Ishik University - Sulaimani

Civil Engineering Department

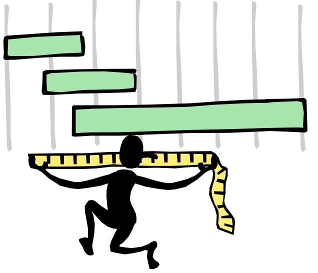
Surveying I

CE 215

CHAPTER -2-

TAPE CORRECTIONS

Contents



1. Objectives

By the end of the lecture students should be able to:

- Identify, enumerate and apply correctly the rules and general statement for tape corrections.
- Discuss the causes of errors in taping and carry out corresponding corrections.
- Determine equations to apply for each tape correction.

Common mistakes encountered in taping are the following:

1. Measuring to or from the wrong marker.
2. Reading the tape incorrectly or transposing figures (e.g., reading or recording 56 instead of 65).
3. Losing proper count of the number of full tape lengths involved in a measurement.
4. Recording the values incorrectly in the notes. Sometimes the note keeper hears the rear surveyor's callout correctly, but then transposes the figures when he or she enters it into the notes. This mistake can be eliminated if the note keeper calls out each value as it is recorded. The rear surveyor listens for these callouts to ensure that the numbers called out are the same as the data originally given.

5. Calling out figures ambiguously (unclearly). The rear surveyor can call out 20.27 as “twenty (pause) two seven.” This might be interpreted as 22.7. To avoid mistakes, this number should be called out as “twenty, decimal (or point), two, seven.”

6. Not identifying correctly the zero point of the tape when a cloth or fiberglass tape is used. This mistake can be avoided if the surveyor checks unfamiliar tapes before use. The tape itself can be used to verify the zero mark.

7. Making arithmetic mistakes in sums of dimensions and in error corrections (e.g., temperature). These mistakes can be identified and corrected if each member of the crew is responsible for checking (and initialing) all computations.

1. Temperature Corrections

The length of the tape increases while the temperature is increased and decreases if the temperature is lowered.

- ✓ Change in the length of the tape due to variations in temperature
- ✓ Occurs when measurements are taken at temperatures above or below the standard temperature of the tape
- ✓ Correction is usually small and negligible
- ✓ Proportional to the number of tape lengths

1. Temperature Corrections

$$C_t = \alpha L (T_m - T_o)$$

Where ;

L = measured length of a line, **(m) or (ft).**

T_m = mean temperature during measurement in **(°C) or (°F)**.

$T_{s,o}$= standard temperature in **(°C) or (°F)**.

C_t = correction due to temperature.

α = coefficient of linear expansion.(**6.5*10^{-6} °F**) or **(11.2*10^{-6} °C).**

*If the $T_{field} > T_{standard}$ the correction is **positive.**

*If $T_{field} < T_{standard}$ it is **negative**.

Example -1-

You must lay out two points that are exactly 100m apart. Field conditions indicate that standard conditions apply except the measured temperature is 27 °C. Determine the distance to be laid out. (Ts=20 °C)

Given:
T = 20 °C
T_s= 27 °C
α = 11.2*10^{-6} °C

Answer:
C_t = +0.00784 m
L_c = 100.00784 m

Example -2-

A distance was recorded as being 150 m at a temperature of 38 °C. What is the corrected distance, if a steel tape was used and the standard temperature 20 °C. $\alpha=1.16*10^{-5}$.

Answer:

$\mathbf{C_t}$ = +0.031 m

$\mathbf{L_c}$ = 150.031 m

Example -3-

A distance was recorded as being 471.37 ft at a temperature of 38°F. What is the corrected distance?

