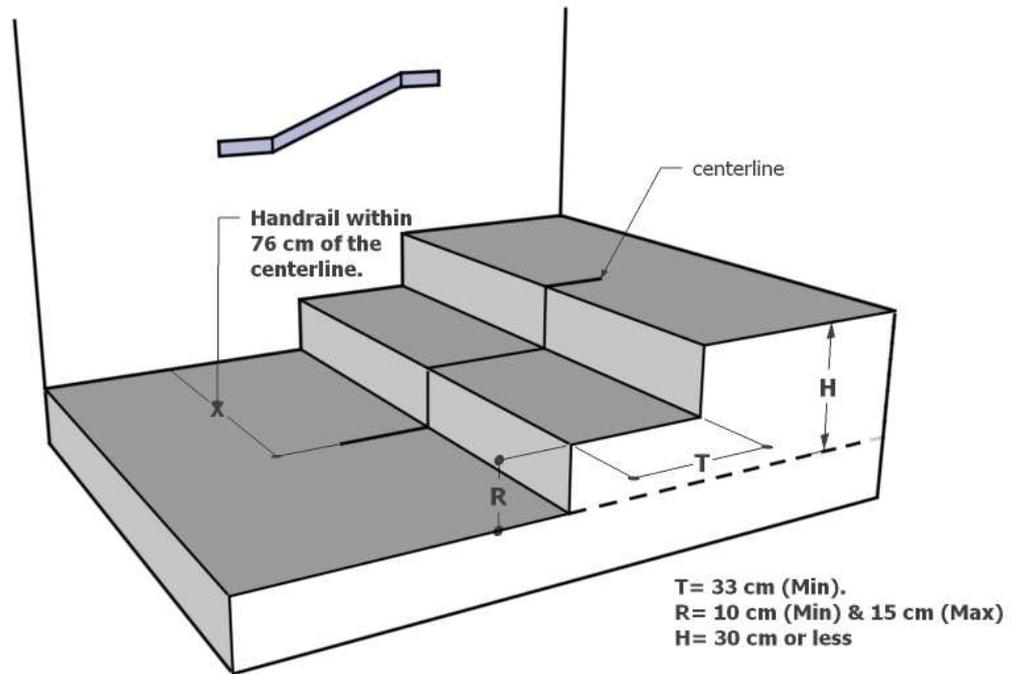
CASE-1: When change in elevation is less than 30 cm and more than 15 cm, a 5 % ramp shall be provided. if the slope can not be achieved then , follw the guidelines in section 4 or (SBC-801, Section 8.10)



CASE-2: When change in elevation is 15 cm or less the ramp shall contrast visually and physically with the surrounding. Or handrail shall be provided.



CASE-3: Provide one or two steps only if the building is not accessible by physically disabled persons and design it as illustrated in the figure below.



Step-8: Calculate the Width of the Required Means of Egress Using the Following Rules.(Reference : SBC-801, Section 8.5 and 8.8)

Rule-1:

For occupant load less than 150 persons, use the minimum width specified for each mean of egress except group H and I-2 as noted in Table 3.2 below.

Rule-2:

For occupant load more than 150 persons use the following formula:

$$W = (OL \times C) / E$$

Where :

W : Width of mean of egress , it shall not be less than the minimum width noted in the Table 3.5.

OL: Occupant load

C : width per occupant from Table 8.5.1 as modified below

E :

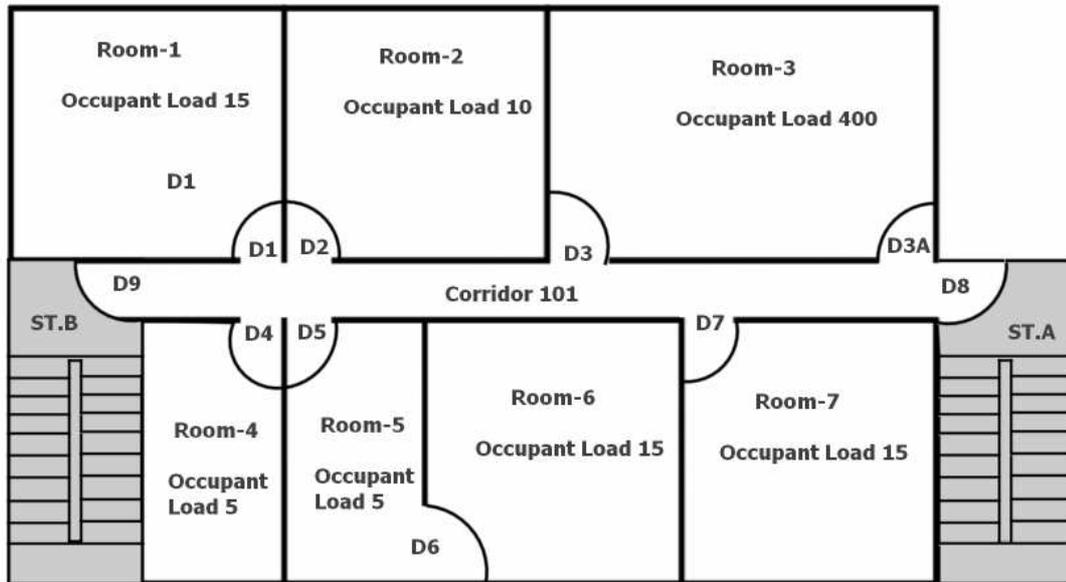
- *For doors : number of available exits serves the occupant load.*
- *For corridor: number of alternative directions connected to an exit outside the space or floor.*
- *For stairway : number of available stairways that are part of the means of egress*

TABLE 3.5: Means of Egress Width

	Section	W "minimum clear width" mm	C " width per occupant "	
			With Sprinkler System	Without Sprinkler system
Stairway	8.9.1	1100 (900 mm for occupant load less than 50 persons)	5.1 7.6 (Group- H & I-2)	7.6 17.8 (Group-H)
Corridor	8.16.2		3.8 5.1 (Group- H & I-2)	5.1 10.2 (Group-H)
Ramp	8.10.5.1			
Passageway	8.20.2			
Exit discharge	8.23.5.1		800	
Doors	8.8.1.1	900 (for Group-B and M)	3.8 (for Group-B & M)	5.1 (for Group-B &M)
Important note : For occupancy in Group A refer to section 8.24				

Example:

Determine the required width for means of egress in this floor plan.

**Solution:****Step-1: Check if the Occupancy Classification.**

(Assume Group-B)

Step-2: Check if the Sprinkler System is Required or Provided .

(Assume No)

Step-3: Check if the Number of Exits and Exit Access Doorways is Accepted.

(Refer to Step-3, Assume Yes)

Step-4: Check the Width of Doors

Doors # 1, 2, 4, 5, 6, 7

Apply Rule # 1: the occupant load is less than 150 for each individual room. The width of each door shall not be less than 800 mm.

Door # 3 and 3A

Occupant load utilizing the two doors are 400

$$W = (OL \times C) / E$$

$$W = (400 \times 5.1) / 2$$

$$W = 1020 \text{ mm,}$$

The minimum width of door 3 and 3A shall be 1020mm each.

Door# 8 and 9: The floor occupant load is 465

$$W = (OL \times C) / E$$

$$W = (465 \times 5.1) / 2$$

$$W = 1185 \text{ mm,}$$

The minimum width of door 8 and 9 shall be 1185 mm each. Note that the maximum leaf width is 1220 mm. if the door width exceeds this value , double leaves shall be provided.

