007 2020-01-12 EN Flexible tubes

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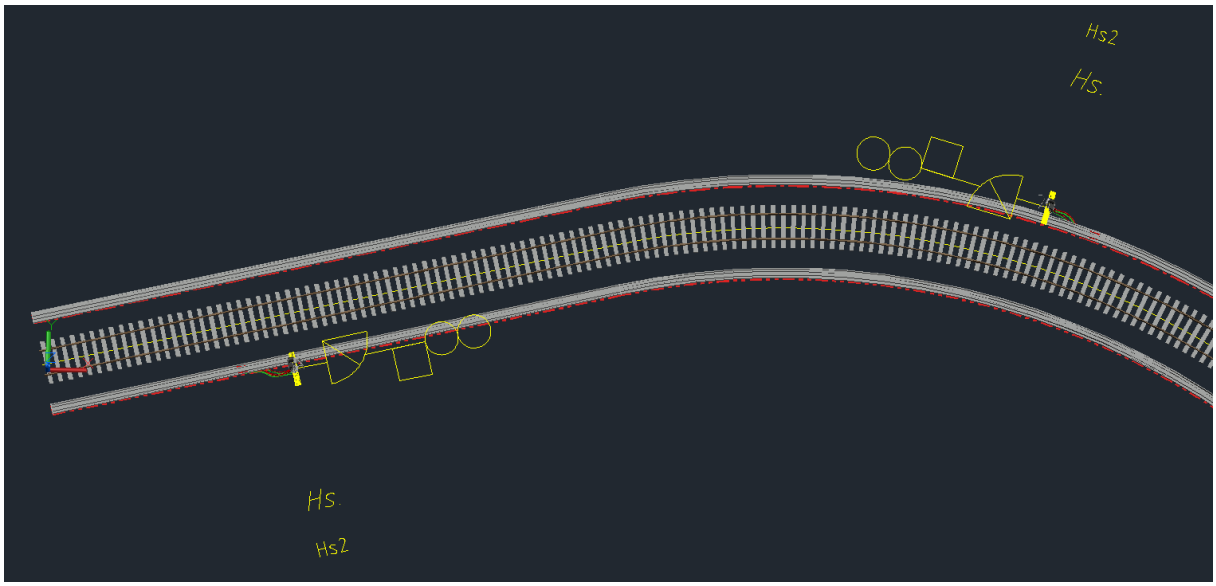
Revised 2020-01-12

- This tutorial's goal is to teach you how to create flexible tubes.
- Assumed RailCOMPLETE skills: Draw alignment, offset alignment.
- Assumed railway skills: You are familiar with cabling, cable ducts and flexible tubes. You know the concept of an alignment, involving horizontal geometry and vertical profile.
- Time to spend here: Newbie: 1 h / Intermediate: 30 min / Proficient: 15 min / Expert: 10 min.

- Notice to users with non-English versions of AutoCAD – see footnote[1].
- This tutorial was prepared using software release 2019.1.1547 with Norwegian DNA version "2019.1 beta(e)"," 2020-01-12T20:30+01:00;2019.1".
- Note: If you are using AutoCAD version 2017 or older, then open the 2013-format version of the tutorial DWG file.



1. Start AutoCAD with RailCOMPLETE, then open the 'General Tutorials' folder and locate the DWG file named after this tutorial. You can either type RC-ShowGeneralTutorials or you can locate the button below the RC logo in the upper left corner of your AutoCAD window.

