EURASIAN JOURNAL OF ACADEMIC RESEARCH
Innovative Academy Research Support Center
UIF = 8.1 | SJIF = 5.685 www.in-academy.uz

COMPOSITE MATERIALS FOR REINFORCING FERRO-CONCRETE ELEMENTS

Sagatov Bahodir Uktamovich

"Construction of Buildings and Structures",
Jizzakh Polytechnic Institute
https://doi.org/10.5281/zenodo.6401659

ARTICLE INFO

Received: 01st March 2022
Accepted: 10th March 2022
Online: 14th March 2022

KEY WORDS

reinforcement, carbon, glass, aramid

ABSTRACT

Traditional reinforcement of reinforced concrete structures. Characteristics of polymeric fiber materials.

To date, in domestic and foreign practice, many different methods and constructive techniques have been accumulated for strengthening reinforced concrete structures. As a rule, the choice of a reconstruction project is determined by the three most important factors: the timing of the work on strengthening; minimum labor costs in the manufacture and installation of reinforcing elements; reliability and durability of the strengthened design.

For the traditional strengthening of reinforced concrete structures, an additional external reinforced concrete or steel jacket or individual steel elements (sheet, rolled) are used, which increase the overall and local bearing capacity of defective structures. However, the use of these traditional amplification methods causes several problems:

- external reinforcement increases the own weight of the structure;

- steel elements are not protected and easily corrode, control

behind which it is especially difficult at the points of contact with the concrete surface;

- you need special equipment for their installation;

- their length is limited (≤ 6...8 m) due to their own weight;

- it is difficult to manufacture reinforcement elements for complex sections of irregular shape;

- when loading structures, the separation of steel elements from concrete surfaces often occurs.

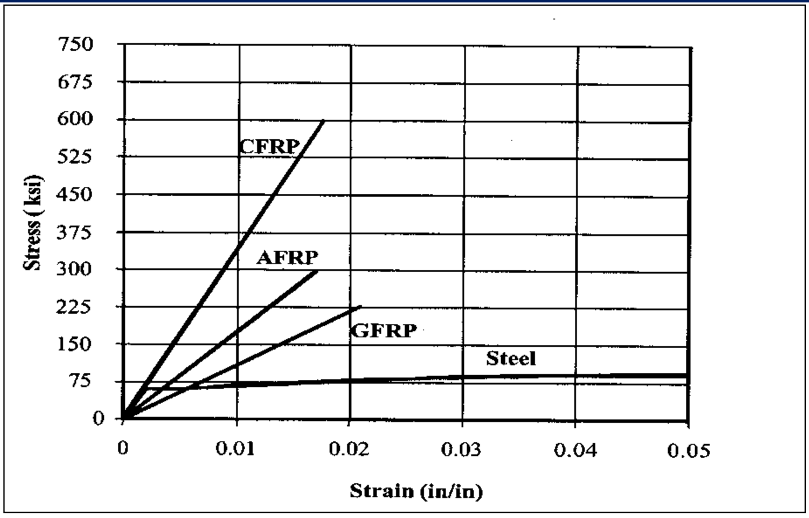
All this requires the development of special devices and a special technology for their installation, which increases the cost of work. Thus, traditional amplification methods are very time-consuming, short-lived, not always effective and economically feasible.

This situation prompts the prompt development of new, extremely rational solutions for maintaining and restoring the operability of structures. To overcome these shortcomings, in recent years there has been an active search for alternative solutions for strengthening and extending the service life of existing reinforced concrete structures of bridges and other structures. Conducted in a number of countries (USA, Europe, Japan, Russia, Turkey, Malaysia, etc.), extensive studies have shown that today the most effective and promising materials for strengthening load-bearing reinforced concrete structures are fabric polymeric fibrous materials (PFM), free from the noted shortcomings. They are made of thin high-strength fibers (threads or yarns) working as part of a matrix of polymer resins. They differ from traditional materials in a combination of unique features: lightness and high strength (six times stronger and five times lighter than steel), durability, resistance to corrosion, low coefficient of thermal expansion, durability, ability to quickly and easily be attached to structures with various geometries surfaces and sections, unlimited length, low labor intensity of use and low operating costs. It is especially important that the work on strengthening structures using such materials can be performed without interrupting the operation of the bridge. Such reinforcement is used to increase the bearing capacity, rigidity and seismic resistance of reinforced concrete structures. The development and application of a new technology for the rehabilitation of reinforced concrete superstructures of bridges, in turn, requires the improvement of their design solutions and methods for calculating the strength of reinforced structures.

