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CREATING CUSTOMIZED WALL FAMILY LIBRARY USING REVIT 2014

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ABSTRACT

BIM applications in construction projects bring many benefits to construction players such as improving communication between construction players and facilitating faster design decision. Moreover, one of the BIM features is ease of use related to its tools; hence, the use of BIM can reduce time spent in design as well as decrease cost and duration of construction Revit architecture become one of the popular BIM tools that has widely used in construction industry.Together with drafting building components in 2D and 3D, it also allows 4D BIM which facilitates for architects and engineers. Wall is one of the elements in Revit. Wall is a structure that defines an area, carries a load, or provides shelter or security. The barrier which always happen in revit is the limitation of wall type in standard Revit family library .Moreover, type of wall that has been provide is not fulfil the specification for construction industry. To cater the issue, this study has been conducted to identify and develop customized wall family library_By using edit type method, new type of wall were created to be used by the BIM user. This semi structure interview was conducted in order to achieve the objectives. The respondents consisted of architects, contractors, developers, consultants and quantity surveyors. The processes of developing new customized wall are using Revit 2014 software. In conclusion, the limitation in standard wall family library in Revit has been identified and discussed. From this research new customized wall family library has been created by using edit type method to catcher the issue of limitation of wall type in standard Revit. This solution can help engineer/architect to develop their own customized wall which is fulfilling the specification from industry.

ABSTRAK

Aplikasi BIM dalam projek-projek pembinaan membawa banyak manfaat kepada peserta pembinaan seperti meningkatkan komunikasi antara pekerja pembinaan dan memudahkan keputusan reka bentuk yang lebih cepat. Selain itu, salah satu ciri BIM adalah kemudahan penggunaan yang berkaitan dengan alat-alat; dengan itu, penggunaan BIM boleh mengurangkan masa yang digunakan dalam reka bentuk dan juga pengurangan kos dan tempoh pembinaan. Selain merangka komponen bangunan dalam 2D dan 3D, ia juga membolehkan 4D BIM yang memudahkan untuk arkitek dan jurutera. Dinding adalah salah satu elemen dalam Revit. Dinding adalah satu struktur yang menentukan kawasan, membawa beban, atau menyediakan tempat perlindungan atau keselamatan. Halangan yang sentiasa berlaku dalam revit adalah had jenis dinding di perpustakaan keluarga Revit standard. Selain itu, jenis dinding yang telah disediakan tidak memenuhi spesifikasi bagi industri pembinaan. Bagi memenuhi isu itu, kajian ini telah dijalankan untuk mengenal pasti dan membangunkan perpustakaan keluarga dinding yang disesuaikan. Dengan menggunakan kaedah mengedit jenis, jenis baru dinding dicipta untuk digunakan oleh pengguna BIM. Temubual separa struktur telah dijalankan untuk mencapai objektif. Responden terdiri daripada arkitek, kontraktor, pemaju, perunding dan juru ukur bahan. Proses membangunkan dinding baru disesuaikan menggunakan perisian Revit 2014. Kesimpulannya, batasan di perpustakaan keluarga dinding standard dalam Revit telah dikenal pasti dan dibincangkan. Dari kajian ini perpustakaan keluarga dinding yang disesuaikan baru telah dibuat dengan menggunakan kaedah mengedit jenis untuk penangkap isu had jenis dinding dalam standard Revit. Penyelesaian ini boleh membantu jurutera / arkitek untuk membangunkan dinding mereka sendiri serta yang memenuhi spesifikasi dari industri.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter contains general ideas and information about BIM and Revit. The following section is present in this chapter which are background of study, problem statements, research objective and scope of the study.

Construction industry nowadays has been through several eras of change according to their interests and needs. Few reasons has been detect such as cost overrun, using traditional technology, delay, and production of low quality product. Expert has come out with a few solutions. One of them is using BIM software which is nowadays has recently attained widespread attention in the architecture, engineering and construction industry. It helps architect, engineer and contractor to visualize what is to be building in simulated environment and to identify potential design, construction or operational problem.

