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Experimental Study on Temperature Behavior of SC Structures under Pure Bending

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1. Introduction

SC(Steel plate Concrete) module method uses steel plate instead of reinforcing bar and mold in existing RC structure. Steel plate modules are fabricated in advance, installed and poured with concrete in construction field, so construction period is remarkably shortened by SC module technique.

In case of existence of temperature gap between internal and external structure surface such as spent fuel storage pool, thermal stress is taken place and as a result of it, structural strength is deteriorated.

In this study, we designed three test specimens and several tests with or without temperature heating were conducted to evaluate temperature behavior of SC structures under pure bending loading condition.

2. Test Procedure

2.1 Outline of Specimen

A list of specimen is shown in Table 1 and the shape of specimen is shown in Fig 1. All the cross section of test specimens are the same. As the major factor which gives influence to bending property of a SC, the steel ratio is chosen as a test parameter. In the tests, SS400 steel plate and 30N/mm^2 concrete materials are used.

Table 1. Test specimen

Specimen	S1.3-0T	S1.3-0	S1.7-0T
Steel ratio	1.32%	1.32%	1.77%
Stud dia(mm)	Φ 13	Φ 13	Φ 16
Stud pitch(mm)	104	104	250
Specimen length(mm)	7,150	7,150	7,150
Cross section B×T(mm)	600×675	600×675	600×675
Steel thickness(mm)	9	9	12
T/t	75	75	56.25
Tie bar	D16	D16	D16
Tie bar pitch(mm)	180	180	180
Temperature gap(℃)	45	-	45

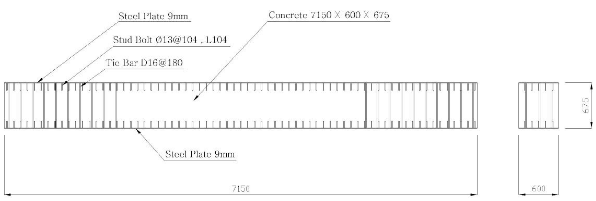

Figure 1. Tests specimen (S1.3-0, S1.3-0T)

2.2 Test Method

Maintaining 45℃ temperature difference between lower and upper steel plate by heating lower part of SC specimen, the flexural deformation due to heat inflation occurs. Under initial deformation condition, two point loadings were applied on the lateral edge of test specimen until yielding failure occurs due to flexural deformation (Fig 2).

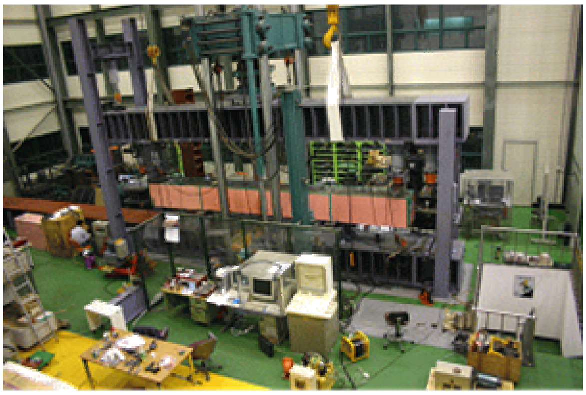

Figure 2. Testing Apparatus

3. Test Results and Discussion

In test results, displacement and crack distribution of specimen were evaluated under temperature loading condition. Also moment-curvature relationship was analyzed under yielding failure condition due to pure bending.

3.1 Deflection distribution under temperature heating

Fig 3. shows deflection distribution of S1.7-0T specimen during temperature heating. Deflection distribution of pure bending section remains constant after 30 hours heating. The curvature of middle point of S1.7-0T is 0.68 × 10^{-6} /mm after heating is finished.

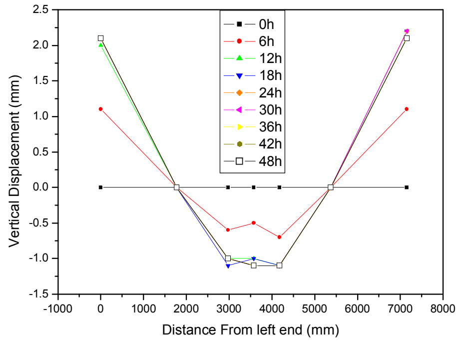

Figure 3. Deflection Distribution (S1.7-0T)

3.2 Deflection distribution under two point loading

Deflection distribution of pure bending section until steel yields is shown in Fig 4. Comparison with S1.3-0, S1.3-0T showed large deflection due to temperature. Comparison with 1.3-0T, S1.7-0T showed large yield displacement due to high steel ratio.

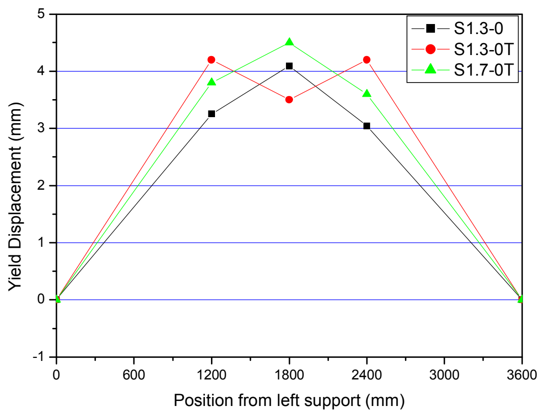

Figure 4. Deflection distribution at yield status

3.3 Moment-Curvature Relationship During loading

Fig 5. shows relationship between moment and curvature of test specimen under pure bending condition. In case of S1.3-0, upper steel plate yields at 93t·m whereas specimen failure occurs at 122 t·m. Moment-failure relationship is summarized in Table 2.

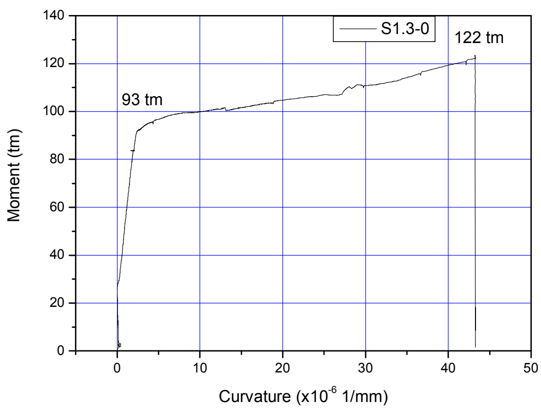

Figure 5. Moment-curvature relationship (S1.3-0)

Table 2. Moment-Failure Relationship

Specimen	Steel yield moment	Specimen Failure moment
S1.3-0	93 t·m	122 t·m
S1.3-0T	100 t·m	119 t·m
S1.7-0T	135 t·m	161 t·m

4. Conclusion

To evaluate the behavior of SC structures under pure bending when exposed to constant heat sources such as spent fuel storage pool, several flexural loading tests were conducted with universal testing machine and oil jack system. Test results are as follows ;

① The distribution of temperature remains constant after 48 hours heating with 2℃/hr velocity.
② After heating is finished, there are some surface cracks on the bottom of the specimens due to thermal stress. As steel ratio goes high, crack frequency are lowered.
③ During pure bending loading condition, tensile cracks occurs on the top of the specimen, shearing cracks on the support. There is little difference in crack distribution with respect to temperature.
④ Larger deflection occurs with constant heating condition. Also larger deflection was seen with high steel ratio.
⑤ There is little difference in bending strength with respect to temperature heating, whereas bending capacity increased with high steel ratio.

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