TECHNICAL NOTE

PERFORMANCE OF INFILLED PROFILED STEEL SHEET DRY BOARD PSSDB LOAD BEARING WALL

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Abstract This paper describes the testing of Profiled Steel Sheet Dry Board (PSSDB) load bearing wall system. Experimental tests were conducted on various PSSDB wall samples, with and without infill materials to study its effect on the PSSDB load bearing wall performance. A proprietary profiled steel sheet, Ajiya Cliplock (0.48 mm thick) attached to Cemboard (10 mm thick) on one side, and Cemplank (10 mm thick) on the other side, via self drilling, self tapping screws spaced at 200 mm centre to centre were used for the tests. The height of the tested panels was all fixed at 3 metres. Results show that the ultimate loads at failure were between 28 kN to 45 kN, and between 158 kN to 182 kN for panels without and with infill materials respectively. Panels filled with polystyrene mortar show better axial load performance than panels without infill materials.

Key Words Profiled Steel Sheet, Dry Board, Load Bearing Wall, Composite, Infilled

چکیده این مقاله آزمایش ظرفیت بارگذاری را بر روی نیمرخ‌های صفحات فولادی دز سیستم دیوار (PSSDB) توصیف می‌کند. تست‌های آزمایشگاهی متعددی بر نمونه‌های دیوار PSSDB با مصالح پر کننده و بدون مصالح پر کننده جهت بررسی اثرات آنها بر عملکرد ظرفیت بارگذاری دیوارهای PSSDB انجام گردید. پروفیل‌های صفحات فولادی Ajiya Chiplock (با ضخامت ۰/۴۸ میلی‌متر) در آزمایش‌ها بکار برده شد که در دو طرف آنها صفحات Cemboard (با ضخامت ۱۰ میلی‌متر) به وسیله پیچ‌های در خواص ۲۰۰ میلی‌متری متصل شده است. ارتفاع کلیه پانل‌ها در آزمایش‌ها برابر با ٤ متر به کار برده شد. نتایج نشان می‌دهند که بار بحرانی در گسیختگی بین ۲۸ تا ٤۵ کیلونیوتن برای پانل‌های بدون و با مصالح پر کننده می‌باشد. پانل‌های پر شده توسط ملات پلی‌استرن عملکرد بهتری در برابر بارهای محوری نسبت به پانل‌های بدون مصالح پر کننده نشان داد.

1. INTRODUCTION

Studies on the behavior of the Profiled Steel Sheeting Dry Board system as a load bearing wall system have been conducted and reported in earlier publications [1–5]. The Profiled Steel Sheeting Dry Board (PSSDB) composite panel system, i.e. profiled steel sheeting connected to dry boards by means of mechanical connectors (see Figure 1), is a structural load bearing system and can be used for a variety of structural purposes such as floor, roof, and wall units. Previous publications reported works on PSSDB walls without any infill materials. This paper deals with the effect of infilling the normally voided trough of the profiled steel sheeting of PSSDB wall panels with infill materials. This formed a very rigid load bearing wall structure as expected.

As a load-bearing wall, the system acts as a membrane carrying the in-plane deformation and shear. The structural behavior and strength of the PSSDB composite panel system depend to a large

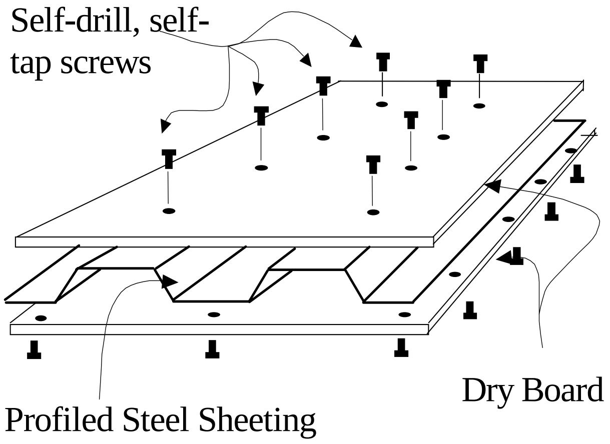

Figure 1. Typical double-skin PSSDB wall panel.

extent on the properties of the basic components forming the system, i.e. the steel sheeting and dry board, and the degree of interaction between them. The degree of interaction can be either full or partial interaction depending on the connector modulus and spacing. In a building, floor loading would be transferred to the PSSDB walls that would in turn transfer the load to the foundation. Therefore, it is of utmost importance to study and understand the behavior and ultimate load capacity of such walls.

