THE EFFECTS OF SCREWS SPACING TO THE STIFFNESS OF PROFILED STEEL SHEETING DRY BOARD (PSSDB) FLOOR PANEL

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ABSTRACT

Industrialized Building System (IBS) is one of the systems that has been widely used in construction industry in Malaysia. One form of the IBS structure is Profiled Steel Sheeting Dry Board (PSSDB). PSSDB is a lightweight composite structure that comprises of Profile Steel Sheeting (PSS) and Dry Board (DB) which are connected by self-drilling and self-tapping screws. The objectives of this thesis are to determine the effect of screws spacing to the stiffness of profiled steel sheeting dry board and to investigate the relationship between the spacing of the screws and the stiffness of the panel. The testing was carried out by using 0.8 mm of Peva 45 and 9 mm thickness of Prima*flex* Board. The size of each specimen is 2440mm of length and 1200mm of width. Both of PSS and DB are connected by the screw with the spacing of 100mm, 200mm and 300mm. The bending test was performed to determine the maximum load that can supported by this PSSDB floor system before its failure. From the experiment, the maximum load can be applied on the panel with spacing 100 mm is 12.725 kN/m, for 200 mm is 9.807 kN/m, and for 300 mm is 9.184 kN/m. The deflection of each panels is 66.655 mm, 58.315 mm and 53.670 mm respectively. After calculating using the deflection formula, the stiffness of the panels is 92.084 kNm^2/m, 85.208 kNm^2/m, and 76.595 kNm^2/m respectively with the spacing. From the result, it is concluded that the screw spacing can affect the stiffness of PSSDB panel. The shorter the distance between the screws, the stiffer panel will be. Therefore, the screws spacing plays an important role in determining the stiffness and the performance of the PSSDB panel.

ABSTRAK

Sistem Bangunan Perindustrian (IBS) adalah salah satu sistem yang digunakan secara meluas dalam pembinaan di Malaysia. Salah satu bentuk struktur IBS itu Kepingan Keluli Berprofil Papan Kering (PSSDB). PSSDB adalah struktur komposit ringan yang terdiri daripada Kepingan Keluli Berprofil (PSS) dan Papan Kering (DB) yang dihubungkan dengan skru gerudi dan ulir sendiri. Objektif tesis ini adalah untuk menentukan kesan skru jarak dengan kekukuhan berprofil keluli cadar papan kering dan untuk mengkaji hubungan antara jarak skru dan kekukuhan panel. Ujian ini telah dijalankan dengan menggunakan 0.8 mm Peva 45 dan 9 mm ketebalan Primaflex Saiz setiap spesimen adalah 2440 mm panjang dan 1200mm lebar. Kedua-dua PSS dan DB dihubungkan dengan skru dengan jarak 100 mm, 200 mm dan 300 mm. Ujian lenturan telah dijalankan untuk menentukan beban maksimum yang boleh disokong oleh sistem lantai PSSDB ini sebelum kegagalannya. Daripada ujikaji tersebut, beban maksimum yang boleh digunakan pada panel dengan jarak 100 mm adalah 12,725 kN/m, 200 mm adalah 9,807 kN/m, dan untuk 300 mm adalah 9,184 kN/m. Pesongan setiap panel adalah 66,655 mm, 58,315 mm dan 53,670 mm. Selepas mengira menggunakan formula pesongan, kekukuhan panel adalah 92,084 kNm^2/m, 85,208 kNm^2/m, dan 76,595 kNm^2/m. Dari keputusan itu, ia membuat kesimpulan bahawa jarak skru boleh mempengaruhi kekukuhan panel PSSDB. Semakin pendek jarak antara skru, kekukuhan panel akan meningkat. Oleh itu, jarak skru yang memainkan peranan penting dalam menentukan kekukuhan dan prestasi panel PSSDB itu.