Building Information Modelling is the development and use of a multi-faceted computer software data model to not only document a building design, but to simulate the construction and operation of a new capital facility or a recapitalized (modernized) facility.(wong and qing,2013)

Diverse BIM tool such as Revit architectureTM, ArchiCADTM, Bentley architectureTM, etc. has been widely adopted. Most popular is Revit architectureTM tool.

Revit architecture is Building information modelling software for architects, structural engineers, MEP engineers, designers and contractors. It allows users to design a building and structure and its components in 3d, annotate the model with 2D drafting elements, and access building information from the building model's database. (Charles River, October 31, 1997)

1.2 BACKGROUND OF STUDY

BIM is a process which contains the features of digital representation of physical and serviceable features of any project. BIM is an innovative way that supports an automated way to be connected electronically among integrated companies. It focuses on delivering quick and reliable information for different functions such as estimating, structural analysis, demolition, reconstruction and others.

It covers whole building's information including wall systems, structural systems, HVAC equipment, plumbing etc. Building information models facilitate decision making about resources through design and construction at the earliest conceptual stage. Various computer programs and software packages have been developed for facilitating the practitioner in easy used of BIM techniques.

Autodesk Revit Architecture is a robust architectural design and documentation software application created by Autodesk for architects and building professionals. The tools and features that make up Revit Architecture are specifically designed to support building information modelling (BIM) workflows. By utilizing BIM as opposed to computer-aided drafting (CAD), Revit Architecture is able to leverage dynamic information in intelligent models — allowing complex building structures to be accurately designed and documented in a short amount of time. Each intelligent model created with Revit Architecture represents an entire project and is stored in a single database file. This allows changes made in one part of the model to be automatically propagated to other parts of the model, thus enhancing the workflow for Revit Architecture users.

Autodesk Revit Architecture is used by architects and other building professionals to help reduce risk, obtain insight into how buildings will perform before construction begins, develop better quality designs, and improve project delivery. For example, a school of architecture may use Revit Architecture as the software of choice to help its 600 full-time students gain real-world experience using a BIM workflow to build high-impact 3D models. In the case of an engineering and architectural services firm, Revit Architecture may be used to fast-track the complex design and construction of a building that wraps around distillery processing equipment and allow for a high level of future maintenance and improvements. Ultimately, Revit Architecture is used to create accurate building designs while minimizing the time it takes to coordinate and design in a virtual environment. This, in turn, allows ideas to be worked through faster and helps to maintain better consistency across projects.

Autodesk Revit is a popular BIM software package which facilitates for architects and engineers. Together with drafting building components in 2D and 3D, it also allows 4D BIM. This has the ability of planning, developing and tracking the project through various stages of lifecycle of a project starting from conceptualization to completing execution, maintenance and demolition.

Various tools of Revit such as built to support BIM workflows can make the practitioners vision able to capture; analyse concepts and maintain through design, documentation and construction [2]. Revit products use RVT files for storing BIM models. It is also capable of performing collision checking which is very useful in detecting whether different components of the building are occupying the same physical space. Revit also supports open XML-based Industry Foundation Classes (IFC) standard, developed by the building SMART organization. This file helps a client or general contractor in obtaining, coordinating and maintaining BIM-based workflow from the different discipline consultants of a construction project. Since, IFC is a non-proprietary and human readable format; its compatible with other databases, such as facility management software

1.3 PROBLEM STATEMENT

Building Information Modelling (BIM) is a collaborative tool used by architectural, engineering and construction (AEC) industries based on a number of software solutions. It is a technology and a process to manage construction projects. BIM is a set of technology developments and processes that has transformed the way infrastructure is designed, analysed, constructed and managed. BIM can enhance and improve planning process, design and construction of projects. BIM concept has been introduced since 1970 by Professor Charles M. Eastman. In mid-year of 2000, AEC industries have started to implement BIM in construction projects The United States of America (USA) is the first country to implement BIM.

In terms of usability, BIM tools such as Revit Architectural and Revit Structural are able to illustrate construction processes through 4-Dimensional (4D) simulation and clash detection. Furthermore, BIM has proven itself through successful projects that have been managed in other countries such as the USA, the UK, Hong Kong and Australia. Examples of the successful projects are One Island East in Hong Kong, Hilton Aquarium Atlanta, Georgia, The Freedom Tower, New York and The Sydney Opera House, Australia. Additionally, the reliability of data exchange between architects and structural engineers must be verified before proceeding to develop a model that can facilitate other processes such as mechanical and electrical design, estimates and construction phase process.

