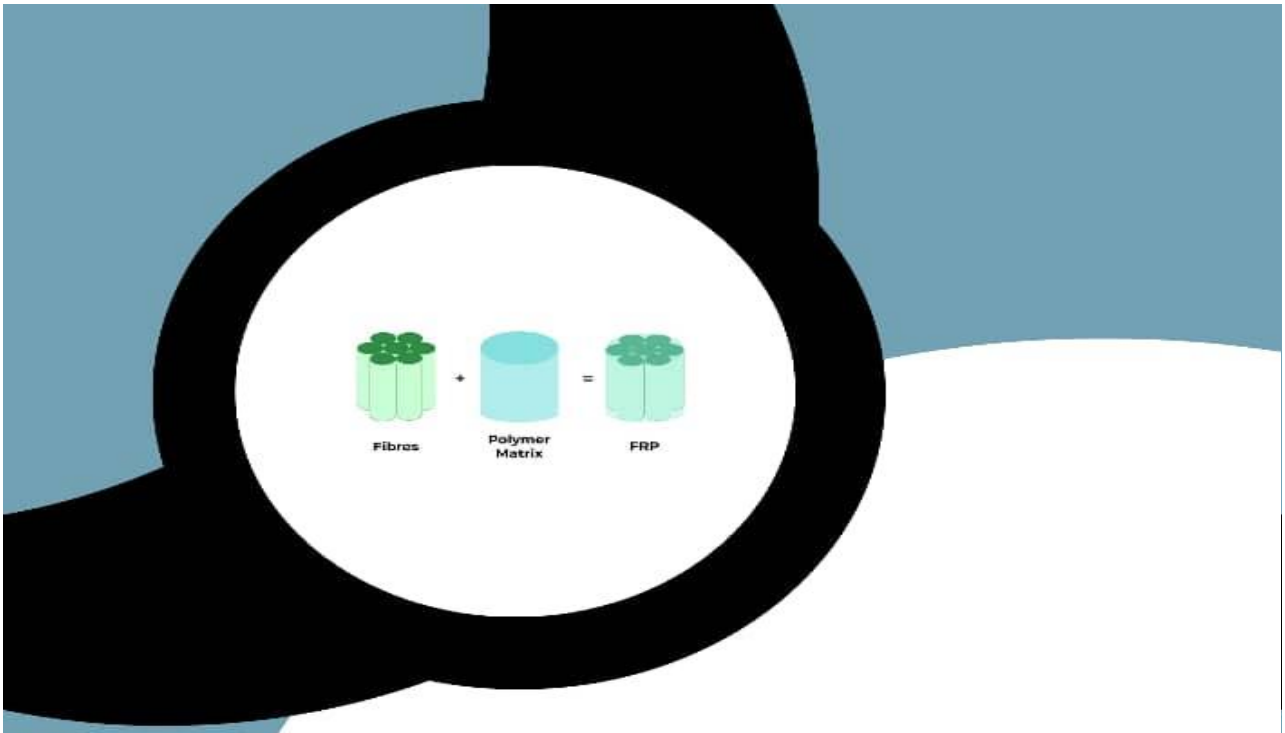
Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Journal of University Studies for Inclusive Research

Vol.8, Issue 16 (2023), 10157- 10174

USRIJ Pvt. Ltd.



FIBER POLYMER AND ITS USE IN THE CONSTRUCTION INDUSTRY

Abed Alhakim Ibrahim Shehadeh Khaleel

Mohammad Amin Youssef Ibrahim Abu shinnar

Qusai zakaria m.abuhadba-abushunnar

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Contents

Research Summary: 3
1) Introduction: 3
2) Research objective: 4
3) research importance: 4
4) Research problem: 4
5) search terms: 4
6) Fiberglass Polymer (FRP) Features: 5
7) Disadvantages of polymer fibers: 7
8) Types of polymer fibers: 7
9) Applications and structural uses of FRP fiber reinforced polymers: 9
10) Reinforcing concrete beams using fiber reinforced polymer: 10167
11) Studies on columns surrounded by carbon-reinforced polymer fibers: 12
12) The future of polymers: 13
13) There are several factors affecting the design of FRP, namely: 14
14) Conclusions: 14
15) the reviewer: 16

