Unleash the Power of Mathcad

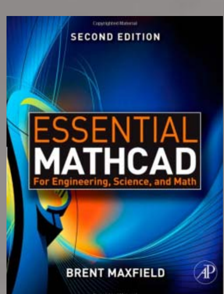
NASCC 2011

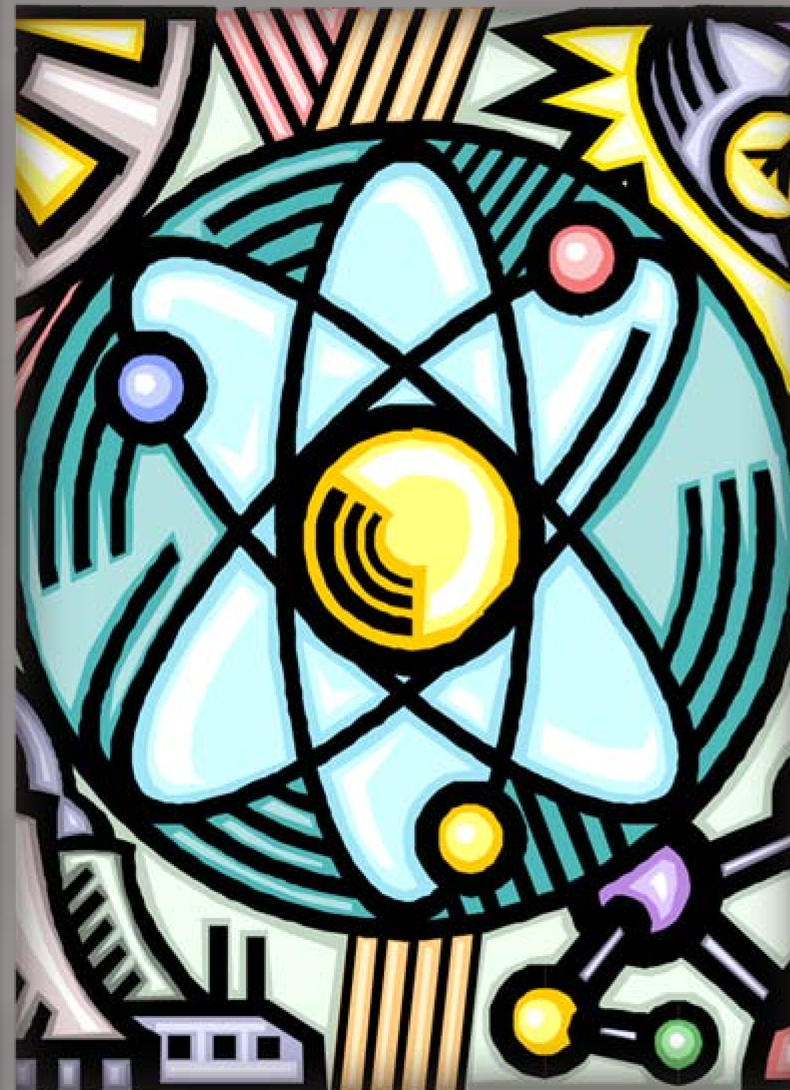
By Brent Maxfield, P.E.

Author of the books

Engineering with Mathcad and

Essential Mathcad





Thursday 8:00 Session
Unleash the Power of Mathcad

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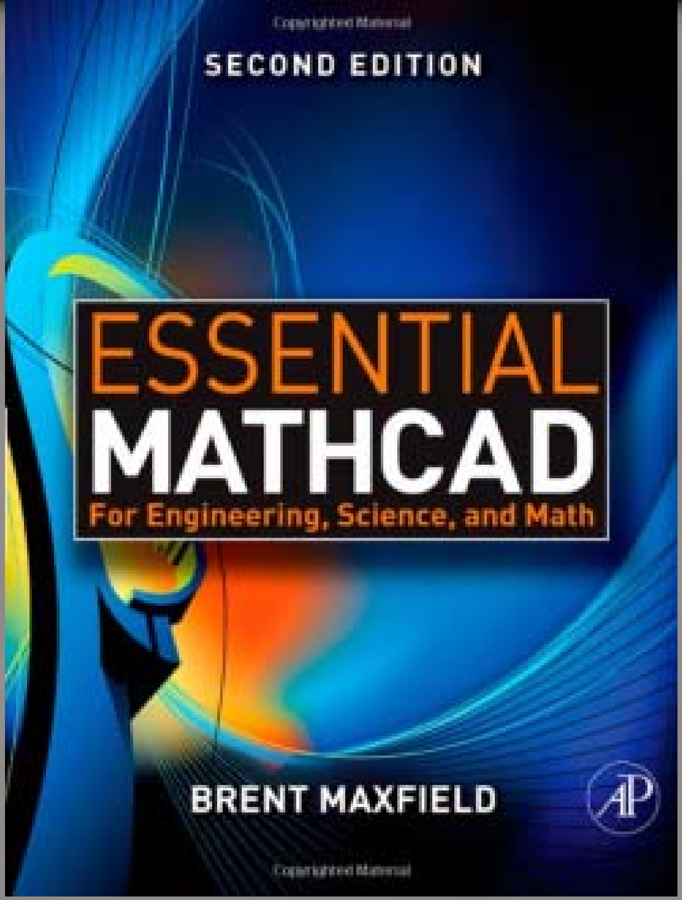


