A BASIC STUDY ON IMPACT RESISTANCE OF RC BEAMS REINFORCED BY CONTINUOUS FIBER COMPOSITE PANEL

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1. INTRODUCTION

In recent years, as the aging of existing RC structures is progressing, research on reinforcement and repair methods has become a concern. However, most of these researches mainly focus on the study of static behavior for RC structures. Therefore, it is necessary to clarify the decrement of the impact resistance of the protective structure that is expected to be subjected to impact loads due to deterioration damage. It is important to provide an appropriate repairing and reinforcing method. From these backgrounds, in this research, we first attempted to corrode the rebar by electrolytic corrosion and to do the drop weight impact test to clarify the decrement of the impact resistance of the beam due to deterioration. Furthermore, by doing the same test, we tried to clarify the impact improvement effect of the beam reinforced by continuous fiber composite panels (CFC panel) which has already been applied to repair and reinforcement such as renewal of tunnel lining and seismic reinforcement of pillar parts.

2. REINFORCEMENT WORK

CFC panel was designed by interposing a carbon fiber sheet (thickness of 1mm) between two flexible boards (fiber reinforced plate with 7mm thickness). It was attached on the surface of concrete structures. Since CFC panel was a light weighted material with high strength and weatherability, it was able to install CFC panel in places where large-sized machines were not available. Details of CFC panel was expressed in Figure 1.

3. IMPACT TEST

3.1 Test specimen

The size of RC beam was 100×120×1200mm (width×height×length) with a span of 1000mm. Since the degree of shear allowance was 2.46, the RC beams failed due to bending. Based on compressive strength of concrete test (JIS A 1108) and the modulus of elasticity of concrete test (JIS A 1149), the compressive strength and modulus of elasticity of concrete were 45.5MPa and 30.3GPa. Figure 2 showed the beam size and reinforcement arrangement. Besides, the electrolytic corrosion tests were conducted to make the reinforcement reach the expected corrosion rate. In Figure 3, three different ways were used to attach the CFC panels, depending on which side of concrete surfaces it attached. Furthermore, a part of RC beams without corrosion were attached by CFC panels to clarify the effects only due to the reinforcement method.

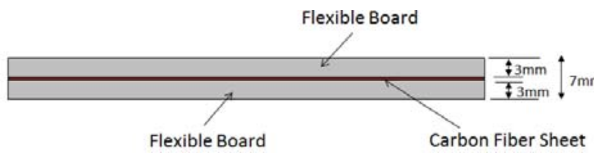

Figure. 1 Composition of CFC panel

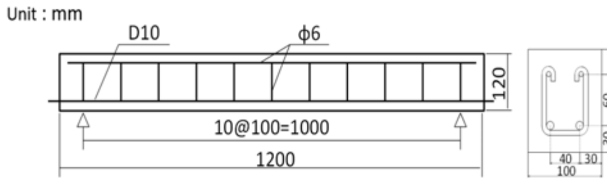

Figure. 2 Beam size and reinforcement arrangement

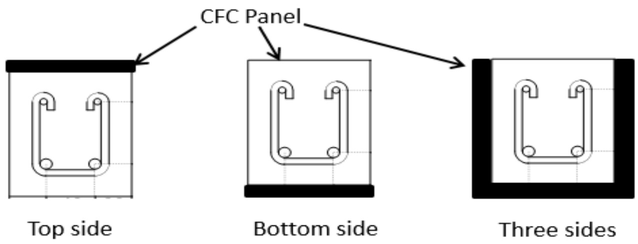

Figure. 3 Installing methods of CFC panel

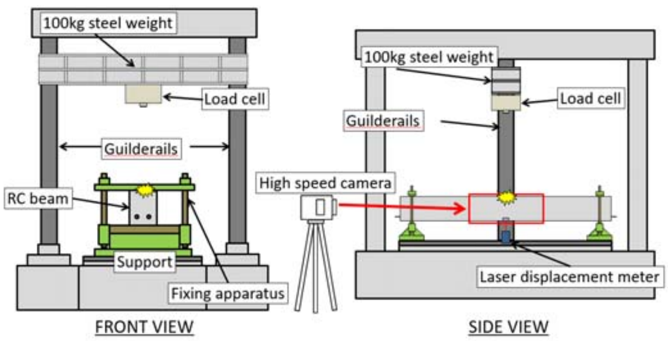

Figure. 4 Falling weight impact machine

3.2 Loading method

A falling weight machine with a 100kg steel hammer was used in this study. The impact velocity was set to be 1m/s or 3m/s. the failure of RC beams was determined when accumulative residual displacement reach 1% of the span length (10mm). The tests were performed repeatedly until failure. In this test, a load cell was installed on the

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steel hammer to determine the impact force during the impact process. The laser displacement meter was installed at the mid-span of the RC beam to determine the time history of displacement. The experimental facilities are shown in Figure 4

4. TEST RESULT AND DISCUSSION

4.1 Effect of displacement due to CFC panel

In Figure 5, the time history of displacement for RC beams was measured when the impact velocity was 3m/s. It was obvious that the RC beam without the attachment of CFC panel failed due to the first impact since the residual displacement exceeded 1% of the span length. While, the residual strength of RC beam with CFC panel attached on bottom side was restrained effectively. In contrast, the installation of CFC panel on top side did not have a significant effect on residual displacement of RC beam.

