

CloKit®™

USER MANUAL



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Table of Contents

1. Why CloKit®™	3
2. Clothoid Definition	4
3. Exploit CloKit®™, feel the benefits.	5
3.1. How to create a clothoid	5
3.2. How to trim or extend a designed clothoid	11
3.3. How to offset a designed clothoid	13
3.4. How to detect a clothoid	15
3.5. How to get clothoid parameters	16
3.6. How to get clothoid parameters at point	17
3.7. How to draw clothoid geometric data	18
4. CloKit®™'s Handy Tools.	20
4.1. CloKit & the Handy accessories.	20
5. CloKit ®™ Settings Palette	21
5.1. How to call the Settings Palette	21
5.2. CloKit ®™ Settings Form	21
6. Our Target is to transform our experience into your tools.	22

1. Why CloKit®™

CloKit®™ is an Autodesk® AutoCAD® tool that incorporates new functionalities for the **Road Layout**, especially in terms of alignment integration and design. It enables a clothoid to be drawn independently, meaning that the clothoid does not belong to any alignment and is not related to any alignment design element. The geometric data and parameters of the designed clothoid are stored in the drawing and can be retrieved any time.

CloKit®™ can also be used to check whether an Autodesk® AutoCAD® polyline fits clothoid criteria and export its parameters and geometric data.

In Autodesk® AutoCAD®, straight line and circular arc can be drawn directly, but clothoid can only be fitted by polyline or spline with special programs. The geometric data of clothoid are stored in the extended data or external files and cannot be queried and modified. Without special programs, the clothoid data cannot be queried, so these problems limit the application of Autodesk® AutoCAD® in alignment design.

If your workload includes tasks such as horizontal alignment studies, **CloKit®™** is a unique tool that will take this task off your shoulders, in a fast and accurate way.

Do you have to modify an alignment?

Do you have to draw an independent clothoid?

Do you have to trim, extend or offset a clothoid?

Do you have to acquire clothoid's parameters?

Do you have to detect if a polyline in Autodesk® AutoCAD® is a clothoid representation?

Our team, having worked for more than 25 years on Railway Projects, and particularly when performing Coordination Works, deals with such tasks on a permanent basis every day. The need for tools such as **CloKit®™**, was born from our needs. The concept was to help perform those tasks quickly and accurately, having a clear mind focused on the real engineering problems instead of drafting secondary issues.

CloKit®™ works in Autodesk® AutoCAD® and Civil 3D (currently not benefiting from the axis properties in Civil 3D, but soon to become available). Considering that there are many colleagues and friends that have previous versions of Autodesk® AutoCAD®, we are supporting previous versions of Autodesk® AutoCAD® until 2012.

The current version of **CloKit®™** is 103.101.101 and has been issued on January 2021). In order to take full advantage of the tool, please read the present User Manual to get acquainted with all capabilities available.

We are confident, you will find in **CloKit®™** the support you need.

You are welcome to visit our site www.tss.link and check on the other tools that can help you, depending on your specialty and expertise.

TSS has a unique target. To link CAD programming expertise with Engineering and Drafting needs.

Thank you for contacting us.

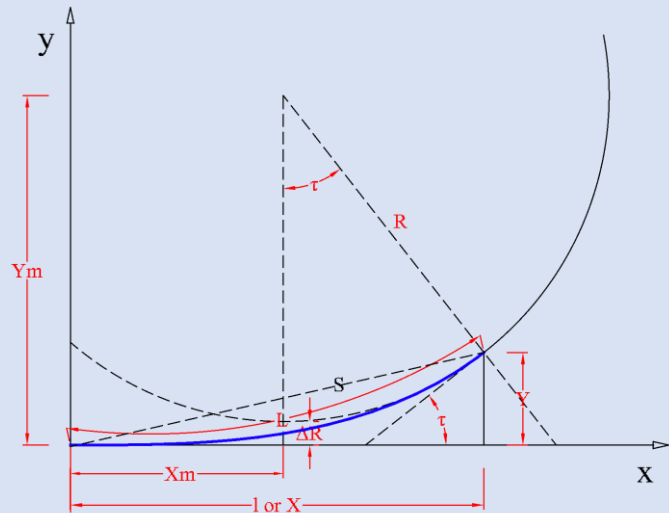
2. Clothoid Definition

In transportation infrastructure design the route is defined based on its axis – the alignment model. For most of the transportation means the alignment design is divided into two main two-dimensional complex strings: the horizontal alignment and the vertical alignment.

The horizontal alignment consists of three types of elements:

- Line segments – straights
- Circular arcs
- Transition curves

A transition curve whose curvature changes smoothly and continuously is arranged between the straight line and circular arc ($R_s = \infty, R_e = R$), or between two circular arcs ($R_s = R_1$ and $R_e = R_2$) with the same deflecting direction. **Clothoid** is the most commonly used form of transition curves. The elements must meet specific connection and combination rules. For example, the adjacent segments must be tangent.



The clothoid equations can be defined starting from the condition of linear relation between radius and length:

$$A = \sqrt{RL}$$

The constant A is called *flatness* or *homothetic parameter* of the clothoid.

The angle τ_i , measured between the tangent in the current point i of the clothoid and the initial direction (where $R = \infty$), is called *direction angle* and is computed dependant on the length of the clothoid arc to the current point L_i , and the current radius R_i :

$$\tau_i = \frac{L_i^2}{2A^2} = \frac{L_i^2}{2RL} = \frac{L_i}{2R_i}$$

where L is the total length of the clothoid and R its final radius.

The Cartesian coordinates of any point of the clothoid, at a distance l away from its starting point, can be defined starting from the above equations; using [Euler \(Fresnel\) integrals](#) for sine and cosine, these coordinates are given by the following infinite series:

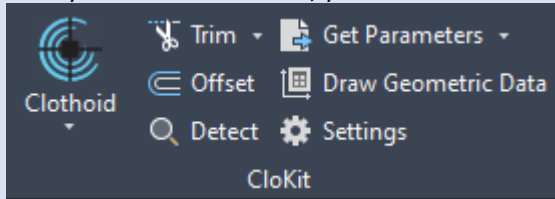
$$x = l - \frac{l^5}{40(RL)^2} + \frac{l^9}{3456(RL)^4} - \frac{l^{13}}{599040(RL)^6} + \dots$$

$$y = \frac{l^3}{6RL} - \frac{l^7}{336(RL)^3} + \frac{l^{11}}{42240(RL)^5} - \frac{l^{15}}{9676800(RL)^7} + \dots$$

3. Exploit CloKit®™, feel the benefits.

See how CloKit®™ can save up your time.

After you install CloKit®™, you will find the CloKit panel in TSS ribbon.



3.1. How to create a clothoid

With CloKit®™ you are able to calculate and draw independent clothoids; transition curves between the straight line and circular arc, or between two circular arcs.

For the clothoid curves a discretisation of the theoretical curve is drawn as a polyline. The drawing interval (density of vertices) may be specified on the Settings Palette (See §5 Settings Palette). This parameter only affects the representation as the results are always calculated analytically.

CloKit®™ provides **three ways** to create a clothoid:

A. Between two entities

Add a free clothoid between two entities with different radius.

You don't have to specify clothoid's length or A parameter's value because free clothoid have only one geometric solution.

