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Catenary Action on RHS Beam with Different Support Conditions

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ABSTRACT

The catenary action of beams with different support condition was investigated through bending test. Beams are made of SPSR400. The support boundary conditions of beams were classified into three types; (A) simply supported with no anchors, (B) embedded anchors with 50 mm depth and (C) embedded anchors with 80 mm depth. Both ends of the beams were connected by fillet and supported on a rigid concrete wall through anchors. The test result shows how much the load carrying capacity is increased by catenary action after large beam deflection.

1. INTRODUCTION

Beams have different failure strength depending on different support conditions. Flexural experiment is generally conducted in a simple support condition. In this study, however, the experiments were performed in conditions of a pin-ended beam and moment-fixed beams. This experimental work was undertaken for the purpose of studying increment of maximum load due to catenary action of beams, depending on support conditions. Catenary action results in the behavior which resists progressive collapse to the last extremity (Khandelwal and El-Tawil 2005). However precisely how catenary action will behavior is not yet clear. Ahn (2013) explained the characteristics of pullout behavior for anchor. The minimum pullout strength that provides a catenary action will be obtained through this research. It shows that the anchor system satisfying the minimum pullout strength is practical or not in the field.

2. EXPERIMENT

The cross section of the beam is a rectangular of 100 (mm) × 50 (mm) × 2T (mm).

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The span length of the beam is 3,600 mm and concrete wall designed as a support is relatively very rigid to the horizontal direction in order to generate the catenary action of the beam. The parameters of the support condition are a simple support and rotationally semi-rigid connection with different horizontal reaction strength generated by anchor depth. The support boundary conditions of beams were classified into three types as summarized in Table 1; S-B : simply supported without anchors, M-F-A50-B : anchor with 50 mm embedded depth, and M-F-A80-B : anchor with 80 mm embedded depth. Both ends of the beams were connected by seat angles and supported on a rigid concrete wall through anchors. Figure 1 is an elevation of S-B specimen, and Figure 2 is an elevation of M-F-A50-B and M-F-A80-B specimens.

Table 1. Parameters depending on specimens name

Specimens	parameters
S-B	Simply supported with no anchors
M-F-A50-B	Moment-fixed, embedded anchors with 50mm depth
M-F-A80-B	Moment-fixed, embedded anchors with 80mm depth