Step-5: Check the Width of Corridor

The occupant load utilize the corridor is 465

$$W = (OL \times C) / E$$

$$W = (465 \times 5.1) / 2$$

$$W = 1185 \text{ mm,}$$

The minimum width of the corridor shall be 1185mm.

Step-6 : Check the Width of Stairways

The occupant load utilize the stairway is 465

$$W = (OL \times C) / E$$

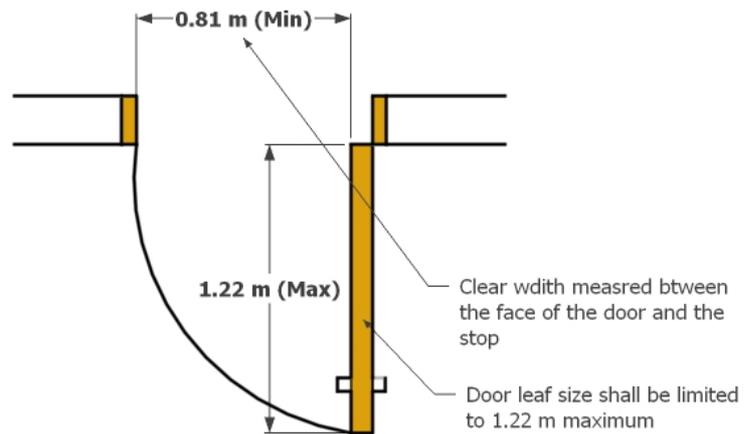
$$W = (465 \times 5.1) / 2$$

$$W = 1185 \text{ mm ,}$$

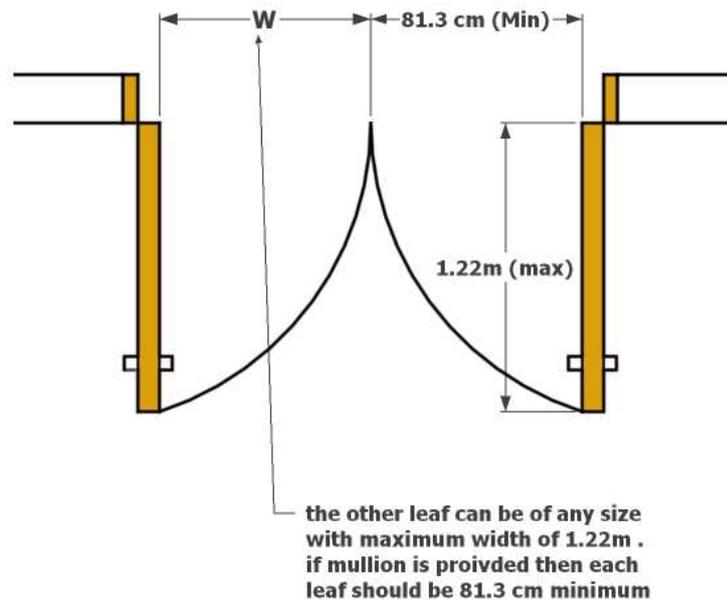
The minimum width of each stairway shall be 1185mm.

**Step- 9: Check the Door Clear Width and Door Leaf Size.
(Reference : SBC-801, Section 8.8)**

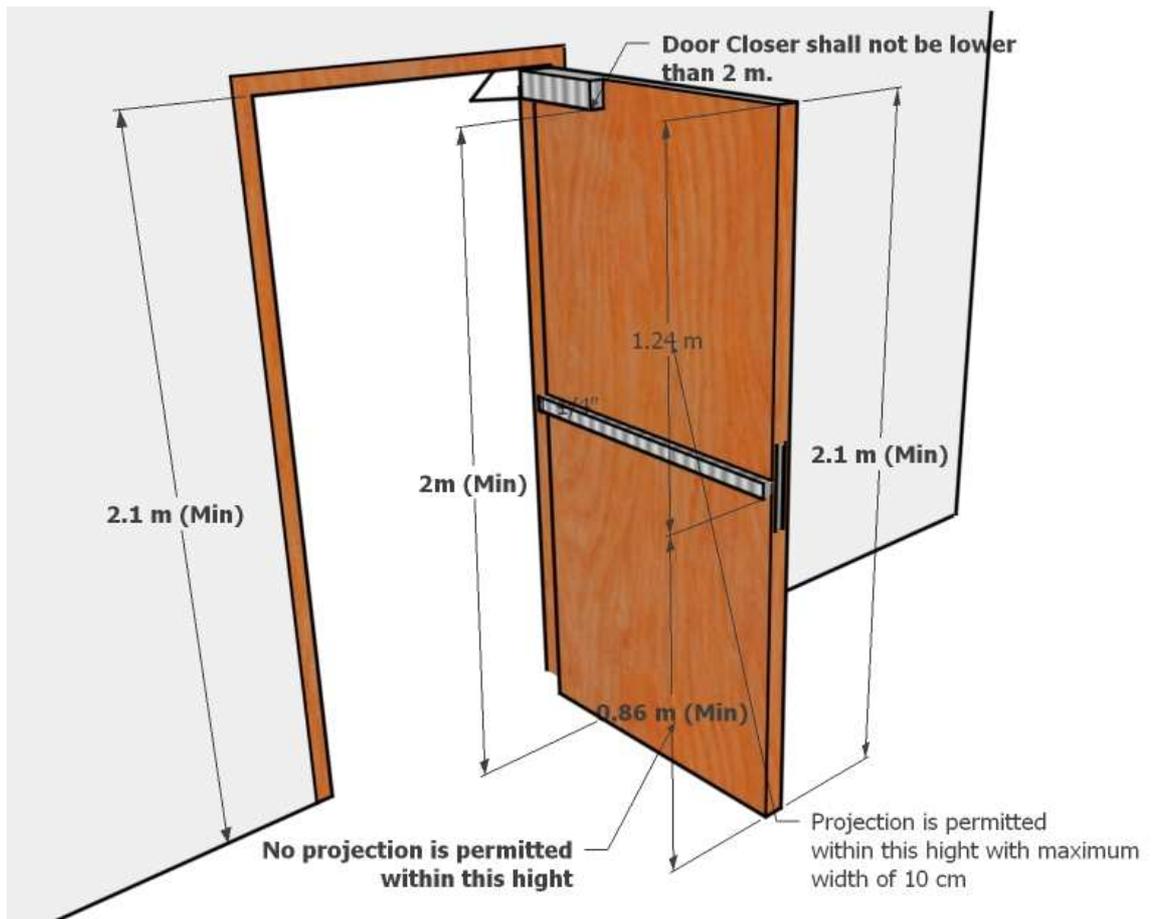
Case-1: One leaf door minimum clear width



Case-2: Two door leaves opening clear width



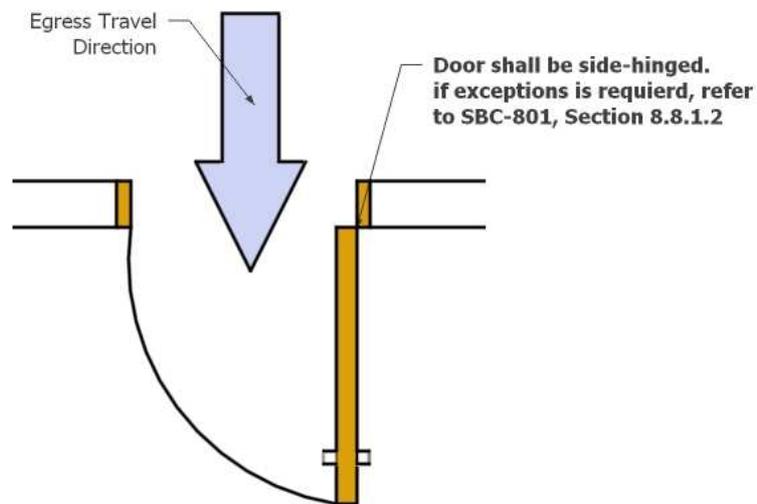
Step-10: Check the Door Height and the Allowable Projection into the Door Clear Width and Height. (Reference: SBC-801, Section 8.8.1.1 and 8.1.1.1)



For additional requirements for revolving doors, power operated door , horizontal sliding doors, access control doors and security grilles , Refer to SBC-801, Section 8.8.

