

PERCEPTION OF TRIANGULATED STRUCTURE SYSTEM IN HIGH-RISE
BUILDING DESIGN

ABOLGHASEM BASSIR

A thesis submitted in fulfilment of the
requirements for the award of the
Master of Architecture

Faculty of Built Environment
Universiti Teknologi Malaysia

SEPTEMBER 2012

*To my beloved wife and my lovely children for their sincere help and companion
during my studies*

ACKNOWLEDGEMENT

I would like to thank my supervisor Prof. Dr. Mohd Hamdan Bin Haji Ahmad for his valuable suggestions, guidance and consistent support throughout this thesis. My thanks are also due to the members of staff of Architecture Department, and Faculty of Built Environment, Universiti Teknologi Malaysia, who contributed to my research.

ABSTRACT

Design of a high-rise building, like any architectural design, is a complex multidisciplinary process with the objective to discover, detail and construct a system to fulfil a given set of performance requirements. In the past decade, significant developments in architectural expression, and increasing demand for lighter and taller buildings resulted in a systematic evolution of structural systems. The developments in the steel industry contributed to the structural efficiency of these new framing concepts. The main design criteria for tall buildings are governed by the lateral stiffness in order to resist wind and earthquake forces. Many countries in the world are exposed to destructive forces of nature like tsunamis, earthquakes and tornados. Considering these factors, construction which can deal with natural disasters is needed for the new generation of structure and Architecture. Although structural engineers have come up with solutions for these criteria, still the numbers of massive concrete structures are the limit for architects to design more efficient space in plan and forms. This research presents a different description of huge triangle frame as a mega structural system for optimal structural design. This structure system provides capability to design a more diverse high rise in terms of shape and forms. The highlighted advantages and disadvantages of this structure system, is compared to the other routine structural systems. Therefore four different buildings are chosen to be compared in terms of criteria involved in high rise design. The efficiency of the comparison of this structural system is the main concern of this research. While this study focuses on high rise buildings, the proposed structural system for the conceptual design is directly applicable to any type of architectural design and objective related criteria.

ABSTRAK

Rekabentuk bangunan tinggi seperti mana rekabentuk senibina yang lain, adalah satu proses pelbagai disiplin yang kompleks dengan objektif untuk menemui, memperinci dan membina satu sistem untuk memenuhi satu set keperluan prestasi yang dikehendaki. Pada dekad yang lalu, perkembangan yang ketara dalam ungkapan senibina, dan permintaan yang semakin meningkat bagi bangunan yang ringan dan yang tinggi mengakibatkan satu evolusi yang sistematik dalam sistem struktur. Perkembangan dalam industri keluli menyumbang kepada kecekapan struktur berkonsepkan kerangka baru. Kriteria rekabentuk utama bagi bangunan tinggi ditentukan oleh kekukuhan sisi untuk menahan daya angin dan gempa bumi. Banyak negara di dunia terdedah kepada bencana alam semulajadi seperti Tsunami, gempa bumi dan tornado. Mengambil kira faktor-faktor ini, pembinaan struktur yang boleh menangani bencana alam adalah diperlukan untuk generasi senibina dan struktur yang baru. Walaupun jurutera struktur telah menemui penyelesaian untuk kriteria ini, namun bilangan struktur konkrit besar adalah takat bagi arkitek untuk mereka bentuk ruang yang lebih cekap dalam pelan dan bentuk. Penyelidikan ini membentangkan huraian perbezaan bingkai segitiga besar sebagai satu sistem struktur mega untuk rekabentuk struktur yang optimum. Sistem struktur ini menyediakan keupayaan rekabentuk untuk bangunan tinggi yang pelbagai dari segi bentuk dan rupa bentuk. Kelebihan dan keburukan yang diketengahkan dalam sistem struktur ini telah dibandingkan dengan sistem rutin struktur lain. Oleh itu, empat bangunan yang berlainan dipilih untuk dibandingkan dari segi kriteria yang terlibat dalam rekabentuk bangunan tinggi. Perbandingan kecekapan sistem struktur ini adalah menjadi tujuan utama kajian ini. Walaupun kajian ini memberi tumpuan kepada bangunan tinggi, cadangan sistem struktur untuk konsep rekabentuk secara langsung boleh digunapakai dalam apa-apa reka bentuk senibina dan objektif kriteria yang berkaitan.

