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Experimental Study of GFRP Reinforced Concrete Bridge Deck

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ABSTRACT

The behavioral characteristics of GFRP reinforced concrete bridge decks, which is designed according to AASHTO design guide specifications, have been examined through the experiment of full-scale decks with dimensions of 4000 x 3000 x 240 mm. Compared to the conventional steel reinforced concrete deck, the GFRP reinforced concrete deck shows relatively low stiffness and load-carrying capacity. However, the GFRP reinforced concrete decks satisfy all the design criteria including deflection, crack width, and ultimate strength.

1. INTRODUCTION

In this study, the behavioral characteristics of GFRP reinforced concrete bridge decks have been examined through the experiment of full-scale decks with dimensions of 4000 x 3000 x 240 mm. The main purpose of the experiment is to show the applicablity of the GFRP rebar fabricated by the modified braidtrusion process (You, et al., 2008; You, et al. , 2015)

2. TEST PROGRAM

A total of eight decks were fabricated and tested statically including two reinforced concrete decks as shown in Table 1. Two identical reinforced concrete decks, named RC, were designed in accordance of the Korean Highway Bridge Design Code: Limit State Degin (KHBDC-LSD, 2012). GFRP reinforced deck named FRP1 is a simple replacement of the steel rebar of RC with the GFRP rebar. FRP2 and FRP3 were designed according to AASHTO design guide speicifications(2009). FRP4, FRP5, and FRP6 are hybrid types of deck, in which GFRP and steel rebars are disposed in top and bottom regions repectively. These specimens simulates the economical use of GFRP rebars as top rebars in bridge deck.

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Table. 1 Test specimens

Name	Top			Bottom			No. of specimens
	Transverse	Longitudinal	Cover	Transverse	Longitudinal	Cover	
RC	H16@200	H13@250	50	H16@200	H16@250	50	2
FRP1	F16@200	F13@250	40	F16@200	F16@250	40	1
FRP2	F16@100	F16@250	40	F16@100	F16@125	40	1
FRP3	F19@125	F16@250	40	F19@125	F16@125	40	1
FRP4	F16@200	F13@250	40	H16@200	H16@250	50	1
FRP5	F16@100	F16@250	40	H16@200	H16@250	50	1
FRP6	F19@125	F16@250	40	H16@200	H16@250	50	1

* H means steel rebar, and F indicates GFRP rebar.

As shown in Fig. 1, dimensions of decks were 4000 x 3000 x 240 mm. H steel beams and C chnnels were installed for simulating girder and crossbeam conditions. Patch load with dimensions of 231 x 577 mm defined in KHDBC was applied at the top of center until failure. The mean strengths of concrete at the time of experiment were 20 to 25 MPa in spite of the design strength was 30 MPa. The reason of low concrete strenghs was poor steam curing conditions supposedly.

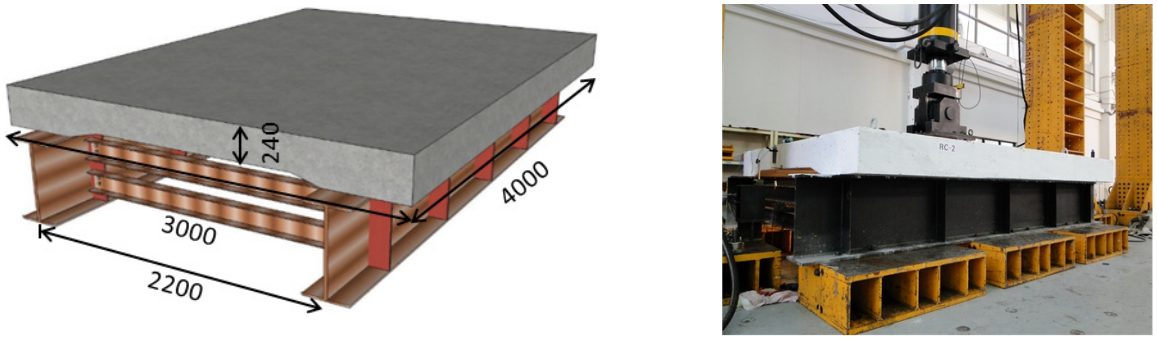

Fig. 1 Test set-up

3. TEST RESULTS

All specimens were failed by punching shear after cracking at the loads 125~165kN. Fig 2. and Fig 3. show load-displacment curve and load-maximum crack width curve, respectively. Compared to the conventional steel reinforced concrete decks, GFRP reinforced concrete decks show relatively low stiffness and load-carrying capacity. The loads at ulitimate and service limit state are 276 kN and 158 kN, repectively. These values were estimated by linear finite element analysis, satisfying that the computed section moments reached the design moments by KHBCD-LSD(2012) at ultimate and service limit states, 52.01 kN-m and 29.79 kN-m,

