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EFFECT OF DIFFERENT TEMPERATURES ON THE SELF-COMPACTING CONCRETE CYLINDERS CONFINED WITH BFRP SHEETS, THE RESULTS - PART B

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ABSTRACT

In this part of the study the effect of exposure to elevated heating regimes on the compressive strength of 21 unconfined and 21 confined concrete cylinders of Basalt Fiber reinforced polymer (BFRP) composites have been investigated and the results have been presented. For 1, 2, and 3 hours, all cylinders were subjected to heating regimes of 100°C and 300°C. The compressive strengths of unwrapped concrete cylinders were compared to wrapped cylinders' counterparts. The extreme temperatures used in the current investigation had essentially minor influence on the compressive strength of the BFRP wrapped cylinders. However, the unconfined specimens had been highly affected. When the exposure hours and heating regimes level increased, the compressive strength of the unconfined cylinders dropped. The highest compressive strength in unconfined specimens loss were measured to be 36.71 % after 3 hours of exposure to 300°C.

Key Words: Compressive strength, basalt fiber reinforced polymers, temperature.

1. INTRODUCTION

One of the most dangerous hazards is fire, and the fire safety of reinforced concrete (RC) Structures are an important strategy consideration. RC buildings are generally fire resistant due to the restricted heat conductivity of concrete at increasing temperatures, which can be used to protect interior reinforcement rebars from fire by correctly planning concrete cover depths. [1]. Post-fire repair and reuse methods are often more cost-effective and environmentally friendly than destroying and rebuilding weak structures. The cross-sectional enlargement of the RC member section and the external jacketing with steel plates are the most common strengthening procedures utilized for weak RC structures. [2–8] However, these strengthening technologies have several drawbacks, including a longer construction time due to the difficulties of the construction and installation procedure, a higher building's self-weight, and undesirable stiffness variation. The latter will transform the basic RC structure's seismic resistance under earthquake loads, and may necessitate new design work [9].

As a result, traditional reinforcing methods may be incompatible with new requirements, such as the need for a quick and cost-effective strengthening solution to reduce the fire's indirect cost.

In the context of civil engineering structures, a typical design life of several decades is taken into account. Changes in the original conditions, such as higher traffic loads or the removal of bearing parts in the case of bridges or buildings, may occur throughout this time period, necessitating the strengthening of structural members. Another reason for the requirement for reinforcement could be poor design. FRP composites, unlike steel, are resistant to electrochemical corrosion and can withstand the corrosive effects of acids, alkalis, salts, and other severe chemical attacks at a variety of temperatures. Another benefit of FRP composites in building is that they consume little energy during the production process. When employed in structures, the use of sustainable raw materials with positive features such as low thermal conductivity for lower energy consumption can help to preserve our natural environment. [10-38]. Consequently, it is possible to estimate that the utilization of FRP sheets has the ability to improve the strengths of thermally injured concrete columns after unintentional fire. Nevertheless, insufficient investigational studies are available on the axial compression performance of thermally injured concrete confined with FRP jackets [39,40].

Jiang Song et al. [41] investigated the compressive behavior of heat-damaged square concrete prisms that were either unconfined or confined by a promising form of basalt fiber-reinforced polymer composite. Under axial compression, 51 specimens were made and tested. The heat-induced damage levels of concrete prisms following exposure to various increased temperatures (200, 400, 600, and 800 °C) and the layers of basalt FRP (BFRP) jackets employed for reinforcing were among the design factors. Increases in the exposure temperature or the number of BFRP jacket layers increased the strength growths and final axial strains of the BFRP-confined heat-damaged square concrete prisms.

The current research aimed to study the influence of heating regimes on the behaviour of concrete specimens wrapped with basalt FRP jacket. An experimental examination involving the preparation and testing of 42 conventional 100 mm diameter x 200 mm height concrete cylinders was conducted to achieve the study's goal. Twenty-one cylinders were left unconfined, while the remaining twenty-one specimens were confined with one layer of BFRP jacket. Some of the specimens were left at ambient temperature, while others were heated to temperatures of 100°C and 300°C for 1, 2, and 3 hours, respectively. After being exposed to high heating regimes, uniaxial compression test were conducted on cylinders till collapse.

