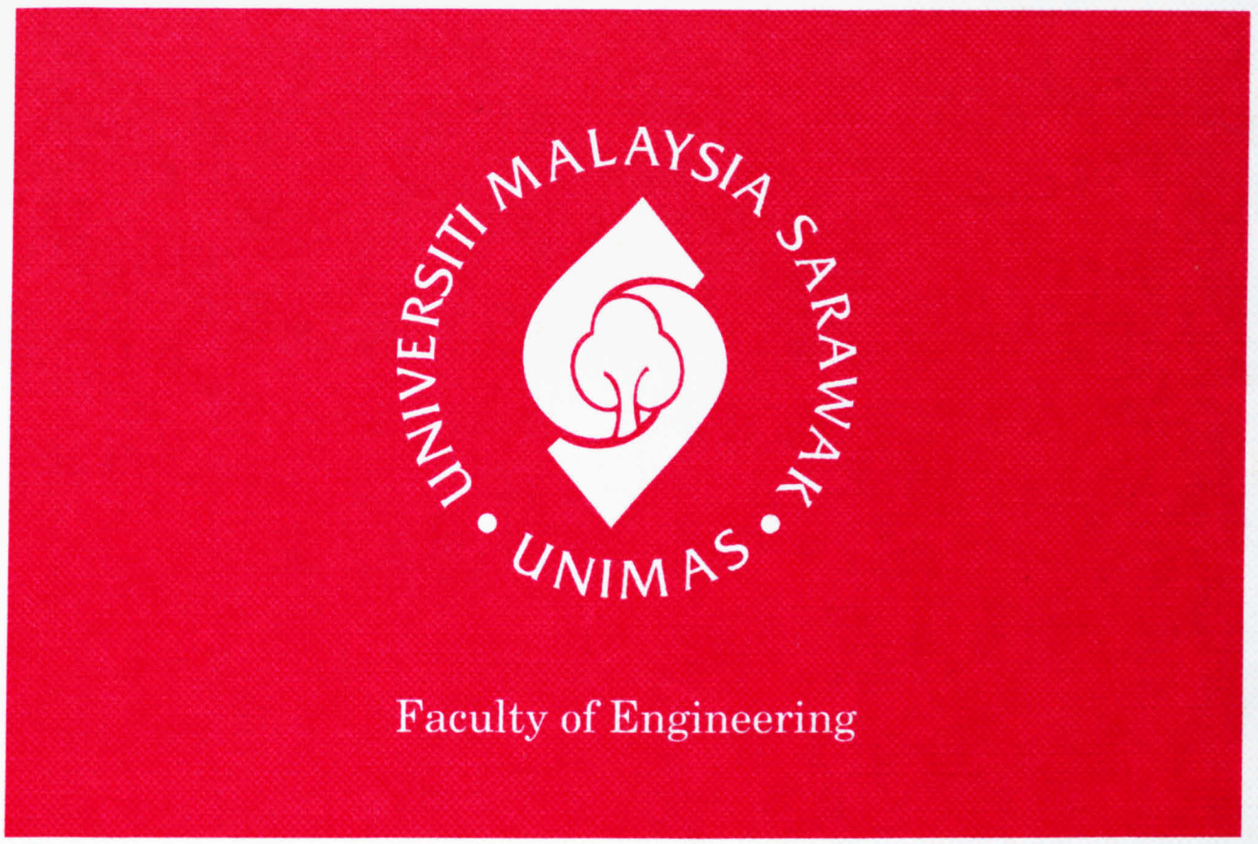

DESIGN OF A SINGLE STOREY HOUSE USING STEEL STRUCTURAL ELEMENTS

Sitihanafiah Binti Ruasin

Bachelor of Engineering with Honours
(Civil Engineering)
2006

Universiti Malaysia Sarawak

fk

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Judul: DESIGN OF A SINGLE STOREY HOUSE USING STEEL STRUCTURAL ELEMENTS

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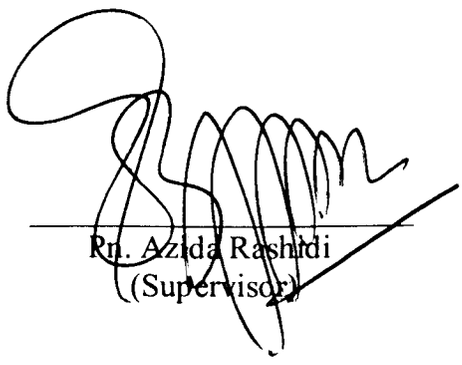

