Mechanical Performance Analysis Based on ANSYS of Concrete Column Confined by BFRP sheets

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Keywords: Mechanical Performance; stress distribution; Numerical simulation; ANSYS software

Abstract. Forty five BFRP confined square and rectangular concrete columns were tested under axial load to evaluate their capacity and ductility ablity. The numerical simulation of Concrete Column Confined by BFRP sheets is simulated by using ANSYS software, and the stress distribution and crack development of BFRP confined concrete columns are obtained, which are compared and analyzed with the test results. The results show that the discrete model for finite element numerical analysis can simulate the axial loaded behavior of BFRP confined concrete columns.

Introduction

The use of externally bonded fiber-reinforced polymer (FRP) has been used in the strengthening of engineering structures. The effectiveness of the confinement of concrete columns by FRP sheet depends on several factors: type of fiber , the concrete strength, fiber volume, shape of the cross-section, length-slenderness ratio and corner radius. The effectiveness of FRP confinement for rectangular sectional short columns is much less known[1]. Rochette and Labossière [2] investigated the behavior of plain concrete columns with square and rectangular cross-sections confined with carbon and aramid fiber sheets. The results from a series of tests on small-scale specimens under uniaxial compression showed that the confinement increased the strength and ductility of the columns. For a given number of sheets around a section, the confinement effect was directly related to the shape of the section. Yan et al. [3] investigated the confinement of concrete in square and rectangular columns using post- tensioned FRP composite shells with expansive cement concrete. They observed that shape modified square and rectangular compression members with post-tensioned FRP shells had a higher axial compressive strength and ductility than members confined using bonded FRP jackets with the same number of FRP layers. It was concluded that the shape modification method can transform the stress-strain behavior of lightly or moderately FRP-confined square or rectangular compression members from softening to hardening, which improves their performance. For square section columns, it has been concluded that the most important shape factor that affects the confinement effectiveness is the corner radius ratio [4,5]. For rectangular section columns, another important factor is the cross-section aspect ratio. However, data for rectangular columns that can be used for the quantification of the isolated effect of the aspect ratio are scarce.

The finite element result analysis

As the result, the maximum tensile stress and strain appear at the corner of the end of load, showing cone distribution. The main failure mode of the specimen is like this: at the corner of the end of load, FRP sheet bias slit, it is the same to the experiment. According to the stress diagram, concrete surface and BFRP sheet are tensile, just like the experiment. so we can say ANSYS can simulate the concrete column confined by BFRP sheets's failure mode. According to Tab 1,the ratio of the concrete column's strength experimental value and the ANSYS value is 0.2%~11.3%,only few exceed 10%,the accuracy is very good. For the strain, the result is good, but ultimate strain need more research. The stress、strain graphs are like Fig 2 and 3.

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Tab.1 Comparison of test and ANSYS calculation values on the strength of BFRP confined columns

specimen	Experimental values	ANSYS value	Experimental values / ANSYS value [%]	specimen	Experimental values	ANSYS value	Experimental values / ANSYS value [%]
1S-1.0	37.6	37.69	0.2	2S-1.0	49.2	54.30	10.4
1R-1.25	36.6	37.21	1.4	2R-1.25	44.6	46.70	4.7
1R-1. 5	36.3	35.82	1.4	2R-1. 5	42.6	45.11	5.9
1R-1.75	35.7	38.05	6.6	2R-1.75	39.2	41.26	5.3
1R-2.0	35.0	36.70	4.9	2R-2.0	36.2	40.28	11.3

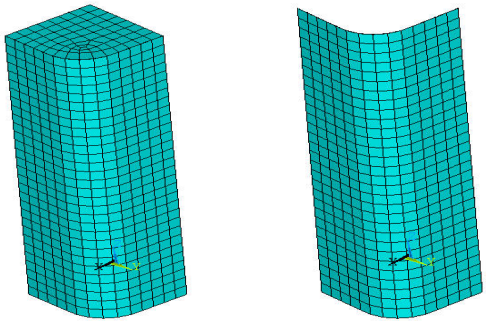
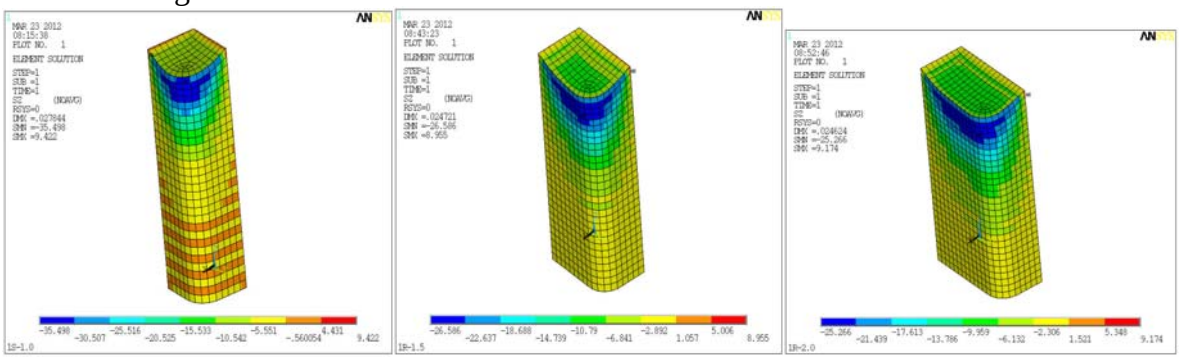
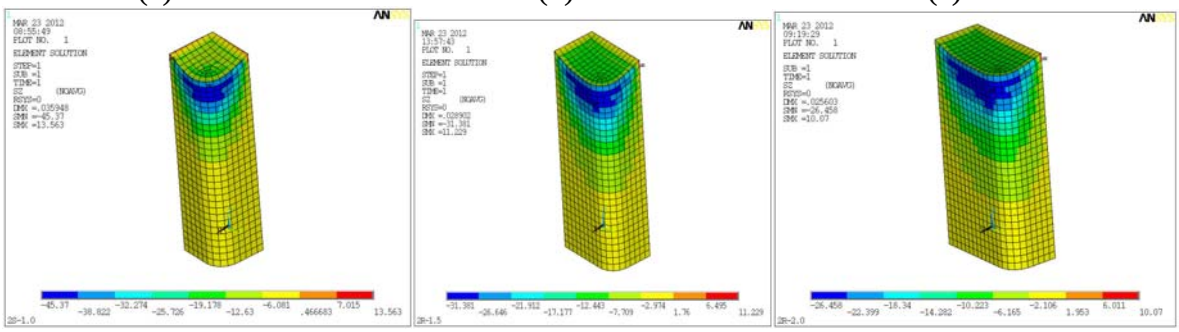