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Research Summary:

Concrete structures can be strengthened by using repair, restoration and development, Fiber-reinforced polymers, where the use of these materials has increased in recent years Because of the many advantages of these compounds compared to traditional materials such as steel, Among the most important of these features: high strength-to-weight ratio, high energy absorption and resistance Excellent abrasion and high tensile strength. by taking the following two variables:

1 - The number of layers of carbon fiber.

2 - Rotate the edges of the samples.

The analytical results showed good agreement with the experimental results, and the analytical model showed importance

Rounded cross-section edges and the number of carbon fiber layers increase the bearing capacity of the columns

Concrete, as the rounding of the edges prevented the concentration of stresses and contributed to the increase of the enclosing area.

1) Introduction:

The cracking and fragmentation that occurs in concrete columns is often accompanied by steel submission

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Reinforcement and its inability to bear, recently the most common method to strengthen the structural elements is the use of steel reinforcement and the application of steel shirts on concrete columns, the use of these shirts provided the horizontal encirclement of the concrete and showed clear effectiveness in increasing the bearing capacity of the concrete columns, however, the basic defects The use of steel shirts is that its corrosion resistance is low and its cost is high in addition to its heavy weight.

Fiber Reinforced Polymers (FRP) appeared to be an alternative and effective option, due to its high strength and hardness relative to its weight, and its resistance to corrosion. Therefore, the use of these materials has become the subject and goal of many studies in recent years due to its many advantages.

2) Research objective:

The research aims to introduce polymers, their types, and their structural uses.

3) research importance:

The importance of the research stems from the need to develop construction building materials and the use of materials with low cost and high durability in building and construction.

4) Research problem:

The research problem comes from the research question, which is:

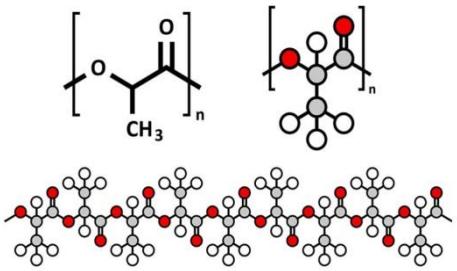
What are polymers and reinforced polymer fibres, and how are they used?

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

5) search terms:

Polymers:

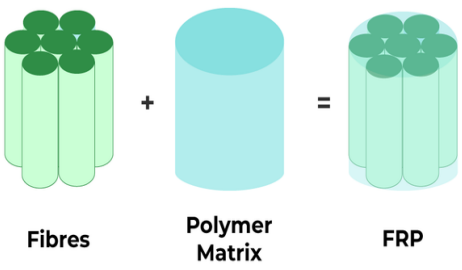
are materials made of long, repeating chains of molecules. These materials have unique properties, depending on the type and how they are bonded.



Fiber Reinforced Polymer (FRP).

4

It is a composite material made of a polymeric network reinforced with fibers, which are usually made of glass, carbon, aramid, or basalt. These fibers are distinguished in their use in construction fields and have distinctive properties with concrete as they produce strong compounds that increase the hardness and resistance of concrete when Adding it to it also enhances its dynamic properties.



Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

6) Fiberglass Polymer (FRP) Features:

1. Light weight:

The density of FRP is about 14-21 kN/m3, which is about 1/6 to 1/4 of that of steel, and it is also lighter than aluminum. When applied to a large span structure, it can greatly reduce the weight of the structure. Take the job theater as an example. The entire carbon fiber roof weighs just 80 tons and can be built by lifting as a whole. Calculated according to the roof diameter of about 47 meters, which is equivalent to an average weight of 46 kg per square meter, which is only equivalent to a 6 mm thick steel plate. Such an amazing weight reduction effect makes it possible for the roof to bear the weight of the surrounding structural glazing, creating a stunning spatial effect.

