THE EFFECT OF] :IFFNESS OF THE PROFILED STEEL SHEETING DRY BOARD (PSSDB) FLOOR PANEL

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ABSTRACT

The past decade has seen an increasingly rapid development in the field of construction due to an initiative from the government to boost the economy and enhance the standard of living. However, these rapid changes result in many delayed and non-completion projects. Due to these matters, there is an extremely high number of lost and cost in terms of wastage and pollution. One effective solution is to implement the Industrialized Building System (IBS) such as the Profiled Steel Sheeting Dry Board (PSSDB). PSSDB is a composite structural panel consists of three elements which are the dry board, steel sheeting and self tapping screw as the connection. It can be used as a wall, roof or floor panel. This research studies the effect of dry board thickness on the overall floor panel stiffness. Two different thicknesses of Primaflex dry board; 6 mm and 9 mm, were used whilst the Peva 45 profiled steel sheeting thickness was maintained at 0.8 mm. Bending tests were performed to identify the thickness that contributed to the higher stiffness of the floor panel. From the result, the maximum load for 6 mm and 9 mm boards are 24.51 kN/m^2 and 27.2 kN/m^2 respectively. The stiffness of the panels was also determined from the slope of the load versus the deflection graph. The stiffness value for the 6 mm board is 85 kNm^2/m. In comparison, the stiffness value of 9 mm Primaflex dry board is 89 kNm^2/m. It can be concluded that the thicker the dry board, the stiffer the floor panel will be. The Primaflex dry board has shown to have a better bending flexibility and a potentially suitable dryboard choice in PSSDB.

ABSTRAK

Dekad yang lalu telah menyaksikan pembangunan yang pesat serta kemajuan semakin pesat dalam bidang pembinaan yang berkaitan dengan inisiatif daripada kerajaan ke arah pembangunan negara dan ekonomi. Walau bagaimanapun, perubahan ini pesat membawa kepada masalah yang serius kerana banyak projek tertangguh berlaku dan yang paling teruk terdapat banyak kes-kes projek terbengkalai dilaporkan. Oleh yang demekian, kos kerugian meningkat, pembaziran tinggi dan membawa kepada pencemaran alam sekitar. Cara yang paling penting ialah mencari sesuatu kaedah yang dapat mengurangi perkara tersebut daripada terus berlaku. Oleh itu, Sistem Kepingan Keluli Berprofil Papan Kering yang dikenali sebagai Sistem Bangunan Perindustrian (IBS) akan menjadi sistem yang paling sesuai untuk dilaksanakan di negara ini. PSSDB adalah satu panel struktur komposit terdiri daripada tiga elemen yang terdiri daripada tiga elemen iaitu papan kering, kepingan keluli dan penyambung skrui sebagai sambungan. Ia boleh digunakan sebagai dinding, bumbung atau lantai panel. Salah satu bidang penyelidikan PSSDB yang perlu dikaji adalah kesan ketebalan PSSDB pada kekukuhan panel lantai. Dua ketebalan yang berbeza daripada Primaflex papan kering yang 6 mm dan 9 mm digunakan. Perbandingan boleh dibuat dalam mengenal pasti yang ketebalan berapakah yang menyumbang kepada kekukuhan yang lebih tinggi. Daripada keputusan itu, beban maksimum selama 6 mm dan 9 mm masing-masing adalah 24.51 kN/m2 dan 27.2 kN/m2. PSSDB juga menunjukkan peningkatan dalam kekakuan lenturan, EI. Semakin tebal papan kering, semakin keras panel lantai. Nilai kekukuhan untuk 6 mm ialah 85 kNm2 / m. Sebagai perbandingan, nilai kekukuhan 9 mm Primaflex papan kering adalah 89 kNm2 / m. Primaflex papan kering telah terbukti mempunyai fleksibiliti yang lebih baik lentur dan pilihan dryboard yang berpotensi yang sesuai di PSSDB pada masa akan dating.

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LIST OF ABBREVIATIONS

MMC	Modern Methods of Construction
IBS	Industrialized Building System
PSSDB	Profiled Steel Sheeting Dry Board
EI	Stiffness
UDL	Uniform Distributed Load
P	Load (kN)
L	Length

LIST OF SYMBOLS

kNm^2/m	kilo Newton metre square per metre
mm	millimetre
kN	kilo Newton

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In the history of development in the construction industry, there has been an increasing interest in modern methods of construction (MMC) which is Industrialized Building System (IBS). Since Industrialized Building System (IBS) was introduced in 1960,it has been very popular and highly in demand in Malaysia especially in creating a clean environment in the green technology construction (Jaillon, et al. 2009). However, the issue of green technology construction had been controversial and much disputed within the construction industry as major problem comes from the lack of knowledge and research in developments of IBS System in Malaysia.

