NONLINEAR PROBLEMS OF FORMATION OF DISCRETE FRAMES BY THE STATIC-GEOMETRIC METHOD

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Summary. **Two approaches are examined in the article the realizations of iterative processes for solving nonlinear problems at the design of discrete frameworks of surfaces and models of lines using static- geometric method of prof. Kovaleva S. Examples that demonstrate the use of these principles and possibility of realization of difficult analysis depending on an error and number of iterations are made. The ways of combination of these approaches are set for optimization of total number of iterations and for the receipt of final result on forming of discrete character, with an arbitrary permissible error.**

Keywords: **iterative process, nonlinear system of equations formative load discrete images, iterative optimization process.**

Formulation of the problem. Solving Nonlinear Systems equilibrium units in the formation of discrete images of static-geometric method (SGM) requires proper organization of iterative processes. This will get signifies our strong result with any acceptable error. SGM allows to solve a variety of problems and modeling of discrete images forming under the external formative efforts can meet the actual physical phenomena. All tasks can be divided into two groups. First log -Any problem in which formative external load is independent of the coordinates assemblies of discrete image. In this case, the external force function as a discrete set of numbers of nodes. An example would be the formation of discrete frame surface coating at a given moment free in terms of the right side of the net where the external forces are distributed evenly between the mesh nodes in the plan.

In this case, the system equilibrium equations units will consist of linear equations. The result of solving the system will determine the abscissa, ordinate and applicants all mesh nodes.

The second - enter the task in which the external formative efforts will depend on a number of related nodes coordinate discrete image formed SGM. Since these coordinates are unknown, the equations of equilibrium units are nonlinear and the challenge of solving systems of nonlinear equations. In the process of solving this type of problems all the time necessary to clarify the magnitude and direction of formative external load.

Analysis of recent research. In [1] developed a method of forming a discrete frame moment free surface coatings constant thickness under its own weight, where the same uniform distributed load external force is not in the plan, and on the surface. As a result, the correct mesh between nodes in terms of load distribution will be uneven, and external efforts will depend on the coordinates of mesh nodes. It is this problem can serve as an example of the second type tasks.

Another example is the formation of surfaces under the influence of internal pressure, type "inflating" the surface. In this case, external efforts should be normal to the surface, and because the surface is modeled not known, the effort will depend on the coordinates of unknown nodes. This principle proposed use SGM for forming bioobolonok in [2, 3].

The wording of Article purposes. Draft main ways to optimize the total number of iterations to form discrete frames or lines of functional surfaces under load formative SGM.

Main part. There are many known methods for solving systems of nonlinear equations, based on the method of successive approximations. The mathematical formulation of the problem of forming discrete image when loading an external force is normal to the simulated surface leads to non linear system of equations of equilibrium knots. This system can be solved by successive approximations using the system Maple. As a result, you can get a lot of solutions. But it must be set to a first approximation, which is very close to the desired result. Therefore, we must find a way, aiming at a solution.

In this case can help SGM, mathematical apparatus which repeats the same machine method of finite differences, but has a higher visibility of the process of forming discrete image. CMB will choose the direction to which you aspire to get the result. Setting some first approximation discrete image, appoint external load, somehow distributed between nodes. This loading units should move in the required direction and form discrete frame image.

The first approach of discrete image can greatly differ from the desired result, and therefore can not immediately specify the correct load. Because the parameters necessary to specify the external load after each iteration step.

There is a problem of convergence of the iterative process (the process can diverge). This convergence depends on how successful was the first approximation, or as it was close to the desired result. We can identify two approaches for convergence of the iterative process.

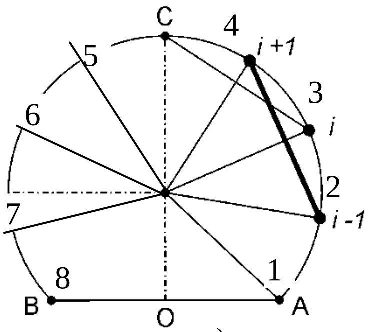
The first approach - the choice quite close to the desired result first approximation. Then, there is a need to study the dependence of convergence of the iterative process of the first approximation.

The second approach - a gradual change shape modeling discrete image by scaling up the external load in the modeling of physical processes shaping discrete serial line or surface. This approach will be followed by a complex iterative process. At the convergence process will significantly affect the number of iterations (you can always choose a number of iterations, when the process begins to match).