2. High strength:

The presence of defects in the crystal structure of natural materials. The finer the material, the fewer defects and the higher the strength. The strength of carbon fiber and glass fiber can reach 10-20 times that of steel. Considering the strength difference between the fibers and the matrix, the strength/weight ratio of FRP materials can usually reach more than 4 times that of steel, which makes the end span of FRP structures with large span more than the traditional structure. Larger.

Some researchers have demonstrated the use of CFRP cables to build the 10,000-meter-long Gibraltar Bridge, and its strength can be seen from this.

3. Easy to shape:

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

FRP production process includes various methods such as pultrusion, rolling, hand laying and injection molding. Not only can regular-shaped FRP products be produced on a large scale, but sheets of almost any shape can be produced to create non-linear architectural shapes.

4. Easy to disassemble and assemble.

5. Modulus of elasticity:

The modulus of elasticity of FRP is equivalent to that of concrete and wood. Compared with its high strength, structural design is often controlled by deformation. Deformation can be controlled by reasonable selection of structural shape, combination with other materials, and prestressing.

6. Linear Expansion Coefficient:

Much smaller than steel, aluminum and other metallic materials. On the one hand, it will not cause obvious temperature stress when applied to very tall structures, conducive to structural design; On the one hand, it has a better thermal insulation effect, and an additional insulation layer is no longer needed for the building to save building space.

7. Fire resistance:

The resin will soften at high temperatures and lead to decreased mechanical properties. FRP + surface fire-retardant treatment method can be used to improve the resin's fire-retardant performance. The fireproof effect of well-cured FRP can be equivalent to that of concrete.

6

Economical: The price of FRP material is higher than that of steel. However, due to its light weight, high strength, corrosion resistance, and low maintenance requirements, the overall cost is competitive.

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

7) Disadvantages of polymer fibers:

The negatives can be summarized as follows:

1- The high cost of materials despite the increase in usage in recent years.

2- Low deformation at collapse, which requires good design methods.

3 - Low lateral bearing capacity due to poor mechanical properties, especially For FRP Nof Aramid.

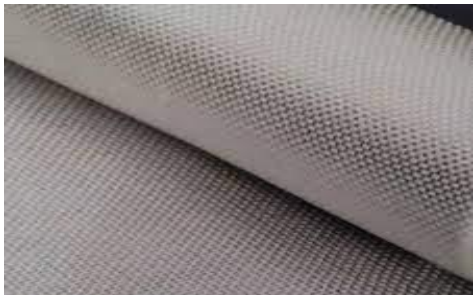
4 - Expansion due to moisture absorption, especially for FRP from Nof Aramid (Aramid FRP).

5 - Rapid and severe loss of bonding, resistance and hardness at high and extreme temperatures

thing in the event of a fire.

8) Types of polymer fibers:

1- Glass Fiber Reinforced Polymers (GFRP):



Glass fiber is mainly made by mixing silica sand, limestone, folic acid and other minor ingredients. The mixture is heated until it melts at about 1260°C.

The molten glass is then allowed to flow through the tiny holes in a platinum plate, forming threads. The glass filaments are cooled and

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

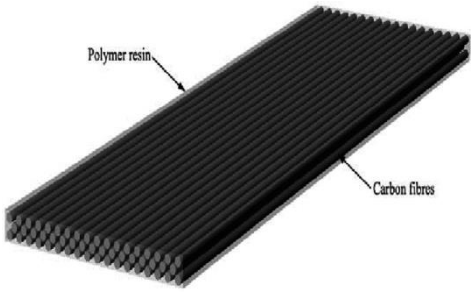
bundled. The fibers are pulled to increase their directional strength. The fibers are then spun into various shapes for use in vehicles.