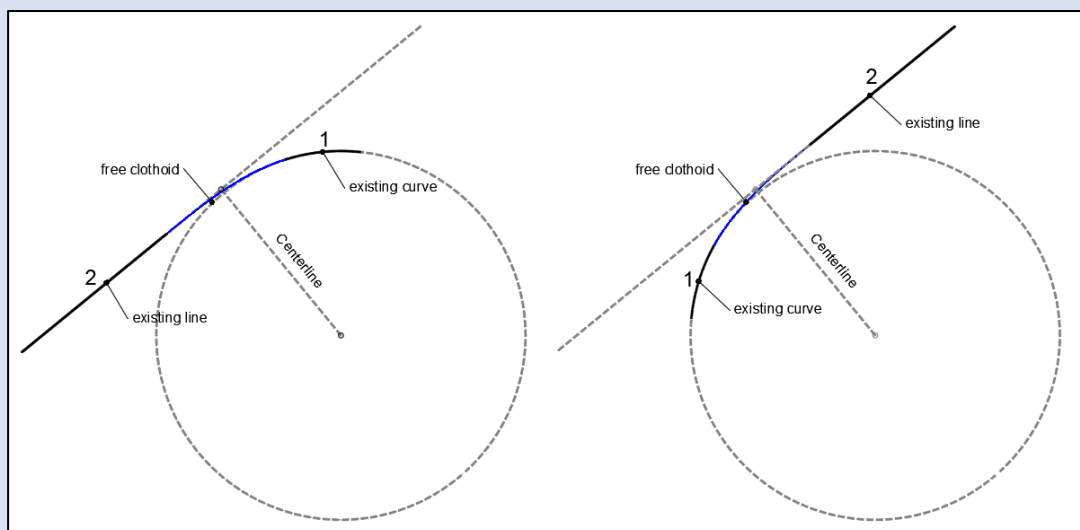
CloKit®™ makes the calculation!

This command enables the transition clothoid to be inserted either between a line and a curve (simple clothoid) or between two curves (egg-shaped clothoid).

Note1: A curve can be either arc or circle.

Note2: In order to create clothoid curves there are requirements concerning the initial line and circle and the distance between them. For the egg-shaped clothoid to exist, the curve having the smaller radius must be defined within the curve having a greater radius.

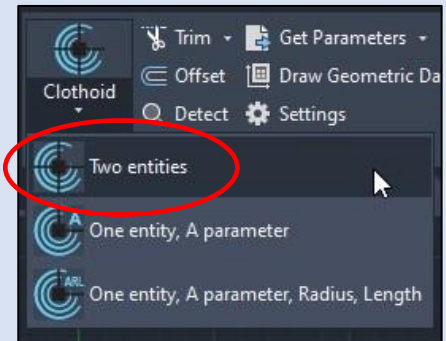
The solution depends on the type of adjacent entities (1, 2), and the side in which they are selected. The following illustrations show a free clothoid between a line and a curve.



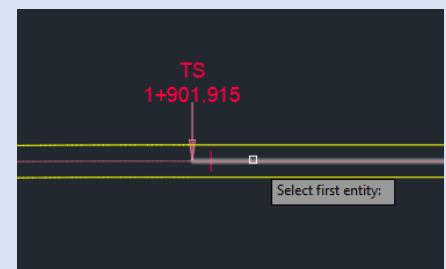
The left illustration shows a clockwise solution, where entity 2 (Line entity) lies to the left of Centerline. The second illustration shows a counterclockwise solution, where entity 2 lies to the right of Centerline.

To create a free clothoid follow the steps below:

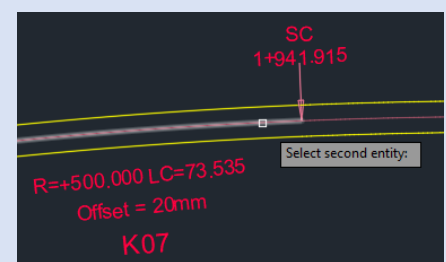
a. Click the [Clothoid] → [Two Entities] button on TSS ribbon or type “tss_clokit_twotentities” at Autodesk® AutoCAD® command line.



b. CloKit™ will ask from you to select the first entity from your active drawing. The first entity can be either line, arc, circle or polyline.

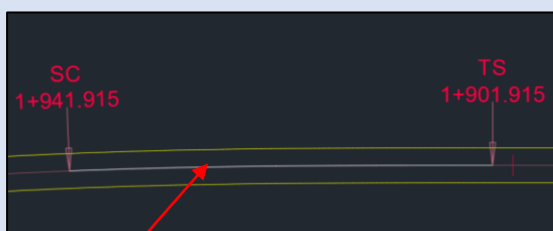


c. Subsequently, CloKit™ will request from you to select the second entity from your active drawing. The second entity can also be either line, arc, circle or polyline.

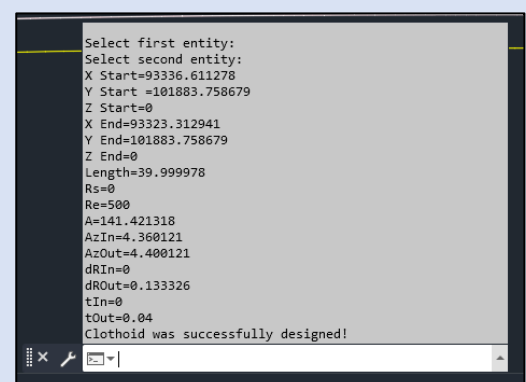


Note3: If the selected entity is a polyline, CloKit™ will consider the part/segment of the polyline you clicked as the first/second entity.

d. After the successful selection of the two entities, CloKit™ will draw the calculated clothoid and write its parameters at command line.



The calculated clothoid



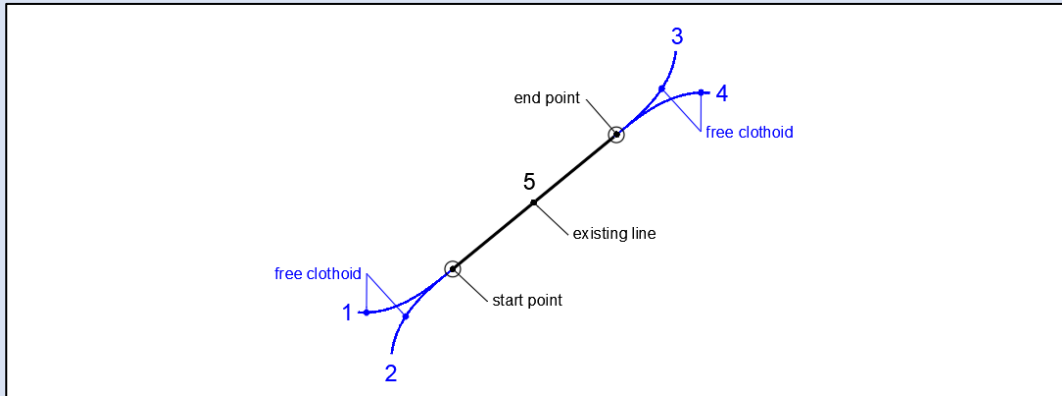
B. One entity , A parameter

Add a fixed clothoid to the end of an existing line in Autodesk® AutoCAD®, given the A parameter.

Use this command in situations where you need to create a simple clothoid whose beginning coincides with the end or start of an existing line.

The start point, curve direction and length of the clothoid depend on the position of your mouse cursor in relation to the existing line.

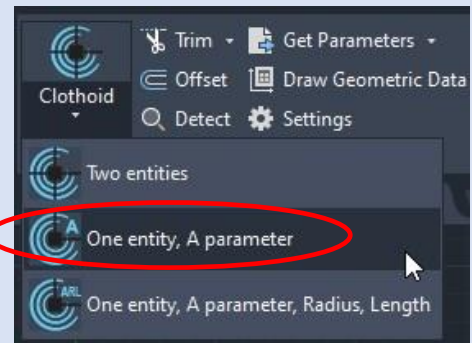
The following illustration shows the various clothoid curves (1,2,3,4) that can be drawn, starting from an Autodesk® AutoCAD® line (5).



The first and second entities (1,2) are clothoids starting from the start point of the existing line (5). In clothoid (1) the cursor position was to the left of the line, while in clothoid (2) was to the right of the line. The (3,4) clothoids are drawn in the same way, starting from the end point of the line (5).

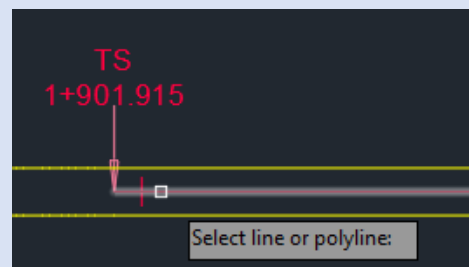
To create a fixed clothoid on a line given the A parameter, follow the below steps:

- Click the [Clothoid] → [One Entity, A parameter] button on TSS ribbon or type "tss_clokit_oneentityA" at Autodesk® AutoCAD® command line.

