THE FLEXURAL PERFORMANCE OF THE PROFILED STEEL SHEETING DRY BOARD (PSSDB) SYSTEM AS TWO-WAY FLOOR PANEL STRENGTHENED WITH STEEL PLATES

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Abstract- This paper presents the investigation of the flexural behaviour of a composite system called the profiled steel sheeting dry board (PSSDB) system. The system basically comprises of a dry board (DB) connected to a profiled steel sheeting (PSS) using self-tapping and self-drilling screws. Many Conducted researches has shown that the system can be used as flooring, roofing and walling units. However, almost all of them have focused on the one-way behaviour. It's rare to find studies about the two-way situations. Therefore, this paper focuses on investigating the effect of presence of steel plates on the two-way behaviour of the PSSDB floor panels subjected to a point load using finite element modelling (FEA). The results have shown that changing the plate thickness can enhance the PSSDB stiffness. However, increasing the number of plates or changing the plate width doesn't greatly affect the performance. Therefore, steel plates can be considered an economic solution to enhance the structural behaviour of the system.

Keywords- Two Way Behavior, Profiled Steel Sheeting, Dry Board, Composite Structure

I. INTRODUCTION

Over the years, many studies have been carried out to enhance construction techniques and materials in order to accomplish the cost-effective structures goal. For this purpose composite structures have been introduced which have shown to be practical since they have greater stiffness, load capacity, material damage resistance, Also they usually have a small size, less construction depth and a lighter weight. This paper focuses on a composite system called the Profiled Steel Sheeting Dry Board (PSSDB) which consists of a dry board (DB) attached to a profiled steel sheeting (PSS) using self-taping & self-drilling screws (see fig. 1). Wright and Evans have introduced the system first in 1986[1]. Later in 1989, studies done by Evans et al. [2] have shown that the system has better stiffness when compared to the steel sheeting alone. Later researches have shown that the system has a potential to be used as flooring, roofing and walling units [3-9]. However most of them only studied the structural behaviour of the system as one way panel, it's rare to find studies that consider the two-way situations. This paper investigates the effect of applying steel plates with various properties on the two-way bending behaviour of the PSSDB flooring system.

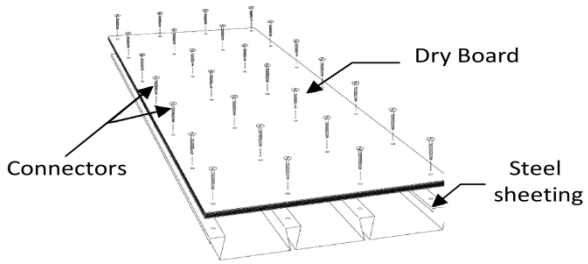

Fig. 1. Typical PSSDB system [5]

II. METHODOLOGY

Finite element modelling (FEA) using ABAQUS program has been conducted to investigate the bending behaviour of the PSSDB system as a two-way floor panels. The standard model has an effective dimension of 1 m by 1 m and it consists of 16 mm thick Cemboard DB connected to 1 mm thick Bondek II PSS with self-drilling and self tapping screws with 200 mm spacing between the screws (Table I shows the materials properties). It has been simply supported on four sides and subjected to a point load at the centre (see fig. 2). The model has been verified with the experimental tests of Ahmed et al. [5].

Table I. Properties of the materials

Material	Young's Modulus (Mpa)	Poisson's Ratio	Yield Strength (Mpa)	Bending Strength (Mpa)
Bondek II	21000	0.3	550	-
Cemboard	4500	0.25	-	8.4
Steel plate	21000	0.3	360	-

After the verification of the standard model, three parametric studies have been conducted to comprehend how the presence of steel plate will affect the system. The first study investigates the effect of changing the width of the plate (see fig 3). All the plates have 2 mm thickness, 970 mm length, and the width ranges between 150mm and 400 mm. The second study considers the effect of changing the plate thickness. Here the plates have 150 mm and 970 mm for width and length respectively and the thickness ranges between 2 and 4 mm. And the final study examines the effect of changing the number of applied plates. All of them have 150 mm width, 970

mm length and 2 mm thickness. The first model has one steel plate at the bottom centre (see fig. 2), while the second model has two plates at the bottom with 200 mm distance between them (see fig. 4), and the final model has three plates: one at the centre, and the other two at the edges with 135 spacing between the three.

