International Journal of Research in Civil Engineering and Technology

E-ISSN: 2707-8272
P-ISSN: 2707-8264
IJRCET 2021; 2(1): 05-09
Received: 07-01-2021
Accepted: 18-03-2021

Buddha Kumar
Kathmandu Engineering College, Kalimati, Kathmandu, Nepal

Corresponding Author:
Buddha Kumar
Kathmandu Engineering College, Kalimati, Kathmandu, Nepal

Construction material and it's experimental plan

Buddha Kumar

Abstract

The event of corroding on strong concrete structures can lead to significant scheme losings. Therefore, steel bars used in the real constitution must be situated with a different material that can hold up water contact without exploit corroding and container secure the safe work of the constitution during its lifespan, even in adverse atmospheric condition. Carbon-fibre-reinforced polymer (CFRP) gymnastic apparatus are one of the real that can replace steel bars and they have already been applied as a ersatz previously. This learning analyses the bonding of these bars with concrete at high physical property and for longer time playing period. It presents an enquiry plan that come to a series of disengagement trials at different ages, days, and thermal opportunité in CFRP rods either fumed with ribbed steel bars or that underwent sand-ribbed surface treatment. Some compression tests for each mixture were performed at the same ages and temperatures as the experimental plan in pullout to determine the determiner of high temperatures on tangible. The work realised with some additive tests on the CFRP rods using optical research, scanning electron research (SEM), and thermonuclear force research (AFM), from the evaluated pullout sample distribution. The high physical property significantly subject the ribbed CFRP bars by decreasing their attraction stress and did not affect the sanded CFRP bars. This uneven behaviour and the influence of high somatesthesia on concrete electrical resistance at the age of 180 d is justified. The effect of bonding agents on strength loss of successive casting of self-compacting concrete (SCC) is the subject of the second paper, authored by Assaad and Daou (2021) from Lebanon. SCC slabs were cast in two layers. The instance interval betwixt the two layers was either 60 or 120 min and different bonding agents were used. The polymer-based bonding agent was earnings to bring forth a better bond between the two slab vocal. In addition, the writer present the drop in bond military strength as a series of charts to aid execute engineers when there is interruption in casting of SCC.

Keywords: thermal conditions, diminishing, microscopy, interruption

Introduction

Steel is the almost used substantial in strengthened concrete as it suffice many function. Its fantabulous tensile stress and compatibility with con-crete are ideal for structural calculations. Although reinforced concrete can be exposed to unfavourable environments such as chloride concentrations (marine structures and ice-melting salts), chance variable in temperature and humidity may cause its structural declension. The repair and maintenance cost of existing infrastructure around the world is computation over 100 billion euros [1, 2]. A significant pro-portion of this detriment is used to address the durability issues in con-crete artefact. The advantages of FRPs include a high resistance against corrosion, high strength-to-weight ratio (10–15 times greater than steel), fantabulous stress characteristics (approximately three times higher than steel), magnetic force neutrality, and easy authorisation work, which reduces building cost. However, their reward include high cost, low ductility with an easy rupture, and low shearing resistance (caused by the poor mechanical properties of the physical tissue, such as fast and severe fastening loss or electric resistance and rigidity at high temperatures). The mend and maintenance cost of existing infrastructure around the world is computation over 100 billion euros [1, 2]. A significant pro-portion of this outgo is used to address the strength issues in con-crete composition. The alkaline environment of touchable usually provides necessary protection for reinforcing stimulus steel over formulaic environments. Nevertheless, environmental wear is inescapable, eventually decreasing the acidity of concrete coating, which leads to the chemical process and deterioration of reinforced concrete that cause shedding and in-creases damage. Studies on the determining factor of temperature on the bond behaviour of CFRP bars with concrete have been carried out, especially, in compass close to the glass transition temperature (Tg) of the organic compound, as it signifi-cantly modifies the bar properties.

The robotlike properties of the polymer begin to trim down at a somaesthesia close to its glass transition temperature, and the polymer cannot effectively transfer the apeurer from the concrete to the fibres, with a considerable reduction in attractive force strength [36].