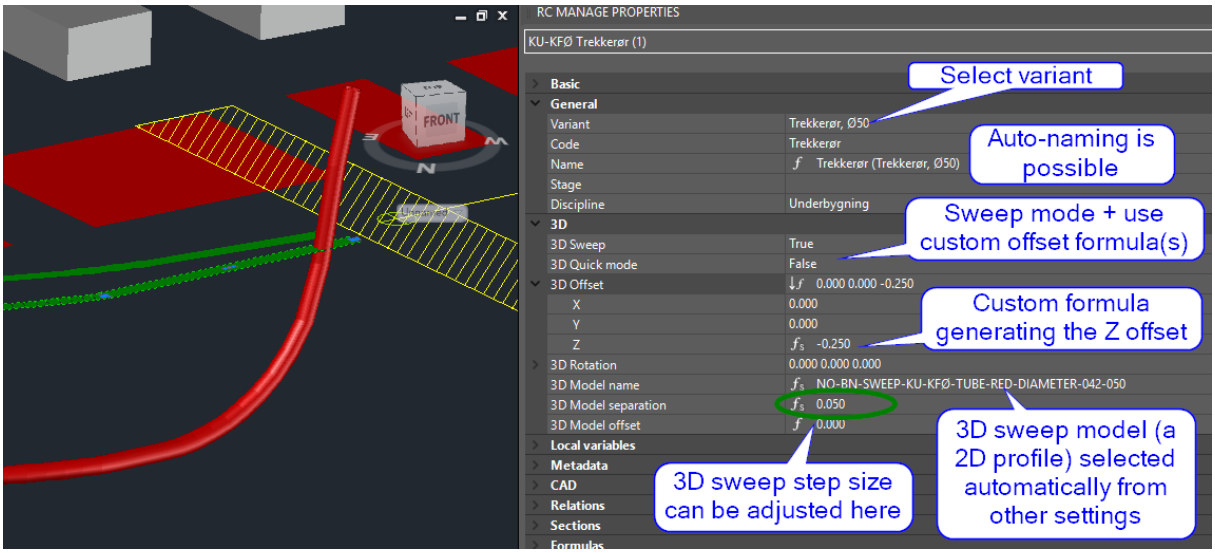
[1] Your AutoCAD session has probably been started from a Windows shortcut of the type: "C:\Program Files\Autodesk\AutoCAD 2019\acad.exe" /product ACAD /language "fr-FR", where "fr-FR" means "French language, France's version", or similar. Native AutoCAD commands may have different names in your language pack, other than the COPY, COPYBASE, FIND etc that you see in our tutorial texts. In order to instruct AutoCAD to accept the native English command name, precede the native (English) command name by an underscore character, '_'. For instance: '_FIND' will start AutoCAD's native 'FIND' command even if you are using AutoCAD with the French language pack, where the command in French is called 'RECHERCHER'. If a command needs an argument 'ON', and the French menu says 'Allumer', then you can enter '_ON' to instruct AutoCAD to use the option's native name. Furthermore, the English AutoCAD object selection prompt (command _SELECT) accepts many keyboard shortcuts such as A = (add) add to selection set, R = (remove) remove from selection set and AL = (all) all objects (and many more). These shortcuts are named differently in other language packs. In French they are for instance A=ajouter, S=supprimer, TO=tout. Consult AutoCAD Help in your native language.

2. The example we have prepared contains a single-track railway line with a 3-channel, 60 cm wide cable duct at each side.

3. The cable ducts were created using RC-CreateAlignment with the appropriate RcType selection for cable duct (Norwegian: 'Kabelkanal') and the appropriate variant (Norwegian: '3-løps'). Instead of drawing them by hand, they were offset with 2.82 meter sideways and -0.35 meter vertically.

4. NOTE: If you try to offset vertically an alignment which does not have any vertical profile data, then the resulting alignment will not contain profile data either.

