THE APPLICATION OF PROFILED STEEL SHEETING DRY BOARD (PSSDB) INDUSTRIALISED BUILDING SYSTEM

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ABSTRACT:
This paper describes the application of Profiled Steel Sheet Dry Board (PSSDB) system, a lightweight load bearing panel system. The PSSDB panels are utilised in constructing walls, floors and roofs of school classroom modules that will be described in this paper. The structural composite panel system consists of profiled steel sheet attached to the dry board via mechanical self-drilling and self-tapping screws. The proposed panel system can be classified to be under the Industrialised Building System (IBS) category since all the structural panel components are manufactured in a factory, transported and assembled into a structure or building with minimal additional site work. Compared to traditional building systems and materials, the PSSDB system eliminates the used of conventional timber formworks, columns and roof trusses in buildings. Besides, the proposed system has many advantages such as it can be easily suited into a modular construction system, relatively very much lighter compared to traditional reinforced concrete system, making construction less labour-orientated, shorter construction time, materials optimisation, and provides better finished products. The system was successfully implemented in two school classroom modules at Sekolah Kebangsaan Telok Mas, Melaka, Malaysia.

Keywords: PSSDB panel, Industrialised building system, School classroom modules.

1. INTRODUCTION

The Industrialised Building System (IBS) is defined as a construction system which components are manufactured in a factory, on or off site, positioned and assembled into structure with minimal additional work [1]. The relatively new concepts in the construction technology are becoming more acceptable to the construction technology. IBS has been promoted in the construction industry in order to enhance the efficiency of construction processes, which in turn would allow for a higher productivity and quality, and would reduce the time of construction, cost saving as well as being environmental friendly.

The government through the Construction Industry Development Board (CIDB) has unleashed. IBS Roadmap 2003-2010 that outlines several well-thought strategies and aggressive steps to promote the use of IBS as an alternative to the conventional method [2]. Contractors adopting the IBS systems are given incentives such as levy exemption based on the percentage usage of IBS in a project. The implementation of IBS in construction activities is not only competitive to conventional methods, in terms of quality control and total construction costs but more importantly, can reduce the dependency on foreign labours [3]. IBS has been introduced into the construction industry in order to enhance the efficiency of construction processes, thus allowing higher productivity and quality, time and cost saving.

2. PSSDB AS IBS

As part of the initiative related to the above needs, an Industrialised Building System (IBS), namely the Profiled Steel Sheeting Dry Board System (PSSDB) has been developed. The PSSDB system is a lightweight composite system consisting of profiled steel sheet connected to dry boards by self drilling and self tapping screws. The screws play an important role in transferring the shear force between the dry board and profiled steel sheeting, thus resulting in composite action between the two components. The performance of a connection depends on the type of screw, profiled steel sheet and dry board used, and also on the spacing of the screws which together determine the degree of composite action and the stiffness of the structural composite system.

The panel results in a strong and efficient composite structural system which can be assembled to virtually numerous sizes and strength combinations. The original concept of PSSDB system was first introduced by

Wright and Evans [4] as a replacement to existing timber joist floor. Its use has been extended to include its application as walling and roofing units in buildings. Figure 1 shows the typical composition of PSSDB system.

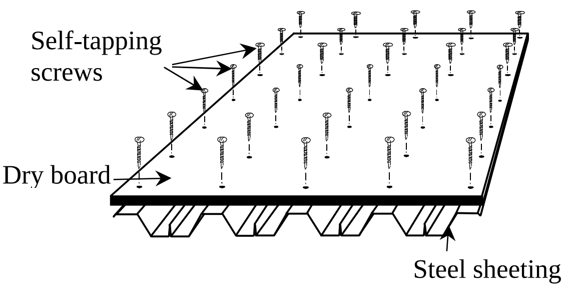

Figure 1: Typical PSSDB system

Most importantly, this system falls under the concept of Industrialised Building System (IBS) in accordance to Badir & Razali's definition [5]. The cost and time of construction are reduced as compared to that of conventional school building by Public Works Department (JKR) [6]. In terms of the environmental aspects, the PSSDB system is environmentally friendly as there is no wastage of construction materials. Fire resistance of PSSDB flooring system was found able to meet the UBBL 1987 [7]. The panels could also be insulated to make them sound and heat proof. Two classroom modules utilising the PSSDB have been built at Sekolah Kebangsaan telok mas, Melaka, Malaysia (Figure 2).

Figure 2: Classroom modules

3. PREPARATION OF PSSDB PANELS

The total area of the each classroom module is approximately 105 m^2. Three types of structural panel members utilising the PSSDB system for the modules are the floor, wall and roof panels. The classroom modules has been built based on IBS.

3.1 Floor

The floor panel is constructed out of a single skin Cemboard (dry board) connected to Peva 45 (profiled steel sheet) using 32 mm self drilling screws. The thickness of Peva 45 and the Cemboard are 0.8 mm and 18 mm respectively. The panel is also light enough to be lifted by two persons (Figure 3) and can be stacked and delivered to the construction site with ease. This is especially beneficial for construction in remote areas where the basic infrastructure is limited and inaccessible to the use of crane and other heavy machineries. Table 1 shows the weight of floor panel with varying dry board thickness. The floor panel size is 2400 mm x 1000 mm with screw spacing of 200 mm and is designed as simply supported.