Fig 1: Sand bar

Thermoplastic polymers (e.g. vinyl ester and polyester) have glass transition physical property in the range of 60–130 °C, while high-performance amorphous and organic fibres, such as glass, carbon, and aramid fibres, exhibit good mechanical property memory at elevated temperatures (up to 250 °C) [37]. [38, 39] observed that, at a somesthesia of 125 °C, the bond strength weakened by almost 50% of that at room temperature [5]. Yu and Kodur, observed 80% bond loss in their tests when the temperature increased from 20 to 200 °C. A structural element uncovered to the sun, in the Mediterra-nean climate zone, can mental object a temperature high than 80 °C and an ratio higher than 600 W/m2 in summer, following the Newton’s law of temperature reduction and the law of heat conduction (Fourier’s law), without entering extreme situations such as desserts. Owing to various trans-verse coefficients of thermal contraction of the FRP bars and concrete, a high radial pressing is created, causing rupture stresses within the concrete. When the breach stresses are equivalent to the tensile strength of concrete (fct), microcracks occur and strengthen the links [40]. The bond strength 'tween the FRP bars and concrete is severely affected, even at relatively low temperatures. A rapid loss in the bond strength was observed (up to 60% of room temperature) at 100 °C [41]. Davalos [11] found 20–30% reduction in the bond stress at a temperature of 80 °C compared to that at 20 °C. Bank *et al.* [34] observed that the FRP bars at a temperature of 80 °C showed negligible material degradation when compared to identical control bars held at room temperature (20–22 °C). Masmoudi *et al.* [42] observed that the ratio of concrete cover thickness to bar diameter must be greater than 1.6 to avoid the cracking of con-crete under high temperatures up to 80 °C. Katz *et al.*

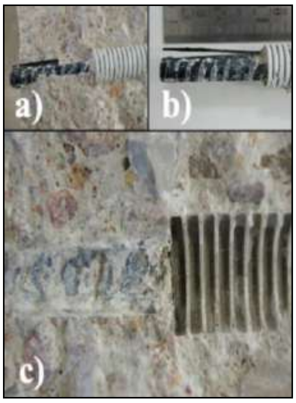

Fig 2: Kind of rupture

Found that sand-coated or helix-bonded FRP bars create by mental act a higher balance personal relationship distinguishing at 200 °C compared to other bars with robotlike anchoring. [28] planned a model of residual tensile strength for FRP bars with somesthesia below 100 °C for a short disclosure time of 4 h. [37] tested instance at a high heating rate of ±5 °C/min, simulating the hasard during a fire. Other authors, Rafi *et al.* [43], also studied the demeanour of CFRPs via beams subjected to a standardised heating curve during a fire. Rafi *et al.* [43] found no signs of damage or splitting cracks owing to the difference in the transversal constant of thermal expan-sion of the CFRP bars and concrete.

Experimental plan

Multiple variables affect the attractive force between the CFRP bars and con-crete resulting in the overflowing attraction stress and mode of failure. Nonetheless, there are a few studies on the effect of the demeanour of CFRP bars on bonding with concrete at high temperatures with the glass transformation temperature (Tg). The subjective of this research is to examine the thermal stages from 50 to 80 °C and their determinant on various types of bars. The criteria used to determine the bonding behaviour are essential for further analysis and discussion. The retreat method was selected owing to the discrepancy of the topic, which has been specific in the norm ACI 440-3R-12 because of the lack of uniformity [27]. It is interesting to compare the receive results of the CFRP bars with the steel ones. The CFRP exerciser were manufactured to fix the durability and fixing issues of the reinforced concrete with steel (justifying the unveiling of CFRP concrete bars over the calculus of the structural organization) [5, 19, 27].

