

TK/Excel Link Case Study: Table Solutions

TK Solver's versatile List Solver lets you generate tables and plots of variables within systems of equations. Once TK models are linked to Excel, you can still use the List Solver but you can also use Excel's functionality to generate tables of solutions based on the linked variables. This case study shows you how that works.

We use the shaft torsion model from the TK Library as our example. Here are the rules and variables.

$$T_{xy} = \frac{\text{torque} \cdot OD}{2 \cdot J}$$

$$J = \frac{\pi \cdot \left[\frac{OD^4 - ID^4}{32} \right]}{32}$$

$$\text{theta} = \frac{\text{torque} \cdot L}{G \cdot J}$$

Status	Input	Name	Output	Unit	Comment
					***** SHAFT TORSION *****
	4.5	OD		in	outside diameter
	0	ID		in	inside diameter
	1	L		ft	length of shaft
		J	40.2577918	in^4	polar moment of inertia
		Txy	26827.1048	lbf/in^2	torsional shear stress
		theta	.683146614	deg	angle of twist
	12000000	G		lbf/in^2	torsional modulus of elasticity
	40000	torque		lbf*ft	torsional moment

Here are the variables after linking to Excel.

Input	Value	Unit	Comment
OD	4.5	in	outside diameter
ID	0	in	inside diameter
L	1	ft	length of shaft
G	12000000	lbf/in^2	torsional modulus of elasticity
torque	40000	lbf*ft	torsional moment

Output	Value	Unit	Comment
J	40.257792	in^4	polar moment of inertia
Txy	26827.105	lbf/in^2	torsional shear stress
theta	0.6831466	deg	angle of twist

Now let's vary the OD from 2 to 5 and generate a table of solutions for the torsional shear stress. The first step is to create the column of OD values. In this example, we start in cell B19 with the value 2 and proceed down, entering 2.5, 3, and so on down to cell B25. For a longer column of inputs, we could use a simple formula such as =B19+0.1 in cell B20, and then copy that cell down as many rows as we like.

The next step is to assign one or more values to the table header row. These values will represent the ID of the shaft and are placed into the row just above the start of the OD values, starting one column to the right.

Here are cells B18..C25 of the worksheet.

	0
2	
2.5	
3	
3.5	
4	
4.5	
5	

The next step is to enter the formula to be used to fill the table into the upper left corner of the table (cell B18). In this example, the formula is =c13, the link to the value of Txy in the TK model. This will place the value of Txy in the corner of the table. This value has no importance to the table but the formula is required. You can hide the value by changing the text color to white if you like.

The last step is to use Excel's Data Table Command to identify the domain of the table. Highlight the rows and columns of the table and then access the Data menu and choose Table. Excel prompts us for the row input cell, which in this case is the ID value, cell C5. Excel also prompts us for the column input cell, which is the OD value, cell C4. Excel will then use the values from the table in cells C4 and C5 and send the resulting C13 values to the output cells of the table.

Here is the solution.

26827.1	0
2	305577.49
2.5	156455.68
3	90541.479
3.5	57017.374
4	38197.186
4.5	26827.105
5	19556.959

The table can have as many columns as we like. Here, the table includes ID values from 0 to 1, along with additional labels.

Txy Table

	0	0.25	0.5	0.75	1 ID
2	305577.5	305652.1	306775.8	311742.3	325949.3
2.5	156455.7	156471.3	156706.4	157733.3	160566.2
3	90541.48	90545.85	90611.39	90896.54	91673.25
3.5	57017.37	57018.86	57041.13	57137.85	57399.88
4	38197.19	38197.77	38206.51	38244.46	38346.98
4.5	26827.1	26827.36	26831.19	26847.82	26892.69
5	19556.96	19557.08	19558.92	19566.87	19588.3

OD