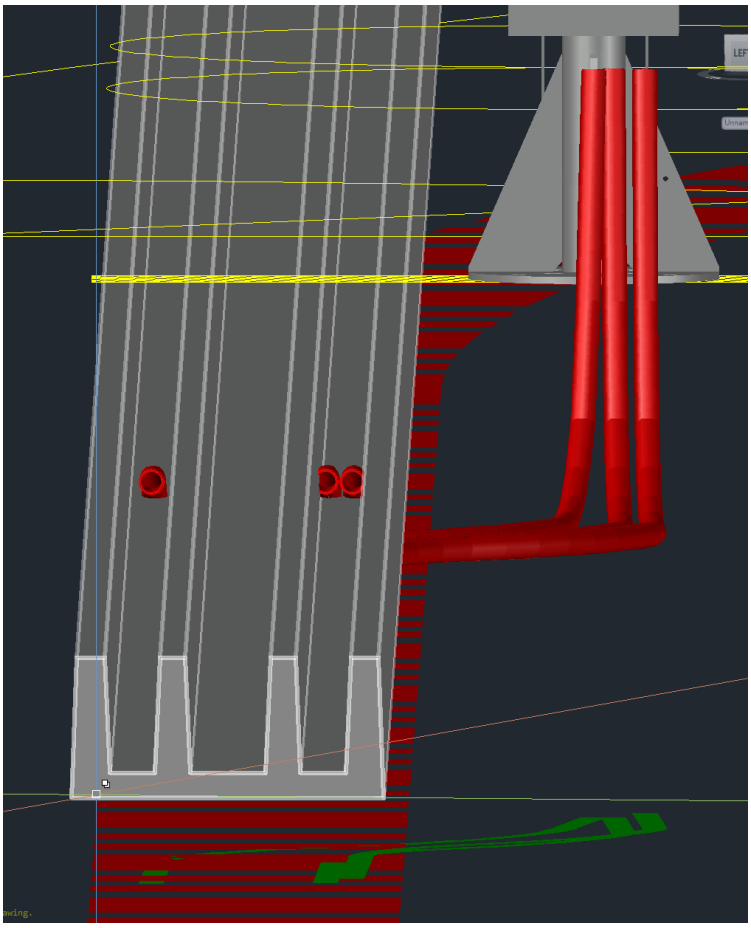
5. After creating the two cable ducts, we opened the RC-ManageProperties tool, opened the 3D tab, and clicked in the cell named Model3DSeparation, then clicked on the browser icon (the ellipsis) and changed 3D sweep model from the default model featuring concrete covers to the one 3-channel duct sweep model without covers.



6. Then we enabled RC-Show3DPreview (the cube icon in the ribbon), selected the railway track and the two signals (but not the cable ducts yet) and then copied their 3D previews to the drawing (using the right-click menu, Copy Annotations to Drawing).

7. Activate the CAD system navigation cube, NAVVCUBE/ON (you might have to turn it off first and then on again to make it appear the first time). View your drawing in conceptual or shaded mode, Top view.

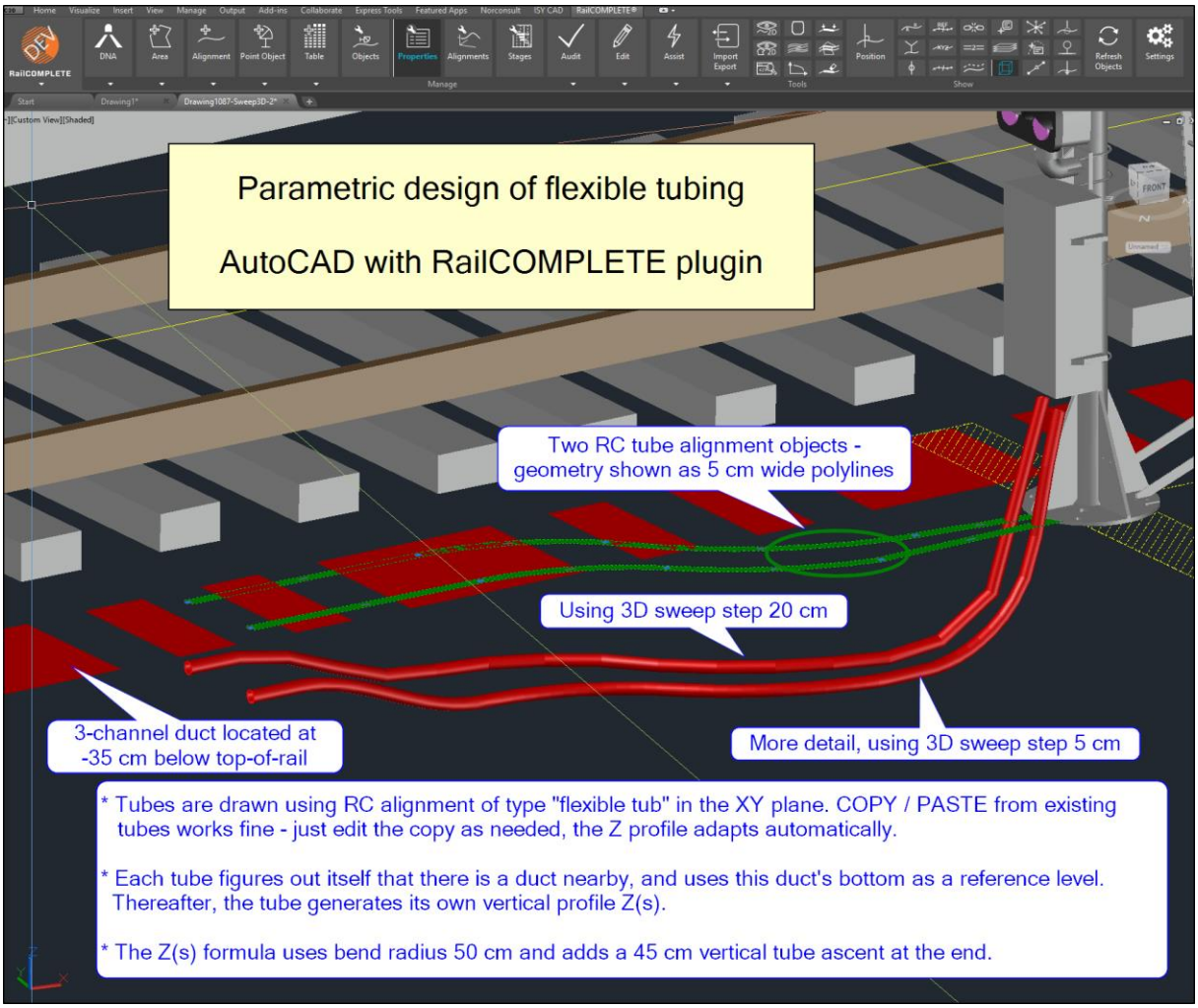
8. Deactivate the 3D preview, since the 3D cables will be a nuisance while drawing their 2D geometry.



