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ЗБІРНИК ТЕЗ ДОПОВІДЕЙ

XX МІЖНАРОДНОЇ КОНФЕРЕНЦІЇ НАУКОВО-ПЕДАГОГІЧНИХ ПРАЦІВНИКІВ, НАУКОВИХ СПІВРОБІТНИКІВ ТА АСПІРАНТІВ «ПРОБЛЕМИ ТА ПЕРСПЕКТИВИ РОЗВИТКУ ТЕХНІЧНИХ ТА БІОЕНЕРГЕТИЧНИХ СИСТЕМ ПРИРОДОКОРИСТУВАННЯ: КОНСТРУЮВАННЯ ТА ДИЗАЙН»

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DETERMINATION OF DEFORMATIONS IN THE JOINT BETWEEN DIFFERENT CONCRETE IN STRENGTHENED REINFORCED CONCRETE STRUCTURES

I.A.Yakovenko, Doc. of.Eng. Sc., Ass. Prof.,
I.V. Grishenko, student

National University of Life and Environmental Sciences of Ukraine

The disclosure of the static uncertainty of the system, which consists of several reinforced concrete rods connected by a longitudinal seams, is carried out by fhe method of structural mechanics. In this case, as the main system, a composite rod is chosen without displacement bonds [1], the action of which is replaced by unknown fhnctions $\tau(z)$.

In accordance with the A.R. Rzhanitsin's work [1]:

$$r' = \frac{T''}{\xi_\Delta}, \qquad (1)$$

where ξ_Δ is the coefficient of the seam rigidity. Then the difference between the relative longitudinal deformations in the joint will be as follows:

$$r' = \frac{T'}{\xi_m}. \qquad (2)$$

In this case, the order of the differential equations [1] can be reduced. Taking into account the foregoing, we obtain:

$$\frac{T'}{\xi_m} = \gamma T + \Delta, \quad \text{then} \quad T = \int_0^z \tau_q(z) \cdot dz. \qquad (3)$$

Subject to the presence of cracks, -

$$\Delta = -\frac{N_{0,1}}{(E_{c,1}A_{c,1})_{ekv}} + \frac{N_{0,2}}{(E_{c,2}A_{c,2})_{ekv}} - \frac{f(x_r)}{\rho}, \qquad (4)$$

$$\lambda = \sqrt{\xi\gamma} = \sqrt{\xi\left[\frac{1}{(E_{c,1}A_{c,1})_{ekv}} + \frac{1}{(E_{c,2}A_{c,2})_{ekv}} + \frac{f^2(x_r)}{M \cdot \rho}\right]}. \qquad (5)$$

In the expressions (3) – (4) it is marked: – M_0 is the total bending moment, it equals the sum of moments in the corresponding cross-section of each composite rods of the main system; $N_{0,1}$ is longitudinal force from external load in the first reinforced concrete rod; $N_{0,2}$ is the same, in the second reinforced concrete rod; $I_{c,1}$, $I_{c,2}$ and $A_{c,1}$, $A_{c,2}$ are the moments of inertia and cross-sectional area of individual reinforced concrete rods; $E_{c,1}$; $E_{c,2}$ are the initial modules of concrete of individual rods; $\varphi_{c,1}$ and $\varphi_{c,2}$ in the first approximation are accepted 0,85; $y_{c,1}$; $y_{c,2}$ are the distances from the geometric longitudinal axes of the corresponding rods to the adjoining seam; $(E_{c,1}A_{c,1})_{ekv}$, $(E_{c,2}A_{c,2})_{ekv}$ are equivalent to the rigidity of individual reinforced concrete rods; $f(x_{fact,m})$ is accepted equal $(x_{fact,m} - 0{,}5h_{f,2})$ in the case of the location of the neutral axis of the composite rod within the first of the formed rods or taken as equal $(2x_{fact,m} - 1{,}5h_{f,2})$ in the case of the location of the neutral axis of the folded rod within the second of the composite rods, where $x_{fact,m}$ is the average actual height of the compressed zone of concrete in the block between the cracks is averaged; ρ is the radius of curvature for a reinforced concrete rod, found in accordance with the offers of works [2, 3]; ξ is the rigidity of the seam, which is determined on the basis of experimental studies of composed prisms, including reinforced [1].