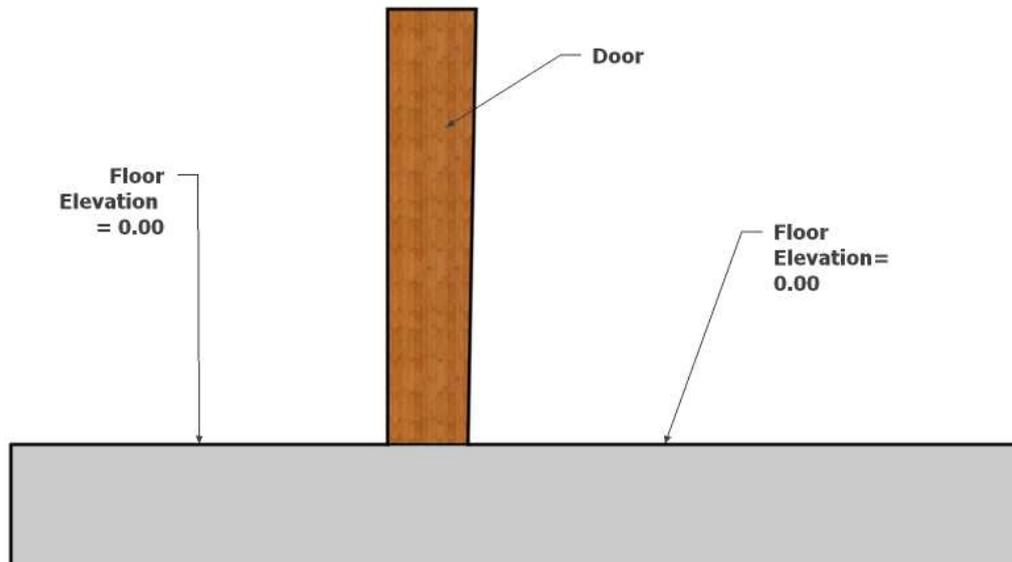
Step-11: Check the Swing Direction of Doors. (Reference: SBC-801, Section 8.8.1.2)

Door shall swing in the direction of egress travel only if the occupant load exceed 50 persons or the occupancy is classified as group-H.



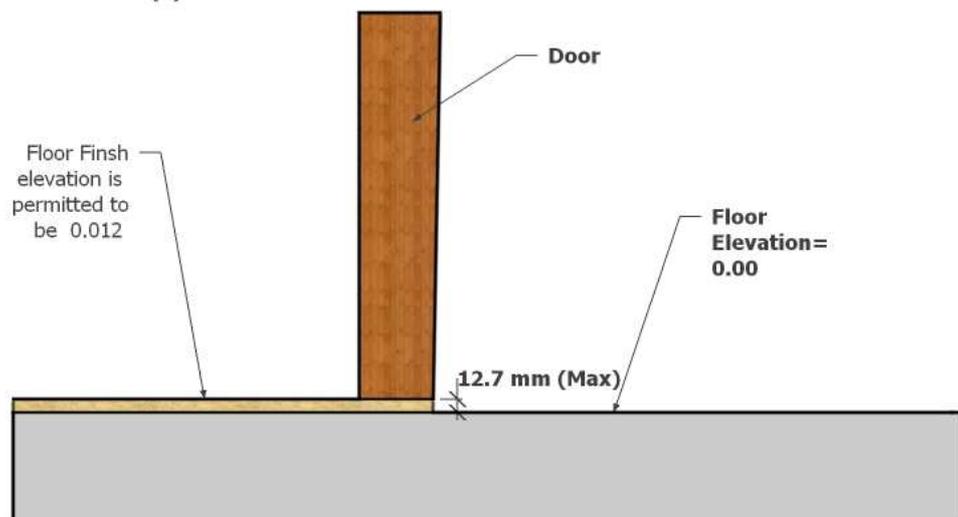
Step- 12: Check the Floor Elevation on Each Side of all Doors as Illustrated in the Following Cases. For More Exceptions Refer to Section 8.8.1.4. (Reference: SBC-801, Section 8.8 .1.4)

CASE-1: Floor Elevations on each side of the door must be the same

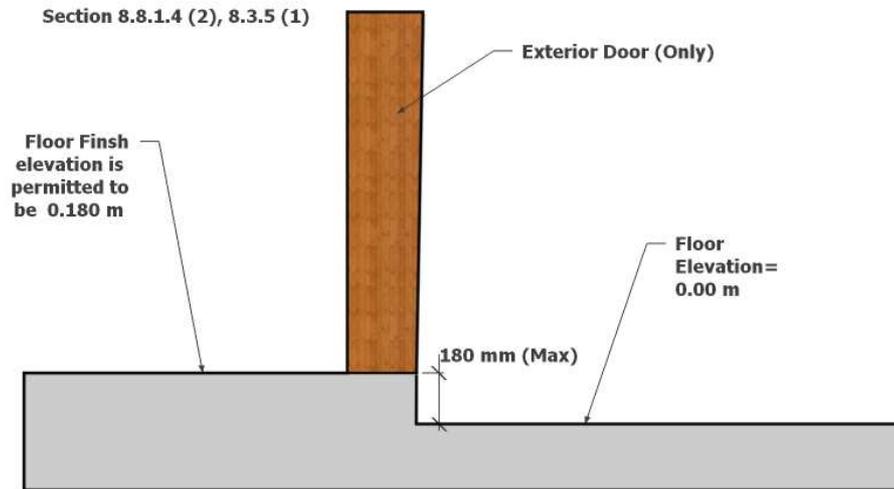


CASE-2: Floor Elevations on each side of the door is permitted to have a change of not more than 12.7 mm due to differences in finishes materials.

Section 8.8.1.4 (4)

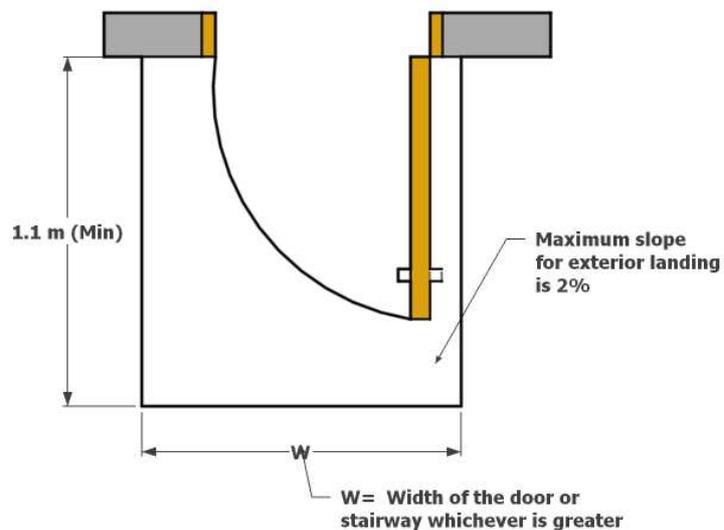


CASE-3: Floor Elevations on each side of the door is permitted to have a change of not more than 180 mm in Group (F, H, R-2, R3,S and U) only if not accessible by persons with disabilities