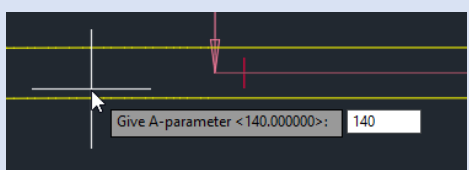


- CloKit™ will ask from you to select a line or polyline from your active drawing.

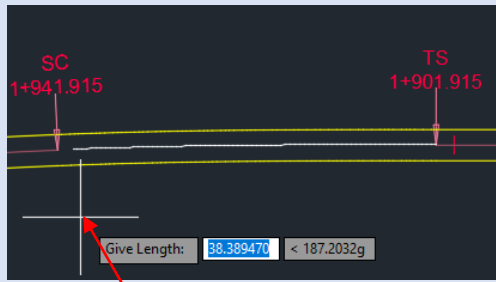
Note4: If the selected entity is a polyline, the segment type of the part you clicked must be line, as this command only creates simple clothoids (does not support egg-shaped clothoids).



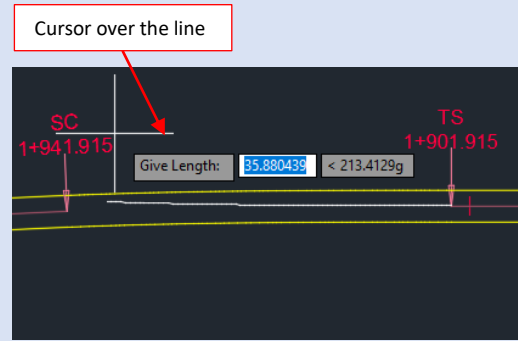
- At the prompt specify the A-parameter of the desired clothoid.



- d. Now move your mouse cursor and CloKit™ will start drawing the clothoid. By changing the mouse position in relation to your selected line, CloKit™ will calculate and draw the corresponding clothoid.



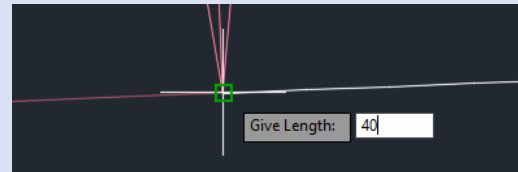
Cursor below the line



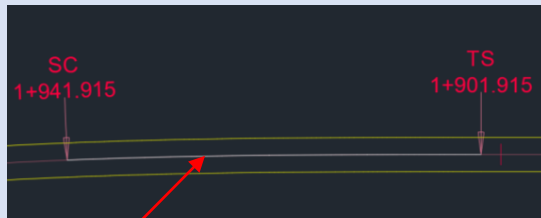
Cursor over the line

Note5: The length of the designed clothoid is equal to the distance from clothoid's start point to the point where your mouse cursor is located in your active drawing.

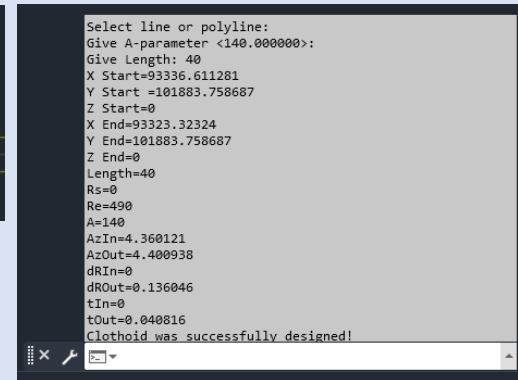
- e. Finally, click on a point in your active drawing or type clothoid's length at the prompt window and press enter.



- f. CloKit™ will draw the calculated clothoid and write its parameters at command line.



The calculated clothoid

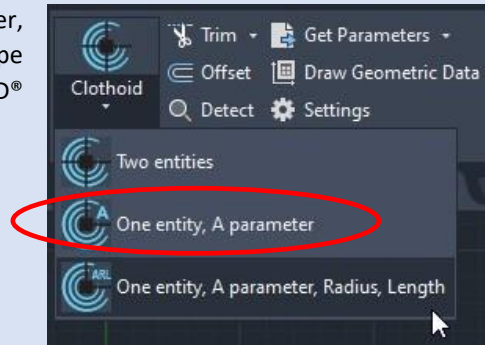


C. One entity , A Parameter – Radius – Length

Add a fixed clothoid to the end of an existing entity in Autodesk® AutoCAD®, which can be defined by a set of two parameters chosen between Length / Radius / A-parameter. Use this command in situations where you need to create a clothoid (simple or egg-shaped) whose beginning coincides with the end or start of an existing line, polyline or arc.

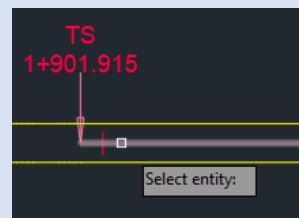
To create a fixed clothoid on an entity, given a set of two parameters (Length/ Radius/ A-parameter) follow the steps bellow:

- a. Click the [Clothoid] → [One Entity, A parameter, Radius, Length] button on TSS ribbon or type “tss_clokit_oneentityARL” at Autodesk® AutoCAD® command line.



- b. CloKit™ will ask you to select an entity, to which the clothoid will be attached.

Note6: The selected entity can be any line, polyline or arc created in Autodesk® AutoCAD®.

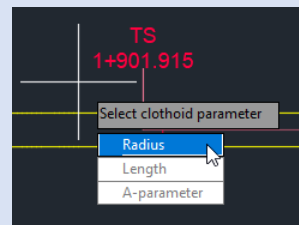


Note7: If the selected entity is a polyline, CloKit™ will consider the part/segment of the polyline you clicked as the desired entity.

- c. Then you are prompted to select one of the three following parameters to define first:

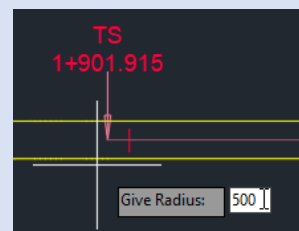
a) Radius b) Length c) A - parameter.

With [**R**adius] option you are able to define clothoid's end/exit radius. If you choose the [**L**ength] option you can specify clothoid's length, while with the [**A**-parameter] option you can set the desired A – parameter of the clothoid.

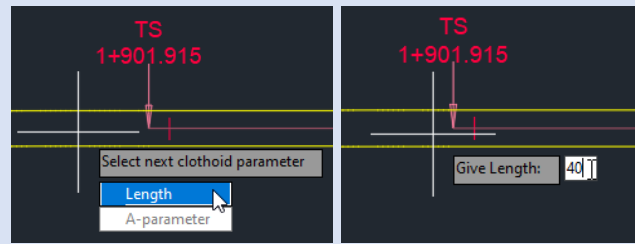


Note8: The value zero in clothoid's end Radius definition corresponds to an infinite radius.

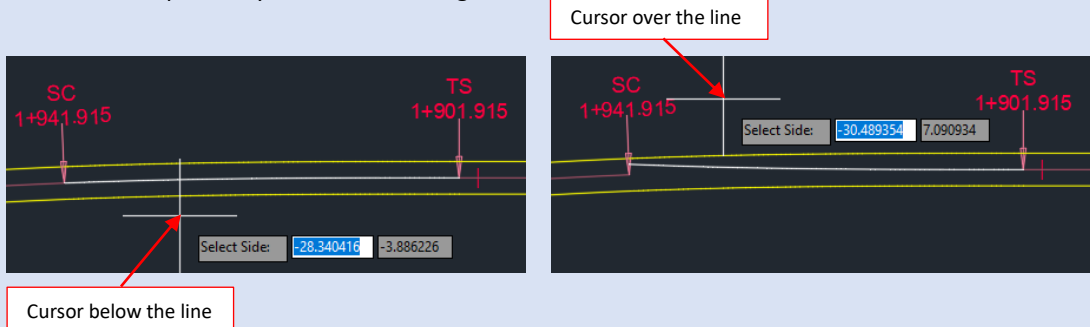
- d. After choosing one of the above parameters, CloKit™ will request from you to specify its value.



