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COLLAPSE TEST ON RECTANGULAR STEEL BEAM WITH DIFFERENT SUPPORT CONDITION

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The behavior of beams with different support condition was investigated through three-point bending test for the purpose of studying difference of maximum load and catenary action of a beam. Beams are made of SPSR400 which has 245MPa of nominal yield strength and 400MPa of nominal tensile strength. The parameters of the supports condition are simple support and rotationally semi-rigid connection with different horizontal reaction strength applied by anchors. The support boundary conditions of beams were classified into three types; (A) simply supported with no anchors, (B) embedded anchors with 50mm depth of ϕ10mm, and (C) embedded anchors with 80mm depth of ϕ10mm. Both ends of the beams were connected by fillet welded angles 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 deflection at the center of the beam. First peak loads from each types are the loads when first plastic hinge occurs at the mid-span. There were no significant differences among the first peak loads measured from three types. After that, tensile force at anchors due to catenary action increased the load carrying capacity by approximately 55%, which is called as the second peak load. However, second peak load happens when the anchors at a support fully resist a tensile force, therefore it doesn’t happen with type (A) and (B). In conclusion, support boundary conditions of a beam don’t have an effect on the first collapse load, but the second collapse load is increased as embedded length of an anchor becomes deeper.

Keywords: Bending test, Catenary action, Boundary condition, Rectangular hollow section, Anchor, SPSR400.

1 INTRODUCTION

Beams have different ultimate strength depending on support conditions. General bending tests are conducted in conditions of simple support. However, in this study, the tests were conducted in conditions of a pin-ended beam and moment-fixed beams. This experiment was undertaken for the purpose of studying increment of maximum load due to catenary action of beams, depending on support conditions. Catenary action is 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 (Kim and An 2008). Ahn (2013) explained the characteristics of pullout behavior for anchor. Through this research, the minimum pullout strength that provides a catenary action will be obtained. It shows that the anchor system that satisfies the minimum pullout strength is practical or not in the field.

2 EXPERIMENT

The beam section is a rectangular of 100 (mm) × 50 (mm) × 2T (mm). The span length of the beam is 3,600mm and concrete wall designed as support is relatively very rigid to the horizontal direction so as to generate the catenary action of the beam. The parameters of the supports condition are simple support and rotationally semi-rigid connection with different horizontal reaction strength applied by anchors. The support boundary conditions of beams were classified into three types; (A) simply supported with no anchors, (B) embedded anchors with 50mm depth of ϕ10mm, and (C) embedded anchors with 80mm depth of ϕ10mm. Both ends of the beams were connected by fillet welded angles and supported on a rigid concrete wall through anchors. Concentrated load was applied on the center of beams.

Figure 1 is a sectional view of type A, and Figure 2 is a sectional view of type B and C. In the Figure 1, the beam is placed on the concrete as a simple beam. In Figure 2, the ends of the beam are supported by using anchors. Table 1 shows the details of support conditions of the test types.

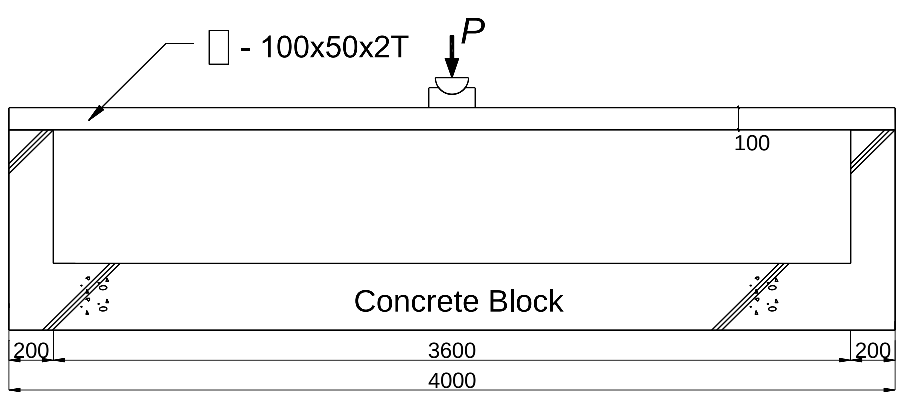


Figure 1. Sectional view of type A.