2. EXPERIMENTAL MODELS

The aim of the experimental work is to gain an understanding of the behavior of PSSDB as load bearing wall panels, and to study the effect of introducing infill materials in the trough of the profiled steel sheet on the structural behavior of the wall panels.

Four small-scale rectangular samples having dimensions of 650 mm x 3000 mm were used in the experimental investigations. Table 1 gives the sample specifications with a typical cross-sectional illustration (taken from sample 3) as shown in Figure 2. The proportional volume of polystyrene cement mortar was cement: sand: polysterene = 1:3:3. The panels were simply supported along the two edges, providing an effective span of 3000 mm. The self-drilling and self-tapping screws were arranged along each rib with a spacing of 200 mm centers.

The test rig consisted of a support frame on one end, and a movable loading frame on the other end (see Figure 3). The loading frame on the other hand was of inverted T-shape cross section having similar dimensions to the support frame. In addition, to allow for movement of the loading frame, the base plate was put on rollers. The loading was applied incrementally via a hand pumped jack connected to two load cells, each having a capacity of 300 kN placed in between the

TABLE 1. Sample Specifications.

Sample No.	Description of Samples
1	Ajiya Cliplock 650 (0.48 mm thick) was used as the base material, whilst Cemboard (10mm thick) was screwed on every rib on Ajiya Cliplock 650 on one side, and Cemplank (10mm thick) was screwed on every rib of Ajiya Cliplock 650 on the other side. No infill material was used in this sample. The sample was tested almost immediately after preparation.
2	As Sample 1, but the Cemplank was screwed only on two middle ribs of Ajiya Cliplock 650.
3	Ajiya Cliplock 650 (0.48 mm thick) was used as the base material, whilst Cemboard (10mm thick) was screwed on every rib on Ajiya Cliplock 650 on one side, and Cemplank (10mm thick) was screwed on every rib of Ajiya Cliplock 650 on the other side. Polystyrene cement mortar was used as infill material in this sample. The sample was tested after 7 days of preparation.
4	As Sample 3, but the Cemplank was screwed only on two middle ribs of Ajiya Cliplock 650.

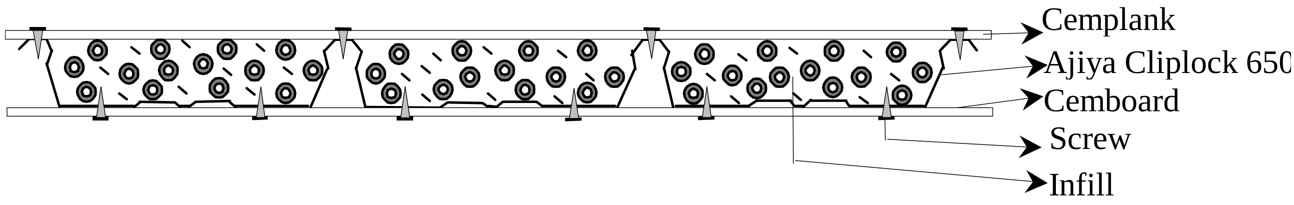

Figure 2. Sample cross section (sample 3).

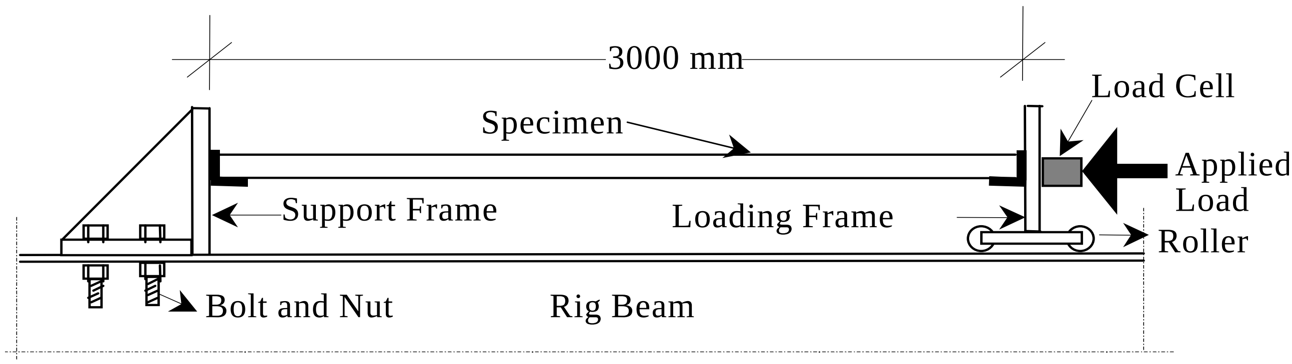

Figure 3. Sketch of support and loading frame.