4.2 Effect of impact resistance due to CFC panel and corrosion

In Figure 6, the time history of accumulative residual displacement for RC beams was expressed when the impact tests were performed repeatedly under 1m/s impact velocity. Figure 6(a) indicated the effect on accumulative residual displacement due to corrosion rate. Also, the effect caused by CFC panel attached on bottom side was showed in Figure 6 (b). Figure 6(c) showed the effect due to different installing methods of CFC panels. Firstly, in Figure 6(a), the RC beam, without corrosion and CFC panel, failed after 84 impacts with 1m/s impact velocity. Whereas, only 14 times of impact caused the failure of RC beam with 12.8% corrosion rate. Thus, it is obvious that the impact resistance, under multiple impacts with 1m/s velocity, was reduced due to the increasing corrosion rate. On the other hand, the accumulative residual displacement of RC beams with CFC panels attached on bottom side were extremely restrained (less than 1mm) under repeated impacts in Figure 6(b). Therefore, the impact resistance was greatly enhanced by installing CFC panels on bottom side. In Figure 6(c), it was considered that the impact resistance of RC beam, when CFC panel was attached on the top side of beam, was not as effective as bottom side attachment and 3 sides attachment. Nevertheless, in Figure 7, it showed that the impact surface of RC beam was well protected after 80 times of impact because of the installation of CFC panel on top side.

5. CONCLUSION

1) The impact resistance of RC beam under repeated 1m/s velocity impacts were extremely improved by attaching CFC panels on bottom side or 3 sides. But the RC beams with top side attachment of CFC panel did not perform as effective as other attachment methods (3 sides and bot side attachment).

2) Although the top side attachment of CFC panel could not improve the impact resistance of RC beam, it could protect the top surface from impact damage.

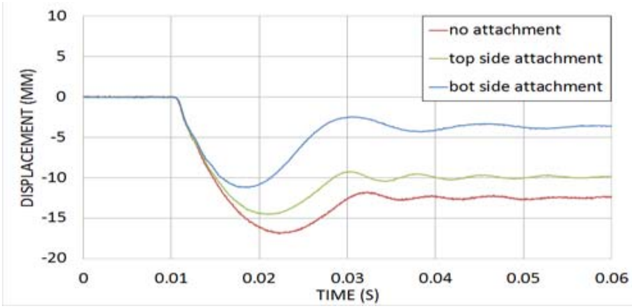
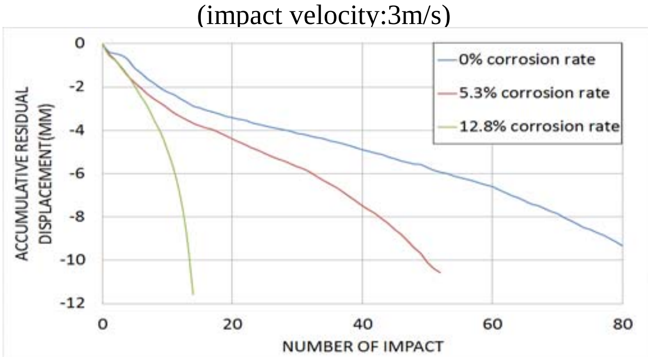
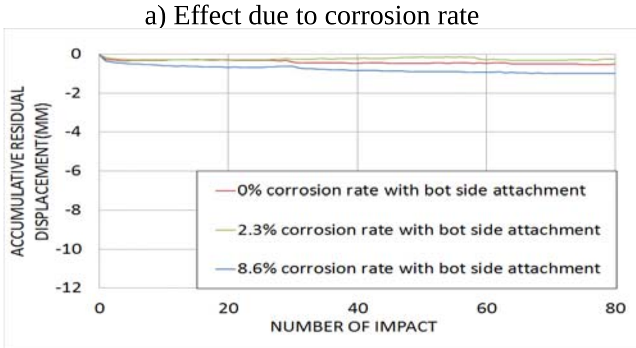


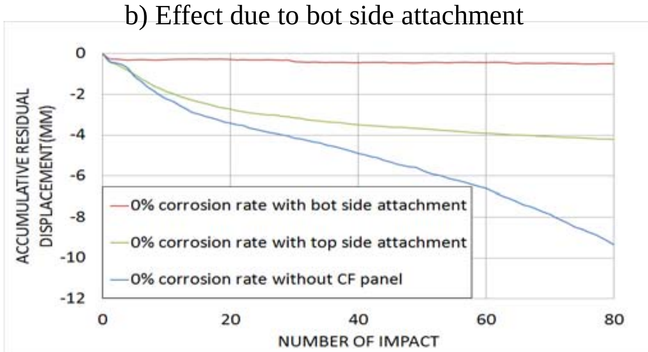
Figure. 5 Displacement vs time without corrosion (impact velocity:3m/s)



a) Effect due to corrosion rate



b) Effect due to bot side attachment



c) Effect due to different installing methods

Figure. 6 Accumulative residual displacement vs Number of impact

a) Non-CFC panel

b) Top side attachment

Figure.7 Damage circumstance