The sorting Hump is a “drawing-analytical” method in finding the coordinates of the elements of the Strait

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Abstract. By analyzing the existing mathematical models and analytical methods used to find the coordinates of the sorting hump elements, their achievements and disadvantages were studied. On the basis of the results of the analysis, the procedures for the implementation of the design process are studied. In contrast to the established sequence in the “Design criteria for railway stops and nodes,” it is possible to select the best of several acceptable options at once. To find the coordinates of the elements of the sorting hump Strait, a mathematical model and a method for determining it have been developed for the “drawing-analytical” method.

1 Introduction

Analysis of existing mathematical models and analytical methods used to find the coordinates of sorting hump throat elements shows that the accuracy in them will depend on the sorting hump throat, which in most cases is a scale-free monand chosen for the calculation. Also, account books work only for one option. The analysis of the resulting result, on the other hand, is carried out at the end of the design process and defines the “design criteria for railway stops and nodes” only for the available option Holos.

1st Vol. The traditional design of the sortable hump throat consists (graphically) of calculating the values of the angles of turns by hand or using exposure based on a scale-free estimation drawing Figure 1. \((\gamma_1, \gamma_2, \gamma_3, \gamma_4)\). Also, arc radii \(R\), based on the requirements set out in the regulatory documents, consist in the mutual arrangement of threaded conductors, braking devices and automatic devices, marking the \(S\) distances between the road axes.

After the calculation is performed, a draft of the sortable hump throat scale is developed. It is required to carry out the project process with great accuracy. Because the error in the turn angle is in the loop, which is one second, and the error of 0.01 meters in length turns into meters as a result. Therefore, when performing the project work by the traditional method, it is carried out with the help of an angle tangent, in order to accurately introduce the turning angles into the project. But even this method cannot reduce the amount of error. An important factor is also the exact inclusion of the length of the...
elements of the sorting hump Strait and the distance between them, the lengths of the arc and the values of its radius [1,2].

2 Methods

The draft of the sorting hump throat on a scale begins with the introduction of X and U arrows into the drawing in the current way. In order for the accuracy to be at a high level, the value of the angle Heights is found by taking the sum of the distances between the road axes from the X axis and subtracting the distances between the road axes from the resulting line downward. But the analysis of this method shows that when finding the elements of the sorting throat, the coordinates of the characteristic points cannot be achieved, since they are found through the base points located on different sides. Also, when we define the direction towards the point in the calculation, the values of the angles of turns are selected to correspond to the angles of the threaded conductor, starting from the edge path of the link at the top, the internal path links are designed. This in turn cannot provide the intended accuracy.

For Track 11 in Figure 1a is

\[ \alpha - \gamma_1 + \gamma_2 + \gamma_3 \]

and if \( \alpha = \gamma_1 + \gamma_2 + \gamma_3 \); \( 0 \leq \gamma_2 \leq \alpha - (\gamma_2 + \gamma_3) \); \( (\gamma_2 + \gamma_3) = 0 \); then \( \gamma_2 = \alpha \) the value \( \gamma_2, \gamma_3 \) will depend on the numbers that we will select. But it is imperative to take into account the boundaries and requirements imposed by the “standards for the design of railway stops and nodes”.

Fig. 1. A selection for the design of the sortable underarm throat without scale, but a monand drawing

2nd Vol. In this method, the sorting Hump underpasses are grouped into links of 4, 6 and 8 tracks, and the design process is performed in several stages (Figure 1b):

1. Bottom link (internal) paths are designed based on regulatory requirements and limits to determine the value and arc length of the angle of inclination \( \beta 1 \).
2. Relying on two internal link paths, a third External link path is designed and the value of the angle of inclination \( \beta 2 \) is determined.
3. A cluster of three link roads is designed by connecting to a Junction Junction Junction at the sorting Hump or to the number one stretch conductor center of Junction 0-1, and the value of the angle of inclination \( \beta 3 \) is determined.
4. At the turn angles $\beta_i$ determination, the inner paths of the two links are approximated by $S = 4.8$ metres, while maintaining the symmetric position of the link paths whenever possible [3-7].