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LIST OF SYMBOLS

δ	Deflection
EI	Stiffness
w / δ	Slope
L	Length

LIST OF ABBREVIATONS

IBS	Industrialized building system
PSSDB	Profiled steel sheeting dry board
PSS	Profiled steel sheeting
DB	Dry board
PL	Point load
UDL	Uniformly distributed load
CH	Channel

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Malaysia is one of the countries that employ the Industrialized Building System (IBS) in construction. IBS is a system that promotes reduction of the construction time, cost, and the number of workers at sites and enhances the quality of building. (Maryam, 2009). Treasury Circular No. 7 of 2008 issued by the Ministry of Finance stated that it is required to use IBS in 70 percent of all government construction projects (Anon, 2009a). One of the IBS forms is Profiled Steel Sheeting Dry Board (PSSDB). Due to the problem associated with time, cost, and material, PSSDB is proposed to help to alleviate the problems.

Overall, this chapter explains the whole part of the research study starting from the research objectives until the result and conclusion of the report.

1.2 BACKGROUND OF STUDY

The PSSDB is one of the panel floors that are frequently used in the construction of the building nowadays. PSSDB is a lightweight composite load bearing structural system. PSSDB is a structure that consists of two components which are the profiled steel sheeting and dry board. Both components are connected with the screws by self-tapping and self-drilling technique. This system can be used as wall, roof and floor in domestic, office building and renovation purposes.

One of the advantages of the PSSDB floor system is the short period of construction time. Other than that, the construction cost also can be reduced because this system does not require much additional construction materials and it also can minimize the space for the installation. In order to understand the performance of this panel, an experiment was carried out to determine the maximum load that can be applied on the panel floor that uses different screw spacing.

1.3 STATEMENT OF PROBLEMS

PSSDB is one of the Industrialized Building System (IBS) that can be used as flooring, roofing and walling systems. The PSSDB system can also be used for a temporary building such as shelter for the victims of disaster and a temporary classroom. The problems in construction work commonly relates to the time, cost and area for work installation. Due to the use of concrete in a construction project, all three of these problems are often compounded. Concrete not only requires a long time to harden and cure, but it also requires high cost to hire employees and provide materials such as cement, aggregate, reinforcement, timber and others. It also needs the space for installation.

According to Mahmood Seraji (2013) the thickness of PSS and DB used in his experiment are 1.0 mm Peva45 and 18 mm Prima*flex* respectively. But in this research, Peva45 and Prima*flex* were used to form a PSSDB panel floor that was connected with self-drilling and self-tapping screws. The panel was tested using the bending machine. The research work is conducted to show that the system can be used practically as a flooring system. For this study, the performances of screw spacing that connect the PSSDB panel floor are expected to play an important role in determining the stiffness of the panel system.

1.4 RESEARCH OBJECTIVES

1. To determine the effect of screw spacing on the stiffness of the PSSDB floor panel.
2. To determine the relationship between screw spacing and the stiffness of the PSSDB floor panel.

1.5 SCOPE OF STUDY

In the proposed study, the effect on screw spacing to the stiffness of floor panel using profiled steel sheeting dry board (PSSDB) will be investigated. 0.8 mm thickness of Peva 45 and 9.0 mm thickness of Primaflex will be used in this test. The length and width of all samples are 2440 mm and 1220 mm respectively. Bending test will be performed to the samples to determine the stiffness PSSDB panel.

1.6 SIGNIFICANCE OF THE STUDY

Lately, many natural disasters have occurred. With the availability of the PSSDB system, shelters for victims of natural disasters can be constructed quickly. The victims can take refuge while waiting for their new house to be completed. Besides that, the PSSDB system can reduce the uses of other material such as timber that are usually used for the formwork. So, the cost of material can be minimized. On the other hand, the PSSDB floor panels usually are made at the factory. Therefore, it can reduce the construction area for mixing concrete and also can reduce the wastage.

1.7 WORK SCHEDULE

Refer to Gantt chart in **Appendix**.