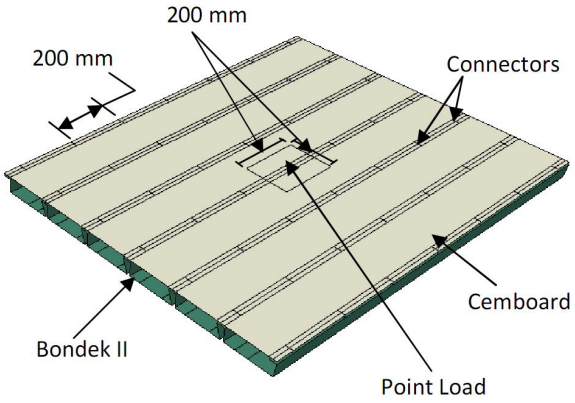

Fig. 2. Standard model

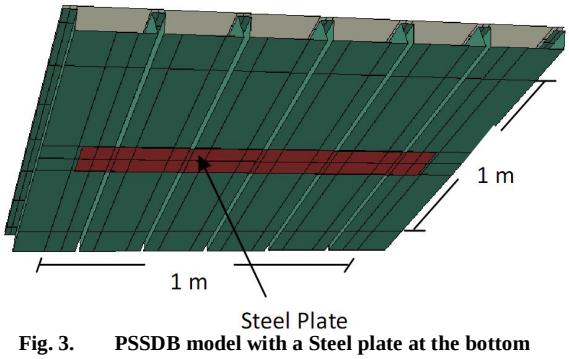

Fig. 3. PSSDB model with a Steel plate at the bottom

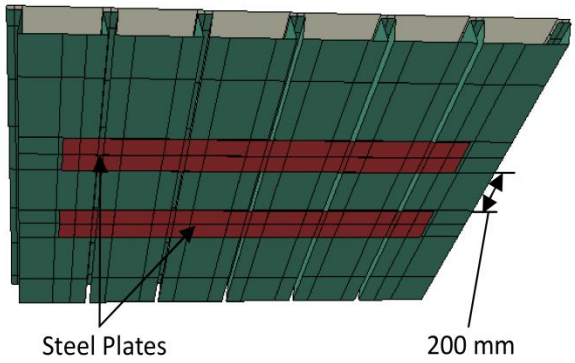

Fig. 4. PSSDB with 2 steel plates

III. RESULTS AND DISSCUSSION

Fig.5 illustrates the results of the first study and it's shown that using steel plates will increase the ultimate load (UL) by 4.5 %. That's because the failure in the PSSDB system occurs due the cracking of the DB, which is caused by the bending of PSS in the weak direction (vertical to PSS ribs) [5]. So, the steel plate role is to delay the failure by reducing the PSS bending. However, the results indicate that increasing the plate's width doesn't greatly affect the stiffness. Therefore, the economic solution is using the least possible width.