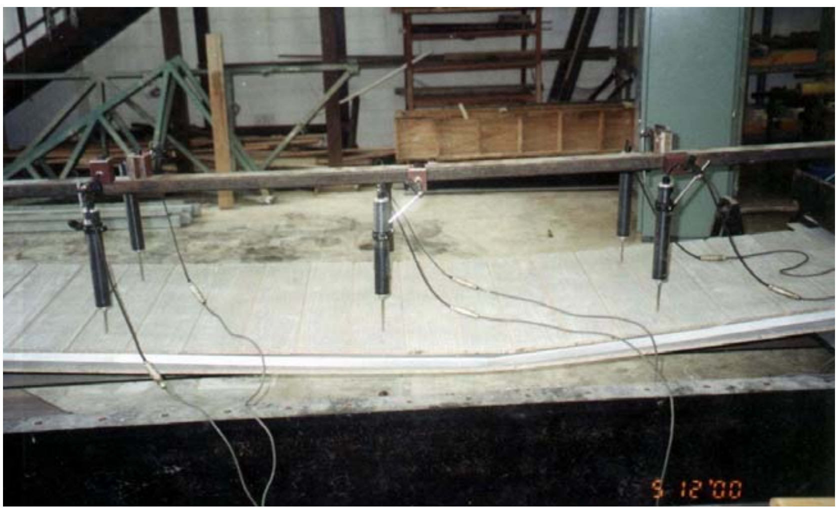

Figure 4. Typical sample failure mode.

end of the sample and the loading frame.

Deflection transducers to measure deflections perpendicular (lateral) to the length of the test panels were placed at various locations on top of the test panels. The most important transducer position was at mid-length (mid-height) and mid-

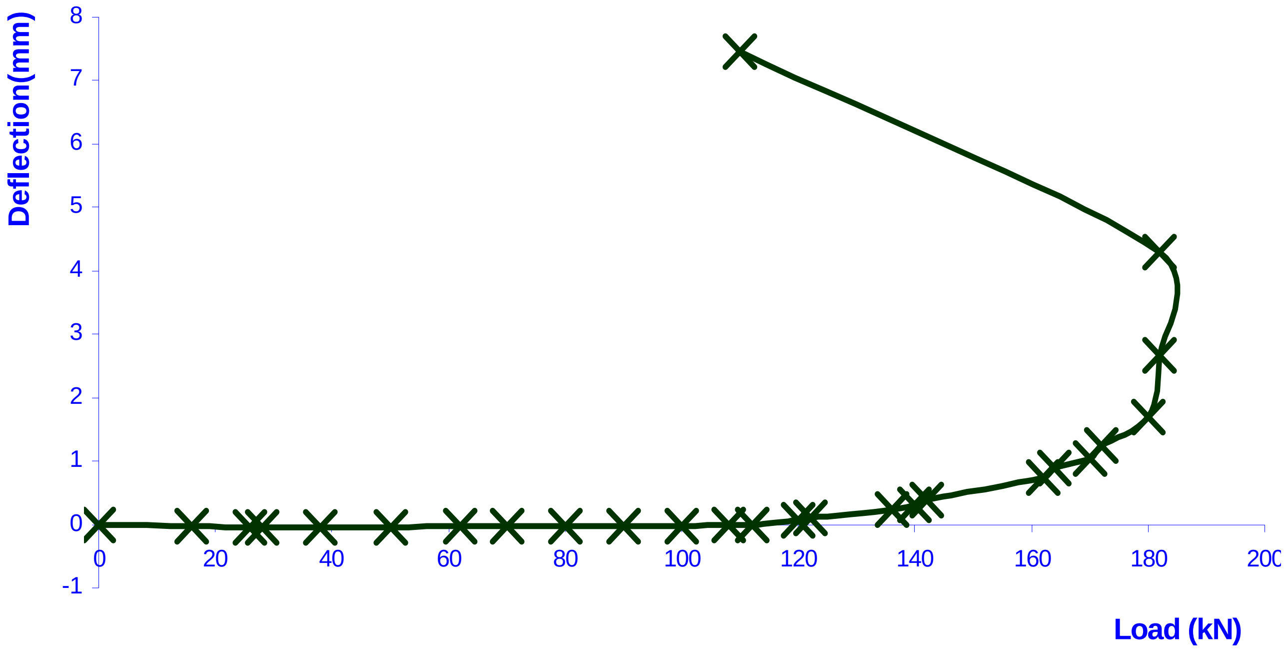

Figure 5. Typical deflection vs. load at middle span (sample 3).

width position of the panels where the maximum value of deflection was expected. Values at other positions, such as at either side of the center point along both x and y directions were used to check for expected symmetrical behavior of the panels (see Figure 4). The load and the corresponding deflection measurements taken from the test were then used to investigate the behavior of the panels.

