# Real3D

Real3D is a powerful structural design / finite element analysis software designed for structural engineers of all skill levels. The software is reliable, easy to use, and affordable. It is designed for accuracy and simplicity in mind, allowing engineers to get the job done without being overwhelmed by useless features. It features unique quad-precision solver, which is able to handle numerically challenging structures. It incorporates a blazingly fast sparse solver based on Intel Math Kernel Library and is able to solve models with millions of degrees of freedom. Other key features include spreadsheet input and output, easy to use command line input, as well as compelling graphics display built upon industry standard OpenGL(R).
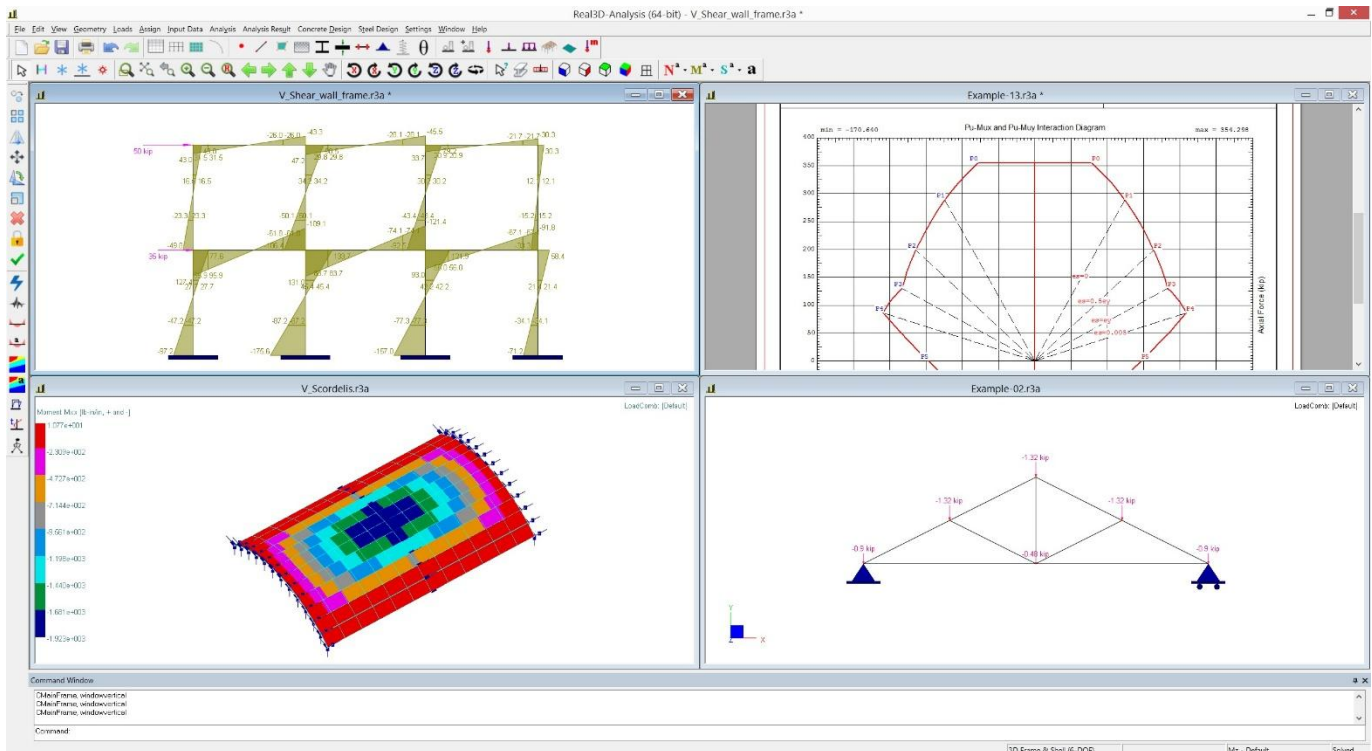
Elements

- 2D and 3D frame (beam and truss) elements, with linear, tension-only or compression-only options
- 2D and 3D four-node plate/shell element, with thick or thin plate bending element (for slab modeling) and compatible/incompatible in-plane stress element (for shear wall modeling)
- 3D eight-node solid (brick) element with compatible and incompatible formulations
- linear and nonlinear nodal, line and surface springs.
- Coupled springs (advanced)
- Moment releases on frame element
- Rigid offset and rigid links
- Element stiffness modifications
- Forced displacements on supports
- Rigid diaphragms in any orientations
- Multi-DOF constraints including inclined rollers, equal constraints etc.
- Nodal, point forces and moments, line and surface forces, self-weight, area loads, thermal loads, pattern loads, and moving loads

Analysis and Design Options

- Static linear analysis.
- Geometric nonlinear (P-Delta) analysis.
- Frequency analysis.
- Response spectrum analysis.
- Sparse solver (in-core and out-of-core) for static and frequency analyses, able to solve very large models with millions of degrees of freedom.
- Standard double-precision skyline solver and unique quad-precision skyline floating point solver (extremely accurate for "numerically challenging" models).
- Concrete design for beams, columns, and slabs according to ACI 318-2019, -2014, -2011, -2008, 2005, and -2002. It includes such as features as exact biaxial column interaction diagrams, automatic moment magnification, cracked section properties, Wood-Armer moments, color coded plots for member capacity, and reinforcement contour plots for plates.
- Steel design according to AISC 360-22 (16th edition) LRFD, AISC 360-16 (15th edition) LRFD, and AISC 360-10 (14th edition) LRFD. It features step-by-step calculation procedures in Word and PDF formats for each design choice.