Book and Mathcad 14 for only $35.00. Use order forms at front of room.
Or order online at www.elsevierdirect.com , Use Discount Code: "**mathcad30**".
Limited number of copies at Materials Pickup using the order form and your credit card number . If you want to pay cash, come see me, and I will give you a receipt to take to Materials Pickup.

Calculate Seismic Weight and Force (Transverse Direction)

$Length_{bldg} = 188\,ft$ $Width_{bldg} = 89\,ft$ $EaveHt = 8\,ft$ $EntRidgeElev = 22.65\,ft$ $Roof_{DL} = 20\cdot psf$

$EntBearingElev = 10\,ft$ $Mezz_{DL} = 15\cdot psf$

$BuildingArea := Length_{bldg}\cdot Width_{bldg} + (15.0ft\cdot 48ft)\cdot 2$ $BuildingArea = 18172\,ft^2$

W =roof & ceilings $Wt_1 := Roof_{DL}\cdot(BuildingArea)$ $Wt_1 = 363440\cdot lbf$

Two Ext. Walls Perp $Wt_2 := \left(ExtWall_{DL}\cdot\frac{EaveHt}{2}\cdot Length_{bldg}\right)\cdot 2$ $Wt_2 = 75200\cdot lbf$

Four Int. walls perp. $Wt_3 := (12\cdot psf\cdot 7.5\cdot ft\cdot 67\cdot ft)\cdot 4$ $Wt_3 = 24120\cdot lbf$

Two corridor ceiling $Wt_4 := (Mezz_{DL}\cdot 7\cdot ft\cdot Length_{bldg})\cdot 2$ $Wt_4 = 39480\cdot lbf$

One entry wall each side plus gable $Wt_5 := \left[ExtWall_{DL}\cdot\left[(48\cdot ft - 14.33\cdot ft)\cdot\frac{EaveHt}{2}\right] + 15psf\cdot\left[\frac{1}{2}\cdot 48\cdot ft\cdot(EntRidgeElev - EaveHt)\right]\right]\cdot 2$

$Wt_{Trans} := \sum Wt$ $Wt_{Trans} = 526256\cdot lbf$ $Wt_5 = 24016\cdot lbf$

Calculate Tributary Mass to Shear Walls

Distance between Shear Walls	Tributary Lengths to Shear Walls		Tributary Building Weight to each Shear Wall	
$Dist_1 := 9.0\cdot ft$	$L_1 := \frac{Dist_1}{2}$	$L_1 = 4.5\,ft$	$WallWt_1 := Wt_{Trans}\cdot\frac{L_1}{Length_{bldg}}$	$WallWt_1 = 12597\cdot lbf$
$Dist_2 := 41.33\cdot ft$	$L_2 := \frac{Dist_1 + Dist_2}{2}$	$L_2 = 25.165\,ft$	$WallWt_2 := Wt_{Trans}\cdot\frac{L_2}{Length_{bldg}}$	$WallWt_2 = 70443\cdot lbf$
$Dist_3 := 43.58ft$	$L_3 := \frac{Dist_2 + Dist_3}{2}$	$L_3 = 42.455\,ft$	$WallWt_3 := Wt_{Trans}\cdot\frac{L_3}{Length_{bldg}}$	$WallWt_3 = 118841\cdot lbf$
$Dist_4 := 40\cdot ft$	$L_4 := \frac{Dist_3 + Dist_4}{2}$	$L_4 = 41.79\,ft$	$WallWt_4 := Wt_{Trans}\cdot\frac{L_4}{Length_{bldg}}$	$WallWt_4 = 116980\cdot lbf$
$Dist_5 := 30ft$	$L_5 := \frac{Dist_4 + Dist_5}{2}$	$L_5 = 35\,ft$	$WallWt_5 := Wt_{Trans}\cdot\frac{L_5}{Length_{bldg}}$	$WallWt_5 = 97973\cdot lbf$
$Dist_6 := 24.1667ft$	$L_6 := \frac{Dist_5 + Dist_6}{2}$	$L_6 = 27.083\,ft$	$WallWt_6 := Wt_{Trans}\cdot\frac{L_6}{Length_{bldg}}$	$WallWt_6 = 75813\cdot lbf$
	$L_7 := \frac{Dist_6}{2}$	$L_7 = 12.083\,ft$	$WallWt_7 := Wt_{Trans}\cdot\frac{L_7}{Length_{bldg}}$	$WallWt_7 = 33824\cdot lbf$