9. Now use RC-CreateAlignment to produce flexible tubes of the category 'Underbygning / Føringsvei / Trekkerør / Ø050' (substructure / ducts / flexible tubes / Ø050). Start drawing each tube at its correct distance from centre of cable duct. 3-channel ducts have a quite narrow channel to the left and to the right, and a slightly wider channel in the middle. Let us assume that the signals need one tube from the channel farthest from the track, for earthing to a longitudinal earthing wire, and two tubes from the channel closest to the track, for signalling. Make sure that you respect your local rules for minimum bending radius, for instance 50 cm. Let the tubes end right under each signal's cabinet, located on the front side of the signal masts.

10. Once you have drawn the tube's geometries, you can active the 3D preview and copy them to the drawing. They will automatically generate a nice Z coordinate along the geometry, consistent with the cable ducts' Z coordinate (corresponding to the gravel bed surface level that the ducts lie on).

11. NOTE: If the tubes are too drawn short, then the Z offset formula returns zero offset. The formula needs a geometry length which can accommodate a level part at the beginning, then a cosine-ish descent through the bottom of the cable duct, and at its end a 90 degrees circular arc and a straight ascent at the very end.



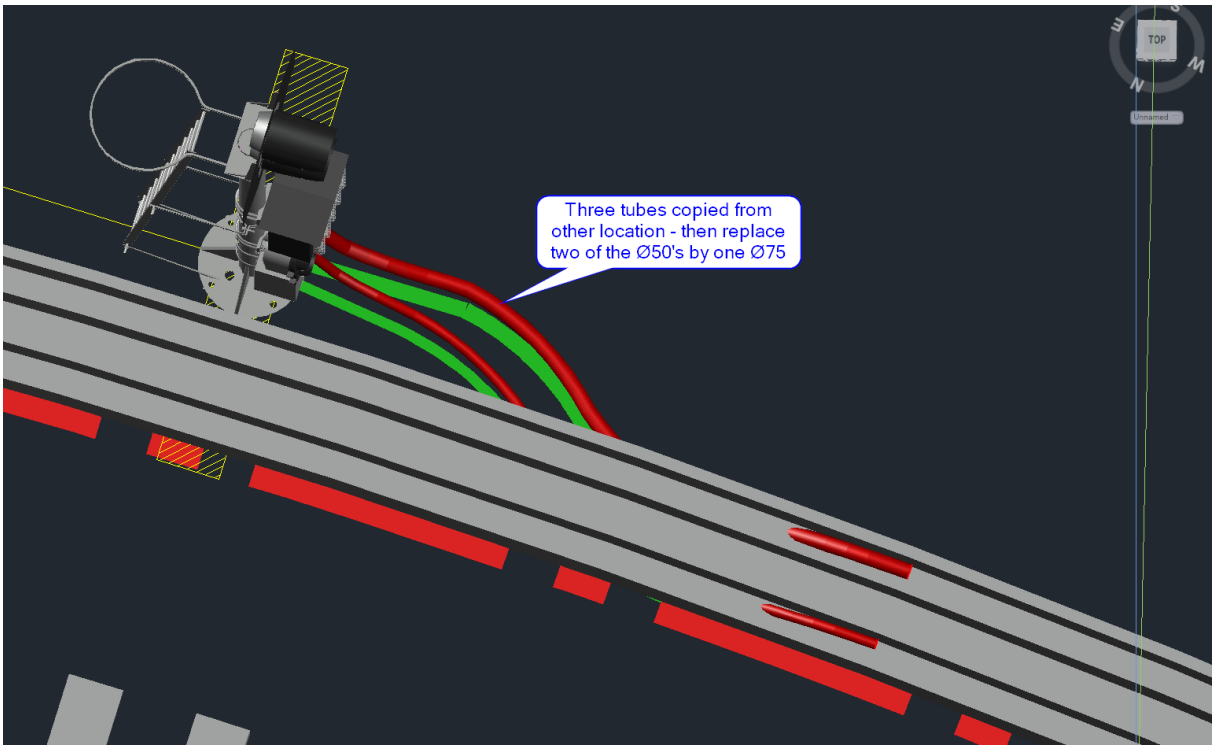
12. Once you are satisfied with your first signal, copy them to the other signal in the example drawing. Place the tube ends under the signal's mast cabinet, and then rotate the tubes such that their starting points are located in the right chambers. Since the track is curved differently at the second signal, you might have to adjust the tube geometries a little.

13. Use Ctrl+Rightclick/None when manipulating CAD polylines sideways and you want to avoid snapping to the existing polylines for tubes or cable ducts. You can add vertices, remove vertices and change between arcs and lines simply by selecting a polyline and hovering over its grip points, then right-clicking.

14. Re-activate 3D preview and check that your cable duct and tubes fit well.

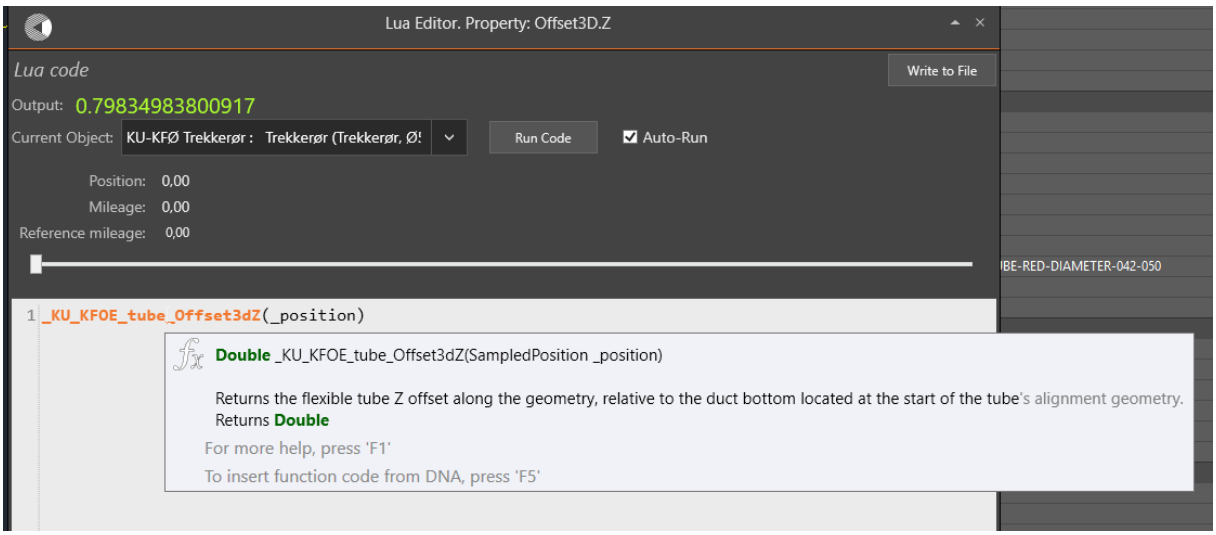
15. Let us assume that you did not want two Ø050 tubes for signalling at signal #2, but instead you need just one Ø075 tube. Delete one of the signalling tubes and then change Variant to Ø075 for the remaining signaling tube. Adjust the geometry sideways over the cable duct if needed.