Properties:

Based on aluminium-borosilicate lime composition, glass fibers are the dominant reinforcement of reinforced polymer composites due to their great electrical insulating properties, low susceptibility to moisture and high mechanical properties.

Glass is generally a good impact resistant fiber but weighs more than carbon or aramid. Fiberglass has excellent properties equal to or better than iron in certain applications.

2- Carbon Fiber Reinforced Polymers (CFRP):

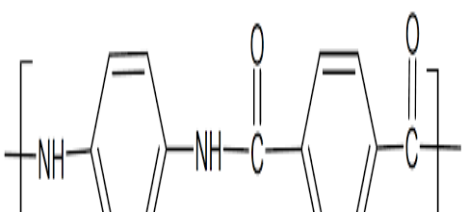


Carbon fiber has a high modulus of elasticity, 200-800 GPa. The final elongation is 0.3 - 2.5% where lower elongation corresponds to higher hardness and vice versa.

Properties:

Carbon fiber does not absorb water and is resistant to many chemical solutions. Carbon fiber has excellent fatigue tolerance, does not wear out, and does not show any creep or relaxation.

3- Aramid Fiber Reinforced Polymers (AFRP):



Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Aramid is the short component for aromatic polyamide. The well known brand of aramid fiber is Kevlar but there are already other brands such as Twaron, Technora and SVM.

The fiber size is 70 - 200 GPa with a final elongation of 1.5 - 5% depending on the quality. Aramid has a high breaking energy and is therefore used for bulletproof helmets and clothing.

Properties:

Aramid fibers are sensitive to high temperatures, humidity, and UV rays and are therefore not widely used in civil engineering applications. Finally, aramid fibers have problems relaxing and corroding under stress.

9) Applications and structural uses of FRP fiber reinforced polymers:

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

- Carbon FRPs are used in prestressed concrete for applications where the high corrosion resistance and electromagnetic transparency of CFRP is required.
- CFRP composites are used in underwater piping and structural parts of offshore platforms. In addition, FRP reduces fire hazards.
- Carbon fiber reinforced polymers are used to manufacture underwater pipes to great depth because they provide a significant increase in buoyancy (due to their lower density) compared to steel.
- They can be used in stairs and hallways to save weight and resist wear.
- They are used in high-performance hybrid architectures.
- FRP bars are used as internal reinforcement of concrete structures to increase durability.
- FRP bars, sheets and strips are used to reinforce various structures that are constructed from concrete, masonry, timber and even metal.
- FRPs are used for seismic rehabilitation and restoration.
- Fiber-reinforced polymers are used in the construction of special structures that require electrical neutrality.
- The high energy absorption capacity of AFRP makes it suitable for the reinforcement of engineering structures subjected to dynamic and impact loads.

10) Reinforcing concrete beams using fiber reinforced polymer:

What does it mean to reinforce concrete beams with fiber reinforced polymer?

Fiber reinforced polymer rods installed close to the surface are used to reinforce the reinforced concrete beam. There are many factors that

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

may reduce the maximum load capacity of concrete structures such as corrosion of steel in aggressive environment, errors in design calculation, and poor mix design. Demolishing and rebuilding dilapidated structures is also uneconomic.

Therefore, it is very important to strengthen and improve peak capacity or restore the strength of degraded structures. There are many methods and techniques that have been used to improve reinforced concrete elements such as externally bonded panels in which steel panels were used and then fiber reinforced polymer layers.

FRP near-surface composite technology is one of several methods used to improve reinforced concrete elements.

Procedures of the Near Surface Fixed Fiber Reinforced Polymer Technology:

1. Cut grooves on the crossbar cover along the tension side.

2. Use the brush and compressed air to remove debris in the grooves.

3. The last epoxy or plaster cement is inserted into the two-thirds ratio of the groove as a binder.

4. The fiber reinforced polymer tape is pushed into the binder materials until it is surrounded by the bonding agent.

5. Finally, the rest of the groove is filled with epoxy putty.

In this process, the steel reinforcement must be prevented from cutting or the element will lose all capacity. Therefore, the covering of the reinforced concrete element must be at least 20 mm thick to be reinforced in this way.

