Experimental Study on the Structural Behavior of HSC Slab under out of plane load

K. W. Ham,[a] ,K. J. Lee,[a] D. S. Park,[a]
a Nuclear Power Lab., KEPRI, 103-16, Munji, Yuseong, Daejeon, hkw@kepri.re.kr

1. Introduction

HSC(Half Steel plate Concrete) Slab is a kind of SC(Steel plate Concrete) structure, so it has a similar advantage of SC structures (short construction period, lower cost and good quality control compared to RC).

To apply HSC to the slab of containment building of NPP, several test with different test condition (shear span ratio, shear bar, loading type) were conducted to verify structural behavior of HSC slab structure under out of plane loading.

2. Test Procedure

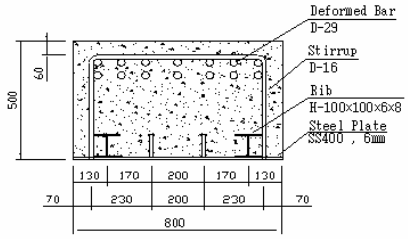
2.1 Specimen Shape

The bottom surface of HSC is composed of steel plate whereas top and bottom one of SC structure is covered with steel plate.

Beam type specimens which were designed as HSC slabs were assumed as a 1-way structure. The letter 'B' stand for bending, 'S' for shear, 'P' for positive bending moment, 'R' for rib, middle 'S' for shear bar, 'ST' for stud. The properties of specimen are summarized in Table 1 and Figure 1,2 shows the schematic view of specimen.

Table 1. Specification of specimen (Unit : mm)

Specimen Number	①	②	③	④, ⑤	⑥	⑦
Specimen	B-2R-2S400-2ST	BP-2R-2S400-2ST	S-2R-2S400-2ST	SP-2R-2S400-2ST (1st, 2nd)	SP-2R-0S-2ST (7.2)	SP-2R-0S-2ST (3.6)
W x D x L	800 x 500 x 8400					
Steel plate thickness	6					
Stud diameter	16					
Stud pitch	2 rows @ 200					
Shear bar pitch	2 rows @ 400				N/A	
Shear span ratio	7.2					3.6
Loading Type	Bending		Shear			



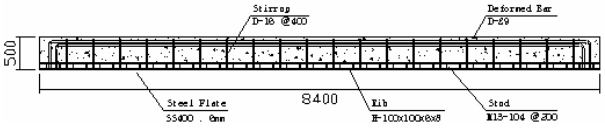


Figure 1. Specimen (①,②,③,④,⑤)

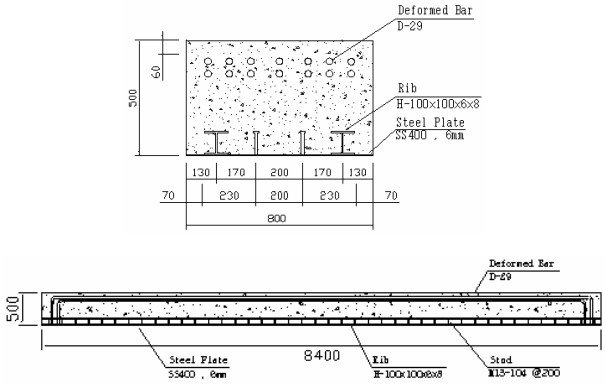
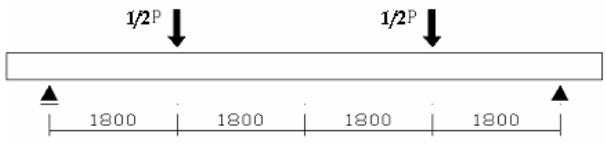


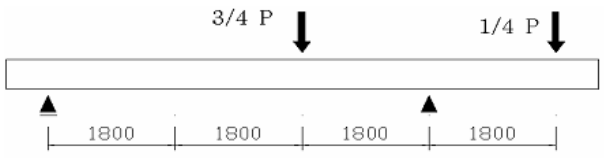
Figure 2. Specimen (⑥,⑦)

2.2 Loading Frame

Loading frame was designed to apply shear and bending load condition by strong beam and 700 tonf UTM (Universal Testing Machine). Figure 3 shows drawing of test apparatus according to loading type and shear span ratio.