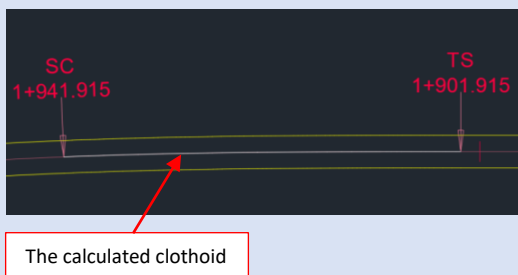
- e. Follow the same procedure in order to define the second parameter required for the clothoid calculation. Choose one of the two remaining parameters that have not yet been set and enter its value.



- g. Now CloKit[™] will ask you to select a side in order to define the curve direction and the start point of the clothoid. By changing the cursor's position in relation to your selected entity CloKit[™] will calculate and draw the corresponding clothoid. Click on a point in your active drawing so as to set the drawing direction/side.



- h. After all the required parameters for the clothoid's calculation are successfully defined, CloKit[™] will draw the calculated clothoid and write its parameters at command line.



```

Select entity:
Select clothoid parameter [Radius/Length/A-parameter]:
R
Give Radius: 500
Select next clothoid parameter [Length/A-parameter]: L
Give Length <40.000000>:
Select Side:
X Start=93336.611281
Y Start =101883.758687
Z Start=0
X End=93323.312937
Y End=101883.758687
Z End=0
Length=40
Rs=0
Re=500
A=141.421356
AzIn=4.360121
AzOut=4.400121
dRIIn=0
dROut=0.133326
tIn=0
tOut=0.04
Clothoid was successfully designed!

```

Tip1: CloKit[™] gives you the possibility to extract the clothoid parameters once drawn (See [§3.5](#) How to get clothoid's parameters).

Tip2: Use TSS Locator[™] to find/locate a point or a KP value along the designed clothoid.

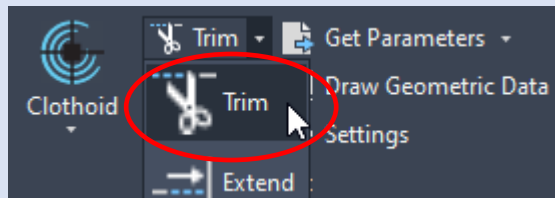
3.2. How to trim or extend a designed clothoid

CloKit™ allows you to shorten or lengthen clothoids to meet the edges of other objects. This means that you can first create a clothoid with CloKit™ and then later adjust it to fit exactly between other entities.

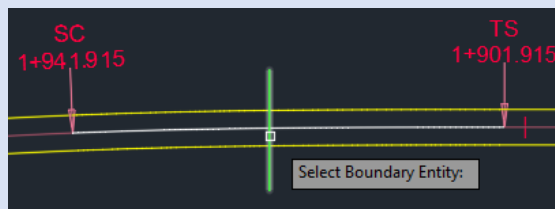
A. Trim

To trim a clothoid made with CloKit™ follow the steps below:

- Click on [Trim] button on TSS ribbon or type "tss_clokit_trim" at Autodesk® AutoCAD® command line.

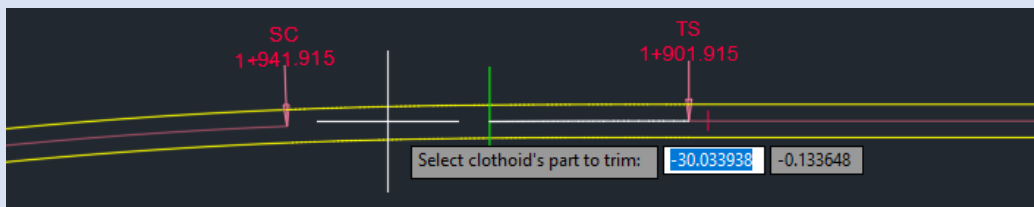
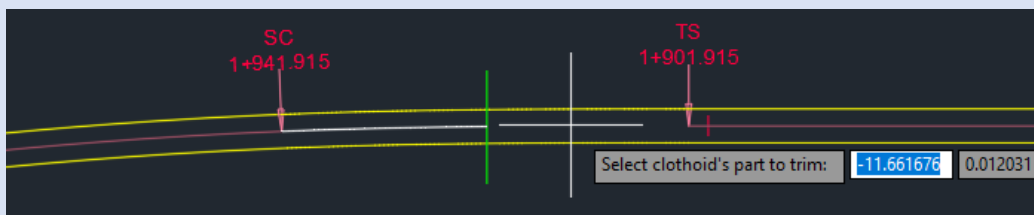


- CloKit™ will ask you to select the boundary entity i.e., the object to serve as cutting edge.

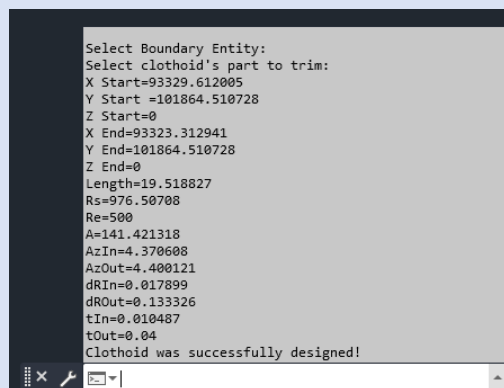
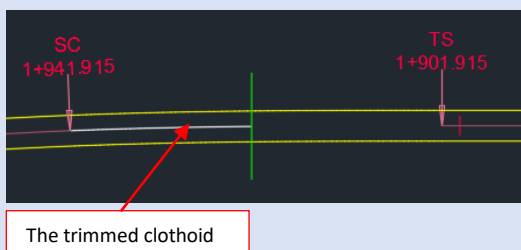


Note1: The selected boundary entity can be any line, polyline, circle or arc created in Autodesk® AutoCAD®.

- Finally, select the part of the clothoid that you want to get trimmed by clicking your mouse near it.



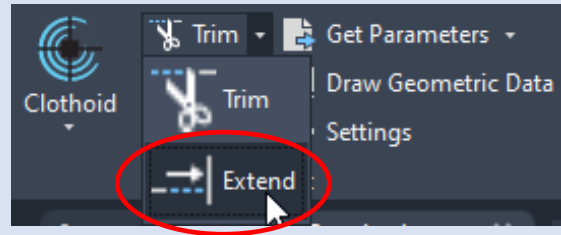
- CloKit™ will add the new clothoid at your active drawing and write its parameters at command line.



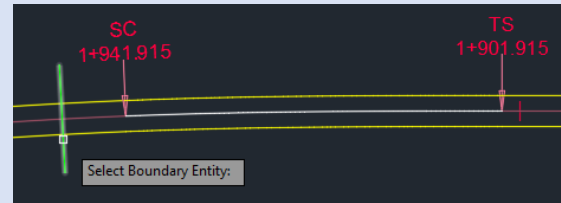
B. Extend

To extend a clothoid made with CloKit[®]™ follow the steps below:

- Click on [Extend] button on TSS ribbon or type "tss_clokit_extend" at Autodesk[®] AutoCAD[®] command line.

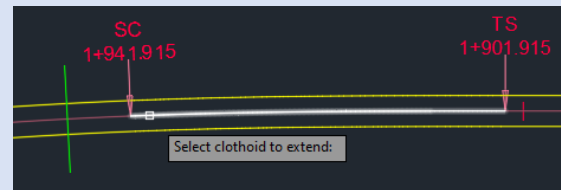


- CloKit[®]™ will ask you to select an entity from model; the object to serve as boundary edge.

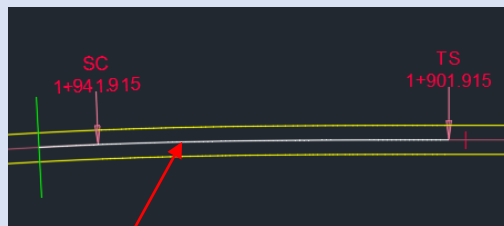


Note2: The selected boundary entity can be any line, polyline, circle or arc created in Autodesk[®] AutoCAD[®].