Fig.1 The Finite Element Model of BFRP confined concrete columns



(a) 1S-1.0 (b) 1R-1.5 (c) 1R-2.0



(d) 2R-1.0 (e) 2R-1.5 (f) 2S-2.0

Fig.2 The stress of BFRP confined conrete columns

Summary

The maximum strain of the BFRP at rupture can be as great as the ultimate strain of the BFRP from the flat coupon test and is apparently unaffected by the aspect ratio.

The maximum BFRP strain at the peak strength decreases significantly with an increase in the aspect ratio.

We can simulate the compressive performance of square and rectangle column confined by

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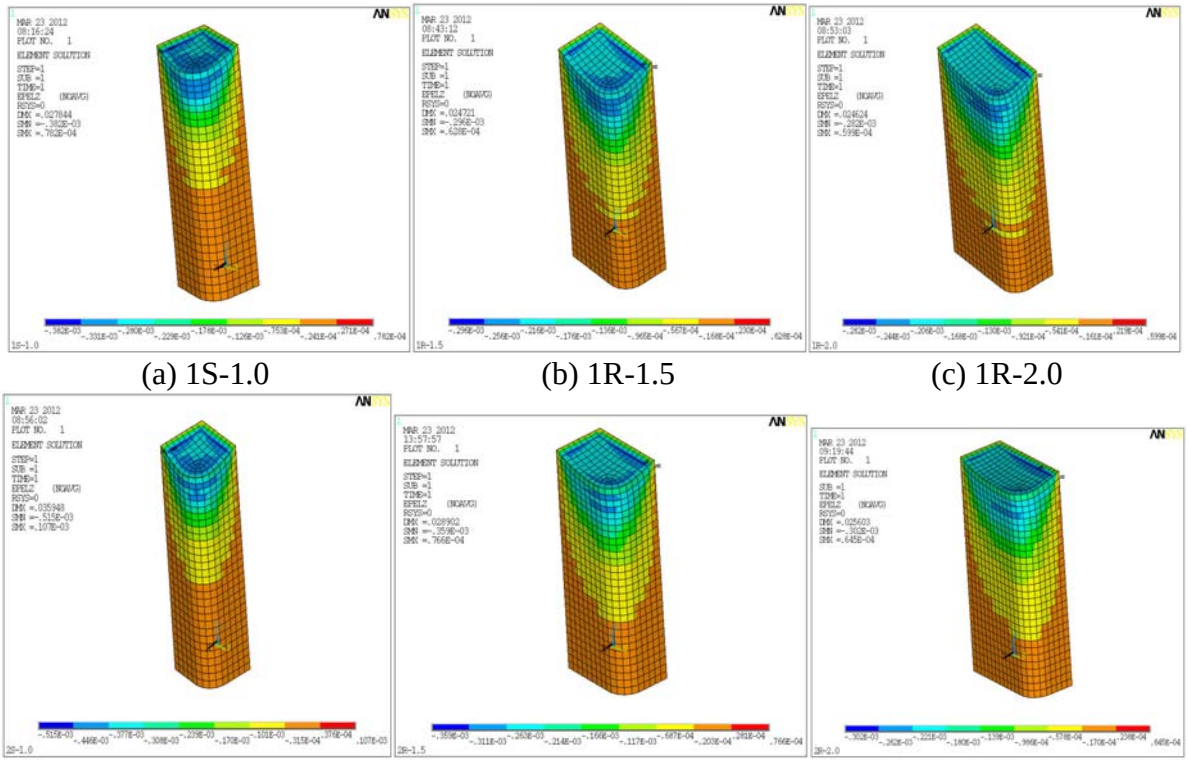
BFRP sheets well.



(a) 1S-1.0 (b) 1R-1.5 (c) 1R-2.0

(d) 2S -1.0 (e) 2R-1.5 (f) 2R -2.0

Fig.3 The strain of BFRP confined conrete columns

Acknowledgements

Supported by Program for Liaoning Excellent Talents(LNET) and Liaoning Province Science Public Research Fund Project.

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