COST EFFECTIVE COMPARISON BETWEEN CONCRETE AND STEEL COMPOSITE STRUCTURE FOR 2 STOREYS BUILDING.

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ABSTRACT

Cost is one of the important things to be considered in construction sector but also to other sector such as selling business. However this research more concentrated in construction sector which are fast developing in Malaysia. Day by day, material price for construction is increasing. Statistics showed many projects is interrupted due to mistake cost calculation during planning stage. Therefore it is important to understand how overall price could be influenced. Price scope involved in this research is price of material, labour wage and machinery rental cost. This research is carried out by comparing two types of building which is concrete structure and steel composite structure. The constant variable for both structures is area of the building. This thesis is to study which building material is more economical and the most influencing of overall cost based on Malaysia current trend of building structure materials.. To analysis the project, two software is using which is Esteem 4.0 and Microsoft Project 2007. Other that, price calculation will be calculated manually. At the end of the research there are significant differences in the overall price that can be guide for those responsible to choose which structure actually is cost saving for the current being.

ABSTRAK

Kos merupakan salah satu perkara yang sangat dititikberatkan dalam sektor pembinaan bangunan malah perkara-perkara lain seperti penjualan barangan. Namun penyelidikan ini lebih tertumpu dalam sektor pembinaan yang sedang pesat membangun di Malaysia. Hari demi hari, harga bahan untuk pembinaan semakin meningkat..Statistik menunjukkan banyak projek tergendala disebabkan kesalahan mengira harga semasa tempoh perancangan. Oleh itu adalah penting untuk memahami bagaimana harga keseluruhan boleh dipengaruhi. Antara skop harga yang terlibat adalah harga bahan, upah pekerja dan kos sewa mesin sepanjang projek dijalankan. Penyelikan ini dijalankan dengan membeza harga dua jenis bangunan iaitu struktur konkrit dan struktur komposit besi. Antara yang dimalarkan adalah keluasan kedua-dua projek tersebut. Objektif thesis ini adalah untuk mempelajari bahan pembinaan mana yang lebih menjimatkan serta yang paling mempengaruhi harga keseluruhan. Antara perisian komputer yang digunakan adalah, Esteem 4.0 dan Microsoft Project 2007. Selebihnya, pengiraan harga akan dibuat menggunakan kiraan manual. Di akhir penyelidikan ini, perkara yang dijangka adalah perbezaan harga keseluruhan yang ketara menyebabkan kontraktor-kontraktor tidak teragak-agak untuk memilih struktur manakah yang sebenarnya menjimatkan dari segi kos.

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LIST OF SYMBOLS / SHORT FORM

3D	Three dimension
Ar	Span over depth ratio
As,prov	Area of steel provided
As,req	Area of steel required
ASCE	Committee on Composite Construction
b	Base
B	Width
b/T	Flange slenderness
BCI	Building Materials Cost Index
cm	Centimeter
CPM	Critical Path Method
D	Depth
d/t	Web slenderness
DL	Dead load
Fcc	Concrete Axial Load
Fcd	Concrete Bending Capacity
Hf	Effective height
I	Second moment of area
JKR	Jabatan Kerja Raya
kg	Kilogram
kg/m	Kilogram per meter
kN	Kilonewton
kN/m^2	Kilonewton per meter square
kNm	Killonewton in meter
LL	Live load
Lx	Length in x direction
Ly	Length in y direction
M	Design bending moment
m	Meter
m^2	Meter square
m^3	Meter cube

Mc	Elastic moment resistance of section
MF	Modification factor
mm	Milimeter
Mp	Plastic moment resistance of composite section
Msx	Moment at support in x direction
Msy	Moment at support in y direction
Mx	Moment in x direction
Mxe	X-Moment Eccentricity
My	Moment in y direction
Mye	Y-Moment Eccentricity
N	Ultimate load
Nuz	Pure Axial load
Py	Steel grade
RC	Reinforced Concrete
RM	Ringgit Malaysia
Sr	Slenderness ratio
Sx	Required section modulus
t	Thickness
UL	Total Ultimate load
V	Applied ultimate shear force
Vc	Shear capacity
w	Factored distributed load
W	Factored point load
Wu	Total factored load
Xc	Neutral axis depth into concrete
Ze	Elastic section modulus
Zx	Elastic modulus

CHAPTER 1

INTRODUCTION

1.1 Introduction

For nowadays in the age that concern for economics, it is essential to construct building in affordable price but in good quality. In many views, cost-effective meaning is influenced by individual's interest and on how they understand the meaning of "cost-effective" .In determining the cost-effective, require a life-cycle perspective where all costs and benefits of a given project are compared over its economics life.

Cost-effective can reduce time, money and manpower toward construction progress. Wilson et al found costs effective are incredibly tools that must be constantly adjusted to function efficiently. The economics of building has become as complex as its design.