![Fig. 2](image1.png)

**Fig. 2.** The selection for the design of the sortable underarm throat is a scale-free, but monand drawing of the result obtained in the traditional way

![Fig. 3](image2.png)

**Fig. 3.** A scale-free, monand drawing of the result obtained using the newly proposed method, based on a traditionally proposed drawing of the sortable submersible throat

![Fig. 4](image3.png)

**Fig. 4.** Sorting of the subsurface of the vertex, without scale in the result of the drawing analytical method, monand drawing

The second method leads to more accurate results compared to the first method. But, the values of the angles of inclination $\gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5$ are used for only one variant, and the tangent $T$ of the height of the angles of inclination $t$ as well as the arc length $K$ are overlooked. The existing mathematically modeled drawing is found in analytical methods using the values of the arc, i.e. the angle of inclination that is characteristic at the angular height $t$ of the tangent of the arc and the trigonometric tables listed in arc length $K$ [8]. Also, in regulatory requirements of the radius of Arc [9,10,11], only one of the proposed ones is selected, and the work is carried out. At the starting point and end point of the arc, the dynamic effect on the wagon wheels and wagon (or pieces of Motion Content) is
overlooked. To reduce this dynamic effect [12,13,14,15] tangent to two sides from the angular height of the path

\[ T_{bb} = R \cdot \tan \frac{\theta}{2} \]

it is recommended to select the radius R of the arc based on the design regulatory requirements, with the determination of the distance in meters and the identification of the starting and end points of the arc in the direction of movement.

In the proposed “drawing analytic” method, the accuracy is more than 0.001, the accuracy at the turning angles is 0.1 per second. While carrying out computational work, taking into account all the requirements of the design standards, simultaneously in parallel calculates the coordinates of the characteristic points and shows the results of the analysis of graphic materials in stages at the desired accuracy. We will analyze the “drawing analytic” method that we propose. (Figure 1)

In existing computational methods, the distance between YV1 and YV2 is found by the ratio of the difference in coordinates to the angular height u axis [16,17]. But the following situation occurs when the possible occurrences in the design process are taken into account (see Figures 3 and 4).

The distance between YV1 and YV2 can be found using the formula above. It follows Figure 2 \( L_{BY1-BY2} = T_{BY1} + T_{BY2} \). But, such a situation is allowed only when the safety of movement of the wagon (or several cars) is not related by the “Standards for the design of railway stops and nodes” in order to reduce the distance from the peak of the sorting hump to the accounting point in “difficult” conditions. Also note that the value of the \( T_{BY1} \) and \( T_{BY2} \) depends on the radius R of the arc and the angle of inclination (Figure 3 f =0 and, Figure 4 f >0)

\[
80 \leq R \leq 200; \quad 180 \leq R \leq 300;
\]

\[
T_{BY1} = R \cdot \tan \frac{\beta}{2} \quad T_{BY2} = R \cdot \tan \frac{\beta + \alpha}{2}
\]

\[
T_{BY1} \leq L_{BY1} - b \quad L_{BY1} = l_{pc} + \Delta \quad L_{BY1+} = T_{BY1} + f + T_{BY2}
\]

\[
T_{BY1} \leq L_{BY1+} - T_{BY2} - f
\]

If 6.25 < f < 12.5 “Standards for the design of railway stations and nodes” we reduce the distance f between points 20-20F to the next “Rubka”, i.e. f ≤ 0, by the criterion of normality, of the end-stretch conductor at the krestovina end. As a result, a “Tangent” position occurs at the initial and final points of the arc along the direction. 3,4,5 photos. This situation reduces the dynamic impact forces that arise from the arc to the wagon wheels and from the wheels to the rails, through the weight of the wagon. As a result, the operating life of the wagon wheels and rails is extended.

Mathematical model for principle drawings of the sorting Park (Figure 1b):

\[
L_{BY1-BY2} = ABS\left(\frac{Y_{BY1}-Y_{BY2}}{\alpha}\right)
\]
Here the shortest distance between the two road axes at the place of braking slowing devices ([2,3,5-8] based on regulatory guidelines);

\[ 4.8 \leq e_{\min} \]

\[ \sum l_i \]

the total length of the braking retardant located in the direction of the link;

\[ j \]

the distance from the finished ground to the center of the threaded conductor (on the basis of a regulatory guide) of the brake retardant located in the direction of the link;

\[ l \]

the distance between the center of the threaded conductors located in one direction is 23.97 m;

\[ \alpha \]

the distance from the center of the threaded conductor to the joint located in front of the ramali rail, \( \alpha = 95.6 \) m for a 1/b - brand symmetric threaded conductor;

\[ \beta \]

distance from the center of the relay conductor to the end of the krestovina;

\[ R \]

the extra arc radius at the descent end of the R-sorting hump is R=200 m., the arc radius behind krestovina is 180 m;

\[ e \]

the shortest distance between the E-Link Edge Road axes is 4.80 m;

\[ e \]

the distance between the e – normal road axes is 5.30 m.