There is a need to study the iterative process depending on the number of iterations. The best way is the one that provides a result with acceptable accuracy with the least number of iterations. This can be achieved by combining both approaches described above. For example, having a discrete image using the second approach, you can take him close enough to the desired (modelyuyemoho) first approximation and specifying it using the second principle, to obtain the desired result. This criterion of the algorithm for solving the problem will be the smallest total number of iterations.

The above-described idea of convergence of the iterative process of analysis to show a simple example, where the test curve was used arc of a circle. Modeling a curve further study and iterative process of convergence with such modeling is much easier than modeling the surface. But you can expect that a number of features that are inherent in the process of modeling discrete lines can be moved to the simulation of discrete frame surface. Given that the surface formed by the same laws as the line is simulated, and the latter acts as an element of the frame surface.

Example. Let inextensible thread, which is fixed at points A and B (Fig. 1, a) takes the form of arc of a circle passing through the given point C under normal load evenly distributed between nodes 1-8.



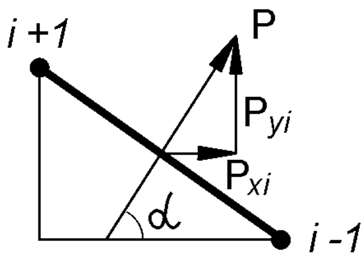


Fig. 1. Scheme modeling discrete image arc of a circle: and - topological circuit arc of a circle; b - equilibrium condition of forces P, P_{xi}, P_{yi}.

Then, SGM arbitrary node balance equations described thread:

$$X_{i-1} - 2X_i + X_{i+1} + \frac{kP(y_{i+1} - y_{i-1})}{\sqrt{(x_{i+1} - x_{i-1})^2 + (y_{i+1} - y_{i-1})^2}} = 0;$$

$$Y_{i-1} - 2Y_i + Y_{i+1} + \frac{-kP(x_{i+1} - x_{i-1})}{\sqrt{(x_{i+1} - x_{i-1})^2 + (y_{i+1} - y_{i-1})^2}} = 0. \qquad (1)$$

As shown in (1), the system equilibrium equations units inextensible thread is nonlinear, so it is a very difficult decision. Applying the method of successive approximations organize iterative process described above two approaches. In the first approximation accept AV components segment, gradually specifying an external load kP_{xi}, kP_{yi} (Fig. 1b) of the formulas.

$$kP_{xi} = kP\cos\propto_i = \frac{kP(y_{i+1}-y_{i-1})}{\sqrt{(x_{i+1}-x_{i-1})^2+(y_{i+1}-y_{i-1})^2}};$$
$$kP_{yi} = kP\sin\propto_i = \frac{-kP(x_{i+1}-x_{i-1})}{\sqrt{(x_{i+1}-x_{i-1})^2+(y_{i+1}-y_{i-1})^2}}, \qquad (2)$$

where kP_{xi}, kP_{yi} – formative components of the load;

x_i, y_i – coordinates assemblies of discrete models.

Form discretely defined contour arc of a circle, which is formed under the efforts of a node depends on the values of these efforts.

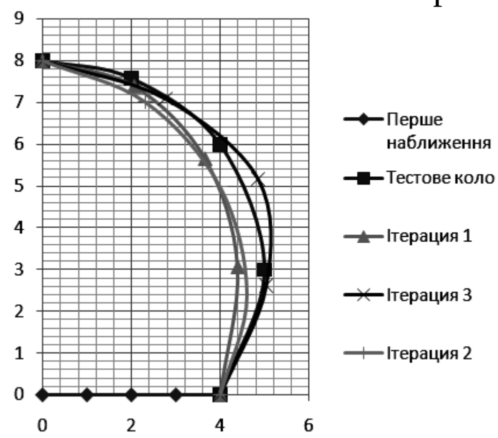


Fig. 2. Example of modeling discrete image of the first approach.

In the first approach to the external load arbitrary node is determined by conditions of discretely defined arc of a circle through the point C with coordinates (0, 8) (Fig. 2). It is seen that when the ratio $\frac{OC}{OA} = \frac{8}{4} = 2$ iterative process is not the same as error in determining the coordinates of nodes with each step iterations increases.