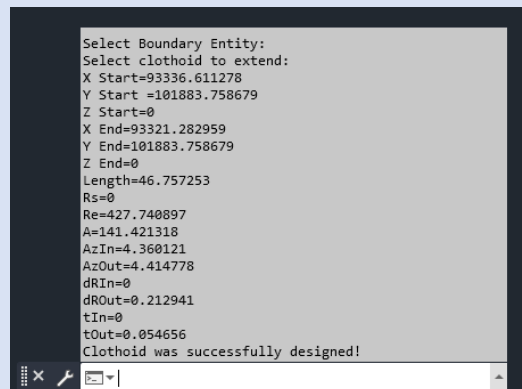
- Finally, select the clothoid to be extended.



- CloKit[®]™ will add the new clothoid at your active drawing and write its parameters at command line.



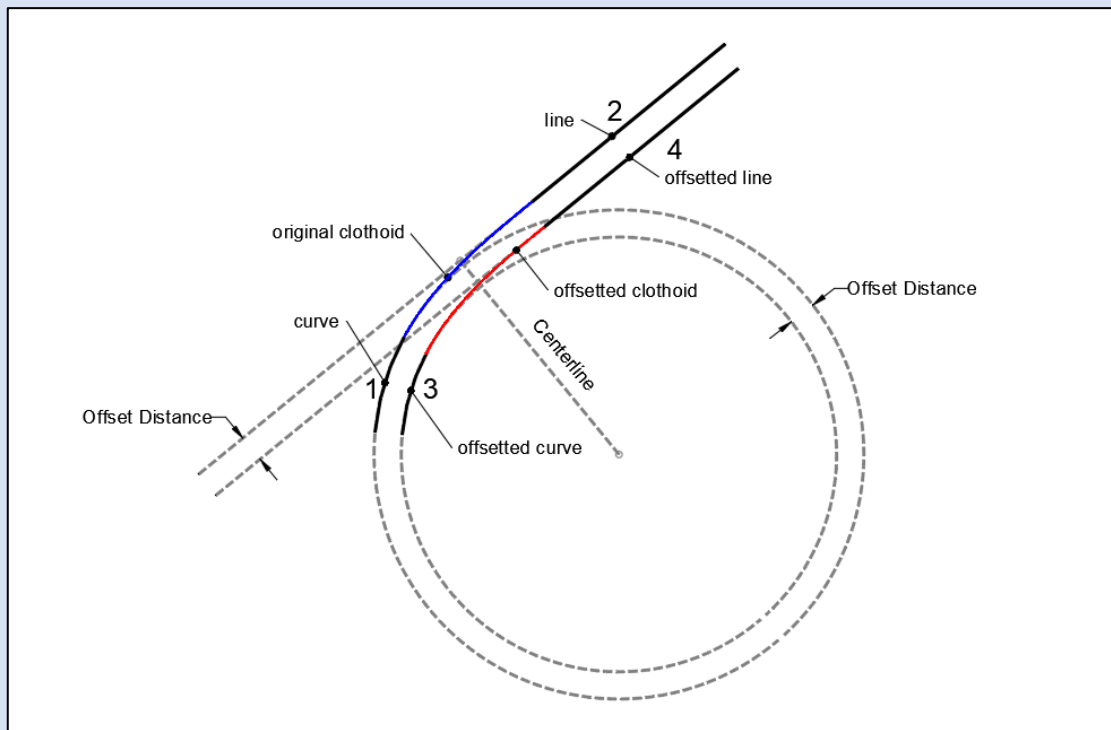
The extended clothoid



3.3. How to offset a designed clothoid

CloKit[®]™ gives you the possibility to offset a clothoid by specifying an offset distance.

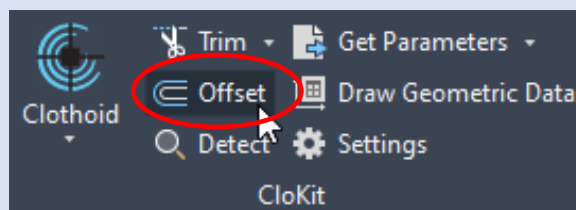
This means that you can create a new clothoid which is calculated by offsetting the adjacent elements (the line segment – arc segment in case of simple clothoid or two arc segments in case of egg-shaped clothoid) of the original clothoid by a given distance. The following illustration shows an offset clothoid made with CloKit[®]™.



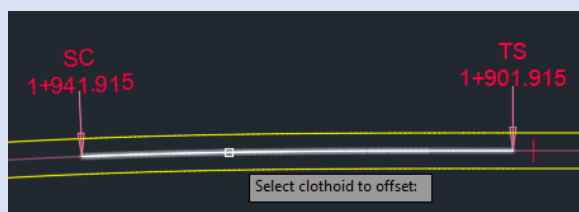
With this command CloKit[®]™ offsets the line (2) and the curve (1) by a given distance and then calculates the clothoid which is connecting the two offset entities (3,4). The offset side depends on the position of your mouse cursor in relation to the original clothoid.

To offset a clothoid made with CloKit[®]™ follow the steps below:

- Click on [Offset] button on TSS ribbon or type “tss_clokit_offset” at Autodesk[®] AutoCAD[®] command line.

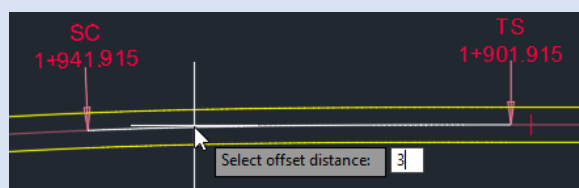


- CloKit[®]™ will ask you to select a clothoid to offset.

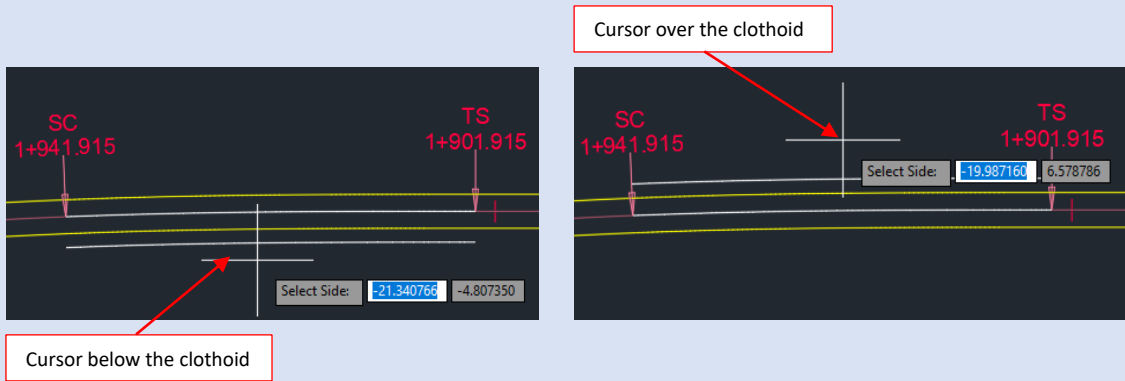


Note1: The selected entity must be a clothoid made with CloKit[®]™.