1.8 SUMMARY

This chapter describes the Profiled Steel Sheeting Dry Board (PSSDB) which is one of IBS structures that commonly used for roofing, flooring and also for wall structures. One of the objectives of this paper is to determine the stiffness of profiled steel sheeting dry board and also to establish the relationship between the stiffness of the panel and the spacing of the screw. This PSSDB panel comprises of Profile Steel Sheeting (PSS) and Dry Board (DB) which are connected by self-drilling and self-tapping screw with different spacing. The testing is carried out by using 0.8 mm of Peva 45 and 9 mm thickness of Prima*flex* Board. Both PSS and DB are connected with self-drilling and self-tapping screw with spacing of 100 mm, 200 mm and 300 mm. The bending test was carried out to determine the maximum load that can be supported by this PSSDB floor system until failure. In conclusion, this PSSDB system can help to minimize the issues that relate to shorter construction time and can reduce wastage of materials.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The profiled steel sheeting dry board (PSSDB) system is environmentally friendly as there is a marked reduction of construction materials wastage because it is one of the Industrialized Building System (IBS) structure. It is a composite system and comprises of two main components, namely, profiled steel sheeting (PSS) and dry board (DB) and they are connected by using self-tapping and self-drilling screws. This panel system can carry the tensile and compressive stress respectively.

In this study, the objective is to determine the effect of screw spacing on the stiffness of Profiled Steel Sheeting (PSSDB). Screw spacing plays an important role in this system because without the screw, the interaction between PSS and DB cannot be achieved.

2.2 PROFILED STEEL SHEETING

The profiled steel sheeting (PSS) is the main structural element of the PSSDB system which is available locally. It is a structural load bearing system. In Malaysia nowadays, thin PSS such as Clip-Lock 660 is often used in roofing systems while thick PSS such as Peva 45 and Bondek II is commonly used for floor and wall. The structural model of PSSDB panel floor can be shown in Figure 2.1.

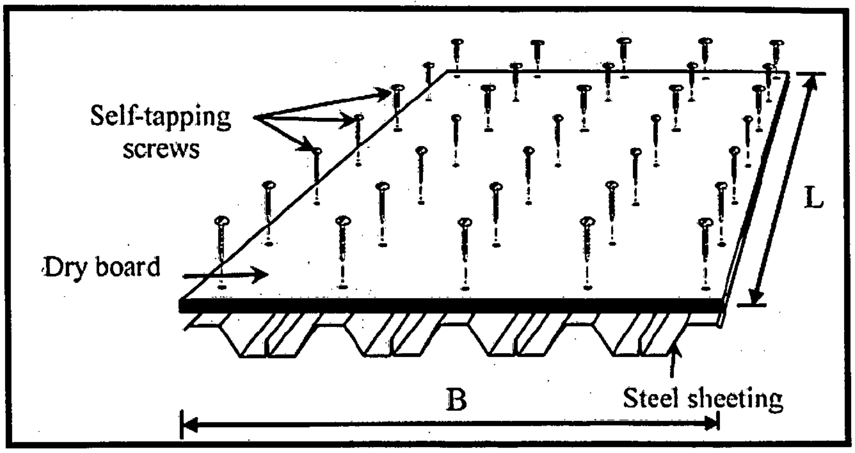

Figure 2.1: PSSDB floor panel model structure

Sources: Hanizam Awang et al. (2010)

According to the thickness and types of PSS, the stiffness of the sheeting increases with the depth of the profiled steel sheeting. (Hanizam & Wan Badaruzzaman, 2010; Ehsan, 2012). It was supported by Mahmood Seraji (2013) that the weakness of PSS in stiffness plays a big role in the failure of the supported PSSDB panel floor. So, the researches show that the stiffness of the PSSDB panel floor can depends on the thickness and type of PSS.

2.3 DRY BOARD

There are many types of dry board can be used for PSSDB system such as cemboard, plywood, chipboard and others. The thickness of dry board depends on the supplier. In this study, type of dry board that will be used is Primaflex with the thickness of 18 mm.

Wright and Evans, (1989) have proposed two types of board that to be used in their experiment on the stiffness of panel floor of PSSDB system which is plywood and chipboard. On the other hand, Mahmood Seraji (2013) and Hanizam Awang (2010) also used this type of dry board. This Primaflex manufactured in Malaysia and is made from top grade cellulose fiber, Portland cement and finely ground sand. They found that the type of dry board also can affect the stiffness of panel floor.

According to Ehsan (2012) 16-24 mm thick board such as plywood, chipboard and cement board are suitable for PSSDB panel floor. Studies also found that the thickness and the types of dry board have a direct effect on the behavior of the PSSDB system (Hanizam Awang, 2010). Ehsan Ahmed (2010)also stated that the strength of the board depends on the thickness and type of dry board of the panel.

