CE 371 Surveying
Systematic Taping Corrections

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Overview

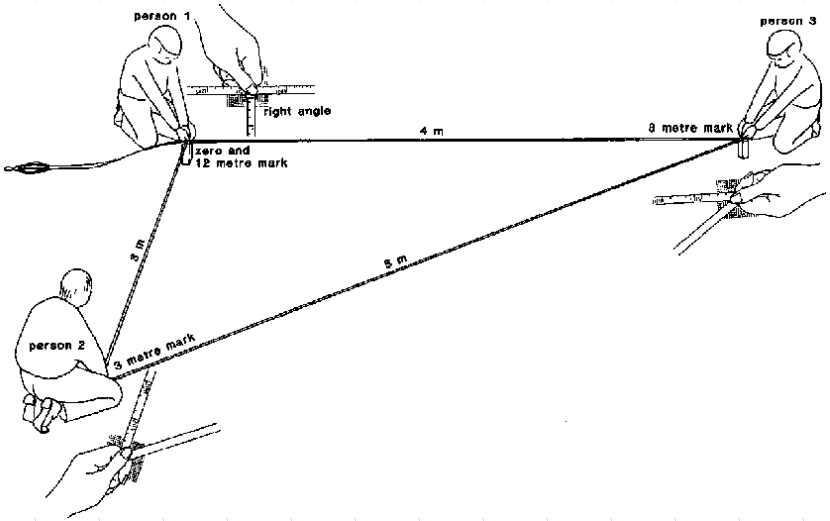
- Special Field Operations Using a Tape
- Sources of Error in Taping
- Types of Error in Taping
- Systematic Taping Corrections
- Poor Alignment

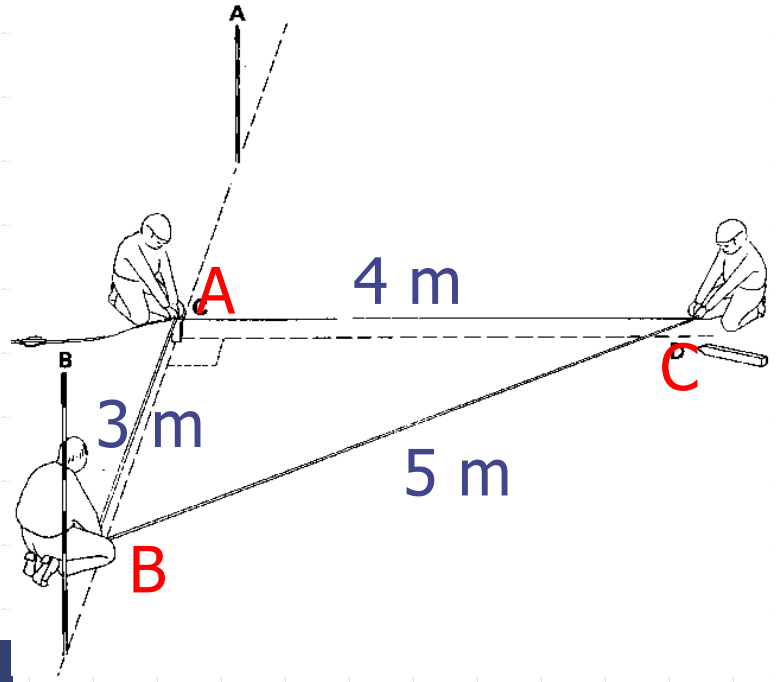
Special Field Operations Using a Tape

- Laying off a right angle
- Measuring an angle with a tape
- Laying off an angle from a given line
- Tape survey of a field

Laying off a right angle

- Set both the zero-meter end of the tape and 12 m mark on A and the 3 m mark on B.
- Have a person hold the 8 m mark on the tape and apply pull.
- When the tape becomes taut, the 4 m length from C will be perpendicular to AB.