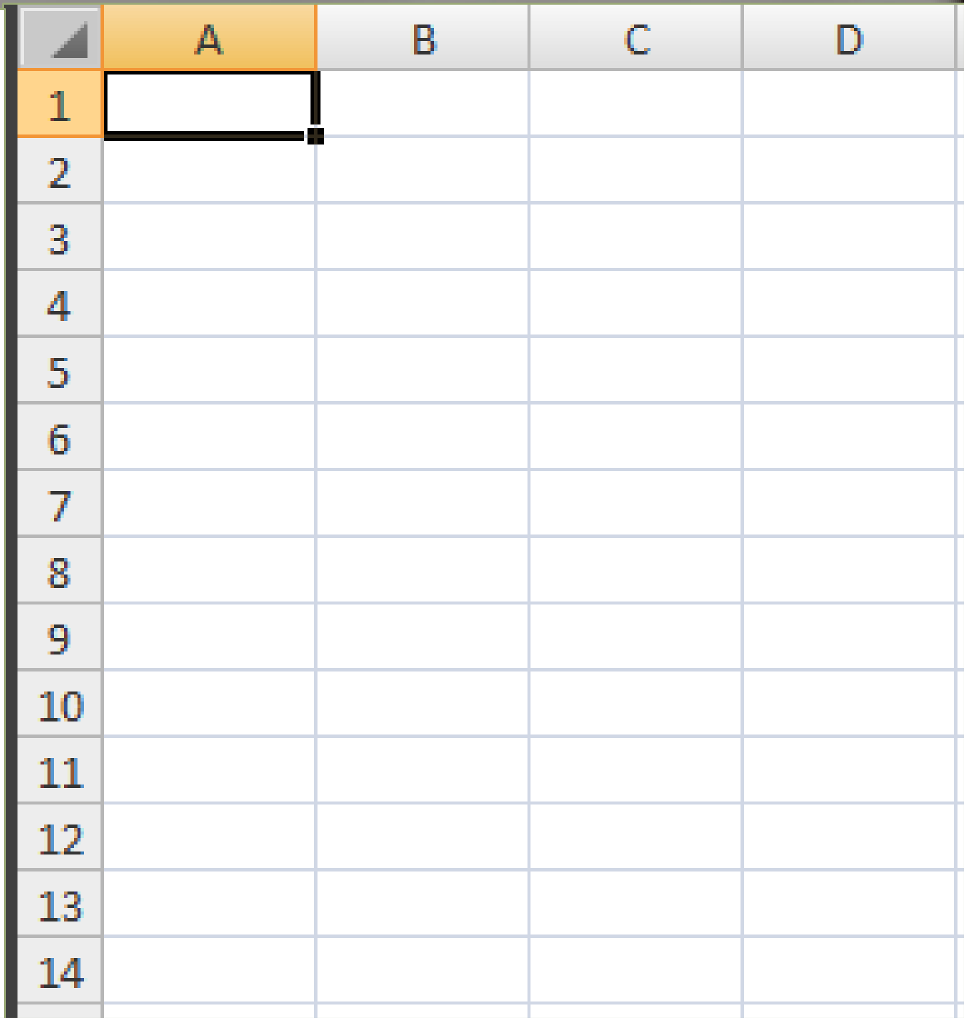
$\sum L = 188.077\,ft$

$SumWallWt := \sum WallWt$ $SumWallWt = 526470.701\cdot lbf$

Agenda

- Introduction to Mathcad
- Units!
- Functions
- Plotting
- Arrays
- Objects
- Excel
- Templates
- Mathcad Prime
- Questions

Introduction



Introduction

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Demonstration

Calculate load and reaction on a 20 foot long beam:

Dead Load: 60 psf
Live Load: 80 psf
Tributary area: 10 ft

	Good	**Better (Assign Variables)**
Dead Load	$60 \cdot 10 = 600.000$	$\mathbf{DeadLoad} := 60 \cdot 10 = 600.000$
Live Load	$80 \cdot 10 = 800.000$	$\mathbf{LiveLoad} := 80 \cdot 10 = 800.000$
Total Load	$600 + 800 = 1400.000$	$\mathbf{TotalLoad} := \mathbf{DeadLoad} + \mathbf{LiveLoad} = 1400.000$
Reaction	$1400 \cdot \frac{20}{2} = 14000.000$	$\mathbf{Span} := 20$ $\mathbf{Reaction} := \mathbf{TotalLoad} \cdot \frac{\mathbf{Span}}{2} = 14000.000$

Best (Assign Units)

$$\mathbf{DL} := 60\mathbf{psf} \cdot 10\mathbf{ft}$$

$$\mathbf{LL} := 80\mathbf{psf} \cdot 10\mathbf{ft}$$

$$\mathbf{TL} := \mathbf{DL} + \mathbf{LL} = 1400.000 \cdot \mathbf{plf}$$

$$\mathbf{Span} := 20\mathbf{ft}$$

$$\mathbf{Reaction} := \mathbf{TL} \cdot \frac{\mathbf{Span}}{2} = 14000.000\,\mathbf{lbf}$$

Units!

