UDC 624.012.45

APPLICATION OF ARMATURE FROM CARBON FIBERS DURING RECONSTRUCTION

TAISYA KAZYANINA, YAHOR LAZOUSKI
Polotsk State University, Belarus

The article discusses the main methods of strengthening bending reinforced concrete elements in the cut zone. The use of carbon fiber reinforcement construction. The main advantages and disadvantages of carbon fiber reinforcement.

Every day the issue of reconstruction and technical re-equipment of existing buildings and structures, which have been in operation for a long time, is becoming increasingly important. It is much more profitable to reconstruct existing funds than to rebuild new ones. The recoupment of capital investments in the renovation takes place several times faster, which once again speaks of its advantage in new construction.

Reconstruction of industrial buildings and structures is an integral part of the overall reconstruction of enterprises. Changing the operating conditions and functionality of building structures due to the introduction of new technologies in some cases requires additional measures for them. The installation of additional equipment leads to an increase in loads, a change in their place of application and nature, the introduction of amendments to the design schemes, which may necessitate a preliminary strengthening of the structures of building structures. In the process of reconstruction, the building structures should be brought into compliance with the requirements of the current regulatory documents in the modified operating conditions.

Civil buildings are also subject to reconstruction, among which the share of physically and morally worn-out objects is growing at a faster pace. The need to provide comfortable housing, the development of small and medium businesses require not only increasing the pace of housing construction, but also the reconstruction of old capital residential and public buildings, in some cases with the strengthening and replacement of structures [1].

The reconstruction of buildings and structures is also resorted to due to the need to restore physically worn out individual elements, parts of buildings and structures. Physical wear causes their transition to a state other than the design and leads to the need for reinforcement.

Options for strengthening building structures today, there are quite a lot. However, special attention should be paid to the strengthening of bent reinforced concrete elements in the cut zone, since in addition to combinations of bending moments and longitudinal forces, transverse forces also act here.

The main methods of reinforcement in the cut-off zone are extensions, collars, jackets, installation of additional transverse reinforcement in the form of rods or strips, normal or inclined to the longitudinal axis of the structure. Each of these methods has its own applicability and application requirements. The main task is to ensure the joint work of the old and the new sections. The joint work of build-ups, clips, shirts with concrete structures in the shear zone is provided by the arrangement of cross-links that work in shear across the structure axis in an inclined section. Cross connections are made in the form of transverse reinforcing bars, as well as cuts and dowels on the side faces of the reinforced structure.

The joint operation of the additional transverse reinforcement with the reinforced structure is ensured by: welding to the existing reinforcement; gluing to concrete in the cut zone; fixing the ends in the upper and lower zones using anchor devices. After installation in the design position, additional transverse reinforcement is concreted or coated with anti-corrosion and flame retardants.

When using the installation method of additional transverse reinforcement, the use of reinforcement from composite materials, which are more cost-effective as reinforcement for bending elements, is becoming increasingly popular. Such composite materials have found their application in construction relatively recently - the middle of the XX century. Composite materials are widely used in the aerospace industry, and later in the automotive industry and construction. [2 and others]

At present, reinforcement from composite materials based on carbon, aramid, polyester, basalt and fiberglass is used for reinforcing reinforced concrete structures in construction [3]. These types of materials differ in mechanical characteristics. Aramid and glass fibers respectively have a tensile strength of 3200 ... 3600 and 483 ... 1600 MPa with an elastic modulus of 124 ... 130 and 35 ... 51 MPa. Carbon fibers have a tensile strength from 2200 to 7200 MPa with a modulus of elasticity in the range from 200 to 785 MPa [4].

For the reinforcement of structures, the use of carbon fiber reinforcement is becoming more and more popular.

Figure 1. – Carbon fiber reinforcement

This valve has several advantages such as [5]:
- Tensile strength is up to 5 times higher than the strength characteristics of steel reinforcement class AIII.
- The indicator strength of metal reinforcement - 390 MPa, composite - not less than 2000 MPa.
- The carbon fittings are not subject to corrosion.
- Resistant to acids, to sea water.
- Carbon fittings practically does not conduct heat.
- Radio transparent.
- Magnetoinert. Does not change properties under the influence of electromagnetic fields.
- Does not lose its strength properties when exposed to ultra-low temperatures.
- It is lighter than metal fittings 10 times.
- Durability in the environment of concrete.
- Durability prediction for a period of> 75 years.

Also, such fittings are much lighter, which reduces transport costs and weight of structures.

