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Bending behavior of sandwich panels with wire meshes

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ABSTRACT

Cementitious sandwich panel (CSP) is a Structural Insulated Panel (SIP) that the cementitious sheet is used to be the facings. Although, the fire rated and strength of panel are improved when using cementitious as facing, cementitious sheet is brittle behavior material. Therefore, the several reinforcements are used to improve the bending behavior of the panels.

This study aims to investigate the flexural behavior of CSPs that reinforced by wire meshes through experimental investigations. The 10.4 x 15 x 120 cm. test specimens consist of the 8 cm.-thick 1 lb/ft^3 density expanded polystyrene foam core layer and 1 cm.-thick cementitious sheets that are glued to each face of the core layer. The wire meshes are inserted between the core layer and the tension facing. The third point load testing technique are performed in order to investigate the flexural behavior of all test specimens. The results focus on bending behavior of panels such as load-deflection relationship and failure mechanism of test specimens.

1. INTRODUCTION

ASTM (2007) defines sandwich panels as a three layered construction made by bonding a thin layer (facing) to each side of a thick layer (core). Structural insulated panel (SIP) that the faces made of cementitious boards called cementitious sandwich panel (CSP). Because of high efficiency-to-weight ratio of this kind of member, it is often used to be the structural components. Although, the fire rated and strength of panel are improved when using cementitious as facing, however, the CSP has brittle failure behavior (Chomchuen and Boonyapinyo, 2016). Therefore, the several reinforcements are used to improve the bending behavior of the panels.

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Several researchers studied about the behavior and improvement of the SIP (Davies (2001), Gara et al. (2012), Husein et al. (2013), Puvanant (2008), and Smakosz and Kreja (2014)). Chomchuen and Boonyapinyo (2016) also studied to enhance the flexural capacity of CSP. The study shows that installing the hidden thin galvanized steel beam can enhance the flexural capacity of CSP and changed the failure behavior of CSP. However, installing the hidden thin galvanized steel beam may be difficulty task in practice. Therefore, this study aims to investigate the flexural behavior of CSPs that reinforced by more practical technique than using hidden beam, i.e., using wire meshes, through experimental investigations.

2. SPECIMEN DETAILS AND PROPOSED REINFORCED TECHNIQUE

The CSPs are made by sandwiching a 8 cm. thick EPS core layer between two 1 cm. thick fiber-cement facings. They are glued together by the general-purpose sandwich panel adhesive (Sikaforce-7710). Cross-section of CSIP test specimens is shown in Fig. 1. Density of non-flammable EPS that used in this study is 32.04 kg/m^3 (2 lb/ft^3). Dimensions of all test specimens are 10.4 x 15 x 120 cm. for height, width, and length, respectively. Wire meshes are inserted between the core layer and the tension facing as shown in Fig. 1

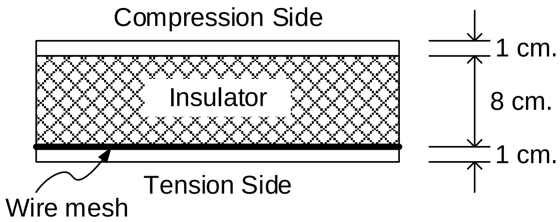

Fig. 1 Details of test specimens

3. Experiments Setup

This study focuses on the influence of the inserted wire mesh on the flexural behavior of CSPs. Therefore, centre point load flexural testing method is used to evaluate flexural behavior the test specimens. Testing schematic is shown in Fig. 2.

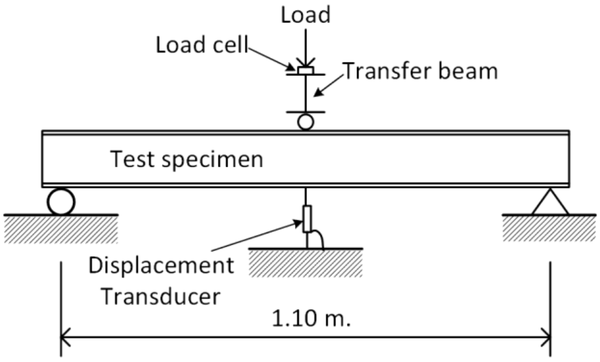

Fig. 2 Details of centre point load flexural test

Simple support apparatus is set up on the Universal Testing Machine (UTM) in order to support the test specimens. Point load that applies at the centre of test specimens is transformed to line load along the specimen width by the transfer beam. Load cell is used in order to record of applied load. Linear variable displacement transducer (LVDT) is set at the centre of test specimens in order to measure vertical displacement. The UTM applies the load to test specimen until a collapse occurred. Fig. 3 shows the testing setup on UTM and the collapse of a CSP tested specimen.