User Interface Features

- Multiple documents may be opened at the same time; each document may have multiple views with different display settings.
- Spreadsheets for input data and results.
- Graphically drawing nodes, frames and finite elements via mouse click or keyboard in command window.
- Quality 3D graphical rendering built on OpenGL(R) with hidden line or surface removal. Graphics display includes loading diagram, moment and shear diagrams for beams, contours for shells and solids, deflection diagram and annotations for input and results.
- Powerful automatic model generations for continuous beams, 2D and 3D frames, 2D and 3D shells, arc beams, and non-prismatic beams. Include AISC steel shape database, ASTM rebar database, regular sections and standard load combinations.
- Flexible editing features such as undo/redo, duplicate, array, move, scale, delete, revolve, extrude, splitting beams, sub-mesh shells, and node and element merging.
- Automatic mesh generator to produce 100% quadrilateral shells.
- Many different selection methods such as window/point select, select by IDs, select by properties, with options to freeze or thaw parts of a model. Ability to pan, zoom, and rotate in real time.
- Ability to append one or more input files.
- Report in plain text, HTML, Word, and PDF formats. Graphic report may contain multiple images.
- Ability to activate/inactivate elements and include/exclude gravity at element level.
- Print previews for graphics and text reports.
- Ability to import from and export to DXF files.
- Ability to import / export AISC steel shapes from/to a comma delimited (csv) file.
- English or Metric units, or combination of the two.
- True 64-bit, fully integrated Windows application, professionally written from the ground up in standardized, object-oriented C++ programming language, resulting in a truly robust software tool for the structural engineering community.

System Requirements

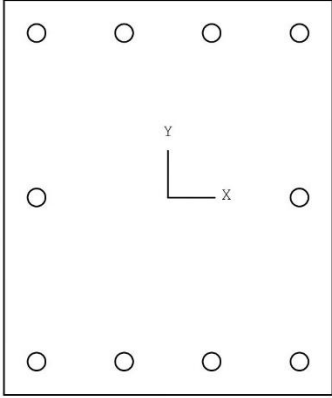Operating System: x64 Windows 7, 8, 10, 11. ARM64 Windows 11