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CHAPTER 1

INTRODUCTION

1.1 Problem Statement of Topic

Nowadays architecture is designed in simple shapes, cube form and geometrical volume. This is caused by structure system in a building, we must follow structure to achieve design forms. This is a time for the rejuvenation of architectural forms, shapes and space. In some countries there is earthquake problem, which need a structural system that can give better resistance against earthquake and ensure a stable building.

By using space triangle frame as a mega structure system we can delete column in our architecture and by combination of this space frame modules we can design fractal forms and shape. There are three main factors that are studied during this research. These are as follows:

1.2 History and Development

There has been considerable research over the last few years on structure, also there are some researches about basic structure, and how it works. How human beings found the usage of structure, and how engineers make buildings with grid structure. The conclusions of these independent surveys carried out in the building industries studied how the best combinations of using structure system criteria may be evolved. The needs of the users (as opposed to the designers, buildings, or

managers) of a building are paramount. In many organizations, the wages cost forms a significant part of the total costs. To achieve real `value for money for its owners, and optimum conditions for its users, attention must be paid to user experience.

1.3 Space Triangle Frame Structure

This is one of the important structure system (space frames) on which regulations are based, as well as developing understanding of these research areas, the module should enable the architect to develop or adapt tests for novel situations, and for purposes of monitoring and evaluation of building effectiveness.

1.4 High Rise Buildings and Mega Structure

In this research the high-rise building and usage of mega structure issues relevant to the building industry will be covered. The patterns of changing structure system in the production of materials and equipment as well as materials. Building form, mass, internal layout and orientation all characterize how a building will react to airflow, heat, loads, and earthquake.

1.5 Research Questions

The key research questions are:

- i) How did space triangle frame structure system, help to build stable building, without huge size of column, large amount of steels and heavy structure?
- ii) What difference does it make by using space triangle frame as a mega structure in high-rise form and shape?

1.6 Research Aim

The aim of this research is to identify appropriateness of triangle space frame as a mega structure in high-rise structure system and the ability of changing form and shape.

1.7 Research Objectives

- i) To establish the importance of space frame in mega structures.
- ii) To create innovation in architectural space through space triangle frame development in mega structure.
- iii) To establish perception of new approach for architecture using space frame.

1.8 Scope of the Research

It has been claimed that 'structure' is always divided into two categories that is physical and efficient which relates physical safety to the design aspect, an architecture where the efficient aspect of the perception of mega structure mention associates to the architecture. It is agreeable to his claim as refer to both dictionaries; it suggested space frame as having both qualities.

This definition leads to the understanding of the space triangle frame design that could promotes physically - which could be accessed by the way architect design a building, as well as efficiency in that design (Fazlur Khan, 2006). Although architectural designer such as planner and architects practiced established theories. Related to this in the design of mega structure especially for the high rise, is however, in the end, the architects who will determine the success of the design.

This research will only focused on the space frame as a mega structure because this method is the efficient way for designing high rise buildings. This space frame form distinguished itself from other types via its size, form, efficient, function the other buildings that are known. This research also examines the influence of space frame as a mega structure in high-rise architecture and while the architect used to design by other structural methods.

1.9 Research Methodology in Brief

- i) Studies on theories and hypotheses, books and published essays on the matter and extract shared and contradicted ideas and taking advantage of different comments.
- ii) Field study involving questionnaires and interview.
- iii) Case study
- iv) Examining into known objective standards for those elements that constitute a Space triangle frame development in mega structure to create innovation in architectural space.

1.10 Organization of thesis

The first chapter discusses the introduction of thesis and research work. Chapter two discusses various literature reviewed that make up the background of this research. The following chapter three presents the methodology adopted for this research. Chapter four presents the case studies of mega structures, while chapter five discusses the analysis of findings of this research. Chapter six presents the conclusion.

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