The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 09 Pages: 10-16
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856

Publisher: The USA Journals

Journal Website: https://theamericanjournals.com/index.php/tajet

Research Article

STUDY OF BONDING OF LOCALLY PRODUCED REINFORCEMENT WITH MEDIUM-STRENGTH CONCRETES

Submission Date: September 10, 2022, **Accepted Date:** September 20, 2022,
Published Date: September 30, 2022 |
Crossref doi: https://doi.org/10.37547/tajet/Volume04Issue09-03

Yusupov R.R.
Candidate of technical sciences, associate professor, Tashkent Institute of Architecture and Construction, Uzbekistan

Khujaev D.Kh.
Doctoral student, Tashkent Institute of Architecture and Construction, Uzbekistan

Khasanov B.B.
Master student, Tashkent Institute of Architecture and Construction (The Republic of Uzbekistan), Uzbekistan

ABSTRACT

The article presents an analysis of the test results obtained by pulling out a reinforcing bar from a concrete sample. In experiments, the reinforcement diameter and concrete strength were taken as variable factors. The results were used to analyze the indicators of coupling of the reinforcement with concrete, the tension-strain state and the nature of fracture of the test specimens to establish the patterns of their changes. The summarized data are presented in tabular form.

KEYWORDS

Reinforcement, concrete, adhesion, pull-out, strength, collaboration, tension, test, result

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 09 Pages: 10-16
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

INTRODUCTION

As is known, the adhesion of reinforcement to concrete, as the main factor ensuring their reliable joint operation in the composition of reinforced concrete, depends on many factors [1]. Among them, the main ones are the quality (form) of the surface of reinforcing bars and the strength of concrete, due to which contacts are formed between them. The magnitude of the bond strength of the reinforcement with the concrete can vary within a wide range (up to two times or more under strongly equal conditions).

The adhesion of reinforcement to concrete is usually represented as a continuous connection along the contact surface of two materials, as a result of which conditions are created for the realization of their strength and quality characteristics when working together. Determination of quantitative indices of bond strength of reinforcement with concrete is carried out mainly by pulling reinforcement bars from concrete mass or specially made prototypes of cubes or prisms. When stepwise gradual uniform loading of such specimens occurs, there are three stages of the tension-strain state before failure, i.e. before pulling out the reinforcing bar, which is accompanied by certain structural changes at the beginning in the contact zone of the reinforcement with concrete and then in the concrete itself before and after overcoming the forces that ensure its crack resistance (elastic and elastic-plastic stages). At a certain level loaded from the action of tensile tensions in the structure of concrete, micro-cracking processes occur, and then cracking. Sequential stages of cracking in a concrete prism without reinforcement in compression according to the experimental-theoretical studies begin with the formation of cracks in the contacts of the mortar component and coarse aggregate. This moment corresponds to the lower limit of micro-destruction. At higher voltages close to failure, the process of crack development intensifies in the concrete structure, which corresponds to the conditional upper limit of crack formation. [2].

In contrast to the concrete specimen, these processes are somewhat different in the specimen with reinforcement. At the first stages of applying tensile forces to the reinforcement, the resistance of the contact zones between the reinforcement and concrete (elastic-plastic stage) is overcome, therefore, gradual formation of contact cracks occurs in weak areas. The pull-out force exceeds the force that the contact zone can take before the formation of such internal cracks, which together lead to the separation of the reinforcement from the concrete. Of course, this is largely depends on the magnitude of the strength formed in the contact zones, which directly depends on the characteristics of the reinforcement and concrete, the technology of preparation of concrete, composition and properties of its mortar component, as well as the tension state of the element (transfer and distribution of forces between reinforcement and concrete in the process of their joint work).

In the framework of these studies, reinforcement of class AIII (A400) with a diameter of 12.18 and 25 mm and concrete of compressive strength classes S15, S20 and S30 were used as reinforcement. All samples hardened under the same temperature and humidity conditions and were tested at the age of more than 28 days.

The mechanical properties of class AIII (A400) grade 35GS reinforcement used in these experimental studies were determined by testing reinforcing bars by stretching on a hydraulic machine GRM-1 according to GOST 12004 [3]. The results of these tests are shown in Table 1.