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

11) Studies on columns surrounded by carbon-reinforced polymer fibers:

Several theoretical and experimental studies have been conducted to calculate the bearing capacity of encircled concrete columns

with carbon fibers, and most of the studies considered the effect of encircling the circular columns, noting that

Square or rectangular cross-sections are used more in our practical reality, so the focus has been placed11

In this research to conduct an analytical study on a model of square-shaped and loaded columns

pivotally. To find out the bearing capacity of the columns, there is a need to develop an experimental model that predicts the behavior of the columns

The columns are a result of applying the combined banding resulting from the transverse delivery and the application of the carbon fibers together.

Since in rectangular columns the lateral pressure is generally different in both directions. The behavior of concrete is described by the stress-deformation curves E and H

Linear and flexible curves up to 30% of the maximum resistance of concrete to pressure, and this increases

The curve gradually above this point until (70-90%) of the maximum resistance to pressure.

Immediately after the maximum value, the stress-deformation curve descends, this part of the curve is determined

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

ductility of concrete. After the slope of the curve, refraction occurs at the maximum deformation (10) Ecu The value of maximum deformation decreases with increasing compressive strength of concrete , Deformation value depends on The bearish part is mainly based on experiments used to obtain a curve Stress-deformation. Numerous mathematical models have been presented to characterize a curve Stress-deformation of concrete includes several cases, including the study of the effect of banding with fibers Carbon on unreinforced concrete models as the model provided by Lam & Teng. And it was approved by the American code R.ACI440-08 , a study carried out by other researchers, such as the model presented by kent&park to characterize the stress-deformation curve equation for concrete to find out The effect of accidental delivery and its role in circumcision in case the section is circular and other models in If the section is rectangular, and there is a study conducted by al et Mander that dealt with the role of Encircling methods through the influence of longitudinal and transverse reinforcement together, in case the section is circular or rectangular.

12) The future of polymers:

Researchers are developing and experimenting with different and new types of polymers, with the aim of further drug development and enhancement of everyday products. For example, the use of carbon polymers in the automotive industry is being developed and promoted.

“Carbon fiber reinforced polymer composites – also called carbon fiber laminates – are the next generation materials for making cars that are lighter, more fuel efficient and safer. Carbon sheets are extremely strong and rigid due to their woven layers of pure carbon fibers combined with a rigid plastic composite,” according to a study by two researchers,

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Nikhil Gupta and Steven Zeltman, in the Mechanics of Composite Materials Lab, Department of Mechanical and Aerospace Engineering, NYU Tandon.

Polymer is also used in hologram enhancement. Scientists at the University of Pennsylvania created a hologram on a flexible polymer material that was embedded in gold nanoparticles, according to a study published online in early 2017 in the journal NanoLetters. The new hologram device can take several pictures instead of just one.

Ritesh Aggarwal, a researcher and professor of materials science and engineering at the University of Pennsylvania, asks a question, and says: “Can we encode a lot of information in a 3D image? .” "It's an important piece of work," he adds, "because it's the first time someone has shown you can record multiple 3D images, and with stretch polymers, you can change the whole image.

Factors affecting the design of FRP:

13

13) There are several factors affecting the design of FRP, namely:

- The spacing between the grooves.
- The thickness of the concrete between the fiber-reinforced polymer bars and the steel.
- concrete compressive strength.
- Axial stiffness of fiber reinforced polymer rods.
- Fiber-reinforced polymer rods for the perimeter of the groove.
- The ratio of fiber reinforced polymer to steel reinforcement.
- The effect of the distance between the reinforcing edge and the grooves.
- Types of failures in reinforced concrete beams.

