

CFS11 Automation Module

RSG Software, Inc.

Overview

CFS11 is a 32-bit class library which provides an API to the core CFS 11 calculation engine for performing design calculations for cold-formed steel structural members. It is also available as a 64-bit library if required for use in 64-bit applications.

System Requirements

- Windows 32/64-bit operating system
- .NET Framework 4.5
- Development environment supporting COM (i.e., Microsoft Excel VBA) or .NET 4.5 (i.e., Microsoft Visual Studio)
- CFS 11 software installed and licensed. The CFS license may be a Single User License or a Network License, but must include the automation option.

Installation

Run the installer program `cfs11dllinst.exe` with administrator permissions. This will step you through the installation process. If you do not have the .NET Framework 4.5 installed, you will be prompted to download and install it.

Licensing

The license to use the CFS11 module is bundled with a CFS license. When you purchase the license, choose the Single User License with Automation or the Network License with Automation. Then use the CFS software to activate the license.

COM Use

Development tools that support COM, such as Microsoft Excel VBA, can reference the **CFS11** module. To add a reference in Excel, open the Visual Basic editor and choose References from the Tools menu. Then select the CFS11 Automation Module.

.NET Use

Development tools that support .NET 4.5, such as Microsoft Visual Studio 2010 or newer, can natively reference the **CFS11** assembly. To add a reference in Visual Studio, use the Browse feature from the Add Reference window to select the assembly (i.e., `C:\Program Files (x86)\RSG Software\CFS11 Module\CFS11.dll`).

Sample Code

Excel VBA

```
On Error GoTo SampleError

Dim cfsCalc As New CFS11.Calculation
cfsCalc.LoadSection "C:\CFS Files\Test.cfss"

Dim cfsProp As CFS11.SectionProperties
Set cfsProp = cfsCalc.GrossProperties()
MsgBox "Gross Area = " & cfsProp.Area

Dim cfsParams As New CFS11.MemberParams
cfsParams.Lx = 96
cfsParams.Ly = 48
cfsParams.Lt = 48
cfsParams.Lm = 96
cfsParams.Spec = CFS11.Specification.Specification_AISI2016USASD

Dim cfsForces As New CFS11.SectionForces
cfsForces.P = 10
cfsForces.Mx = 20

Dim cfsCheck As CFS11.MemberUnityCheck
Set cfsCheck = cfsCalc.MemberCheck(cfsParams, cfsForces)
MsgBox "Unity Check 1=" & cfsCheck.PMxMy1

cfsCalc.ReleaseLicense
Exit Sub

SampleError:
MsgBox Err.Source & " Error: " & Err.Description
```

VB.NET

```
Dim cfsCalc As New Calculation
cfsCalc.LoadSection("C:\CFS Files\Test.cfss")

Dim cfsProp As SectionProperties = cfsCalc.GrossProperties()
Debug.Print("Gross Area=" & cfsProp.Area)

Dim cfsParams As New MemberParams
cfsParams.Lx = 96
cfsParams.Ly = 48
cfsParams.Lt = 48
cfsParams.Lm = 96
cfsParams.Spec = Specification.AISI2016USASD

Dim cfsForces As New SectionForces
cfsForces.P = 10
cfsForces.Mx = 20

Dim cfsCheck As MemberUnityCheck = cfsCalc.MemberCheck(cfsParams, cfsForces)
Debug.Print("Unity Check 1=" & cfsCheck.PMxMy1)

cfsCalc.ReleaseLicense()
```

API Documentation

Namespace: RSG.CFS11

Calculation Class

Initialization Methods

Sub **DefineSection**(*SctData* As [SectionData](#))

Defines a CFS section to be used in subsequent calculations

SctData: Section data object which defines the type of section, dimensions, and material properties

Sub **LoadSection**(*Filename* As String, [*Fy* As Single], [*Fu* As Single], [*ColdWork* As Boolean], [*Reserve* As Boolean], [*UseDSM* As Boolean])

Loads a CFS section file to be used in subsequent calculations

Filename: Name of a CFS section file (*.sct or *.cfss) or the name of a section in a CFS section library (*.scl or *.cfl). Example: CFS Files\SSMA.cfl|U-Channels\250U050-54.cfss

Fy: Optional. Yield stress override (ksi). If omitted, the yield stress stored in the section file will be used.

Fu: Optional. Tensile strength override (ksi). If omitted, the tensile strength stored in the section file will be used. If *Fy* is provided but *Fu* is omitted, *Fu* will be set to *Fy*.

ColdWork: Apply cold-work of forming. Default value is False.