2. RESULTS AND DISCUSSIONS

The results of wrapped and unwrapped test specimens are summarized in Tables 1 and 2. The compressive strength values shown in the tables are the average of three samples. The standard deviation ranged between 6.54 and 7 MPa for unconfined specimens with coefficients of variations between 14 and 17 %. For the BFRP confined specimens, the standard deviations ranged between 3.14 and 2.62 MPa with coefficient of variation between about 5.8 and 4.7%.

Table 1. Testing records of BFRP unwrapped cylinders.

Average compressive strength (MPa)			
Temperature	**Exposure time (h)**		
	1h	**2h**	**3h**
100°C	**52.51**	**39.77**	**37.72**
300°C	**45.94**	**46.28**	**31.58**
Room		**49.8 ± 0.7**	

Table 2. Test records of BFRP wrapped specimens.

Temperature	**Exposure time (h)**		
	1h	**2h**	**3h**
100°C	**58.21**	**51.24**	**51.31**
300°C	**51.93**	**55.56**	**58.34**
Room		**58.64 ± 1.2**	

2.1. Unwrapped Specimens

For the unconfined samples before the testing put in the room temperature and the heating according explained earlier. The cylinders were then put through a uniaxial compression test. Under axial load, the behavior of specimens was found to be consistent. The compressive strength of the unwrapped cylinders is shown in Table 1. from the results for the unconfined cylinders.it can be shown that different temperatures effect on the compressive strength for cylinders.

2.2. BFRP Wrapped Specimens

The compressive test results of the BFRP wrapped cylinders are shown in Table 2. The temperature level had a little effect on the BFRP confined specimens at 100 and 300 c, as shown in Table 2. When compared to unwrapped specimens at 300 °C temperature at 3 hours, all specimens wrapped exposed to elevated temperatures demonstrated similar strength for control sample. As demonstrated in Figure 1, increasing the temperature had a substantial impact on the color of the wrapped specimens. Figure 1 shows how the BFRP sheets changed color after being exposed to 300°C. All samples wrapped with BFRP failed because tearing-off the BFRP, the failure was relatively sudden and without warning regardless of temperature level or exposure period.

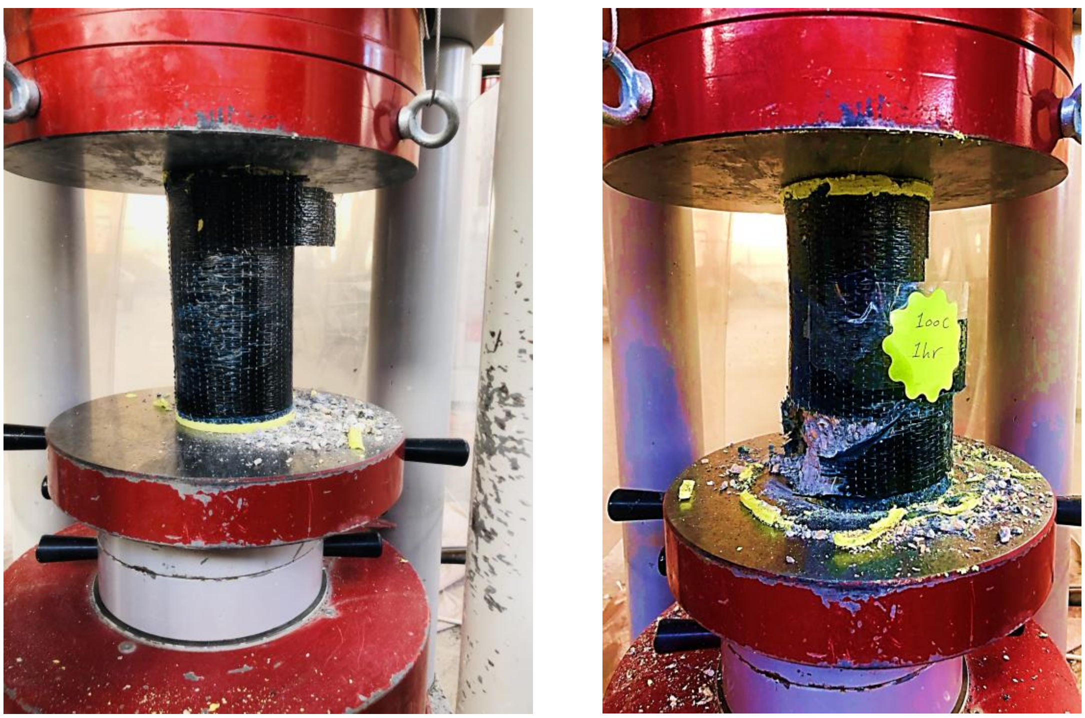

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Figure 1. Failure of BFRP wrapped specimens.

