Evaluation of Structural Behaviour of High Performance Permanent Form with Stainless Steel Fiber

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ABSTRACT

Nowadays, the stripping work of form has generated some problems such as increasing total constructing cost result from delayed work schedule by the stripping work of form and environmental issues by wasting the debonded form. According to recent research for form work, it has studied about permanent form to solve economic and environmental problem which is commented above.

In this study, high performance permanent form method was developed and tested by adopting COM and TEN specimens adopted on the Compression and Tensile section then the structural behaviour was investigated. In the test result, the specimen adopted the form showed better structural performance than control specimen in the point of ductility, failure mode and ultimate load.

1. INTRODUCTION

Stripping work of form is one of the most important stage of work to guarantee the quality of constructing structure. This kind of stripping work, however, has been performed by depending on just manpower then this was the reason for increase of the cost by a delayed term of work and environmental problem which makes lots of construction wastes. Nowadays, for reasons of acquiring construction efficiency, some studies for new construction method by using high performance permanent form is progressing actively. This method has some advantages; reduction of total construction cost for a reduced term of work from unnecessary stripping work of form, reduction of construction wastes, and additional strengthening effect by using the permanent form with high performance material properties.

Traditional permanent form was used to be a type of reinforced concrete which has thickness of 80~100mm. This method, however, was so difficult to be treated in construction site because the concrete form is so heavy as concrete cover for reinforced bar is acquired.[2] In this study, a permanent form method using stainless steel fiber which can improve construction efficiency and be friendly for environment was developed then the availability was investigated. To do this, the two experimental variables were selected. One is to simulate compressive zone and the other is to simulate tensile zone of a structure then the structural behavior was evaluated.

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2. EXPERIMENT PROGRAM

2.1 Material properties

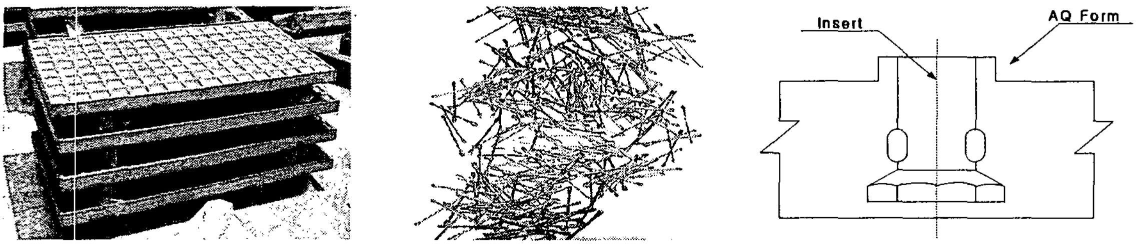
Figure 1 shows the properties of ingredient of the permanent form, concrete and steel which is used in these test specimens. Dimension of the permanent form is 1000×2000mm and the thickness is 50mm included prominent shape with thickness of 20mm such as waffle shape. And insert nuts to assembly each permanent form was layed on waffle sections.

Table 1 Properties of concrete and steel (MPa)

	Fy	Fck	Elastic modulus
Concrete	-	28	2.5×10^4
Steel	300	-	2.0×10^5

Table 2 Properties of ingredient of permanent form (MPa)

	Fy	Fck
Mortar	-	80
Stainless steel fiber	900	-

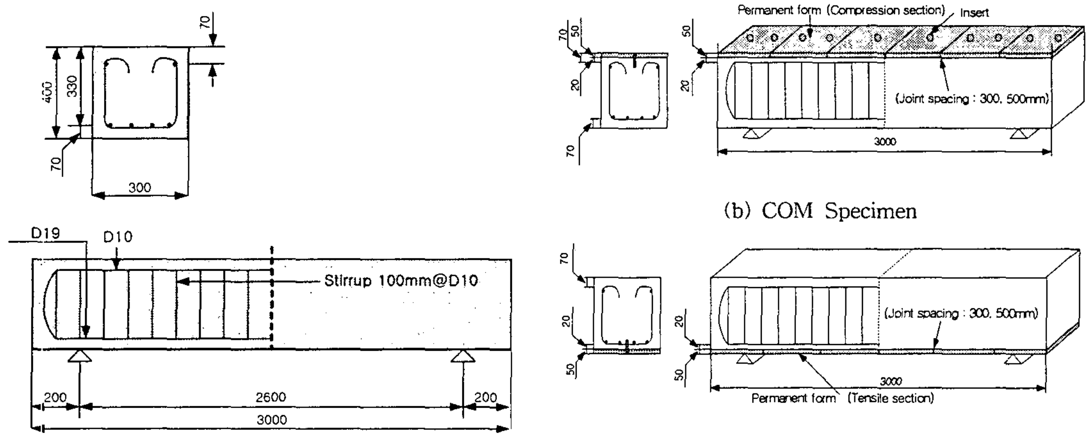


(a) Shape of permanent form (b) Stainless steel fiber (c) Insert

Figure 1 High performance permanent form

2.3 Experimental specimens and variables

Figure 2 shows control and variable specimens. Span is 2,600mm and test variables are adopted section (compression and tensile section) and assembled joint spacing of the permanent form. To definitely evaluate structural behavior between two test variables, all of the adjoined interface area between the permanent form and concrete and a number of insert nuts were adopted equally. Table 3 shows test variables.