The main problem faced by architect in the Malaysia construction industry is because the default to create the model for the building before the construction phase begin. This is because of the limitation of wall type in the standard library of Revit. Based on the specification from real project, for brick walls, a common thickness is 230mm(9"), and for concrete block walls, common thicknesses are 200mm(8"), 150mm(6") and 100mm(4").Common type of wall that has been used in Malaysia is masonry wall. Detail information about the type of wall has been discuss in chapter 2. So this research is a study to attempt an answer for limitation of wall type in standard Revit problem and to proposed

method to create new customized wall family library using edit type method to help BIM user create their own customized library and cater the issue about limitation in type of wall.

1.4 OBJECTIVES OF STUDY

The objectives of the study are:

i. To analyse specification for wall properties in real field industry

ii. To investigate type of wall has been used in standard Revit

iii. To establish new architecture wall family library using REVIT 2014 software

1.5 SCOPE OF STUDY

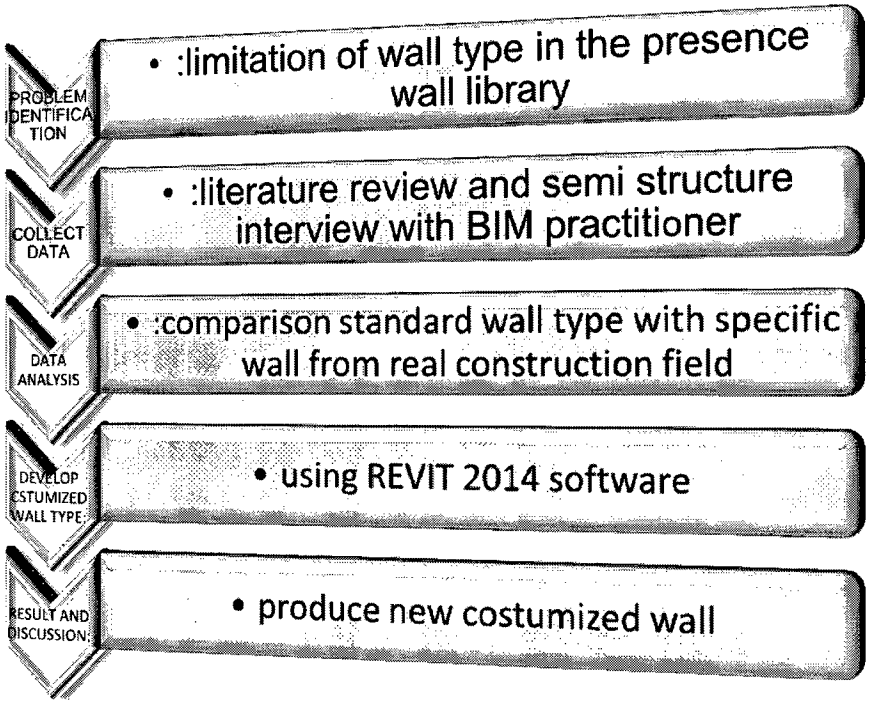
The scope of this study is simplifying processes for gathering the information and data collection about the use of Revit in developing new family library for wall type. This study analysed within the appropriate time limit that is conducted under supervision from Faculty of Civil Engineering and Earth Resource of University Malaysia Pahang. The detail of the scope of study will be explain in research methodology.

In order to achieve the objectives of this study, the scope of the research only focusing on the development of construction industry in Malaysia. Concentrating on construction industry in Malaysia could give a clearer sight of view of the overall development in local industry. therefore the research are just restricted to the building projects that uses Revit only. By review on previous researches that focus on the similar area of study, some of the barriers was highlighted and the input is obtained by questionnaires for interview prepared based on it. The respondents are mainly consisted of contractors, consultants, developers, in Malaysia. This is to survey on the type of wall that has mostly used in construction industry.

