The American Journal of Engineering and Technology
(ISSN – 2689-0984)
Published: June 21, 2021 | **Pages:** 55-58
Doi: https://doi.org/10.37547/tajet/Volume03Issue06-10

IMPACT FACTOR
2021: 5. 705
OCLC - 1121105677

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

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Calculation Of The Cracking Forces Of Eccentrically Compressed Reinforced Concrete Elements Made Of Agglоporite Concrete In A Dry Hot Climate

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ABSTRACT

The article presents the results of experimental studies on the calculation of the fracture toughness of compressed reinforced concrete elements made of aggloporite, operated in a dry hot climate. Calculation formulas are indicated for determining the crack resistance of compressed reinforced concrete elements operated in areas with a dry hot climate.

KEYWORDS

Reinforced concrete, crack resistance, deformation, stress, moment of cracking, deflection, aggloporite concrete.

INTRODUCTION

In the course of the development of the theory of reinforced concrete, many methods have been developed for calculating the forces of cracking in normal sections. Many of these methods are very cumbersome, since attempts are made in them to take into account all the variety of factors, which, first of all, include the properties of materials, section shapes, eccentricity and nature of load application, etc. At the same time, even "exact" methods in a number of cases give a perceptible error. One of the reasons for such results should be considered some uncertainty of the concept of "formation" of cracks [1]. For engineering practice, simplified calculation methods are of greatest interest, the main of which should be considered the method of core moments, adopted in the norms, as the most universal and sufficiently clear in its physical essence.

THE MAIN FINDINGS AND RESULTS

This method, like many other calculation methods that refine and supplement it, is based on a fixed stress plot; it is a rectangle in a tension zone with stresses of $R_{bt,ser}$ and a triangle in a compression zone. The angle at the vertex of the triangular diagram of compressive stresses is taken such that when the inclined straight line continues from the compressed zone to the stretched one, a segment equal to $2 \cdot R_{bt,\ ser}$ is cut off at the extreme fiber. Any calculation method that assumes a diagram of the stress distribution over the cross-section of a reinforced concrete element that is fixed in shape, as Professor V.I.Murashev noted, cannot claim universality. At the same time, calculation methods based on the adopted plot can, in a number of cases, give acceptable results. The method adopted in the design standards for calculating the crack resistance of reinforced concrete structures by the core moments is approximate. Based on the calculated stress diagram in concrete proposed by V.I.Murashev, this method was improved and extended to eccentrically compressed and eccentrically tensioned elements with conventional and pre-stressed reinforcement by A.A. Gvozdev. In accordance with the normative methodology, the moment of cracking of bending, eccentrically compressed and eccentrically tensioned elements is determined by the formula:

$$M_{crc} = R_{bt.ser}\, W_{pl} + M_{rp} \qquad (1)$$

The main assumption of this method is that the effect of the longitudinal force on the change in the magnitude of the compressed zone and on the position of the resultant of the compressive stresses is not taken into account, i.e. elastic-plastic moment of resistance.

To determine the fracture toughness of eccentrically compressed reinforced concrete elements, a series of columns of B20 class

aggloporite concrete with dimensions of 160x300x1000 mm were made. Column samples were made in August, when daily temperature fluctuations reached 15°C. For 18 months they were stored under the following conditions: under solar radiation, in the shade under a canopy, in a workshop under constant conditions and under normal conditions. The columns stored under solar radiation were oriented to the south by the extended zone, the compressed zone and the lateral side.

The experimental values of the longitudinal compressive force, at which the cracks were formed, were determined visually using an MBP-2 microscope with a 24-fold magnification. The moment of cracking is determined by the first accelerated increase in tensile strain measured by strain gauges on the stretched face. The lowest fracture toughness is noted in columns stored under solar radiation and oriented by the extended zone to the south. In the columns oriented by the compressed zone and the lateral side to the south, fracture toughness was practically the same, but 8-12% higher than in the columns oriented to the south, by the extended zone. The highest fracture toughness is observed in columns stored under normal conditions. The fracture toughness of columns exposed to solar radiation with an extended edge to the south is, respectively, 27 and 37% less than the fracture toughness of columns stored under normal conditions. For all experimental columns with a relative eccentricity of $e_o/h_o >$ 0,5, the moments of cracking were determined according to the method of norms. Comparison of the experimental moments of cracking with the theoretical ones calculated by formula (1) showed their significant discrepancy.