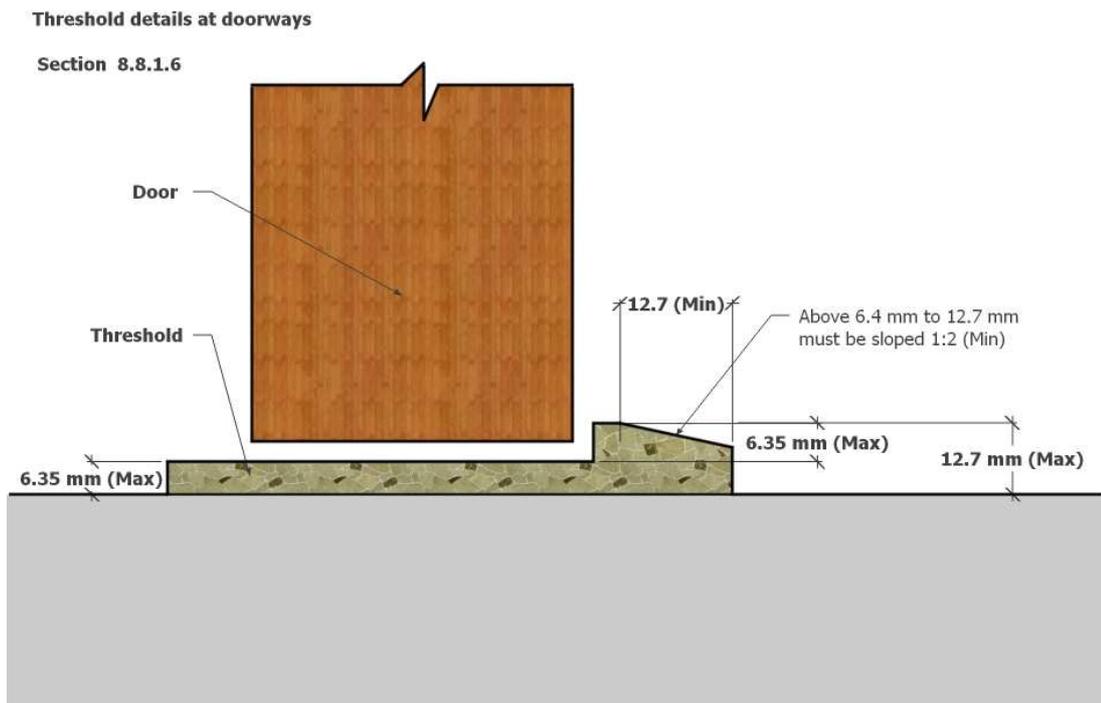


Step-13: Check the Details of Floor Landing. For More Exception Refer to Section 8.8.1.4. (Reference: SBC-801, Section 8.8 .1.5)

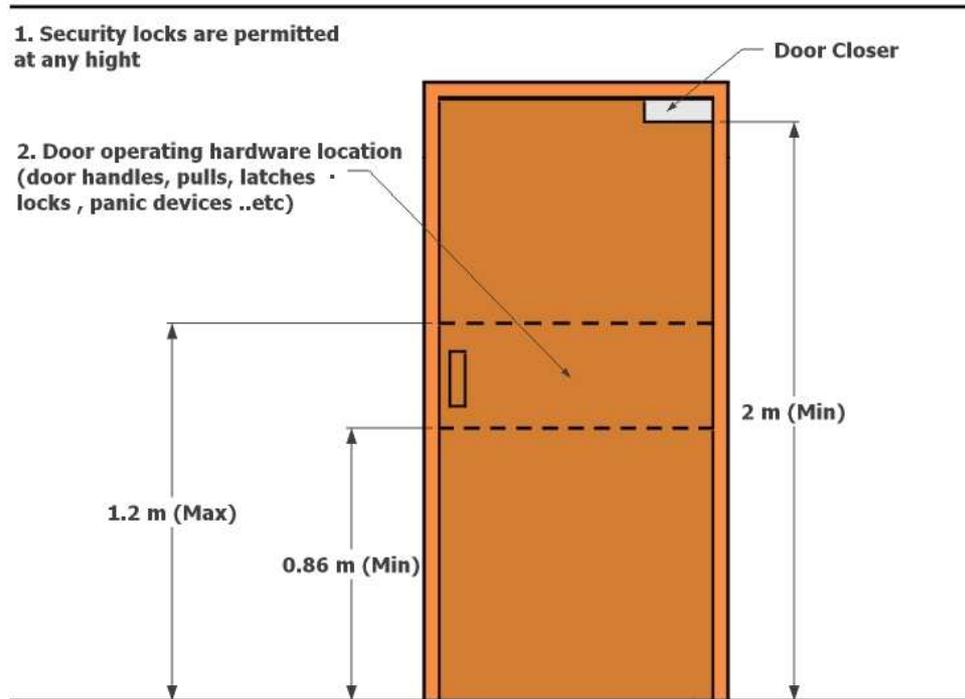
Section 8.8.1.5



Step-14: Check the Details of the Thresholds at Doorways as Illustrated Below. For Exceptions Refer to Section 8.8.1.6. (Reference: SBC-801, Section 8.8 .1.6)



Step-15: Locate the Door Hardware as Permitted by Section. For Exceptions and Further Details Refer to Section 8.8.1.6. (Reference: SBC-801, Section 8.8 .1.8)

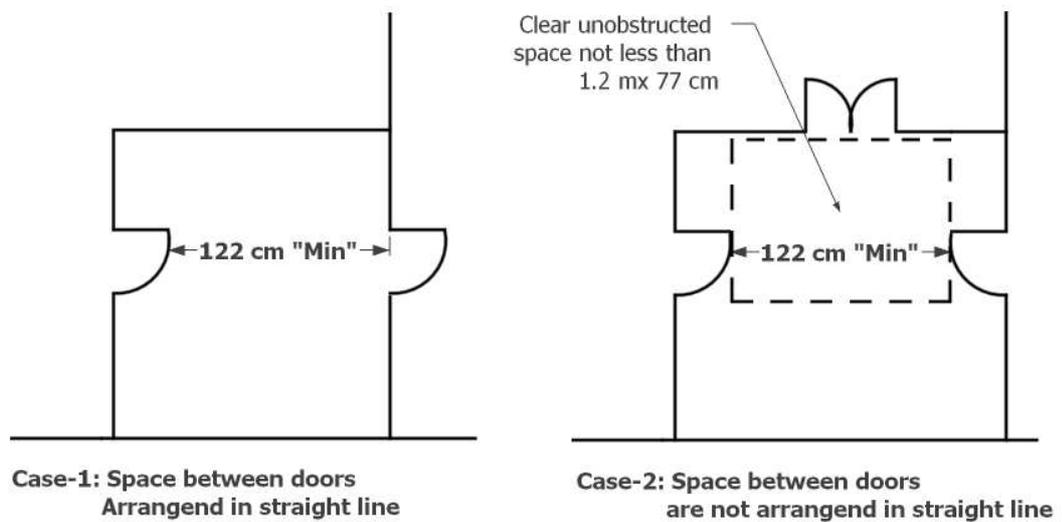


Step-16: Check the Specific Details for Locks, Latches and Panic Hardwires. Refer to SBC-801, Section 8.8.1.8.1 through 8.8.1.8.9. (Reference: SBC-801, Section 8.8 .1.8)

Step-17: Check that all required Exits are Obvious to the Building Occupant and not Obstructed. (Reference: SBC-801, Section 8.8.1)

No mirror, curtain, drapes or decoration is permitted to be attached to the egress doors. Moreover, the egress door shall be obvious and distinguishable for the adjacent walls or elements.