3. TEST RESULTS

Figures 2 and 3 show the average compressive strength of all test specimens after exposure to different temperatures and exposure periods. The figures shows that the BFRP confined specimens had the maximum compressive strength followed by the unconfined specimens.

The specimens BFRP confined, the exposure period had a minor effect on the compressive strength specimen at 300°C were increasing the exposure period from 2 to 3 hours resulted in a significant stability in the compressive strength.

For the BFRP confined specimens, Figure 4 shows that compressive strength losses were recorded. The strength losses ranged between 1 and 7 at 100°C, and 6.69 and 0.22 at 300°C.while the unconfined specimens, the compressive strength significant losses ranged between 10 and 12 at 100°C, and 3.48 and 18.13 at 300°C.

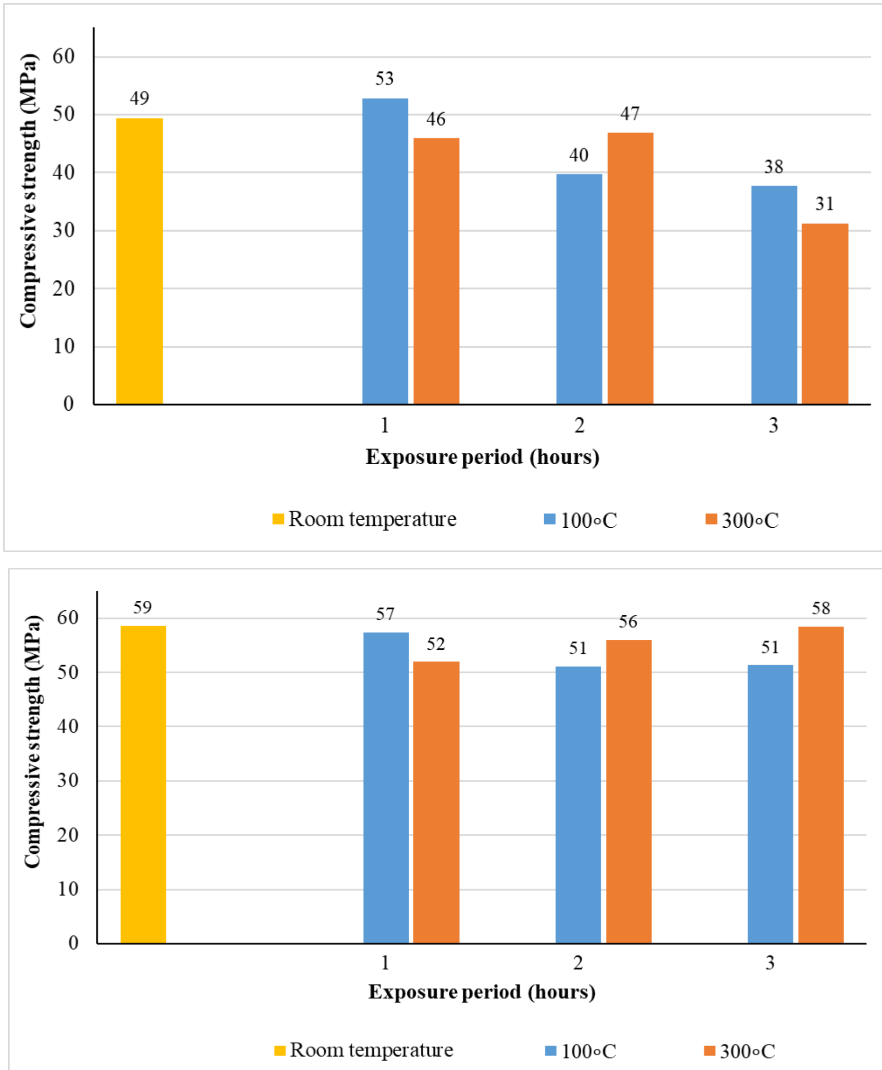

Figure 2. Average compressive strength of unconfined and BFRP confined specimens after exposure to different temperatures.

