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CALCULATION OF THE STABILITY OF THE EQUILIBRIUM FORM. SOFTWARE DEVELOPMENT

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Keywords

critical load, critical state,
stability, iteration

Abstract

The paper presents software for calculating the stability of the equilibrium form of the first kind of compressed discrete systems by the displacements method in combination with the methods of bisection and iterations. The use of the methods makes it possible to effectively determine the minimum critical stress or strain at the first bifurcation and their corresponding form of loss of stability, both for statically determined and statically undetectable systems. This algorithm is implemented in the software complex "Persist" for a PC in Windows OS.

There are various methods for calculating the stability of the shape of the equilibrium of discrete systems, due to the large volume of computations associated with the solution of the analytical condition for the loss of equilibrium stability. The solution of the analytical condition for the loss stability of the equilibrium of compressed discrete systems, which has high orders, and the definition of the critical load of the form of loss of stability, is one of the topical problems.

The solution of the problem of calculating the analytical condition for stability loss of the equilibrium of compressed discrete systems, which has high orders, and the determination of the corresponding critical load of the form of stability loss, generated a large number of methods by many mathematicians (Laverier, Krylov, Danilevsky, Jacobi [1 – 6] etc.).

The calculation of the compressed discrete system on the stability of the form of equilibrium actually reduces to the solution of the difficultly described nonlinear transcendental equation, which is the equation of loss of stability. The difficulty lies in the absence of analytical solution of such equation due to the presence of complex functions of Zhukovsky, which have transcendental functions in their structure. Such solution can be performed only with the use of numerical methods. The purpose of the work is to develop an algorithm and software for the PC in Windows OS, which will enable students and engineers to automate calculations of stability of equilibrium forms of compressed discrete systems.

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To solve this engineering problem, the Persist software was developed and implemented on the PC on the Department of Building Structures National University “Yuri Kondratyuk Poltava Polytechnic”. This software contains several subroutines, implemented in a modern compiler, utilities, which are presented and combined in the same software package form [6].

Compressed rods parameters description. The dialog for describing the parameters of the compressed rods is activated by pressing the corresponding button, Figure 1. In this case, it should be noted that only non-zero parameters are described, that is, the parameters of only compressed rods, rods with zero value of longitudinal force are not part of the ones described.

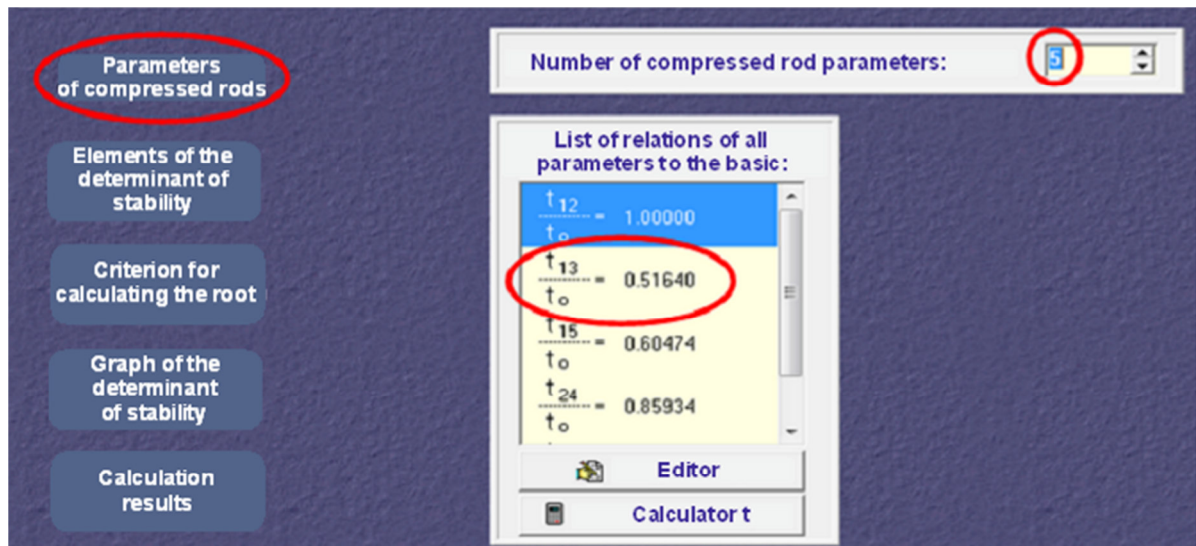


Figure 1 – Visual components for managing the description parameters of the compressed rods

As a precision criterion, the "Persist" program uses the so-called absolute criterion when the process of iterative refinement of the root stops when the absolute value of the desired root does not exceed the value of the given error, which is recommended to set in the range $10^{-6} \dots 10^{-4}$.

Directly solving equation of stability in «Persist». As noted above, solving the equation of loss of stability of the form of equilibrium involves the use of numerical methods. Thus, in the "Persist" organized an iterative process of solving a complex nonlinear equation using the chord method in conjunction with refinement on its iterations by the method of bisection. The search for the interval of existence of the first root is carried out by the method of selection as for the method of dichotomy [6]. The process of iterative refinement of the root continues until the root value reaches the given accuracy.

For a solution already described in the program "Persist" equation of loss of stability of the form of equilibrium, the user must use the item in the main menu, Figure 1.

It is necessary to emphasize the prevention of the passage of the first root when numerically iterative solving of such equation. To do this, you need to analyze the results. As a rule, it is enough to visually assess the type of graph of the dependence of the determinant of stability of the form of equilibrium from the value of the basic parameter.