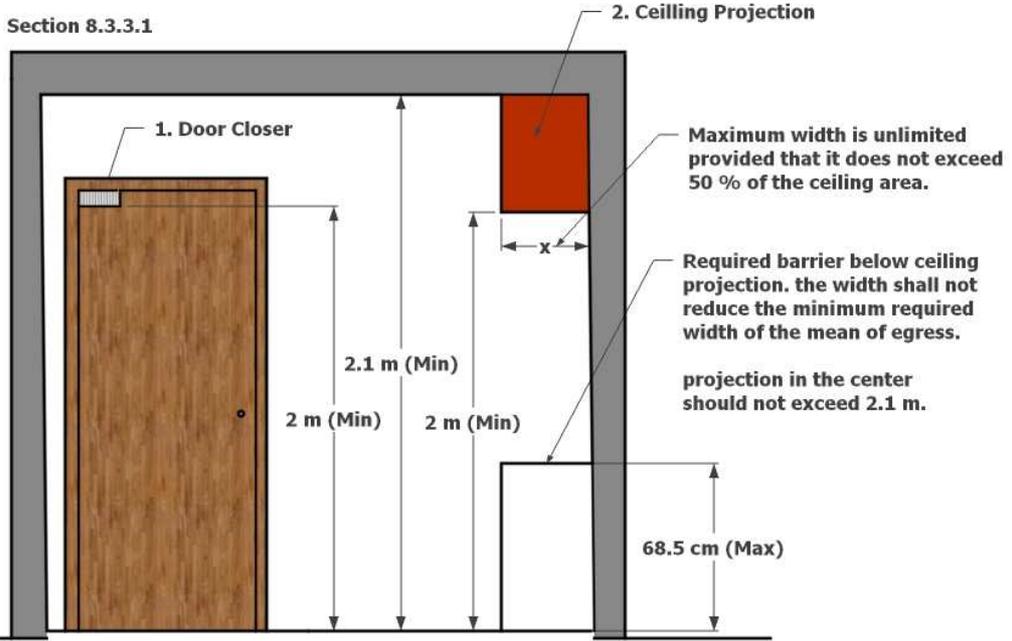
**Step-18: Check the Space between Two Doors in Series.
(Reference: SBC-801, Section 8.8.1.7)**



Step-19: Check the Acceptable Projection into Means of Egress. (Reference: SBC -801, Sections 8.5.2 & 8.9.4)

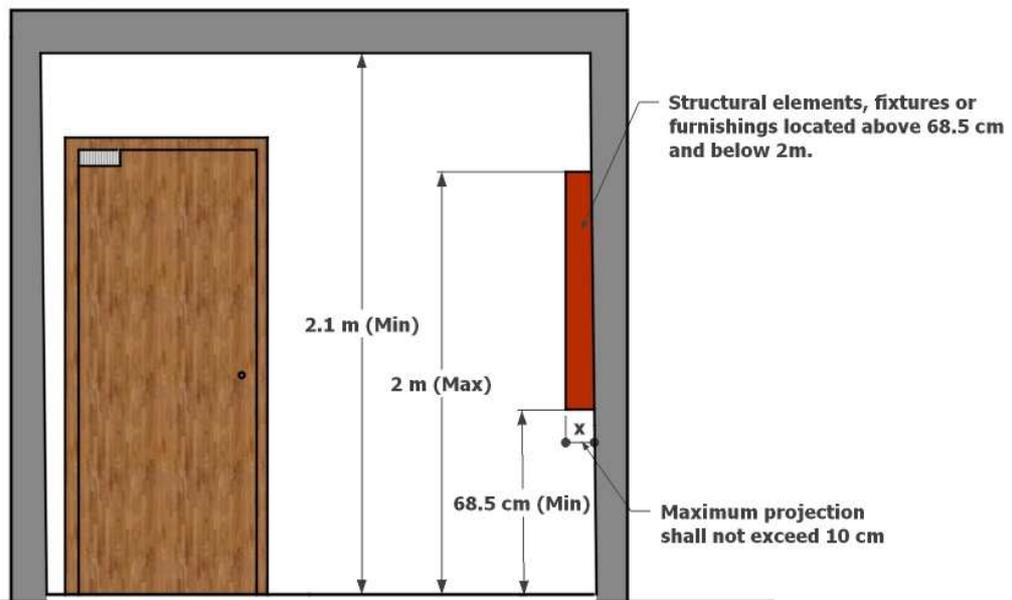
**Case-1: Projection into Headroom for means of egress
(Not permitted for ramps or stairway)**

Section 8.3.3.1



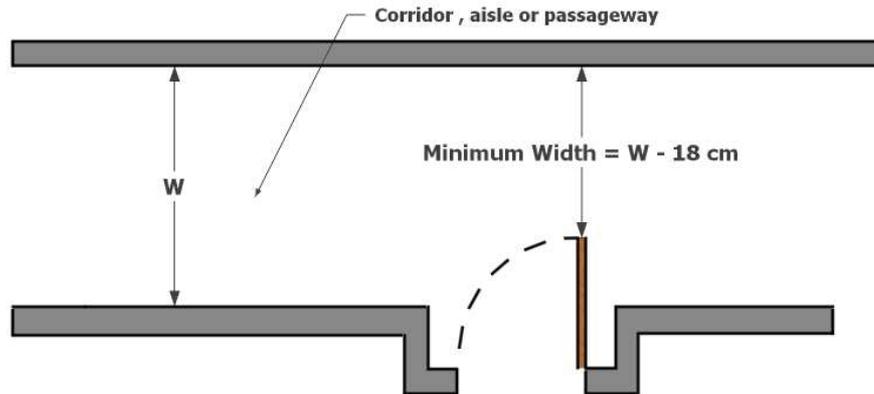
Case-2: Horizontal Projection into means of egress

Section 8.3.3.3



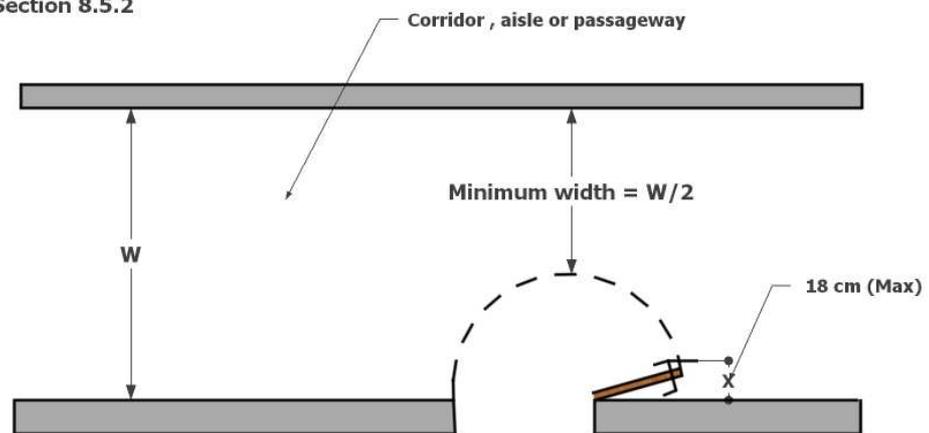
Case-3: Door projection into corridor, aisle and passageway (90 degree fixed door swing into path of egress)