Decisions made by engineers, managers, corporation presidents, and individuals are commonly the results of choosing one alternative over another. Engineers play a major role in capital investment decisions based on their analysis, synthesis, and design efforts.

We can achieve cost effectiveness in construction at various stages right form planning to construction. Essential aspect of planning a house is that user friendly environment is available at all the time to the occupants and must satisfy our needs. Time consuming and labour intensive components in exterior may be avoided. Examples are putting ornamental borders, art work on wall and Sunshades, Putting unsymmetrical and costly elevations in the name of architecture etc., shall be avoided.

1.2 Problem Statement

Materials are the main factor that can affect overall price for a building. Designers should consider carefully the selection of materials for a project to produce economic building with same strength. However, with the lack of cost-effective knowledge can lead to the wrong material selection. Thus, the problem is to identify the best material that could be used for the structural system prior to cost effectiveness for two storey building in Malaysia specifically

1.3 Objective of the study

The research is going to study about material selection in construction due to cost-effectiveness. The study will take analysis in cost, activity and materials for structural work only. Also calculate overall cost using current local market price and "Kadar Harga Kecil 2011" by JKR and arrange construction activity using Critical Path Method after designing structure using Esteem Plus software.

1.4 Scope of study

This research will compare the cost of concrete structure and composite structure for two storeys building in structural work. Firstly, the study will design the two-storey building with 4 lot of shop with different structure using Esteem Plus software. After that, all activities in construction progress will be considered using Microsoft Project. Then, the study will examine the design structure, the factors that affect cost, and how those differ among material selection. The examination will be implemented using Bill of Quantity.

1.5 Expected outcome

At the end of the research, there will be differ in price for concrete structure and composite structure. The most economics structure must short in duration, less activity and no delay. The Microsoft Project will show which project is shorter in duration. And, percentage of price differ will be showed using Statistic Graph in Microsoft Excel.

1.6 Significance of the study

The result of this research can give financial planning information to most contractors in Malaysia. They can decide properly which structure will gain same strength but less in cost. More than that, the research can provide knowledge in planning work and selection best materials. Also, the study can develop practical procedure for assessing cost-effectiveness analysis which takes into account market interactions and agents adaptive behaviors.

1.7 Conclusion

This chapter is introducing the meaning of cost-effective roughly among construction people and how they understand the factor that affecting the price of the building. Other that, this chapter also identifies the problem statement to be investigated along the research which is how material is affecting overall building cost. By that, the objective is to study about material selection in construction due to cost effectiveness. There is a scope of study in fulfill the research objective which mainly is comparing the cost for concrete structure and composite structure. After the research is finish, expected outcome is there will be differ in price for both structure and proof this research can give financial planning information.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will be explained about my research knowledge for cost comparison between concrete structure and composite structure for two storey building. The knowledge sources are from previous researcher journal, website, article, theory and others. This chapter is important because, it will make my research more credible for everybody mostly contractor or designer.

Cost comparison research in the construction industry involves the investigation of all matters that including cost. The research will give the benefit for client, contractor or developer or to suit the needs of professionals in the industry.

In the Malaysian context, the Industrialised Building System must replace the traditional building practises in order to save on labour, cost and time of construction. More than that, it can increase quality and durability (Elias, 200). However, there is no organized body that able to give information about building cost comparison between conventional and fully prefabricated system for Malaysia construction industry. Thus, it is necessary to finish this particular study.

2.2 Cost Comparison between Conventional and Industrialised Prefabrication System

Minister of Housing and Local Government in 1964 identified two pilot projects in order to try out the industrialised prefabrication system. Project A was constructed along Jalan Tun Razak (Jalan Pekeliling) for the construction of 7 blocks of 17-storey flats, and 4 blocks of 4-storey flats. Project B was constructed for 6 blocks of 17-storey flats and 3 blocks of 18-storey flats in Pulau Pinang. (Harun Din, 1984)

After both of projects were completed, an evaluation was done to compare the advantages and disadvantages of both system which is conventional and industrialised system in terms of cost, speed of construction, labour requirement and quality control. The results are evaluated as follows:

2.2.1 Cost

Conventional system for Project A was cheaper than Industrialised prefabricated construction. Its cost was 8.1% lower than an Industrialised prefabricated system completed around that time. Meanwhile for Project B, the cost was 2.6% higher.

2.2.2 Speed

The time taken to complete both projects is 27 months including the time taken in setting up the precasting factories. However, industrialised building system has more advantages than conventional construction which is;

- Saving of time and materials involved in the erection of scaffoldings
- Shorter construction time as a result of well-planned and co-ordinated sequence of construction
- Not affected by weather condition as building components are manufactured in the factory, and there is no on-site concreting.