cColumn

cColumn is a powerful Windows program designed specifically for structural engineers to perform axial-flexural analysis and design of concrete columns, as well as beams and shear walls, according to ACI 318-19/14/11/08/05/02 and ACI 318-99. It analyzes the uniaxial or biaxial bending capacity of multiple sections of regular shapes (rectangular, round, Tee, I, L) and generic shapes (with openings) simultaneously in an accurate, fast, and user-friendly manner. Multiple load sets may be inputted and checked against section capacities. It features tabulated strain-P-M at every user defined neutral axis step, 2D P-Mx and P-My interaction diagrams, and incredible 3D P-Mx-My interaction surface. It is built upon OpenGL(R).
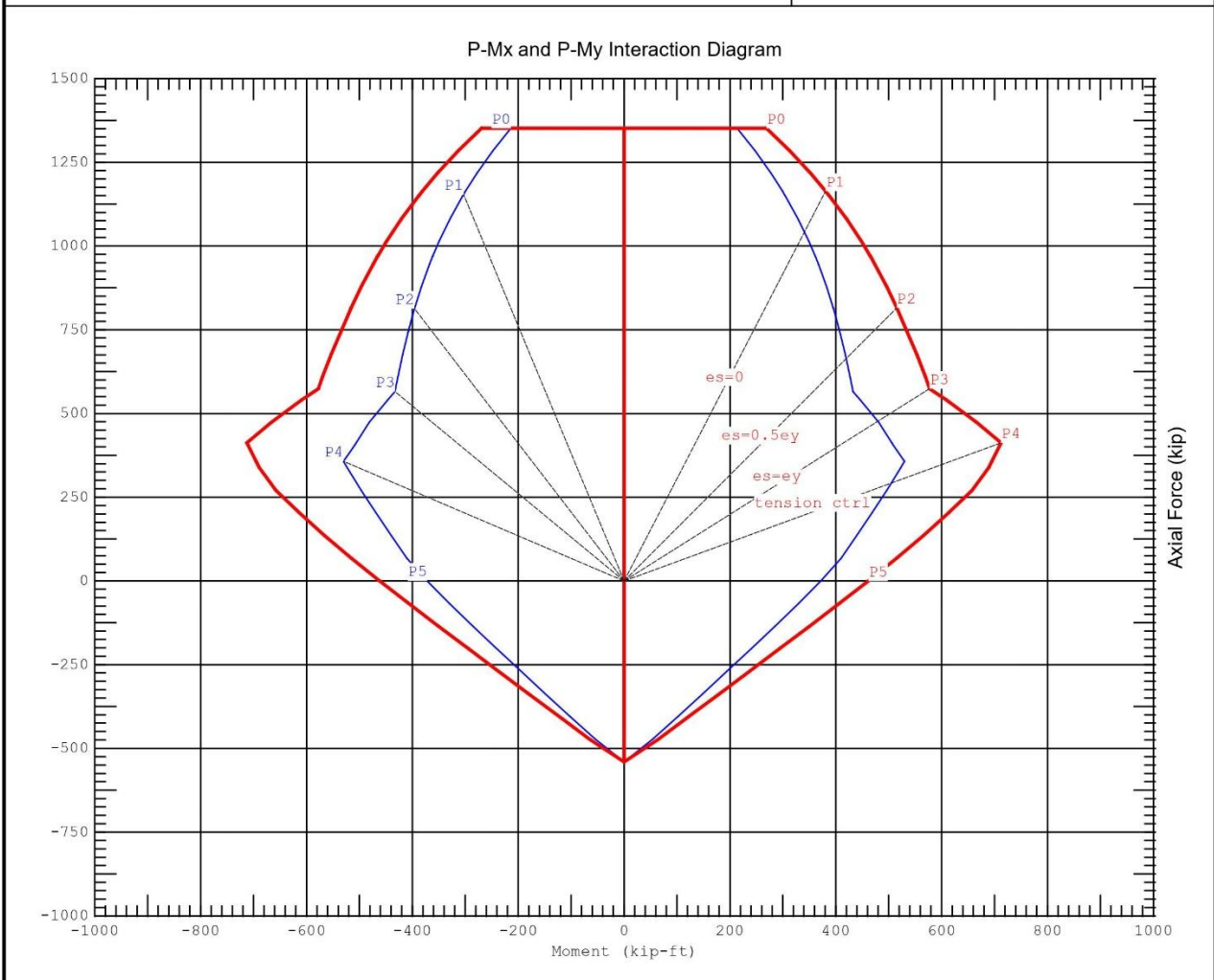
Key Features

- Codes: ACI 318-19, -14, -11, -08, -05, -02, and -99.

- Unit: English, Metric or Mixed.

- Section Shapes: Unlimited number of rectangular, Tee, circular, I, inverse L and generic (with up to 3 openings) sections. Ability to convert various regular sections to generic sections. Ability to parametrically generate multiple rectangular or circular sections with different sizes and reinforcement configurations. Great tool for shortening the trial-and-error design process.

- Loads: Unlimited number of load sets (Pu, Mux, Muy). Adequacy of each section to carry the loads is computed in terms of simple unity ratio.

- Column slenderness effects may be considered.

- Solver: Unique, exact and blazingly fast solution algorithms that can accurately solve hundreds even thousands of sections, uniaxially or biaxially, simultaneously in seconds. Solution options include strength reduction factor, tied or spiral confinement, variable number of neutral axis steps, variable biaxial angle steps, variable axial steps for display, and inclusion or exclusion of displaced concrete.

- Result Data: Very detailed result data is tabulated in spreadsheets. P-M result includes neutral axis depth, eccentricity, maximum tensile strain and strength reduction factor, as well as axial capacity P and moment capacity M.

- Diagrams: Available diagrams include 2D P-Mx, P-My and Mx-My interaction and 3D P-Mx-My interaction surface or wire-frame. Key points shown automatically on the interaction diagrams. Input loads shown with different colors on the 2D/3D diagrams or surface denoting the adequacy of the section for each load

- Capability to batch save P-M and Mx-My interaction diagrams to high resolution image files

- Professional report in Word and PDF file formats (see next page)

- Printing: Automatic printing of very impressive interaction diagrams for multiple sections. You can even create your very own design handbook similar to CRSI Handbook!

System Requirements

Operating System: x64 Windows 7, 8, 10, 11. ARM64 Windows 11

Project/Job:		**cColumn v10**
Engineer:	Date & Time: 06/19/2023 10:32	(C) Computations & Graphics, Inc.

