2015 Design Training Expo

Geometric Design
in Civil 3D 2015

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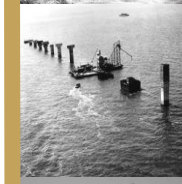
Engineering/CADD Systems Office

Centennial FDOT 1915 ★ 2015

Celebrating 100 Years of Innovation, Mobility and Economic Development



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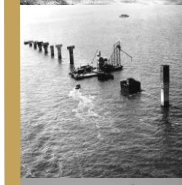

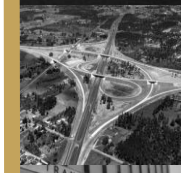


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Geometric Design in Civil 3D
Agency Standards

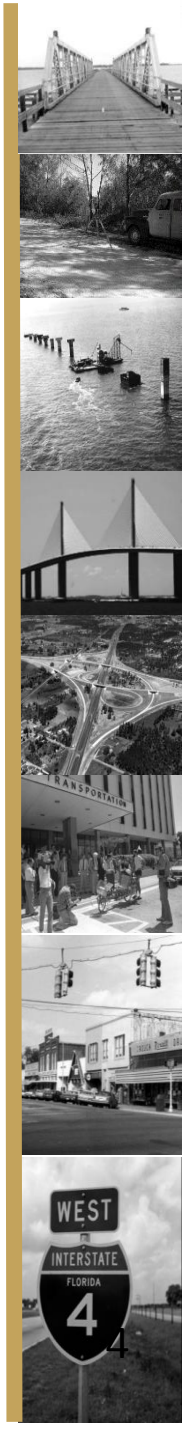
Federal Standards "A Policy on Geometric Design of Highways and Streets"

- AASHTO Green Book

- The most current/latest version of the FDOT Civil 3D State kit should be installed. This will ensure you are using the latest subassemblies developed specific for FDOT roadway modeling Design Standards.

State of Florida Design Standards:

- Non- State highway systems
  - Florida Green Book
- State highway systems
  - FDOT Design Standards
  - PPM , Other



Geometric Design in Civil 3D
Agency Standards

FDOT2015.C3D State Kit

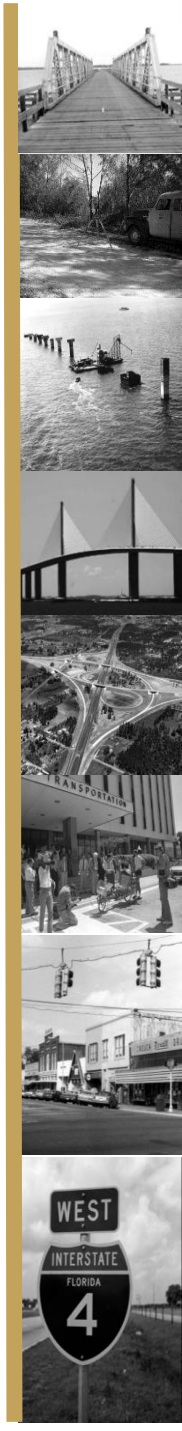
`C:\FDOT2015.C3D\Data\Corridor Design Standards`

- FDOTGreenbook-2007.xml
- FDOTGreenbook-2013.xml

2015 Civil 3D – Out of the Box (OOTB)

`C:\ProgramData\Autodesk\C3D 2015\enu\Data\Corridor Design Standards\Imperial`

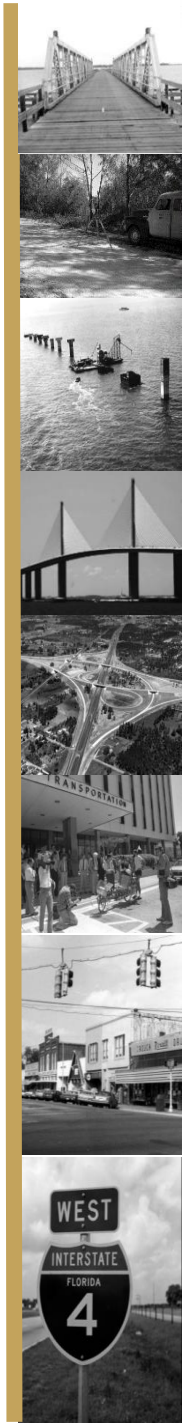
- _Autodesk Civil 3D Imperial (2011) Roadway Design Standards.xml
- _Autodesk Civil 3D Imperial Roadway Design Standards.xml
- Autodesk Civil 3D Imperial (2004) Roadway Design Standards.xml