2.2.3 Labour Requirement

Less of labour number need to handle industrialised building system which is can save labour cost up to 30%-40% mainly of skilled labour. We already know skilled labour cost is too expensive compare to normal labour. We can overcome this by introducing industrialised building system into construction which can be managed by normal labour and less of number.

2.2.4 Quality

The industrialised building system method shows it quality higher compare to conventionally built low cost housing unit. It is because the interior walls was much superior to be achieved by using cement sand hollow blocks.

2.3 Labour Cost

Labour cost is a very important component that can influence overall cost of project construction. The cost of a work progress, type, category and performance of the labour should be considered before construct begin because it will brings a lot of different in cost. Skilled labour wage is high and depend on craftsmanship type and the employee competence.

For labour cost calculation, usually labour output average is used. This labour output average was average time taken by an employee to complete some unit work. Correct labour usage is important to generate right labour cost. Contractor might bear the loss if during making price rate calculation, he is lowering labour time that it is needed by labour to complete a work unit. However, if the labour time is too much that it might increasing tender price.

2.4 Technology Improvement

Technological improvement during the construction phase of the project makes the biggest contribution to constructability enhancement. As a result those improvements contribute to manpower-input reduction can shorten the schedule and reduce the costs.

The potential impact of the technological improvement was assessed by comparison with the potential impact of the other types of improvements, such as formal preplanning, logistics, working conditions, professional level of the construction managers and the foremen. Technological improvements were perceived as having the same impact as the professional level of construction managers and preplanning, yet a higher impact than working conditions.

The possible reason for long duration in construction according to writers' judgement, are listed below in the following

- The projects are much various than projects in other organization so manpower does not have a good chance to specialize.
- The site engineers and construction managers are mostly junior engineers, who change jobs very frequently as they get promoted
- The annual work program is subject to constant changes caused by operational claim.

More user-friendly construction technologies will definitely improve the external conditions for the workers to perform the task, enabling them to present a higher total performance.

2.5 Consider all possible on site scenarios

The analysis in comparing for two building structure will be using bill quantity and critical path method (CPM) calculation. CPM scheduling is a technique that has been used since the 1950s, and the construction industry benefits from it's for planning and controlling the projects and communicating plans.

Project managers usually use project management software for calculating critical path analysis, such as Primavera Project Planner P3 or Microsoft Project, which are based on heuristic methods to plan and control schedules. In one research investigation, labour productivity improved by 6% when resources were considered in CPM schedules and an additional 4–6% improvement was obtained when using computerized systems Perdomo-Rivera 2004.

Schedules may not simulate reality if they do not incorporate material constraints. Also there are some other variables that can affect construction duration such as activity durations, early start time, late start time, early completion time, normal costs and crash costs. The weather, traffic, and all availability resources like skilled workers, machines, equipment, etc also can cause delay problem. Therefore, float calculated using CPM techniques will lose its significance and new critical sequences will occur.

2.6 Building Materials Cost Rising For Peninsular Malaysia

The Building Materials Cost Index (BCI) is an index designed to measure the average rate of change of building materials prices in Malaysia market. Starting from January 2009 publication, the series is based on the revised base year which has been charged from (July 2002 = 100) to (July 2008 = 100) as well as the selection of new building material specification and weight age updated by JKR

2.6.1 Calculation of percentage changes

Building Materials Cost Index	180.5
Less previous index	100.0
Difference	80.5
Percentages	80.5 %

2.6.2 Building materials cost index

Table 2.1: Building material cost index (with steel bars)
Year 2009 - 2011 (July 2008 = 100)

Category of building	Period		Region
			Pahang
2-4 Storey (R.C) building (Flat Roof)	2009	Jan	91.6
		Feb	91.4
		Mac	91.1
		April	90.3
		May	90.9
		June	91.0
		July	90.7
		August	90.4
		Sept	92.4
		Oct	91.9
		Nov	92.1
		Dis	94.3
	2010	Jan	94.1
		Feb	94.6
		Mac	97.8
		April	98.8
		May	100.6
		June	99.3
		July	99.0
		August	99.2
		Sept	99.6