RectC

Y

X

Section 1 of 1

Code: ACI 318-19
Strength reduction: Auto
Neutral axis steps: 250
Biaxial angle steps: 16
Axial capacity steps: 20
Excl. displ'd concrete: Yes

b x h: 20 x 24 in
fc: 5.00 kip/in^2
fy: 60.00 kip/in^2
Cover (t.c): 2 in
Bars: 10 # 9
Confinement: Tied
Ag: 480.00 in^2
As: 10.00 in^2
Roh: 2.08%
Ix: 23040 in^4
Iy: 16000 in^4
X0: 0.00 in
Y0: 0.00 in
Clear spacing: 4.21 in

Control Points (kip, kip-ft)

PT	P	Mx(+)	max es
P0	1350.70	268.63	-0.00040
P1	1163.23	380.10	0.00000
P2	814.63	514.57	0.00103
P3	573.32	576.52	0.00207
P4	412.14	711.35	0.00507
P5	-0.01	461.02	0.01630
Pmin	-540.00	0.00	0.20000

PT	P	My(-)	max es
P0	1350.70	-213.10	-0.00042
P1	1152.92	-302.69	0.00000
P2	811.81	-395.13	0.00103
P3	565.09	-432.05	0.00207
P4	357.01	-528.95	0.00507
P5	0.02	-371.23	0.01124
Pmin	-540.00	0.00	0.20000

P-Mx and P-My Interaction Diagram

QuadMaker

QuadMaker is an interactive 64-bit Windows finite element mesh generator that produces 100% quadrilateral elements (shell4) on planar and curved surfaces in 3D space. The supported shapes include flat surface, cylindrical surface, spherical surface, surface of revolution (rev), and general patch surface. With these types of regions, arbitrarily complex geometrical shapes can be constructed.
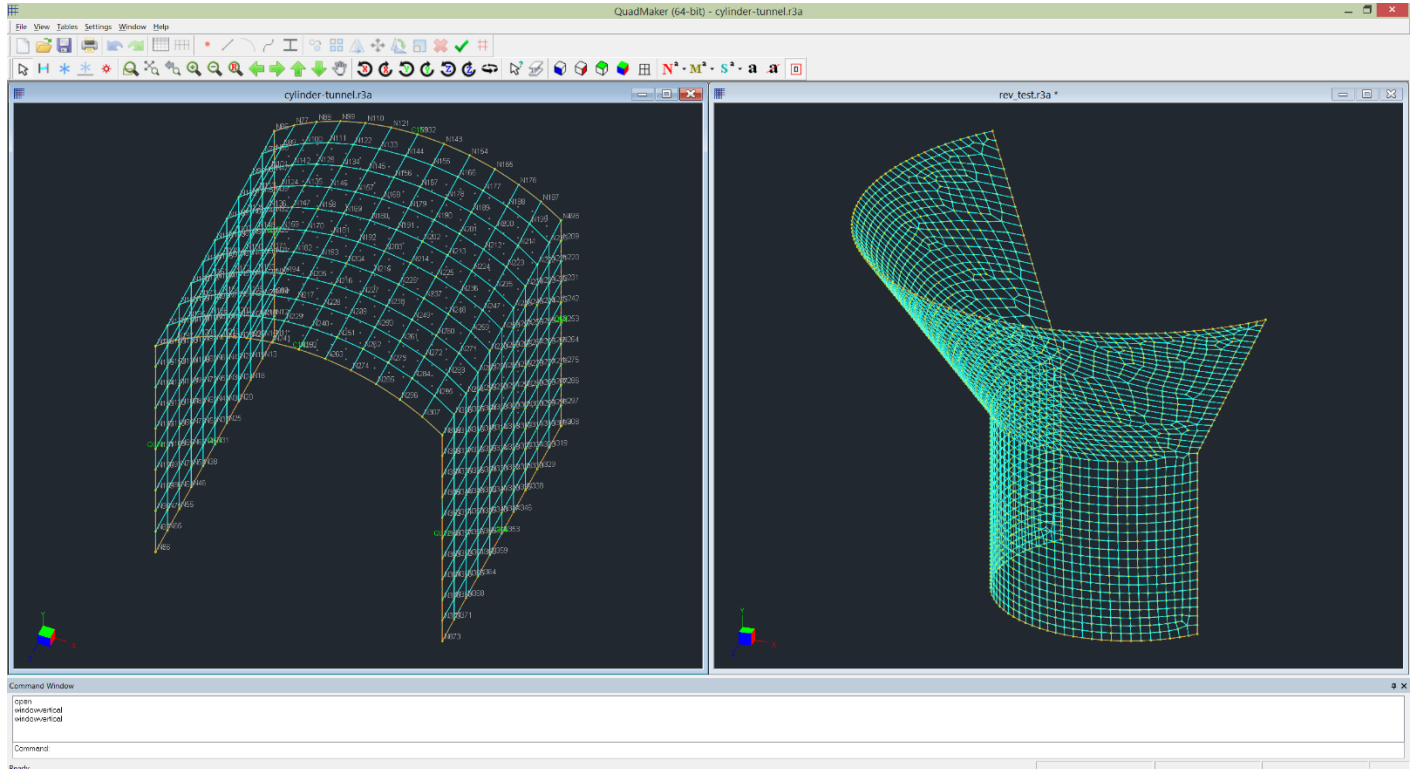
Supported Shapes