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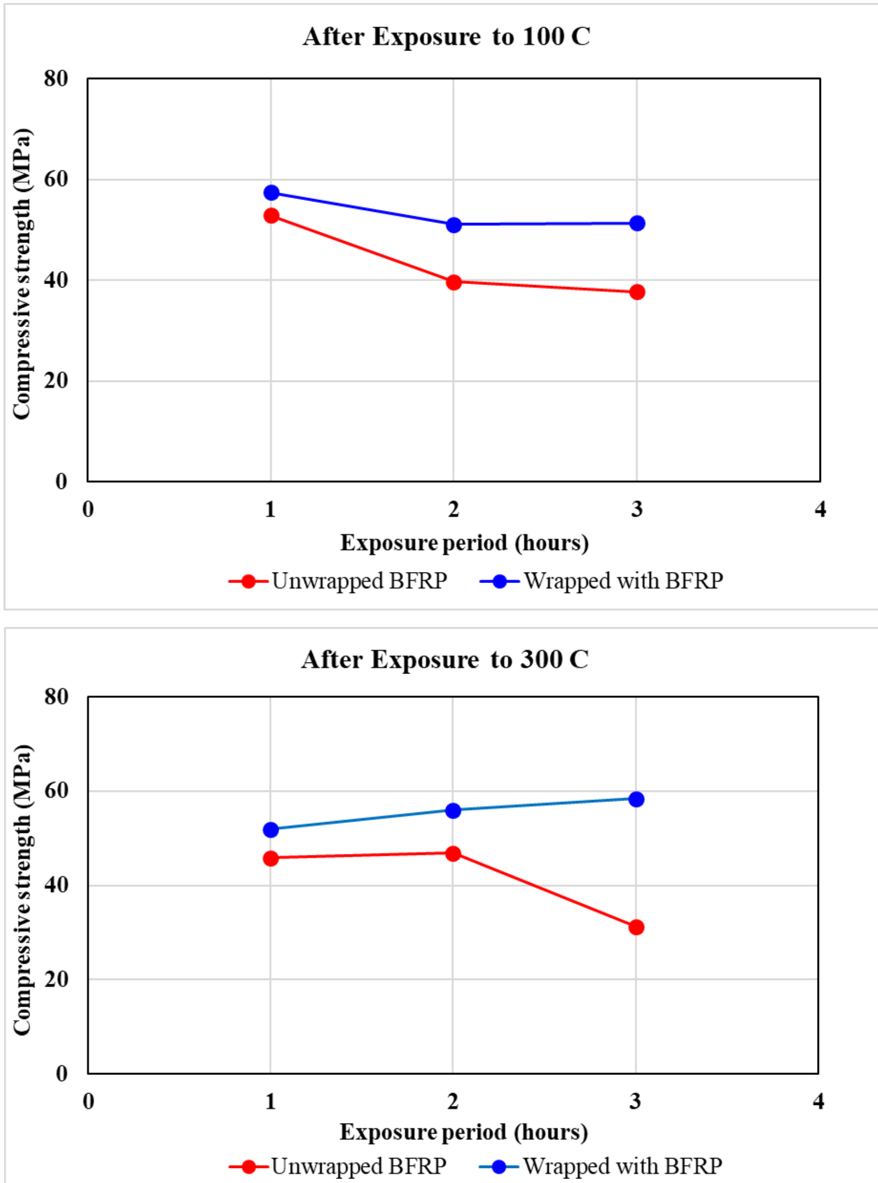

