FE 308
Lecture 4 – Horizontal Distance cont.

Tape corrections

Measurements of distance with a steel tape are subject to a number of errors:

Blunders:

Random:

Systematic:

There are several types of systematic errors that must be accounted for in precise work.

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For a tape that is longer than its standardized length, you will _____ a correction factor to get the correct length.

For a tape that is shorter than its standardized length, you will _____ a correction factor to get the correct length.

Standardization

All tapes are manufactured to fairly exact standards but they are not guaranteed to be exactly their stated length.

Tapes are generally tested for length against a standard, generally 68^0 F. with a pull of 12 lbs. fully supported, and at 68^0 F. with a pull of 20 lbs. supported only at the ends.

$$correction = C_l = \frac{l - l'}{l'}(L)$$

Where: C_l = The correction to be applied to the measured length
l = actual length of the tape
l' = the standardized or nominal tape length
L = the measured length of the line

Example: You have measured a distance between two points to be 915.67'. You find out your tape is 99.97' long when compared to a standard. What is the true distance of the line?

Temperature

All tapes are standardized at 68^0 F. A temperature higher or lower than this causes a thermal expansion or contraction of the steel and causes the tape to be either longer or shorter than the standard. Typically, a 100' tape will expand 0.01' for every 15^0 F increase in temperature.

The thermal expansion coefficient for the steel used in most tapes is 6.45 x 10^{-6}. The correction for tape thermal expansion is:

$$correction = C_t = k(T_1 - T)L_s$$

Where: C_t = the correction to be applied to the measured length
k = the coefficient of thermal expansion
T_1 = tape temperature at time of measurement
T = tape standardized temperature
L_s = the distance between supports

Example: You have measured a distance between two points of 915.67'. The temperature at the time of measurement is 79^0 F. What is the true distance of the line?

Pull or tension

Many tapes are standardized at a specific tension of 12 lbs under full support. A tension higher or lower than this causes the tape to be either longer or shorter than the standard.

The modulus of elasticity coefficient for the steel used in most tapes is 29,000,000 lbs./sq. in. The correction for tape stretch is:

$$correction = C_p = (P_1 - P)\frac{L}{AE}$$

Where: C_p = the correction to be applied to the measured length
P_1 = tape pull at time of measurement
P = tape standardized pull
L = the measured length of the line
A = the cross-sectional area of the tape
E = the coefficient of modulus of elasticity

Example: You have measured that same distance between two points to be 915.67' at 68^0 F. The pull on the tape is measured at 21 lbs. fully supported while the standardized pull is 12 lbs. fully supported. The cross sectional area of the tape is 0.006sq. in. What is the true length of the line?

$$correction = C_p = (21-12)\frac{915.67'}{0.006in^2 x29000000}$$

$$C_p = (21-12)\frac{915.67'}{0.006in^2 x29000000}$$

$$C_p = 0.04736 = 0.05'$$

Adjustment: 915.67 + 0.05 = 915.72'

Sag

Many tapes are standardized at full support at 12lbs. A support at two ends will cause a tape to sag in the form of a catenary causing the measured distance to be greater than the actual. The correction for tape sag is:

$$correction = C_s = -\frac{W^2 L_s}{24 P_1^2}$$

Where: C_s = the correction for each 100' tape length
W = the total weight of the tape between supports
L_s = the distance between supports
P_1 = tape pull at time of measurement

Example: You have measured a distance between two points to be 915.67' at 68^0 F with a 100.00-foot tape. So we know that temp and standardization are fine. The pull on the tape is measured at 20 lbs. when not fully supported while the standardized pull is 20 lbs. when not fully supported. So, we also know that the pull is OK. The weight of the tape is 1.61lbs. What is the true length of the line?

$$correction = C_s = \frac{-1.61^2 100'}{24 x 20^2}$$

$C_s = -0.027'$ Correction for each 100' segment

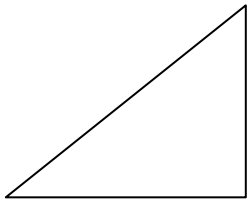
Now we multiply by the number of tape segments we used to measured:

$$C_s = 9.1567 * -0.027' = -0.24723' = -0.25'$$

And apply the adjustment to get our adjusted length:

915.67' – 0.25' = 915.42'

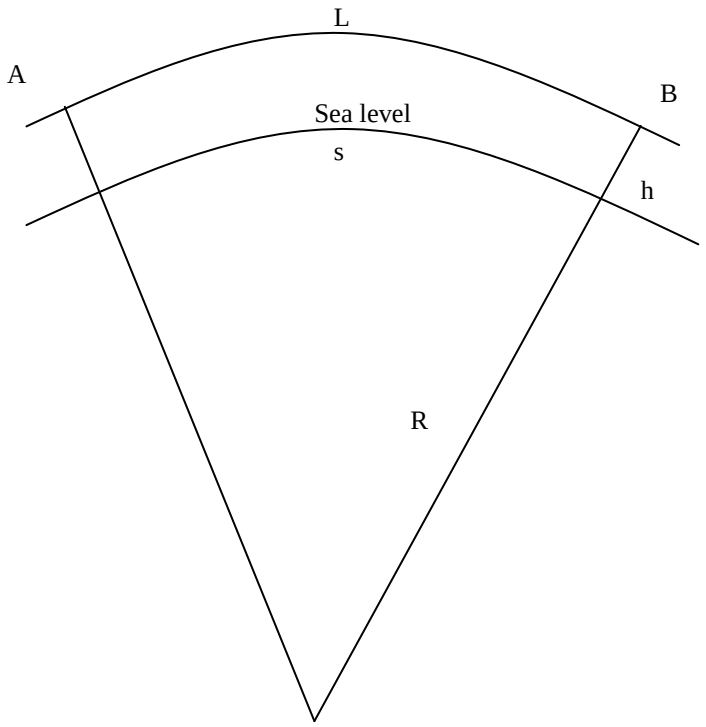
Slope



Alignment

Sea level

This is a special correction factor applied to precise geodetic surveys. It works on the principle that measurements are reduced to their sea-level equivalents in order to support comparisons.



$$correction = C_{sea} = \left(\frac{R}{R+h} \right) L$$

Where: C_{sea} = the corrected length of the line
R = radius of the Earth, usually 20.9 x 10^6
h = the average ground elevation above sea level
L = the measured length of the line

Example: You have measured a distance of 915.67’ for a geodetic baseline at an average elevation of 950.00’ above sea level. What is the true length of the line?

Summary of taping errors