Characteristics of PFM polymeric fiber materials. Composite PFM compounds are heterogeneous and their properties depend on many factors. The most important of these are the type of fiber and the configuration of the reinforcing fiber. Compounds consist of a combination of two or more different materials that have different properties (characteristics) in different forms or formulations. The fibers (filaments or yarns) can be run unidirectionally (in continuous sheets) or woven at various angles into a fabric. The fibers are characterized by high tensile strength in the longitudinal direction and low tensile strength in the transverse direction. These fibers make up a unidirectional fiber system. Bidirectional fabrics are made up of fibers oriented in a mutually perpendicular (0/90º) fashion with an equal distribution of fibers in each direction.

Fibers are divided into carbon, glass and aramid. These fibers are commercially available as continuous filaments. The main difference between PFM alumination and steel lamination is that PFM has higher strength, lower stiffness and elastic behavior up to failure without a yield plateau. PFM joints are corrosion resistant and perform better than other building materials in terms of environmental impact.

EURASIAN JOURNAL OF ACADEMIC RESEARCH
Innovative Academy Research Support Center
UIF = 8.1 | SJIF = 5.685 www.in-academy.uz



Rice. 1.2. Stress-Strain Relationship for FPM: Carbon Fiber (CFRP), Glass Fiber (GFRP), Aramido-Fibrous (AFRP) and Steels

The AFRP matrix consists of a polymer or resin used as a matrix for reinforcing threads. The matrix has two main functions: (a) it allows the load to be redistributed between adjacent fibers; and (b) protects the fibers from environmental impacts.

The fibers are impregnated with a polymer resin that surrounds and binds the fibers. The resin acts as a protective coating for the fibers to prevent potential damage. Polymer compounds differ from conventional materials such as steel, aluminum and concrete because the fibers are anisotropic in nature, meaning their properties depend on the direction of the fibers. Carbon fiber and fiberglass PVMs are six times stronger than steel and five times lighter. AVPM connections have become more popular and widely accepted by designers due to the variety of combinations of such unique features as: light weight; high strength to weight ratio (structural strength); directional strength; corrosion resistance; weather resistance; low thermal conductivity and low coefficient of thermal expansion; non-magnetic and high dielectric properties; low operating costs; durability; excellent surface polishing ability (finishing); unlimited length.

The main materials in the joints are reinforcing fibers with a length of at least 100 times the diameter and a polymer matrix. For maximum efficiency, reinforcing fibers are introduced in a specific direction and volume content in the matrix, allowing the composite bond to conform to the desired shape and specification. The resulting materials are anti-magnetic, non-conductive, and have high strength and stiffness in the fiber direction compared to steel. Other materials included in the compound are less significant in terms of performance and properties. Reinforcing fibers have three main orientations: in one direction, when the fibers lie in one direction; in two directions, when the fibers lie at an angle of 90 ° to each other; randomly oriented, when the fibers are randomly distributed in the same plane.

Fiberglass is the most common type of reinforcing fiber. Commercially, glass fibers are produced by extruding a molded mass through holes with a diameter of 0.79...3.18 mm, followed by drawing through a narrow hole with a diameter of 3...20 microns. The main advantage of glass fibers is that they are cost effective, have high tensile strength and excellent insulating properties [2]. Fiberglass can be divided into two types:

- type 1, which have an elastic modulus of 70 GPa and strength in the range of 1000...2000 MPa after treatment (denoted E, A, C, E–CR); glass fibers of class E, have a modulus of 70 GPa and produce joints with a limited modulus value;

- type 2, which has a modulus of 85 GPa and strength ranging from 2000...3000 MPa after treatment (denoted R, S and AR).