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

14) Conclusions:

In the following research, we reached many conclusions, including:

- The need to use polymer fibers of various types in construction and construction.

- Polymer fibers have several advantages and benefits, including:

. Carbon fiber fabric has a light weight, as its density is not more than ¼ of that of steel.

. The strength of the carbon fiber fabric is so high that 1mm of this fabric is sufficient to replace the reinforcement, without any increase in the weight or cross-section of the supporting element.

. The carbon fiber fabric is very single-curved as it can be applied to elements in any geometric shape and also in a narrow space.

. The application of unidirectional carbon fiber fabric is very easy and does not require huge mechanical devices or complex equipment.

. The applicability of the unidirectional carbon fiber fabric is very high, as it can be applied as reinforcement on concrete, wooden and masonry structures.

- And we find that the polymer fibers have several disadvantages, including:

1- Double long-term temperature resistance:

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Generally, FRP cannot be used for a long time at high temperature. The strength of FRP general-purpose polyester is obviously lower than 50 degrees Celsius, and usually only used below 100 degrees Celsius; The general-purpose epoxy FRP is above 60 degrees Celsius, and the strength is obviously reduced. However, it is possible to choose a high temperature resistant resin so that a long term operating temperature of 200 to 300°C is possible.

2- aging phenomenon:

Aging is a common defect of plastics, and FRP is no exception. It is easy to cause performance deterioration under the influence of ultraviolet rays, sand, rain, snow, chemical and mechanical stress.

3- Low shear strength:

The resin bears the interstellar shear force, so it is very low. The adhesion between the layers can be improved by selecting a process, using a coupling agent, etc., and most importantly, avoiding shearing between the layers during product design.

15

15) the reviewer:

1- C.Ershad "BEHAVIOUR OF FIBRE REINFORCED POLYMER CONFINED REINFORCED CONCRETE COLUMNS UNDER FIRE CONDITION" Kingston, Ontario, Canada,2009.
2- ACI Committee 440. Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures; ACI 440.2R-08 American Concrete Institute: Farmington Hills, MI, USA, 2008.

3- H. E., A Study of Combined Bending and Axial Load in Reinforced Concrete Members, Illinois: University of Illinois Engineering Experiment Station, 1951
4- P. S., "Review of Stress-Strain Relationships for Concrete," ACI Journal Proceddings, vol. 67, no. 3, pp. 243-248, 1970.
5- Lam, L.; Teng, J.G. Design-Oriented Stress-Strain Model for FRP-confined Concrete in Rectangular Columns.J. Reinf. Plast. Compos. 2003, 22, 1149– 1186
6- P. R. Kent DC, "Flexural Members with Confined Concrete," J Struct EngASCE, vol. ST7, no. 97, 1971.
7- Mander, J.B.; Priestley, M.J.N.; Park, R. Seismic design of bridge piers; Research Report No. 84–2; University of Canterbury: Christchurch, New Zealand, 1984.
8- ANSYS. Manuals, 2015.
9- M. W. Hadi, "Axial and flexural performance of square RC columns wrapped with CFRP under eccentric loading," Journal of Composites for Construction , vol. 16, no. 6, pp. 640-649, 2012.
10- https://www.researchgate.net/publication/
11- Choi. H.T.; West, J.S.; Soudki, K.A., 2008, Analysis of the flexural behavior of partially bonded FRP strengthened concrete beams' journal of composites for construction, /July/August. ,P375-286.
12- Taljsten, B., 2003, FRP strengthening of existing concrete structures design guidelines, lulea university printing office: lulea, sweden,.
13- Dussek I.J. , 1974, Strengthening of bridge beams and similar structures by means of epoxy resin bonded external reinforcement, Transport research record, National Research Council, No. 785,1974,pp21-24.
14- https://theconstructor.org/concrete/using-nsm-frp-rcc-beam-strengthening/13238/