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Bending Behavior of Semi-Continuous Prefabricated Profiled Steel Sheeting (PSSDB) Floor Panels

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A R T I C L E I N F O

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A B S T R A C T

Profiled Steel Sheeting Dry Board (PSSDB) floor panel is a composite of dry board and profiled steel sheeting screwed together by means of self-tapping, self-drilling shear connectors. The system has been successfully implemented in many Malaysian construction projects. Recently, the PSSDB system has been expanded to be an easy to assemble prefabricated floor for rural school cabin construction. An innovative prefabricated panel consists of three PSSDB parts which are then screwed together on site to form a semi-continuous panel has been proposed. This paper describes the three distinct parts of the panel, their assembly and the experiment to study the bending behavior of the panel. The semi-continuous panel performance was also compared to that of a continuous panel. All together, six 3.0 m span samples were tested under a uniformly distributed load until failure. The semi-continuous panels showed a two-phase behavior whilst the continuous panels showed a three-phase behavior under loading which were related to the time of cracking of the dry board and the buckling of the profiled steel sheeting. The mid span deflections were recorded and used to determine the stiffness of the panels. Results showed that the stiffness of the semi-continuous panels were half of that of the continuous panels. It can be concluded that the discontinued spanning of the profiled steel sheeting has severely reduced the overall semi-continuous panel stiffness. The 25 screws used in the 0.6 m middle connecting panel had shown to be quite insufficient to hold the whole semi continuous panel together. Therefore, the addition of screws with closer spacing is recommended to increase the panel stiffness.

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1. Introduction

Profiled Steel Sheeting Dry Board (PSSDB) floor panel is a composite of dry board and profiled steel sheeting screwed together by means of self-tapping, self-drilling shear connectors. When the two components are combined to form the panel, composite action takes place. This action depends on the shape, depth, thickness and the strength of the sheeting, the type, thickness and strength of the dry board, and the type and spacing of the connectors. The system has been successfully implemented in many Malaysian construction projects which use locally available materials. The PSSDB panel system can also be used as walling and roofing unit in buildings. Studies have also been done to non-structural aspects as well, such as fire resistance performance, vibration, water proofing, finishes, sound properties, assembling techniques and cost.

Among the advantages of using this system are:
1. Light weight. One typical floor panel with a span of 2.4 m is around 70 kg and can be carried by two workers only.
2. Simple and easy to construct. It doesn't need formwork or prop and can be built by unskilled workers.
3. Save space as the panels can be easily stacked.
4. Shorter construction time
5. Less dependent on heavy equipment on-site
6. Reduced on-site labor time and costs.
7. Less wastage of materials

Studies on the behaviour of the PSSDB system as floor panels have been reported in earlier publications (Wright *et al* (1989), Ahmed (1999), Ahmed *et al* (2002), Wan Badaruzzaman *et al* (2001a), (2001b), (2003a), (2003b)). A typical PSSSDB panel is shown in Figure 1.

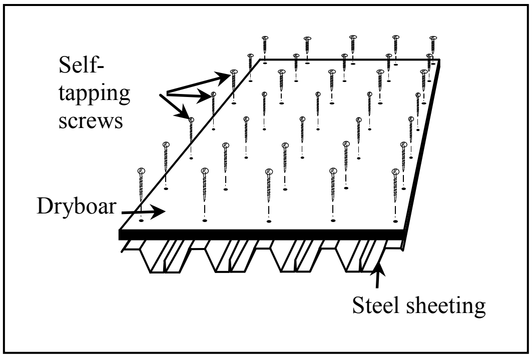

Figure 1: A typical PSSDB panel

Recently, the PSSDB system has been expanded to be an easy to assemble prefabricated floor for rural school cabin construction.

This new system consists of two PSSDB floor panels laid end-to-end on three beams. A shorter connecting panel is then screwed in the middle to transform the two end-to-end simply supported panels, into a semi-continuous configuration as shown in Figure 2 and Figure 3.

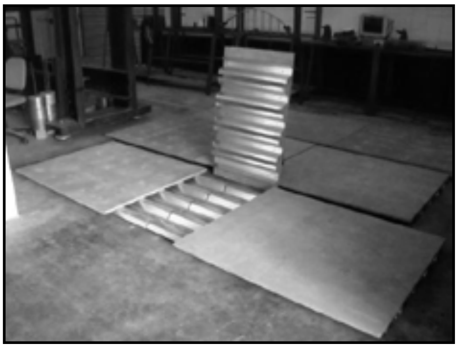

Figure 2: Semi-continuous panel with the connecting panel

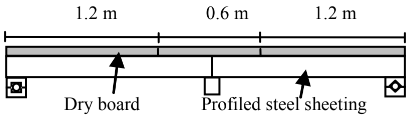

Figure 3: End view of a semi-continuous panel

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This type of arrangement allows for shorter panels design which is easier to transport and manage. This is especially beneficial to the construction in rural areas which has limited infrastructural facilities.

1.1 Test Specimens

Three semi-continuous and three continuous panels were fabricated and tested to failure. All the panels used 0.8 mm thick Peva 45 profiled steel sheeting and 18 mm thick Cemboard dry board.

The semi-continuous panel consists of two 1.5 m profiled steel sheetings which are screwed to two 1.2 m dry boards and a 0.6 m middle connecting panel as shown in Figure 4.