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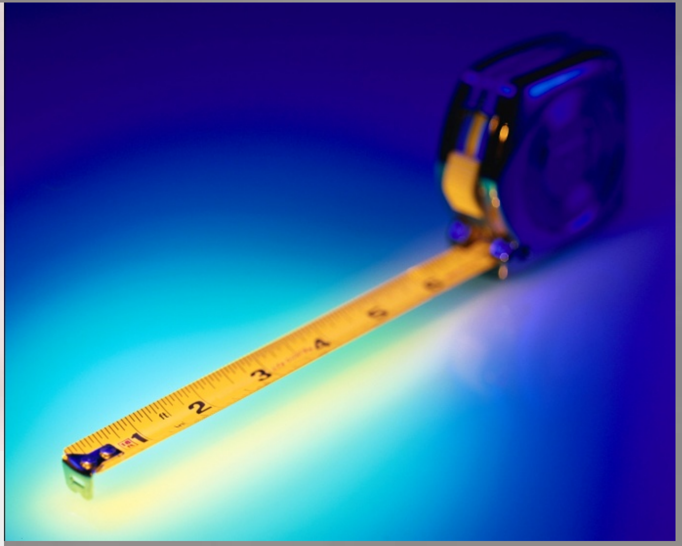
Excel



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Best (Assign Units)

$60\,\text{psf} = 2.873 \cdot \text{kPa}$

$\text{DeadLoad} := 2.87\,\text{kPa} \cdot 10\,\text{ft} = 599.412\,\text{plf}$

$\text{LiveLoad} := 100\,\text{psf} \cdot 10\,\text{ft} = 1000.000\,\text{plf}$

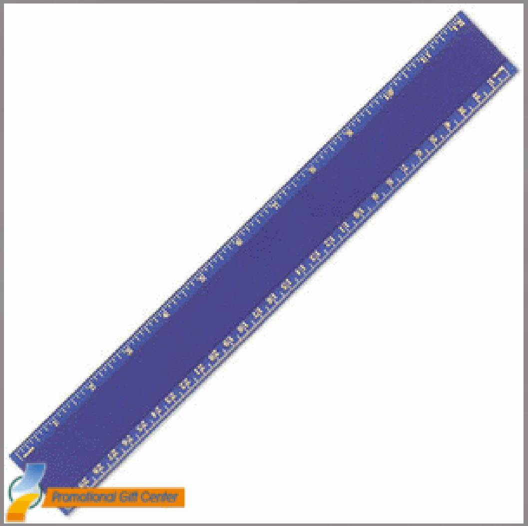
$\text{Span} := 20\,\text{ft}$

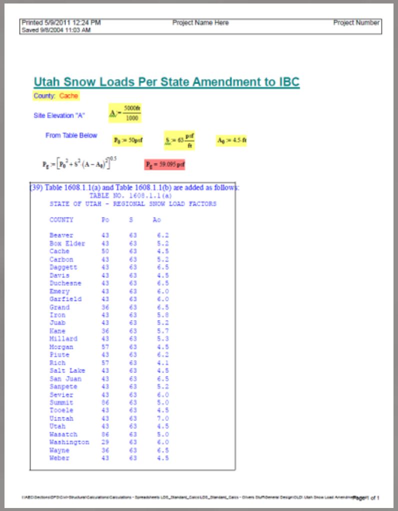
$\text{TotalLoad} := \text{DeadLoad} + \text{LiveLoad} = 1599.412\,\text{plf}$

$$\text{Reaction} := \text{TotalLoad} \cdot \frac{\text{Span}}{2} = 15994.120\,\text{lbf}$$

Uses of Mathcad

- Calculator
- Conversion tool
- Standard calculation worksheet to supplement hand calculations
- Replace hand calculations and calculation binder





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Saved 9/8/2004 11:03 AM

Utah Snow Loads Per State Amendment to IBC

County: Cache

Site Elevation "A" $A := \frac{5000ft}{1000}$

From Table Below $P_0 := 50psf$ $S := 63 \frac{psf}{ft}$ $A_0 := 4.5 \cdot ft$

$P_g := \left[P_0^2 + S^2 \cdot (A - A_0)^2\right]^{0.5}$ $P_g = 59.095 psf$

(39) Table 1608.1.1(a) and Table 1608.1.1(b) are added as follows:

TABLE NO. 1608.1.1(a)
STATE OF UTAH - REGIONAL SNOW LOAD FACTORS

COUNTY	Po	S	Ao
Beaver	43	63	6.2
Box Elder	43	63	5.2
Cache	50	63	4.5
Carbon	43	63	5.2
Daggett	43	63	6.5
Davis	43	63	4.5
Duchesne	43	63	6.5
Emery	43	63	6.0
Garfield	43	63	6.0
Grand	36	63	6.5
Iron	43	63	5.8
Juab	43	63	5.2
Kane	36	63	5.7
Millard	43	63	5.3
Morgan	57	63	4.5
Piute	43	63	6.2
Rich	57	63	4.1
Salt Lake	43	63	4.5
San Juan	43	63	6.5
Sanpete	43	63	5.2
Sevier	43	63	6.0
Summit	86	63	5.0
Tooele	43	63	4.5
Uintah	43	63	7.0
Utah	43	63	4.5
Wasatch	86	63	5.0
Washington	29	63	6.0
Wayne	36	63	6.5
Weber	43	63	4.5

When performing engineering calculations, ALWAYS attach units to your variables.

Understand the difference between lbf (pound force) and lbm (pounds mass).

When your formula expects a unitless number, divide the Mathcad value, by the units expected by the formula.

Use the “accent” key (below the ~) for the prime.

Do not use the single quote key because it will give you parenthesis.

Create Custom Units

Length of Golden Gate Bridge including approaches is 8981 ft.

$$Jesse := 5ft + 10in = 5.833\,ft$$

$$GoldenGateBridge := 8981ft$$

$$GoldenGateBridge = 1539.600\,Jesse$$

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Customize the Unit System in your worksheet to meet your specific needs.

Do not just rely on the Mathcad default units.

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Try User-Defined functions to avoid repeating the same expression

