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APPROXIMATE METHOD FOR FORMING DOUBLE BELT LATTICE STRUCTURES

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Abstract:

The question of a geometric method for controlling the angles between adjacent links of a polyline is considered. The transformation of the original polyline by moving a node is given under various geometric conditions

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A variety of discrete models of surfaces and curved lines, a large number of options for design requirements determine different formulations of discrete modeling problems.

One of the possible formulations of the problem can be the following: the original broken line is smoldering, modeling a certain curve. It is necessary to transform this polyline into a new one so that the values of the angles between its adjacent links are equal to some specified values.

The transformation of the original polyline can be interpreted in different ways. One of the possible options is that the resulting polyline can be provided as a result of moving the nodes of the original polyline. Like any directional movement, the movement of a polyline node can be represented by a vector, the beginning of which coincides with the initial position of the node, and the end of which coincides with the resulting one.

Analysis of existing design requirements, taking into account the relationship of the parameters of the position of the nodes of the initial and resulting polygonal lines, allows us to divide the possible ways of movement into two groups:

1. The directions of the vectors of the displacements of the nodes do not depend on the shape of the original broken line and are determined at the stage of setting the problem.
2. The directions of the displacement vectors are quantities that depend on the parameters of the shape and position of the polyline and cannot be predetermined.

In the first case, the directions of the displacement vectors are specified. For example, nodes can only move vertically. Therefore, the position of the nodes depends on only one parameter.

In the second case, the task becomes more complicated: the direction of the node displacement vector is not known. A pair of adjacent nodes defines a one-parameter set of node positions with a given value of the angle αi at the vertex. In order to find a single position, it is necessary to impose an additional condition linking this parameter. Such conditions can be:

1. Ensuring equality of bond lengths.
2. Preservation of the regularity of the position of the nodes of the polyline.
3. Preservation of the ratio of the lengths of adjacent bonds, etc.

In accordance with this, the process of changing the angles of the adjacency of the broken line links (HSS) can take place subject to the following geometric conditions:

1. The step of the nodes of the polyline changes (for example, along the 0x axis) and the lengths of its links (Fig. 1, a).
2. The lengths of the links of the broken line change with the same step of the nodes (Fig. 1, b).
3. The step of the nodes changes with the same lengths of the links (Fig. 1, c).
4. The pitch of the nodes and the length of the links remain unchanged (Fig. 1, d)

The dependence of the adjacency angle of the links converging at the i-th node of the polyline on the step of the nodes and the length of the links in the general case has the form:

$$\tan\alpha_i = \left\{h_{i-1}^{i}\left[\left(l_i^{i+1}\right)^2-\left(h_i^{i+1}\right)^2\right]^{\frac{1}{2}}+h_i^{i+1}\left[\left(l_{i-1}^{i}\right)^2-\left(h_{i-1}^{i}\right)^2\right]^{\frac{1}{2}}\right\}\times$$
$$\left\{\left[\left(l_{i-1}^{i}\right)^2-\left(h_{i-1}^{i}\right)^2\right]^{\frac{1}{2}}\times\left[\left(l_i^{i+1}\right)^2-\left(h_i^{i+1}\right)^2\right]^{\frac{1}{2}}-h_{i-1}^{i}h_i^{i+1}\right\}^{-1} \quad (1)$$

where ***l*** - link length;

h - link pitch.

At $h_{i-1}^{i} = h_i^{i+1} = h$ equation (1) has the form:

$$\tan\alpha_i = \left\{h\left[\left(l_i^{i+1}\right)^2 - h^2\right]^{\frac{1}{2}} + \left[\left(l_{i-1}^{i}\right)^2 - h^2\right]^{\frac{1}{2}}\right\}\times \left\{\left[\left(l_{i-1}^{i}\right)^2 - h^2\right]^{\frac{1}{2}} \times \left[\left(l_i^{i+1}\right)^2 - h^2\right]^{\frac{1}{2}} - h^2\right\}^{-1} \quad (2)$$