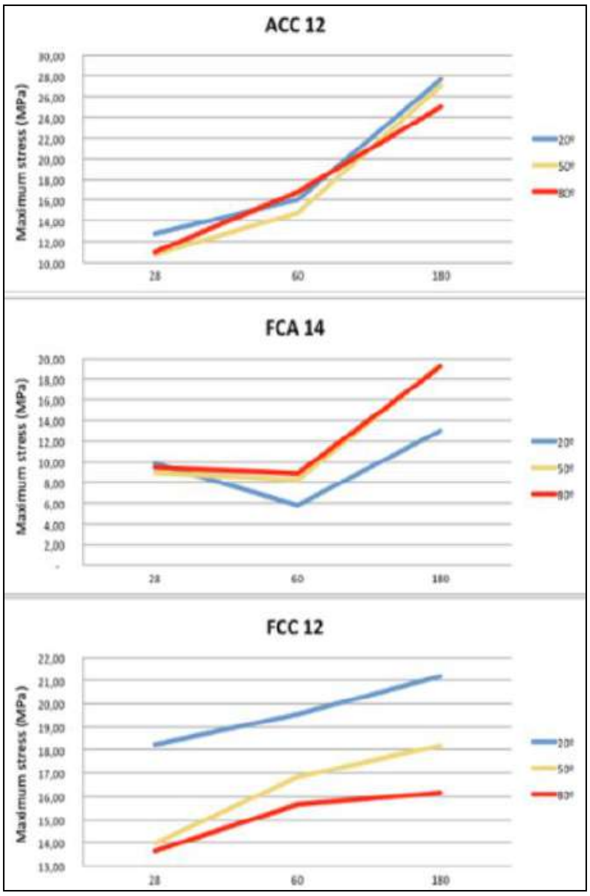

Fig 3: Evolution of stress

Sciolistic treatment was conducted over ribbed and sanded bars to actively collaborate the gathering of bonding. Optical microscopy tests such as Replication Electron Microscopy (SEM) and Atomic Force Microscopy (AFM) were plant part to analyse the effect of graduate temperatures on the CFRP bars before and after the fallback tests. Eighty-one pullout tests were conducted comparable to three samples of each bar (sanded CFRP, ribbed CFRP, and steel), age (28, 60, and 180 d), and temperature (20, 50, and 80 °C). Furthermore, the effect of weather on reinforced tangible was studied for a sufficient duration. To shape the influence on bonding and compressive stress of the concrete and its effects at high temperatures, stress compression tests were conducted for each mixture of concrete. The variation between the results on ruptures by pullout at tem-peratures between 20 and 50 °C are not significant [11, 29]. Therefore, to comparability the results of this study, a humidity variable was included in the samples at 20 °C, inducing moisture pervasion. The absence of studies on the influence of wetness on the bonding of CFRP bars is representative, even without state the main objective of this study, it is essential to know the stage of coverage that can be reached. Therefore, the samples of the pullout of each type studied, and of all ages (28, 60 and 180 d), were kept on the curing chamber with moisture-saturated samples, against those which were 50 and 80 °C, all dry without any moisture inside.