Sketch. 3, and shows the formation of discrete frame-circle arc second approach, where the number of iterations in scaling up formative load (Fig. 3, c) is 8.

At the end of the iterative process received dyskret frame arc of a circle with an error, which is also defined δ_i as the rms difference of test results. To reduce errors received in the last iteration discretely defined by a curved line take the first approach for subsequent iterative process that organize the first approach. According to a test case (Fig. 3, b) to obtain the final result when the allowable error does not exceed 1%, must spend five iterations.

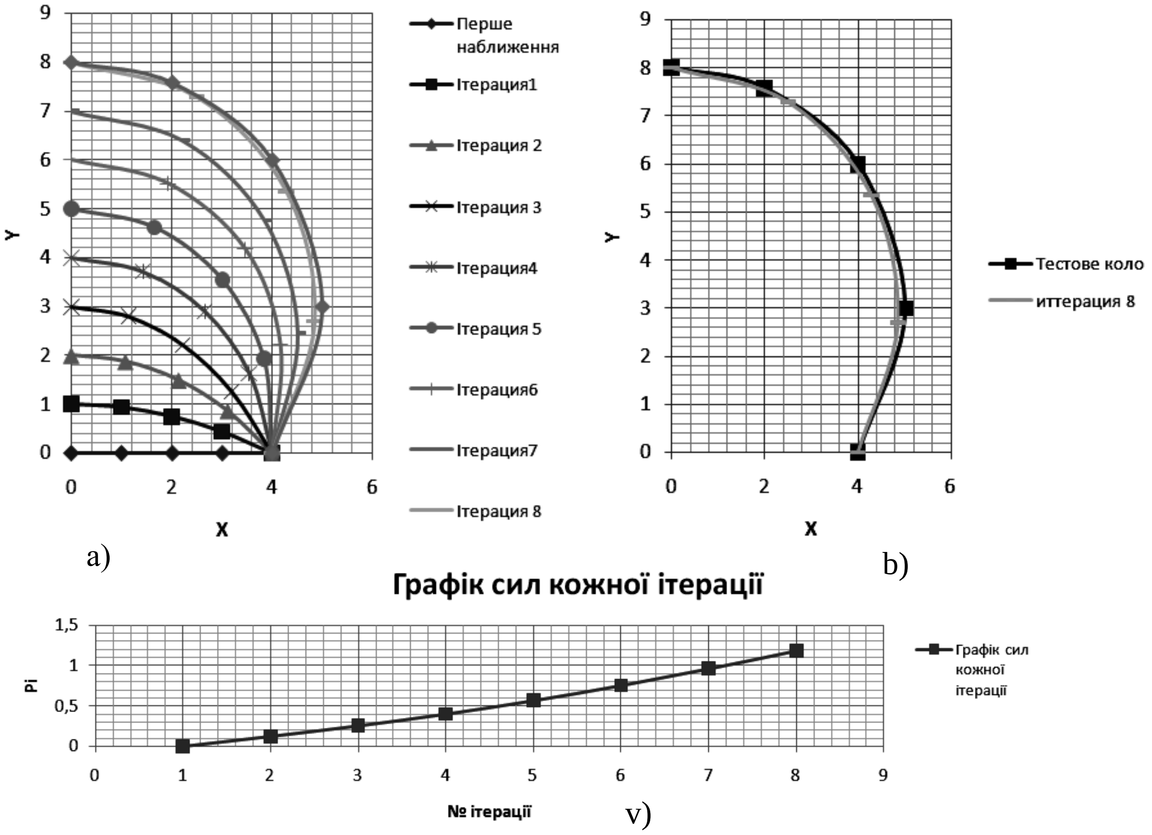


Fig. 3. Experimental results of constructing discrete fig. 8 iterations: a - simulated discrete curves each iteration; b - discrete curve and test the latest iteration of the circle; v - schedule the external load capacity.

Conclusions. Investigated two approaches organizations iterative processes for solving nonlinear equilibrium of nodes in the formation of discrete images SGM. The combination of these approaches provides a signifies our strong result with any acceptable error.

Further research is planned to conduct both towards the optimization of the total number of iterations in the combined iterative process and towards generalization of the results to form discrete frames surfaces under functional - distributed load on the grid nodes, the parameters of which depend on the coordinates of nodes.

Properties frame forming discrete moment free surface can be obtained from the generalization of the properties forming discrete model line.

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