The Behavior Characteristics of Tapered Wall in Steel Plate-Concrete Structure

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SUMMARY:
This paper addresses the strength characteristics of steel plate reinforced concrete structure (SC) and the experimental results of SC wall subjected to out of-plane flexure. Two experimental research programs were carried out. One was the experimental specimen in which the influence of the flexural moment, another was that in which the influence of the shear force was investigated.

Keywords: Steel plate-concrete (SC), Structural modules, Stiffened Steel plate-concrete (SSC)

1. INTRODUCTION

Composite structure utilizes exterior steel plates with concrete Infill. This has many advantages relative to bult-up steel-plate or reinforced-concrete structure[1-6]. The objective of this study is to investigate strength characteristics of steel plate-concrete tapered wall, stiffened steel plate-concrete (SSC), with variables of failure modes, flexural failure and shear failure.

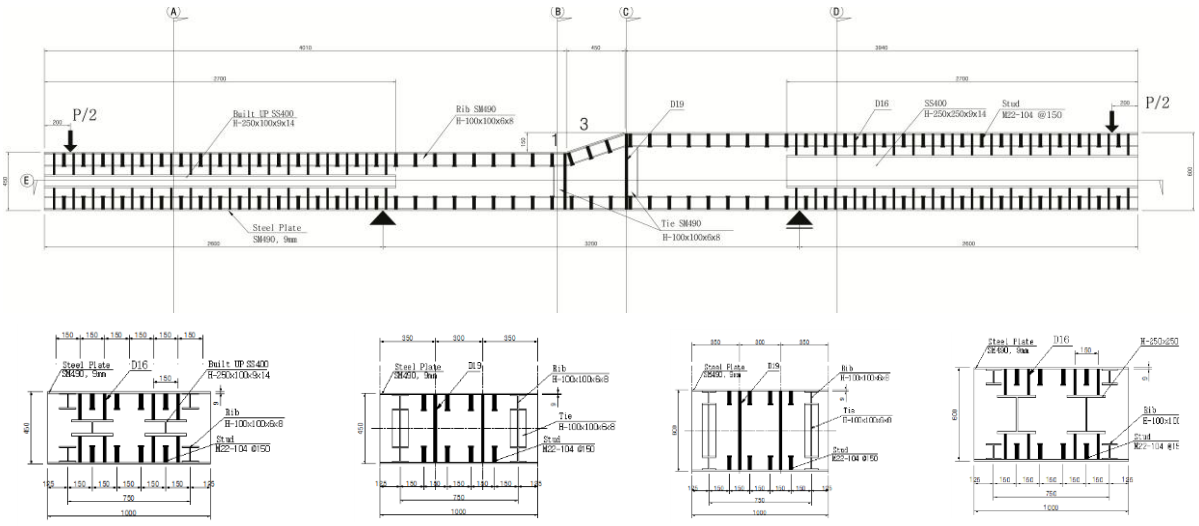
2. EXPERIMENTAL PROGRAM

2.1. Test specimen

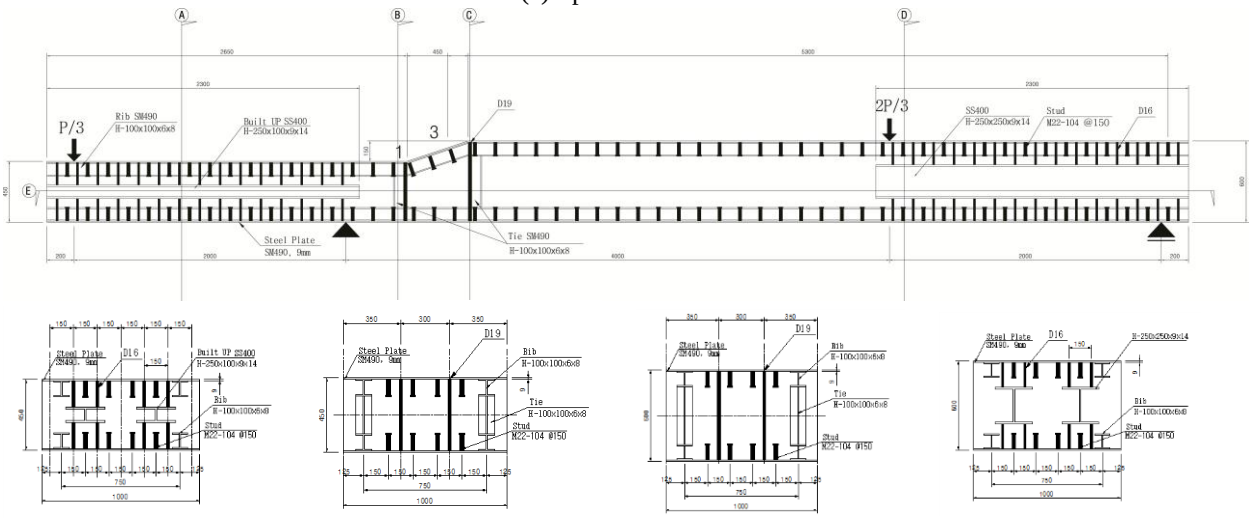
Table 1 shows the specimen types and specifications. In order to investigate the strength characteristics of two specimens were designed and manufactured. Detail of specimens is shown in Fig. 1.