3. TEST OBSERVATIONS

Failure Mode Failure of the panels started within the vicinity of their mid-length. It began with the appearance of crack near the mid-length of panel on the Cemplank. With further increase in loading the crack pattern propagated further perpendicular to the corrugation of the steel sheeting. This is an expected mode of failure for the kind of tested sample configuration as described in another publication [5], i.e. failure due to overall buckling. Figure 4 shows a typical specimen after failure.

Load-Deflection Response The results for the four test panels showed similar characteristics. A typical individual load-deflection responses at mid-length (mid-height) of the panels are given in Figure 5 (taken from sample 3). The tests showed that the two samples (samples 1 and 3) that had Cemplank screwed to every Ajiya Cliplock 650 rib performed better, i.e. having higher ultimate failure loads than similar panels with Cemplank screwed only on the middle ribs (samples 2 and 4 respectively). The latter buckled much earlier than the former. In all cases, when the overall buckling limit was exceeded, significant lateral deflections were recorded.

The onset of buckling was indicated by the sudden jump in deflection values prior to the failure of the tested panels. The load value that was considered being the ultimate load at failure was the highest reachable load recorded by the data logger. It was observed from the curves that the initial load-deflection responses were relatively linear and elastic. The elastic response continued until overall buckling started before failure of the panel. The ultimate loads at failure of all the samples are given in Table 2.

TABLE 2. Ultimate Load at Failure.

Sample No.	Max. Load (kN)
1	44.8
2	28.0
3	182.0
4	158.3

4. DISCUSSIONS

As mentioned earlier, the structural behavior and strength of the PSSDB composite panel system depends on the properties of the steel sheeting, dry board, and the degree of interaction between them. This was confirmed by the test results described above. Results show that sample 2 was the weakest sample with the lowest failure load of 28 kN. This was due to the absence of any infill material in addition to the already weak attachment of Cemplank to Ajiya Cliplock 650 at only two middle ribs. Sample 3, as expected show the strongest resistance against axial load, where the load at failure is 182 kN. This was so because Cemplank was screwed onto every rib of Ajiya Cliplock 650 in addition to the polystyrene mortar used as infill material. As has been mentioned earlier, by attaching or screwing Cemplank on every rib of steel sheeting, the ultimate load capacity has increased tremendously, i.e. from 28 kN to 44.8 kN in the case of samples without infill material, and from 158.3 kN to 182 kN for samples with infill material. This indicates an increase of strength by 60% and 15% respectively for the panels with and without infill material.

From the above, it can be seen that the role of the screws in increasing or decreasing the strength of the PSSDB wall panels is more significant for the panels without infill material compared to those with infill material. This could be explained by the fact that the panels without infill material depend solely on the screwed connection to provide the interaction in between the components forming the panels, whereas in the case of panels with infill material, there exists some degree of interaction afforded by the natural bonding of the polystyrene mortar with Cemplank and steel sheeting.

5. APPLICATION

As shown in Table 2, simple PSSDB panel without infill with Cemplank screwed on every rib of the steel sheeting (sample 1) can support 44.8 kN/650 mm = 68.9 kN/m of uniformly distributed loading. Supposed the assumed safety factor is 5, the capacity of 1 meter width and 3 m height of PSSDB panel is 13.8 kN/m. If the total roof load is 4 kN/m^2, the panel can support a roof that spans 6.9 meter without requiring any column. It seems that the PSSDB panel can be applied as load bearing wall for any simple building.

6. CONCLUSIONS

Four PSSDB load bearing wall panels have been tested successfully. It has been shown that infill material has significant contribution in increasing the ultimate load carrying capacity. The ultimate load increased almost 5 times compared to the panel without infill. Moreover, the screws contribute in improving the ultimate load capacity of PSSDB load bearing wall panel. These are indications that wall panel is an innovative building material with the potential of being implemented in building constructions.

7. ACKNOWLEDGEMENT

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