Section 8.5.2

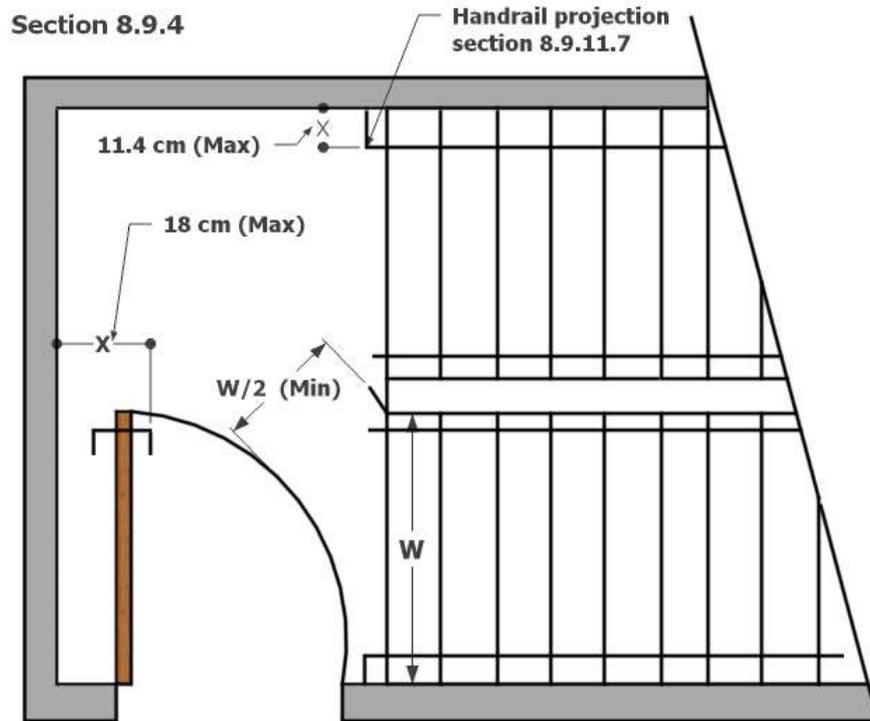


Case-4: Door projection into corridor, aisle and passageway (180 degree door swing into path of egress).

Section 8.5.2

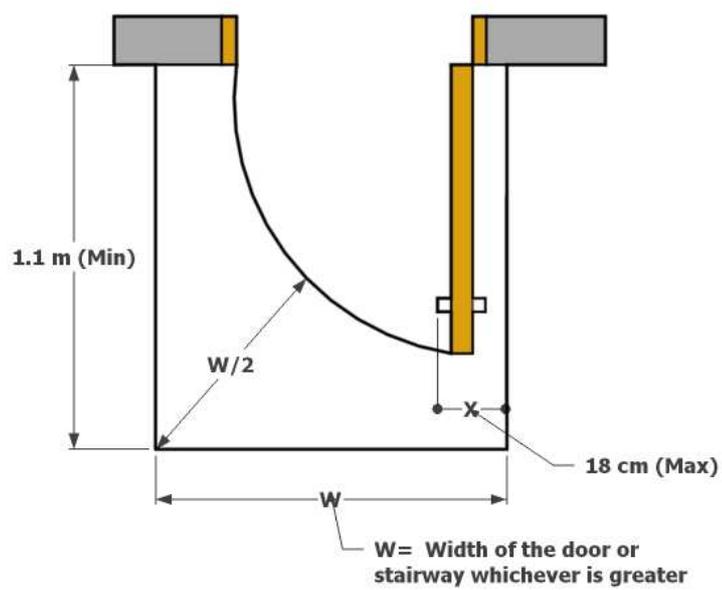


Case-5: Door projection into stairway landing.



Case-6: Door projection into door landing

Section 8.8.1.5



Step-20: Check the General Requirements of Means of Egress as Listed Below. (Reference: SBC -801, Sections 8.3.4, 8.3.6 & 8.3.7.)

1. Walking surface shall be slip resistance and attached securely to the floor.
2. Path of egress travel shall not be obstructed by any building element.
3. No escalator or elevator or moving walkway is permitted to be part of mean of egress.

Appendix –C

Survey Results

TABLE C.1: Factor Ranking By General Administration of Civil Defense

Group	Sub-Factors	Extreme effect	Strong effect	Moderate effect	Slight effect	Does not effect	Total Responses	Important Index	Rank
		x=4	x=3	x=2	x=1	x=0		\bar{x}_i	
A	Code Text and Language							75.93	Fourth
1	The original version of the Saudi code is written in English language	2	4	3			9	72.22	10
2	The translation of the English Version of the code to Arabic Version	5	3	1			9	86.11	3
3	The Code requirements are subject to different interpretations among the A/E professionals	2	4	2	1		9	69.44	12
B	Enforcement Practice							73.61	Sixth
4	Mixing of old regulations or other sanders requirements with the new Saudi Building Code requirements	2	1	5	1		9	61.11	14
5	Lack of a written building inspection policy and procedures by the building authorities	2	5	1	1		9	72.22	10
6	the tendency of using a restricted implementation policy(violation, fee, stop work orders)	4	4	1			9	83.33	5
7	Lack of violations tracking system.	3	4	2			9	77.78	8
C	Building Authorities and Design Offices Practice							77.50	Second
8	Implementing the Saudi building code increases the working load of your office	1	2	5		1	9	62.50	13
9	Lack of continues Coordination between the building code authorities	4	5				9	86.11	3
10	Lack of continues coordination between the design offices and building authorities	5	3	1			9	86.11	3
11	Overlapping of responsibilities between building authorities	3	4	2			9	77.78	8
12	lack of Design office classification	3	4	1	1		9	75.00	9
D	Public Awareness and Insurance Role							76.39	Third
19	The low awareness of the public about the importance of building code	5	2	2			9	83.33	5
20	Lack of an effective role of insurance companies	3	3	1	2		9	69.44	12
E	Construction Methods & Materials							75.46	Fifth
13	The type of construction methods specified in the Saudi Building Code	3	4	1			8	81.25	6
14	The type of materials and equipments specified in the Saudi Building Code	1	5	2		1	9	71.88	11
15	lack of authorized testing laboratories and agencies to test and certify building products	6		1	1	1	9	84.38	4
16	lack of listed and classified building products in the local market	4	2	3			9	77.78	8
17	The code requirements limit the flexibility of buildings architectural design	0	3	4	1	1	9	56.25	15
18	Implementing the Saudi building code increases the project cost	3	4	1		1	9	81.25	6
F	Professionals & Labors Training and Qualifications							85.65	First
21	Lack of specialized training canters in the field of building Codes	4	2	3			9	77.78	8
22	Lack of professionals accreditation programs	4	4	1			9	83.33	5
23	Lack of an effective and related on job training for engineers and inspectors	4	5				9	86.11	3
24	lack of skilled and certified construction labors	7	2				9	94.44	1
25	Lack of certified and trained engineers in the field of building code	4	3	2			9	80.56	7
26	Lack of certified and trained building inspectors	6	3				9	91.67	2