- Planar surface with holes, internal points, internal lines (trees)
- Cylindrical surface
- Spherical surface with 2, 3, or 4 edges
- Surface of revolution
- General patch surface

User Interface Features

- Multiple documents may be opened at the same time; each document may have multiple views with different display settings.
- Spreadsheets for input data and results.
- Graphically drawing nodes, curves via mouse click or keyboard in command window.
- Flexible editing features such as undo/redo, duplicate, array, mirror, move, scale, delete.
- Automatic mesh generator to produce 100% quadrilateral shells.
- Many different selection methods such as window/point select, select by IDs, select by properties, with options to freeze or thaw parts of a model. Ability to pan, zoom, and rotate in real time.

System Requirements

Operating System: x64 Windows 7, 8, 10, 11. ARM64 Windows 11

sCheck

sCheck is a very useful Windows program for structural engineers to design and check steel beam-columns according to AISC 360-22 (16th edition) LRFD, AISC 360-16 (15th edition) LRFD, and AISC 360-10 (14th edition) LRFD.
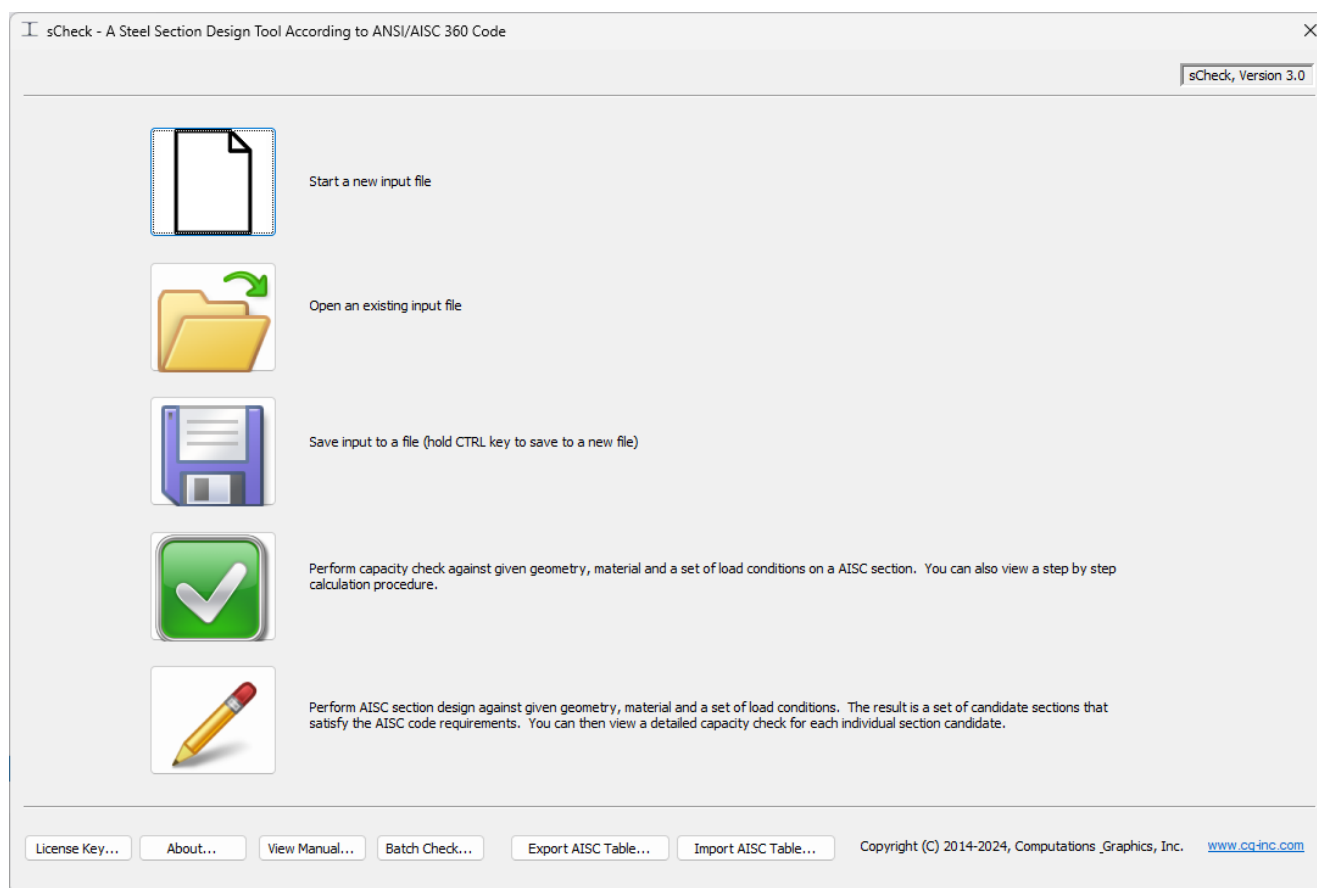
Key Features

- ANSI/AISC 360-22 (16th Edition) LRFD, AISC 360-16 (15th Edition) LRFD, and AISC 360-10 (14th Edition) LRFD
- Check the capacity of any of the standard AISC shapes (W, M, S, HP, C, MC, L, WT, MT, ST, 2L, HSS, PIPE) against a set of load effects.
- Design and select optimal standard AISC shapes against a set of load effects.
- Consider moment magnification for non-sway condition.
- Capability to generate extremely detailed calculation procedures in Word and PDF formats (see next pages).