respectively. Deflection limit at service limit state is 2.5625 mm for displacement, which comes from L/800. The maximum crack width at service limit state should not be greater than 0.3 mm and 0.5 mm for steel reinforced and GFRP reinforced decks, respectively. As shown in figures, it is confirmed that all the specimens satify the design criterion for ultimate and service limit state, even though FRP1 deck, a simple replacement of the steel rebar of RC deck with the GFRP rebar.

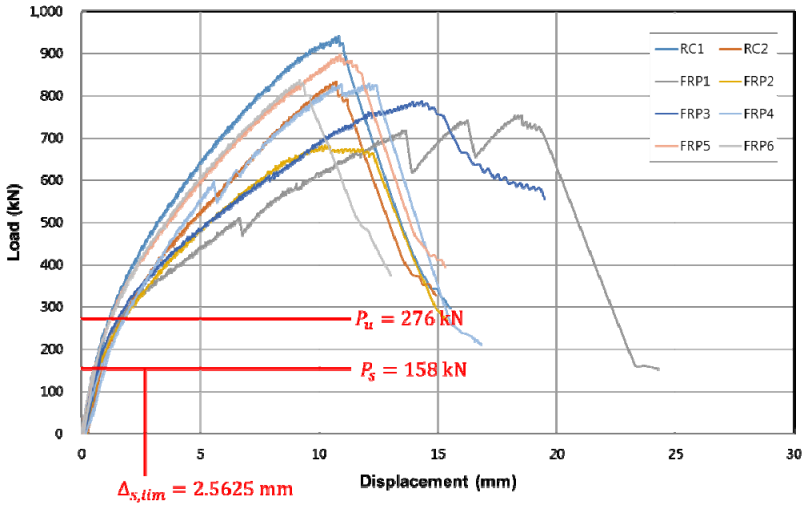

Fig. 3 Load-displacement curves

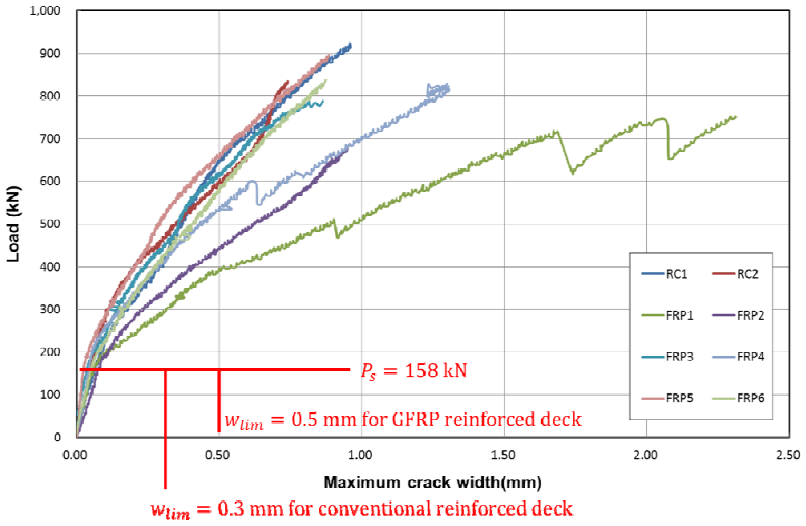

Fig. 4 Load-maxium crack width curves

3. CONCLUSIONS

The behavioral characteristics of GFRP reinforced concrete bridge decks have been examined through the experiment of full-scale decks with dimensions of 4000 x 3000 x 240 mm. Compared to the conventional steel reinforced concrete deck, the GFRP reinforced concrete deck shows relatively low stiffness and load-carrying capacity. However, the GFRP reinforced concrete decks satisfy all the design criteria including deflection, crack width, and ultimate strength.

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