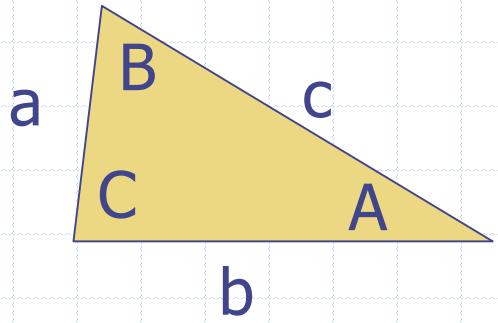




Measuring an angle with a tape

- If all 3 sides (a,b,c) of a triangle are measured, any of the 3 angles (A,B,C) can be found from the following:

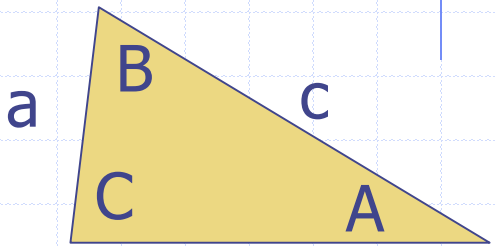
$$Cos\,(A) = \frac{b^2 + c^2 - a^2}{2bc}$$



- $s = \frac{a+b+c}{2}$
- $\sin(\frac{A}{2}) = \sqrt{\frac{(s-b)(s-c)}{bc}}$

Example 1

In a triangle ABC, sides a= 5.7 m, b= 6.4 m and c= 8.9 m. Compute angle A.



Solution:

$\text{Cos}(A) = (6.4^2+8.9^2-5.7^2)/(2\text{x}6.4\text{x}8.9) = 0.769663$

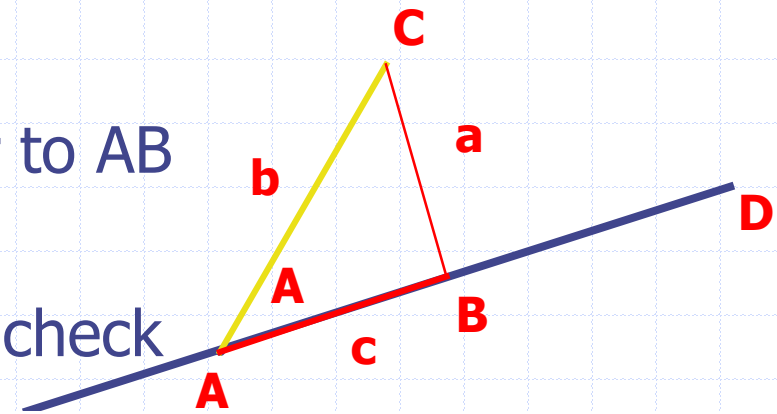
$A = \arccos(0.769663) = 39.67637°$

B= ??

C=??

Laying off an angle from a given line

- To lay off an angle (A)
- From point A of line AD, measure a distance like c, mark point B.
- compute (a) $a = c\tan(A)$
- Erect distance a perpendicular to AB
- Draw line AC
- Compute (b) $b = c/\cos(A)$ for check



Example 3-7

Angle A=48° is to be laid off at point A of line AD. A distance c=10.0 m is measured from A and point B is marked. Compute lengths of sides a and b.

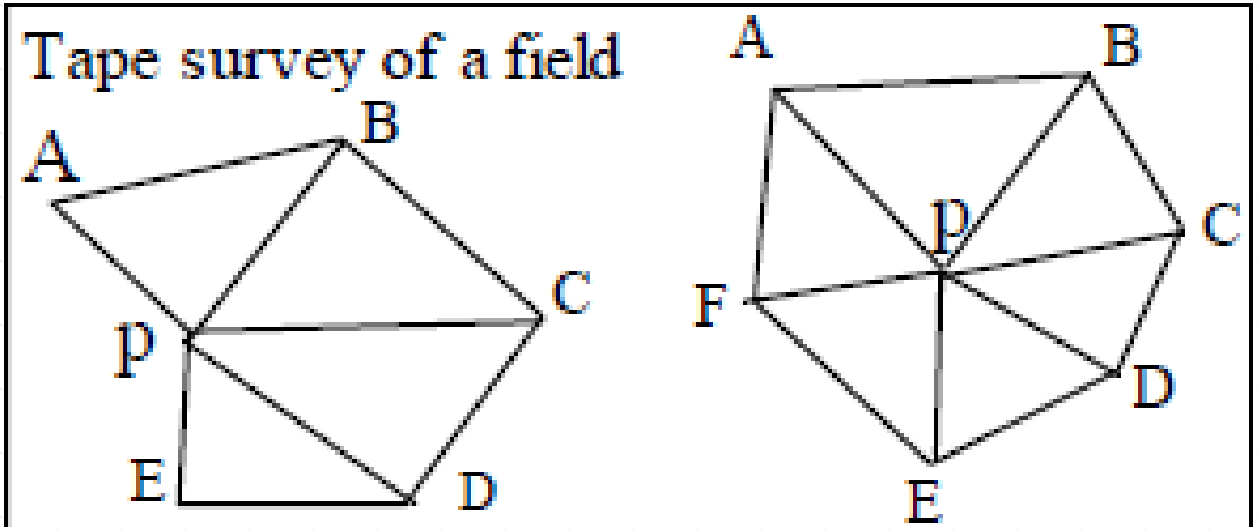
Solution:

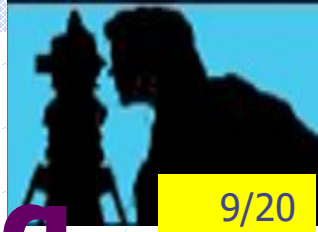
Side a = c tan(A) = 10.0 tan(48°) = 11.106 m = 11.1 m

Side b = c / cos(A) = 10.0 / cos(48°) = 14.945 m = 14.9 m.

Tape survey of a field

- field can be totally surveyed with a tape by measuring distances from a selected point to all corners of the field. Other quantities can be computed indirectly, such as angles and areas



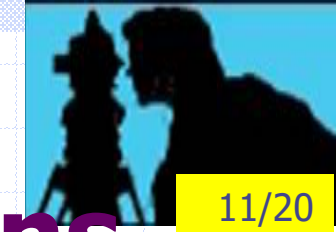


Sources of Error in Taping

1. **Instrumental errors**: such as incorrect length of tape as a result of kinks or due to manufacturing defect.
2. **Natural errors**: tape elongation due to temperature, and tape sags due to its weight.
3. **Human errors**: such as misalignment, misreading measurement, and not maintaining tape leveled.

Types of Error in Taping

1. **Systematic**: such as errors due to temperature, excess tension, sag of the tape due to its weight, incorrect length of tape and poor alignment.
2. **Random**: such as variations in temperature, tension, and wind speed.
3. **Mistake**: such as misreading measurements.



Systematic Taping Corrections

- Incorrect length of tape (standardization)
- Temperature other than standard
- Inconsistent tension (Pull)
- Sag correction

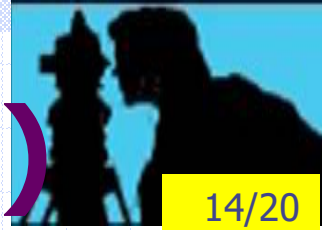
Standardization

- $C_l = \frac{l - l_s}{l_s} L$
- *l: actual tape length*
- *l_s: standard length*
- *L: measured distance*
- *C_l: correction*
- Ex. A measurements was recorded as 85.39 m with a 20 m tape that was found to be 20.05 under standard conditions. What is the corrected measurement?
- *C_l=((20.05-20)/20)x85.39= 0.213 m*
- *Lc= 85.39+0.213 =85.60 m*

Temperature other than standard

- $C_t = k(T - T_s)\mathrm{L}$
- *k: coefficient of thermal expansion of tape material*
- *T: field temperature*
- *T_s: standard temperature (usually 20°)*
- *L: measured distance*
- *C_t: correction*
- Ex. A distance was recorded as being 150.00 m at a temperature of 38°C. What is the corrected distance, if a steel tape was used and the standard temperature was 20°C. (k=1.16E-5)
- *C_t= 1.16E-5 (38-20)x150.00= 0.031 m*
- *Lc= 150.00+0.031 =150.03 m*

Inconsistent tension (Pull)