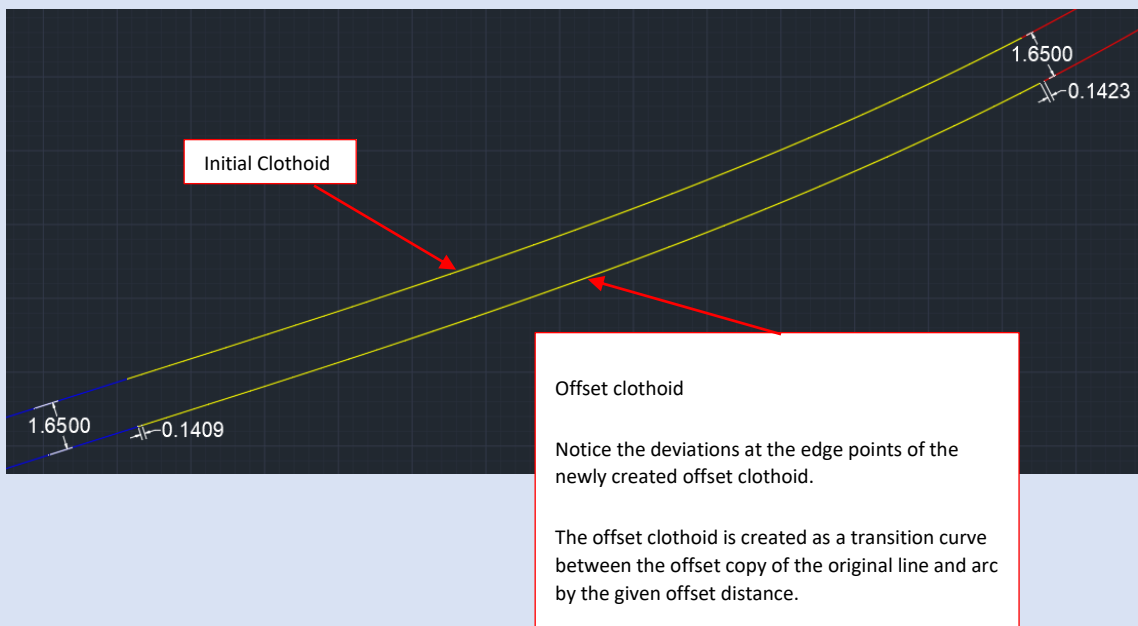
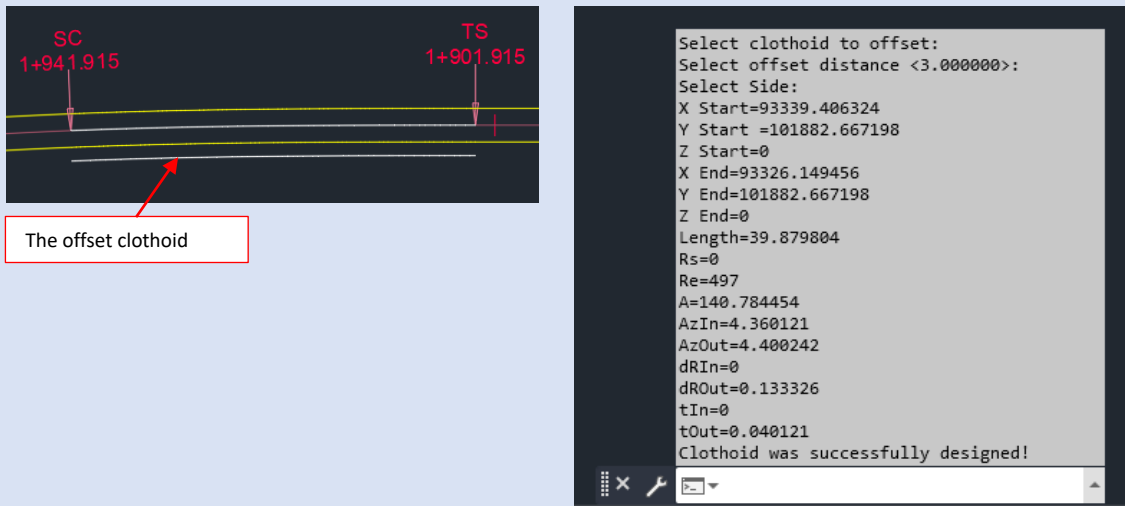
- Then you have to specify the offset distance.



- d. Now CloKit[®]™ will ask you to select a side in order to define whether the new clothoid is to be offset inside or outside of the original selected clothoid. By changing the cursor's position in relation to your selected entity CloKit[®]™ will calculate and draw the corresponding clothoid. Click on a point in your active drawing so as to set the offset side.



- e. CloKit[®]™ will add the new clothoid at your active drawing and write its parameters at command line.



3.4. How to detect a clothoid

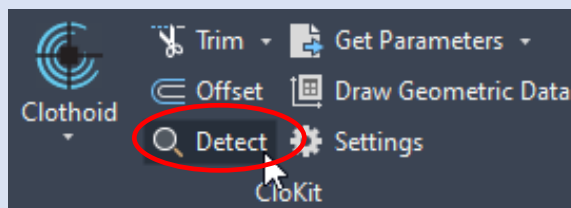
CloKit[®]™ allows you to investigate whether a polyline drawn in Autodesk[®] AutoCAD[®] meets clothoid criteria and is, therefore, a representation of a clothoid.

With this command you can extract the geometric data and parameters of any polyline representing a clothoid that may have been imported in Autodesk[®] AutoCAD[®] by other special programs.

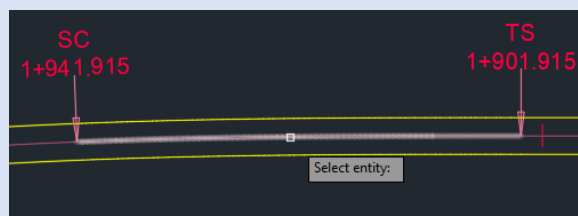
In order to be able to detect a clothoid it is necessary to include in your active drawing the adjacent segments (the line segment – arc segment in case of simple clothoid or two arc segments in case of egg-shaped clothoid) that this polyline connects.

To detect a clothoid follow the steps bellow:

- a. Click on [Detect] button on TSS ribbon or type "tss_clokit_detect" at Autodesk[®] AutoCAD[®] command line.



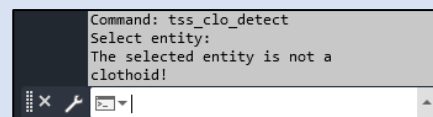
- b. CloKit[®]™ will ask you to select an entity from model.



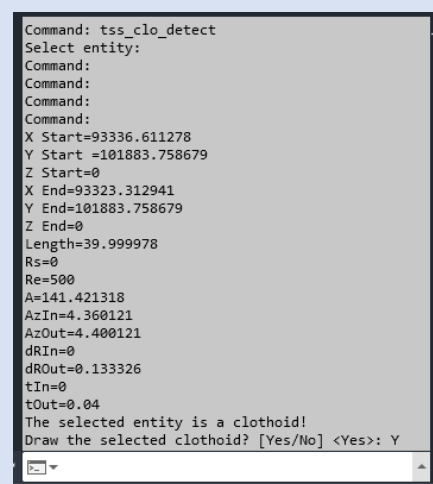
Note1: The selected entity must be polyline.

- c. Then CloKit[®]™ will calculate the clothoid that fits between the two adjacent segments of the selected polyline and compare it (by distance) with the selected entity.

If the selected entity is **not** a clothoid, a message will appear in Autodesk[®] AutoCAD[®] command line.

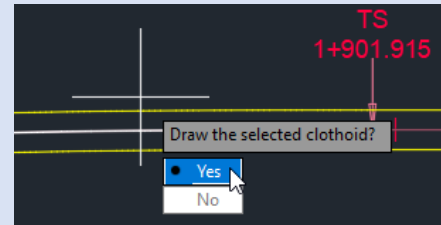


Otherwise, if the selected entity meets clothoid's criteria, CloKit[®]™ will write clothoid's parameters at command line and a message will appear notifying you that the selected entity is a clothoid.



Tip1: The detection fuzz distance, i.e. the detection accuracy, may be specified on the Settings Palette (See §5 Settings Palette).

- d. You are then asked to choose whether you want to draw the clothoid calculated with CloKit[®]™. If you want to include the calculated clothoid in your active drawing select [Yes], otherwise select [No].



3.5. How to get clothoid parameters

CloKit[®]™ gives you the ability to extract the design parameters from clothoid curves created by CloKit[®]™ and write them in a table at your active drawing.