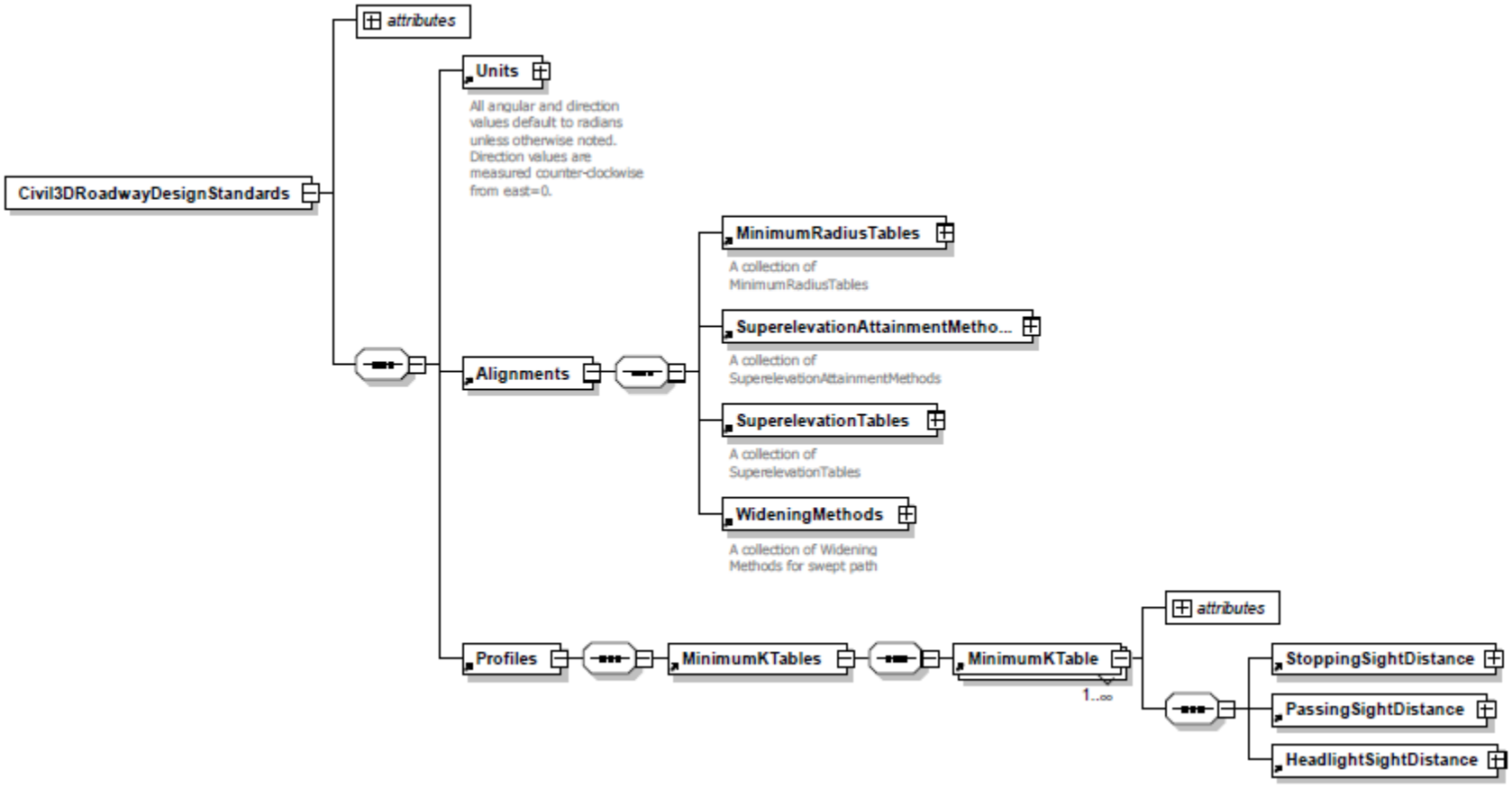


Geometric Design in Civil 3D
Agency Standards

What is in the Standards File?

- Units
  - Imperial
  - Metric
    - Linear, Area, Volume, Speed
- Alignments
  - Minimum Radius Tables (interpolated radii, design speed)
  - Super Elevation Attainment Methods
  - Super Elevation Tables
  - Widening Methods
- Profiles
  - Minimum K Tables
    - Stopping Sight Distance
    - Passing Sight Distance
    - Headlight Sight Distance