The analyses are based on respondent's data from semi structure interview only. The analysis results do not represent the whole construction industry in Malaysia. However the discussion is based on comparison of the analysed data and information from literature studies. Conclusions were made according to objectives of the study.

1.6 RESEARCH METHODOLOGY

The research methodology has been carried out to fulfil the objectives of the study which include the method of data collection such as documents study, case study, and data collection. The research procedures are as shown in **Figure 1.1**



1.7 SIGNIFICANT OF THE STUDY

The purposes of the study are:

i. Determine the problem that face by engineer according development of wall in Revit

ii. To reduce the problem according wall family library in Revit software

iii. Guide user to develop their own wall family library for their Revit model

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Building information modelling (BIM) is a process involving the generation and management of digital representations of physical and functional characteristics of places. Building information models (BIMs) are files (often but not always in proprietary formats and containing proprietary data) which can be exchanged or networked to support decision-making about a place. Current BIM software is used by individuals, businesses and government agencies who plan, design, construct, operate and maintain diverse physical infrastructures, such as water, wastewater, electricity, gas, refuse and communication utilities, roads, bridges and ports, houses, apartments, schools and shops, offices, factories, warehouses and prisons.

Building Information Modelling (BIM) is currently being popularized worldwide. BIM is a process which contains the features of digital representation of physical and serviceable features of any project. BIM is an innovative way that supports an automated way to be connected electronically among integrated companies. It focuses on delivering quick and reliable information for different functions such as estimating, structural analysis, demolition, reconstruction and others.

BIM covers whole building's information including wall systems, structural systems, HVAC equipment, plumbing etc. Building information models facilitate decision making about resources through design and construction at the earliest conceptual stage. In system

and measured the benefits to the resultant organisation (direct benefits). The third stage was the post-delivery which measured the benefits to a wider stakeholder community (indirect benefits)

2.2 IMPLEMENTATION OF REVIT FAMILY

Over the last 17 years, the design and construction industry has transitioned from the scale rule and tee-square to the digital scale rule and tee-square known as AutoCAD® and now native 3D BIM construction software, Revit. With each change it also brings new workflows to the construction industry.

Revit family is any related graphical representation of elements that share particular definitions through established parameters that distinguish certain values. The family type parameters are used to define the set of values to identify each family. To better understand this, a family can be bathroom fixtures and family type can be bathtubs, sinks, toilets, shower, shower boxes and so on. The family defines the kind of element that the user wants to use, while the family type essentially specifies the detail that will be used in any particular element of the family. In other words, the family type provides the specifics, while the family provides the general description of the element. There are four levels that can be used when creating an element in a family. The levels include the element category, family, family type and instance.

As mentioned earlier, there are three kinds of families within Autodesk Revit Architecture: in-place families, system families, and standard component families. Each family has specific characteristics that should be carefully studied to understand the features and possibilities when using them in a design. Below is a short description of each and applicability.

- **System Families**

This type of family is predefined and comes loaded in the software. The configuration features available make it possible to duplicate system families to incorporate specific features according to the guidelines of a project. These family types cannot be loaded into the software and it is not necessary to export for use elsewhere; they are already pre-loaded. The Transfer Projects standards command allows the user to transfer system family design between projects. This command is located in the file menu.

- **In-place Families**

Projects that have specific requirements that cannot be addressed with system families or standard component families can be resolved with in-place families. This family category is created by the user according to tailored specifications. It can include anything from specific materials to project-specific components. The Transfer Projects standards command is not applicable to in-place families and if the need arises the user can simply cut and paste to be able to use in another project. The software also allows the user to upload as groups as well.

- **Standard Component Families**

Standard component families are customizable families used to create building components and/or annotation elements. They are different from the system family category because they can be created by the user. The software also comes with predefined component families and allows the user to include designs from a Revit Web Library anyway from the manufacturer's website. These type of families can be saved in external .rfa files which can be loaded into any project. It should be noted that once this is done these are project-specific.

The Family Editor uses reference planes to guide the user when creating different family types. These reference planes take into consideration a coordinated system that makes it easy to create designs in two-and-three dimensions. By varying the length, height, and width of an element the user specify the family type which can be done using the Family

Type Editor. This editor is a pop-up area that can be used to establish the constraints and parameters that define the characteristics of the geometry which will eventually be used in a project. Constraints should be fixed to avoid changes to particular characteristics when editing designs within a family.