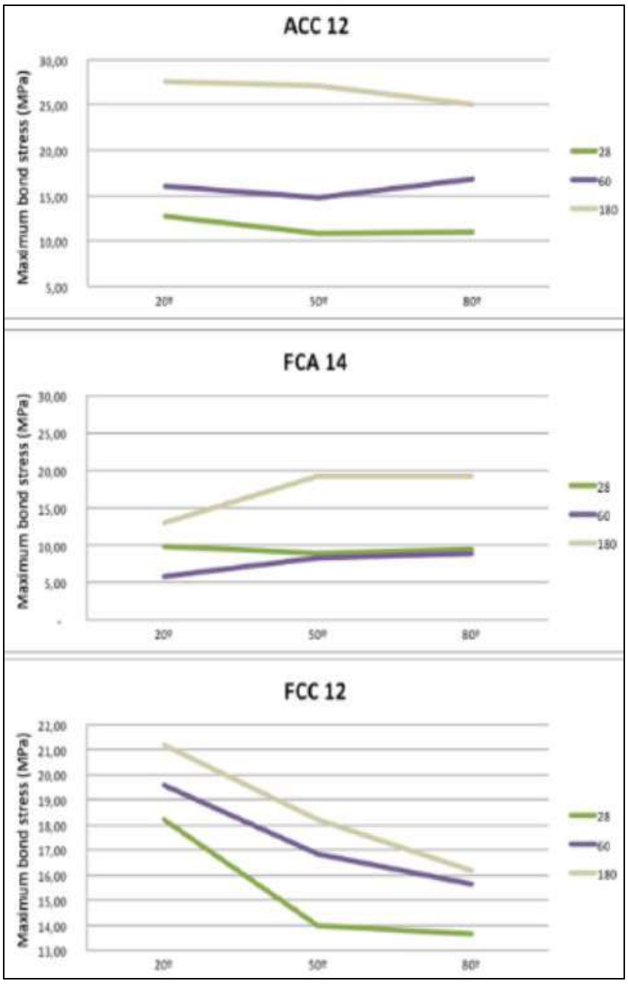

Fig 4: Characteristics of stress

Four complementary color tests were plant part (concrete compressive stress, optical research, SEM, and AFM). The behaviour of different bars was analysed using the data obtained from Hypothese tests. The development of concrete compressive stress with somesthesia and age was analysed. As shown in Fig., the influence of high tem-peratures on the concrete compressive stress was instantly correlated to the duration of climatic conditions of the sample, showing a decrease of approximately 28% when the representative were placed at 80 °C for 180 days. Two test thing were analysed, one from each type of the CFRP bar regardless of the somaesthesia and climatic conditions. These test opus were subjected to the same climatic conditions as those used for the pullout, without being processed by pullout. The persona which suffered stress from the pullout method and those subjected to climatic conditions were taken from the gymnastic apparatus that were used as test pieces in the pullout. The cross-section areas of the pieces were observed through an electron microscope. This technique reveals the activeness of fibres and polymeric matrix, as shown in the images (Fig. 11) obtained. Here, two author test pieces were used: 14, 60, and 80 d old at 20, 50, and 80 °C, respectively

Materials

The concrete used in this acquisition was HA-30/B/20/I, made with CEM I 52, 5 R from CEMEX, sand, limestone, and superplasticiser (Sika Vis-cocrete 3425). The steel exerciser were B 500 SD of 12 mm straight line made by Corrugados Azpeitia. The nomenclature used in this problem solving for these bars is ACC12. There are two character of CFRP bars: corrugated and sanded. These were hand-picked because they are the most used and commonly available bars. CFRP-sanded bars were made of a vinyl-ester polymeric ground substance reinforced with carbon fibres, and the bonding was achieved by silica sand coating. The straight line was 14 mm the manufacturer was Pulltrall Inc.

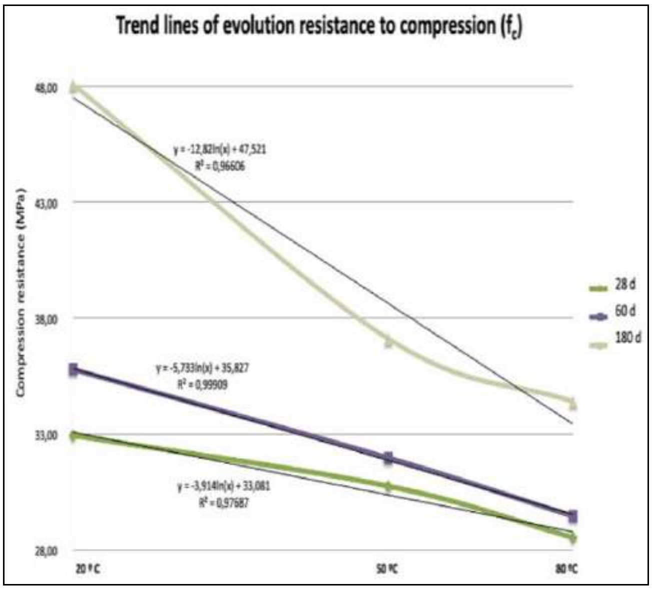

Fig 5: Evolution graph

Result

The compressive inflection in concrete (with steel bars, sand CFRP, and ribbed CFRP, respectively) at the supreme and normalised apeurer of every test portion, the replacement of every endpoint, and the conclusion of the batch. In addition to the obtained data about the rupture, a column was included for each test piece with its kind of break, according to: PO: A rupture that occurs after the wedging or friction between the bar and concrete fades. RA: A breach that occurs due to the bonding rupture between the object geometry and bar nucleus. RC: This rupture is a mix of PO and RA with partial fastening or wedging, but with damage to other parts of the bar. It occurs in corru-gated CFRP bars, in which some corrugates endure the pressing, while others are cut up.