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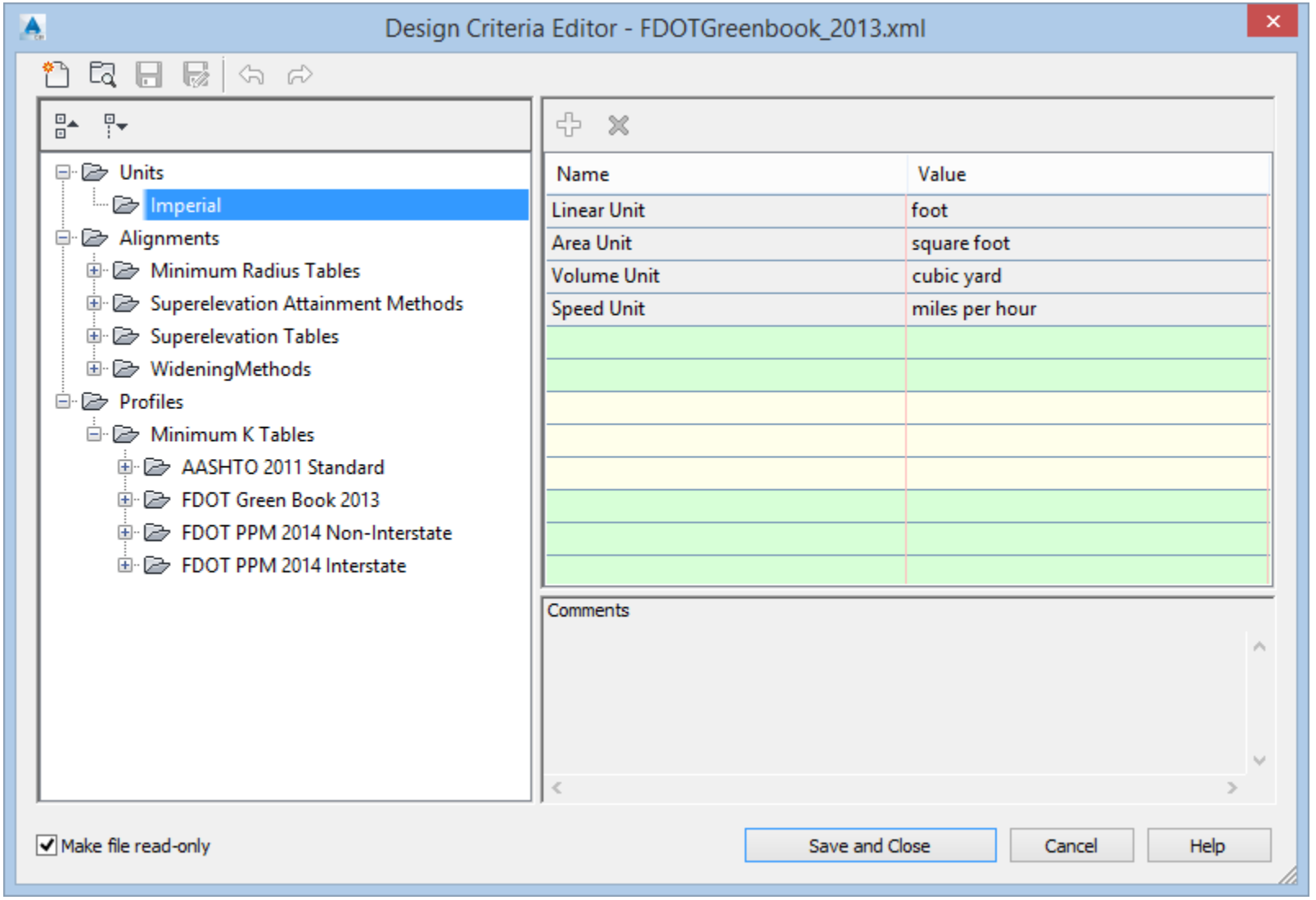

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Geometric Design in Civil 3D

Topic # 625-000-015
Manual of Uniform Minimum Standards
for Design, Construction and Maintenance
for Streets and Highways

May - 2013

TABLE 3 – 4
HORIZONTAL CURVATURE

RURAL Based on e_{MAX} = 0.10			URBAN High-Speed Highways and Streets Based on e_{MAX} = 0.05		
Design Speed (MPH)	Max. Degree of Curvature	Min. Radius (FEET)	Design Speed (MPH)	Max. Degree of Curvature	Min. Radius (FEET)
15	104° 45'	55	---	---	---
20	57° 45'	100	---	---	---
25	36° 15'	160	---	---	---
30	24° 45'	230	30	20° 00'	285
35	17° 45'	320	35	14° 15'	400
40	13° 15'	430	40	10° 45'	535
45	10° 15'	555	45	8° 15'	695
50	8° 15'	695	50	6° 30'	880
55	6° 30'	880	55	5° 00'	1125
60	5° 15'	1095	---	---	---
65	4° 15'	1345	---	---	---
70	3° 30'	1640	---	---	---

Geometric Design in Civil 3D

Standards XML File

```
<!-- ================================================== -->
<!-- FDOT Green Book 2013 - Minimum radii table extracts -->
<!-- Defines minimum radii for road type and design speed -->
<!-- Source:Table 3-4 HORIZONTAL CURVATURE -->
<!-- ================================================== -->
        <MinimumRadiusTable name="FDOT 2013 Green Book eMax 10% Rural Highways">
                <MinimumRadius speed="15" radius="55"/>
                <MinimumRadius speed="20" radius="100"/>
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                <MinimumRadius speed="30" radius="230"/>
                <MinimumRadius speed="35" radius="320"/>
                <MinimumRadius speed="40" radius="430"/>
                <MinimumRadius speed="45" radius="555"/>
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                <MinimumRadius speed="55" radius="880"/>
                <MinimumRadius speed="60" radius="1095"/>
                <MinimumRadius speed="65" radius="1345"/>
                <MinimumRadius speed="70" radius="1640"/>
        </MinimumRadiusTable>
```

