FINITE ELEMENT PREDICTION OF THE AXIAL LOAD TEST ON THE PROFILED COMPOSITE PANEL

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ABSTRACT

The usage of composite structure has been run for a long time in construction industry and its have become more popular to civil engineers. Profiled steel sheeting structures are getting famous because its stiffness, strength and faster the construction period. The objective of this project is to analyse the behaviour of profiled composite panel under axial load by using finite element method. Foam concrete, Spandek and Trimdek profiled steel sheeting panel are used as composite material and the dimension of panels are set as 700 – 760 mm width with 1000 mm height and 85mm thickness. There are six types of models have been analyses in this project. LUSAS Modeller 14.0 Finite Element Software is able to carry out linear analysis to determine the deformed mesh, maximum stress and strain under axial load condition. In addition, critical buckling load can be predicted under the linear eigenvalue analysis. It concludes that Spandek Profiled Composite Panel can sustain higher buckling load than Trimdek Profiled Composite Panel.

ABSTRAK

Penggunaan struktur berkomposit telah lama diaplikasikan dalam sektor pembinaan dan semakin popular di kalangan jutera awam. Struktur kepingan besi berprofil adalah terkenal kerana kekerasan, kekuatan dan tempoh pembinaan yang singkat. Tujuan projek ini adalah untuk menganalisa perwatakan komposit kepingan besi berprofil di bawah beban paksi dengan menggunakan kaedah elemen terhingga. Konkrit berbuih, kepingan besi berprofil Spandek dan Trimdek adalah digunakan sebagai bahan komposit panel yang berdimernsi 700 – 760 mm lebar dan ketingggian 1000 mm ketinggian dan ketebalan 85 mm. Kaedah elemen terhingga perisian ' LUSAS Modeller 14.0' dapat menjalankan analisis lelurus untuk menentukan pesongan jejaring, ketegasan dan keteringan maksima dapat diramalkan berdasarkan analysa nilai eigen lelurus. Kesimpulannya, panel komposit berprofil Spandek mampu menanggung beban tekul yang lebih tinggi daripada panel komposit berprofil Trimdek.

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LIST OF ABBREVIATIONS

BMT	=	Base Metal Thickness
TCT	=	Total Coated Thickness
SPTP	=	Single Profiled Trimdek Panel
SPSP	=	Single Profiled Spandek Panel
TFCP	=	Trimdek Foam Concrete Panel
SFCP	=	Spandek Foam Concrete Panel
TPCP	=	Trimdek Profiled Composite Panel
SPCP	=	Spandek Profiled Composite Panel
QTS4	=	Quadrilateral Thick Shell 4 Nodes
HX8	=	Hexagon 8 Nodes

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Profiled composite panel is a combination of two masonries unit of different type of material which are profiled steel sheeting and foamed concrete. Profile steel sheeting is a thin sheet of high tensile steel which formed the face of wall support for foamed concrete. Foamed concrete is a lightweight concrete due to it is composed without coarse aggregate but with a substantial volume of foam bubbles. In the foam concrete mortar, these bubbles provide the stability of the foam concrete. In addition, foam concrete is very effective isolating material. Buildings constructed from foam concrete are able to accumulate cold or heat, which allows to greatly minimizing conditioning or heating expenses.

Wright et al. (1992) and Gallocher (1993) proposed the concept of composite walling based on the advantages of composite slabs. In the use of a composite wall, the profiled steel sheeting is erected to provide temporary shear bracing to wind and destabilising forces during construction.

Wright (1997) has investigated the behaviour and design of profiled composite walling when subjected to axial loading. He found that axial load capacity affected by the local buckling of the component plates in the steel sheeting and also influenced by the profiled shape of the concrete cross section. Moreover, the advantages of the longitudinal bending stiffness of composite walling offers to maintain stability and preventing the early occurrence of global buckling.

1.2 Problem Statement

Profiled composite panel consists of concrete and profiled steel sheeting which is a load-bearing wall that are laterally supported and braced by the rest of the structure that resist in plane vertical loads acting downward on the top of the wall. However, plain composite panel without profiled happened to be less strength if subjected to high load. By using profiled steel sheeting as the composite panel's permanent formwork, it can increase the stiffness and strength of the panel.

The strength of a material depends on its stability to sustain a load without deformation or failure. However, profiled steel sheeting is weak at compression and cause buckling. Besides that, the steel will also cause stress distribution due to its gripping at the connection where the load is applied. Thus, different shape of profiled sheet sheeting will influenced the strength of the composite profiled system.