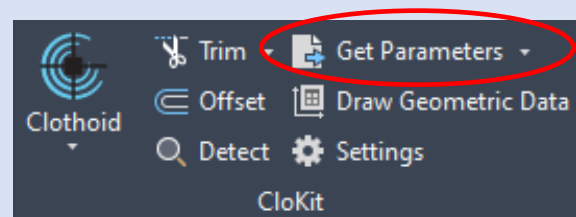
The clothoid parameters shown in the data table are listed below:

X Start	The x coordinate of the starting point
Y Start	The y coordinate of the starting point
Z Start	The z coordinate of the starting point
X End	The x coordinate of the ending point
Y End	The y coordinate of the ending point
Z End	The z coordinate of the ending point
Length	Clothoid Length
Rs	The radius of curvature at the start point
Re	The radius of curvature at the end point
A	Clothoid A - parameter
AzIn	Start azimuth of the clothoid in radians
AzOut	End azimuth of the clothoid in radians
dRIn	Start Radius difference (Start Shift)
dROut	End Radius difference (End Shift)
tIn	Angle of tangent at the start of the clothoid in radians
tOut	Angle of tangent at the end of the clothoid in radians

Note1: The value zero in clothoid's Radius (end or start) corresponds to an infinite radius (line).

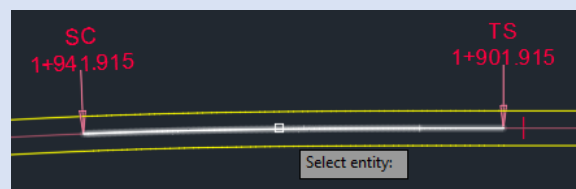
To extract clothoid's parameters follow the steps below:

- a. Click on [Get Parameters] button on TSS ribbon or type "tss_clokit_getparameters" at Autodesk[®] AutoCAD[®] command line.

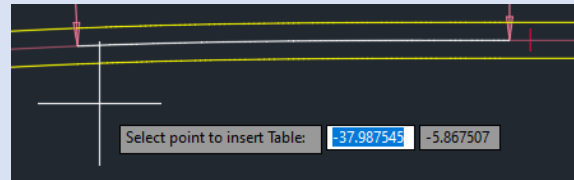


- b. CloKit[®]™ will ask you to select an entity from model.

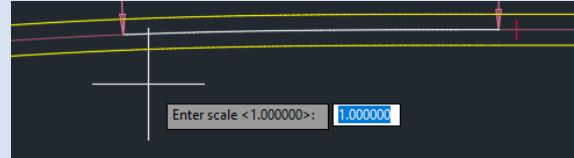
Note2: The selected entity must be a clothoid made with CloKit[®]™.



- c. Then, you have to specify a point to insert your clothoid data table.



- d. After you successfully pick an insertion point, CloKit™ will ask you to select a scale for your data table.



- e. CloKit™ inserts a data table at your active drawing containing clothoid parameters and also writes them at command line.

X start	93336.611278
Y start	101883.758679
Z start	0
X end	93323.312941
Y end	101846.037001
Z end	0
Length	39.999978
Start Radius	0
End Radius	500
A-parameter	141.421318
AzIn	4.360121
AzOut	4.400121
dRIn	0
dROut	0.133326
tIn	0
tOut	0.04

```
Select entity:
Select point to insert Table:
Enter scale <1.000000>:
X Start=93336.6112780837
Y Start =101883.758678919
Z Start=0
X End=93323.3129405916
Y End=101846.037001454
Z End=0
Length=39.9999784001048
Rs=0
Re=500.000000003363
A=141.421318054199
AzIn=4.3601214817618
AzOut=4.40012146016164
dRIn=0
dROut=0.133325570560544
tIn=0
tOut=0.0399999783998357
```

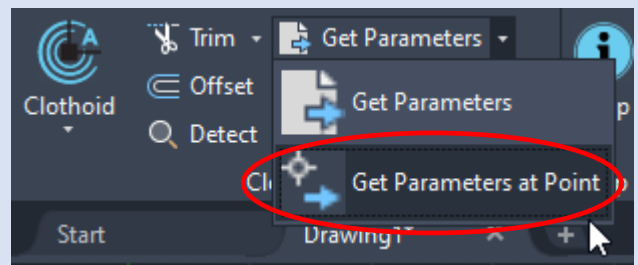
Note2: The number of decimal places displayed in clothoid’s data table is based on your drawing units precision settings.

Tip1: You can customize the text height of the data table on the Settings Palette ([See §5 Settings Palette](#)).

3.6. How to get clothoid parameters at point

If you need parameters at a specific point on the clothoid curve, use [Get Parameters at Point] and retrieve them from the inserted table. The calculated parameters are: point’s coordinates, clothoid direction (azimuth) at this point, length from starting point to this point along the clothoid, clothoid radius at this point and clothoid A-parameter (constant).

- a. Click on [Get Parameters at Point] button on TSS ribbon or type “tss_clokit_getparametersatpoint” at Autodesk® AutoCAD® command line
- b. CloKit™ will ask you to select an entity from model



- c. CloKit™ will ask you to define the point giving either the point, or the length, or the radius.
- d. If you select [Point], CloKit™ will ask you to click on a point in the drawing and it will calculate its projection to the clothoid curve. CloKit™ will calculate the parameters.

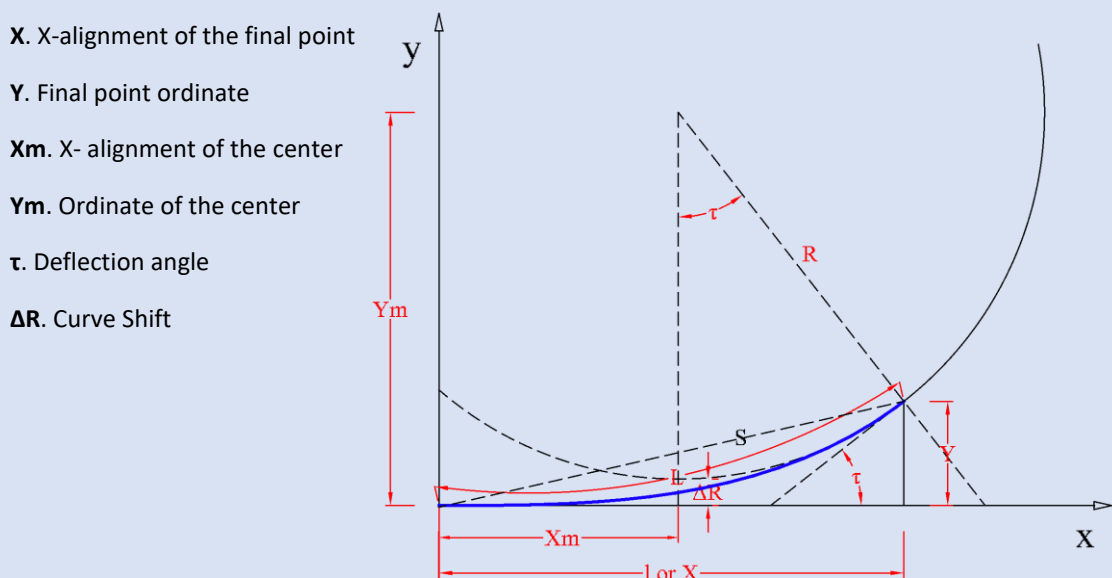
- e. If you select [Length], CloKit™ will ask you to give the desired length and it will calculate the point's parameters measuring the length from clothoid starting point along the clothoid.
- f. If you select [Radius], CloKit™ will ask you to give the desired radius and it will calculate the point's parameters where clothoid gets the given radius.
- g. Afterwards, CloKit™ will ask you to give table's location and scale factor. Finally, CloKit™ will draw a vertical line at the calculated point and add the table with the parameters in the current drawing as a block.

Clothoid Parameters at Point	
X	57.7945
Y	7.7877
Z	0
Az	6.1481
Length	27
Radius	1200
A-parameter	180

3.7. How to draw clothoid geometric data

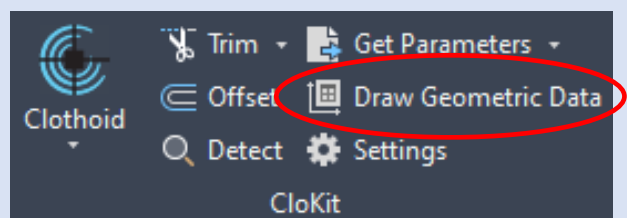
CloKit™ gives you the possibility to draw the geometric data of a clothoid made with CloKit™.