Table 1. Variables and details of test specimens

Section	failure type	
	Specimen 1 (Flexural failure)	Specimen 2 (shear failure)
length × width × height	8,400 × 1,000× 600(450) mm	
Steel plate thickness, t_p (SM490)	9mm	
Stud diameter	16@150	
Rib	H-100×100×6×8	
Reinforcement vertical Tie (Rib)	H-100×100×6×8	
Reinforcement vertical Tie (Reinforcing bar)	D19	
Reinforcement Rib (SS400)	450mm section : Built-Up H-250×100×9×14 600mm section : H-250×250×9×14	
Shear span-to-depth ratio	5.33	4.44



(a) Specimen 1



(b) Specimen 2

Figure 1. Test specimens

2.2. Material properties

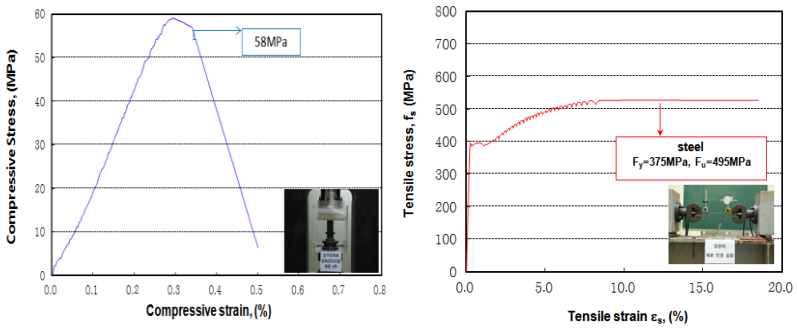
Concrete with a minimum specified 28-day compressive strength of 58MPa was used for each of the three specimens. 100 x 200 mm (3.9 x 7.9 in.) cylinders were constructed to measure the compressive strength of the concrete. The compressive tests were conducted on the specimens in accordance with the method defined in ASTM C39 to deter mine the compressive strength. Tension tests were conducted on the specimens in accordance with ASTM A370 to determine the yield strength and so on. The mechanical properties of the concrete, steel are reported in Table 2 and Fig. 2.

Table 2. Mechanical properties of materials

Material	Type	Compressive strength (MPa)	Strain ($\times 10^{-6}$)	Modulus of Elasticity (GPa)
Concrete	C28	58	2,900 (Ultimate)	36.4
SM490	SS490	F_y=375 F_u=495	1,923 (Yield)	195

2.3. Experimental set-up

The test specimens were loaded two points both ends of the specimen by way of displacement control at a rate of 0.02mm/sec using universal testing machine with a capacity of 7,000kN. The displacement of each specimen was measured using Linear Variable Differential Transducers (LVDTs) at critical locations. Fig. 3 shows the specimen installations.