Reserve: Apply inelastic reserve strength increase. Default value is False. If set to True, cold-work of forming will not be applied.

UseDSM: Use the Direct Strength Method. Default value is False.

Sub **ReleaseLicense**()

To be called when done with the Calculation class so the license is immediately freed up

Calculation Methods

Function **SectionData**() As [SectionData](#)

Collects section information and interprets geometry for the current CFS section

Function **GrossProperties**() As [SectionProperties](#)

Calculates the gross section properties for the current CFS section

Function **NetProperties**() As [SectionProperties](#)

Calculates the net section properties for the current CFS section

Function **EffectiveProperties**(*Forces* As [SectionForces](#), *Spec* As [Specification](#)) As [SectionProperties](#)

Calculates the effective section properties for the current CFS section

Forces: Internal forces applied to the section

Spec: Specification to use for the effective section calculation

Function **Strength**(*Spec* As [Specification](#)) As [SectionStrength](#)

Calculates the fully braced strength for the current CFS section

Spec: Specification to use for the strength calculation

Function **MemberCheck**(*Params* As [MemberParams](#), *Forces* As [SectionForces](#), [*FixCG* As Boolean]) As [MemberUnityCheck](#)

Calculates a member design check for the current CFS section

Params: Member parameters

Forces: Internal forces applied to the section

FixCG: Option to prevent axial eccentricities caused by a shift in the effective section centroid under axial compression. Default value is False.

Function **WebCheck**(*Params* As [WebParams](#)) As [WebUnityCheck](#)

Calculates a web-crippling design check for the current CFS section

Params: Member parameters

SectionData Class

Properties

ColdWork: Apply strength increase from cold-work of forming (Boolean)

ConnSpacing: Longitudinal spacing of shear connectors in built-up members (in)

Depth: Overall depth of section (in)

Description: Section description (read only)

E: Modulus of elasticity (ksi) (read only)

Flange: Flange width (in), negative return value indicates flange width varies

Fu: Section tensile strength (ksi), default is 50 ksi

Fy: Section yield strength (ksi), default is 50 ksi

HoleLength: Longitudinal dimension of holes in member (in)

HoleSpacing: Longitudinal center-to-center spacing of holes in member (in)

Lip: Lip length (in), negative return value indicates lip length varies

LipAngle: Angle of lip (radians), negative return value indicates lip angle varies

Material: Section material name (read only)
NumParts: Number of parts in the section (read only)
Project: Section project name (read only)
Radius: Inside bend radius (in), negative return value indicates radius varies
Reserve: Apply strength increase from inelastic reserve (Boolean)
RevDate: Section revision date (read only)
RevUser: Section revision user name (read only)
SectionType: Type of section (see [SectionType](#) options)
Thickness: Thickness of section parts (in), negative return value indicates thickness varies
UseDSM: Use the Direct Strength Method (Boolean, read only)
WebAngle: Angle of web (radians), negative return value indicates web angle varies

SectionProperties Class

ReadOnly Properties

Alpha: Angle of the major axis from the horizontal X axis, CCW positive (radians)
Area: Cross section area (in²)
Cw: Torsional warping constant (in⁶)
Ic: Polar moment of inertia about centroid (in⁴)
Io: Polar moment of inertia about shear center (in⁴)
Ix: Moment of inertia about X axis (in⁴)
Ixy: Product of inertia (in⁴)
Iy: Moment of inertia about Y axis (in⁴)
J: St. Venant torsion constant (in⁴)
jx: Property used for lateral torsional buckling calculation (in)
jy: Property used for lateral torsional buckling calculation (in)
Rc: Polar radius of gyration about centroid (in)
Ro: Polar radius of gyration about shear center (in)
Rx: Radius of gyration about X axis (in)
Ry: Radius of gyration about Y axis (in)
Sxb: Section modulus about X axis for bottom fiber (in³)

Sxt: Section modulus about X axis for top fiber (in³)
Syl: Section modulus about Y axis for left fiber (in³)
Syr: Section modulus about Y axis for right fiber (in³)
Trace: Detailed calculation trace report (String)
Xl: Horizontal distance from centroid to left fiber (in)
Xo: Horizontal coordinate of shear center from centroid (in)
Xr: Horizontal distance from centroid to right fiber (in)
Yb: Vertical distance from centroid to bottom fiber (in)
Yo: Vertical coordinate of shear center from centroid (in)
Yt: Vertical distance from centroid to top fiber (in)