Table 1: Weight of floor panel with varying dry board thicknesses

Thickness of Profiled Steel Sheet, Peva 45 (mm)	Thickness of Dry Board, Cemboard (mm)	Weight of 1 m x 2.4 m PSSDB panel (kg)
0.8	16	67.2
	18	73.2
	20	79.2

Figure 3: Two workers lifting a 2.4 m PSSDB floor panel

3.2 Wall

The wall panel is constructed out of a double skinned Prima*flex* (dry board) attached to a central core of CL660 (profiled steel sheet). The thickness of CL 660 is 0.48 mm. The inner part of Prima*flex* is 6 mm thick while the outer part is 9 mm thick. The general width of the wall panel is 660 mm but smaller sizes are also available accordingly. Figure 4 below shows a typical PSSDB wall panel with window opening. The lengths (heights) are however varied according to the tapered height of the wall. The wall panel is connected to the adjacent panel using a longitudinal timber strip acting as a spline as shown in Figure 5.

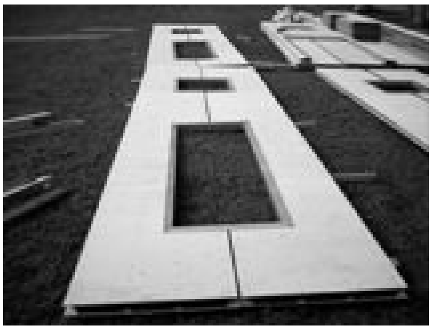

Figure 4: Double skinned wall panel with window openings

Figure 5: Details of a narrow wall panel with timber spline and U capping at the ends

3.2 Roof

Based on the original concept of the system, the application of the PSSDB system has been extended to form a new concept of roofing system. The PSSDB roof panel was constructed using Ajiya Cliplock CL 660 (profiled steel sheet) and Prima*flex* (dry board). The thicknesses of the sheeting and the board are 0.48 mm and 9 mm respectively. The sheeting and dry board were screwed together via self-tapping and self-drilling screws at a distance of 100 mm on every rib of Ajiya CL 660. The normal position of the PSSDB panel is shown in Figure 1 above. However, the roofing panel in the normal PSSDB position could pose durability problems in the long run, as the dry board is exposed to the environment. In order to solve this problem, the position of the PSSDB panel was reversed (see Figure 6).

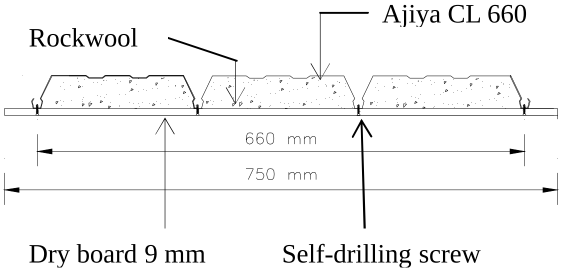

Figure 6: Reversed position of proposed PSSDB roof panel

Two sizes of panels were involved; 750 mm wide x 2000 mm length (14 nos) and 750 mm wide x 4000 mm length (28 nos) and the screw spacing is 100 mm.

4. CONSTRUCTION STAGES

The site was cleared and prepared prior to the beginning of the installation of the modules. The footing was constructed out of normal reinforced concrete. All modules were prefabricated in the factory and stacked at the site as shown in Figure 7.

The erection process started with the placement of the floor after construction of the floor beam/C channel has been completed. After all the floor panels have been placed, the wall panels are installed one after another. Finally, the roof panels were installed into position. Figures 8 (a-d) show the processes of erection of the modules.

Figure 7: Stacks of PSSDB panels at the construction site

Figure 8(a). Construction of footing

Figure 8(b). Erection of floor panel

Figure 8(c): Wall panels

Figure 8(d): The propped wall and laid floor panels

Figures 9 (a) and (b) show the erection of the PSSDB roof panels. The end panels (4 m long) were connected onto the front or back PSSDB wall at one end, and specially designed purlins (inverted T-shaped structural members – 30 mm x 50 mm x 4 mm RHS welded onto 150 mm x 5 mm thick mild steel plate) at another end. On the other hand, the interior panels (2 m long) were connected to the specially designed purlins at both ends. The purlins were placed and screwed onto mild steel rafters (76.2 mm x 120 mm x 6 mm RHS) and two side PSSDB walls, whilst the rafters span in between the front and back PSSDB walls. All connections were simple screwed connections. The panels were finally connected and covered by an additional top layer of profiled steel sheet which act as a cladding system. The rafters play an important role in transferring load from the purlins onto the load bearing PSSDB walls. Figure 9 (c) shows the flat surface on the underside of the roof facing into the room.

Figure 9(a): Erection of rafter

Figure 9(b): Erection of roof panels

Figure 9(c): Flat surface on the underside of the roof

Figure 10 shows the completed modules. The whole construction process was completed in a timely manner with minimal material wastage, less site materials, neater and safer site condition and better quality control.

Figure 10: Completed classroom modules

5. CONCLUSION

This paper has described the application of Profiled Steel Sheet Dry Board (PSSDB) system as a structural component in constructing innovative lightweight composite school classroom modules. The system has many advantages. It was successfully implemented in two school classroom modules at Sekolah Kebangsaan Telok Mas, Melaka, Malaysia. The described application manifests the potential of the PSSDB system to be implemented as a complete IBS in the construction of buildings.

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