TABLE C.2: Factor Ranking By Design Offices

Group	Sub-Factors	Extreme effect	Strong effect	Moderate effect	Slight effect	Does not effect	Total Responses	Importance Index	Rank
		x=4	x=3	x=2	x=1	x=0		xi	
A	Code Text and Language							62.53	Sixth
1	The original version of the Saudi code is written in English language	5	4	8	6	3	26	58.70	24
2	The translation of the English Version of the code to Arabic Version	5	7	7	3	5	27	65.91	16
3	The Code requirements are subject to different interpretations among the A/E professionals	5	6	11	3	1	26	63.00	19
B	Enforcement Practice							69.46	Fourth
4	Mixing of old regulations or other standers requirements with the new Saudi Building Code requirements	4	8	6	7	2	27	59.00	22
5	Lack of a written building inspection policy and procedures by the building authorities	5	13	5	1	1	25	72.92	12
6	the tendency of using a restricted implementation policy(violation, fee, stop work orders)	6	8	7	5	1	27	64.42	18
7	Lack of violations tracking system.	11	13	2	1		27	81.48	5
C	Building Authorities and Design Offices Practice							74.27	Third
8	Implementing the Saudi building code increases the working load of your office	4	3	8	6	5	26	55.95	25
9	Lack of continues Coordination between the building code authorities	10	14	1	1		26	81.73	4
10	Lack of continues coordination between the design offices and building authorities	9	16	1	0	1	27	82.69	3
11	Overlapping of responsibilities between building authorities	12	6	4	3	1	26	77.00	7
12	lack of Design office classification	9	7	6	2	3	27	73.96	11
D	Public Awareness and Insurance Role							76.83	Second
19	The low awareness of the public about the importance of building code	14	9	1	2	1	27	83.65	1
20	Lack of an effective role of insurance companies	7	8	8	2	2	27	70.00	14
E	Construction Methods & Materials							65.24	Fifth
13	The type of construction methods specified in the Saudi Building Code	2	11	6	2	5	26	65.48	17
14	The type of materials and equipments specified in the Saudi Building Code	2	9	7	4	4	26	60.23	21
15	lack of authorized testing laboratories and agencies to test and certify building products	9	11	4	2		26	75.96	9
16	lack of listed and classified building products in the local market	7	10	6	4		27	68.52	15
17	The code requirements limit the flexibility of buildings architectural design	3	5	8	4	7	27	58.75	23
18	Implementing the Saudi building code increases the project cost	6	4	7	5	4	26	62.50	20
F	Professionals & Labors Training and Qualifications							78.70	First
21	Lack of specialized training centers in the field of building Codes	10	11	3	3		27	75.93	10
22	Lack of professionals accreditation programs	9	10	4	2	2	27	76.00	8
23	Lack of an effective and related on job training for engineers and inspectors	5	14	1	3	1	24	72.83	13
24	lack of skilled and certified construction labors	10	14		2	1	27	80.77	6
25	Lack of certified and trained engineers in the field of building code	12	11	3		1	27	83.65	1
26	Lack of certified and trained building inspectors	10	13	2		1	26	83.00	2

TABLE C.3: Factor Ranking By Municipality

Group	Sub-Factors	Extreme effect	Strong effect	Moderate effect	Slight effect	Does not effect	Total Responses	Importance Index xi	Rank
		x=4	x=3	x=2	x=1	x=0			
A	Code Text and Language							57.13	Sixth
1	The original version of the Saudi code is written in English language	2	2	4	3	2	13	56.82	16
2	The translation of the English Version of the code to Arabic Version	5	2		5	1	13	64.58	12
3	The Code requirements are subject to different interpretations among the A/E professionals	1	2	5	4		12	50.00	18
B	Enforcement Practice							69.54	Fourth
4	Mixing of old regulations or other standers requirements with the new Saudi Building Code requirements	1	4	5	3		13	55.77	17
5	Lack of a written building inspection policy and procedures by the building authorities	5	5	2	1		13	76.92	8
6	the tendency of using a restricted implementation policy(violation, fee, stop work orders)	2	6	2	1	1	12	70.45	11
7	Lack of violations tracking system.	6	2	4	1		13	75.00	9
C	Building Authorities and Design Offices Practice							78.46	Third
8	Implementing the Saudi building code increases the working load of your office	3	2	3	3	2	13	61.36	14
9	Lack of continues Coordination between the building code authorities	7	4	1	1		13	82.69	6
10	Lack of continues coordination between the design offices and building authorities	6	6	1			13	84.62	5
11	Overlapping of responsibilities between building authorities	4	5	3		1	13	77.08	7
12	lack of Design office classification	7	5	1			13	86.54	4
D	Public Awareness and Insurance Role							86.54	Second
19	The low awareness of the public about the importance of building code	9	1	3			13	86.54	4
20	Lack of an effective role of insurance companies	7	5	1			13	86.54	4
E	Construction Methods & Materials							61.35	Fifth
13	The type of construction methods specified in the Saudi Building Code	2	2	4	2	2	12	60.00	15
14	The type of materials and equipments specified in the Saudi Building Code		3	4	3	2	12	50.00	18
15	lack of authorized testing laboratories and agencies to test and certify building products	3	7	3			13	75.00	9
16	lack of listed and classified building products in the local market	4	4	5			13	73.08	10
17	The code requirements limit the flexibility of buildings architectural design		3	3	4	3	13	47.50	19
18	Implementing the Saudi building code increases the project cost	2	5	2	3	1	13	62.50	13
F	Professionals & Labors Training and Qualifications							88.01	First
21	Lack of specialized training centers in the field of building Codes	7	5	1			13	86.54	4
22	Lack of professionals accreditation programs	8	5				13	90.38	2
23	Lack of an effective and related on job training for engineers and inspectors	10	3				13	94.23	1
24	lack of skilled and certified construction labors	4	6	1	2		13	73.08	10
25	Lack of certified and trained engineers in the field of building code	7	5			1	13	89.58	3
26	Lack of certified and trained building inspectors	10	3				13	94.23	1

TABLE C.4: Factors Ranking By NCSBC

Group	Sub-Factors	Extreme effect	Strong effect	Moderate effect	Slight effect	Does not effect	Total Responses	Importance Index	Rank
		x=4	x=3	x=2	x=1	x=0		xi	
A	Code Text and Language							54.24	Fifth
1	The original version of the Saudi code is written in	3	3	5	3	4	18	60.71	13
2	The translation of the English Version of the code to Arabic Version	2	1	8	3	4	18	53.57	16
3	The Code requirements are subject to different interpretations among the A/E professionals	1	2	8	5	2	18	48.44	18
B	Enforcement Practice							66.32	Third
4	Mixing of old regulations or other standers requirements with the new Saudi Building Code requirements	1	5	7	4		17	54.41	15
5	Lack of a written building inspection policy and procedures by the building authorities	3	8	6		1	18	70.59	8
6	the tendency of using a restricted implementation policy(violation, fee, stop work orders)	6	2	6	4		18	63.89	12
7	Lack of violations tracking system.	4	11	3			18	76.39	6
C	Building Authorities and Design Offices Practice							62.41	Fourth
8	Implementing the Saudi building code increases the working load of your office	0	4	4	6	3	17	46.43	20
9	Lack of continues Coordination between the building code authorities	3	8	3	4		18	63.89	12
10	Lack of continues coordination between the design offices and building authorities	3	11	2	2		18	70.83	7
11	Overlapping of responsibilities between building authorities	2	7	6	1	2	18	65.63	9
12	lack of Design office classification	2	10	3	3		18	65.28	10
D	Public Awareness and Insurance Role							73.33	Second
19	The low awareness of the public about the importance of building code	8	7	3			18	81.94	3
20	Lack of an effective role of insurance companies	2	8	5	2	1	18	64.71	11
E	Construction Methods & Materials							53.79	Sixth
13	The type of construction methods specified in the Saudi Building Code	1	3	2	7	4	17	46.15	21
14	The type of materials and equipments specified in the Saudi Building Code	1	3	4	6	3	17	48.21	19
15	lack of authorized testing laboratories and agencies to test and certify building products	9	7	2			18	84.72	1
16	lack of listed and classified building products in the local market	3	3	9	2	1	18	60.29	14
17	The code requirements limit the flexibility of buildings architectural design		1	1	7	9	18	33.33	22
18	Implementing the Saudi building code increases the project cost	2		7	4	5	18	50.00	17
F	Professionals & Labors Training and Qualifications							81.54	First
21	Lack of specialized training centers in the field of building Codes	8	6	3	1		18	79.17	5
22	Lack of professionals accreditation programs	7	7	3			17	80.88	4
23	Lack of an effective and related on job training for engineers and inspectors	7	10		1		18	81.94	3
24	lack of skilled and certified construction labors	7	9	2			18	81.94	3
25	Lack of certified and trained engineers in the field of building code	7	9	2			18	81.94	3
26	Lack of certified and trained building inspectors	8	8	2			18	83.33	2