1.3 Objective of Study

The objectives of the axial load test of the profiled steel sheeting panels are:

i. To analyze the stress- strain behaviour of profiled composite panel under axial load test by using finite element method.

ii. To study the comparison between the Spandek and Trimdek profiled steel sheeting composite panel

iii. To study the linear buckling analysis between the Spandek and Trimdek profiled steel sheeting composite panel

1.4 Scope of Study

The scope of study of this project is to monitor the effect of axial load test upon profiled Trimdek and Spandek panel through simulation 3D finite element analysis. Comparison will be made between the performance of two types of profiled steel sheeting of the composite panel which are the Spandek and Trimdek. The axial load test on the panel results the linear buckling, stress-strain, load deflection and modes of failure.

1.5 Significant of Study

The rapid expansion of research and development in material and utility innovations cause the use of composite materials in construction is no longer novel. Concrete in filled structural steel hollow sections, girders erected in concrete and concrete against structural decking as formwork or primary reinforcement can be included composite steel and concrete construction system. Thus, the usage of composite structures is becomes famous in the construction industry. The profiled composite panel is one of the famous composite structures in the construction industry.

The application of profiled steel sheeting as a permanent formwork for composite walling in a typical steel framed building has shown its potential as vertical and lateral load- resisting structural elements. Furthermore, the profiled steel sheeting acting as formwork providing the necessary resistance to concrete pressure in the construction stage

The behaviour of composite walls under axial loading was found to be quite different than that of composite slabs. It is associated with the difficulty in transferring load between the steel skins and the concrete core, buckling of the steel sheeting and reduced capacity of the concrete core due to profiling. Axial loading caused breakage of chemical bond and brittle failure at the interface. This phenomenon is happened due to the absence of sufficient strain to develop force in the embossments (Anwar Hossain and Wright, 2004).

The priority of this research is to analyse the behaviour of profiled Trimdek and Spandek panel act as a load bearing wall. We also can predict the critical region of Trimdek and Spandek panel when the axial load is applied on it by using LUSAS finite element analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Normally, combination of steel and concrete in the building construction are known as composite materials The steel and concrete are then to be constructed into composite structure such as walls, floors and beams. The usage of this composite structure has been run for a long time in construction industry and its have become more popular to civil engineers. These composite structures have been carried out by various researchers .They prove that the composite structures have more advantages than the ordinary concrete structure. Thus, many types of new composite materials have been introduced in the construction technology.

In the early 1950s, the application of profiled steel sheeting as both permanent formwork and reinforcement to concrete slabs was first developed in America. It would appear to be a logical development of composite flooring that the profiled steel sheeting should span vertically between the floor levels, infill with concrete and form a composite wall suitable as a lift shaft, stairwell or shear wall.

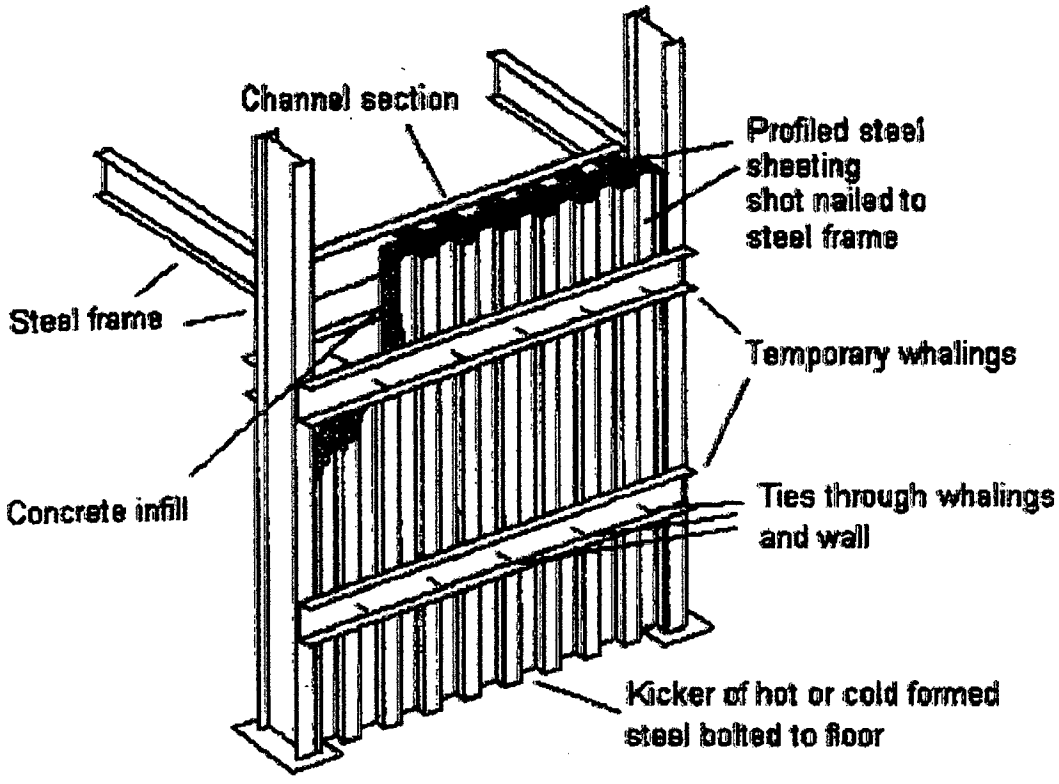


Figure 2.1: Schematic Diagram of Composite Walling

(Howard Wright, 1998)