The past test years have seen rapidin the construction industry and the government has implemented many acts and Malaysian Plan towards moving a developing country (KPM, 2006). However, traditional construction method requires a large number of waste and pollution to the environment. Since Malaysia has been introduced to the Industrialized Building System (IBS), representatives from the Public Work Department (PWD) together with the Ministry of Housing and Local Government (MHLG) visited a number of European Countries to evaluate their housing development programmes and to implement the programmes in Malaysia (Thornton et al. 2003). This is a way to reduce the number of waste and promotes safer sustainability construction industry. In addition, Green Building Index (GBI) has been developed by government to promote sustainability construction in a built environment (CIDB 2006). Therefore, Malaysia can reduce the problem with the use of IBS.

This chapter includes a brief explanation of the problem statement, research objectives, research questions and significance of the study.

1.2 BACKGROUND OF STUDY

As part of the IBS System, Profiled Steel Sheeting Dry Board (PSSDB) is a lightweight composite structural material consisting of three major elements which are dry board, profiled steel sheeting and self-tapping screws. The dry board is attached to the steel sheeting by multiple numbers of screws in equal distance. The concept is quite similar to the traditional construction which involved reinforcement bar and concrete. The steel sheeting in (PSSDB) will act as a reinforcement bar and the shear will be distributed to self-tapping screws.

In fact, the Profiled Steel Sheeting Dry Board (PSSDB) system can also be used and applied in such a critical condition such as the temporary shelter when disaster occurred such as earthquakes, flood, and also refugee camp due to shorter construction time. The short construction time is based on the material itself as Profiled Steel Sheeting Dry Board (PSSDB) eliminates the use of formwork thus promotes the clean environment and minimize waste and pollution. Therefore, more research on IBSneeds to be carried out to ensure the effectiveness of Industrialized Building System (IBS) in the industry.

1.3 STATEMENT OF THE PROBLEM

The past decade has seen the rapid development as well as increasingly rapid advances in the field of construction. For example, the construction of many houses, schools, offices and others in the country is related to an initiative from the government towards the development of the country and economy. However, these rapid changes leads to serious problems as many delayed projects occurred and the worst there are many cases of non-completion projects had been reported. Due to these matters, there is an extremely high number of lost and cost in terms of wastage and pollution. According to the Housing and Local Government Ministry, the statistics show that abandoned housing projects is increasing year by year (Malaysia National News Agency, 2008).

One of the most significant current discussions is finding the most effective way to reduce the waste and pollution in the construction of building without affecting the strength performance of the structure. Therefore, Profiled Steel Sheeting Dry Board (PSSDB) which is known as Industrialized Building System (IBS) will be the most appropriate system to be implemented in this country. In terms of reducing the number of wastage and pollution, PSSDB material will eliminates the use of formwork and the PSSDB System can be disassembled back easily and kept safely. Besides that, the material can be used back or reusable to other place therefore less wasteful to environment and pollution.

1.4 RESEARCH OBJECTIVES

The following are the research objectives of this study:

- To investigate the effect of Primaflex dry board thickness on the Profiled Steel Sheeting Dry Board (PSSDB) floor panel.
- To determine the stiffness of PSSDB floor panel through bending test.

1.5 SCOPE OF STUDY OF PROPOSED RESEARCH

In this study, the effect of Primaflex dry board thickness on the stiffness of the Profiled Steel Sheeting Dry Board (PSSDB) floor panel will be investigated. The combination of Primaflex dry Board and Peva 45 steel sheeting connected by self tapping screw will be used in this research. The Peva 45 steel sheeting will be the reinforcement bar and the shear will be distributed to the self-tapping screw. Different thicknesses of Primaflex dry board will be used in this experiment. However, the thickness of Peva 45 steel sheeting will be the same and constant. The purpose of different thickness used in this research is to ascertainthe load capacity and the performance of Primaflex dry board. Finally, the stiffness of the Profiled Steel Sheeting Dry Board (PSSDB) floor panel will be determined through bending test.

1.6 EXPECTED OUTCOME OF PROPOSED RESEARCH

The results and data analysis of the study are important to establish the relationship between the thickness of Primaflex dry board and the stiffness. This research focus on the stiffness of the sample values before the material fails. From the bending test, the reading is taken to tabulate the data by plotting the graph. From the graph, load **(kNm^2/m)** versus deflection **(mm)** graph can be obtained. Therefore, the stiffness value can be determined based on the plotted graph. The expected outcome is as the thickness of the dry board increases, the stiffness of floor panel is also increased.