Answer:

$\mathbf{C_t}$ = -0.09 m

$\mathbf{L_c}$ = 471.28 m

2. Tension (Pull) Corrections

If the *pull* used in the field is different from that used during calibration, the tape changes its length slightly according to the relationship between stress and strain.

the correction for pull **Cp** is given by

$$C_p = (P_m - P_o) \times L / AE$$

where:

C_p = correction for pull

P_m = pull applied during measurement, kg or N

P_o = pull under which the tape is standardized, kg or N

A = cross-sectional area of the tape, (cm^2 or mm^2)

E = modulus of elasticity of steel, (kg/cm^2 or N/mm^2)

L = measured length

Example -4-

A 30-m tape is used with a 100N force instead of the standard tension of 50N. If the x-section area of the tape is 1.8 mm^2, what is the tension error per tape length? E=200 GPA

<u>Answer:</u>

$\mathbf{C_p}$ = +0.0042 m

$\mathbf{L_c}$ = 30.0042 m

Example -5-

Given a standard tension of a 10-Ib force for a 100 ft tape, that is being used with a 20 Ib force pull. If the cross sectional area of the tape is 0.003 in^2, what is the tension error for each tape length used? If a distance of 421.22 ft had been recorded, what is the total correction? E=3.03 *10^7 Psi

<u>Answer:</u>

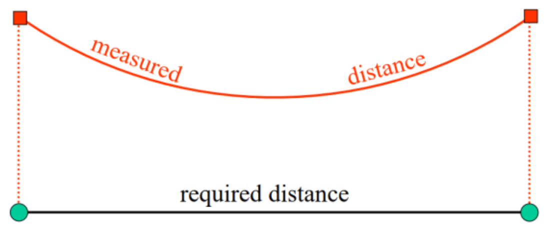
$\mathbf{C_p}$ = +0.011 ft per each tape length

$\mathbf{C_p}$ = +0.046 ft per total tape length

$\mathbf{L_c}$ = 421.27 ft total correction for length

3. Sag Corrections

$$C_s = -\frac{w^2L^3}{24P^2} = -\frac{W^2L}{24P^2}$$



3. Sag Corrections

$$C_s = -\frac{w^2L^3}{24P^2} = -\frac{W^2L}{24P^2}$$

where:

C_s = correction for sag

P = applied pull at the time of measurement

W = total weight of the tape between supports, kg or N

w = weight of tape per unit length W/length of tape, kg/m

L = length of tape between supports

Example -6-

A 100 ft steel tape weighs 1.6 Ib and is supported only at the ends with a force of 10 Ib. What is the sag correction and corrected length? If the force were increased to 20 Ib, what will happen?

$$C_s = \frac{-1.6^2 \times 100}{24 \times 10^2} = -0.11 \text{ ft}$$

$$C_s = \frac{-1.6^2 \times 100}{24 \times 20^2} = -0.03 \text{ ft}$$

Example -7-

Calculate the length between two supports if the recorded length is 42.071 m, the mass of this tape is 1.63 kg, and the applied tension is 100 N. find the corrected length between supports.

$$C_s = \frac{-(1.63 \times 9.807)^2 \times 42.071}{24 \times 100^2}$$
$$= -0.045$$

Therefore, the length between supports:

$$= 42.071 - 0.045 = 42.026 \text{ m.}$$

Example -8-

The distance measured between two tripods with the steel tape in full catenary is 82.971 m. The weight per unit length of the tape is 0.009kg/m. standard tension 7N is applied.

Determine: 1. the correction to be applied. 2. the corrected distance between the two tripods.

$$C_{sag} = \frac{-w^2 d^3}{24 f_f^2}$$

$$= \frac{-0.009^2 \times 82.971^3}{24 \times 7^2}$$

$$= -0.039 \text{ m.}$$

$$\text{Corrected length} = 82.971 - 0.039$$

$$= 82.932 \text{ m.}$$

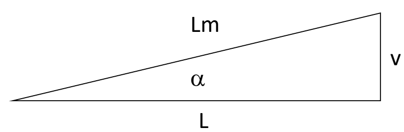
4. Slope Corrections

$L = Lm * \cos(\alpha)$

$Csl = Lm - L$

$Csl = Lm - Lm * \cos(\alpha)$

$$\mathbf{Csl = Lm(1 - \cos(\alpha))}$$



The distance measured along the slope between two station is always greater than the horizontal distance is known as slope correction.