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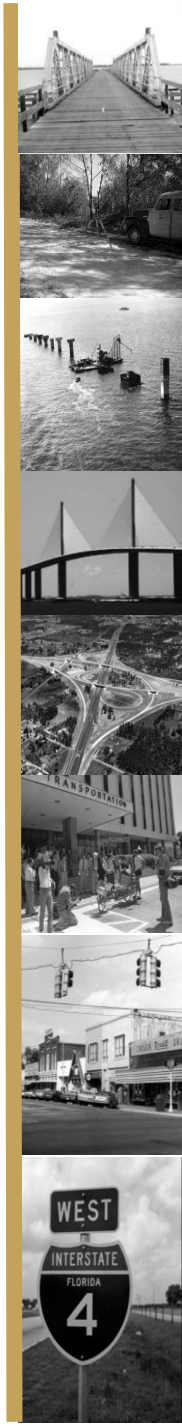
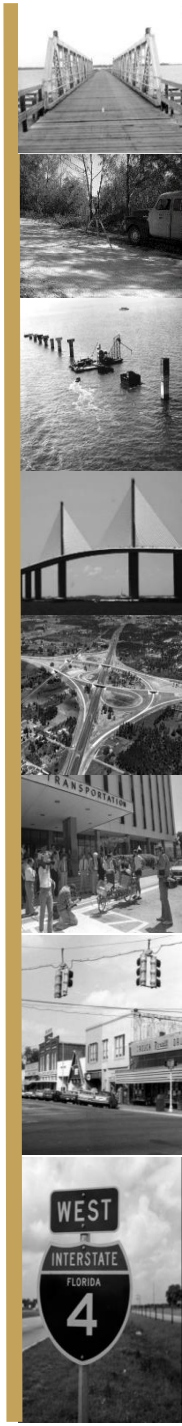


Geometric Design in Civil 3D
Standards by Formula

Variable	Definition
e	Full super elevation rate for the curve from the tables (%)
c	Normal crown slope (%, positive)
s	normal shoulder slope (%, positive)
t	transition length from the tables
w	greatest width from the pivot point to edge of traveled way
l	Length of the spiral (found in alignment)
p	fractional part of transition length achieved before BC point
q	Rate of increase of centripetal acceleration traveling along curve at constant speed



Geometric Design in Civil 3D

Standards by Formula

Transition Type	Definition	Formula
LCtoFS	Level Crown to Full Super (runoff)	{t}
LCtoBC	Level Crown to Beginning of Curve	{p}*{t}
NCtoFS	Normal Crown to Full Super	{t}-{t}*{c}/{e}
NCtoBC	Normal Crown to Begin Curve	{t}*({p}-{c}/{e})
NCtoLC	Normal Crown to Level Crown	{t}*{c}/{e}
NStoNC	Normal Shoulder to Normal Crown	{t}*({s}-{c})/{e}

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Geometric Design in Civil 3D

Standards XML file

```
<SuperelevationAttainmentMethod name="Crowned Roadway">
<TransitionStyleStandard>
<TransitionFormula formula="{t}" type="LCtoFS"/>
<TransitionFormula formula="{p}*{t}" type="LCtoBC"/>
<TransitionFormula formula="{t}*{c}/{e}" type="NCtoLC"/>
<TransitionFormula formula="{t}*{c}/{e}" type="LCtoRC"/>
<TransitionFormula formula="{t}*({s}-{c})/{e}" type="NStoNC"/>
</TransitionStyleStandard>
</SuperelevationAttainmentMethod>
<SuperelevationAttainmentMethod name="Planar Roadway">
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<TransitionFormula formula="{t}-{t}*{c}/{e}" type="NCtoFS"/>
<TransitionFormula formula="{t}*({p}-{c}/{e})" type="NCtoBC"/>
</Continuing>
<Opposing>
<TransitionFormula formula="{t}" type="LCtoFS"/>
<TransitionFormula formula="{p}*{t}" type="LCtoBC"/>
<TransitionFormula formula="{t}*{c}/{e}" type="NCtoLC"/>
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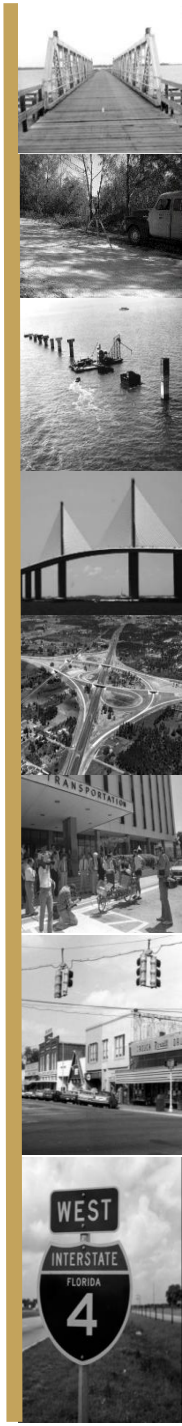
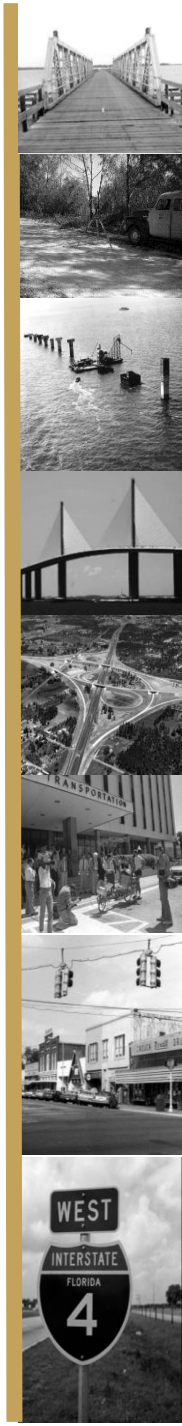


Geometric Design in Civil 3D

Super Elevation