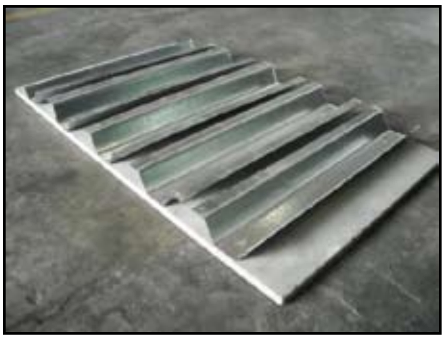

Figure 4: Close-up view of the connecting panel

The stiffeners of the profiled steel sheeting are first removed, leaving only the troughs which are then nailed to the dry boards to form the connecting panel. The connecting panel is then screwed to the two 1.2 m panels to form a semi-continuous 3.0 m panel. The screw spacing for the two 1.5 m parts is 200 mm whilst the screw spacing for the connecting panel is 100 mm.

On the other hand, the continuous panel is made up of a single, 3.0 m long profiled steel sheeting screwed to two 1.5 m and a middle 0.6 m dry boards.

2. Testing and Observation

Both the semi-continuous and continuous panels were mounted on three supports with a distance of 1.5m between them. A uniformly distributed loading was simulated by arranging eleven rectangular hollow sections to form four line loads as shown in Figure 5.

Figure 5: The semi-continuous panel loaded until failure

For the semi-continuous panel testing, the deflections for both middle spans were found to be comparable up to the ultimate load. When the load reached the ultimate load, the local buckling of the steel sheeting was detected under the rectangular hollow sections and the loading arrangement started to tilt to one side. Additional loading caused screw failure which led one of the 1.5 m profiled steel sheeting to detach from the connecting panel. The panel then behaved nonlinearly before it finally failed.

Figure 6 shows the continuous panel under loading. In the linear region, the panel deflected in a balanced manner for both middle spans. However, at the loading of 13 kN/m^2, the profiled steel sheeting web on the center support started to cripple. At the loading of 20 kN/m^2, the dry board above the middle support cracked.

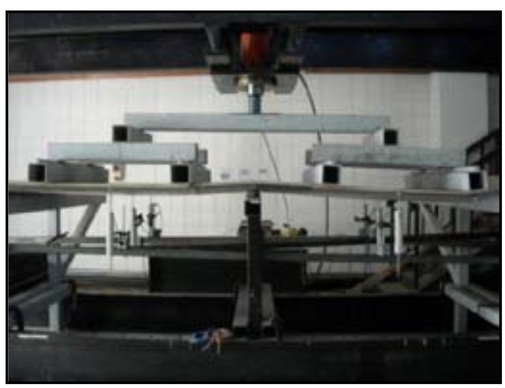

Figure 6: The continuous panel loaded until failure

3. Test Results and Analysis

The comparison between the behavior of the total six semi-continuous and continuous panels can be seen from the load versus deflection graph of Figure 7.

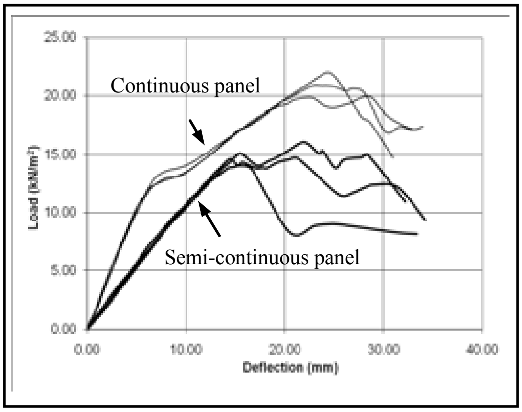

Figure 7: Graph of load versus deflection

The behavior of the semi continuous panels can be divided into two phases. The first phase shows a linear load-deflection behavior up to the ultimate loading of 14 kN/m^2. All three samples behaved very similarly in this region. However in the non-linear phase, the samples showed varied behaviors after the onset of the local buckling. The starting location of the local buckling was on either span which was most likely triggered by the imperfections of the profiled steel sheeting.

The continuous panel follows a three-phase behavior. The first is the linear phase up to the loading of 13 kN/m^2, The second phase is from the loadings of 14 kN/m^2 to 20 kN/m^2, where the slope of the load-deflection graph decreases due to the web crippling of the profiled steel sheeting on the middle support. The third phase, which happens after the ultimate load of 20 kN/m^2 until failure, is due to the cracking of the dry board of the connecting panel.

The semi-continuous panel has also shown to have only half of the stiffness of a continuous panel as evident in Table 1.

Table 1: Stiffness values comparison.

Sample panel	Stiffness (kNm^2/m)
Semi-continuous	28.08
Continuous	54.02

4. Conclusion

The characteristics of the panel continuity depends mostly on the ability of the connecting panel screws to hold the two overlapping profiled steel sheetings. The 25 screws used in the 0.6 m middle connecting panel had shown to be quite insufficient to hold the whole semi continuous panel together. It can be concluded that the discontinued spanning of the profiled steel sheeting has reduced the semi-continuous panel stiffness to half of that of the continuous panel. Therefore, the addition of screws with closer spacing is recommended to increase the semi-continuous panel stiffness.

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