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STABILITY OF MODERN ARCHES

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Abstract
In modern architecture, arches have historically been one of the most important elements of architecture, but their constructive and aesthetic significance remains relevant today. Through innovations and innovations, new forms and materials for arches are being developed. This article discusses the role of modern arches, their constructive features, functional purposes and aesthetic values.

Keywords: Modern arches, architecture, constructive features, aesthetics, innovation, materials, history of architecture.

Introduction

The work of radically reforming the education system in our country, raising it to the level of modern requirements, and raising a well-rounded generation for the future has become a priority direction of state policy. The main goal of the reforms being carried out in Uzbekistan is to form a healthy and well-rounded, educated, and highly moral generation in our country.

Currently, flexible arches are widely used in the construction of buildings and structures. In some elements of structures and mechanisms, the axes passing through the center of curvature are curved. An example of this is arches. All rods encountered in practice are not straight, but have some degree of curvature; they are called parabolic flexible arches Figure 1. [1, 2, 3, 4, 5, 6, 7].

Arches have historically been used as a key element of architecture in various civilizations since ancient times. They were very common in ancient Roman, Greek, and Islamic architecture. Today, arches are used in modern architecture not only as a technical solution, but also as elements with aesthetic and spiritual value.

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Figure 1. Historical monument

Arches are used to carry loads of a specific height or a large volume. They are mainly found in tunnels, bridges, office buildings and freight yards. Structurally, arches can be long, strong and integrated with auxiliary elements. Arches can be one of the main elements used in accordance with modern ecological principles. These elements are designed using the latest materials and processing technologies. This, in turn, reduces the impact on the environment [8, 9, 10, 11, 12].Modern arches are mainly used in urban construction, bridges, tunnels, museums and new buildings. Also, their functional purpose is determined precisely by their constructive properties Figure 2.

Figure2. Modern bridge

The modern arch is not only an engineering but also an architectural element. Therefore, in determining the superiority of parabolic flexible arches, the element equilibrium of flexible parabolic arches loaded with a uniformly distributed load is examined and the following expression is obtained:

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$$\frac{dQ}{dy}+N\left(R_y+\frac{d^2\omega}{dy^2}\right)+q=0 \qquad (1)$$

Here: Q-shear force, N- longitudinal force, R_u - radius of curvature, ω- displacement of the cross section of the arch in the direction of the center. From differential connections

$$Q=-\frac{dM}{d\acute{o}}; \qquad M=EJ-\frac{d^2\omega}{d\acute{o}^2} \qquad (2)$$

using this, we find the differential equation of the superiority of flexible arches with a constant parabolic cross section.

$$\text{EJ}\ \frac{d^4\omega}{d\acute{o}^4}+N\left(\frac{d^2\omega}{d\acute{o}^2}+k\acute{o}\right)=\text{q} \qquad (3)$$

Here: EJ- the stiffness of the arch material.

We solve the resulting differential equation using the Bubnov-Galerkin method (3,4). Assuming that the arch is hinged on both sides, the boundary conditions are as follows.

$$\left.\begin{matrix}\acute{o}=0 & \ddot{a}\grave{a} & Z=0\\ \acute{o}=\ell & \ddot{a}\grave{a} & Z=f_0\end{matrix}\right\} \qquad (4)$$

These conditions are given by the general form of the arc bending axis beam functions (2)

$$\omega=B, \qquad \text{Z}_{\acute{o}}=f_0\left(\frac{\acute{o}}{\ell}\right)^n \qquad (5)$$

can be expressed by equations.For the problems under consideration, we formulate the Bubnov-Galerkin equation.

$$\int_0^{\ell}\left\{EJ\frac{d^4\omega}{d\acute{o}^2}+N\left[f_0n(n-1)\ell^{-n}\acute{o}^{n-2}+\frac{d^2\omega}{d\acute{o}^2}\right]-q\right\}Z_{\acute{o}}d\acute{o}=0 \qquad (6)$$

Considering the last expression (5) and then integrating, we get

$$q=\frac{24EJB}{\ell^4}+\frac{5N}{2\ell^2}\left[\frac{f_0n(n+4)}{(n+1)(n+3)}-\frac{136B}{35}\right] \qquad (7)$$

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The longitudinal force N (3) is determined from the following conditions:

$$\left.\begin{aligned} &-\int \frac{dv}{dó}dó \ = 0 \\ &\varepsilon_{ó} = \frac{dv}{dó} - \frac{\omega}{\rho} + \frac{1}{2}\left(\frac{d\omega}{dó}\right)^2 \\ &\varepsilon_{ó} = \frac{N}{\mathrm{E}F} = -\frac{Ð}{\mathrm{E}F} \end{aligned}\right\} \qquad (8)$$

As a result $$N = \frac{8EAB}{\ell^2}\left[\frac{f_0 n(n+4)}{(n+1)(n+3)} - \frac{68B}{35}\right] \qquad (9)$$

We obtain .Substituting the found longitudinal force expression into the uniform distributed force formula (7) according to (9),

$$q^* = \frac{q\ell}{EA}; \qquad \alpha = \frac{h}{\ell}; \qquad \xi = \frac{B}{\ell}; \qquad \beta = \frac{f_0}{\ell}; \qquad (10)$$

We introduce dimensionless quantities and form

$$q* = C_1\xi^3 - C_2\xi^2 + C_3\xi \qquad (11)$$

here $$\left.\begin{aligned} &C_1 = \frac{36992}{245}; \qquad \tilde{N}_2 = \frac{816n(n+4)}{(n+1)(n+3)}\beta \\ &C_3 = 2\alpha + \frac{10n^2(n+4)^2}{(n+1)^2(n+3)^2}\beta^2 \end{aligned}\right\} \qquad (12)$$

If we differentiate the uniformly distributed dimensionless quantity with respect to the stiffness of the central section of the arch and set the resulting expression to zero, we can find the formulas for the critical forces and the expressions for the stiffnesses corresponding to the critical forces.

$$q_{1,2}^* = \frac{2}{27C_1^2}\left[C_2\left(\frac{9}{2}C_3C_1 - C_2^2\right) \pm \left(C_2^2 - 3C_3C_1\right)^{3/2}\right] \qquad (13)$$

$$\xi_{1,2}^* = \frac{C_2}{3C_1} \mp \sqrt{\frac{C_2^2}{9C_1^2} - \frac{C_3}{3C_1}} \qquad (14)$$

The conclusions obtained are consistent with the results obtained for similar constructs in the scientific literature.

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Conclusion

Modern arches offer new opportunities and cutting-edge solutions in architecture. They allow, in addition to traditional forms and materials, to create new heights through the use of innovative materials and construction methods. In addition, modern arches make a significant contribution to architecture with their aesthetic value and functional properties.

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