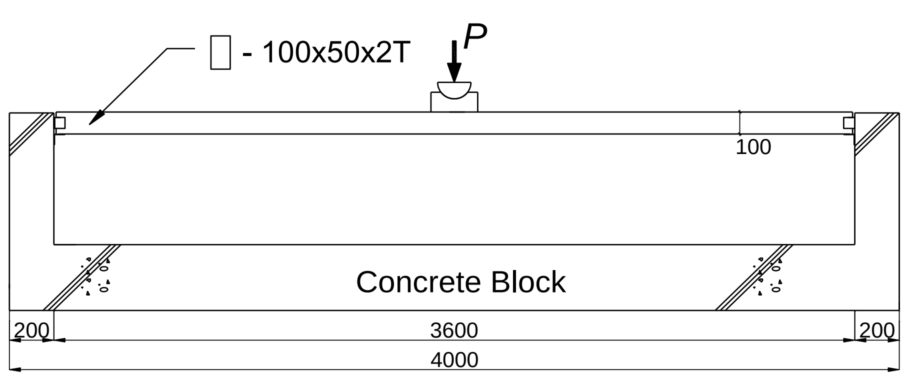
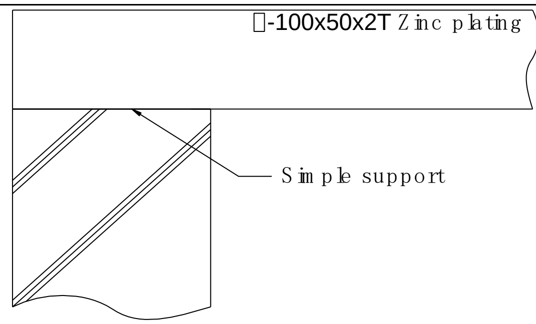
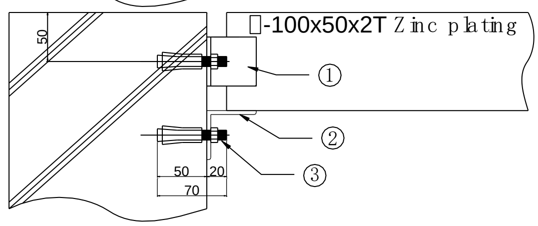
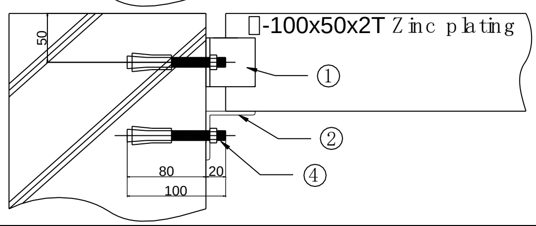


Figure 2. Sectional view of type B and C.

Table 1. Support conditions depending on types.

Type	Support Condition
A	
B	
C	
Note: ① 2L - 50×50×4T (Set anchor ϕ10mm -2EA) ② L - 50×50×4T (Set anchor ϕ10mm -1EA) ③ Embedded length 50mm (+20mm) ④ Embedded length 80mm (+20mm)	

3 EXPERIMENTAL RESULTS

Figure 3 shows the test result of the beam. The beam was yielded at the center when the load reached to the first maximum load. After then, when the load reached to the second maximum load, the concrete which was connected to the ends of the beam was fractured as shown in Figure 3.

Figure 4 shows the load-displacement graphs of experimental results depending on support conditions. The first maximum loads from each types are the loads when the first plastic hinge occurs at the center of the beams. After that, tensile force at the anchor due to catenary action results in increasing of load carrying capacity by approximately 55%. This is the second maximum load. The second maximum load happens when the anchors at a support fully resist the tensile force, therefore it doesn't happen with type A 'simply supported' and type B '50mm embedded anchor'.

Figure 3. Test result of the beam. (Type C)

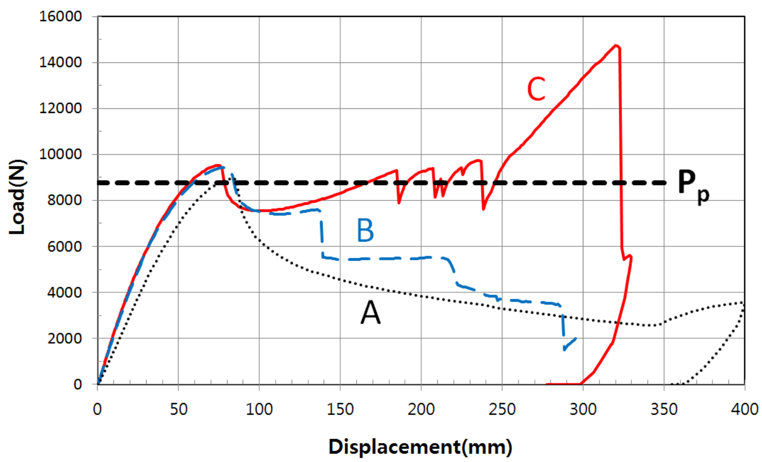


Figure 4. Load-displacement depending on support conditions.

Table 2 shows the first and the second maximum loads according to specimen types. There are no significant differences among the first maximum loads measured from 3 types. However, maximum load increased when catenary action happens with type C '80mm embedded anchor'.

Table 2. 1st and 2nd maximum load.

Type	A	B	C
1st Maximum Load (N)	8,959	9,433	9,531
2nd Maximum Load (N)	-	-	14,733

4 CONCLUSIONS

Support boundary conditions of a beam don't have an effect on the first collapse load, but the second collapse load is increased by 55% as embedded length of the anchor becomes deeper. If the embedded length is short, the catenary action may not expected.

Acknowledgements

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