System Requirements

Operating System: x64 Windows 7, 8, 10, 11. ARM64 Windows 11

General Info

File Name	C:\CGInc\sCheck3\Examples-LRFD16\Example03-AiscDesignExamples-F5.sck
Design Code	AISC 360-22 (16th edition) LRFD
Using Direct Analysis Method	Yes
Consider Multiplier B1 for P-delta Effect	Yes
Date & Time	11/27/2023 20:36

Section Property - W12X58

Property	Value	Unit	Property	Value	Unit	Property	Value	Unit
A = Ag	17	in^2	bf	10	in	tf	0.64	in
tw	0.36	in	d	12.2	in	h / tw	27	
Cw	3570	in^6	h0	11.6	in	rts	2.81	in
Zx	86.4	in^3	Sx	78	in^3	Ix	475	in^4
rx	5.28	in	Zy	32.5	in^3	Sy	21.4	in^3
Iy	107	in^4	ry	2.51	in	J	2.1	in^4

Design Input

Input	Value	Unit	Input	Value	Unit	Input	Value	Unit
Pu = Pr	0	kips	Mux = Mxr	0	kip-ft	Muy = Myr	113	kip-ft
Cmx	1		Cmy	1		Vux	0	kips
Vuy	30	kips	Fy	50	ksi	Cb	1	
Lb	15	ft	Kx	1		Ky	1	
Kz	1		Lx	15	ft	Ly	15	ft
Lz	15	ft						

* Lcx = Kx * Lx; Lcy = Ky * Ly; Lcz = Kz * Lz

Axial Capacity Calculation

Step		Equation	Value	Note
Checking flange slenderness				
		b = bf / 2	5 in	
		b / tf	7.8125	
		$\lambda_r = 0.56\sqrt{\dfrac{E}{F_y}}$	13.487	
The section has non-slender flange element				
Checking web slenderness				
		b / t = h / tw	27	
		$\lambda_r = 1.49\sqrt{\dfrac{E}{F_y}}$	35.884	
The section has non-slender web				
Compressive strength to account for flexural buckling				

	Equation	Value	Note
	$\dfrac{K_x L_x}{r_x}$	34.091	
	$\dfrac{K_y L_y}{r_y}$	71.713	
	$\dfrac{KL}{r} = \max\left(\dfrac{K_x L_x}{r_x}, \dfrac{K_y L_y}{r_y}\right)$	71.713	
	$F_e = \dfrac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$	55.654 ksi	Eq.E3-4
	$4.71\sqrt{\dfrac{E}{F_y}}$	113.43	
	$\dfrac{KL}{r} \leq 4.71\sqrt{\dfrac{E}{F_y}}$		
	$F_n = \left(0.658^{\frac{F_y}{F_e}}\right) F_y$	34.329 ksi	Eq.E3-2
	$P_n = F_n A_g$	583.6 kips	Eq.E3-1
Compressive strength to account for torsional and flexural-torsional buckling			
	$F_e = \left(\dfrac{\pi^2 E C_w}{L_{cz}^2} + GJ\right)\dfrac{1}{I_x + I_y}$	94.6 ksi	Eq.E4-2
	$\dfrac{F_y}{F_e}$	0.52854	
	$\dfrac{F_y}{F_e} \leq 2.25$		
	$F_n = \left(0.658^{\frac{F_y}{F_e}}\right) F_y$	40.077 ksi	Eq.E3-2
	$P_n = F_n A_g$	681.31 kips	Eq.E4-1
	Flexural buckling controls: Pn	583.6 kips	
	$\phi_c P_n$	525.24 kips	

Moment Magnification Calculation

Step	Equation	Value	Note
Stiffness reduction parameter			
	$\alpha = 1.00 (\text{LRFD})$	1	
	Pr / Pns = Pr / (Fy * Ae)	0	
	$\alpha P_r / P_{ns} \leq 0.5$		
	$\tau_b = 1.0$	1	Eq.C2-2a
Moment magnifier B1 for P-delta effects in local x direction			

SolverBlaze

SolverBlaze Finite Element Library (SDK) is a leading structural and finite element analysis Application Programming Interface (API). It is based on the time-tested finite element solver engine in Real3D, which is being used by hundreds of civil and structural engineering offices in the United States and around the world. You can use this powerful and easy-to-use API to develop your custom software royalty-free. SolverBlaze is available in both 64-bit and 32-bit, with easy-to-use C++ and .NET interfaces (binary and source code).