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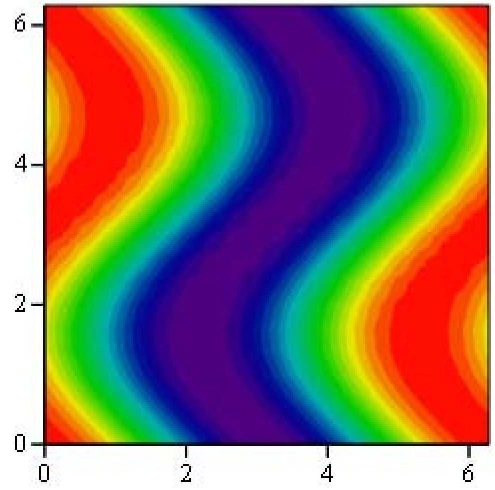
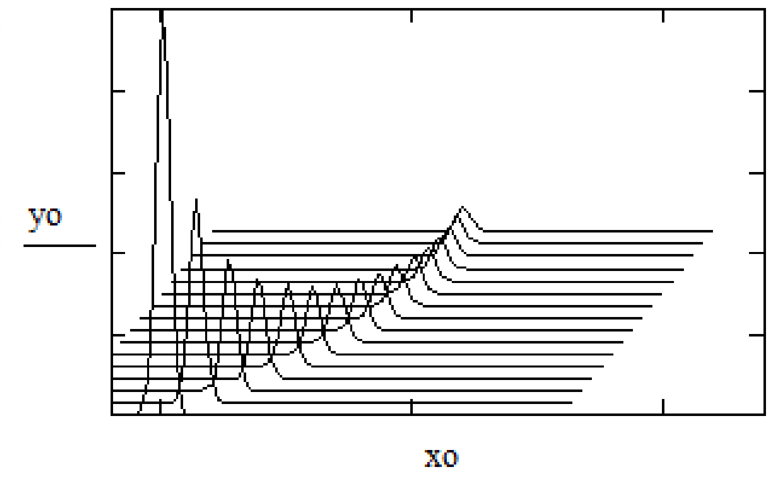
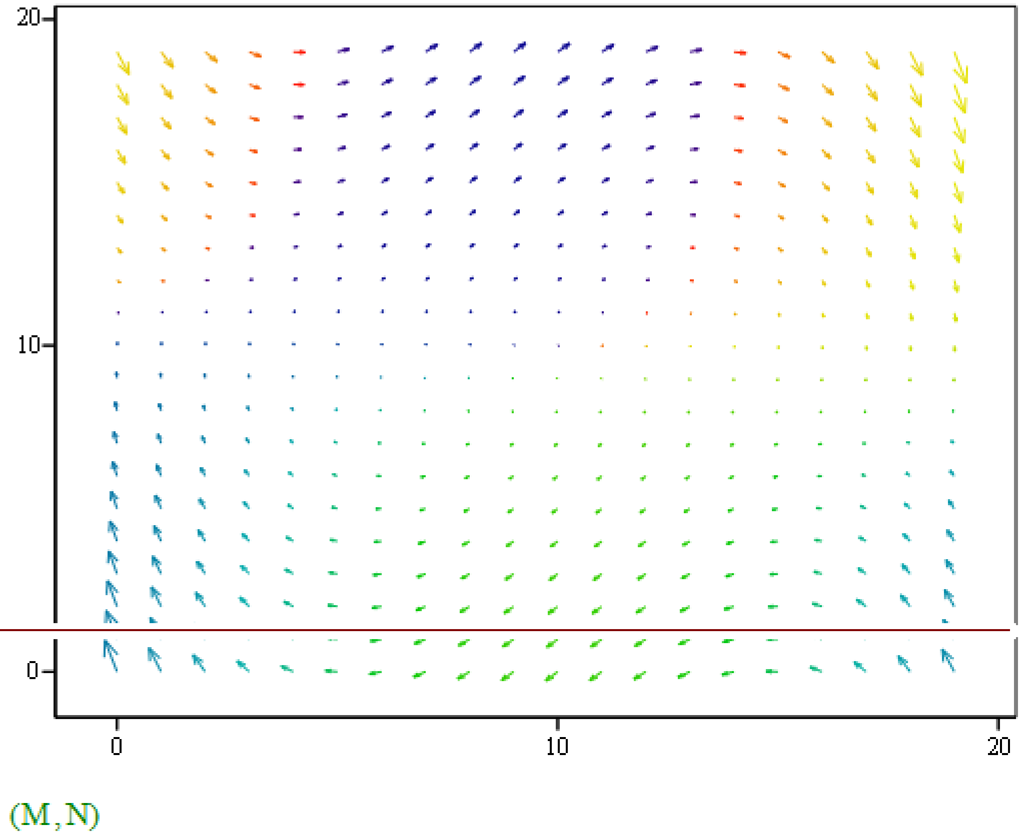
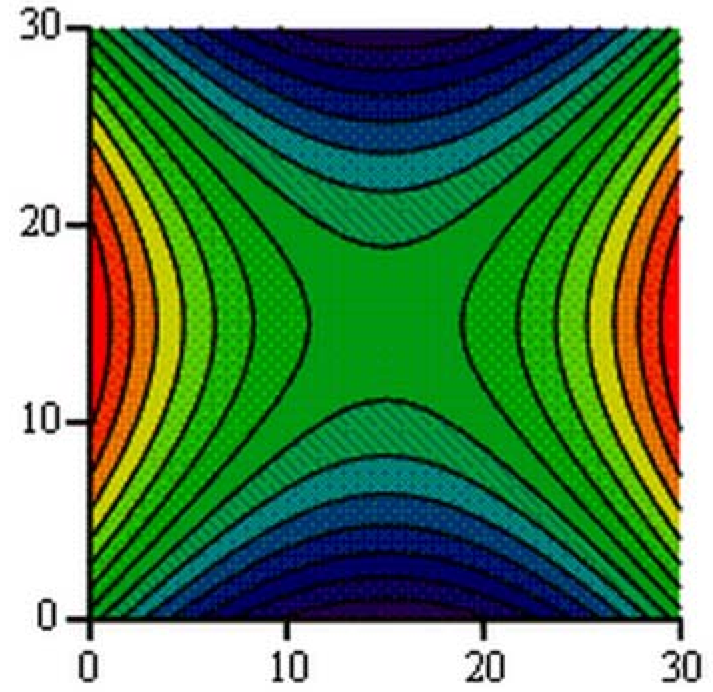
Plotting









When plotting, divide the function or data by the units you want plotted.

Arrays (for multiple inputs and results)

$$\mathbf{Matrix} := \begin{pmatrix} 1 & 3 & 4 \\ 4 & 5 & 5 \\ 5 & 5 & 5 \end{pmatrix} \qquad \mathbf{Matrix} = \begin{pmatrix} 1.000 & 3.000 & 4.000 \\ 4.000 & 5.000 & 5.000 \\ 5.000 & 5.000 & 5.000 \end{pmatrix}$$

$$\mathbf{Vector} := \begin{pmatrix} 3 \\ 4 \\ 5 \end{pmatrix} \qquad \mathbf{Vector}_1 = 3.000$$

Note that ORIGIN has been changed to 1 in this worksheet.

$$\mathbf{ORIGIN} = 1.000$$

Understand the difference between "literal" subscript and "array" subscript.