With an increase in the relative eccentricity, the application of the external force of the divergence of the experimental and theoretical moments of crack formation decreased, since the influence of the longitudinal force, which was not taken into account in the calculation, decreased. The forces of cracking of eccentrically compressed reinforced concrete elements can be determined by solving two equations of statics drawn up in the proposal for design stress diagrams at the time of cracking, proposed by V.I. Murashev. In this case, the effect of the longitudinal force on the position of the central line and the elastoplastic moment of resistance is explicitly taken into account.

Two ways of solving this problem have been outlined. The first way is appropriate for reinforced concrete columns with large eccentricities of the external force, i.e. in cases where the stresses on the tensile face reach the ultimate tensile strength before the depletion of the bearing capacity of the columns. The static equations are as follows:

$$N_{crc}+\gamma_{bt}\cdot R_{bt}\cdot b(h_o+a-x_{crc})+A_s(\sigma_s+2\alpha\gamma_{tt}R_{bt})+A_s(\sigma_s-2\alpha\gamma_{tt}R_{bt}\frac{x_{скс}-a}{ho+a-x_{crc}})-\frac{\gamma_{tt}R_{bt}bx_{crc}}{h_0+a-x_{crc}}=0 \quad (2)$$

$$N_{crc}\cdot(e_{crc}-h_o+x_{crc})=\gamma_{tt}\cdot R_{bt}\cdot\frac{b(h_0+a-x_{crc})^2}{2}+A_s\cdot(\sigma_s+2\alpha\gamma_{tt}R_{bt})\cdot(h_o-x_{crc})-A_s\cdot(\sigma_s-2\cdot\alpha\cdot\gamma_{tt}\cdot R_{bt}\cdot\frac{x_{crc}-a}{ho+a-x_{скс}})\cdot(x_{crc}-a)+\frac{2}{3}\cdot\frac{\gamma_{tt}R_{bt}bx_{crc}^2}{h_0+a-x_{crc}} \quad (3)$$

where: $e_{crc}=e_o+0{,}5(h_o+a')+f_{crc}$

γ_{tt} - coefficient of concrete working conditions, taking into account the effect of a dry hot climate on the tensile strength of concrete. The above equations are solved relative to N_{crc} and x_{crc}. It should be noted that the determination of the cracking forces of short elements can be made from equations (2) and (3). The use of this technique when calculating columns with relatively small eccentricities of the external force in some cases does not allow solving the problem, since stresses on a tensile face may not reach the ultimate tensile strength. In these cases, it is advisable to use another way of solving the problem, which is as follows. At each increasing step of loading, the stresses on the stretched face $б_{bt}$ and x_{crc} are determined from the equilibrium equations:

$$N_к+\sigma_{bt}b(h_o+a-x_{crc})+A_s(\sigma_S+2\alpha\sigma_{bt})+A_s(\sigma_S-2\alpha\sigma_{bt}\frac{x_{crc}-a}{ho+a-x_{crc}})-\frac{\sigma_{bt}bx_{crc}^2}{h_0+a-x_{crc}}=0 \quad (4)$$

$$N_k(e_k-h_o+x_{crc})=\sigma_{bt}\frac{b(h_0+a-x_{crc})^2}{2}+A_s(\sigma_S+2\alpha\sigma_{bt})(h_o-x_{crc})-A_s(\sigma_S-2\alpha\sigma_{bt}\frac{x_{crc}-a}{ho+a-x_{crc}})(x_{crc}-a')+\frac{\sigma_{bt}bx^2{}_{crc}}{h_0+a-x_{crc}}\cdot\frac{2}{3}x_{crc} \quad (5)$$