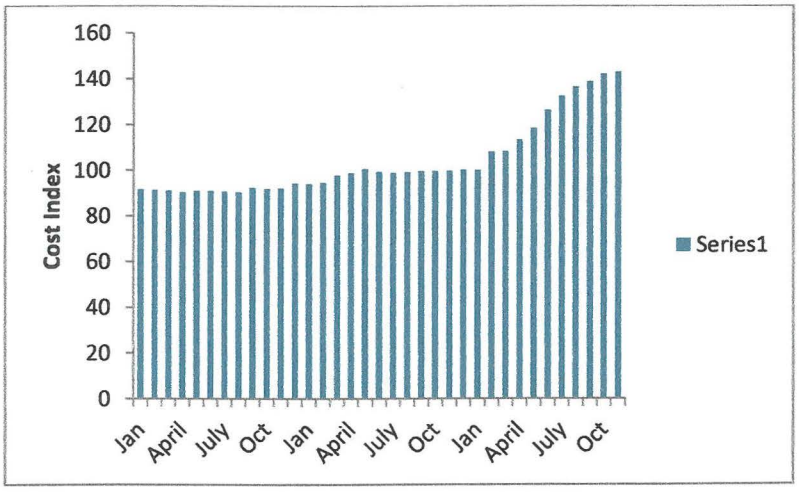
	Oct	99.6
	Nov	99.7
	Dis	100.2
2011	Jan	100.0
	Feb	108.0
	Mac	108.4
	April	113.4
	May	118.4
	June	126.3
	July	132.4
	August	136.5
	Sept	138.6
	Oct	142.0
	Nov	142.9

Source: Department of Statistic, Malaysia

Steel is the main component used in construction, it price will be increasing if the demand of steel in construction is higher. The steel component is expensive compare to other component because its element is hard to be found nearly Malaysia. From the table above, we can observe the steel price is increasing from 2009 until 2012. To understand more realistic of above table, the graph is plotted below.

Chart 2.2: The building material cost index in statistic graph.

Year 2009 - 2011 (July 2008 = 100)



Sources: Department of Statistic, Malaysia

In year 2009, the graph shown that the building prices is slightly increasing. As well in year 2010, there are not much of prices changing. But for year 2011, the graph show that the price of building is rapidly increased.

This may happen due to development plans in conjunction with Rancangan Malaysia Ke-10 (2011-2015). In this plan, there are new investments on construction sector and also many new projects for next 5 years. Thus, when the demand for building materials is increasing can caused wholesalers to raised material prices. The increase in cost production and demand will push the prices of some materials. From that, it will affect overall project prices.

The continued rise in prices of construction materials would have a big impact on clients and the contractor is implementing the project. Meanwhile, the client also feels the impact of prices increasing causes him to slow or narrow the scope of the project.

2.7 Construction Consideration for Composite Steel-and-Concrete Floor Systems

There is improvement since past 40 years toward composite systems. At the beginning of composite-steel, it first serve is as work platforms and concrete formwork and as slab reinforcement in resisting loads after the concrete hardens. The advantages of using composite structure is to improve economy resulting from more realistic design specifications and from better construction methods. ASCE Committee on Composite Construction during 1997 had done the informal survey that indicated that construction-related problem in composite floors are widespread and costly. However, these problems can be however by improving communication between designers and builders.

There are two method in constructing composite floors; shored and unshored. In a shored system, temporary supports are placed beneath the beams or joist in order to reduce deflection when concrete is placed. For unshored system, the beams and girders support the loads and there are deflects when concrete is placed. However,

extensive test show that the flexural strength of a composite beam is same whether it is shored or unshored when concrete is placed Viest et al 1997. In order to decrease cost in construction, the unshored system must be approached because it costly to install and remove shoring also can cause delay for other construction activities until they can be removed.

2.8 Construction Project Scheduling With Time, Cost and Material Restrictions

Schedules are initially stage in construction management, yet all possible scenarios should be considered. CPM technique with discrete information has proved to be more effective instead of continuous functions. (Moder et al. 1983). Therefore, having similar characteristics such as the plans and project duration, and using the same equipment, standard conditions, and resources for two projects does not imply the application of the same procedure nor guarantee similar results. Condition could change and there could be delays and unexpected situations that arise during construction.

For example, as the demand for steel or cement increases, deliveries could be delayed and activity might be cancelled. Thus, Project Manager may use their experience to help achieve the goal or objective as effectively as possible by replanning and rescheduled projects when it becomes necessary to do so.

2.9 Conclusion

Understanding cost-effective is important before construction project planning. Planner will practically cut the project cost if he knew exactly what the main factor that affect the price. Construction cost must be lower as possible to win project tender and bring huge profit to the company. Thing that must remain unchanged is the quality of the building. Most contractors will reduce the cost by construct the building below requirement provided. It will lead to structural damage and contractor must pay for maintenance cost thus it will increase the building price.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Methodology is a guideline system for solving problem statement which is content components such as phases, tasks, methods, techniques and tools. A methodology can be considered to include various methods, which will be applied for each step to obtain the final results. This chapter will be explaining a guideline to analysis the data for cost comparison between concrete structure and composite structure for two storey building. Comparative method will be used to identify which structure design is cost effective. Comparative method is a technique for studying comparison of two or more component with common types.

3.2 Cost Comparison Steps

Cost effective can be investigated by following four major stages:

1. Design
    a. Design two-storey building using Esteem Plus software for conventional structure