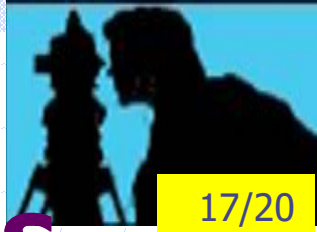
- $C_p = (P - P_s)\frac{L}{AE}$
- *P: applied pull*
- *P_s: standard pull (usually 5 kg)*
- *L: measured distance*
- *A: tape cross-sectional area*
- *E: modulus of elasticity*
- *C_p: correction*
- Ex. A measurement was recorded as 171.278 m with a 30-m steel tape and standard pull is 5 kg. tension at the field was 8.5 kg. Modulus of elasticity E is 21E05 kg/cm2, and tape cross-sectional area A=0.02 cm2. Compute the correction and the corrected distance.
- *C_p= (8.5-5)x171.278/(0.02x21E05)= 0.014 m*
- *Lc= 171.278+0.014 =171.292 m*

Sag correction

- $C_s = -\frac{w^2 L^3}{24 P^2}$
- *w: tape weight per unit length*
- *P: applied pull*
- *L: measured distance*
- *C_s: correction*

Sag correction

- A distance of 235.736 m is measured using a 100-m invar tape. The tape is suspended from its two ends at a tension of 150 N, total tape weight is 2 kg. Compute the total correction and the corrected distance.
- Solution
- w= 2/100 0.02 kg/m p= 15 kg
- The distance measured on 3 segments (100,100, 35.736)
- $C_{s1} = -(0.02^2 x 100^3)/(24x15^2) = -0.074\ m$
- $C_{s2} = C_{s1}$
- $C_{s3} = -(0.02^2 x 35.736^3)/(24x15^2) = -0.003\ m$
- $Total\ correction = -(0.074+0.074+0.003) = -0.151$
- $Lc = 235.736 - 0.151 = 235.585\ m$



Total systematic corrections

- The total correction **C** for length **L** is the sum of all systematic corrections

- $C = C_l + C_t + C_p + C_s$
- $L_c = L + C \quad when\ measuring\ L$
- $L_c = L - C \quad when\ laying\ off\ L$

Example

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/cm2, and tape cross-sectional area A=0.025 cm2. Compute the total correction and the corrected distance to be laid down.

Solution:

$$C_l = \frac{l - l_s}{l_s} L = \frac{50.008 - 50}{50} 85.000 = 0.0136 \text{ m}$$

$$C_t = k\,(T - T_s)L = 1.2\text{E-}5(30\text{-}20)85.000 = 0.0102 \text{ m}$$

$$C_p = (P - P_s)\frac{L}{AE} = (85.000)(10\text{-}5)/(0.025 \times 21\text{E}05) = 0.00810 \text{ m}$$

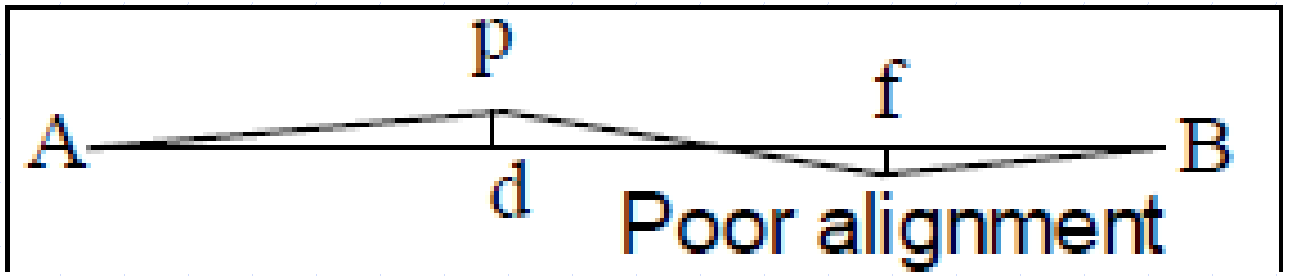
$C_s = 0$ m (because the tape is laid on the ground)

Total correction $C = C_l + C_t + C_p = 0.0136 + 0.0102 + 0.0081 = 0.0319$ m

Corrected distance = $L_c = L - C = 85.000 - 0.0319 = 84.968$ m.

Note: The correction is subtracted because the distance is to be laid off.

Poor Alignment



- $Ad = \sqrt{Ap^2 - pd^2}$

Next lecture

- 1st Quiz
- Time: 45 minutes
- Cover all subjects