The obtained values σ_{bt} at each stage of loading are compared with the ultimate tensile strength R_{bt}. The calculation ends either at N_u, which reaches the limit of the bearing capacity of the columns, or at $\sigma_{bt}=\gamma_{tt}\cdot R_{bt}$. In addition, the following simplified method for determining the cracking forces is proposed. The limiting deformations of the extreme tensioned concrete fiber $\varepsilon_{b,u}$, and the deformations of the extreme compressed concrete fiber are recorded, which are realized by the time cracks appear $\varepsilon_{b,crc}$. Plot of stresses in concrete at the moment of cracking: a rectangle in a tensioned zone and a triangle in a compressed zone. In this case, the angle at the vertex of the triangular diagram is not specified. The equilibrium equation is as follows:

$$N_{crc}+\gamma_{bt}R_{bt}b(h-x_{crc})+A_s[\sigma_s+\varepsilon_{b,crc}(\frac{h_0}{x_{crc}}-1)E_s]+A'_s[\sigma'_s+\varepsilon_{b,crc}(1-\frac{'a'}{x_{crc}})E_s]-\frac{\sigma_b b x_{crc}}{2}=0 \quad (6)$$

where $x_{crc}=h\frac{\varepsilon_{bcrc}}{\varepsilon_{bcrc}+\varepsilon_{btu}}$

The stress in the concrete of the extreme compressed fiber σ_b at the time of the appearance of cracks can be determined from the deformation $\varepsilon_{b,crc}$ using any relationship: binding stress and deformation of concrete. It is most convenient to use the formula EKB-FIP with adjustments that take into account the plastic properties of concrete, proposed by S.A. Kholmirzaev [2].

CONCLUSION

Calculation of experimental reinforced concrete columns using dependence (6) provides a good convergence of experimental and theoretical cracking forces. To evaluate the obtained experimental values of the column cracking forces, the theoretical cracking forces were calculated by the method of sound moments.

$N(e_o\text{-}z)=R_{bt\,ser}W_{pl}$ (7)

This formula gives satisfactory results for structures operating in stable temperature and humidity conditions.

REFERENCES

1. КМК 2.03.04.-98 Concrete and reinforced concrete structures designed for operation in conditions of high and high temperatures by the State Committee for Architecture and Construction of the Republic of Uzbekistan. – Tashkent. 1998.
2. Razzakov S.Zh. Kholmirzaev S.A., Bakhtiyor Maksud ugli. (2015) Calculation of the cracking forces of compressed reinforced concrete elements in a dry hot climate International *journal* ISSN 2410-700X “Symbol of Science”. Russia. – Ufa. Number 3. - pp. 57-60. (Раззаков С.Ж. Холмирзаев С.А., Бахтиёр Максуд угли Расчет усилий трещинообразования сжатых железобетонных элементов в условиях сухого жаркого климата Международный журнал ISSN 2410-700X «Символ науки».Россия, г. Уфа. -2015. №3. – стр. 57-60.)
3. Kholmirzaev S.A. (2001) Temperature change in expanded clay concrete columns in a dry hot climate. *Scientific, technical and production journal* “Concrete and Reinforced Concrete” (No. 2. – pp. 7-9) Moscow-2001. (Холмирзаев С.А. Температурные изменение в керамзитобетонных колоннах в условиях сухого жаркого климата. Научно-технический и производственный журнал «Бетон и железобетон» (№2 2001г. стр. 7-9) Москва-2001г.)
4. S.A. Kholmirzaev N.Kh. Komilova. (2015) Influence of dry hot climate on the width of crack opening of compressed reinforced concrete elements. *International journal “Privolzhsky scientific bulletin”* Russia. – Izhevsk. No. 4. (С.А. Холмирзаев Н.Х. Комилова Влияние сухого жаркого климатана ширину раскрытия трещин сжатых железобетонных элементов

Published: June 21, 2021 | Pages: 55-58
Doi: https://doi.org/10.37547/tajet/Volume03Issue06-10

Международный журнал «Приволжский научный вестник» Россия, г. Ижевск -2015. №4.)