

### Thermal Expansion Coefficients

Due to temperature:  
(add/subtract); measured length  
 $C = \alpha L(T_2 - T_1)$

Due to pull:  
(add/subtract); measured length  
 $C = \frac{(P_2 - P_1)L}{EA}$

Due to sag:  
(subtract only); unsupported length  
 $C = \frac{w^2 L^3}{24P^2}$

Due to slope:  
(subtract only); measured length  
 $C^2 = S^2 - h^2$

Normal Tension:  
 $P_N = \frac{0.204W\sqrt{AE}}{\sqrt{P_N - P}}$

too long    measure    lay-out  
too short    add        subtract  
                 subtract    add

### Probable Error

Probable Error (single):  
 $E = 0.6745 \sqrt{\frac{\sum(X - \bar{X})^2}{n - 1}}$

Probable Error (mean):  
 $E_{\text{m}} = \frac{E}{\sqrt{n}} = 0.6745 \sqrt{\frac{\sum(X - \bar{X})^2}{n(n - 1)}}$

Proportionalities of weight, w:  
Error:  $w \propto \frac{1}{E^2}$     Error:  $w \propto \frac{1}{d}$     Error:  $w \propto n$

too long  
 $CD = MD \left(1 + \frac{e}{TL}\right)$

too short  
 $CD = MD \left(1 - \frac{e}{TL}\right)$

### Graphic Trigonometry

Horizontal:  
 $D = d + (f + c)$   
 $D = \left(\frac{f}{l}\right) s + C$   
 $D = Ks + C$

Inclined:  
 $D = Ks \cos \theta + C$   
 $H = D \cos \theta$   
 $V = D \sin \theta$

### Effect of Curvature & Refraction

$h_{\text{cor}} = 0.067K^2$   
 $h = h_2 + \frac{D_2}{D_1 + D_2} (h_1 - h_2) - 0.067D_1 D_2$

### Leveling

Elev<sub>B</sub> = Elev<sub>A</sub> + BS - FS  
Inclined upward:  
error/setup = -e<sub>BS</sub> + e<sub>FS</sub>  
Inclined downward:  
error/setup = +e<sub>BS</sub> - e<sub>FS</sub>  
Total Error:  
e<sub>t</sub> = error/setup · no. of setups

Azimuth  
from South

### Reduction to True Level

$\frac{CD}{R} = \frac{MD}{R + h}$

### Galvanic Bar

$D = \cot \frac{\theta}{2}$

### Parabolic Curves

Symmetrical:  
 $H = \frac{L}{B} (S_1 + S_2)$

$\frac{x^2}{y} = \left(\frac{L}{2}\right)^2 L_2$

Unsymmetrical:  
 $H = \frac{L_1 L_2}{2(L_1 + L_2)} (S_1 + S_2)$   
 $S_1(L_1 + L_2) = S_1 L_1 + S_2 L_2$   
Note: Consider signs.

### Area of Circular Trapezoid

Let  $\theta = 1$  radian  
Let  $\theta = 1$  radian

Error of Closure:  
 $= \sqrt{\sum L^2 + \sum E^2}$

Relative Error/Precision:  
 $= \frac{\text{Error of Closure}}{\text{Perimeter}}$

### Area of Irregular Boundaries

Trapezoidal Rule:  
 $A = \frac{d}{2} [h_1 + h_n + 2\sum h_i]$

Simpson's 1/3 Rule:  
 $A = \frac{d}{3} [h_1 + h_n + 2\sum h_{\text{odd}} + 4\sum h_{\text{even}}]$   
Note: n must be odd

### Double Meridian Distance Method (DMD)

$DMD_{\text{first}} = Dep_{\text{first}}$   
 $DMD_n = DMD_{n-1} + Dep_{n-1} + Dep_n$   
 $DMD_{\text{last}} = -Dep_{\text{last}}$   
 $2A = \sum(DMD \cdot Lat)$

### Double Parallel Distance Method (DPD)

$DPD_{\text{first}} = Lat_{\text{first}}$   
 $DPD_n = DPD_{n-1} + Lat_{n-1} + Lat_n$   
 $DPD_{\text{last}} = -Lat_{\text{last}}$   
 $2A = \sum(DPD \cdot Dep)$