Carbon fibers are used as a reinforcing element mainly to achieve high strength and rigidity of PVM. The term carbon fiber (graphite fiber) refers to a family of materials with a wide range of strength and stiffness. Manufacturers make small diameter carbon fibers (4...10 m) to achieve higher tensile strength with lower bending strength. The main advantages of carbon fibers are high strength in relation to mass; low coefficient of thermal expansion; low sensitivity to fatigue loading; and excellent resistance to moisture and chemical attack. The density of carbon fiber is on the order of 1900 kg/m3. Typical values of the elastic modulus of the fiber can vary within 230...300 GPa, and the strength after processing is in the range of 3000...5000 MPa [3]. Carbon fibers have greater strength and stiffness and lower thermal expansion coefficients than glass and aramid fibers. In bidirectional UPVMs, the carbon fibers are arranged in orthogonal directions. According to the manufacturer's specification (Sikawrap-160C 0/90), the properties of bidirectional carbon fibers are as follows: tensile strength - 3800 N/mm2; fiber modulus E in tension - 230000 N/mm2.

Aramid (or aromatic polyamide) fibers with high thermal stability, high strength and stiffness are made by extruding a polymer solution through a spinneret. This is mainly due to the highly ordered region of the translucent fiber. These fibers are very rigid organic synthetic fibers characterized by high strength up to 3000 MPa, elastic modulus in the range of 60–120 GPa, and very low density of about 1400 kg/m3 [3]. Aramid fibers are flame retardant and work well at high temperatures. They are good insulators for electricity and heat, resistant to organic solvents, fuels and lubricants. Like carbon fibers, aramid fibers have a negative coefficient of thermal expansion in the longitudinal direction and a positive one in the radial direction [2]. Unlike carbon and glass fibers, aramid fibers are not brittle.

Aramid fibers have two categories: the elastic modulus of the first category is like that of glass (60–70 GPa), and the modulus of the second category is twice as high. There are two types of commercially available aramid resins: Kevlar 29 (category 1 modulus) and Kevlar 49 (category 2 modulus). Unidirectional aramid fibers have high tensile strength in the range of 1200-1400 MPa. With characteristic rigidity in the longitudinal direction, they are effectively used in tension elements. Some aramids have a relatively low compressive strength (230 MPa), so for composites that work exclusively in compression or bending, such fibers are used with great care.

The purpose of our research was to study the properties of composite materials for reinforcing reinforced concrete elements.

References:

1) Sagatov B. U. About transfer of effort through cracks in ferro-concrete elements //European Science Review. – 2016. – №. 7-8. – С. 220-221.
2) Sagatov B. U. et al. Review of strengthening reinforced concrete beams using cfrp Laminate //European Science Review. – 2016. – №. 9-10. – С. 213-215.
3) Ашрабов А. А., Сагатов Б. У., Алиев М. Р. Усиление тканевыми полимерными композитами железобетонных балок с трещинами //Молодой ученый. – 2016. – №. 7-2. – С. 37-41.
4) Asatov N., Jurayev U., Sagatov B. Strength of reinforced concrete beams hardenedwith high-strength polymers //Problems of Architecture and Construction. – 2019. – Т. 2. – №. 2. – С. 63-65.
5) Sagatov B., Rakhmanov N. Strength of reinforced concrete elements strengthened with carbon fiber external reinforcement //Problems of Architecture and Construction. – 2019. – Т. 2. – №. 1. – С. 48-51.
6) Bakhodir S., Mirjalol T. Development of diagram methods in calculations of reinforced concrete structures //Problems of Architecture and Construction. – 2020. – Т. 2. – №. 4. – С. 145-148.
7) Сагатов Б. У. Исследование усилий и деформаций сдвига в наклонных трещинах железобетонных балок //European science. – 2020. – №. 6 (55). – С. 59-62.
8) Asatov N. A., Sagatov B. U., Maxmudov B. I. O. G. L. Tashqi to’siq konstruksiyalarini issiqlik fizik xususiyatlariga ta’siri //Science and Education. – 2021. – Т. 2. – №. 5. – С. 182-192.
9) Sagatov B. U. O’zbekistonda energiya tejamkor binolar qurilishining ahvoli //Science and Education. – 2022. – Т. 3. – №. 1. – С. 261-265.
10) Ашрабов А. А., Сагатов Б. У. О передаче напряжений через трещины железобетонных элементах //Молодой ученый. – 2016. – №. 7-2. – С. 41-45.