- This is always **negative**.

$Csl = Lm - L$

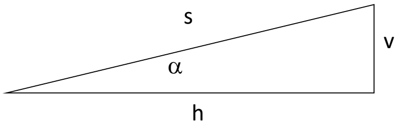
$v^2 = Lm^2 - L^2 = (Lm - L)(Lm + L)$

$(Lm - L) = (\frac{v^2}{Lm+L}) \approx \frac{v^2}{2Lm}$

$$\mathbf{Csl = (\frac{v^2}{Lm+L}) \approx -\frac{v^2}{2Lm}}$$

Example -9-

Determine: the correction to be applied.



- **If s = 300.00' and α = 5°**
  - h = 300 cos(5) = 298.86'
  - v = 300 sin(5) = 26.15',
- **If you had measured v = 26.15', s = 300.00'**
  - $C_S = v^2/2S = 26.15^2/600.00 = 1.14'$
  - h = v – C_S = 300.00 – 1.14 = 298.86'

5. Incorrect Tape Length Corrections

Sources of Error
Bad repair
Poor standardization

$C_L = (L_{true} - L)$ **$C_a = L.C/ l$**

Example -10-

- Your Task: Measure distance A to B
- You measure 500.00'
  - Your tape is actually 100.02' long
  - Actual length = 500.10'
- C_L = (100.02' – 100') = 0.02'/pull
- $D_{true} = D_{measured} + C_L$
- D_{true} = 500.00 + 5*(.02') = 500.10'

Example -11-

A measurement was recorded as 171.278 m with a 30-m tape that was only 29.996 m under standard conditions. What is the corrected measurement?

Solution

$$\text{Correction per tape length} = -0.004$$

$$\text{Number of times the tape was used} = \frac{171.278}{30}$$

$$\text{Total correction} = -0.004 \times \frac{171.278}{30}$$

$$= -0.023 \text{ m}$$

$$\text{Corrected distance} = 171.278 - 0.023$$

$$= 171.255 \text{ m}$$

or

$$\text{Corrected distance} = \frac{29.996}{30} \times 171.278 = 171.255 \text{ m}$$

Example -12-

A line was measured with a steel tape which was exactly 30 m at 18°C & a pull of 50N & the measured length was 459.242m. Temperature during measurement was 28°C & the pull applied was 100N. The tape was uniformly supported during the measurement. ***Find the true length of the line*** if the cross-sectional area of the tape was 0.02cm^2, the coefficient of expansion per °C = 0.0000117 & the modulus of elasticity = 21 × 10^6 N/cm^2.

Solution:

Here,

ℓ = 30m, T_s = 18°C, T_m = 28°C, α = 0.0000117/C, L= 459.242m

P_m = 100N, P_s = 50 N, A = 0.02 cm^2, E = 21 × 10^6 N/cm^2

temperature correction for total length = 0.0000117 × (28-18) × 459.242

C_t = + 0.054 m

pull correction for total length = (100 - 50) × 459.242 /(0.02 × 21 × 10^6)

C_p = + 0.055 m

Therefore,

true correction for total length **= 459.242+0.054+0.055**

Lc =459.35 m

Example -13-

Homework -1-

A base line AC was measured in two parts along two straight drains AB & BC of length 1650m & 1819.5m with a steel tape which was exactly 30m at 25°C at a pull of 100N. The applied pull during measurement of both parts was 200N whereas respective temperatures were 45°C & 40°C. The slopes of drains AB & BC were 3° & 3°30′. Find the correct length of the base line if the cross sectional area of the tape was 2.5 mm^2. The coefficient of expansion & modulus of elasticity of tape material were 3.5 × 10^{-6} per °C & 21 × 10^5 N/mm^2 respectively.