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$$\mathbf{KLrValues} := \begin{pmatrix} 25 \\ 50 \\ 75 \\ 125 \\ 150 \end{pmatrix}$$

$$\mathbf{F_e}(\mathbf{KLrValues}, \mathbf{E}) = \begin{pmatrix} 457949.644 \\ 114487.411 \\ 50883.294 \\ 18317.986 \\ 12720.823 \end{pmatrix} \cdot \mathbf{psi}$$

$$F_e\left(\left[\frac{\mathbf{KL}}{\mathbf{r}}\right], \mathbf{E}\right) := \frac{\pi^2 \cdot \mathbf{E}}{\left(\left[\frac{\mathbf{KL}}{\mathbf{r}}\right]\right)^2}$$

$$F_{cr}\left(\mathbf{F_y}, \left[\frac{\mathbf{KL}}{\mathbf{r}}\right], \mathbf{E}\right) := \left| \begin{array}{l} \mathbf{F_e} \leftarrow \dfrac{\pi^2 \cdot \mathbf{E}}{\left(\left[\frac{\mathbf{KL}}{\mathbf{r}}\right]\right)^2} \\ 0.658^{\frac{\mathbf{F_y}}{\mathbf{Fe}}} \cdot \mathbf{F_y} \quad \mathbf{if} \ \left[\frac{\mathbf{KL}}{\mathbf{r}}\right] \le 4.71 \cdot \sqrt{\frac{\mathbf{E}}{\mathbf{F_y}}} \\ 0.877\mathbf{F_e} \quad \mathbf{otherwise} \end{array} \right.$$

Range Values will display only. You cannot assign values

$$\overrightarrow{\mathbf{F_{cr}}(50\mathbf{ksi}, \mathbf{KLrValues}, \mathbf{E})} = \begin{pmatrix} 47766.507 \\ 41647.021 \\ 33139.912 \\ 16064.874 \\ 11156.162 \end{pmatrix} \mathbf{psi}$$

Use range variables for plotting. Use vectors for multiple variable input.

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To do element by element multiplication, use the "Vectorize" operator. (CTRL + MINUS)

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Use vectors to give multiple inputs to functions and expressions.

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Solve blocks provide powerful tools to solve simple or complex engineering problems.

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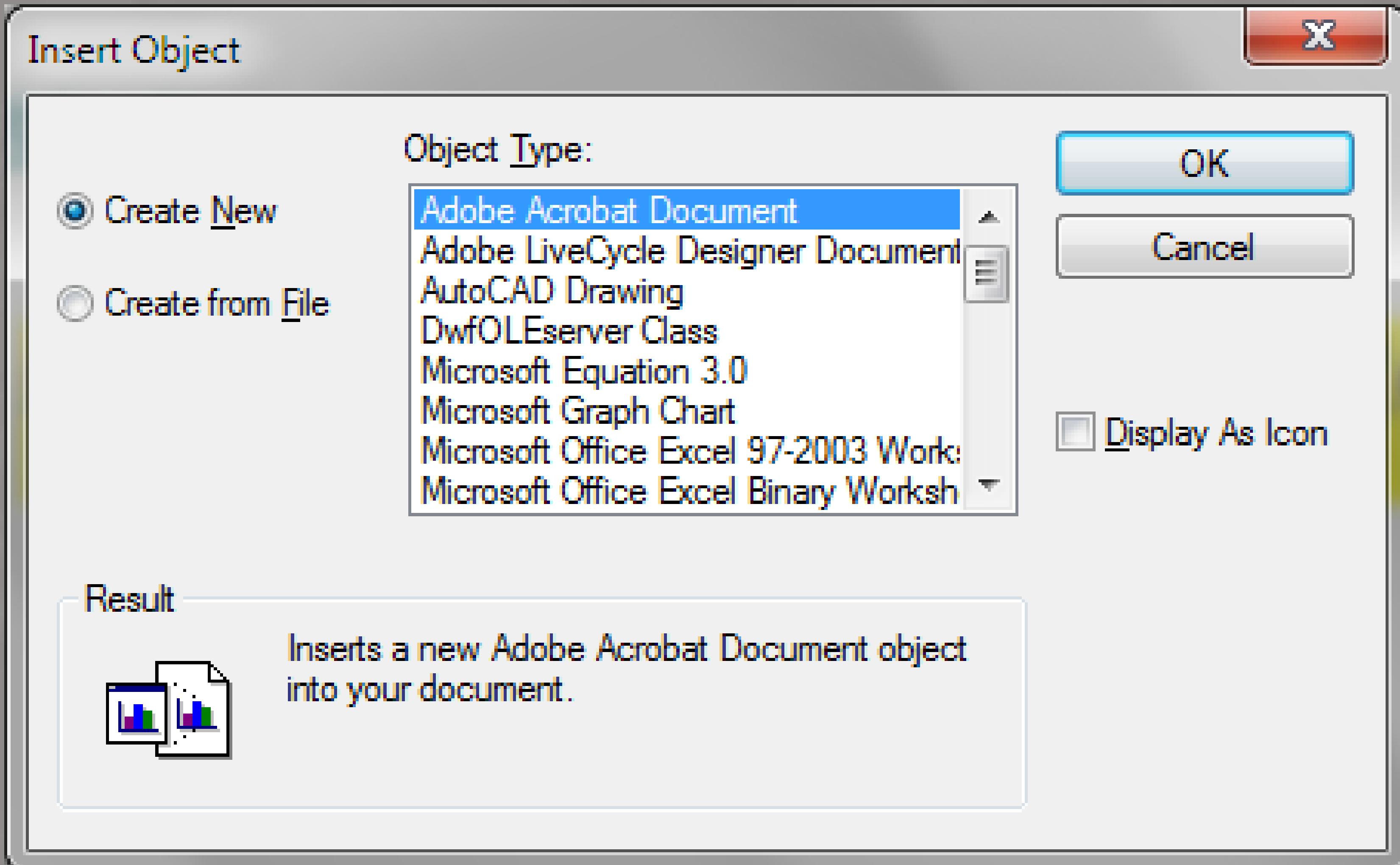
Objects