The normal forces in the composite rods are divided into longitudinal relative deformations, calculated with respect to the selected longitudinal axis in determining the equivalent rigidity:

$$(E_{c,i}A_{c,i})_{ekv} = \frac{N_i}{\varepsilon_0}; \tag{6}$$

where

$$\varepsilon_0 = B_{12}M_i + B_{22}N_i, \tag{7}$$

$$B_{12} = \frac{1}{(z_s + z_c)^2}\left[\frac{\psi_s z_c}{E_s A_s} - \frac{\psi_c z_s}{(\varphi_f + \xi) b d E_c \tilde{v}}\right]; \tag{8}$$

$$B_{22} = \frac{1}{(z_s + z_c)^2}\left[\frac{\psi_c z_s^2}{(\varphi_f + \xi) b d E_c \tilde{v}} + \frac{\psi_s z_c^2}{E_s A_s}\right]. \tag{9}$$

The axis y is located within the working height of the cross-section (fig. 1). If it is located above the center of gravity of the cross-sectional area of the compressed zone, then the value of z_s should be taken as negative.

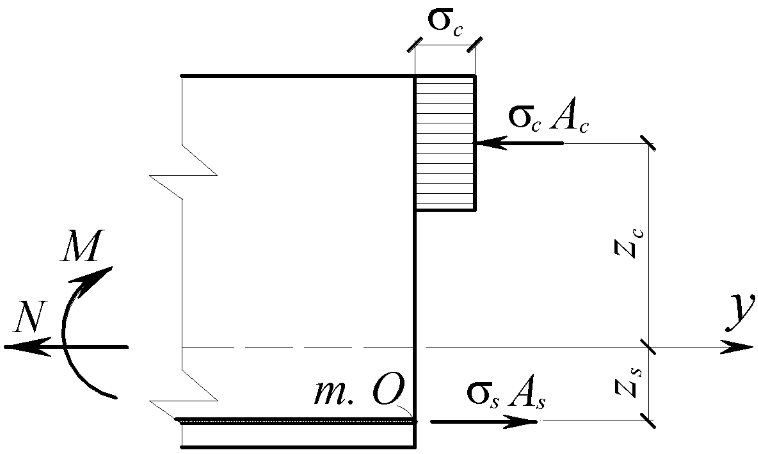

Fig. 1. The calculation scheme in the normal section for each of the formed rods

If the axis coincides with the averaged neutral axis of the reinforced concrete element, then in formula (7) (for the composite rod in which this neutral axis passes) the first term is assumed to be zero.

Performing the corresponding algebraic transformations, the solution of equation (3) will have the form:

$$T = \pm\xi_m e^{\gamma\xi_m z} \int \frac{\Delta(z)}{e^{\gamma\xi_m z}} d(z) \pm C e^{\gamma\xi_m z}. \tag{10}$$

Taking into account the expression (5), we have:

$$\tau = T' = \xi_m^2 \gamma e^{\gamma \xi_m z} \int \frac{\Delta(z)}{e^{\gamma \xi_m z}} d(z) + \xi_m e^{\gamma \xi_m z} \frac{\Delta(z)}{e^{\gamma \xi_m z}} + C_\tau . \qquad (11)$$

The definition of constant integration and the corresponding boundary conditions depend on the backing and loading conditions of the composite rods.

Conclusion

Thus, the working condition of the concentrated pliability of the seam is formulated based on the analysis of accumulated experimental data on the resistance of the composite reinforced concrete structures. It provides an opportunity to get a complete picture of the stress-strain state in a composite reinforced concrete rod with incompatible laminated deformations in the seam area in the presence of cracks. The proposed algebraic dependences allow us to simplify the differential equations obtained in [1] without reducing the accuracy and rigor of their solution.

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