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(Supervisor)

12 JUNE 2006
(Date)

DESIGN OF A SINGLE STOREY HOUSE USING STEEL STRUCTURAL ELEMENTS

SITIHANAFIAH BINTI RUASIN

This project is submitted in partial fulfillment of
the requirements for the degree of Bachelor of Science with Honours
(Civil Engineering)

Faculty of Engineering
UNIVERSITY MALAYSIA SARAWAK
2006

ACKNOWLEDGEMENT

Bismillahirrahmanirrahim

Very sincere thanks to my supervisor Puan Azida Rashidi for the support, guidance, advices, and knowledge that has been given throughout finishing this final year project. This project will never complete without your guidance and encouragement.

To my beloved mother and father, very deep thanks from bottom of my heart for all your support, pray and love that encouraging me. With your support and encouragement I finally finish this project.

Last but not least, i also would like to thank to my lecturers for all the knowledge that they have teach me and to all my friend thanks for the kindness in giving support and help to complete this project.

ABSTRACT

This research is about designing a single storey house using steel structural elements. This research is done by using hand calculation in the analysis and design of the steel structural member with accordance to BS5950-1:2000.

Simple design method is used in designing the house. As the general principal of design is to insure that the structure is capable to sustain the loads through its life span limit state design principle is applied in the analysis of this project. The member must satisfy the design criteria such as shear strength, moment capacity, deflection and other criteria that must take into consideration.

The scope of this study is only concentrating in designing the steel beam, column and column baseplate which there is no reinforced concrete design included in the analysis and design. This study only considering dead load and imposed load and also only considering hot rolled section.

The result of this research shows that the proposed member size is adequate according to design code BS 5950: Part 1 – 2000. UB 127x67x13, UB 203x102x23, UB 305x127x48 and UB 305x127x42 were found adequate sizes for the beams however UB 305x127x48 and UB 305x127x42 is quite large; which is not suitable for the single storey house. Column size UC 152x152x23 and column baseplate size 250x250x15mm were found adequate for the single storey house construction.

The feasibility of using steel in residential house construction also discussed in this study.

ABSTRAK

Kajian ini adalah berkenaan dengan merekabentuk rumah setingkat dengan menggunakan bahan keluli. Analisis dan rekabentuk rumah setingkat ini dilakukan dengan menggunakan kaedah penggiraan tanpa menggunakan sebarang perisian komputer tetapi berpandukan kod rekabentuk struktur keluli BS5950 -1:2000.

Kaedah rekabentuk yang digunakan dalam kajian ini ialah **'Simple design method'.** Prinsip umum dalam rekabentuk bangunan adalah untuk memastikan struktur bangunan dapat menampung beban yang ditanggung. Bahan struktur keluli yang digunakan mesti menepati criteria yang ditentukan didalam kod rekabentuk. Ruang lingkup kajian ini hanya memfokuskankan rekabentuk rasuk, tiang dan tapak tiang dan tiada rekabentuk konkrit prategasan dilakukan dalam kajian ini. Limitasi kajian ini juga hanya mempertimbangkan beban mati **(dead load)** dan beban hidup **(live load)** dan bahan struktur keluli yang dibuncangkan hanya 'hot rolled section'.

Berdasarkan kepada kajian, didapati saiz rasuk yang dicadangkan iaitu UB 127x67x13, UB 203x102x23, UB 305x127x48 and UB 305x127x42 menepati standard kod rekabentuk struktur keluli. Walaubagimanapun didapati bahawa UB 305x127x48 and UB 305x127x42 adalah saiz yang kurang sesuai digunakan kerana terlalu besar. UC 152x152x23 untuk tiang dan tapak tiang saiz 250mmx250mmx15mm adalah sesuai .

Selain daripada analisis dan rekabentuk yang telah dijalankan, kajian ini juga merangkumi kajian terhadap kebarangkalian dan kebolehan struktur bahan keluli sebagai bahan dalam pembinaan rumah.