```
<SuperelevationDesignSpeed speed="45">
        <SuperelevationRate radius="3480" eRate="2.2"/>
        <SuperelevationRate radius="2980" eRate="2.4"/>
        <SuperelevationRate radius="2490" eRate="2.6"/>
        <SuperelevationRate radius="2100" eRate="2.8"/>
        <SuperelevationRate radius="1800" eRate="3.0"/>
        <SuperelevationRate radius="1550" eRate="3.2"/>
        <SuperelevationRate radius="1340" eRate="3.4"/>
        <SuperelevationRate radius="1150" eRate="3.6"/>
        <SuperelevationRate radius="970" eRate="3.8"/>
        <SuperelevationRate radius="711" eRate="4.0"/>
</SuperelevationDesignSpeed>
```



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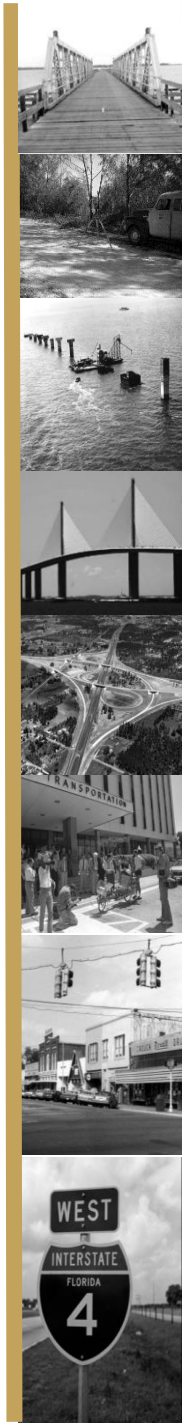

Geometric Design in Civil 3D

Topic # 625-000-015
Manual of Uniform Minimum Standards
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May - 2013

TABLE 3 – 5B
ADJUSTMENTS FOR TRAVELED WAY WIDENING VALUES ON OPEN HIGHWAY CURVES (TWO-LANE HIGHWAYS, ONE-WAY OR TWO-WAY)

Radius of Curve (FEET)	Design Vehicle						
	SU	WB-40	WB-62	WB-65	WB-67D	WB-100T	WB-109D
7000	-1.1	-1.1	0.1	0.1	0.0	0.0	0.3
6500	-1.1	-1.1	0.1	0.1	0.0	0.1	0.3
6000	-1.2	-1.1	0.1	0.2	0.0	0.1	0.3
5500	-1.2	-1.1	0.1	0.2	0.0	0.1	0.4
5000	-1.2	-1.1	0.1	0.2	0.0	0.1	0.4
4500	-1.2	-1.1	0.1	0.2	0.0	0.1	0.5
4000	-1.2	-1.2	0.2	0.2	-0.1	0.1	0.5
3500	-1.3	-1.2	0.2	0.3	-0.1	0.1	0.6
3000	-1.3	-1.2	0.2	0.3	-0.1	0.1	0.7
2500	-1.4	-1.2	0.3	0.4	-0.1	0.1	0.8
2000	-1.5	-1.3	0.3	0.5	-0.1	0.2	1.0
1800	-1.5	-1.3	0.4	0.5	-0.1	0.2	1.1
1600	-1.6	-1.4	0.4	0.6	-0.1	0.2	1.3
1400	-1.7	-1.4	0.5	0.6	-0.2	0.2	1.5
1200	-1.8	-1.5	0.5	0.8	-0.2	0.3	1.7
1000	-2.0	-1.6	0.6	0.9	-0.2	0.3	2.0
900	-2.1	-1.7	0.7	1.0	-0.2	0.4	2.3
800	-2.2	-1.8	0.8	1.1	-0.3	0.4	2.6
700	-2.4	-1.9	0.9	1.3	-0.3	0.5	2.9
600	-2.6	-2.0	1.1	1.5	-0.4	0.6	3.4
500	-2.9	-2.2	1.3	1.8	-0.4	0.7	4.1
450	-3.2	-2.4	1.4	2.0	-0.5	0.7	4.6
400	-3.4	-2.5	1.6	2.3	-0.5	0.8	5.1
350	-3.8	-2.8	1.9	2.6	-0.6	1.0	5.9
300	-4.3	-3.0	2.2	3.0	-0.7	1.1	6.9
250	-4.9	-3.5	2.6	3.7	-0.9	1.4	8.3
200	-5.9	-4.1	3.3	4.6	-1.1	1.7	10.5