1.7 SIGNIFICANCE OF PROPOSED RESEARCH

The biggest beneficiary will be the construction industry. The Profiled Steel Sheeting Dry Board (PSSDB) floor panel aims to ease the construction work especially in rural areas. In rural areas, some areas might be narrow and limited for transporting precast concrete through the area, so it is inconvenient to use the traditional method. In addition, the machineries and tools such as crane are very limited to use in rural areas. By using the Profiled Steel Sheeting Dry Board (PSSDB) floor panel, problem to transport the material in rural areas can be solved since the dry board can be arranged and stacked on top of each other because of its flat surface and shape. The amount of wastage in the environment and hazardous materials can be reduced as the PSSDB is made up of three elements only and eliminates the use of formwork in construction site. Therefore, cleaner and safer environment can be created.

1.8 GANTT CHART

The research will be done starting from the early semester which takes about 14 weeks. The task and activities of each week is shown in table. (Refer appendix).

1.9 SUMMARY OF THE CHAPTER

In this chapter, preliminary study is needed to conduct a research. In addition, the research objectives and problem statement must be strong and clear enough to carry out this research. The task and activities also need to plan in this chapter by using Gantt Chart. This is to make sure this research is carry out in a systematically way.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In the past few years, Profiled Steel Sheeting Dry Board System (PSSDB) used three major elements which are steel sheeting, dryboard and screw connection and became a new alternative to traditional construction. By using this new method, formwork and concrete will not be required to construct a simple floor panel anymore. Besides that, by using this PSSDB method, it will shorten the construction time, and it is most efficient when transporting, placing and assembling due to the size and thinness, reducing the cost of construction due to the elimination of formwork and concrete compared to the traditional construction processes.

The purpose of PSSDB System in this research with the different thicknesses of the dry board used, aimed to promote the PSSDB and apply it in rural areas or during a critical conditions such as earthquakes, flood and therefore more research related to IBS is needed to be carried out to ensure the effectiveness of PSSDB System. The main purpose of this literature review is to provide information on the components of PSSDB, materials as well as type of test that had been done by the previous researchers.

2.2 INDUSTRIALIZED BUILDING SYSTEM (IBS)

Industrialized Building System (IBS) can be described as a construction technique in which components are manufactured in a controlled environment on-site or off-site, transported, positioned, and assembled into a structure with minimal additional site work (CIDB, 2003). The application of IBS System in Malaysia has been widely used such as for the building of high rise building, complex, airport, hospital, apartments, residential house and college. The usage of IBS in Malaysia had been decreased in number (Hamid, et al. 2008) as the factor may due from the lack of knowledge and research related to IBS development. The major influence of using IBS System is to reduce both cost and time simultaneously, attempting better quality and productivity of construction, lowering the risk related to occupational safety and health, higher number of issues of foreign labor associated with negative impact in our country (Lou &Kamar, 2012).

2.3 COMPONENTS OF PSSDB

2.3.1 Dry board

There are many types of dry board available locally in Malaysian market such as Primaflex, Plywood, Chipboard, Cemboard and others. These dry boards are classified according to their properties and strength depending on their types. Many research indicate, two types of commonly dry board are chipboard and plywood (Wright & Evans, 1989). In some research, the use of Cemboard is also regularly in use (Hanizam, et al. 2008). According to Awang and Badaruzzaman (2010) in their study they found that between three types of dry board which are Chipboard, Plywood and Cemboard, based on the strength and properties, Cemboard performance is better than the rest of the board because Cemboard generally can withstand the insect and fungal attack, good resistant in fire and weather condition.

The type of dry board chosen will play an important role in determining the stiffness of the floor panel. Primaflex dry board in PSSDB System is not frequently used by other researchers. Besides that, the number of study of Primaflex dry board is

quite low in number of research. The Primaflex dry board is made up of top grade cellulose fibres, Portland cement and finely ground sand which has higher in resistance when being exposed under sun, rain, wind and dryness. Research done by Awang and Badaruzzaman (2010) stated that Primaflex dry board has higher value in terms of Young's Modulus that is 8000 MPa, compared to other dry board used by other researcher such as Cemboard which is only 4800 MPa. Moreover, in terms of fire resistance, Primaflex dry board is found to have a higher fire resistance according to Australia and British Standard (Awang&Badaruzzaman, 2010). Due to these properties, Primaflex dry board is recommended for this research as the Primaflex dry board has better endurance after being exposed to sun, rain, wind, dampness and dryness (Awang&Badaruzzaman, 2010).