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NOTATIONS

A	-	Area of section
A_{be}	-	Effective area of baseplate
A_g	-	Gross sectional area of steel section
A_v	-	Shear area
B	-	Breadth of section
b	-	Outstand of flange
c	-	Largest perpendicular distance from the edge of the effective portion of the baseplate to the face of the column cross-section
D	-	Depth of section
d	-	Depth of web
E	-	Modulus of elasticity
F_c	-	Ultimate applied axial load
I_x, I_y	-	Second moment area about the major and minor axes
L	-	Actual length
L_e	-	Effective length
M	-	Design moment or large end moment
M_b	-	Buckling resistance moment
M_c	-	Moment capacity
M_{cx}, M_{cy}	-	Moment capacity of section about the major and minor axes in the absence of axial load

M_x	-	Maximum major axis moment
M_{LT}	-	Maximum major axis moment in the segment between restraint against lateral torsional buckling
m_{LT}	-	Equivalent uniform moment factor for lateral torsional buckling
P_v	-	Shear capacity of a section
P_c	-	Compressive strength of steel
P_b	-	Bending dtrength of steel
P_y	-	Design strength of steel
p_{yp}	-	Design strength of baseplate
r_x,r_y	-	Radius of gyration of a member about its major and minor axes
Sx,Sy	-	Plastic modulus about major and mionr axes
T	-	Thickness of flange
t	-	Thickness of web
t_p	-	Thickness of baseplate
u	-	Buckling parameter of the section
x	-	Torsional index of section
Z_x, Z_y	-	Elastic modulus about major and minor axes
n	-	Slenderness factor for beam
β_w	-	A Ratio for lateral torsional buckling
λ	-	Slenderness ratio
λ_{LT}	-	Equivalent slenderness ratio
ω	-	Pressure under the baseplate

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter discussed the introduction to the project that had been carried out. The scope of study, objectives of the study and the significant of study are included in this chapter.

1.2 Background of study

Building construction is the erection of various types of materials to form building. There were stages that should be followed to construct any projects. Design stage is a part of it and can be said as the most critical and important stage whereby the design of the structure will be performed and analysis will take place to confirm that the design is adequate for construction.

Designing is an important stage that required to be satisfactory and acceptable by the clients and surely by engineers in order to produce a safe structure. Design process is both creative and technical and requires a fundamental knowledge of material properties and the laws of mechanics which govern material response (R.C. Hibbeler, 2002). Good and well designed project produce good quality of work and product besides reduce the project cost.

Analysis is part of the design process but only take place after the basic form of the structure has been decided. A particular structure will be analyzed or investigated to determine the distribution of its force throughout the various members that make up that structure, determine the distribution of stress and other required calculation to insure the design is adequate. The analysis of structure is necessary to prove that the structure is strong enough to support the loads as the aim of it is to get as close as possible to correct solution in order to avoid the various factors that can affect the structure.

Selection of types of materials that is going to be used must be really taken into consideration such the properties and the performance of the materials. It is necessary to know the material's behavior if the safety, reliability and durability are concern. Although materials that is strong and cheap are desirable for construction but it is really necessary to examine various factors that can affect the safety and durability of structure.

1.3 Scope of study

The objective of design is to provide the information necessary for the construction of a single storey house including drawing, plan, detailing of connection and others. According to Frederick S. Merritt, the ultimate objective of design is production of drawings or a plan, showing what is going to be constructed, specification stating what materials and equipment are to be incorporated in the building, and a construction contract between client and a contractor (1994). But for this study, the equipment specification and construction are not discussed. Plans are produced to specify the proposed design of the house that is going to be design.

In this study the scope of the project is limited which is only to design the steel beam, column and column baseplate. There is no reinforced concrete design involved in this study. The loads that was taken into consideration is only the dead load and the imposed load which is defined at clause 2.4.1.2 of BS5950 which mean the wind load is not affecting the house structure. Only hot rolled formed steel section is considered in this study.

Inadequate design of any construction project can bring to unsuccessful and sometimes disastrous product. Through the analysis of this design project study, the adequacy of design will be achieved. Actually, in the process of designing, several studies are required before adopting the most suitable structural form for the specified project.

1.4 Significant of study

Design process is involving several of procedure. Even though only the analysis procedure was discuss in this study but it has create intention that design work must be really done in proper way as to insure that the structure is safe and anyone that carry out any building or other construction should aware and responsible to create safety structure for the end users. Design not only fulfilling the client requirement but also meeting the cost provided, quality of product and safety beside the time consuming for the completion of the project.