3 Results and discussion

The results obtained are taxable:

1. Recommended in the technical design instructions for railway stations and nodes - determining the sum of the distances between the road axes, and then in the design process in finding the coordinates of characteristic points, starting from the last path of the outermost link of the sorting subsurface roads, the thickness of the road axes is ignored. The analysis of current exemplary projects and programs created for PC, as well as those used in the design process (e.g. AutoCAD), mathematical models, shows the following:

- in the straight line model in the design process, the type of line and its weight (VES linii), the rain its thickness is neglected in the traditional way;

- in the process of calculating the coordinates of the elements of the sorting node, the straight line model pushes the sorting node model with its own weight from the starting point of the coordinate Axis (X=0.00 and Y=0.00). For this reason, the concept of line thickness-in the case of line weight-is included in the model;

- the algorithm for calculating the coordinates of the elements of the sorting loop and the models used in it must be implemented, which relies on the starting points of the X and Y axis.
The error is 2-3 meters away when the number of lane arrows in the sorting park is 10 and more. Usually the number of roads in the sorting park will be 20 - 40 and more. As a result, the value of the coordinates found in the mathematical method is fundamentally different from the results of the graphical method, the rain project is distinguished by large errors in the construction process.

2. Also, during the determination of the coordinates of characteristic points, the urination state with the path axis is not formed, the arc found using the initial and axial points of the arc of angular Heights. As a result, the first base point at the beginning of the coordinates (OX and OY) is “pushed”. The distance $\sum Y_i$ between the OX axis of the coordinate and the extreme path of the sorting Park means that the values of the angular height $Y_{BY}$ remain inconsistent, i.e., with a difference of $d = Y_{BY3} - Y_{BY2}$ there is a push to the value V3 (3 and Figure 8).

![Fig. 5](image)

**Fig. 5.** Finding the distance between the angular height of V1 and V2 and the values of the T-tangent, R-radius and, in the case where $f=0$, the graph model for the analysis

![Fig. 6](image)

**Fig. 6.** For the case where the distance $e$ between the angular balances V1 and V2 is constant, and when $f>0$, the graph model for finding the T-tangent, R-radius values as well as their analysis

![Fig. 7](image)

**Fig. 7.** At the initial (20F) and final (22) points of the arc, the simple method has a value of $R=200$ meters (red and air in color), as well as the “Tangent” (yellow in color) state of the arc at those points.
In Figures 5 and 6, The Tangent is T and the value of the twist is in a fixed position, the arc fixed in the traditional way, and its radius is $R=200$ m. (in red), as well as the tangent position $R=94.515$ m. (yellow) difference $\Delta=200.00-94.515=105.485$ m. makes up (Figure 6). Also, $R=140$ m in this urination state. The “Technical design guide for railway stations and nodes” recommends the application in “extremely difficult conditions”. Therefore, we take advantage of the additional possibility in us, that is, we shorten the distance $\Delta_{20-20F}$ between points 20 and 20F towards points 20. The coordinates of 20 points in this case must remain constant, as well as $0 \leq \Delta_{20-20F} \leq L_{20-20F}$. For these $\Delta_{20-20F}$ intermediate values, we define and then carry out the calculation work, each time making changes to the coordinates of the characteristic points and the lengths of the elements (Figure 7).

Fig. 8. At the initial (20) and final (22) points of the arc, the simple $R=$ has a value of 200 meters (in red), as well as the “tangent” (in yellow) state of the arc at those points.

In Figure 8, the distance $\Delta_{20-20F}$ between points 20, 20F is zero, i.e. at $\Delta_{20-20F}=0$ - the angle of inclination remains unchanged at $Y=32^\circ57'45''$ when $T=59.6$ m. da (yellow) $R=201.45$ m. and red and air colors $R=200$ m. This fully complies with the requirements set out in the "technical design instructions for railway stations and nodes".