Table 1

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 09 Pages: 10-16
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

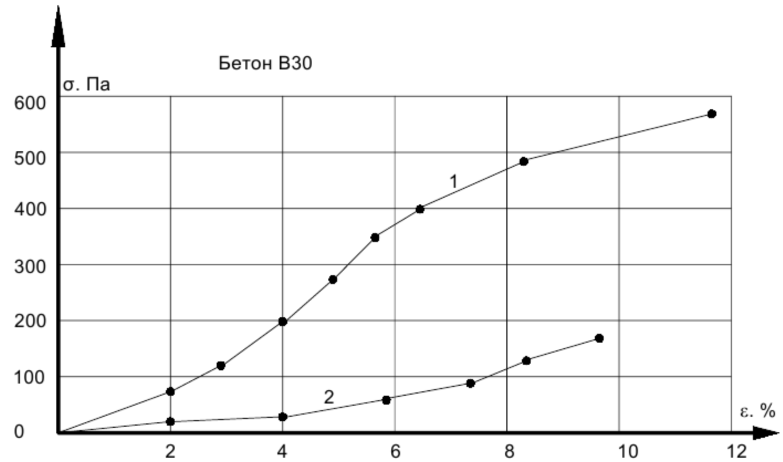
Reinforcing bar diameter, mm	Yield strength, MP	Tensile strength, MP	Relative elongation after rupture, %
12	412,0 420,0 418,0	610,0 642,0 645,0	16,0 16,8 15,4
18	424,0 426,0 431,0	652,0 640,0 646,0	14,6 14,2 14,2
25	432,0 429,0 440,0	660,0 658,0 642,0	18,0 17,6 17,4

The data in this table show that the used reinforcement of class AIII (A400) meets the requirements of the standard in terms of its mechanical properties. [4].

An analysis of the methods of experimental studies made it possible to choose a test scheme that allows obtaining sufficiently reliable information about the adhesion of reinforcement to medium-strength concrete. This is the extrusion of a centrally placed rebar from a concrete sample cube. According to this scheme, a series of samples were tested, differing in the diameter of the reinforcement and the strength of concrete at a constant anchoring length. The length of the anchorage (L=15 cm) was chosen from the condition that the limiting stage - (cohesion failure over the entire surface of the reinforcement with concrete) occurs in the plastic stage of the tested prototype.

At the initial stage of continuous loading, the “tension-strain” dependence has a smooth curve, then it reaches the physical yield strength, then, before pulling out the reinforcement, the tension in it does not reach, in all cases of tests, the tensile strength (to see graph).

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 09 Pages: 10-16
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals



Dependence diagram "σ-ε" when pulling out reinforcement from a concrete sample for:

1 fittings A III (A400) with a diameter of 12 mm;

2nd is the same, with a diameter of 25 mm.

In specimens in which the adhesion strength between reinforcement and concrete is relatively lower, its pulling out is observed in the elastic stage of their joint work. If this indicator is sufficiently high (for stronger concretes and reinforcement with a rigid shape), then the pulling out of the reinforcement occurs in the elastic-plastic stage of the tension-strain state, i.e. the strength of the reinforcement is used to a greater extent. This analysis of the destruction process of samples is purely empirical in nature, in order to fully reveal the physical picture of deformation, it is necessary to establish the dependence of the influence of many factors, including the strength characteristics of the contact zone between reinforcement and concrete. At this stage, one can only limit oneself to a purely empirical approach, based on the experimental data and analysis of the nature of sample destruction.

The mechanism of destruction of the contact zone between reinforcement and concrete can be considered as the result of a temporary process developing in the specified area under the action of gradually increasing mechanical forces. In this case, the uneven distribution of tensions, as the results of experiments show, can lead to a spread in the values of adhesion at the interface, if there are under consolidations and other defects on the contact surface, leading to weakening of bonds.

At the same time, one can only consider the stage-by-stage destruction, formation and growth as a process of successive breaking of bonds between the components of the concrete itself.

According to the results obtained, it can be noted that the destruction of prototypes occurs in two ways: the first - the sample is split into two parts along the surface along the reinforcing bar, the second - the sample is split into three parts, each of which is directed randomly from the location of the reinforcement.

In both cases, by the moment of pulling out the reinforcement, it corresponds to its complete separation from concrete after breaking the contact bonds between these two materials. These bonds provide the adhesion strength of the reinforcement to the concrete, and the second variant of destruction is most characteristic of concretes of sufficiently high strength, since. They have a relatively high axial tensile strength and hence an increased ultimate elongation. According to the experimental data, in all cases, the adhesion of reinforcement to concrete of class

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 09 Pages: 10-16
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

V 30 is greater than for other concretes of a smaller class. Reinforcement with a diameter of 12 mm has a higher adhesion strength of reinforcement to concrete, which gives reason to conclude that in order to implement the strength properties of reinforcement of class A III (A400) and better adhesion to concrete when designing reinforced concrete bending elements, the diameter of tensioned rods should be limited. This is confirmed by the results of experiments, according to which the adhesion of reinforcement with a diameter of 12 mm on 30-40% more, other things being equal, with a similar characteristic of reinforcement with a diameter of 25 mm.

The cracks formed on the side surfaces as a result of the splitting of the concrete sample are the main ones and are located parallel to the tensile forces applied to the reinforcement.