2.4 SCREW SPACING

Both components of a PSSDB panel floor which is PSS and DB will be connected by screws. But, the stiffness of the PSSDB panel floor can also be affected with the spacing of the screws.

The required interaction between the two main components is provided by self-drilling and self-tapping screws. According to Mahmood (2013), the system is treated as a partial interaction system due to the deficiency of the screws to transmit the entire horizontal shear forces. Besides, as the fasteners of screw are deformable, the slip between the profiled steel sheets and dry board is inevitable.

Ehsan Ahmed (2012) recommended that the spacing for the PSSDB flooring system to be about 100 mm to 200 mm. This recommendation is based on economy. In the same article, he stated that the closer the spacing of connectors in PSS, the stiffer the panel will be. This was supported by Farhan Abbas (2013).

Other researchers on the static behavior of the PSSDB system stated that screw spacing has a significant effect on the stiffness of the system as the panel with lower screw spacing is stiffer than a panel with higher spacing (Wan Badarazzaman, 2013; Ehsan Ahmed, 1996). But, Ehsan Ahmed (2012) claimed that the spacing of screw that is less than 50 mm is not suitable for the PSSDB system. So, the spacing that will be chosen in this study is 100 mm, 200 mm and 300 mm.

2.5 TESTING METHOD

There are into two types of panel testing. They are the bending test and push out test. The purpose of the bending test is to determine the maximum load, flexural stiffness and load-deflection behavior of the test. According to Hanizam Awang (2009) the timber strips in the PSSDB will increase the stiffness and strength of the models. In another study using bending test it was found that the stiffness of the panels depends on the connector modulus and spacing, the types of board and the thickness of steel sheeting. (Ehsan & Ghazali, 2010)

On the other hand, the damping and natural frequency of the PSSDB panel floor can also be tested by using Heel Impact Test. According to Ehsan and Wan Hamidon, (2012), the heel impact test was used to estimate the damping coefficient of the panel test and it is on average 3 % log decrement damping for the test panel. This was supported by Ehsan and Ghazali, (2010) that the average log decrement damping is 3.2 %. In the research, they also claimed that the smaller span will produce a larger frequency; where by longer span will produce a smaller frequency.

As a conclusion, bending test is the best test that can be used to determine the stiffness of the PSSDB panel floor. All the research is very useful and helpful in this study especially in comparing the main part use in the experiment of PSSDB panel floor which is the screw spacing.

2.6 SUMMARY OF CHAPTER

This chapter has explained about the entire component that used in the PSSDB floor panel. It was related to the previous researches that were conducting the experiment using this PSSDB panel floor. From the previous researches, the researchers have stated that the thickness and types of dry board and profiled steel sheeting can affect the stiffness of the PSSDB panel floor. They also have stated that the screw spacing play important part in determining the stiffness of that board. Therefore, this chapter is very useful in getting some idea about what will be needed in the experiment that will be carried out.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this research, the methodology consists of several procedures for conducting the bending experiment. Bending test is carried out to determine the stiffness of the PSSDB panel floor that will be connected by different screw spacing. In this research, the materials that will be used are 0.8 mm Peva45 of profiled steel sheeting and 9 mm Primaflex of dry board. Both PSS and DB will be connected by screw spacing of 100 mm, 200 mm and 300 mm.

3.2 PREPARATION OF SPECIMENT

For the experiment, three panel samples were prepared. All the specimens consist of 0.8 mm Peva 45 and 9 mm Primaflex. The positions of screws were marked on the Primaflex. Each specimen consists of screw spacing of 100 mm, 200 mm, and 300 mm. after plotting work is done, the Primaflex and Peva were connected by self-tapping and self-drilling screws. Table 3.1 shows the size of material that been used in this experiment.

Table 3.1: Size of material use.

Types Of material	Name of material	Size Of material
Profiled Steel Sheeting (PSS)	Peva 45	0.75 m x 2.4 m
Dry board (DB)	Primaflex	1.22 m x 2.44 m
Screws	MK Fastener	30 mm (length)

In this research, the Primaflex were chosen as the dry board because this type of dry board is not commonly used in construction. Figure 3.2 (a) shows the Primaflex that used as the dry board in this experiment.