Key Features

- Supports beam, truss, plate and shell (thin and thick, compatible and incompatible formulations) as well as brick elements.
- Supports nodal, point, line, surface, and area loads.
- Supports thermal loads.
- Supports conversion from area loads to line loads, local loads to global loads.
- Supports linear and nonlinear nodal, line and surface springs
- Supports advanced coupled springs.
- Supports tension only/compression only members.
- Supports moment releases, rigid elements, and rigid diaphragms.
- Supports inactive elements.
- Supports element stiffness modifications
- Supports forced displacements.
- Supports multi-DOF constraints such as inclined support.
- Supports both English and Metric units.
- Supports static linear and P-Delta analysis.
- Supports frequency (eigenvalue and eigenvector) analysis.
- Supports response spectrum analysis.
- Supports classic skyline solver.
- Supports extremely fast sparse solver that can handle models with millions of degrees of freedom.
- Supports unique quad-precision solver for numerically challenging problems such as rigid diaphragms.
- Automatically generate input and result report in plain text and html formats
- *Provides bidirectional communications between SolverBlaze and Real3D:* you can open and graphically view SolverBlaze models in Real3D, or generate SolverBlaze source code from the current Real3D model.
- Supports .NET 4.0, 4.5x, 4.6x, 4.7x, 4.8x and .NET Core 5.0, 6.0, 7.0, 8.0, 9.0 in C# and VB.NET languages.
- Supports native C++ language.
- Supports both x64 and x86 CPUs architecture on Windows.
- Supports ARM64 CPUs architecture on Windows through C++ or P/Invoke.
- Supports Unicode and Non-Unicode in Microsoft Visual Studio 2015, 2017, 2019, 2022.
- Available in both binary and source code.
- A free copy of Professional Real3D program for source code customers.
- Provides numerous source code samples in C++ and C# free of charge.
- Offers technical support by the SolverBlaze author.
- Reasonably priced and royalty-free.

System Requirements

Operating System: Windows 7, 8, 10, 11

ColumnBlaze

ColumnBlaze Concrete Library (SDK) is a powerful concrete column API (Application Programming Interface) to calculate section capacity of rectangular, circular, and generic sections. It is based on the solver engine in our cColumn concrete analysis and design software. You can use this reliable and user-friendly API to develop your custom software royalty-free. ColumnBlaze is available in both 64-bit and 32-bit, with easy-to-use C++ and .NET interfaces (binary and source code).

Key Features

- Supports rectangular, circular, and generic (with openings) sections.
- Easy-to-use programming interfaces to define input, solve, and retrieve results for one or multiple sections.
- Supports P-Mx-My interaction diagram at different angles.
- Supports Mx-My diagram for a given axial load.
- Calculates unity ratio for a section under a given load (P, Mx, My).
- Provides interface to export sections input to cColumn input file. You can then use cColumn to open and graphically view geometry, reinforcement, and result diagrams.
- Supports various American Concrete Institute codes including ACI 318-19, -14, -11, -08, -05, -02, and -99.
- Supports .NET 4.0, 4.5x, 4.6x, 4.7x, 4.8 and .NET Core 5.0, 6.0, 7.0 in C# and VB.NET languages.
- Supports native C++ language.
- Supports both 64-bit and 32-bit CPUs architecture on Windows.
- Supports Unicode and Non-Unicode in Microsoft Visual Studio 2015 or above.
- Available in both binary library and source code forms.
- A free copy of Professional cColumn Program.
- Numerous source code samples in C++ and C# are freely available.
- Technical support by the ColumnBlaze author.
- Reasonably priced and royalty-free.

System Requirements

Operating System: Windows 7, 8, 10, 11

SteelBlaze

SteelBlaze Library (SDK) is a powerful steel design API (Application Programming Interface) to calculate section capacity of AISC sections. It is based on the solver engine in our sCheck steel analysis and design software. You can use this reliable and user-friendly API to develop your custom software royalty-free. SteelBlaze is available in both 64-bit and 32-bit, with easy-to-use C++ and .NET interfaces (binary and source code).

Key Features

- Check the capacity of any of the standard AISC shapes (W, M, S, HP, C, MC, L, WT, MT, ST, 2L, HSS, PIPE) against a set of load effects.
- Design and select optimal standard AISC shapes against a set of load effects.
- Consider moment magnification for non-sway condition.
- Auto generate detailed calculation procedures in Word and PDF formats. Please note that a proper Aspose.Words for C++ license is required to use the report feature. For more information, visit Aspose's website at https://aspose.com.
- Easy-to-use programming interfaces to define input, solve, and retrieve results for one or multiple sections.
- Supports various American Institute of Steel Construction codes including AISC 360-22, AISC 360-16, AISC 360-10.
- Supports two-way communication with sCheck through file save and file open.
- Supports .NET 4.0, 4.5x, 4.6x, 4.7x, 4.8 and .NET Core 5.0, 6.0, 7.0 in C# and VB.NET languages.
- Supports native C++ language.
- Supports both 64-bit and 32-bit CPUs architecture on Windows.
- Supports Unicode and Non-Unicode in Microsoft Visual Studio 2015 or above.
- Available in both binary library and source code forms.
- A free copy of Professional sCheck Program.
- Numerous source code samples in C++ and C# are freely available.
- Technical support by the SteelBlaze author.
- Reasonably priced and royalty-free.