According to Howard Wright (1998), the composite walling described herein was originally conceived for use as a core wall to stabilize steel frame building structures although it also has potential in concrete buildings, basements and blast resistance structures. It can note that the steel sheeting acts as to stabilize the building frame as soon as it is fixed. It also provides permanent formwork for the infill concrete and with the assistance of temporary whaling supports as shown in Figure 2.1. Once the concrete has hardened, axial load, lateral load and in – plane loads will be carried through both steel and concrete.

Furthermore, according to Wright and Gallocher (1995), the strength and stiffness of the wall will be dependent upon the material properties of the steel and concrete, the geometry of the profiling, the spacing between the sheets, the bond at the steel or concrete interface and the fixings between the wall and the steel frame. Therefore, this project is investigation about two type of profiled steel sheeting wall panel.

2.2 Profiled Steel Sheeting

Profiled steel sheeting has been widely used in North America as permanent formwork for *in- situ* cast concrete slabs since 1940. It acts as a tensile reinforcement for the slabs. Nowadays, there are many types of profiled steel sheeting with various geometries, sizes and other features which are specific to their manufacturers. Individual manufacturer produce different profiles for purposes, such as a floor system, wall member or folded plate roofing structure.

There are various types of profiled steel sheeting used in Malaysia such as Trimdek and Spandek. The shape and the dimension are the main difference between these two types of profiled steel sheeting. According to Howard Wright (1998), the axial load capacity was found to be influenced by the local buckling of the component plates in the steel sheeting and by the profiled shape of the concrete cross-section.

2.2.1 Trimdek

Trimdek profile is a subtle square fluted roofing and walling profile as shown in Figure 2.2. The fluting in the pans provides strength and long spanning capabilities, making one of the more economical profiled steel sheeting. It has bold, widely spaced ribs and is available in long lengths, governed only by transportation considerations. It also can be used with safety due to its strength, spanning ability, lightness and rigidity, wide support spacing.

The Trimdek profiled steel sheeting can be curved by crimp curving process. It is available in both convex and concave shapes to provide versatility and creativity to building designs. The minimum radius of curvature must be at least 450mm to underside or pan of sheet. Custom cut length are available at any measurement to a maximum transportable length (Blue Scope Lysaght, 2007). The physical properties of Trimdek profiled steel sheeting can be referred to Table 2.1