Note Figure 6, for the case where the distance $E$ between the angular balances $V1$ and $V2$ is constant, and when $d>0$, the T-tangent and R-radius values make the change at the expense of reducing the distance d, the arc is $0 \leq d \leq L_{D-M}$. In this case, the first case is red, $R=200$ m. the second position is tangent position in the air color $R = 94.52$ m. Based on the recommendation of the "technical design guide for railway stations and nodes", we will carry out changes in T-tangent and R-radius values for $d=0$ (Figure 5) red in yellow Ham, respectively $R=200$ m., $R = 180$ m. As a result, the requirements of the router are fully implemented.

Figure 8 has a simple method value of $R=200$ meters at the initial (20F) and final (22) points of the arc (red and air in color), and the “Urinma” of the arc at those points (yellow in color) $R=162.815$ m. the position in is shown, with a turning angle of $Y=32^\circ57'45''$. By zeroing the distance between 20F and 20 points due to the failure of the instruction requirements, the tangent value is 59.6 m from 48.17 meters we convey to. As a result, the value of the radius of the arc in the urination state is 200 meters (see Figure 6).

In the traditional method, finding the tangent T value based on the angles $Y$ and radius $R$ values was done using the formulas given in [18,19,20]. In this method we find the arc of the designed angle height, its radius $R$ at values of 200, 250, 300 and greater that the urination state occurs munkin. In cases where the radius of the arc is $R \leq 200$, the urination state does not occur. This does not meet the requirements set out in the “Technical silencing instructions for railway stations and nodes". As a result, we would have to repeatedly determine the coordinates of all characteristic points and the dimensions of their elements, in the sub-strait of the sorting hump.
The proposed “drawing analytical” method finds the coordinates of the characteristic points of the sorting sub-hump throat, the dimensions of their elements, and the values of the angles of turns. Having the opportunity to bring the arc to the urination state, we will be able to determine the starting HK and the end KK points (9.a-figure).

**Fig. 9.** The value of the angular height \( V_2 \) (280 23'15") is the change in the T-value of tangents in the change of radii from the initial HK and endpoints KK of the arc in the fixed state.

**Fig. 10.** When the radius \( R \) of the circle changes at the angle height, the tangent \( T \) value changes in the urination state.

As we can find the value of tangents by changing the radius of the circle in the analysis of Figure 10 above, that is, in the case of a circle at the height of an angle and in the case of a circle with the same angle of inclination. And the change in the value of radii only leads to a change in the value of the tangent. So, in the “drawing analytical” method we propose, sorting is not limited to finding the coordinates of the characteristic points of the subsurface of the hill (fig.11a), but by following the requirements and rules in the “conditions for the design of railway stations” (TUPS) and the elements of the Strait, relying on the characteristic points found, the optimal option is (Figure 11 vb)
Fig. 11. The proposed “analytic-drawing” method identified sorting is scale-free drawings of the subsurface of the hill.

An analysis of the exemplary drawings of the sorting sub-hump throat determined by the proposed “analytical-drawing” method shows that the number of changes to the length of the paths in the slope decreases sharply during the next stages of the clay-laying process.

4 Conclusions

The difference between the length of the “Heavy path” and the “Light path” of the sorting throat is sharply reduced, the number of switching conductors in the calculated paths is equal. The length of the sections allocated for braking devices is clear, made without any additional reserve lengths.

As a result, the time spent on repeatedly determining the coordinates of all characteristic points and the dimensions of their elements in the unnecessary sorting Hill substructure is reduced to 30 days in the middle.

The difference between the height of the sorting Hill and the power of the braking ridges is reduced. Outthrow, the number of braking devices, for a positive path, will be reduced to at least one.

Currently, the issue of rebuilding the sorting humps at all sorting stations remains a current issue, as the “rolling” bearings completely replace the “sliding” bearings in the wagon parks. For this reason, the application of the clay method, which is considered above, will have a great economic effect.

References


8. Shukhrat Saidivaliev, Ramazon Bozorov, Elbek Shermatov. Kinematic characteristics of the car movement from the top to the calculation point of the marshalling hump. E3S Web of Conferences 264, 05008 (2021) https://doi.org/10.1051/e3sconf/202126405008


20. Jamol Shihnazarov, Yadgar Ruzmetov, Oksana Molchanova, Calculation of solid-state cargo fastener under the influence of longitudinal forces, E3S Web of Conferences 157, 01016 (2020) KTI-2019, https://doi.org/10.1051/e3sconf/202015701016 (Scopus IF = 0,5).