Some knowledge concerning the behavior of materials is vital if, safe, reliable and long-lasting structures are result (Derek Seward, 1998). Study on properties of structural materials gave better understanding of how selection of materials is very important, through the design process which can affect the structure. Properties such strength and stiffness of the materials, it's durability, fatigue, brittle fracture and other properties was really take into consideration. This can be use as guidance in choosing materials for the structure that is going to be constructed. Thus any failure can be avoided.

Apart from the analysis and design, this study also see the feasibility of using steel structural element in residential construction by considering some issue that promoting steel to become the material for house construction.

As the study focus on steel design, it is hope that this study can be used as a source of reference for future study and perhaps encourages other people who involved in this industry to deliver better quality of work by do good quality of design project towards producing good quality of structure.

1.5 Objective

The objective of this study is to analyze and design the residential house. Below are the main objectives that have to be achieved in this study.

1. To analyze and design the structural elements that commonly used in residential or domestic construction.
2. To identify the steel structural elements in designing the project study according to BS 5950: Part 1.
3. To study the detailing and connection of the steel elements in a single storey house.
4. Determine the feasibility study of using steel for house construction.

1.6 Conclusion

This chapter began with the introduction of the design project which indicates the scope of the study and the objective of this study. The next chapter will discuss about the theory and other literature review that relevant to this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will discuss about the theory, concept and literature reviews that related with the steel structural elements design and analysis.

2.2 Steel background

Steel is iron alloyed with small amount of carbon. Various types of steel are produced by varying the percentage of carbon. Besides the quantity of carbon added, other factors such as the cooling rate influence the properties of steel produced. To produce consistent and reliable steel for structural purpose quality control are required.

High strength, high fracture toughness, longer fatigue life, high corrosion resistance and better weldability are the user demands for new constructional steel (Yuhshi Fukumoto, 1990). The common type of steel used is mild steel because apart

from the properties mentioned it is also cheaper. High yield steel is a stronger grade and commonly used for reinforcing bars in concrete. It has irregular surface pattern to improve bond in the concrete. There were also some special types of steel for special purpose such as stainless steel which has high corrosion resistance.

2.3 Design method

British Standard codes of practice for structural steelwork BS5950:Part 1:2000 'Structural use of steelwork in Building' will be used for the design analysis of the structural elements. The method for designing will be focused on the limit state design. The concept of limit state design is to produce a safe and economical structure that fulfills its required purpose.

In accordance to clause 2.1.2 of BS5950 the design method for building are carried out by three design methods.

2.3.1 Simple design

In this method, the connection between members is assumed not to develop moment that affecting either the member and or the whole structure. The structure is assumed to be pin jointed for analysis. The structure should

laterally restrained both in-plane and out-plane to resist horizontal stability and provide sway stability.

2.3.2 Rigid design

Rigid design is also known as continuous design which elastic and plastic analysis method can be used for the analysis. The connections are assumed to be capable resist the moment and forces resulting from the analysis.

2.3.3 Semi-rigid design

This method which also known as semi continuous design may be used where the connection have some degree of strength and stiffness which means it can transmit some moment and elastic and plastic analysis.

2.4 Loading

In structural design the loading needs to be estimated for the life span of the structure.

The types of loads carried by structural member are

(i) Dead load from self weight of beam, slabs, finishes and other load that the beam should be carry.

(ii) Imposed loads from people, fittings, snow on roof and others

(iii) Wind loads mainly purlins and sheeting rails.

The characteristic dead and imposed loads can be obtained from BS 6399: Parts 1 and 3. Wind load should be determined from BS 6399: Part 2 or from CP3: Chapter V: Part 2. Clause 2.4.1.2 of BS5950 state the principal of loads combination.

2.5 Factor of safety

Clause 2.1.3 of BS 5950: Parts 1 stated that structures should be designed by considering the limit states which the structure become unfit for their intended use. To obtain design loading at ultimate limit state the characteristic load is multiplied by a load factor, γ_f. For dead load the load factor is 1.4 and for imposed load is 1.6.

2.6 Design of steel structural member procedure

The design of steel structural member procedures is as stated in section 4 of BS5950: Part 1.