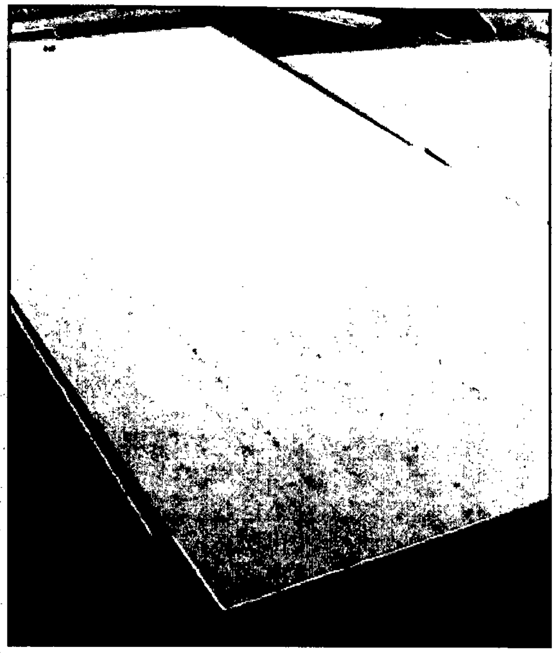

Figure 3.2 (a): Primaflex as dry board.

The profiled steel sheeting that was used in this experiment is Peva 45. Hanizam (2010), said the stiffness of panel can be increased if the depth of profile steel sheeting increases. So, Peva 45 was chosen because the depth of this PSS is bigger than Bondek II. Figure 3.2 (b) and (c) shows the properties of Peva 45.

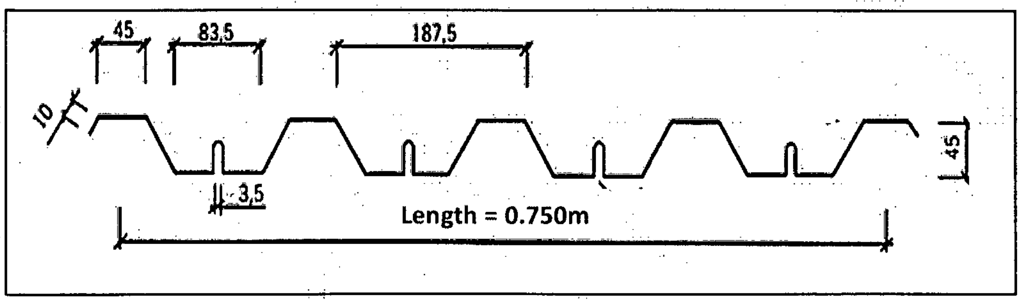

Figure 3.2 (b): Properties of Peva 45

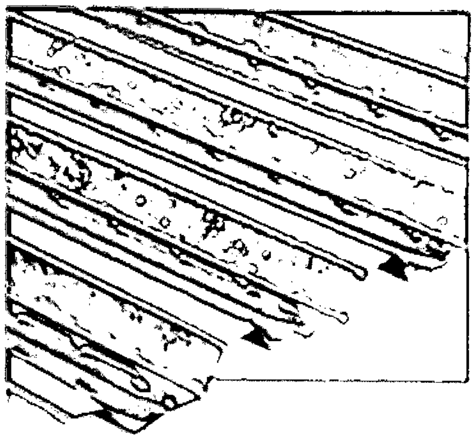

Figure 3.2 (c): Ajiya Peva 45

Sources: Ajiya Group

Figure 3.2 (d) shows the properties of, the self-tapping and self-drilling screws used. This type of screws is available locally and can be easily found.