16. Select your objects, copy their 3D annotation to the drawing – and you have successfully created flexible tubing for two signals.

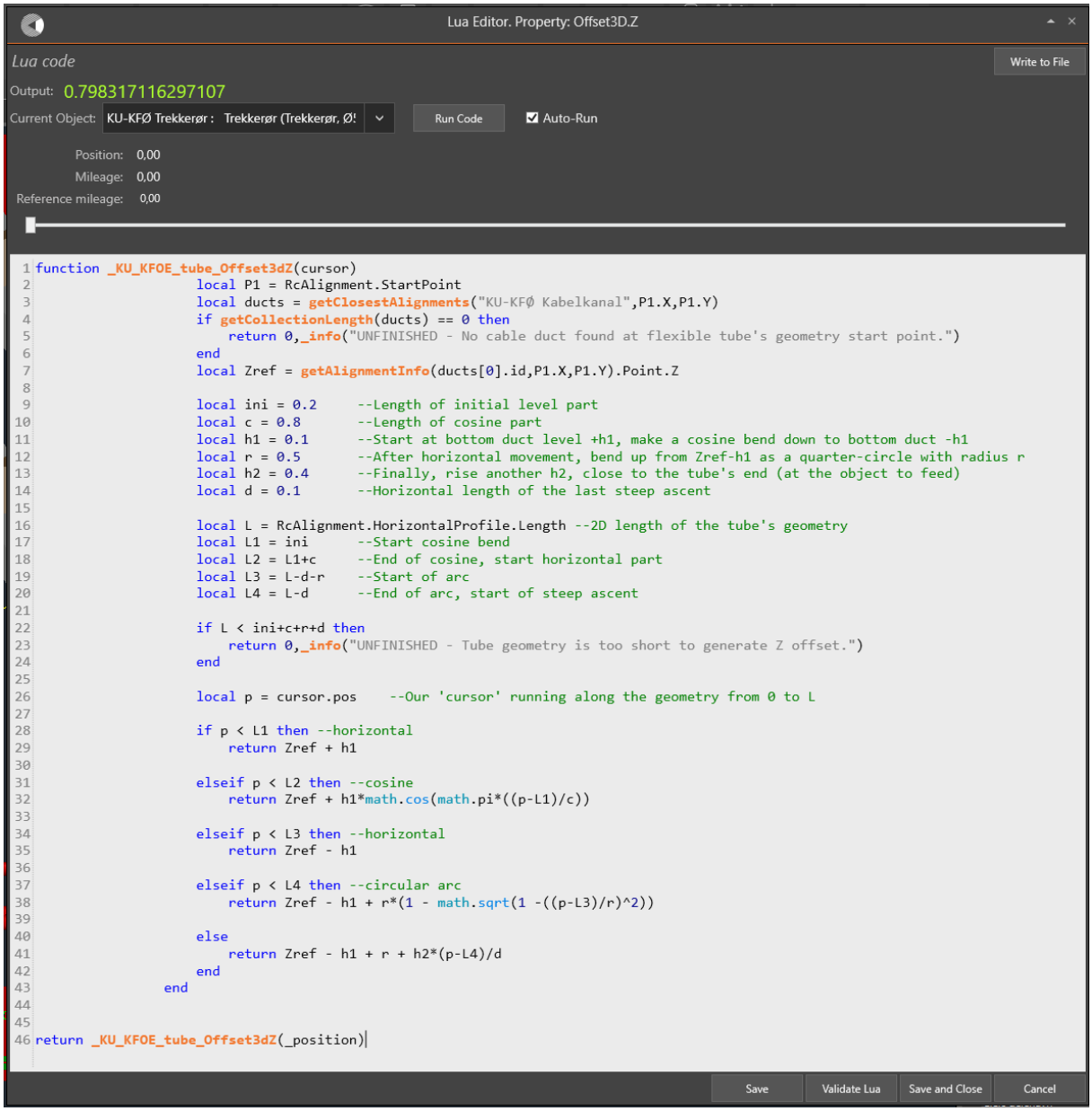


17. (Advanced info): Using RC-ManageProperties and the 3D tab, you can press F3 over the cell named Model3DSeparation. It holds a formula which computes a sample step size for use when sweeping tubes as small straight segments. The formula takes a number as input, representing the approximate step that you need (for instance 0.10 is a suitable trade-off for flexible tubes, whereas the draft 3D for a railway track might use 8 meter to speed up 3D performance). The formula then finds the closest step which will result in an integer number of sweep segments covering the 3D tube exactly from start to end.

18. (Advanced info): Many properties (cells) are driven by formulas. Some are native Lua (like math.cos()), some are part of the RailCOMPLETE/Lua API and cannot be inspected either. But the remaining formulas are usually defined in the DNA, and are open for inspection by you. To see the contents of a formula, open the property (cell) with F3 (Lua editor):



19. Then hover over the function name '_KU_KFOE_....'. Since that function has been enabled for inspection (in its DNA declaration), you will see a text explaining that you can click on F5 to insert a local copy of the function (which you may copy or modify). When you try this for the tube's Offset3D.Z formula, you will see the following formula:




```lua
function _KU_KFOE_tube_Offset3dZ(cursor)
                    local P1 = RcAlignment.StartPoint
                    local ducts = getClosestAlignments("KU-KFØ Kabelkanal",P1.X,P1.Y)
                    if getCollectionLength(ducts) == 0 then
                        return 0,_info("UNFINISHED - No cable duct found at flexible tube's geometry start point.")
                    end
                    local Zref = getAlignmentInfo(ducts[0].id,P1.X,P1.Y).Point.Z

