Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 29-30, 2009

A Parametric Study for Estimating the Effective Prestress Force of the Grouted Tendon

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1. Introduction

The grouted tendon was adopted to the containment building of some nuclear power plants in Korea and the assessment of effective prestress force on the grouted tendon is being issued as an important pending problem for continuous operation beyond their design life. In order to assess the effective prestress force on the grouted tendon at present, indirect assessment techniques have been applying to the test beams of grouted tendon type which were manufactured on construction time.

Therefore, the research project was started to assess directly the effective prestress force on the grouted tendon of containment building using System Identification(SI) technique. As a first step, the scaled model tests were carried out to examine the sensitivity of various parameters to effective prestress force for SI technique and the optimal parameters were determined for SI technique in this study.

2. Scaled Model Test

In order to investigate the variation of the parameters according to the level of effective prestress force at the grouted tendon, post-tensioned concrete beams with the grouted tendon type were manufactured. The total number of post-tensioned concrete beams is 6 and their length is 8.0 m and area is 0.09(0.3×0.3 m) m^2. The effective prestress forces which were applied to each prestressed strand, are 0 kN, 146 kN, 264 kN, 356 kN, 465 kN, 523 kN and prestressed strand is located at center of the post-tensioned concrete beam.

Fig. 1. Post-tensioned concrete beam

In order to investigate the variation of various parameters according to the level of effective prestress force, experimental modal test and bending test were carried out. The natural frequency was got by experimental modal test and the displacements were got by bending test using Optical Fiber Sensor(OFS) and Compact DisPlacement transducer(CDP). Fig. 2 shows the test setups of experimental modal test and bending test.

(a) Experimental modal test

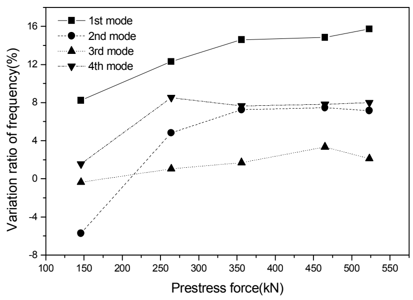
(b) Bending test by OFS and CDP

Fig. 2. Test setup

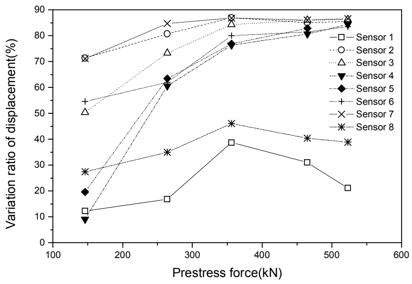
Fig. 3 shows the variation of each parameter according to the effective prestress force. As shown in Fig. 3, the parameters such as natural frequency and displacement, are varied according to the level of effective prestress force and natural frequency is increased in proportion to the effective prestress force but displacement is decreased in inverse proportion to the effective prestress force.

The best data among the test results at Fig. 3, were selected to examine the sensitivity of each parameter according to the effective prestress force. The 1^{st} mode was selected at experimental modal test and the sensor 4 was selected at bending test by OFS and the CDP 4 was selected at bending test by CDP. Table 1 shows the test data selected by above criteria and the variation ratio of each parameter means how much the values are changed comparing with a value for effective prestress force of 0 kN.

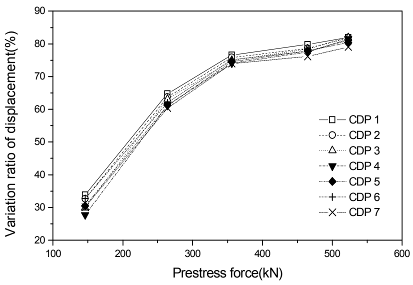
Fig. 4 shows the variation ratio of each parameter according to the effective prestress force. As shown in Fig. 4, Displacement by OFS and CDP, is largely sensitive to the effective prestress force but natural frequency is less sensitive than displacement. The variation ratio by OFS and CDP, is almost same. Therefore, displacement by OFS and CDP is more useful than natural frequency when the effective prestress force is predicted using SI technique.



(a) Experimental modal test – natural frequency



(b) Bending test – displacement by OFS



(c) Bending test – displacement by CDP

Fig. 3. The variation of each parameter by prestress force

Table 1. The variation ratio of each parameter

Prestress force (kN)	Natural frequency (Hz)		Displacement OFS (m)		Displacement CDP (mm)	
	Value	Ratio (%)	Value	Ratio (%)	Value	Ratio (%)
0	7.567	0.0	0.959	0.0	-25.33	0.0
146	8.190	8.2	0.872	9.1	-18.31	27.7
264	8.498	12.3	0.379	60.5	-9.84	61.2
356	8.672	14.6	0.227	76.4	-6.56	74.1
465	8.690	14.8	0.186	80.7	-5.70	77.5
523	8.757	15.7	0.150	84.4	-4.69	81.5

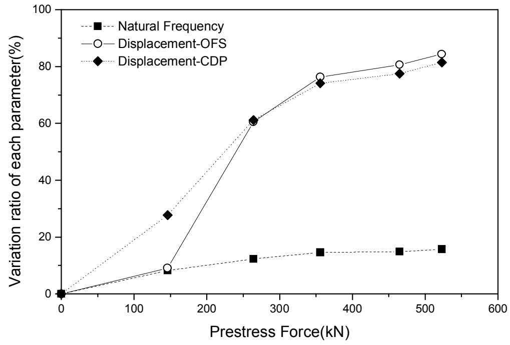


Fig. 4. The variation ratio of each parameter

4. Conclusions

The scaled model tests were carried out to investigate the sensitivity of various parameters to effective prestress force for SI technique. The natural frequency by experimental modal test and the displacement by bending test using OFS and CDP were considered as parameters for SI technique.

As a result of test, the parameters such as natural frequency and displacement, were varied according to the level of effective prestress force and natural frequency is increased in proportion to the effective prestress force but displacement is decreased in inverse proportion to the effective prestress force. Also, displacement by OFS and CDP, is larger sensitive to the effective prestress force than natural frequency and the variation ratio by OFS and CDP, is almost same. Therefore, displacement by OFS and CDP is more useful than natural frequency when the effective prestress force is predicted using SI technique.

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