Example -14-

Homework -2-

A steel tape of nominal length 30 m was used to measure a line AB by suspending it between supports. The following measurements were recorded.

Line	Length Measured	Slope Angle	Mean Temp.	Tension
AB	29.872 m	3^{o} 40'	$5^{o}C$	120 N

The standardisation temperature and tension was $20^{o}C$ and 50 N.

If the tape weighs 0.17 N/m and has a cross sectional area of 2 mm^2, calculate the horizontal length of AB.

Example -15-

Homework -3-

A line was measured at 98.306 m with steel tape. The temperature at the time of observation was 23℃ and the applied tension was 5 kg, the tape was supported in the center in catenary, on a slope of +2° 35'.

Chain Standards:

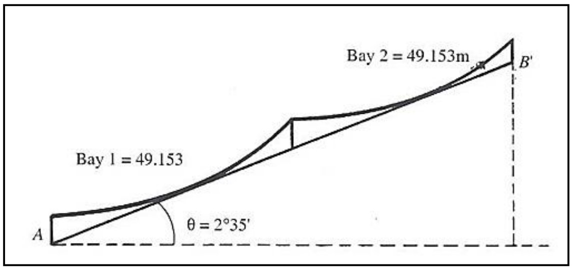
L= 100 m at 20℃, 7kg

A= $0.75*10^{-6}$ m^2

E= $20*10^{9}$ kg/m^2

W= 0.6 kg

α= 0.000011/℃



Example -16-

Homework -4-

A distance of 85.000 m is to be laid down using a 50-m steel tape that is actually 50.008 m long. The tape is to be laid on the ground throughout its length. Tension applied is 10 kg, while standard tension is 5 kg. Field temperature is 30 °C, while standard temperature is 20 °C. Coefficient of thermal expansion k = 1.2E-5, Modulus of elasticity E = 21E05 kg/ cm^2, and tape cross-sectional area A=0.025 cm^2. Compute the total correction and the corrected distance.

Example -17-

Homework -5-

A steel tape standardized at 68 °F, and supported throughout under a tension of 12 lb was found to be 99.991 ft long. This tape was used to lay out a horizontal distance AB of 650.23 ft. The ground was on a smooth 4% grade; thus, the tape was used fully supported. If a pull of 25 lb was used and the temperature was 42° F. (The cross sectional area of the tape = 0.005 sq. in. and the elasticity of steel = 29,000,000 lb/sq. in) , Determine:

1. The slope distance
2. Correction for temperature, pull and incorrect length
3. Actual (Corrected) length

Example -18-

Homework -6-

A 30m steel tape, standardized at 20 °C using a tensile force of 70N. Measured against a standard tape, the tested tape had a length of 29,998m. The 30m tape has a weight of 0.196N/m and a cross sectional area of 1.69 mm^2. Young's Modulus of Elasticity for the tape is 2.068 x 10^{11} N/m^2, coefficient of thermal expansion is 1.17×10^{-5}

A field measurement of 29.663m found at a temperature of 30 °C using a tensile force of 50N. Find the actual or true length.

Correction	Sign	Formula
Absolute length (c_a)	±	$\frac{c}{l} L$
Temperature (c_t)	±	$\alpha(t_m - t_0)L$
Pull (c_p)	±	$\frac{(P - P_0)}{AE} L$
Sag (c_g)	−	$\frac{1}{24}\left(\frac{W}{P}\right)^2 L$
Slope (c_s)	−	$(1 - \cos\theta)L$ (*exact*)
Alignment (c_m)	−	$\frac{h^2}{2L}$ (*approximate*)
Mean sea level (c_{msl})	−	$\frac{d^2}{2L}$ (*approximate*)
		$\frac{HL}{R}$ (*approximate*)