Notes: Adjustments are applied by adding to or subtracting from the values in Table 3-20A
Adjustments depend only on radius and design vehicle; they are independent of roadway width and design speed.
For 3-lane roadways, multiply above values by 1.5.
For 4-lane roadways, multiply above values by 2.0.

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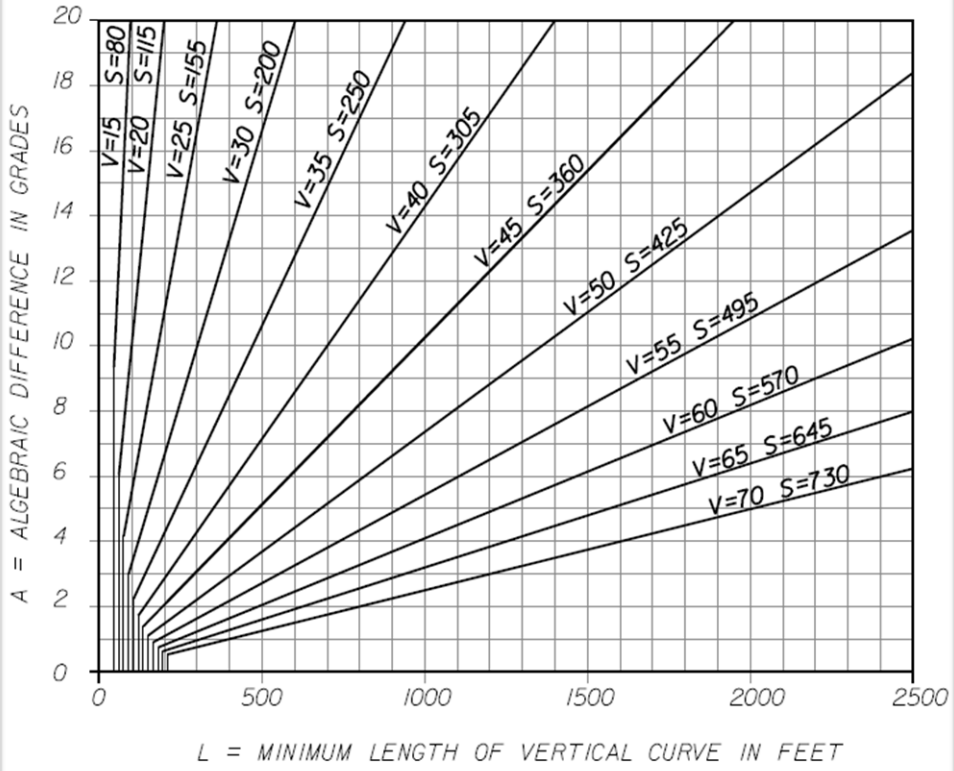
Geometric Design in Civil 3D

FIGURE 3 – 4
LENGTH OF CREST VERTICAL CURVE
(Stopping Sight Distance)



Lengths of vertical curves are computed from the formula: $L = \frac{AS^2}{1329}$

A = Algebraic Difference In Grades In Percent
S = Sight Distance
L = Minimum Length Of Vertical Curve In Feet

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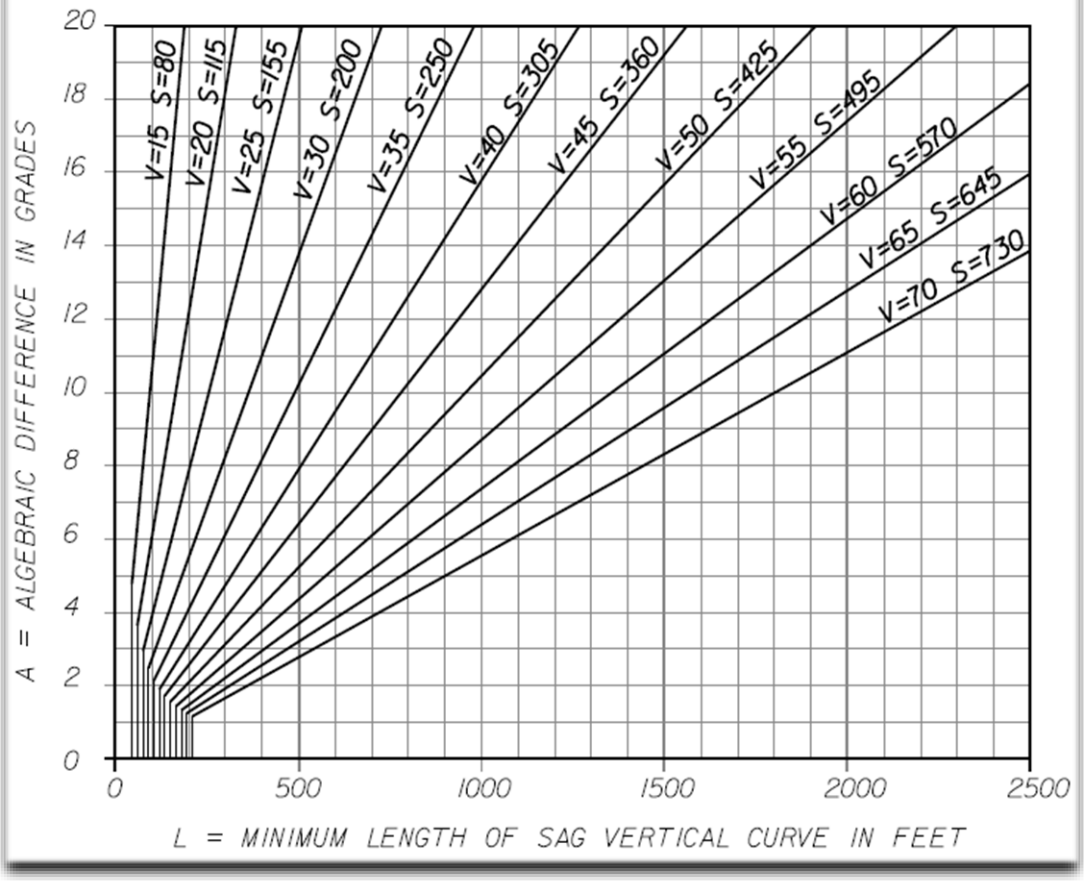
Geometric Design in Civil 3D

FIGURE 3 – 6
LENGTH OF SAG VERTICAL CURVE
(Headlight Sight Distance)

Lengths of vertical curves are computed from the formula:

$$L = \frac{AS^2}{400 + 3.5(S)}$$



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Horizontal Design

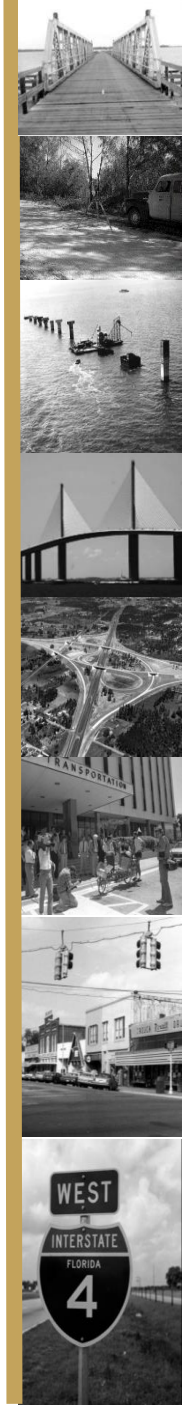
Rules of the Road!

There are a few items to know when working with Civil 3D creating Horizontal and Vertical Designs for your Transportation Project. The First item are Alignments.

Alignments can be **created** by using the following methods

- **From Objects –** Convert Existing Lines and Arcs into Alignments
- **By Using Alignment Layout Tools –** Using the Alignment Layout Tools to design complex and simple Alignments
- **Best Fit –** Using blocks, Cogo Points, Feature Lines, Entities, & set constraints will fit smoothly
- **Offsets –** Alignments that are dynamically linked to the parent Alignment at the set offset distance
- **Widening –** Are based on either centerline or offset alignments and are dynamically linked to them. Most commonly used for road widening in a corridor
- **From Corridor –** Create alignment from corridor feature line
- **From Network Parts –** Create alignment from pipe networks and pressure pipe networks