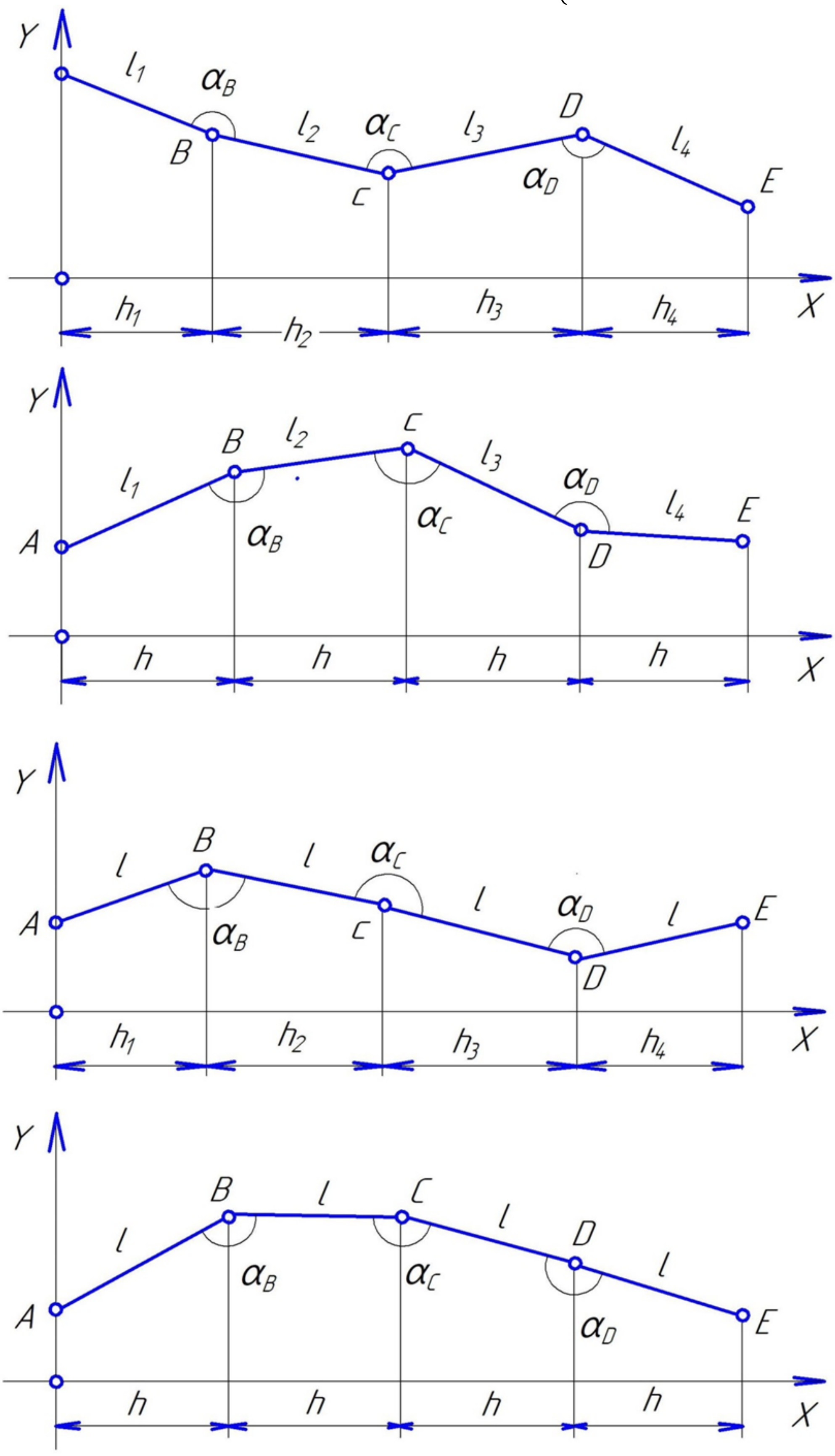

Fig. 1. Geometric conditions for changing the angles of adjacency of breaking links

At $l_{i-1}^{i} = l_{i}^{i+1} = l$ equation (1) has the form:

$$\tan\alpha_i = \left\{h_{i-1}^{i}\left[l^2 - \left(h_i^{i+1}\right)^2\right]^{\frac{1}{2}} + h_i^{i+1}\left[l^2 - \left(h_{i-1}^{i}\right)^2\right]^{\frac{1}{2}}\right\}\times$$

$$\left\{\left[l^2 - \left(h_{i-1}^{i}\right)^2\right]^{\frac{1}{2}} \times \left[l^2 - \left(h_i^{i+1}\right)^2\right]^{\frac{1}{2}} - h_{i-1}^{i}h_i^{i+1}\right\}^{-1} \quad (3)$$

Equation (I) at $l_{i-1}^{i} = l_{i}^{i+1} = l$ и $h_{i-1}^{i} = h_i^{i+1} = h$

$\tan\alpha_i = 2h(l^2 - h^2)^{\frac{1}{2}}(l^2 - 2h^2)^{-1}$ (4)

Based on these dependencies, a geometric algorithm for controlling the HSS polyline is proposed.