Insert Object
Object Type:
OK
Cancel
Create New
Create from File
Adobe Acrobat Document
Adobe LiveCycle Designer Document
AutoCAD Drawing
DwfOLEserver Class
Microsoft Equation 3.0
Microsoft Graph Chart
Microsoft Office Excel 97-2003 Work
Microsoft Office Excel Binary Worksh
Display As Icon
Result
Inserts a new Adobe Acrobat Document object into your document.

Use objects to insert graphics that can be edited within Mathcad.

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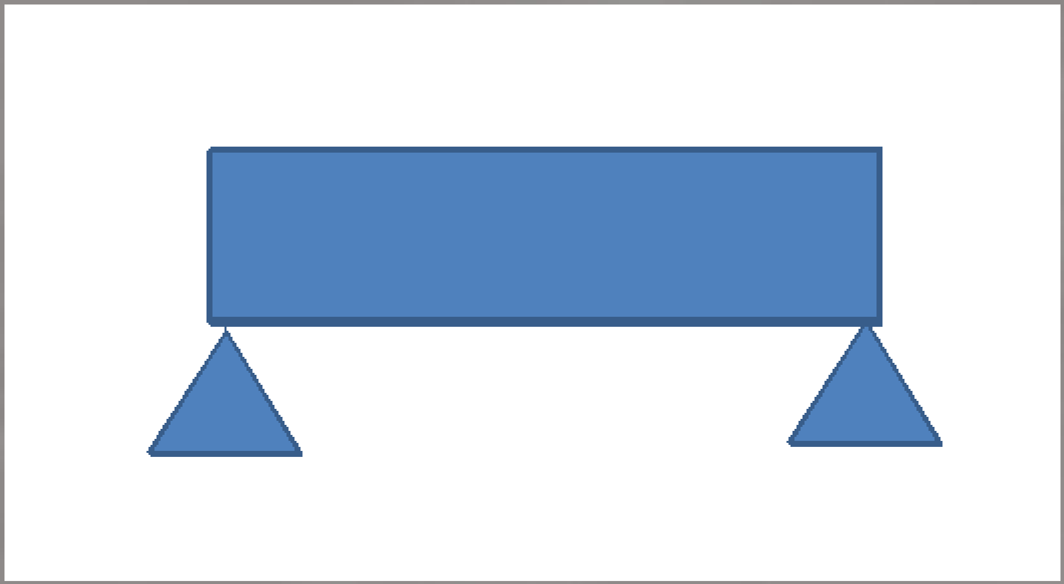

When exchanging data with the Excel component, divide the Mathcad input data by the units expected by Excel.

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Summary

1. When performing engineering calculations, always attach units to your variables.
2. Understand the difference between “lbf” and “lbm”.
3. In empirical equations, divide by the units expected by the equation.
4. Use the “accent” key for the prime.
5. Customize the worksheet Unit System to meet your specific needs.
6. Try User-Defined functions to avoid repeating the same expression.
7. When plotting, divide the function or data by the units you want plotted.
8. Understand the difference between “literal” and “array” subscripts.
9. Use range variables for plotting and vectors for multiple variable input.
10. Use “Vectorize” (CTRL + MINUS) for element-by-element multiplication.
11. Use vectors to give multiple inputs to functions and expressions.
12. Solve blocks provide powerful tools to solve simple or complex engineering problems.
13. Use Objects to insert graphics that can be edited within Mathcad.
14. Use the Excel component for existing Excel files or to take advantage of the strengths of Excel.
15. Create a Standard Template and use it as you “Normal.xmct” template.