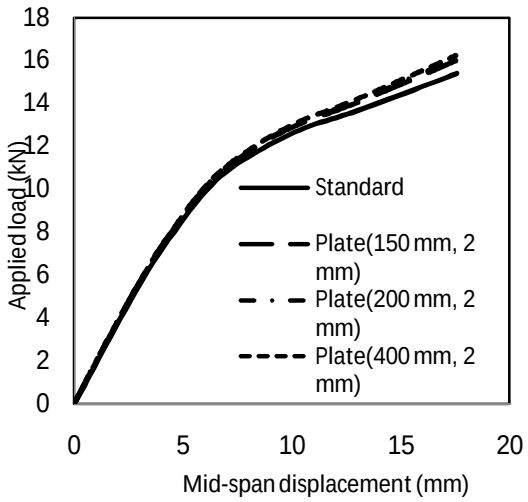

Fig. 5. Load-deflection curve for the first study

As for the second study, the results shown in fig 6 indicate that changing the plate thickness can moderately affect the stiffness. For example the sample with 3 mm thick plate has better UL than the standard sample by 8.3 %, while the sample with 4 mm thick plate is better by 11.6 %. Thus, selecting the right thickness is important for improving the structural performance.

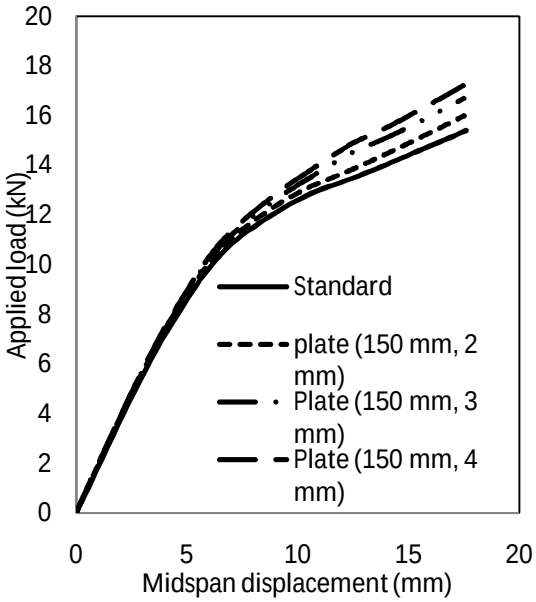

Fig. 6. Load-deflection curve for the second study

Fig 7 shows the results for the final study. As expected, the PSSDB model stiffness when using 2 plates is pretty much the same when using single steel plate, while the sample 3 plates has a slightly better stiffness. This can be explained by the fact that the maximum stress occurs at the center. Thus, the center plate is the most effective, while placing the plates far from the center will reduce the stiffness of the model.

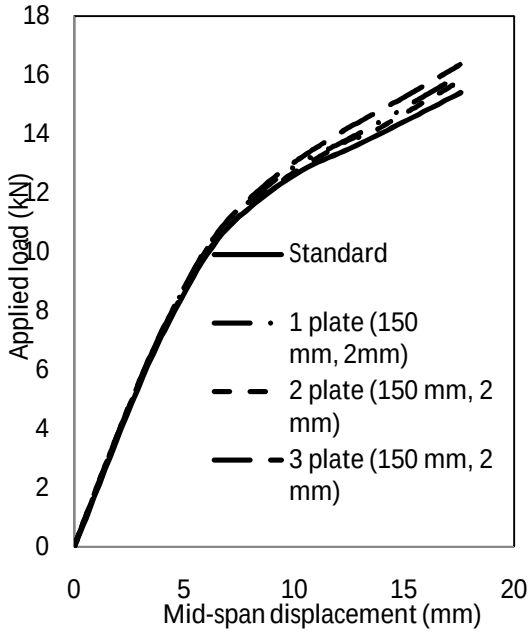

Fig. 7. Load-deflection curve for the third study

CONCLUSION

This paper has described the conducted studies to investigate the flexural behavior of the two-way PSSDB floor panels' strengthened with steel plates using FEA. The purpose is to prove that applying steel plates can optimize the structural performance of the system.

Steel plates with various properties have been used and it was found that increasing the steel plate thickness can enhance the PSSDB behavior. However, changing the width or using multiple plates doesn't greatly affect the performance. Therefore the thickness of steel plate can be considered the crucial factor in optimizing the two-way bending performance of the PSSDB system. Future studies should focus on finding alternative methods to optimize the two-way behavior of the system.

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