References

1. Faza S. Bending and Bond Behavior and Design of Concrete Beams Reinforced with Fiber Reinforced Plastic Rebars, West Virginia State University 1991.
2. Castã neda-Valdez A, Rodriguez-Rodriguez M. Las ṕ erdidas econ ́omicas causadas por el fen ́omeno de la corrosi ́on atmosf ́erica del acero de refuerzo embebido en el hormig ́on armado, CENIC Ciencias Químicas 45 2014, 52-59.
3. Hollaway LC. A review of the present and future of FRP composites in the civil infrastructure with reference to their important in-service properties, Constr. Build. Mater 2010;24(12):2419-2445, https://doi.org/10.1016/j. conbuildmat.2010.04.062.
4. Bakis CE. In: Fiber-Reinforced-Plastic (FRP) Reinforcement for Concrete Structures, Elsevier 1993, 13-58, https://doi.org/10.1016/B978-0-444- 89689-6.50006-9.
5. Achillides ZP. Bond behaviour of FRP bars to concrete. Roc, 3rd Int. Symp. On Non-Metallic (FRP) Reinforcement for Concrete Structures 1997, 341-348. Japan Concrete Society.
6. Al-Zahrani MM, Al-Dulaijan SU, Nanni A, Bakis CE, Boothby TE. Evaluation of bond using FRP rods with axisymmetric deformations, Constr. Build. Mater 1999;13(6):299-309. https://doi.org/10.1016/S0950-0618(99)00038-0.
7. Baena M, Torres L, Turon A, Barris C. Experimental study of bond behaviour between concrete and FRP bars using a pull-out test, Compos. Part B-Eng 2009;40(8):784–797. https://doi.org/10.1016/j.compositesb:2009.07.003.
8. Benmokrane B, El-Salakawy E, El-Gamag SE. 2 2001 1517-1525. ISBN: 0-08- 043945-4.
9. Chang KK. In: Composites, ASM International 2001, 41-45. https://doi.org/ 10.31399/asm.hb.v21.a0009242.
10. Jl, S Goulet. Construction and Testing of Canada's First Concrete Bridge Deck Totally Reinforced with Glass FRP Bars, J Bridge Eng 2007;12(5):632-645, https://doi.org/10.1061/(ASCE)1084-0702.
11. EA Byars, P Waldron, V Dejke, S Demis. Durability of FRP in concrete deterioration mechanisms. FRP Compos. Civ. EnF. Davalos, Y. Chen, I. Ray, Effect of FRP bar degradation on interface bond with high strength concrete, Cem. Concr. Compos 2008;30(8)722-730, https://doi. org/10.1016/j.cemconcomp.2008.05.006.
12. AD Edwards, PJ Yannopoulos. Local bond stress-slip relationship under repeated loading, Mag. Concr. Res. 1978;30(103):62-72. https://doi.org/10.1680/ macr.
13. RF Gibson. Principles of Composite Material Mechanics, fourth ed., CRC Press 2016.
14. Malvar LJ, Joshi NR, Ja B, Novinson T. Environmental effects on the short-term bond of carbon fiber-reinforced polymer CFRP composites, J. Compos. Constr 2003;7(1):58–63. https://doi.org/10.1061/(ASCE)1090-0268(2003)7:1(58).
15. A Nanni. Guide and Specifications for the Use of Composites in Concrete and Masonry Construction in North America, in: Proceedings of the International Workshop Composites in Construction: A Reality, 2001, pp. 9–18. [16]M.M. Schwartz, Composite Materials Handbook, second ed., McGraw-Hill, New York, 1992.
16. R Tepfers. Bond clause proposal for FRP-bars/rods in concrete based on CEB/FIP Model Code 90. Part 1: design bond stress for FRP reinforcing bars, Struct. Concr 2006;7(2):47–55.
17. YC Wang, PMH Wong, V. Kodur, An experimental study of the mechanical properties of fibre reinforced polymer (FRP) and steel reinforcing bars at elevated temperatures, Compos. Struct. 80 (1) (2007) 131–140.
18. WM Yuan. Buckling analysis of concrete-filled FRP tubes, Int. J. Struct. Stab. Dyn 2001;1(3):367–383.
19. HM Mohamed, AH Ali, B Benmokrane. Behavior of circular concrete member reinforced with carbon-FRP bars and spirals under shear. J. Compos. Constr 2017;21(2):04016090-1/12. https://doi.org/10.1061/(ASCE)CC.1943-5614.000746.
20. EA Ahmed, EF El-Salakawy, B Benmokrane. Shear performance of RC bridge girders reinforced with carbon FRP stirrups. ASCE J. Bridge Eng 2010;15(1):44-54. https://doi.org/(ASCE)BE.1943-5592.000035.
21. AK El-Sayed, EF El-Salakawy, B Benmokrane. Mechanical and structural characterization of new carbon FRP stirrups for concrete members, ASCE J. Compos. Constr 2007;11(4):352-362. https://doi.org/(ASCE)1090-0268(2007)11: 4(352).
22. HA Mesbah, R Benzaid, B Benmokrane. Evaluation of bond strength of FRP reinforcing rods in concrete and FE modelling, Int. J. Civ. Eng. Constr. Sci 2017;4(3): 21-41.
23. B Benmokrane, B Zhang, K Laoubi, B Tighiouart, I Lord. Mechanical and bond properties of new generation of carbon fibre reinforced polymer reinforcing bars for concrete structures, Can. J. Civ. Eng 2002;29:338-343. https://doi.org/ 10.1139/L02-013.
24. D Moon, U Ebead, B Benmokrane. Effective surface deformation height and bond rigidity of FRP reinforcing bars with ribs, Polym. Polym. Compos 2009;17(3):161–171. https://doi.org/10.1177/096739110901700305.
25. MA Aiello, M Leone, M Pecce. Bond performances of FRP rebars-reinforced concrete, ASCE J. Mater. Civ. Eng 1997;19(3):203–210. https://doi.org/ 10.1061/(ASCE)0899-1561(2007)19:3(205).
26. V Calvet, M Valcuende, J Benlloch, JC ́anoves. Influence of moderate temperatures on the bond between carbon fibre reinforced polymer bars (CFRP) and concrete, Constr. Build. Mater. 94 2015 589-604. https://doi.org/ j. conbuildmat 2015;07:53.
27. RJA Hamad, MA Megat-Johari, RH Haddad. Mechanical properties and bond characteristics of different fiber reinforced polymer rebars at elevated

