Geo Tech Note:

Computation of Cross-Axis Tilts

900 Series Biaxial Inclinometers

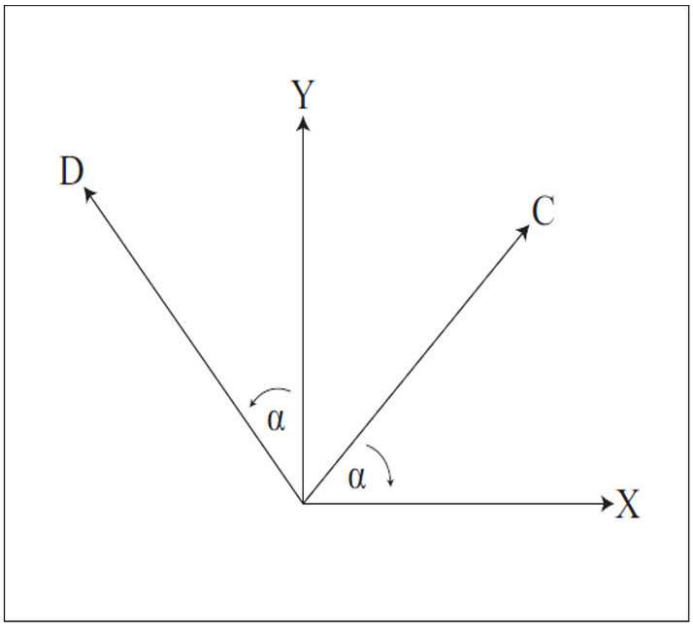

Figure 1. Plan View

Assumptions

1. Planes XY and CD are initially horizontal.
2. Scale factors, S_X and S_Y, for rotations in vertical planes parallel to X and Y directions are given.
3. Voltage outputs of X and Y channels, V_X and V_Y, are: measured voltages minus bias (see below).
4. Bias voltages, B_X and B_Y, have been measured. Bias voltages are the tiltmeter's X and Y outputs when it is perfectly horizontal.

Problem

1. Rotation occurs in a vertical plane parallel to direction C.
2. Find angle α, which defines C direction.
3. Find amplitude of rotation, θ_C.

Solution

For rotation in the X or Y directions, rotation amplitude is given by $\theta_X = S_X V_X$ and $\theta_Y = S_Y V_Y$ where S_X and S_Y are the scale factors given in the user's manual or calibration certificate.

For rotation in the C direction we define new scale factors:

$S_C' = S_X/\cos\alpha$ and $S_C'' = S_Y/\cos(90° - \alpha)$

The rotation amplitude in the C direction then becomes:

$\theta_C = S_C' V_X = (S_X/\cos\alpha)(V_X)$ [1]

$\theta_C = S_C'' V_Y = [S_Y/\cos(90° - \alpha)](V_Y)$ [2]

Equating [1] and [2] and solving gives:

$$\frac{S_X V_X}{\cos\alpha} = \frac{S_Y V_Y}{\cos(90° - \alpha)}$$

$$\frac{S_X V_X}{S_Y V_Y} = \frac{\cos\alpha}{\cos(90° - \alpha)} = \frac{1}{\tan\alpha}$$

$$\alpha = \tan^{-1}\left[\frac{S_Y V_Y}{S_X V_X}\right] \quad [3]$$

Substituting α in equation [1] or [2] along with the known values of S_X and V_X, or S_Y and V_Y, gives the rotation angle, θ_C.

Summary: Steps in Measuring Cross-Axis Tilt Angle, θ_C

1. Measure bias voltages, B_X and B_Y, on both tilt channels.
2. Subtract B_X and B_Y from measured voltages to obtain corrected outputs V_X and V_Y for use in eqns. [1] through [3].
3. Compute α from equation [3] using known scale factors S_X and S_Y.
4. Compute θ_C from equation [1] or [2].

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