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Анализ прогиба регулярной фермы
с крестообразной решеткой

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Analysis of the deflection of the regular
truss with cross type lattice

Методом индукции с применением системы компьютерной математики Maple получена формула для прогиба плоской статически определимой фермы от действия силы в середине пролета в зависимости от числа панелей. График найденной зависимости имеет точку экстремума

Ключевые слова: ферма, прогиб, индукция, Maple

By induction, using the computer algebra system Maple the formula for the deflection of statically determinate flat truss under the force at Midspan depending on the number of panels is obtained. The graph of has a point of extremum

Key words: truss, deflection, induction, Maple

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Analytical calculation of the trusses and accurate formulaic expressions for various characteristics of the structure are very important for practice. These formulas can serve as a test for numerical methods, as a simple evaluation of truss health and to check its stiffness. Modern symbolic mathematics packages make it easy to obtain the solution for trusses with a specific number of panels. Deduce the same formula for arbitrary number of panels you can use the method of induction developed for flat [1-8] and spatial [9-11] systems. In particular, in [12] obtained the solution for the deflection of a girder, with a lattice cruciform shape (Fig. 1) under the action of a uniform load applied to the nodes of the lower belt. Plots of deflection against the number of panels are given. It is noted that the obtained dependence is nonmonotonic, which is explained by the presence in the solution of the summands $(-1)^n$. The extreme point is not detected, with increasing numbers of panels for a fixed span length, the deflection increases. In [13] constructed the lines of influence console farms of the same type (Fig. 2), induction method used and the system Maple. In this paper we consider the same truss under the action of a single concentrated force at Midspan. It is assumed that the truss has an even number of panels.

Fig. 1. Truss, $n=3$

Fig. 2. Cantilever truss $n = 5$ [13]

Efforts will be defined using cut nodes in an analytical form without loss of accuracy of calculations [6], the deflection – by the formula of Maxwell – Mohr $\Delta = P \sum_{i=1}^m \frac{S_i^2 l_i}{EF}$, where EF is the stiffness of the rods, S_i the effort stems from the action of the individual external loads, l_i – the length of the rods. The stiffness of the bars (modulus of elasticity and the cross-sectional area) are constant for all cores. Efforts determined by the method of cutting of knots. To do this, using the program [14], we make the matrix guides of the cosines and the vector of right parts of the system that contains the current load.

Fig. 3. The dependence of the deflection on the number of panels. $L=30m$

The number of unknowns come in and support reactions (two reactions stationary support and one movable support reaction). The system of equations is written and solved in matrix form using Maple. Debugged the algorithm allows to calculate the

sequence of farms with increasing number of panels. The coefficients of the decision revealed a pattern found from the solutions of recurrent equations, which is the sequence of coefficients satisfies. In particular, one of the coefficients of the solution satisfies the equation of the fifth order $A_n = 4A_{n-1} - 6A_{n-2} + 4A_{n-3} - A_{n-4}$. As a result of induction by the number of panels in half of the span obtained the following relation $\tilde{\Delta} = (a^3 A + b^3 B + c^3 C)/b^2$, where $A = n/6 + n^3/3$; $B = (1 + (-1)^{n+1})/2$; $C = n/2$; $c = \sqrt{a^2 + b^2}$ and introduced the notation for the relative deflection $\Delta = \Delta EF / P$. Figure 3 shows that a graph of deflection against the number of panels is low, suggesting the possibility of optimizing the size of the farm. Extreme points fall on an even number of panels.

A review of some analytical solutions of the deflection of the truss is contained in [15]. The problem of truss taking into account of creep is solved in [16].

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