Renovation of concrete columns by wrapping basalt fiber sheets

Eythor THOHALLSSON
Associated Professor
Reykjavik University
Reykjavik, Iceland
eythor@ru.is

Eythor Thorhallsson, born 1962, received his structural Engineering degree from the Heriot Watt University, Scotland in 1987. He worked for Mannvit Consultants Engineers before join the Reykjavik University

Arngrimur KONRADSSON
Structural Engineer
Ferill consultant Engineers
Reykjavik, Iceland
arngrimur@ferill.is

Arngrimur Konradsson, born 1982, received his structural Engineering degree from the Reykjavik University, Iceland in 2011.

Summary

Basalt Fibre Reinforced Polymer (BFRP) is a new material in civil engineering and has shown to be a promising material for infrastructure strengthening and also in comparison to carbon fiber, glass fiber and other composites, it has some advantages such as high-temperature resistance, corrosion resistance and low cost.
Test program was carried out at Reykjavik University Structural and Composites Laboratory (SEL), by wrapping of fibre-reinforced composite sheets around concrete columns to test the strength and ductility, with and without wrapping. The results of the experimental tests show that BFRP can give a good lateral confinement pressure to concrete columns. This effectiveness provides a good ductile behaviour and delay's column failure even though the confinement ratio is low. This ability is important, for example, in case of earthquake actions.

Keywords: Renovation, confinement, basalt patching, BFRP, concrete strengthening, columns, wrapping, FRP.

1. Introduction

Strengthening of reinforced concrete elements by carbon fiber (CFRP) and glass fiber (GFRP) and aramid fibers materials are well known, few guidelines have been published to guide strengthening calculations for these materials. Another fiber material Basalt fiber (BFRP) have not been used as widely as the other mentioned before, and in the guidelines mentioned the basalt material is not included. It is believing of the authors that strengthening by basalt sheets could be used instead of CFRP, GFRP and Aramid fibers. The research here explained is step in to give valuable data for guided strengthening rules for BFRP.

In this previous work of the authors [1] it was shown that strengthening BFRP on concrete cylinders have grate effect on compressive strength and ductility.

2. Experimental procedure

Two groups of columns were prepared and tested where the group CA contained four columns with a corner radius of 20 mm and group CB contained four columns with a corner radius of 35 mm. All columns are same size 180 x 180 mm and of length 1400 mm. All the columns were reinforced in the same way one longitudinal bar of diameter 12mm of steel grade B500C in each corner and hoops space was 180 mm with same steel grade same size of column specimen was used in former research to investigate the ductility of reinforced concrete with different hoop spacing [2] Each group contained a column wrapped with one, two and three layers of BFRP jacket and one column without BFRP jacket as a reference. The basalt mats are from BASALTEX of type BAS UNI 600. The epoxy resins are from Sika

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2. Test results

The results of tested columns are summarized by reporting the key parameters at milestones throughout the loading time in table 1 and table 2. Each table includes the unconfined axial load capacity at first peak where Fc is for the unconfined columns, and Fcc_1 is for the confined columns, the confined axial load capacity at the jacket rupture Fcc and the load capacity at the failure of the unconfined columns Fcu. Corresponding strain at Fc is εc_1, at Fcu is εcu, at Fcc_1 is εcc_1, and at Fcc is εcu. For comparison of the performance of confined columns and the unconfined columns, the strength ratio Fcc/Fc and the strain ratio $\varepsilon cu / \varepsilon c_1$ is shown.

Table 1 - Results of unconfined columns.

Column	n	F_c (kN)	F_{cu} (kN)	ε_{c1} (%)	ε_{cu} (%)
CA0	0	1129,5	1111,1	0,346	0,348
CB0	0	1076,7	1068,5	0,343	0,344

Table 2 - Results of confined columns.(n=number of layers)

Column	n	F_{cc1} (kN)	F_{cc} (kN)	F_{cc1}/F_c	F_{cc}/F_c	ε_{cc1} (%)	ε_{cu} (%)	$\varepsilon_{cu}/\varepsilon_{c1}$
CA1	1	1179,4	971,2	1,04	0,86	0,332	0,783	2,26
CA2	2	1169,7	1197,6	1,04	1,06	0,270	0,950	2,74
CA3	3	1310,1	1355,7	1,16	1,20	0,344	1,378	3,98
CA3	3	1310,1	1520,2	1,16	1,35	0,344	1,088	3,14
CB1	1	1127,1	1048,3	1,05	0,97	0,330	0,711	2,07
CB1	1	1127,1	1078,4	1,05	1,0	0,330	0,655	1,91
CB2	2	1193,2	1497,2	1,11	1,39	0,286	1,014	2,95
CB3	3	1209,5	1527,3	1,12	1,42	0,332	2,198	6,40

3. Conclusion

In this paper, the behaviour of BFRP confined reinforced concrete columns was investigated. The experimental results clearly demonstrated that BFRP wrapping can enhance the structural performance of concrete columns under axial loading. The confinement effect is directly related to the shape of the cross-section. The number of BFRP layers and the corner radius are the major parameters having the effect on the behaviour of concrete columns. To enhance the confined behaviour, the stiffness of the BFRP jacket can be increased by applying additional layers and also by increasing the corner radius of square columns.

Acknowledgments

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