In this case, the following important conclusions should be borne in mind when designing reinforced concrete structures:

-the bond between the reinforcement and the concrete means the continuous connection on the contact surface between the reinforcement and the concrete, which ensures their joint work;

- the type and quality of the surface of the reinforcing bar has the most influence on the adhesion of the reinforcement to concrete;

- the connection of reinforcement with concrete increases the extensibility of concrete and can provide smooth placement of microcracks on the contacts and restrain their development;

- The effect of concrete strength on the movement of the reinforcing bar during its curing is non-linear. Increasing the concrete compressive strength class above V20 does not significantly affect the joint operation of reinforcement and concrete. At lower concrete strengths (less than B20), the deformations of the reinforcing bars will increase non-linearly. With a constant anchorage length of not more than 6d

(d is the diameter of the reinforcing bar) samples of all classes of concrete collapsed due to the achievement of plastic deformations in the reinforcement. According to the method [5], the calculated value of the ultimate adhesion tension for rods of a periodic profile is determined by the formula:

$$f_{bd} = 2.25 \cdot \eta_1 \cdot \eta_2 \cdot f_{ctd} \qquad (1)$$

where f_{ctd}- the calculated value of the tensile strength of concrete according to [5];

$\eta_1 -$ coefficient, which takes into account the quality of bonding conditions and the position of the bars during concreting;

$\eta_1 = 1{,}0 -$ if good conditions for adhesion are provided;

$\eta_1 = 0{,}7 -$ for all other cases.

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 09 Pages: 10-16
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

η_2 – coefficient taking into account the diameter of the rod.

$\eta_2 = 1{,}0 - \text{for } d \leq 32mm$

The behavior of reinforcing steel is largely determined by the characteristics of the surface of the rods of a periodic profile and is evaluated by the strength of adhesion to concrete. Coupling tensions according to CEB/RILEM recommendations can be determined by the following expressions:

$$\tau_m = 0{,}098(80 - 1{,}2d) \quad (2)$$

$$\tau_r = 0{,}098(130 - 1{,}9d) \quad (3)$$

where d is the nominal diameter of the rod, mm;

τ_m- average tension value MPa, with slippage 0.01; 0.1 and 1mm;

τ_r- the average value of the adhesion tension at decoupling.

Formulas (2) and (3) do not take into account the strength of the concrete that surrounds the reinforcing bar, which leads to a distortion of the adhesion strength in its design determination.

The calculation according to the above methods, in your opinion, can lead to some imperfection. Therefore, the determination of the adhesion strength of reinforcement to concrete should be used a differentiated approach and proceed from its standard values, which are given in the table for reinforcement manufactured by Uzmetkombinat OJSC, according to the data of these studies. These data are generalized and are given depending on the diameter of the bar reinforcement and the class of concrete in terms of compressive strength. (Table 2)

Adhesion strength of reinforcement to concrete, MP **Table 2**

№	Grade of strength	Diameter (mm) of fittings				
		10	12	18	25	40
1	B15	8,0	7,0	6,0	5,0	3,0
2	B20	8,5	8,0	6,5	5,5	3,5
3	B22,5	9,0	8,5	7,0	5,75	3,75
4	B25	9,9	9,0	7,7	6,0	4,0

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 09 Pages: 10-16
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

5	**B30**	11,0	10,5	8,0	7,0	4,5

Note. Intermediate values are determined by linear interpolation.

CONCLUSIONS

It has been established that the patterns of change in the adhesion strength of the reinforcement of a periodic profile with medium-strength concrete are a rather complex and time-consuming task. This is due, firstly, to the lack of a standard test procedure for determining the adhesion strength of reinforcement to concrete. Secondly, different characteristics of the surface of reinforcing bars produced by different manufacturers. It has been established that the choice of a test scheme based on pulling out a reinforcing bar from a concrete sample made it possible to obtain reliable experimental data, confirmed by the materials of this article. The values of the adhesion strength of the reinforcement of a periodic profile with concrete of medium strength before the accumulation of the database can be established by the experimental material of this work.

REFERENCES

1. Baykov V.N., Sigalov E.E. Reinforced concrete structures. M., 1985, p.727.
2. Zaisev Yu.V. Prefabricated building structures. M., “Высшая школа” (“Vysshaya shkola”) 1987, p.260.
3. GOST 12004-81. Reinforcing steel. Tensile test methods.
4. T.c. 48.3-004:2003. Reinforcing steel for reinforced concrete structures. Changes №1 from August 26, 2008 y.
5. ТКП EN 1992-1-1-2009(02250). Eurocode 2. Design of reinforced concrete structures. Part 1-1. General rules and regulations for buildings. Ministry of Architecture and Construction of the Republic of Belarus. Minsk 2010, p.191.