The results of the solution the equation of stability loss of the equilibrium form in table and graph forms are presented at the Figure 2 and Figure 3 [6].

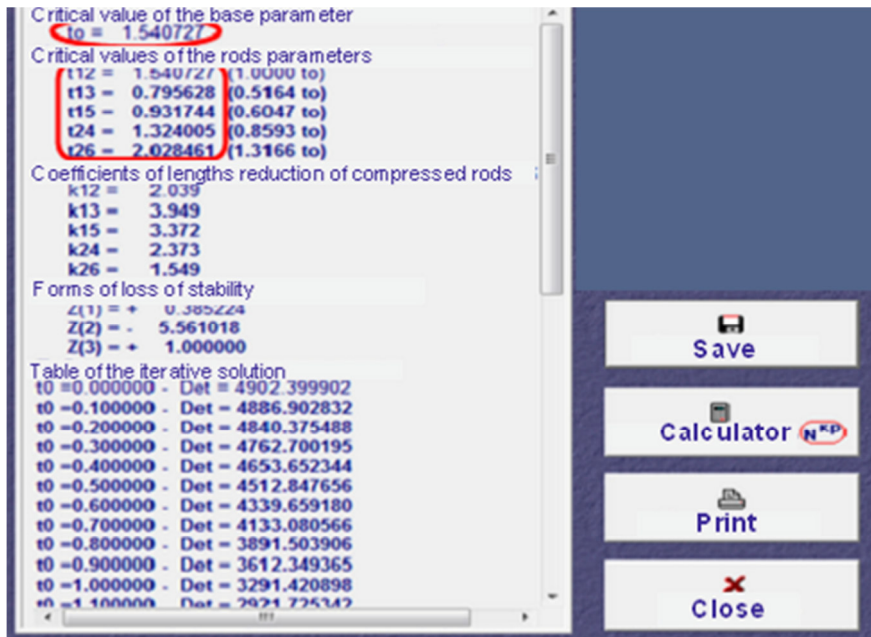


Figure 2 – View the results of the solution the equation of stability loss

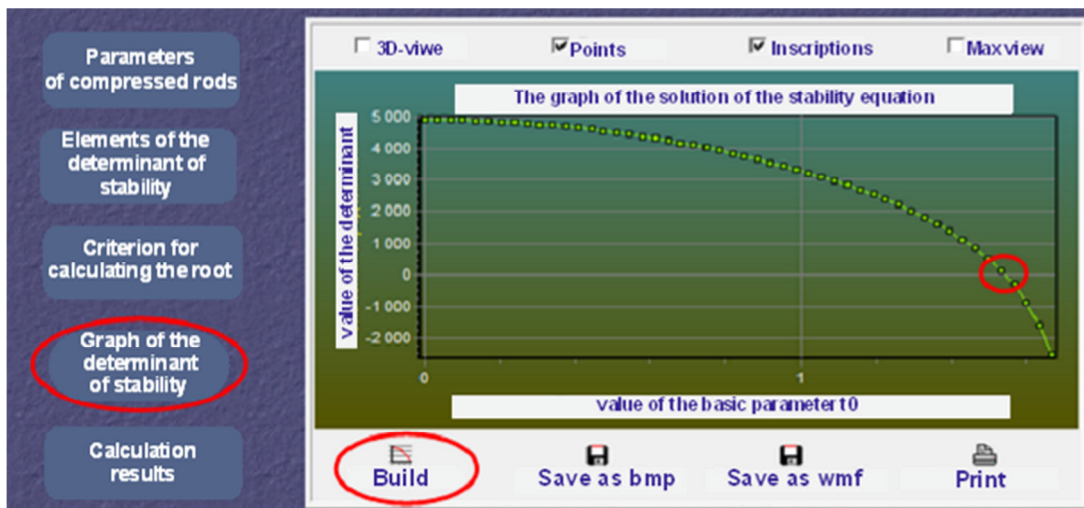


Figure 3 – Graphic representation of the solution of the equation of stability loss

Save results and getting a copy of them. For the possibility of further analysis and processing of the results of calculations in the "Persist" provided the possibility of saving them in a .txt file. To do this, please use the appropriate menu item "Save" in the viewport of the main results. In this case, all actions of saving file are absolutely similar to those used in any program for OS Windows family software.

Conclusions.

For the PC in Windows OS are developed the algorithm and program complex "Persist". It will enable students and engineers to automate calculations of the stability of the equilibrium form of compressed discrete systems, calculate critical stresses and determining the corresponding principal forms of oscillations. The program has been implemented and approbated in the educational process at the National University "Yuri Kondratyuk Poltava Polytechnic" during the training of specialists in engineering specialties.

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РОЗРАХУНОК СТІЙКОСТІ ФОРМИ РІВНОВАГИ. РОЗРОБКА ПРОГРАМНОГО ЗАБЕЗПЕЧЕННЯ

МИТРОФАНОВ Павло, МЕНСАХ Лемуель

Анотація. В роботі представлено програмне забезпечення для розрахунку стійкості форми рівноваги першого роду стиснутих дискретних систем методом переміщень у сполученні з методами бісекції та ітерації. Використання зазначених методів дозволяє ефективно визначити мінімальні критичні деформації або напруження при першій біфуркації а також відповідну їм форму втрати стійкості як для статично невизначних систем так і для статично визначних. Алгоритм реалізований у програмному комплексі "Persist" для ПК на базі ОС Windows.

Ключові слова: критичне навантаження, критичний стан, стійкість, ітерація.