In this research, the study of Primaflex dry board with different thickness will be investigated to compare the stiffness of the floor panel. The Table 2.1 below shows the comparison between the different types of dry board.

Table 2.1: Structural properties of dry board

Type of board	**Young's Modulus (MPa)**		**Bending strength (MPa)**	
	Parallel to grain	**Perpendicular to grain**	**Parallel to grain**	**Perpendicular to grain**
18 mm plywood	5300	9775	40.4	66.5
18 mm chipboard	1950	1950	11.4	11.4
12 mm Cemboard	4800	4800	8.4	8.4
9 mm Primaflex	8000	8000	14	22

Source: Awang and Badaruzzaman (2010)

Seraji et al. (2013) investigated in his research that Primaflex dry board has potential to develop the compressive membrane action which influences the flexural capacity of PSSDB floor system. The Primaflex dry board can gain higher mechanical properties compared to the other types of board. In another research, Awang, (2010) claimed that Primaflex dry board is weak in tension properties eventhough Primaflex has higher Young's Modulus value and strength properties. There is no sign of crack shown or detected before the sample started to fail and there is still a risk when using

Primaflex dry board due to safety. In sum, research that investigates the use of Primalex dry board is timely.

2.3.2 Steel Sheeting

There are numerous locally available types of profiled steel sheeting such as AjiyaCliplock, Bondek II and Peva 45 Steel. The suitable material and thickness of steel sheeting need to be selected because steel sheeting plays an important role in PSSDB System as it acts as a reinforcement. Steel sheeting selected for use should be clean, hard, strong, and durable properties that will affect the bond between dry board and steel sheeting is connected by self tapping screw. During the installation process, it is important to make sure that the steel sheeting and dry board are stiff enough to prevent it from sliding each other. In this research, the Peva 45 profiled steel sheeting will be use and the thickness will be 0.8 mm. Research by Awang et al. (2008) explains that due to the lightweight properties, the panel can be lifted by two persons easily, stacked and delivered to sites easily. Therefore, it gives benefit to the worker where the infrastructure is limited and sometimes inaccessible to use crane or heavy machineries.

Besides that, the high strength steel properties of profiled steel sheeting offers a good quality and standard that maintained the structural form of PSSDB System as well as good resistance towards accidental buckling, denting, damage occurred when handling due to transportation, erection or services (Surat et al., 2008)

2.3.3 Screw connection

Screw connection acts as a connector between the dry board and steel sheeting. The shear will be distributed equally towards the dry board by the self tapping screw. It is important to select a suitable material and length of the screw in sustaining the load. Suitable self-tapping screw must be selected in order to suit the thickness of Primaflex dry board when combining with the steel sheeting. This criteria is important as to make sure the bond between the panel is strong enough to prevent sliding between the material during laboratory testing therefore will affected the values of data. In this research, MK Fastener self-drilling and self-tapping screw is being used. The size of the screw selected is 30 mm (Malaysian Made). The performance of connection will determine the degree of stiffness as a composite unit (Surat et al., 2008) and in their findings, found that there are two major modes of failure occur which are the crushing of board surrounding the connectors and connectors shearing off at the base. In this research, the stiffness of the screw to the panel system will be compared with the different thicknesses of Primaflex dry board.

2.4 TYPE OF TEST

2.4.1 Bending test

Bending test is commonly known as the ability of the structure to resist failure in bending and determines the value properties of a material. Sometimes it is referred to as a flexural test, it consists of placing a sample and subjected the load at a midpoint of sample. As discussed by Udomphol (2009), the bending test which is one of laboratory testing in order to evaluate the strength of the materials. Three point bending arrangement subjected to a load commonly is used in the bending test.

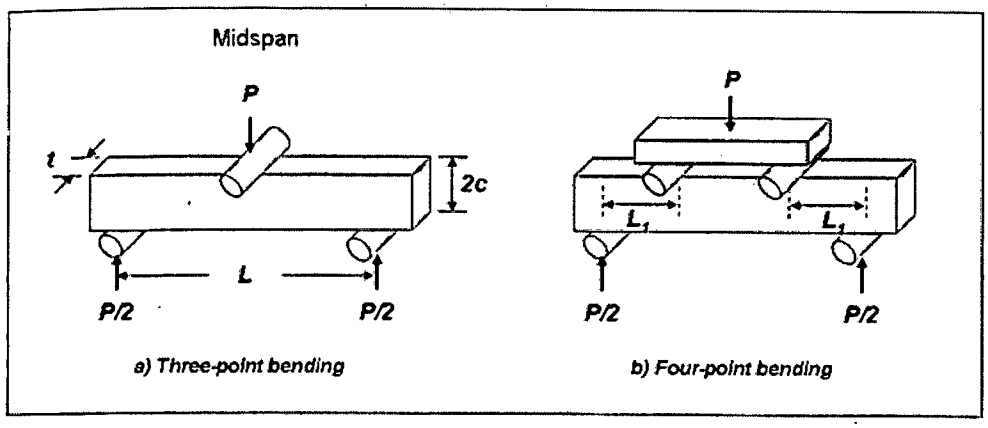

Figure 2.1: The three-point and four-point bending method in testing the sample

Source: Udomphol (2009)