The geometric data are shown in the image below:



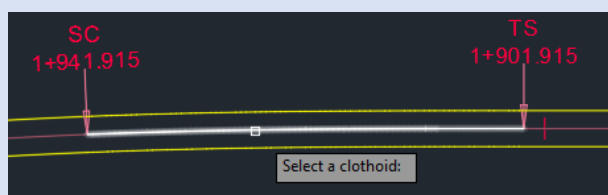
To draw clothoid's geometric data follow the steps bellow:

- a. Click on [Draw Geometric Data] button on TSS ribbon or type "tss_clokit_drawgeometricdata" at Autodesk® AutoCAD® command line.

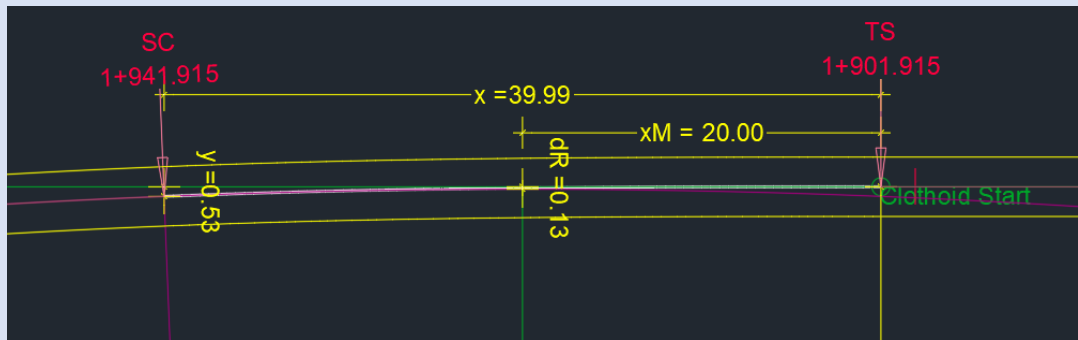


- b. CloKit™ will ask you to select a clothoid from model.

Note1: The selected entity must be a clothoid made with CloKit™.



- c. After the successful selection of an entity, CloKit[®]™ will add a block reference at your active drawing containing all the entities required (lines, circles, texts, dimensions) to visualize the geometric data of the selected clothoid.



4. CloKit®™'s Handy Tools.

4.1. CloKit & the Handy accessories.

The real benefits using **CloKit**®™ become more obvious when applied to certain types of project, such as **Alignment Design** projects. It becomes really handy every time there is a need to create an alignment in Autodesk® AutoCAD® or modify an existing one.

With **CloKit**®™ you are able to draw an independent clothoid (simple or egg-shaped), meaning that the clothoid does not belong to any alignment and is not related to any alignment design element. The parameters of the designed clothoid are stored in the drawing and can be retrieved any time.

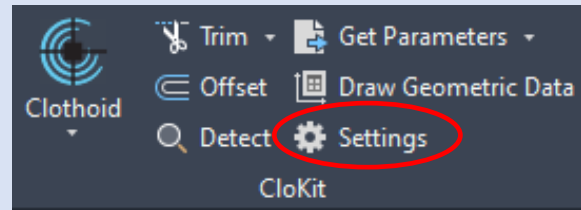
CloKit®™ can also be used to extract the geometric data and parameters of any polyline depicting a clothoid, even if it has been imported in Autodesk® AutoCAD® by other special programs. So, in case you are working on an Autodesk® AutoCAD® drawing that contains clothoid curves imported from other programs and you don't know their geometric data, **CloKit**®™ is the tool you need to retrieve them!

*Tip1: Visit www.tss.link to get acquainted with TSS **ToolKit**®™. Bring in your work some of the most advanced and intelligent analysis tools that will help you perform tasks you wouldn't even think you could, previously.*

5. CloKit ®™ Settings Palette

5.1. How to call the Settings Palette

In AutoCAD environment, at the command line, type “tss_clokit_settings” or press the button [Settings] on the TSS ribbon in order to gain access to CloKit®™ Settings Palette and be able to modify the calculation/design parameters for clothoids.



Note1: You can set different properties/settings on every drawing and CloKit®™ will remember the settings you defined.

5.2. CloKit ®™ Settings Form

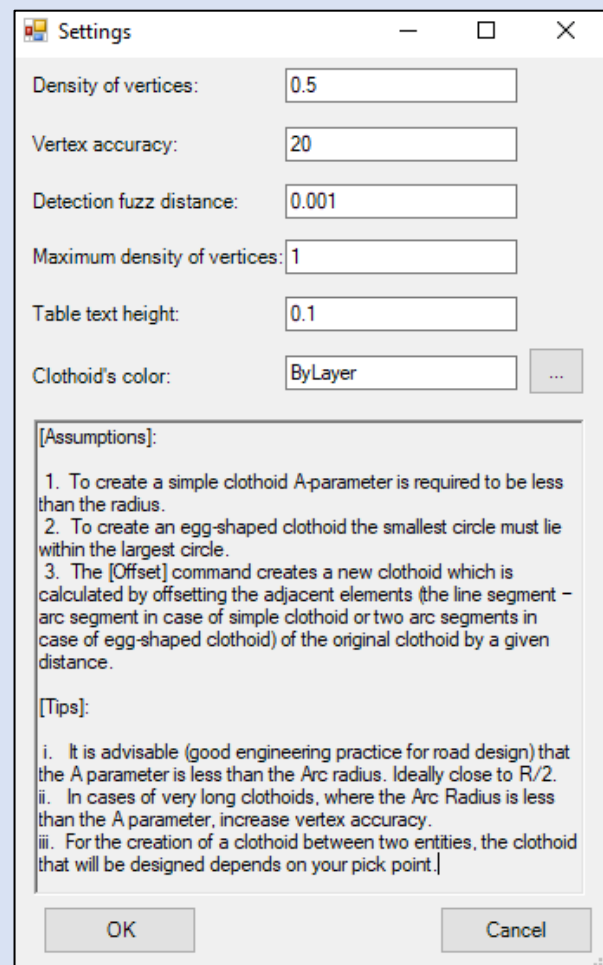
CloKit®™ Settings Form opens and you can modify the parameters that concern clothoid’s calculation/depiction.

On the top you can set the parameters necessary for the calculation and design of a clothoid. These parameters are:

- A. **Density of vertices:** Vertices’ distance in m.
- B. **Vertex Accuracy:** Number of sequence factors for the clothoid’s calculation.
- C. **Detection fuzz distance:** The accuracy to detect if a polyline is a clothoid
- D. **Maximum density of vertices:** Maximum vertices’ distance.
- E. **Table text height:** The text height of clothoid’s data table.
- F. **Clothoid’s color:** Clothoid’s display color.

At the bottom of the Palette you will find some Assumptions & Tips concerning the clothoid creation.

Press [OK] button and all modifications will be applied at the current drawing.

A screenshot of the 'Settings' dialog box. It has a title bar with 'Settings' and standard window controls. The dialog contains several input fields: 'Density of vertices' (0.5), 'Vertex accuracy' (20), 'Detection fuzz distance' (0.001), 'Maximum density of vertices' (1), 'Table text height' (0.1), and 'Clothoid's color' (ByLayer). Below these fields is a text area containing '[Assumptions:]' and '[Tips:]' sections. The 'OK' and 'Cancel' buttons are at the bottom.

Save your drawing and the parameters get saved in the drawing. They will be automatically retrieved the next time you open this drawing.

6. Our Target is to transform our experience into your tools.

Get connected with our sources at www.tss.link and gain access to all our intelligent tools created by our team.

Our goal is to support Engineering and let Engineering community spend more time on real Engineering problems and less on drawings tricks and tweaks.

Sincerely,

TSS TEAM