TABLE C.5: Factors Ranking by SASO

Group	Sub-Factors	Extreme effect	Strong effect	Moderate effect	Slight effect	Does not effect	Total Responses	Importance Index	Rank
		x=4	x=3	x=2	x=1	x=0		\bar{x}_i	
A	Code Text and Language							25.00	Fifth
1	The original version of the Saudi code is written in English language				1		1	25.00	4
2	The translation of the English Version of the code to Arabic Version				1		1	25.00	4
3	The Code requirements are subject to different interpretations among the A/E professionals				1		1	25.00	4
B	Enforcement Practice							43.75	Fourth
4	Mixing of old regulations or other standers requirements with the new Saudi Building Code requirements				1		1	25.00	4
5	Lack of a written building inspection policy and procedures by the building authorities			1			1	50.00	3
6	the tendency of using a restricted implementation policy (violation, fee, stop work orders)			1			1	50.00	3
7	Lack of violations tracking system.			1			1	50.00	3
C	Building Authorities and Design Offices Practice							60.00	Third
8	Implementing the Saudi building code increases the working load of your office				1		1	25.00	4
9	Lack of continues Coordination between the building code authorities		1				1	75.00	2
10	Lack of continues coordination between the design offices and building authorities		1				1	75.00	2
11	Overlapping of responsibilities between building authorities		1				1	75.00	2
12	lack of Design office classification			1			1	50.00	3
D	Public Awareness and Insurance Role							75.00	Second
19	The low awareness of the public about the importance of building code		1				1	75.00	2
20	Lack of an effective role of insurance companies		1				1	75.00	2
E	Construction Methods & Materials							37.50	sixth
13	The type of construction methods specified in the Saudi Building Code				1		1	25.00	4
14	The type of materials and equipments specified in the Saudi Building Code				1		1	25.00	4
15	lack of authorized testing laboratories and agencies to test and certify building products			1			1	50.00	3
16	lack of listed and classified building products in the local market			1			1	50.00	3
17	The code requirements limit the flexibility of buildings architectural design				1		1	25.00	4
18	Implementing the Saudi building code increases the project cost			1			1	50.00	3
F	Professionals & Labors Training and Qualifications							83.33	First
21	Lack of specialized training centers in the field of building Codes		1				1	75.00	2
22	Lack of professionals accreditation programs		1				1	75.00	2
23	Lack of an effective and related on job training for engineers and inspectors		1				1	75.00	2
24	lack of skilled and certified construction labors	1					1	100.00	1
25	Lack of certified and trained engineers in the field of building code		1				1	75.00	2
26	Lack of certified and trained building inspectors	1					1	100.00	1

TABLE C.6: Factors Ranking by Saudi Council of Engineers

Group	Sub-Factors	Extreme effect	Strong effect	Moderate effect	Slight effect	Does not effect	Total Responses	Importance Index	Rank
		x=4	x=3	x=2	x=1	x=0		\bar{x}_i	
A	Code Text and Language							75.00	Third
1	The original version of the Saudi code is written in English language			1			1	50.00	3
2	The translation of the English Version of the code to Arabic Version	1					1	100.00	1
3	The Code requirements are subject to different interpretations among the A/E professionals		1				1	75.00	2
B	Enforcement Practice							93.75	Second
4	Mixing of old regulations or other standers requirements with the new Saudi Building Code requirements		1				1	75.00	2
5	Lack of a written building inspection policy and procedures by the building authorities	1					1	100.00	1
6	the tendency of using a restricted implementation policy(violation, fee, stop work orders)	1					1	100.00	1
7	Lack of violations tracking system.	1					1	100.00	1
C	Building Authorities and Design Offices Practice							70.00	Fourth
8	Implementing the Saudi building code increases the working load of your office				1		1	25.00	4
9	Lack of continues Coordination between the building code authorities	1					1	100.00	1
10	Lack of continues coordination between the design offices and building authorities	1					1	100.00	1
11	Overlapping of responsibilities between building authorities	1					1	100.00	1
12	lack of Design office classification				1		1	25.00	4
D	Public Awareness and Insurance Role							75.00	Third
19	The low awareness of the public about the importance of building code	1					1	100.00	1
20	Lack of an effective role of insurance companies			1			1	50.00	3
E	Construction Methods & Materials							50.00	Fifth
13	The type of construction methods specified in the Saudi Building Code			1			1	50.00	3
14	The type of materials and equipments specified in the Saudi Building Code					1	1	0.00	4
15	lack of authorized testing laboratories and agencies to test and certify building products		1				1	75.00	2
16	lack of listed and classified building products in the local market		1				1	75.00	2
17	The code requirements limit the flexibility of buildings architectural design			1			1	50.00	3
18	Implementing the Saudi building code increases the project cost			1			1	50.00	3
F	Professionals & Labors Training and Qualifications							100.00	First
21	Lack of specialized training centers in the field of building Codes	1					1	100.00	1
22	Lack of professionals accreditation programs	1					1	100.00	1
23	Lack of an effective and related on job training for engineers and inspectors	1					1	100.00	1
24	lack of skilled and certified construction labors	1					1	100.00	1
25	Lack of certified and trained engineers in the field of building code	1					1	100.00	1
26	Lack of certified and trained building inspectors	1					1	100.00	1

Appendix –D

Experts Survey Form

Expert Evaluation

To building code expert,

Please find attached a document that contains a set of guidelines to help A/E professionals in implementing the fire protection requirements of the proposed Saudi Building Code. It was prepared as partial requirement of a master thesis presented to the Architectural Engineering Department at King Fahad University of Petroleum and Minerals in May 2009 based on the draft edition of the proposed Saudi Building Code issued in 2007 and the International Code Council publications.

The following are not in the scope of these Guidelines:

1. Structural requirements.
2. Maintenance or housekeeping related requirements.
3. Hazardous requirements.
4. Existing buildings requirements.

Based on your experience with international building codes, please evaluate and rate the attached Guidelines as follows:

Criteria		1 (Strongly Disagree)	2 (Disagree)	3 (No opinion)	4 (Agree)	5 (Strongly Agree)
1	Clear (<i>In term of language</i>)					
2	Simple (<i>effortless to comprehend by the reader</i>)					
3	Consistence (<i>free from contradictory rational</i>)					
4	Comprehensive (<i>content covers all cases or scenarios covered by the scope</i>)					
5	Methodical (<i>orderly displays the process followed</i>)					
Your years of experience with building code		1-5 Years	5-10 Years	10-15 Years	15-20 Years	More than 20
Recommendations						
1						
2						
3						

VITAE

Name : ALI ABDURAHMAN YAHYA AL-MUDHEI

Nationality : Saudi

Address : Saudi Arabian Oil Company
P.O. Box 11026
Dhahran 31311, Saudi Arabia

Telephone : +9663-872-8133

E-mail : ali.mudhei@aramco.com