System Requirements

Operating System: Windows 7, 8, 10, 11

QuadSdk

QuadSdk is a 64-bit Windows finite element mesh generation API that produces 100% quadrilateral elements on planar and curved surfaces in 3D space. QuadSdk supports both .NET languages such as C# and VB.NET, and native C++ language. A mesh model is defined and solved through an easy-to-use Application Programming Interface (API). A mesh model consists of one or more mesh regions (aka sub-regions) of different geometrical shapes. The supported regions include flat surface, cylindrical surface, spherical surface, surface of revolution (rev), and general patch surface. With these types of regions, arbitrarily complex geometrical shapes can be constructed.

Key Features

- Generate 100% quadrilateral elements.
- Supports flat surface, cylindrical surface, spherical surface, surface of revolution (rev), and general patch surface.
- Supports internal points, internal lines (trees), and holes.
- Supports .NET, .NET Core, and native C++ languages on 64-bit CPU architecture on Windows.
- Supports Microsoft Visual Studio 2015 and up including Visual Studio 2022.
- *Bidirectional supports between QuadSdk and QuadMaker.* You can use QuadMaker to open and graphically view mesh models generated by QuadSdk. You can use QuadMaker to automatically generate QuadSdk source code that corresponds to the current QuadMaker model.
- A free copy of Professional QuadMaker program.
- Numerous source code samples in C++ and C# are freely available.
- Reasonably priced and royalty-free.

System Requirements

Operating System: 64-bit Windows 7, 8, 10, and 11

OpenGraph

OpenGraph Library (SDK) is a powerful 2D and 3D visualization and charting software tool on x64 and x86 Windows. It is built on the industrial strength OpenGL. The library shields you from the need to learn the complex OpenGL API, and makes it easy to setup impressive and interactive graphics such as zooming, panning, selecting, etc. This library is especially suitable for building scientific, engineering, and financial software applications.

Key Features

- Capability to draw different objects such as points, lines, triangles and quads.
- Capability to draw texts including Unicode texts.
- Automatic support for zooming, panning, rotating 3D models using mouse events.
- Supports graphic selections on drawing objects.
- Supports both 3D objects as well as 2D screen objects.
- Supports transparency.
- Supports native C++ language.
- Supports .NET 4.x, 4.5x, 4.6x, 4.7x, and 4.8x using as C# and VB.NET.
- Supports Unicode and Non-Unicode.
- Supports x64 and x86 platform architectures.
- Supports Visual Studio 2015 and up including Visual Studio 2022.
- Ability to save rendered image to file.
- Available in both binary library and source code form.
- Very easy to learn. The library comes with a variety of examples that illustrate the uses of the library including Win32 Windows, MFC Dialog, MFC Document-View, WinForms and WPF Form.
- Reasonably priced and royalty-free on binary redistribution.

System Requirements

Operating System: Windows 7, 8, 10, and 11

double128

double128 Math Library (SDK) is 128-bit quad-precision math library that implements approximately 32 decimal place floating point arithmetic for Microsoft Visual Studio. The library includes a new floating point type double128 and a list of corresponding standard math functions such as sqrt(), pow(), sin() etc.. The implementation of the library is based on Intel C++ Compiler _Quad data type. The following table show a comparison among float, double and double128 types:

Parameter	single	double	double128
Format width in bits	32	64	128
Sign width in bits	1	1	1
Mantissa	24	53	113
Exponent width in bits	8	11	15
Max value	3.40282 E38	1.79769 E308	1.18973 E4932
Min value	1.17549 E-38	2.22507 E-308	3.36210 E-4932
Epsilon	1.192092896 E-07	2.2204460492503131 E-016	1.925929944387235853055977 9425849272 E-34

Key Features

- Quad-precision (128-bit) floating point data type in Visual C++.
- Quad-precision (128-bit) floating point data type in C# and VB.NET, and .NET Core (including .Net Core 7.0, 6.0, 5.0, .NET 4.8x, 4.7x, 4.6x, 4.5x, and 4.0).
- Supports standard math functions.
- Supports basic I/O operations.
- Supports Microsoft Visual Studio 2015 and up including Visual Studio 2022.
- Supports x64 and x86 platform architecture.
- Reasonably priced and royalty-free on binary redistribution.

System Requirements

Operating System: Windows 7, 8, 10, 11