

## DTMS Fitting Spreadsheet Instructions

Revised: August 4, 2015

The Deflection and Twist Measurement System treats each measurement segment as a vector. It uses vector addition to calculate the position at the end of each segment with respect to the coordinate system at the root of the string of segments. Each vector has a length (that is, the segment length) and an angle.

The DTMS fitting spreadsheet allows a user to estimate the number of DTMS segments that will be required to measure a structure's deflection and the length of each segment. The spreadsheet uses a simple, one-dimensional model of the DTMS to fit the customer's data from the axis that is expected to have the most deflection (Y or Z). The goal of the fitting exercise is to ensure that the DTMS can measure *at least* as much deflection as you are expecting in that axis.

The columns on the spreadsheet that are highlighted in yellow are for customer data entry. The blue-highlighted columns are for calculated results and should not be changed.

The steps to use the fitting spreadsheet are –

1. Enter your expected worst-case deflections (X and Y, meters) in the Customer Data section (columns A and B). Your data can be put in as formulas or imported from a structural model.

The spreadsheet is set up to allow 10 data points, but you can put in as much data as you want. If you need more than 10 points, modify the green Customer curve in the graph below the data to plot all of your points. The Customer curve shown on this graph represents the deflection of a simple, 100-meter cantilevered beam with a 0.1-meter x 0.1-meter cross-section and a load at the end.

2. Next, enter your initial guess at segment lengths in column E. The spreadsheet is set up for 10 segments, but you can use fewer than 10. If you want to use more than 10 segments, extend the area by copying row 20, columns D through U. To plot the extra points, you must also edit the red DTMS curve in the graph.
3. When you have entered the segment lengths, the +/-Max Deflection (column F) will update. It will display the maximum range that can be measured in each segment, assuming that the system is initialized with the cross-hair in the center. As the segment length increases, the laser line width increases, which reduces the measurement range.
4. Y Deflection (Column G) is for entering the deflection you expect between the two ends of the segment. This value should not exceed the +/- Max Deflection calculated in column F. If it does, you must reduce your segment length.
5. The Maximum and Minimum Tangent Angle at End (columns H and I) are calculated results based on the expected deflection that you entered in column G. The tangent angle is the initial vector angle of the next segment. The DTMS uses

the initial vector angle combined with the angle formed by the deflection within a segment as the vector angle when adding segments together.

Set Tangent Angle at End (Column J) is where you enter the tangent angle at the end of each segment. This angle must be somewhere between the calculated Maximum and Minimum Tangent Angle at End (columns H and I).

6. The X and Y data in columns M and N are the calculated positions of the ends of the segments based on the data entered. This data is represented on the graph by the red DTMS curve.
7. The final step is to set the Z deflection (column P) in the Twist Calculations section. The maximum twist that can be measured depends on the deflections in both Y and Z axes.
  - a. Figure 1 shows the maximum twist that can be measured with zero Y and Z deflections. In this case, angle  $\alpha$  equals angle  $\beta$ .
  - b. Figure 2 shows the maximum Y deflection, where any twist would cause one arm of the cross-hair to move off of the sensor array.
  - c. Figure 3 shows deflections in both Y and Z. In this case, the maximum twist that can be measured counter-clockwise ( $\alpha$ ) is less than the twist that can be measured clock-wise ( $\beta$ ).
  - d. Figure 4 shows the maximum twist that can be measured in either direction based on Y and Z deflections.

The Set Z Deflection (column P) is for entering your Z deflection data, which is the orthogonal axis to the Y axis (column G). Using this data, the spreadsheet will calculate the maximum twist that can be measured for these conditions, which is displayed in column U, Maximum Twist. Note that the angle displayed is the smaller of the clock-wise and counter-clockwise rotations.

Figure 1

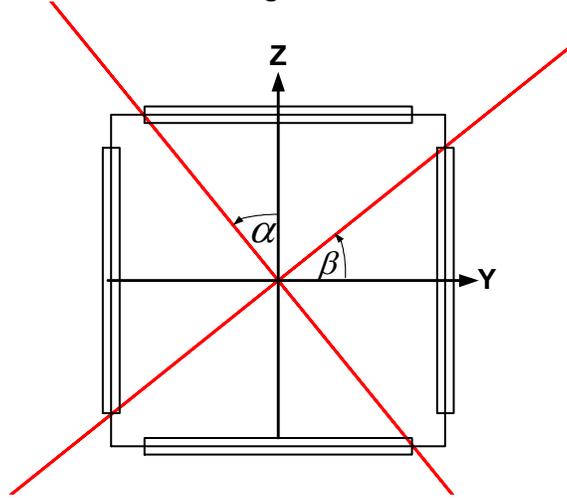


Figure 2

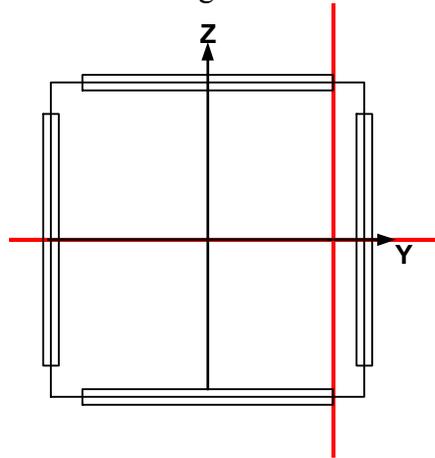


Figure 3

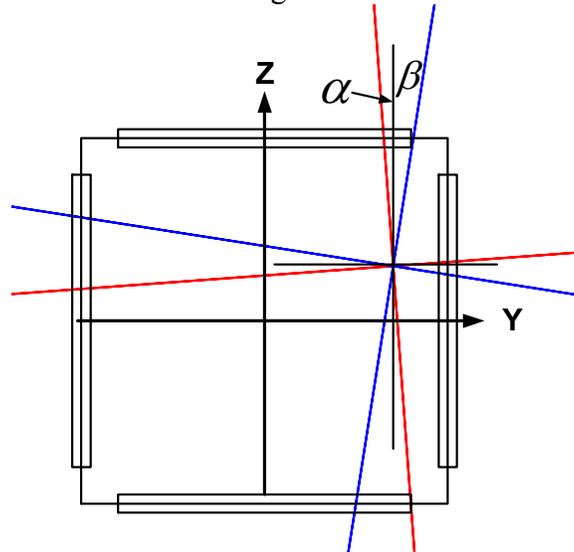


Figure 4