SectionForces Class

Properties

Dx: Horizontal deflection (in), use 0 to skip the deflection check and improve performance
Dy: Vertical deflection (in), use 0 to skip the deflection check and improve performance
Mx: Moment about X axis (k-in), compression on top is positive
My: Moment about Y axis (k-in), compression on right is positive
P: Axial force (k), compression is positive
Vx: Horizontal shear force (k)
Vy: Vertical shear force (k)

SectionStrength Class

ReadOnly Properties

Ae: Effective area at nominal compressive strength (in²)
Flags: Combined flags indicating strength calculation notes (see [NoteFlags](#))
Ixen: Effective moment of inertia about X axis at negative Mnx (in⁴)
Ixep: Effective moment of inertia about X axis at positive Mnx (in⁴)
Iyen: Effective moment of inertia about Y axis at negative Mny (in⁴)
Iyep: Effective moment of inertia about Y axis at positive Mny (in⁴)
Mxn: Negative moment strength about the X axis (k-in)
Mxp: Positive moment strength about the X axis (k-in)
Myn: Negative moment strength about the Y axis (k-in)

Myp: Positive moment strength about the Y axis (k-in)
P: Compressive strength (k)
Sxben: Effective section modulus for bottom fiber at negative Mnx (in³)
Sxbep: Effective section modulus for bottom fiber at positive Mnx (in³)
Sxten: Effective section modulus for top fiber at negative Mnx (in³)
Sxtep: Effective section modulus for top fiber at positive Mnx (in³)
Sylen: Effective section modulus for left fiber at negative Mny (in³)
Sylep: Effective section modulus for left fiber at positive Mny (in³)
Syren: Effective section modulus for right fiber at negative Mny (in³)
Syrep: Effective section modulus for right fiber at positive Mny (in³)
T: Tension strength (k)
Trace: Detailed calculation trace report (String)
Vx: Horizontal shear strength (k)
Vy: Vertical shear strength (k)

MemberParams Class

Properties

BracedFlange: Braced flange (see [Flange](#) options)
BucklingTheory: Use elastic theory for global buckling calculations (Boolean)
Cbx: Coefficient for bending about X axis (defaults to 1)
Cby: Coefficient for bending about Y axis (defaults to 1)
Cmx: Coefficient for moment about X axis (defaults to 1)
Cmy: Coefficient for moment about Y axis (defaults to 1)
DxMax: Maximum allowable horizontal deflection (in)
DyMax: Maximum allowable vertical deflection (in)
ex: Axial load eccentricity in the X direction (in)
ey: Axial load eccentricity in the Y direction (in)
Kf: Flange rotation stiffness (k-in/rad/in)
Kt: Effective length factor for twisting
Kx: Effective length factor for buckling about X axis

Ky: Effective length factor for buckling about Y axis
Lm: Unbraced length between distortional buckling restraints (in)
Lt: Unbraced length for twisting (in)
Lx: Unbraced length for buckling about X axis (in)
Ly: Unbraced length for buckling about Y axis (in)
MxMax: Maximum moment about X axis (k-in), used to adjust vertical deflection
MyMax: Maximum moment about Y axis (k-in), used to adjust horizontal deflection
R: Moment reduction factor for fully braced tension flange
Spec: Specification to use for the member check (see [Specification](#) options)

MemberUnityCheck Class

ReadOnly Properties

Dx: Unity check for horizontal deflection
Dy: Unity check for vertical deflection
Flags: Combined flags indicating strength calculation notes (see [NoteFlags](#))
Mx: Moment strength about X axis (k-in)
MxVy: Unity check for combined shear/bending about X axis
My: Moment strength about Y axis (k-in)
MyVx: Unity check for combined shear/bending about Y axis
P: Axial strength (k)
PMxMy1: Unity check #1 for combined axial/bending
PMxMy2: Unity check #2 for combined axial/bending
Trace: Detailed calculation trace report (String)
Vx: Shear strength in horizontal direction (k)
Vy: Shear strength in vertical direction (k)

WebParams Class

Properties

Dir: Load direction (1=vertical, 2=horizontal)
Fastened: Bearing flange is fastened to the support (Boolean)
Lend: Distance from edge of load to end of member (in)

Load: Distance from edge of load to edge of opposite load (in), use large value if no opposing concentrated load

M: Moment at the point of bearing (k-in)

N: Flange bearing length (in)

P: Concentrated load or reaction (k), positive load is on bottom flange (or left flange for horizontal load)

Spec: Specification to use for the web check (see [Specification](#) options)

WebUnityCheck Class

ReadOnly Properties

Flags: Combined flags indicating strength calculation notes (see [NoteFlags](#))