(a) concrete (b) steel

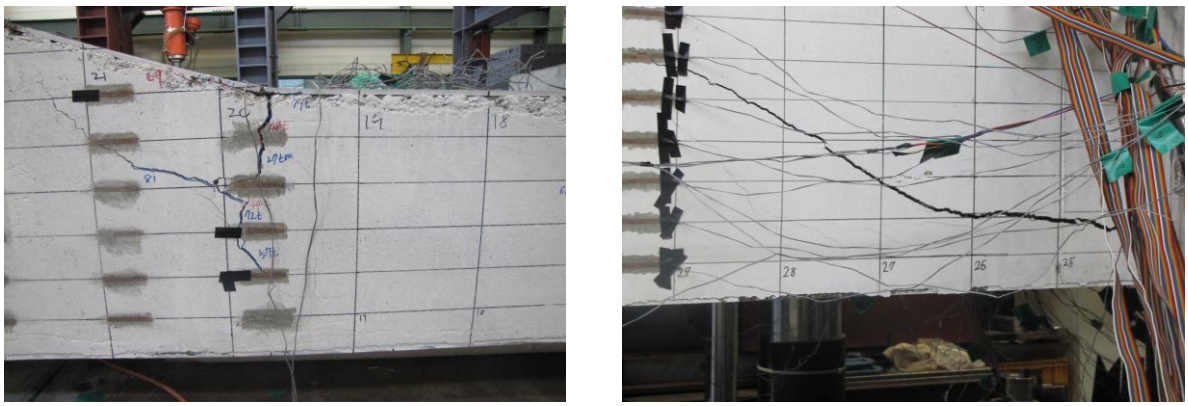
Figure 2. Mechanical properties of materials

Figure 3. Test set-up

3. EXPERIMENTAL RESULT

3.1. Failure mode

Fig. 6 shows the failure modes of Specimens 1 and 2. The flexural failure of SC wall for specimen 1, the ductile failure, was occurred in the top steel plate of the tapered region before concrete in connection region was rupture by uplifting force. The shear failure for specimen 2, brittle failure, was occurred after the shear inclined crack width rapidly increased.

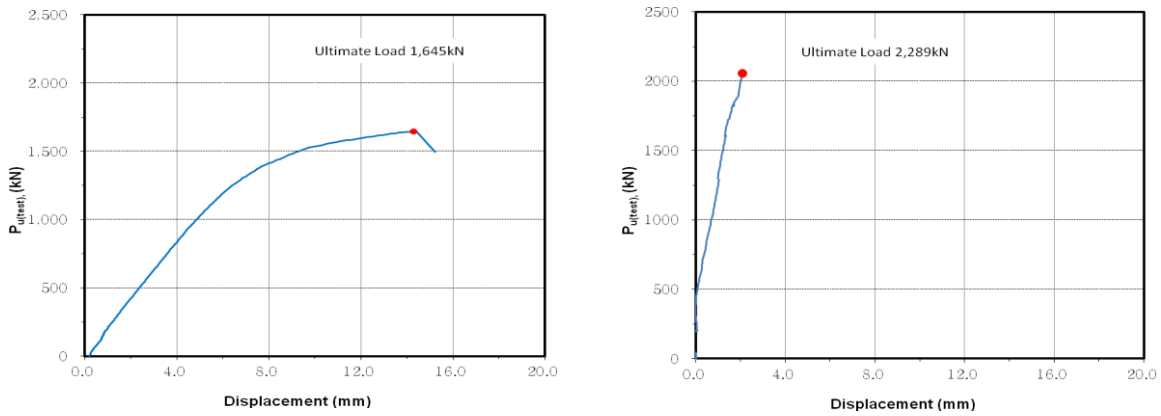


(a) Specimen 1 (b) Specimen 2

Figure 4. Failure mode

3.2. Load - displacement relationship

Fig. 5 shows the load-displacement relationship curves of specimens 1 and 2. Specimens 1 and 2 developed maximum capacities equal to 1,645kN and 2, 289kN, respectively. Specimen 1 shows stable behavior characteristics without strength degradation after yielding of top steel plate. However, specimen 2 shows unstable behavior characteristics, reducing sharply strength after the ultimate strength. This is attributed to the failure mode, shear failure of this specimen.



(a) flexural type (b) shear type

Figure 5. Load-Displacement Relationship Curves

4. CONCLUSIONS

Specimens 1 and 2 show ductile failure and brittle failure, respectively. In addition, Specimens 1 and 2 show stable after yielding of top steel plate and unstable behavior after ultimate strength in SC wall, respectively. Based on the observations of test results, Failure modes and behaviors should be considered when SC wall will be designed to achieve good performance.

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