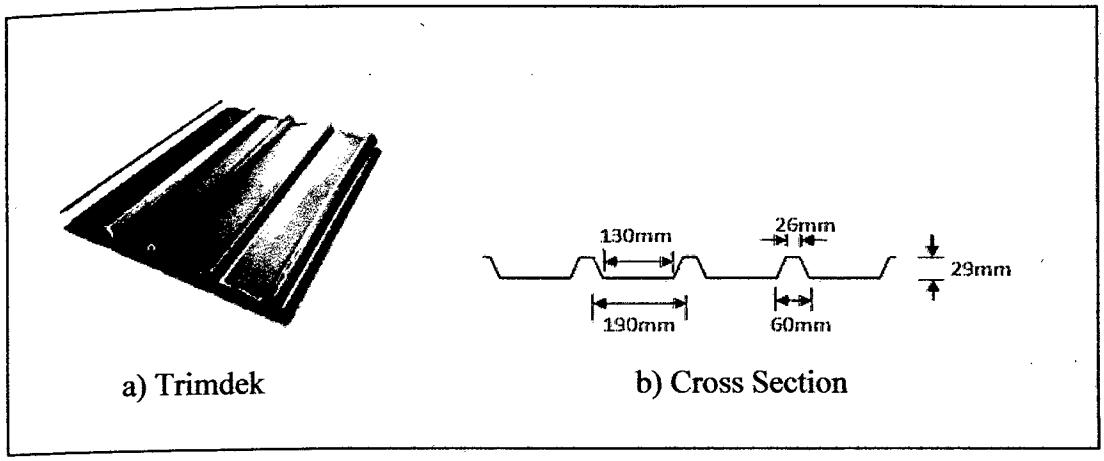


Figure 2.2: Trimdek Profiled Steel Sheeting

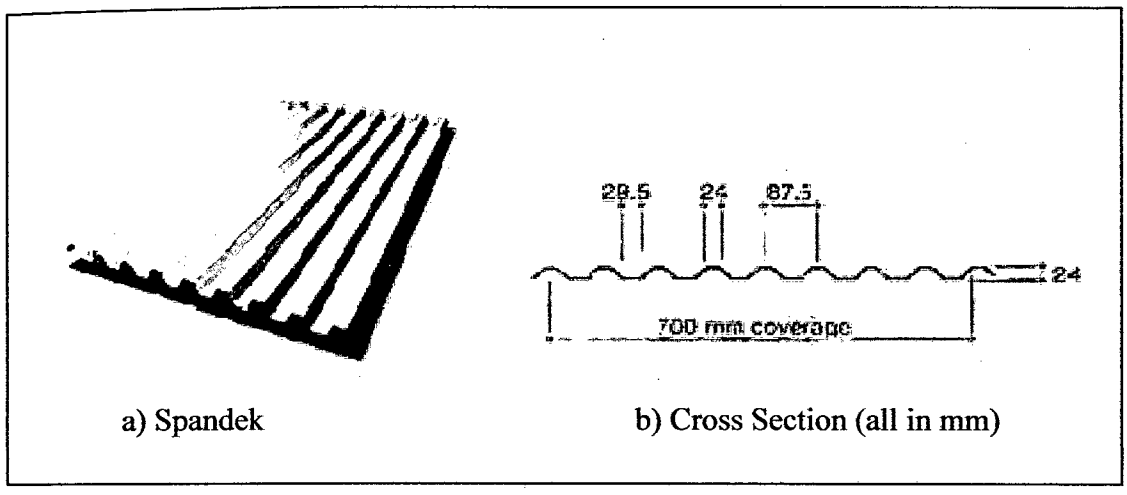
Table 2.1: Physical Properties of Trimdek

Profiled	Lysaght Trimdek
Grade of Steel	G550 (550 N/mm^2 yield strength)
Effective coverage width	760 mm
Rib depth	29 mm
Base Metal Thickness(BMT)	0.42 mm
Total Coated Thickness(TCT)	0.47 mm
Packing	In strapped bundles of 1 tones maximum mass
Custom cut length	Any measurement to a maximum transportable length
Tolerances	Length, +/- 15 mm. Width, +/- 2 mm

2.2.2 Spandek

Spandek profiled steel sheeting is a tough, symmetrical trapezoidal ribbed roofing and wall cladding profiled, ideal where stronger, bolder and more modern corrugated appearance is required. The profiled steel sheeting capitalizes on building requiring long spans as it permits wider purlin spacing and utilizes fewer fasteners. Its rigid trapezoidal ribs make it excellent choice among designers for contemporary roof and wall cladding designs as shown in Figure 2.3.

The profiled steel sheeting can be sprung curved if the curvature radius falls between 20 m and 60 m. When used for wall cladding, the trapezoidal ribs can run vertically or horizontally. This profiled steel sheeting combines strength with lightness, rigidity and economy (Blue Scope Lysaght, 2007). The physical properties of Spandek profiled steel sheeting shown in Table 2.2



a) Spandek b) Cross Section (all in mm)

Figure 2.3: Spandek Profiled Steel Sheeting

Table 2.2 : Physical Properties of Spandek

Profiled	Lysaght Spandek
Grade of Steel	G550 (550 N/mm^2 yield strength)
Effective coverage width	700 mm
Rib depth	24 mm
Base Metal Thickness(BMT)	0.42 mm
Total Coated Thickness(TCT)	0.47 mm
Packing	In strapped bundles of 1 tones maximum mass
Custom cut length	Any measurement to a maximum transportable length
Tolerances	Length, +/- 15 mm. Width, +/- 2 mm

2.3 Foam Concrete

Foam concrete is either a cement paste or mortar, classified as lightweight concrete, in which air-voids are entrapped in mortar by suitable foaming agent. It possesses high flow ability, low self-weight, minimal consumption of aggregate, controlled low strength and excellent thermal insulation properties. Application of structural, partition, insulation and filling grades can be obtained by the proper control in dosage of foam with a wide range of densities (1600 – 400 kg/m^3). The construction applications as lightweight non- and semi-structural material are increasing in the last few years although the material was first patented in 1923 (Valore, 1954).

The selection of foaming agent, method of foam preparation and addition for uniform air voids distribution, material section and mixture design strategies, production of foam concrete will influence production of stable foam concrete mix. It will affect the performance with respect to fresh and hardened state are of greater significance (Ramamurthy et. al , 2009)

2.3.1 Properties of Foam Concrete

Table 2.3 presents the summary of fresh and hardened properties studied by researchers. The hardened properties are classified into physical, mechanical, durability properties and functional characteristics. The mechanical properties are classified as compressive and tensile strength, modulus of elasticity and prediction models while thermal conductivity, acoustical properties and fire resistance under functional characteristics.