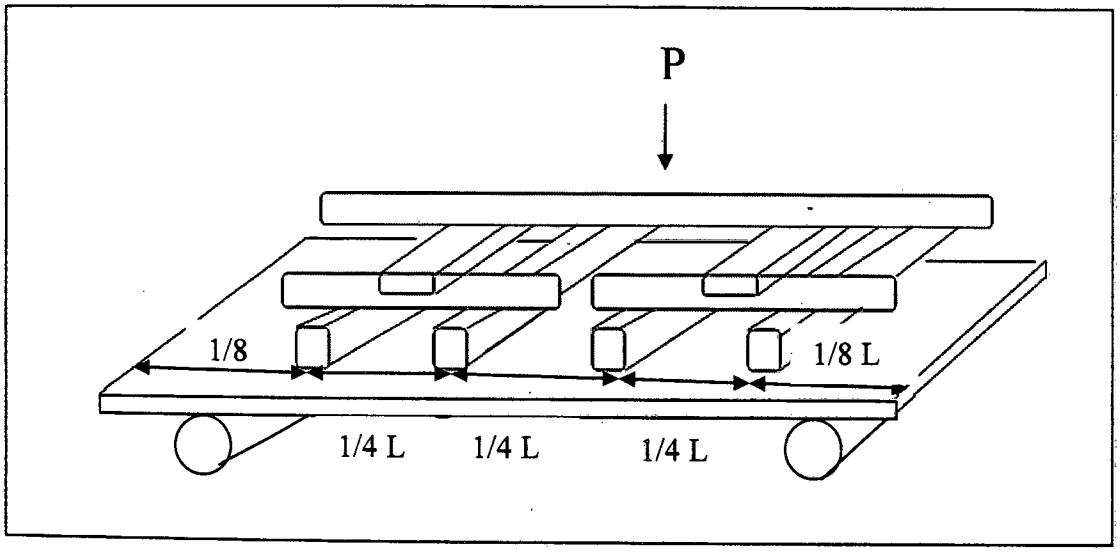

Figure 2.2: The waffle-tree method in bending test

In this research, the method of experiment used is waffle-tree as shown in Figure 2.2. The purpose of waffle-tree arrangement is to simulate the uniform distributed load (UDL). By using waffle-tree method, force is applied at the middle point at known distance.

From the bending test, the maximum amount of load subjected before the material failed can also be evaluated. The strength of a material is the maximum amount of load or stress that it can sustain before the material fails. Therefore, the stiffness of the screw to the floor panel in this research can be determined. Besides that, the thickness of the dry board between the samples can be compared by using this method to evaluate the valueof stiffness of the screw. Therefore, the relationship between thickness of dry board and stiffness of screw can be established.

2.5 SUMMARY OF THE CHAPTER

Basically, in this chapter summarized the literature review related to the research done before. The two major elements in this chapter are material and method. In this chapter, the material of each element is briefly explained and the method of research also being discussed. Primaflex dry board is not commonly used by other researchers before and the Primaflex dry board is found to be better than other type of dry board. Besides that, many researchers found the other type of board such as plywood, cemboard have a good in terms of resistance, fungal attack and others. So, in this research, the properties of Primaflex dry board will be investigated to compare with the existing type of dry board.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this research, the study will be focusing on the method to carry out testingof the sample of Primaflex dry board towards the stiffness of the Profiled Steel Sheeting Dry Board (PSSDB) floor panel.Through this study, an overview and general explanation about the detail of this research such as tools to be used, techniques, arrangements of the system will be discussed in this chapter.

3.2 DATA COLLECTION

Before any laboratory testing is carry out, the sample must be prepared systematically. Preparation of sample must be followed according to the procedure and steps so that the research will be carried out smoothly. There are two different thickness of dry board sample need to be prepared in this research. There are two samples to prepare with two different thicknesses. The purpose of carry out twosamples is to compare the experiment for each thickness so that the average value can be calculated. Therefore, more accurate value and comparison can be determined from the experiment.