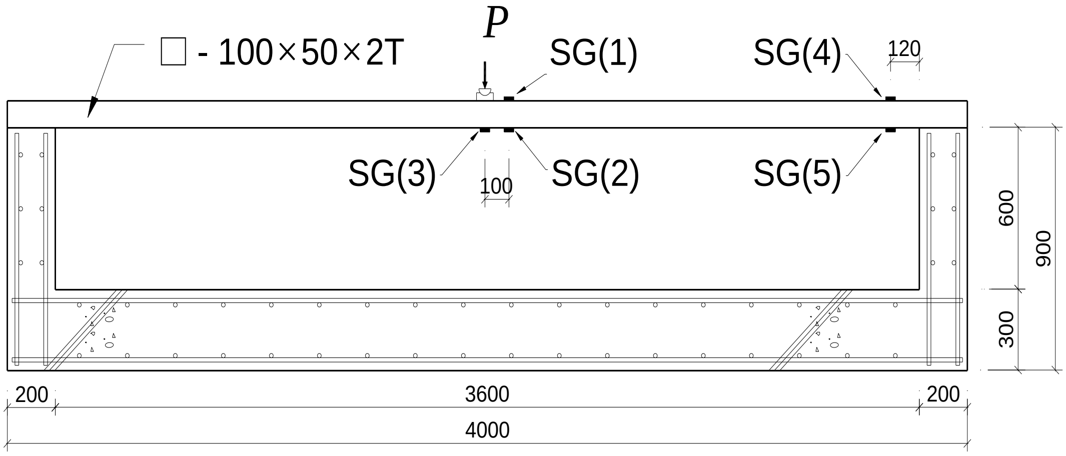

Fig. 1 Elevation of S-B

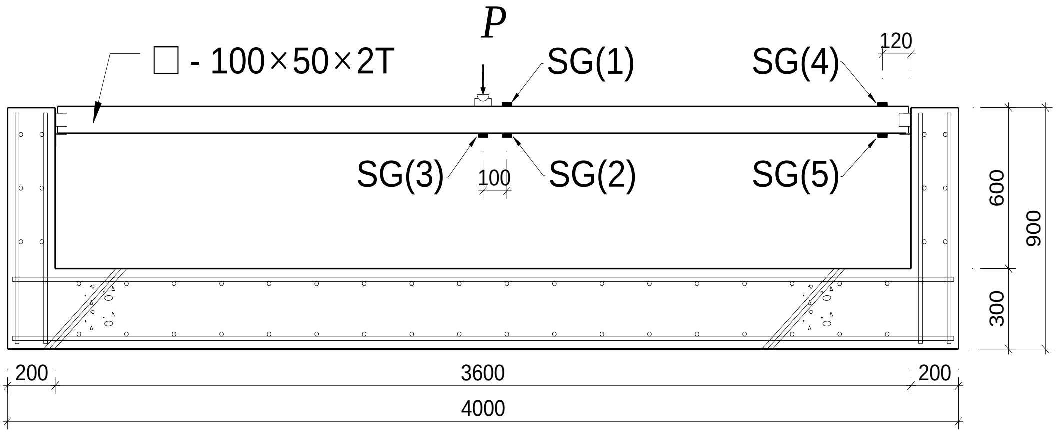

Fig. 2 Elevation of M-F-A50-B and M-F-A80-B

3. EXPERIMENTAL RESULTS

Fig. 3 shows the experimental result of the beam. The beam yielded at mid-span when the first maximum load reached. After then, M-F-A80-B specimen reached to the second maximum load. Concrete connected to the ends of the beam fractured as shown in Fig. 3. On the contrary to this, the embedded anchor of M-F-A50-B pulled out when the load surpassed the first maximum load and it results in concrete cone breakout. Fig. 4 shows the load-deflection curves as experimental results depending on support conditions. The first maximum loads from each type reached when the first plastic hinge occurs at mid-span. After that, tensile force developed at the anchor due to catenary action results in increasing of load carrying capacity by approximately 55%. This is called as the second maximum load. This second maximum load happened when the anchors at a support fully resist the tensile force. Therefore it didn't happen in S-B and M-F-A50-B specimens.

Fig. 3 Test result of M-F-A80-B

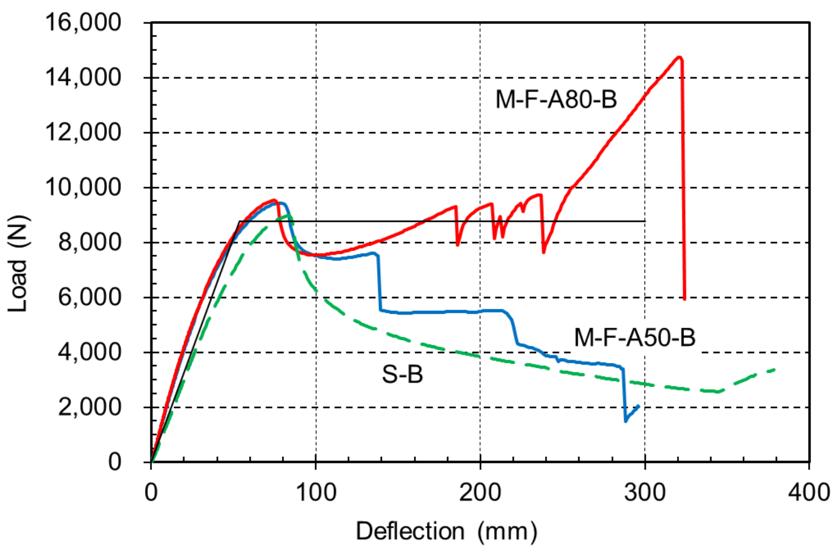

Fig. 4 Load-Deflection depending on support conditions

Fig. 5 shows the change of the tension and moment depending on the applied load of M-F-A80-B specimen. The tension switched to tensile force starting from 75 mm deflection because of catenary action.

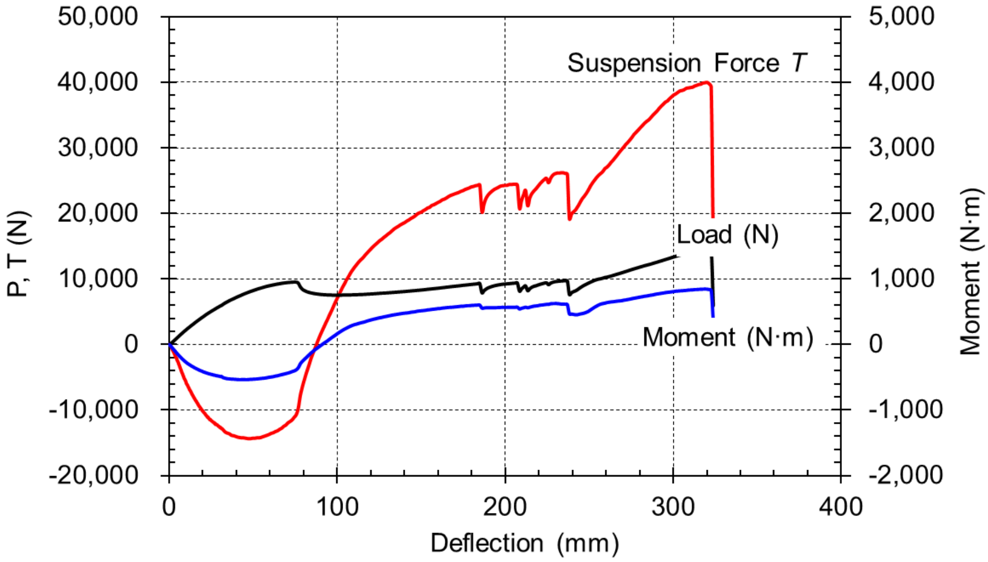

Fig. 5 Tension, Moment and Load of M-F-A80-B

Table 2 summarizes the first and the second maximum loads according to support conditions. There are no significant differences among the first maximum loads. However, second maximum load shows a different result. Catenary action occurred when the anchor is embedded with more than 80 mm depth in concrete. it increased load-carrying capacity by approximately 55%.

Table 2. 1st and 2nd maximum load

Support conditions	1st maximum load (N)	2nd maximum load (N)
simply supported'	8,959	-
50mm embedded anchor'	9,433	
80mm embedded anchor'	9,531	14,733

4. CONCLUSIONS

In the experiment, the 1st maximum load is the load when the plastic hinge occurs at mid-span, and there are differences within 10% at entire support conditions. Therefore, support conditions of both end of beam do not affect 1st collapse load of beam.

REFERENCES

Ahn, Y.C. (2013), *Characteristics of Pullout Behavior for Expansion Anchor*, Master's thesis, Chungbuk National University, Korea.

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