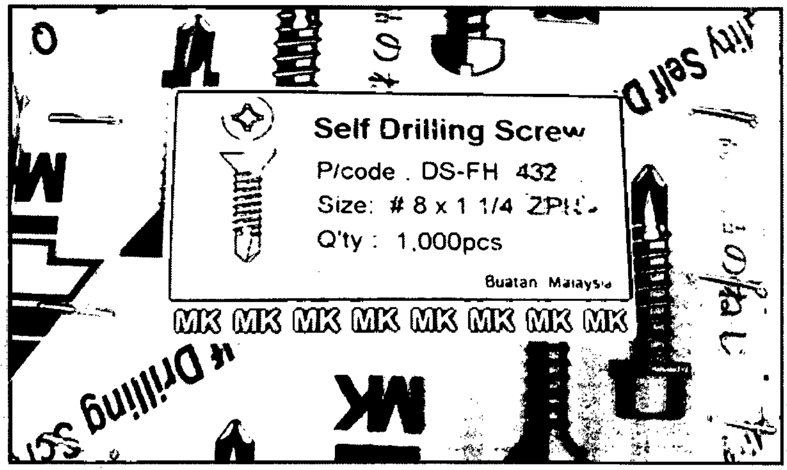

Figure 3.2 (d): MK Fastener screws

Table 3.2 listed the materials properties used in this study.

Table 3.2: Properties of PSSDB floor panel

Profiled steel sheeting	Dry board	Type of screw	Name of sample	Screw spacing (mm)
Peva 45 (T = 0.8mm)	Primaflex (T = 9mm)	MK Fastener (L = 30mm)	Sample A	100
			Sample B	200
			Sample C	300

Figure 3.3 shows the example of panel arrangement for 200 mm screw spacing. For each panel, the distance for starting the first line of screws is different. For this example, the gap between the first screws and the side of panel is 120 mm. This gap depends on the screws spacing.

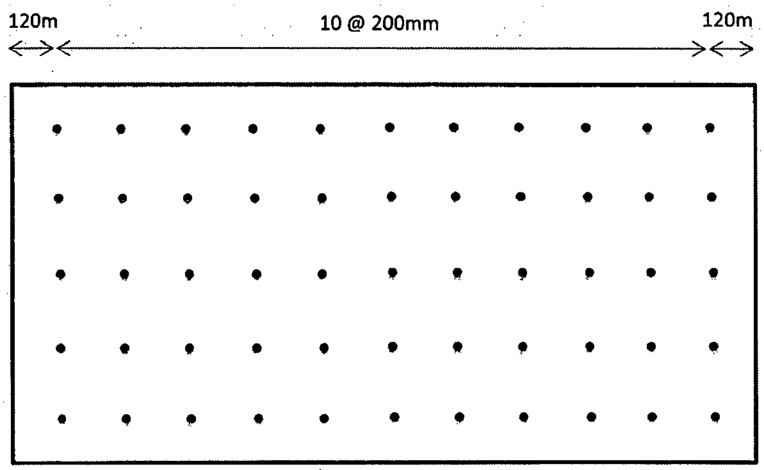

Figure 3.3: Structural model for 200mm screw spacing

3.3 PROCEDURE OF TESTING

In this research, the panel was tested on a simple span using the concepts of whiffle-tree loading to simulate a uniformly distributed load. The steel hollow sections are used to construct the whiffle-tree loading. Figure 3.4 (a) and (b) below shows the figure of steel hollow section and the arrangement of hollow section