- **Using Existing Alignment –** Create alignments from previously defined alignments

What are **Sites** in Civil 3D? Sites contain Topology that won't interact with another site with a different name. Think of a utility easement crossing a Highway ROW, they are both on separate sites so the easement won't subdivide while crossing the ROW. Since Civil 3D 2008 Alignments can either be on a site or site less which is how we work currently.



Horizontal Design

Rules of the Road!

There are 5 **Types** of Alignments

- **Centerline –** Most commonly used for Roadway design can also include Swales and Streams
- **Offset –** Stays dynamically linked to the parent alignment using offset parameters
- **Curb Return –** Used for curb returns, which are the radii at intersections. The difference between this and the offset alignment is that instead of offset parameters, you have the option in the Alignment properties dialog to set Curb Return parameters, such as setting two parent alignments and offsets
- **Rail –** Used for rail design. The difference is rail design uses rail geometry including curvature and cant
- **Miscellaneous –** This is a stripped-down type that contains only Information, Stationing, Masking, Point Of Intersection, and Constraint Editing tabs

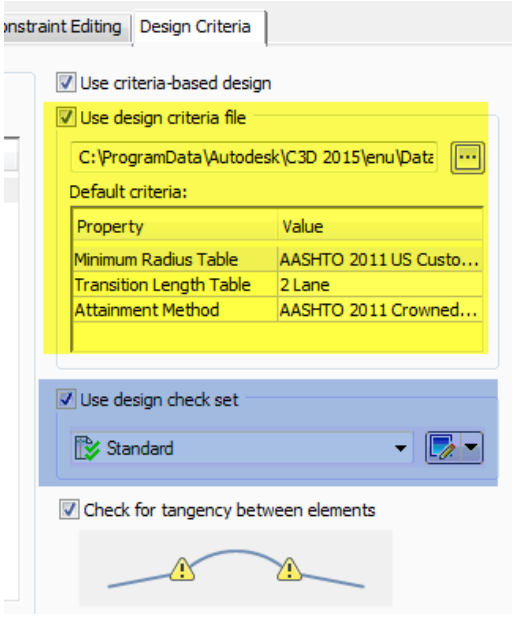
Horizontal Design

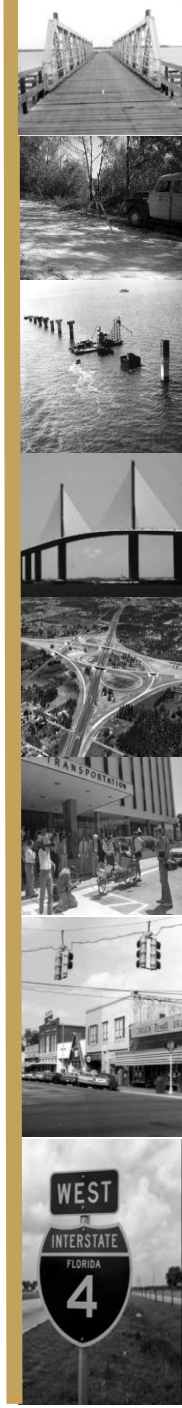
Rules of the Road!

Design Checks Vs. Design Criteria

What's the difference between design checks and design criteria? A design check uses basic properties such as radius, length, grade, and so on, to check a particular portion of an alignment or profile. These constraints are generally dictated by a governing agency based on the type of road involved.

Design Criteria uses speed and related values from design manuals such as AASHTO and Florida's Greenbook to establish these geometry constraints. Design Criteria is like having a big basket of design checks.





Vertical Design

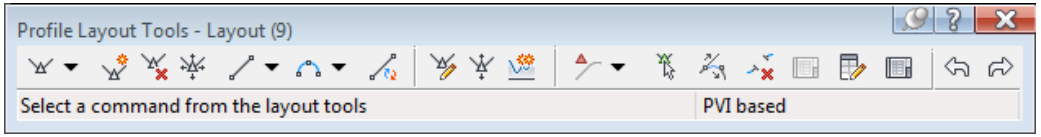
Peas and Carrots!