Fig. 3 Flexural collapse of test specimens

4. RESULTS

The five specimens with and without reinforcement are tested by center point load testing method. Loads and corresponding center displacements are recorded and presented in form of load-displacement relationship called flexural behavior in this study. Fig. 4 and 5 show flexural behavior of test specimens without and with reinforcement, respectively.

Fig. 4 shows that average strength of specimen without reinforcement is 233 kg while average maximum deflection is 5.42 mm. Fig. 5 shows that average strength and average maximum deflection of specimen with reinforcement are 261.8 kg and 9.38 mm, respectively.

Comparing results of the specimen with and without reinforcement, inserting wire mesh as the reinforcement can enhance the strength about 12 percent. While, failure behavior of specimens change from suddenly collapse to semi-ductile collapse when wire mesh is inserted. In other words, when the wire mesh is inserted into the CSP to be the reinforcement, crack starts at the tension side facing and grows vertically into the core material. However, the specimen did not separate after collapsed.

Fig. 4 Flexural behaviour of specimens without reinforcement

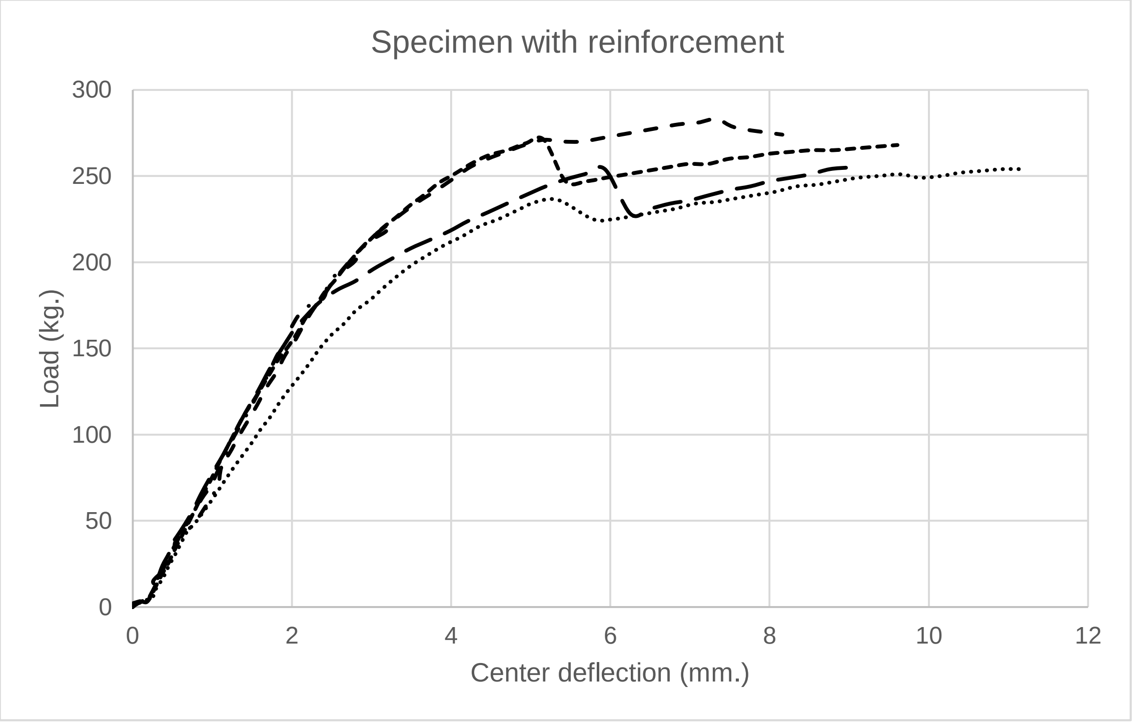

Fig. 5 Flexural behaviour of specimens with reinforcement

5. CONCLUSIONS

This study aims to investigate the effect of reinforcement of CSPs by ductile material, i.e. wire mesh, on their flexural behaviour. The results of this study lead to following conclusions.

- The test specimens with reinforcement can resist the load 12 percent higher than one without reinforcement.

- The test specimens with reinforcement show gradually collapse. Crack starts at the tension side facing and grows vertically into the core material. However, the specimen did not separate after collapsed.
- Inserting wire mesh as reinforcement can be done during CSPs production process.

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