(a) CONTROL Specimen (b) COM Specimen (c) TEN Specimen

Figure 2 Test specimens

Spcimen name	Adopting section of the permanent form	Joint spacing
3-COM	Compression section	300mm
5-COM		500mm
3-TEN	Tensile section	300mm
5-TEN		500mm

Table 3 Test variable

3. RESULT AND DISCUSSION

3.1 Evaluation for the joint spacing of the permanent form

Figure 3 shows structural behavior of control and variable specimens with assembly joint spacing. In the case of control specimen, reduction of stiffness occurred around 160kN after steel yielded around 140kN. TEN specimens showed the first reduction of stiffness around 158kN, however, the stiffness gradually increased until 180kN. In the case of COM specimens, its stiffness gradually decreased after ultimate load of 181kN was reached then failed.

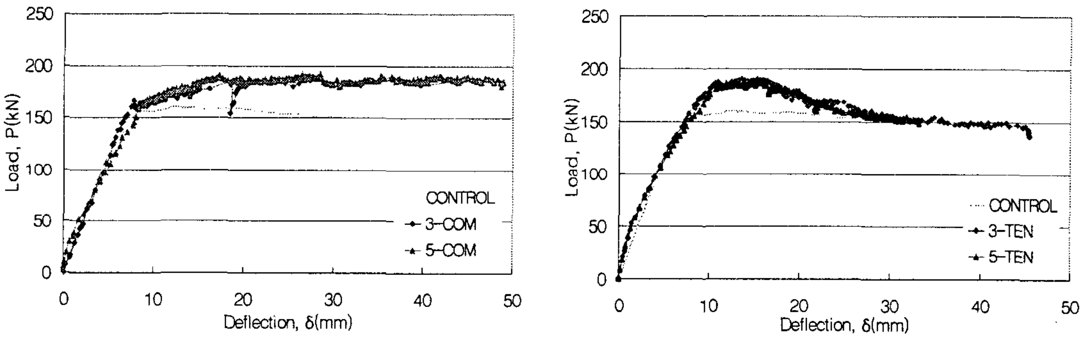


Figure 3 Load-deflection relationship for assembled joint spacing

3.2 Evaluation for adopted position of the permanent form

Figure 3 shows structural behavior of variable specimen with different adopting section of the permanent form. COM specimens showed similar structural behavior, however, in the case of COM specimens, 3-TEN specimen showed more efficient ductile behavior than that of 5-TEN.

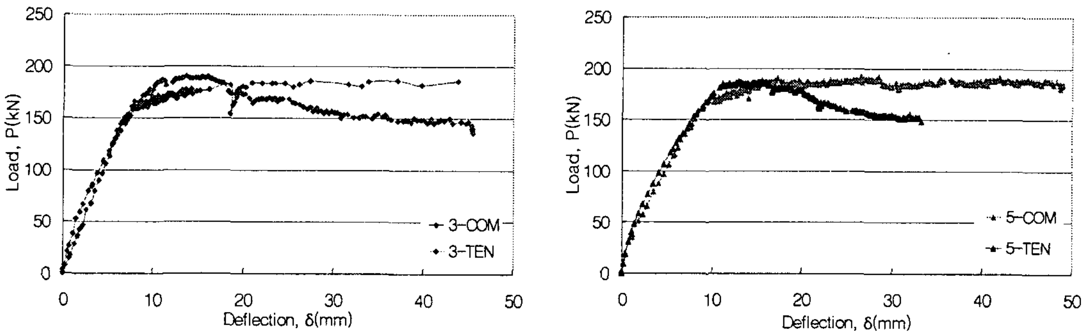
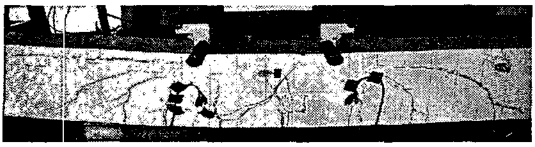


Figure 4 Load-deflection relationship for adopting section of the permanent form

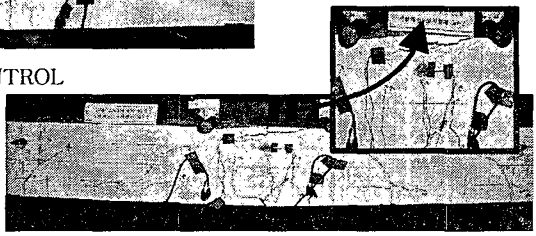
3.3 Failure mode

Figure 5 shows failure condition of test specimens. In the case of CONTROL specimen, flexural and compression failure occurred with some of penetrated cracks on the bottom of the specimen. In the case of TEN and COM specimens, it was like the behavior of control specimen, however, both COM and TEN specimens had no debonding failure on the adjoined interfaces between the permanent form and concrete.

(a) CONTROL



(b) COM specimen



(c) TEN Specimen

Figure 5 Failure mode of test specimens

4. CONCLUSION

In this study, the field availability of the construction method used permanent form was evaluated by experimental study. The conclusion is as follows.

1) CONTROL and variable specimens showed similar structural behaviors and failure modes, however, variable specimen had more 20KN of ultimate load than CONTROL. This is because improved curvature resistance by acting composite behavior of the permanent form perfectly affected variable specimens of additional strengthening effect.
2) TEN specimen showed more efficient structural behavior that COM specimen. This means that additional compressive strengthening effect was acted by the high performance permanent form. In the case of the joint spacing, 3-TEN specimen had more ductile structural behavior than 5-TEN specimen. This means that the more joint spacing is, the better stress distribution occurs.
3) None of variable specimens showed debonding failure between the permanent form and concrete. Therefore this construction method can acquire sufficient monolithic structural behavior when it is adopted on construction structure.

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REFERENCES

1. Kim, U. J., Im, N. K., and Kim, S. S., "The permanent form system", Magazine of the KCI, Vol. 14, No. 5, pp. 31~38
2. High Performance Permanent Form (AQ Form), Kajima Construction Co., Technical Report, Japan, 2000.