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ABOUT ONE METHOD OF CONTROLLING THE PARAMETERS OF A GIVEN POLYLINE

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Abstract
An iterative algorithm of the static-geometric method of forming a broken line with equal angles of adjacent links and pairwise equal links is considered.

Keywords: modeling, broken, structure, system, iteration.

Introduction

Here is the English translation of your text:

The geometric method of controlling the initial polyline's control system (CS) is, first of all, characterized by a significant dependence of the number of iterations on the number of nodes in the polyline (and, consequently, by multiple step-by-step iterations, which slow down the solving process). Secondly, there are a number of constraints imposed to ensure the convergence of the process.

The use of a static-geometric approach to solving this problem allows overcoming these shortcomings. In this case, the solution also has an iterative nature; however, the control of angles is not carried out sequentially from one node to another but simultaneously for all nodes of the polyline (by solving a system of linear equations).

In the static-geometric method, the solution to the above-mentioned problems is carried out by moving the original nodes under the action of certain conditional forces. In this case, the forces defined for each node are substituted into a system of linear equilibrium equations of the form:

$$\sum_{i=1}^{n}(u_i^t - u_0^t) + \sum_{i=1}^{n} P_i + Q - kT = 0, \qquad (1)$$

where ***T*** – is a static interpretation of the requirement imposed on the system.

The projection of the vector ***T*** onto the coordinate axes is determined by the formula:

$$kT_{u,i}^{t+1} = 2u_i^t - u_{i,1}^t - u_{i+1}^t \qquad (2)$$

where ***u*** – a generalized designation of coordinates;

i – Node numbers;

k – proportionality coefficient;

t – ordinal step of the iterative refinement process.

Let us consider the solution of some of the problems given above in a static-geometric way. Let us assume that it is required to ensure the equality of the values of the angles of adjacent links (AAR) to a given value with simultaneous equalization of the lengths of the links (Fig. 1).

To apply this method, it is necessary to consider the equilibrium of a separate node of a broken line.

Let it be necessary to ensure for a broken line ABCDE the equality of the angles of adjacent links according to the required graph of values, with the simultaneous equalization of the lengths of the links converging at the nodes.

In this case, the node is in equilibrium (Fig. 2.5) under the action of the following forces:

1. Efforts in connections

$\bar{P}_{AB} = k(u_A - u_B)$; $\bar{P}_{CB} = k(u_C - u_B)$; (3)

In the desired position, the node must also be in equilibrium. The forces acting on the node:

2. Balancing their efforts $k\bar{P}$

$k\bar{P} = (2u_B - u_C - u_A)$ (4)

In the desired position, the node must also be in equilibrium. The forces acting on the node:

1. In connections

$\bar{P}^0_{AB} = k(u_A - u^0_B)$; $\bar{P}^0_{CB} = k(u_C - u^0_B)$. (5)

2. Holding the knot in a new position when the angle between the bonds is $\boldsymbol{\alpha_B}$ and ***AB₀ = B₀C***

$$kT_{x,B} = \{(y_A - y_C)(x_A y_c - x_C y_A) + (x_A - x_C)[x_B(x_C - x_A) + y_B(y_C - y_A)] + x_B\}\left\{l_{AC} \pm [(1 + tg^2\alpha_B)l^2_{AC}]^{\frac{1}{2}}\right\}(tg\alpha_B l_{BH})^{-1}$$

$$kT_{y,B} = \{(x_A - x_C)(x_C y_A - x_A y_C) + (y_A - y_C)[x_B(x_C - x_A) + y_B(y_C - y_A)] + y_B\}\left\{l_{AC} \pm [(1 + tg^2\alpha_B)l^2_{AC}]^{\frac{1}{2}}\right\}(tg\alpha_B l_{BH})^{-1} \quad (6)$$

where $\boldsymbol{kT_{x,B}}$, $\boldsymbol{kT_{y,B}}$ - are the projections of the force $\boldsymbol{kT}$ applied at node B, respectively, on the ***x, y*** axes ;

$$\boldsymbol{l_{AC}} = |[(x_A - x_C)^2 + (y_A - y_C)^2]^{\frac{1}{2}}|;$$

$$\boldsymbol{l_{BH}} = |[(x_B - x_H)^2 + (y_B - y_H)^2]^{\frac{1}{2}}|;$$

the coordinates of the node ***H*** are determined from the relations (6):

$$x_H = [(x_C - x_A)^2 x_B + (y_C - y_A)^2 x_A + (x_C - x_A)(y_C - y_A)(y_B - y_A)](l_{AC})^{-2}$$

$$y_H = [(x_C - x_A)^2 y_A + (y_C - y_A)^2 y_B + (x_C - x_A)(y_C - y_A)(x_B - x_A)](l_{AC}).^{-2} \quad (7)$$