Table 1. – Physical and mechanical characteristics of carbon fiber reinforcement [5]

The name of indicators	Unit of ISM	Value (depending on diameter)
Diameter of CFRP	mm	4; 6; 8; 10; 12; 14; 16; 18
Tensile Modulus	GPa	not less 140
Destructive tensile stress	GPa	not less 1,6
Carbon Density	t/m^3	1,5

However, it is worth noting the existing disadvantages of carbon fiber reinforcement, such as:
- High cost, compared with traditional steel reinforcement.
- The main technical drawback is fragility, especially shock. Any slightest crack, even invisible to the eye, significantly reduces the strength characteristics.
- A narrow circle of manufacturers.
- Low fire resistance. At 600 ° C begins to soften, which leads to the need to provide protective measures in case of fire.

Another not unimportant problem is the lack of a regulatory framework in our country, which allows manufacturers to widely advertise their products using only their strength advantage.

The use of this type of reinforcement in the reconstruction is primarily due to the simplicity and ease of use, since the external reinforcement elements of carbon fiber are attached to the structure with the help of mounting glue (epoxy, epoxy polyurethane or polycomment), they effectively respond to the increment of structural deformations, and large increments of effort arise in them. It also allows for reconstruction in a short time and with significantly lower labor costs compared to traditional methods. At the same time, although the repair period is reduced several times, the lifetime of the structure also increases several times. The bearing capacity of the structure is not only restored, but also increases several times [6].

Carbon fittings have found wide application in foreign construction practice [7]. Due to a number of positive properties, such as high tensile strength with a sufficiently high modulus of elasticity, corrosion resistance, high fatigue strength, low weight, ease of installation, etc., carbon fiber reinforcement is a good alternative to steel reinforcement both in new construction and to strengthen the structures of a number of existing facilities during reconstruction.

In our country, the use of composite reinforcement has not yet found wide application and is used relatively recently, which indicates the relevance of this topic. However, based on the experience of foreign colleagues, we can

say that this direction is worth promoting. But It is worth noting that in order to expand the possibility of using carbon fiber reinforcement, it is necessary to study it in more detail, in order to expand the possibility of using it. In the course of further work on this topic, it is planned to resolve the following issues: how to ensure the joint operation of the reinforcement elements and the old structure, how to ensure the strength of the contact, prepare a calculation methodology for selecting the number of reinforcing rods from carbon fibers.

REFERENCES

1. Проектирование реконструкции зданий и сооружений : учеб.-метод. комплекс : в 3 ч. – Ч. 2. Оценка состояния и усиление строительных конструкций / Д. Н. Лазовский. – Новополоцк : ПГУ, 2010. – 340 с.
2. Motavalli, M. FRP composites for retrofitting of existing civil structures in Europe: state-of-the-art review / M. Motavalli, C. Czaderski [Electronic resource]. – American Composites Manufacturers Association, 2007. – Mode of access: http://www.acmanet.org/resources/07papers/Motavalli183.pdf. – Date of access: 23.01.2012
3. Лешкевич, О.Н. Перспективы применения композитной арматуры / О.Н. Лешкевич // Проблемы современного бетона и железобетона: материалы III Междунар. симп. (Минск, 9–11 нояб. 2011 г.): в 2 т. / М-во архитектуры и строительства Респ. Беларусь; Научно-исследовательское республиканское унитарное предприятие по строительству «Институт БелНИИС»; редкол.: М.Ф. Марковский [и др.]. – Минск: Минсктиппроект, 2011. – Т. 1 : Бетонные и железобетонные конструкции. – С. 233–238.
4. Армированные пластики – современные конструкционные материалы / Э.С. Зеленский [и др.] // Рос.хим. журнал (Журнал Рос. хим. о-ва им. Д.И. Менделеева). – 2001. – Т. XLV, № 2. – С. 56–74.
5. Информационные материалы фирмы FibARM [Электронный ресурс]. – 2018. – Режим доступа: http://mtsk.mos.ru/Handlers/Files.ashx. – Дата доступа: 08.12.2018.
6. Информационные материалы [Электронный ресурс]. – 2018. – Режим доступа: http://www.hccomposite.com/sectors/125/projects/. – Дата доступа: 10.12.2018.
7. Информационные материалы [Электронный ресурс]. – 2018. – Режим доступа: http://www.alientechnologies.ru/articles/bridge_with_frp/. – Дата доступа: 11.12.2018.