temperatures, Constr. Build. Mater 2017;142;521-535. https://doi.org/ j. conbuildmat 2017.03.113.
28. Z Achillides, K Pilakoutas. Bond behavior of fiber reinforced polymer bars under direct pullout conditions, J. Compos. Constr 2004;8(2):173-181. https://doi.org/10.1061/(ASCE)1090-0268(2004)8:2(173).
29. B Tighiouart, B Benmokrane, D Gao. Investigation of bond in concrete member with fibre reinforced polymer (FRP) bars, Constr. Build. Mater 1998;12(8):453-462, https://doi.org/10.1016/S0950-0618(98)00027-0.
30. B Benmokrane, B Tighiouart, O Chaallal. Bond Strength and load distribution of composite GFRP Reinforcing Bars in Concrete, ACI Mater. J 1996;93(3):246-253.
31. S Islam, HM Afefy, K Sennah, H Azimi. Bond characteristics of straight and headed-end, ribbed-surface, GFRP bars embedded in high-strength concrete, Constr. Build. Mater 2015;83:283-298. https://doi.org/j. conbuildmat.2015.03.025.
32. A Hadhood, HM Mohamed, B Benmokrane. Strength of circular HSC columns reinforced internally with carbon-fiber-reinforced polymer bars under axial and eccentric loads, Constr. Build. Mater 2017;141:366-378. https://doi.org/10.106/j. conbuildmat.2017.02.117.
33. LC Bank, M Puterman, A Katz. The effect of material degradation on bond properties of fiber reinforced plastic reinforcing bars in concrete, ACI Mater. J. 1998; 232-243.
34. MM Rafi, A Nadjai, F Ali, D Talamona. Aspects of behaviour of CFRP reinforced concrete beams in bending, Constr. Build. Mater 2008;22(3):277-285 https:// doi.org/10.1016/j.conbuildmat.2006.08.014.
35. E Nigro, A Bilotta, G Cefarelli, G Manfredi, E Cosenza. Performance under Fire situations of concrete members reinforced with FRP rods: bond models and design Nomograms, J. Compos. Constr 2012;16(4):395–406. https://doi.org/10.1061/(ASCE)CC.1943-5614.0000279.
36. A Katz, N Berman, LC Bank. Effect of high temperature on bond strength of FRP rebars, J. Compos. Constr 1999;3(2):73-81 https://doi.org/10.1061/(ASCE) 1090-0268(1999)3:2(73).
37. A Katz. Effect of cyclic loading and elevated temperature on the bond properties of FRP rebars. Int. Conference on the Durability of Fiber Reinforced Polymere (FRP) for Construction, Canada 1998, 403-413.
38. M Saafi. Effect of fire on FRP reinforced concrete members, Compos. Struct 2002;58(1):11-20. https://doi.org/S0263-8223(02)00045-4.
39. EB Lubl΄Ov. Bond of CFRP wires under elevated temperature, in: Proceedings of the International Symposium on Bond Behaviour of FRP in Structures (BBFS), 2005, 163-168.