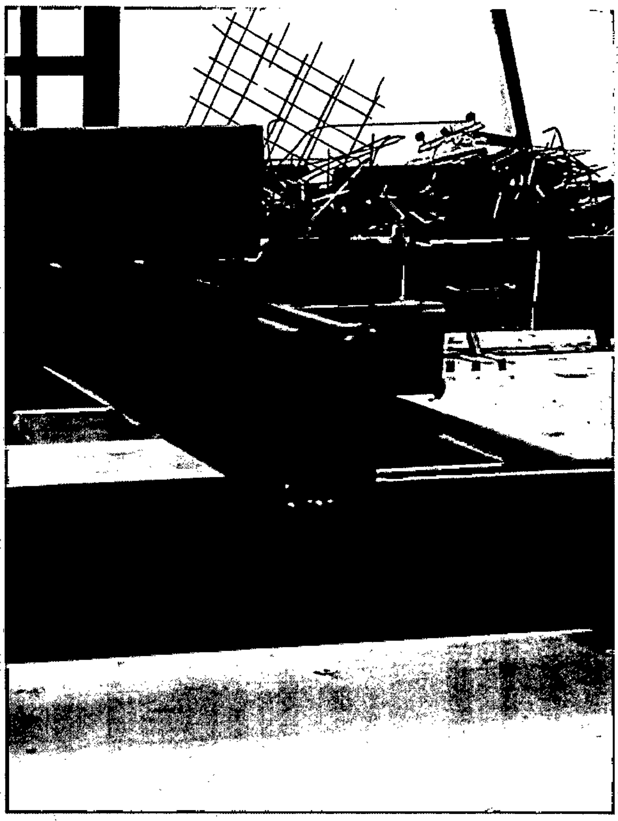

Figure 3.4 (a): Steel hollow section

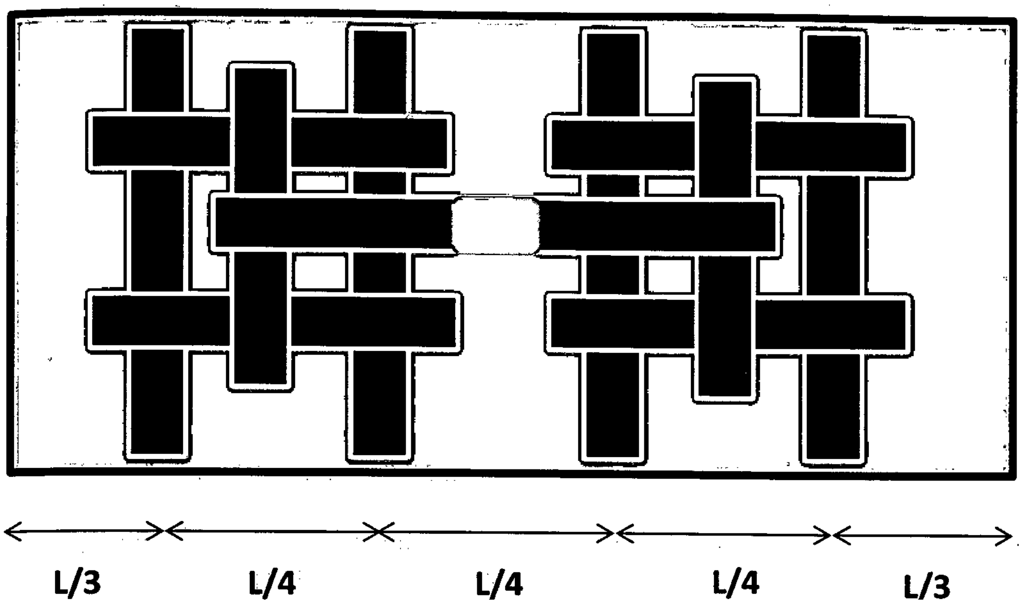

Figure 3.4 (b): Whiffle-tree loading arrangement.

By using displacement transducers, the deflection values will be measured. The transducers will be located at both ends of the mid-width line to detect any unintentional eccentricity of loading. It will also locate at the middle and quarter span along the mid span line. The figure 3.5 (a) and (b) below shows the arrangement of the transducers. The load will be applied to the transducers by using hydraulic jack.

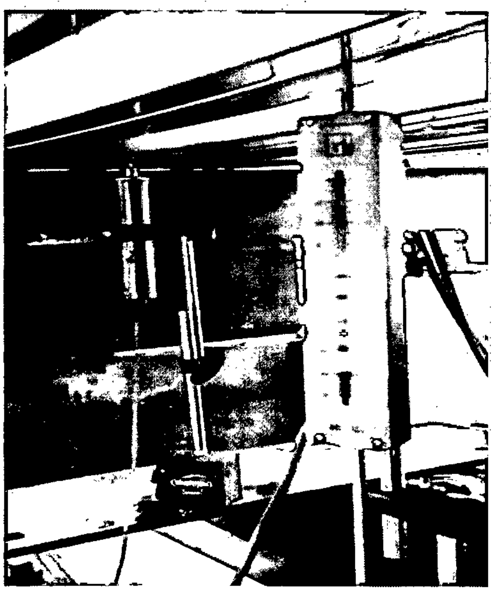

Figure 3.5 (a): Transducer used.