M: Unity check for bending only

P: Unity check for web-crippling only

PM: Unity check for combined bending/web-crippling

Trace: Detailed calculation trace report (String)

SectionType Enum

Constants

Unknown = 0 (returned if loaded section does not match one of the other profiles)

Cee = 1

CeeStiffened = 2

Zee = 3

ZeeStiffened = 4

DoubleCee = 5

DoubleCeeStiffened = 6

Box = 7

Tube = 8

Angle = 9

AngleStiffened = 10

Hat = 11

Cylinder = 12

Specification Enum

Constants

AISI1999USASD = 0

AISI1999USLRFD = 1

AISI2001USASD = 2

AISI2001USLRFD = 3

AISI2001MexASD = 4

AISI2001MexLRFD = 5

AISI2001CanLSD = 6

AISI2004USASD = 7
AISI2004USLRFD = 8
AISI2004MexASD = 9
AISI2004MexLRFD = 10
AISI2004CanLSD = 11
AISI2007USASD = 12
AISI2007USLRFD = 13
AISI2007MexASD = 14
AISI2007MexLRFD = 15
AISI2007CanLSD = 16
AISI2010USASD = 17
AISI2010USLRFD = 18
AISI2010MexASD = 19
AISI2010MexLRFD = 20
AISI2010CanLSD = 21
AISI2012USASD = 22
AISI2012USLRFD = 23
AISI2012MexASD = 24
AISI2012MexLRFD = 25
AISI2012CanLSD = 26
AISI2016USASD = 27
AISI2016USLRFD = 28
AISI2016MexASD = 29
AISI2016MexLRFD = 30
AISI2016CanLSD = 31
AISI2018USASD = 32
AISI2018USLRFD = 33
AISI2018MexASD = 34
AISI2018MexLRFD = 35
AISI2018CanLSD = 36

Flange Enum

Constants

None = 0
Bottom = 1
Top = 2
Left = 3
Right = 4

CalculationException

Messages

No license found
Error loading section: ...
Geometry error: ...
Properties error: ...
No section has been loaded or defined yet

Section has no DSM data
 Invalid section definition
 Invalid yield stress
 Invalid tensile strength
 Invalid thickness
 Invalid radius
 Invalid section depth
 Invalid flange width
 Invalid lip length
 Invalid web angle
 Invalid lip angle
 Invalid section type
 Invalid connector spacing
 Invalid hole length
 Invalid hole spacing
 Invalid specification
 Invalid unbraced length
 Invalid effective length factor
 Invalid braced flange
 Invalid moment reduction factor
 Cannot apply one-flange bracing to a fully braced member
 Invalid value for C_b
 Invalid value for C_m
 Invalid value for maximum deflection
 Invalid load direction
 Invalid bearing length

NoteFlags Enum

Constants (additive)

ThinTubeWall = 1: D/t exceeds maximum for cylindrical tube
 SlenderElement = 2: w/t exceeds maximum for an element
 LongEdgeStiffener = 4: D/w or d_o/b_o exceeds maximum for an edge stiffener
 EdgeStiffenerAngle = 8: Edge stiffener angle outside limits
 SlenderColumn = 16: KL/r exceeds maximum for a column member
 SheathedColumnLimits = 32: Section does not meet all req's for sheathed column provisions
 SheathedColumnFastener = 64: Sheathed column fastener assumed to be at middle of flange
 ConnectorSpacing = 128: a/r_i exceeds $0.5KL/r$
 BendRadius = 256: R/t exceeds limit
 HoleDepthRatio = 512: d_h/h exceeds limit
 HoleDepth = 1024: Hole depth exceeds limit
 HoleLength = 2048: Hole length exceeds limit
 HoleSpacing = 4096: Clear distance between holes less than limit

Appendix 1 – Changes from CFS10

The CFS11 module has implemented the following interface changes over the CFS10 module:

Sub **LoadSection**: Added optional parameters Reserve and UseDSM

Sub **ReleaseLicense**: New method to release license

SectionData Class: Added properties E, ConnSpacing, HoleLength, HoleSpacing, NumParts, Reserve, and UseDSM

MemberParams Class: Separated effective length properties KxLx, KyLy, and KtLt into effective length factors Kx, Ky, and Kt (default = 1) and unbraced lengths Lx, Ly, and Lt. Added BucklingTheory property.

Specification Enum: Added 2018 Edition values and renamed NAS prefix to AISI

NoteFlags Enum: Added constants BendRadius, HoleDepthRatio, HoleDepth, HoleLength, and HoleSpacing