                    local ini = 0.2     --Length of initial level part
                    local c = 0.8       --Length of cosine part
                    local h1 = 0.1      --Start at bottom duct level +h1, make a cosine bend down to bottom duct -h1
                    local r = 0.5       --After horizontal movement, bend up from Zref-h1 as a quarter-circle with radius r
                    local h2 = 0.4      --Finally, rise another h2, close to the tube's end (at the object to feed)
                    local d = 0.1       --Horizontal length of the last steep ascent

                    local L = RcAlignment.HorizontalProfile.Length --2D length of the tube's geometry
                    local L1 = ini      --Start cosine bend
                    local L2 = L1+c     --End of cosine, start horizontal part
                    local L3 = L-d-r    --Start of arc
                    local L4 = L-d      --End of arc, start of steep ascent

                    if L < ini+c+r+d then
                        return 0,_info("UNFINISHED - Tube geometry is too short to generate Z offset.")
                    end

                    local p = cursor.pos    --Our 'cursor' running along the geometry from 0 to L

                    if p < L1 then --horizontal
                        return Zref + h1

                    elseif p < L2 then --cosine
                        return Zref + h1*math.cos(math.pi*((p-L1)/c))

                    elseif p < L3 then --horizontal
                        return Zref - h1

                    elseif p < L4 then --circular arc
                        return Zref - h1 + r*(1 - math.sqrt(1 -((p-L3)/r)^2))

                    else
                        return Zref - h1 + r + h2*(p-L4)/d
                    end
                end


return _KU_KFOE_tube_Offset3dZ(_position)
```

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Corrections and suggestions are welcome to support@railcomplete.no.

Thank you for using RC Tutorials!