(a) Bending Loading (shear span ratio : 7.2)



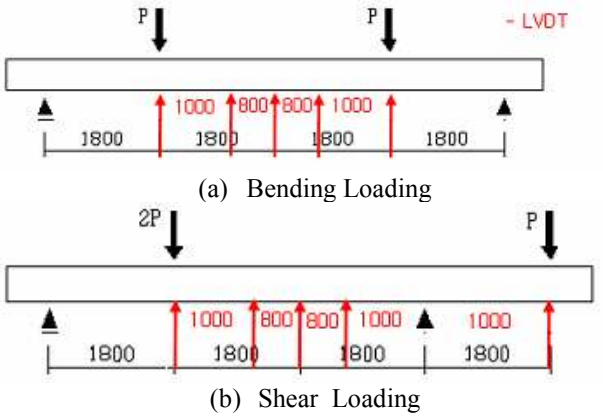
(b) Shear Loading (shear span ratio : 7.2)

(c) Shear Loading (shear span ratio : 3.6)

Figure 3. Loading Condition

2.3 Sensor and Data Acquisition

Several LVDTs were installed at the maximum displacement position and a number of strain gauges were attached internal and external steel plate to analyze structural behavior of HSC structures.



(a) Bending Loading

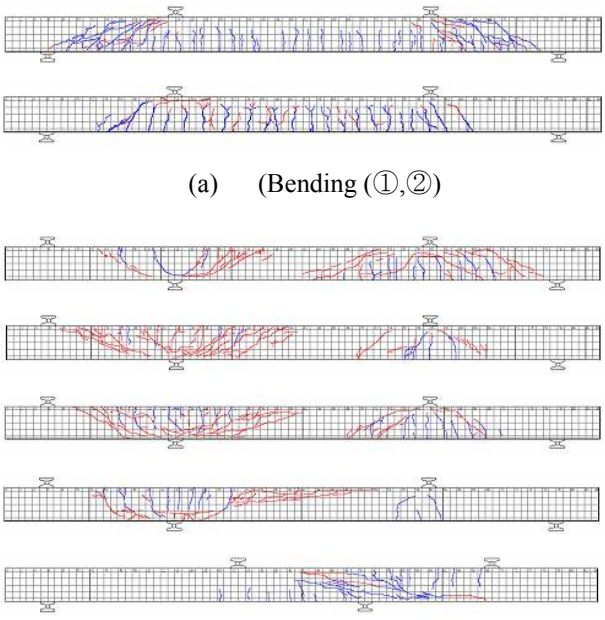
(b) Shear Loading

Figure 4. LVDT Setting

3. Test Results and discussion

3.1 Failure Shape

On the basis of failure shapes, shear failure crack patterns were observed. There is little difference w.r.t positive and negative loading (① vs ②, ③ vs ④,⑤) whereas there is more crack distribution w.r.t shear bar reinforcement (⑤ vs ⑥). Figure 5 shows crack distribution.



(a) (Bending (①,②)

(b) Shear (③,④,⑤,⑥,⑦)

Figure 5. Crack Distribution

3.2 Load-Displacement Relationship

Figure 6 shows a load - max displacement relation w.r.t shear bar reinforcement. As shear bar reinforcement increases, shear capacity is strengthened up to 156.1%

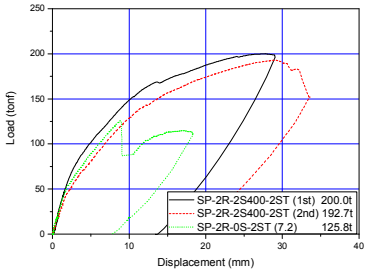


Figure 6. Load-Displacement relation

Figure 7 shows a load - max displacement relation w.r.t loading type (bending, shear). Shear type loading case showed larger strength compared to bending one, whereas bending type showed larger ductility vice versa.

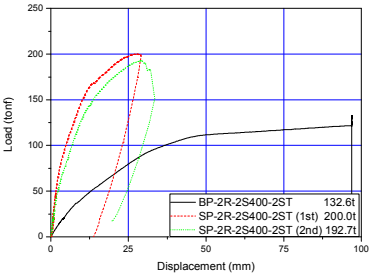


Figure 7. Load-Strain relation

4. Conclusion

Seven different type of HSC slab tests were conducted to verify structural behavior of HSC slab under bending and shear loading condition.

As a result of experiments, it is found that increase of shear bar reinforcement is a main factor of HSC slab capacity. And shear type loading case showed larger strength compared to bending one, whereas bending type showed larger ductility on the contrary

ACKNOWLEDGEMENT

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[2] 日本電氣協會 鋼板ユソクリ-ト構造 耐震設計技術指針 JEAG 4618-2005