<u>ASSIGNMENT</u>

Course No: CE 103
Course Title: Surveying

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Section: B
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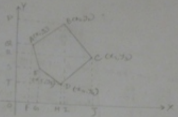
① Derive an expression using co-ordinate method for area of polygon.

Solⁿ:



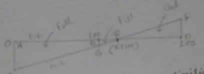
Area of Polygon ABCDE = Area of Trapizium PBCR + Area of Trapezeam RCDT − Area of Trapizium PBAQ − Area of Trapezeam QAES − Area of Trapeziam SEDT

$\Rightarrow$ Area of Polygon ABCDE $= \frac{1}{2}[(x_2+x_3)(y_2-y_3)+(x_3+x_4)(y_3-y_4) - (x_1+x_2)(y_2-y_1) - (x_1+x_5)(y_1-y_5) - (x_4+x_5)(y_5-y_4)]$

$\therefore$ Area of Polygon ABCDE =

$\frac{1}{2}[x_1(y_2-y_5) + x_2(y_3-y_1) + x_3(y_4-y_2) + x_4(y_5-y_3) + x_5(y_1-y_4)]$ [$\because$ As Area is always positive; so we avoid the (−ve) sign]

(3)



From the figure, $\triangle BGC$ and $\triangle CFD$ are similiar triangle.

So, $\frac{BC}{CD} = \frac{BG}{FD}$; | Now, Let, $BC = x$ ft So, $CD = (100-x)$ ft
From Given data, $BG = 17.4 - 16 = 1.4$ ft
$FD = 21.6 - 17.4 = 4.2$ ft

$\Rightarrow \frac{x}{100-x} = \frac{1.4}{4.2}$

$\Rightarrow 4.2x = 140 - 1.4x$

$\therefore x = 25$ ft

So, at point C chainage will be $(x+100) = 125$

<u>Now,</u> for the chainage 0 to 100 →

$$\text{Volume (Fill)} = \frac{100}{6}\left[7.6(60+2.5\times7.6) + 4.5(60+2.5\times4.5)\times4 + 1.4(60+2.5\times1.4)\right]$$

$$= 32863.33 \text{ ft}^3$$

For the chainage 100 to 125 →

$$\text{Volume (Fill)} = \frac{25}{6}\left[1.4(60+2.5\times1.4) + 4\times0.7(60+2.5\times0.7) + 0\right]$$

$$= 1090.833 \text{ ft}^3$$

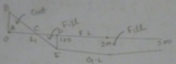
$\therefore$ Total Volume (Fill) = 33954.163 ft^3 (Ans)

For the chainage 125 to 200 →

$$\text{Volume (Cut)} = \frac{75}{6}\left[0 + 4\times 2.1(60+2.5\times 2.1) + 4.2(60+2.5\times 4.2)\right]$$

$$= 10552.5\ ft^3$$

(3)



From figure, Δ ABC & Δ CDE are similar.

So, $\frac{AC}{CD} = \frac{AB}{DE} \Rightarrow \frac{L_1}{100-L_1} = \frac{3}{2}$

$\Rightarrow 2L_1 + 3L_1 = 300$

$\Rightarrow L_1 = 60\ ft$

For the chainage 0 to 60 →

$$\text{Volume (cut)} = \frac{60}{6}\left[(30+2\times 3)\times 3 + 4\times 1.5(30+2\times 1.5) + 0\right]$$

$$= 3060\ ft^3$$

If we apply trapezoidal rule for 0 to 60 chainage

$$\text{Volume (cut)} = \frac{60}{2}\left[3\times(30+2\times 3) + 0\right]$$

$$= 3240\ ft^3$$

$$\text{Prismoidal Correction} = \frac{60\times 2}{6}(3-0)^2 = 180\ ft^3$$

$\therefore$ Actual Volume (Cut) $= 3240 - 180 = 3060\ ft^3$

For the chainage 60 to 100 →

$$\text{Volume (Fill)} = \frac{40}{6}\left[(30+2\times0)\times0 + 4\times1\times(30+2\times1) + 2\times(30+2\times2)\right]$$

$$= 1306.67\ ft^3$$

If we apply Trapezoidal Rule for 60 to 100 chainage →

$$\text{Volume (Fill)} = \frac{40}{2}\left[0 + 2(30+2\times2)\right]$$

$$= 1360\ ft^3$$

$$\text{Prismoidal correction} = \frac{40\times2}{6}(2-0)^2 = 53.33\ ft^3$$

$$\therefore \text{Actual Volume (Fill)} = 1360 - 53.33 = 1306.67\ ft^3$$

For the chainage 100 to 200 →

$$\text{Volume (Fill)} = \frac{100}{6}\left[2(30+2\times2) + 4\times2.5(30+2\times2.5) + 3(30+2\times3)\right]$$

$$= 8766.67\ ft^3$$

For the chainage 200 to 300 →

$$\text{Volume (Fill)} = \frac{100}{6}\left[3(30+2\times3) + 4\times2.5(30+2\times2.5) + 2(30+2\times2)\right]$$

$$= 8766.67\ ft^3$$

$$\therefore \text{Total Volume (Fill)} = 18840.01\ ft^3$$

(Ans)

(4) There are four methods of Computation of Area from Maps →

1) Division of area into simple geometric figures.
2) Subdivision into squares.
3) Mechanical method: use of Planimeter.
4) Modern method: use of Digitizer.

I think Modern method: use of Digitizer is best at modern times for the computation of area from a map.

⊛ This method requires a machine called a digitizer, which obtains co-ordinates from map and saves it as digital data in computer.

Figure: Digitizer

⊛ The operator moves a special mouse or pen around the map and activates the mouse at each desired location.