### Earthwork

$\frac{d_L}{\pm f_L} \pm \frac{D}{\pm f_c} \pm \frac{d_R}{\pm f_R}$

$A = \frac{f}{2} (d_L + d_R) + \frac{w}{4} (f_L + f_R)$

Volume (End Area):  
 $V_e = \frac{L}{2} (A_1 + A_2)$

Volume (Prismoidal):  
 $V_p = \frac{L}{6} (A_1 + 4A_m + A_2)$

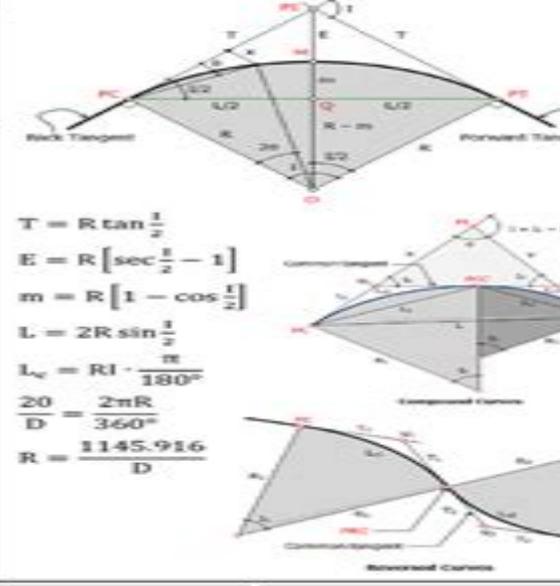
Prismoidal Correction:  
 $C_p = \frac{L}{12} (C_1 - C_2) (d_1 - d_2)$

$V_p = V_e - C_p$

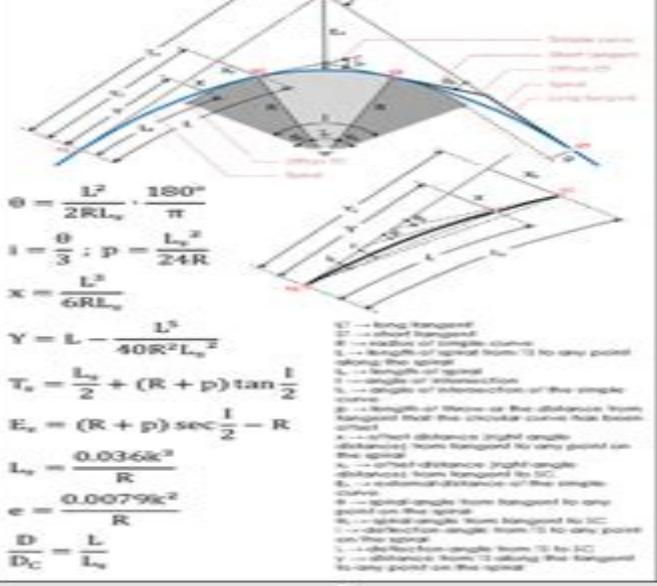
Volume (Truncated):  
 $V_T = A_{\text{base}} \cdot H_{\text{ave}} = A \left(\frac{2h_1 + h_2}{3}\right)$   
 $V_T = \frac{A}{6} (\sum h_1 + 2\sum h_2 + 3\sum h_3 + 4\sum h_4)$

1 acre = 4047 m<sup>2</sup>

### Simple, Compound & Reverse Curves



### Spiral Curves



### Slipping Sight Distance

$S = vt + \frac{v^2}{2g(f \pm G)}$   
 $a = g(f \pm G)$  (deceleration)  
 $t_b = \frac{v}{g(f \pm G)}$  (braking time)  
 $ESD = \frac{f}{f_{\text{ave}}} (100)$   
v → speed in m/s  
t → perception-reaction time  
f → coefficient of friction  
G → grade/slope of road

### Parabolic Summit Curve

$L > S$   
 $L = \frac{A(S)^2}{200(\sqrt{h_1} + \sqrt{h_2})^2}$   
 $L < S$   
 $L = 2(S) - \frac{200(\sqrt{h_1} + \sqrt{h_2})^2}{A}$   
L → length of summit curve  
S → sight distance  
h<sub>1</sub> → height of driver's eye  
h<sub>2</sub> = 1.143 m or 3.75 ft  
h<sub>0</sub> → height of object  
h<sub>0</sub> = 0.15 m or 0.50 ft

### Parabolic Sag Curve

$L > S$   
 $L = \frac{A(S)^2}{122 + 3.5S}$   
 $L < S$   
 $L = 2(S) - \frac{122 + 3.5S}{A}$   
A → algebraic difference of grades, in percent  
L → length of sag curve  
S → sight distance

### Asymptotic Sight Distance

$L > S$   
 $L = \frac{A(S)^2}{800H}$        $H = C - \frac{h_1 + h_2}{2}$   
 $L < S$   
 $L = 2(S) - \frac{800H}{A}$   
A → algebraic difference of grades, in percent  
L → length of sag curve  
 $L = \frac{A(K)^2}{395}$  for passenger comfort, where K is speed in km/h

### Horizontal Curve

$L > S$   
 $R = \frac{S^2}{8M}$   
 $L < S$   
 $R = \frac{L(2S - L)}{8M}$   
L → length of horizontal curve  
S → sight distance  
R → radius of the curve  
M → clearance from the centerline of the road

# Quantity Surveying Formulas

**Katrin Zwirglmaier**



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