Equations (6) for an arbitrary node in the indices of the reference system have the form:

$$kT^{t+1}_{x,i} = \{(y^t_{i-1} - y^t_{i+1})(x^t_{i-1}y^t_{i+1} - y^t_{i-1}x^t_{i+1}) + (x^t_{i-1} - x^t_{i+1})[x(x^t_{i+1} - x^t_{i-1}) + y^t_i(y^t_{i+1} - y^t_{i-1})] + x^t_i\}\left\{l^{t,i+1}_{i-1} \pm [(1 + tg^2\alpha_B)(l^{t,i+1}_{i-1})^2]^{\frac{1}{2}}\right\}(tg\alpha_0 l^{t,H}_i)^{-1};$$

$$kT_{y,i}^{t+1} = \{(x_{i-1}^t - x_{i+1}^t)(x_{i+1}^t y_{i-1}^t - y_{i+1}^t x_{i-1}^t) + (y_{i-1}^t - y_{i+1}^t)[x_i^t(x_{i+1}^t - x_{i-1}^t) + y_i^t(y_{i+1}^t - y_{i-1}^t)] + y_i^t\}\left\{l_{i-1}^{t,i+1} \pm [(1+tg^2\alpha_0)(l_{i-1}^{t,i+1})^2]^{\frac{1}{2}}\right\}\left(tg\alpha_0 l_i^{t,H}\right)^{-1}; \quad (8)$$

Based on these dependencies, an iterative algorithm of the static-geometric method of forming a broken line with equal angles of adjacent links (EAAL) and pairwise equal links is constructed:

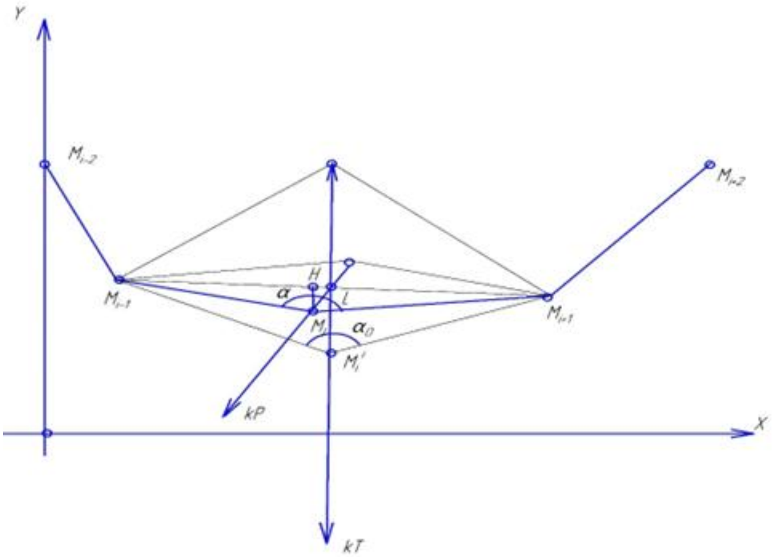

Fig. 1. Equality of angles of adjacent links

1. The parameters of the nodes of the first approximation broken line are determined.
2. The projections of the conditional forces ***kT*** for each of the unfixed nodes are determined using the coordinates of the nodes of the first iteration broken line.
3. The values of ***kT*** are supplied to equations of the form (1), which are composed for the coordinates ***x*** and ***y***.
4. The systems of equations (1) are solved together, as a result of which the coordinates of the nodes of the new approximation are determined.
5. Similar to how this was done in the geometric method, the quality of the solution is assessed by comparing it with the specified values δ_i and S_i.. If the check is positive, the iteration process is terminated. If not, it continues. The data of the last solution are accepted as new initial data and the process is repeated, starting from point 2.

Схема данного алгоритма показана на рисунке 2.

Работа алгоритма иллюстрируется численным примером.

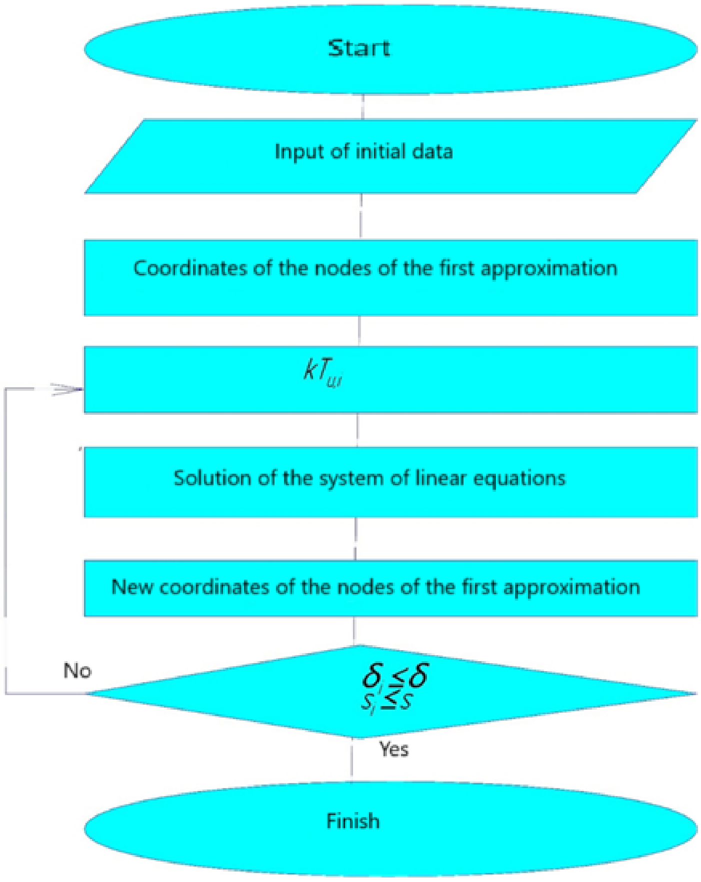

Fig.2. Scheme of the algorithm for controlling the parameters of a broken line

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