The key is to make all families parametric so that designs can be modified when needed. These are also the option to create semi-parametric families which is considerably different from parametric families and should be carefully thought out when used. With semi-parametric families only specific features on the design can be changed as opposed to fully parametric designs in which the entire design can be changed. So for example with a semi-parametric design of a chair where the legs are parametric, only the parameters on the legs can be changed. The seat, handle, or any other feature that is not established as parametric cannot be changed.

When selecting which types of families to work with, a generic family template can easily be used use for different creations. This applies to both engineers and architectures who use the software.

2.3 OVERVIEW TYPE OF WALL IN CONSTRUCTION

Wall is a structure that defines an area, carries a load, or provides shelter or security. There are many kinds of walls such as defensive walls in fortification, walls of buildings which are a fundamental part of the superstructure or which separate the spaces in buildings sections sometimes for the purpose of fire safety, walls which hold back earth called retaining walls, offer protection from oceans such as a seawall or river as a levee. Permanent, solid fences are walls, and border barriers between countries are sometimes walls.

Building walls purposes are to support roofs, floors and ceilings, enclose a space as part of the building envelope, along with a roof to give buildings form, and to provide shelter

and security. In addition, the wall may house various types of utilities such as electrical wiring or plumbing. Wall construction falls into two basic categories: framed walls or mass-walls. In framed walls the load is transferred to the foundation through posts, columns or studs. Framed walls most often have three or more separate components: the structural elements (such as 2×4 studs in a house wall), insulation, and finish elements or surfaces (such as drywall or panelling). Mass-walls are of a solid material including masonry, concrete including slip form, log building, cordwood construction, adobe, rammed earth, cob, earth bag construction, bottles, tin cans, straw-bale construction, indices. Exterior walls may be built with moisture control gaps called a cavity wall, rain screen. Building walls frequently become works of art, externally and internally, such as when featuring mosaic work or when murals are painted on them; or as design foci when they exhibit textures or painted finishes for effect.

Masonry Walls are walls made of brick or cement blocks held together with cement mortar and are often plastered with cement plaster on both surfaces. Cement blocks can also be called Concrete Masonry Units or CMUs, and come in a variety of types, including

- Solid Concrete Blocks
- Hollow Concrete Blocks
- Lightweight Aerated Concrete Blocks
- Fly ash Concrete Blocks

Masonry walls are heavy, and require lots of skilled labour, which means that they are falling out of favour in most countries in which labour is expensive. Their weight is also a problem in high rise building. Other materials for walls include stone or furnace (ceramic) bricks. Stone that is cut into cuboids with smooth faces is called dressed stone, and walls constructed with this type of stone are called ashlar masonry walls. Walls that are made with rough (pieces of stone are called rubber render wall.

For brick walls, a common thickness is 230mm(9"), and for concrete block walls, common thicknesses are 200mm(8"), 150mm(6") and 100mm(4"). In the building trade, the thickness of the walls excludes the plaster, so if a wall is plastered on both sides, its actual thickness will be 1" or 1.5" more than its stated thickness in an architectural Masonry walls cannot be constructed to an unlimited height - broadly speaking, most are considered stable only to a height of 10-15 ft. (3 - 4m). To construct a masonry wall higher than that, you have to design a special wall that has intermediate structural members to support the building.

2.4 FUNCTION OF WALL IN A BUILDING

A wall plays several functions in the performance of a house and these functions need to be fully understood in order to create suitable and comfortable homes for our families.

2.4.1 Sound Proofing

Walls are used as boundary markers to define the various functional spaces within a house plan and there are two types of walls in a house; one type is the internal walls which define the interior spaces while the external wall separates the interior spaces from the external surrounding space. As space dividers, walls also act as acoustic barriers ensuring acoustic privacy between the various rooms which tends to be compromised when dividing walls are only built up to wall-plate level.