Profiles and Alignments go together like well you know the above caption says it, this is the beauty of being dynamically related. Every Profile View requires an Alignment. Creating profiles looks similar to creating alignments as you will see.

Profiles can be **created** from the following five ways

- **Sampling from a Surface –** Typically used to generate the Existing Ground Profile along an Alignment
- **By Using Profile Layout Tools –** Used to create Tangents, Vertical Curves, Critical Stations based off of design standards
- **Best Fit –** Similar to Best Fit Alignment option
- **Creating a Profile from a File –** Uses a text file with stations and elevations to plot the profile in the profile view
- **Creating a Profile From a Corridor –** You can use a corridor's feature line to create a profile such as the flow line of a curb

Tip – If you accidently close the profile layout toolbar you can select the profile and on the contextual menu select geometry editor.



Vertical Design

Editing a Profile

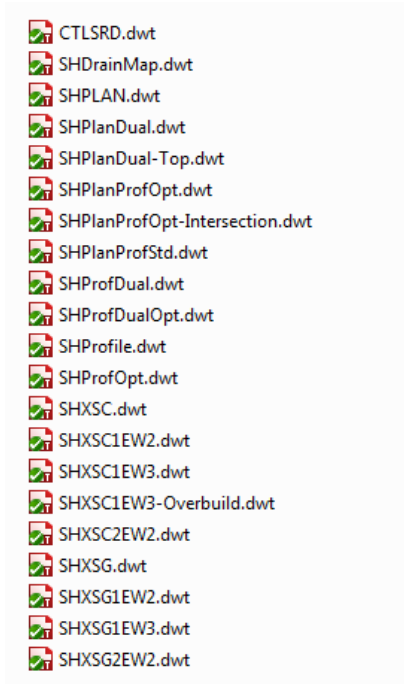
You can edit a profile using various methods including

- Grip-Editing Profiles
- Using Profile Layout Parameters
- Using Profile Grid View
- Component Level Editing

Define Then Refine – This not only is a good way to use Civil 3D but it is recommended. It used to be that you had to have a complete design and then draw it in CAD, but since Civil 3D came on the scene it is recommended that you do a first definition of your 3D design then refine it. You can apply this to all Civil 3D objects Corridors, Pipe Networks, Profiles, Sections, and more. So Define and Refine.

OSDisk (C:) ▸ FDOT2015.C3D ▸ Data ▸ Templates ▸ Sheets ▸ Roadway

Predefined Profile Sheets in the state kit- I'm sure you have used the SHPLAN.dwt as a sheet border but there are many more sheets in the same directory that you will use in you plan production. Profiles, Plan & Profile, Overbuild, Regular Cross Sections, Cross Sections with Volumes, and others.



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