Let there be some broken line ABCDE. In this case, the nodes A and E are considered fixed (i.e., their position remains unchanged), and the nodes B. C. D - free (or not fixed).

It is necessary to transform it into a new polyline having the values of the adjacency angles that correspond to the specified change schedule.

As an additional geometric condition that ensures the uniqueness of the solution, one can choose the condition of equality of the connections converging at a node with each other. In this case, adjacent nodes are considered to be fixed. In particular, for node B (Fig. 2, a) its new position b0 will be determined on the straight line B0M· AC with AM = MC.

The coordinates of the new position of the node B can be found from the formula:

$$x_B^0 = \frac{x_a + x_c}{2} - (x_H - x_B)(2\tan\alpha_B\, l_{BH})^{-1}\{l_{AC} \pm [(1+\tan^2\alpha_B)(l_{AC})^2]^2\}^{\frac{1}{2}}$$

$$y_B^0 = \frac{y_a + y_c}{2} - (y_H - y_B)(2\tan\alpha_B\, l_{BH})^{-1}\{l_{AC} \pm [(1+\tan^2\alpha_B)(l_{AC})^2]^2\}^{\frac{1}{2}}, (4)$$

Where α_B – angle value *α,* taken according to the UZC change schedule for node B*,*

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

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

The coordinates of the point H are determined by the formulas:

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

$$y_H = [(x_C - x_A)^2 y_A + (y_C - y_A)^2 y_B + (x_C - x_A)(y_C - y_A)(x_B - x_A)](l_{AC}).^{-2} \quad (6)$$

Substituting the values (6) into (5) and replacing the alphabetic indices of the cut-off system, we obtain the formula for determining the coordinates of an arbitrary node:

$$x_i = \frac{x_{i-1} + x_{i+1}}{2} - \{(y_{i+1} - y_{i-1})(x_{i-1}y_{i+1} - x_{i+1}y_{i-1}) + (x_{i+1} - x_{i-1})[x_i(x_{i+1} - x_{i-1}) + y_i(y_{i+1} - y_{i-1})] - x_i\}\left\{l_{i-1}^{i+1} \pm \left[(1 + tg^2\alpha_0)\left(l_{i-1}^{i+1}\right)^2\right]^{\frac{1}{2}}\right\}(2tg\alpha_0 l_i^H)^{-1} \ (7)$$

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

where ***i*** - node number.

If $\frac{(y_{i+1} + y_{i-1})}{2} \geq y_i$ in formulas (7) the sign "+" is accepted, otherwise - the sign "-".

Using the obtained relations, an iterative process of solving the problem of transforming the original polyline into the required one is organized:

The order of traversing nodes is set.

For the first of the loose nodes at a given value

α_i a new position is determined from relations (7).

For the node following it, a new position is also determined by formulas (7). In this case, the coordinates of the previous node found at step 2 are substituted into relation (7).

The coordinates of all non-anchored nodes are determined in the same way.

The quality of the result obtained is assessed.

As a rule, the parameters reflecting the degree of achievement of the required result are used as evaluation criteria and signs of stopping the iterative process.

In this case, for each of the loose nodes, calculate the values

$\delta_i = /tg\alpha_i - tg\alpha_g\,|$

$S_i = \Delta l_i$ (8)

where α_i , α_g - respectively, the current and specified angle value for this node;

Δl_i - the difference in the lengths of the bonds converging at the i -th node.

These values are compared with predetermined values for δ_g and S_g. If for each of the nodes the condition is met

$\delta_i \leq \delta_g$;

$S_i \leq S_g$; (9)

then the solution is considered to have been received. If not, the process continues from point 2.

REFERENCES:

1. Суванкулов И.Ш., Элмонов С.М. Приближенный способ формирования двухпоясных решетчатых. – Москва. UNIVERSUM: ТЕХНИЧЕСКИЕ НАУКИ. Научный журнал. Выпуск:№ 6(75). Июнь 2020 г. Часть 2, с. 10-14.
2. Суванкулов И.Ш., Узоков Ш.Х., Элмонов С.М. Абдумоннонов М. Молелирование двухпоясных решетчатых структур – Москва. UNIVERSUM: ТЕХНИЧЕСКИЕ НАУКИ. Научный журнал. Выпуск № 6(78). Сентябрь 2020 г. Часть 2, с. 10-14.