Sound or noise will be transmitted from one room to another mainly through airborne transmission as the effective separation between rooms in this kind of construction is only the thickness of the non-continuous ceiling board with the weakest entry points being the joints between the ceiling boards. In such type of construction privacy will be compromised as discussion meant to be private and restricted will easily be audible in next adjoining rooms.

2.4.2 Fire Protection

In order to slow down the rate of flame spread in case of fire within a building, architects apply various techniques including the creation of fire compartments which would contain the fire for some time before spreading to other parts of the building.

One method is to take the block work walls between rooms up to the underside of the roof; for instance and depending on the quality of the aggregates used a 100mm thick solid brick work wall may have a Fire Resistance Rating of up to one and half (1.5) hours while a 200mm thick hollow concrete block work wall may have a Fire Resistance Rating of up to four (4) hours. This may make a significant difference between what may or may not be lost during a fire depending on how a house is constructed and the fire insurance you take may also be affected by the method of construction used in your house.

2.4.3 Load Bearing

Depending on the method of construction adopted walls may be used as structural elements or load bearing walls used to provide an anchor and support to the roof structural system. The walls used in this manner must have the required capacity to carry all the loads imposed on it including the walls' own weight failure to which a building may develop structural cracks which may lead to the ultimate and eventual building failure and shortened life span.

This possibility is even more pronounced especially now that concrete blocks are usually made to anyone's specifications which are usually inferior to the minimum preferred crushing strength of not less than 3.5N/mm2.Partition walls within a house can be used to resist lateral movement in a building and provide cross-bracing in the roof structural system. All these structural benefits may be lost when all internal walls are only built up to wall plate level and out of 150mm thick walls.

2.4.4 Thermal Protection

Geographically Zambia lies between latitudes 8 and 18 degrees south of the equator and between longitudes 22 and 34 degrees east, climatically Zambia is classified as a Tropical Upland. The generally high altitudes tend to lower the air temperatures but the clear skies, however result in strong solar radiation being the dominant climatic design consideration. A building, among other functions, is also a climatic filter and among the various building elements the roof surface receives the highest solar radiation intensity followed by wall surfaces facing east and west. Walls facing south receive the least, if any, solar radiation intensity. There are two major contributors to indoor temperatures which may result in the uncomfortable overheating of indoor spaces.

The first is what is commonly known as the "Green House" effect; window glass panes are practically transparent to short-wave infra-red radiation emitted by the sun entering the house through windows but glass panes are almost opaque to long wave radiation emitted by objects within a room. The consequence of this is that the solar radiation, once it has entered the window, gets trapped inside the building and the temperature just builds up.

The second contributor has to do with the Periodic Heat Flow where in the hot period heat flows from the environment through the built fabric into the inside of a building. Now depending on the thermal characteristics of the wall material the out-door temperature may have reached its peak and started decreasing before the inner surface temperature has reached the same temperature level.

The retention of night-time low wall surface temperatures is desirable in the hot season and the construction of walls with thermal capacities such as of solid masonry or concrete walls with nine (09) to twelve (12) hours thermal time-lag in heat transmission may be used to lower indoor temperatures.

However the thinner the thickness of an external wall the more transparent it will be to heat flow and the less will be the thermal storage capacity, in other words the indoor temperatures may reach their peak at the same time as the out-door air and solar temperatures.

This means a 150mm thick external concrete block work wall may not be as effective in helping lower internal temperatures as may be the case for more massive masonry or concrete walls unless, of course thermal insulation is used. A building, therefore constructed from 150mm thick external concrete block walls is more likely to overheat during the hot season.

2.4.5 Moisture Protection

An external wall also acts as a moisture barrier separating the outer and wet environment from the inner environment and the effectiveness of the wall may depend on the absorptive capacity of the external fabric used.

Normally an architect may need to know whether intense rains are associated with strong winds or the likelihood of driving rain or the Driving Rain Index which characterises a given location and expresses the degree of exposure. Although this index only broadly classifies the given location, the actual rain penetration will depend on the instantaneous rain intensity and the simultaneous wind velocity.

A thin external wall which is likely to easily allow passage of moisture into the inside is unlikely to offer protection against this element even where generous roof overhangs are allowed this may not completely offer protection to such walls and may lead to damp internal wall surfaces during the rainy season.