Figure 3. Comparison of test results

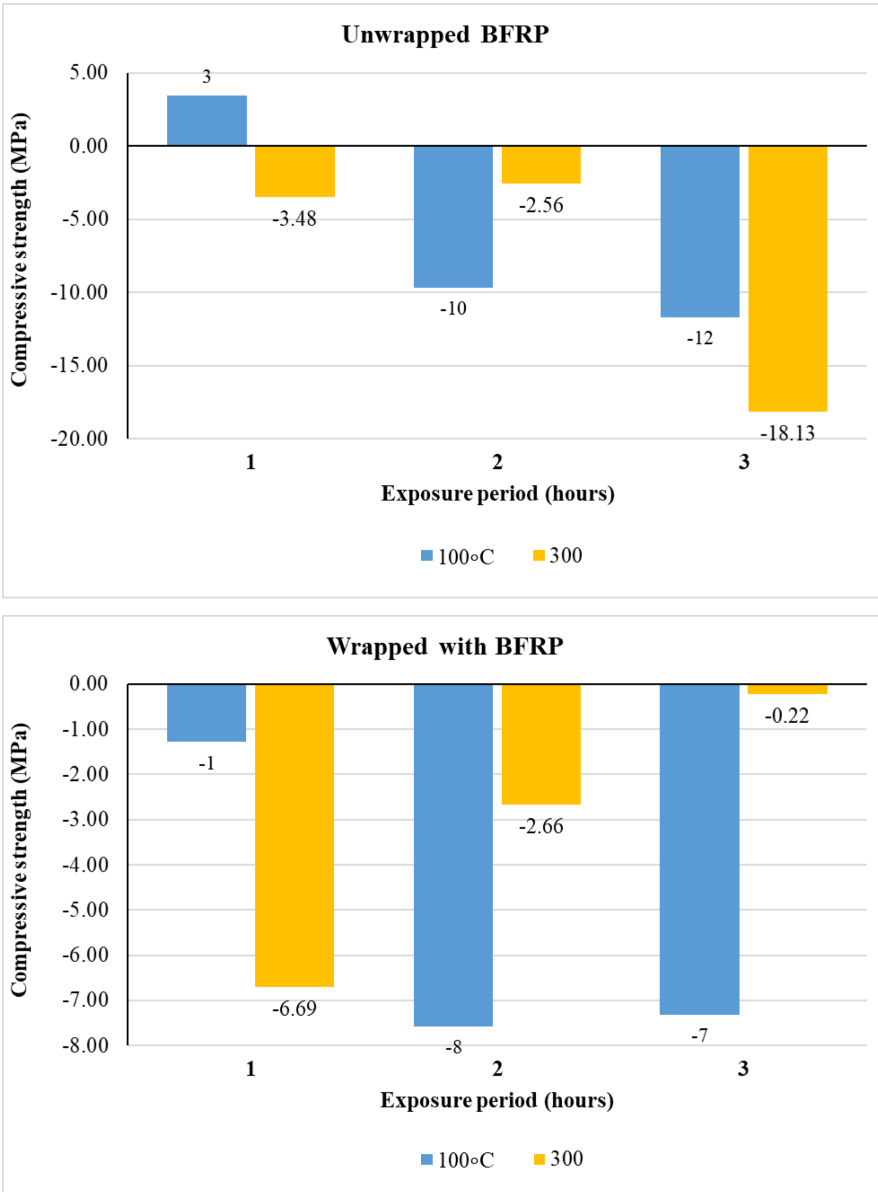

Figure 4. Compressive strength loss of unconfined and BFRP confined specimens after exposure to different temperatures.

4. CONCLUSIONS

The purpose of this study was to look into the compressive strength of BFRP wrapped concrete cylinders after being exposed to high temperatures. The test procedure involved 42 concrete cylinders: 21 unconfined and 21 confined with BFRP sheets. All of cylinders were heated to 100°C and 300°C for 1, 2, and 3 hours. The compressive strength of confined specimens with BFRP sheets was matched with the unconfined specimens under the same conditions. According to experimental records, the next results can be illustrated:

1. All of confined concrete cylinders failed by splitting of the BFRP sheets.
2. The increasing heat had a significant influence on the compressive strength of the unwrapped cylinders. The compressive strength decreased as the heating degree or exposure hours increased. An extreme compressive strength loss of 36.71% was recorded after 3 hours of heating at 300 C temperature.
3. The increasing heat had a significant influence on the compressive strength of the BFRP wrapped cylinders. For BFRP confined the compressive strength keeps when the heating degree or exposure hours increased.

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