(e) Computer records x-y coordinates of each location.

This method is best because of its perfection when it gives the value of area. This method is modern and it perfroms very quickly. It gives almost exact reading than the other three methods. Though this method is quite costly, but because of its accuracy and modern technologies this method is best for the computation of area from a map. Moreover, the whole process is activated by a machine called digitizer. There is no need of any manual activity.

(5) Area of bottom $= (30 \times 40)\ ft^2$

$= 1200\ ft^2$

Area of Top $= (62 \times 72)\ ft^2$ [Applying $b + 2 \times s \times h$]

$= 4464\ ft^2$

Area of Mid $= (46 \times 56)\ ft^2$

$= 2576\ ft^2$

Volume $= \frac{8}{6}(1200 + 4 \times 2576 + 4464)$

$\therefore V_{prismoidal} = 21290.667\ ft^3$

In Case of Trapezoidal Rule:

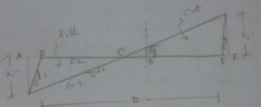
$V_{Trapezoidal} = (4464 + 1200) \times 8/2\ ft^3$

$= 22656\ ft^3$

So, we find that $V_{Trapezoidal} > V_{prismoidal}$

(6) Derive the expression for side hill two level section.

If it is excavation at centre line (cut):



Area of fill $= \frac{1}{2} \times h_1' (0.5b - rh)$ ——— (1)

Area of cut $= \frac{1}{2} \times h_2' (0.5b + rh)$ ——— (2)

From figure:

$$AB + BD = AC + CD$$

$$\Rightarrow sh_1' + 0.5b = rh_1' + rh$$

$$\Rightarrow (r - s) h_1' = 0.5b - rh$$

$$\therefore h_1' = \frac{0.5b - rh}{r - s}$$

Again, from figure: $CF - CD = DE + EF$

$$\Rightarrow rh_2' - rh = 0.5b + sh_2'$$

$$\Rightarrow (r - s) h_2' = 0.5b + rh$$

$$\Rightarrow h_2' = \frac{0.5b + rh}{r - s}$$

By putting the value of h_1' & h_2' in equation ③ and ④ we get,

$$\text{Area of fill} = \tfrac{1}{2} \times \left\{ \frac{(0.5b - nh)^2}{n-s} \right\}$$

$$\text{Area of cut} = \tfrac{1}{2} \times \left\{ \frac{(0.5b + nh)^2}{n-s} \right\}$$

In similar way when it is excavation at centre line (fill):

$$h_1' = \frac{0.5b + nh}{n-s}$$

$$h_2' = \frac{0.5b - nh}{n-s}$$

So, we get the $\text{Area of fill} = \tfrac{1}{2} \left\{ \frac{(0.5b + nh)^2}{n-s} \right\}$

$\text{Area of cut} = \tfrac{1}{2} \left\{ \frac{(0.5b - nh)^2}{n-s} \right\}$

(7) Given,

Ground level elevation = 2.5 m

Each square = 10 m × 10 m

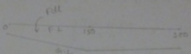
The Volume of the earth = Summation of the Volume of the each square.

The volume of the 1st square = $\frac{1}{4} \times 10 \times 10\,[(3.9 - 2.5) + (2.8 - 2.5) + (3.7 - 2.5) + (4.1 - 2.5)] = 137.5$

In the similar way, we get the 2nd → 16th squares' volume.

So, The total volume of the earth = $\frac{1}{4} \times 10 \times 10\,(5.5 + 5.8 + 6.4 + 6.1 + 4.7 + 3.9 + 4.4 + 4.3 + 5.7 + 5.7 + 3.8 + 5.4 + 6.8 + 6.9 + 7.5) = 2225\ m^3$ (Ans)

(5)



As, it is a two level section, so we have to apply the formula of determining the Area of two level section.

For the chainage 0 to 150 →

$$V_{prismoidal}\ (\text{fill}) = \frac{150}{6}\left[\frac{5^2\times20\times6+2(0.5\times20)^2+5^2\times2\times6^2}{5^2-2^2} + 4\times\frac{5^2\times20\times7.5+2(0.5\times20)^2+5^2\times2\times7.5^2}{5^2-2^2} + \frac{5^2\times20\times9+2(0.5\times20)^2+5^2\times2\times9^2}{5^2-2^2}\right]$$

$\therefore V_{prismoidal}\ (\text{fill}) = 48571.5\ ft^3$

For the chainage 150 to 300 →

Similarly, $V_{prismoidal}\ (\text{fill}) = 52976.27\ ft^3$

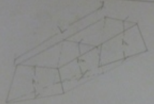
$\therefore$ Total Volume (fill) $= 101547.77\ ft^3$

If we apply trapezoidal rule & then use prismoidal correction. Here the formula of prismoidal correction for two level section is →

$$C.P = \frac{LS}{6}(h_1-h_2)^2\left(\frac{n^2}{n^2-s^2}\right)$$

We also get the total volume (fill) = 101547.77 ft^3

(Ans)



$h_m = \frac{h_1+h_2}{2}$

We have to derive the expression for prismoidal correction for two-level section.

In case of two level section,

$$\text{Area} = \frac{r^2bh + s(0.5b)^2 + r^2sh^2}{r^2 - s^2}$$

Trapezoidal Volume, $V_T = (A_1 + A_2)\frac{L}{2}$

$$\therefore V_T = \left(r^2bh_1 + s(0.5b)^2 + r^2sh_1^2 + r^2bh_2 + s(0.5b)^2 + r^2sh_2^2\right)\frac{L}{2(r^2-s^2)}$$

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

$$= \frac{L}{6(r^2-s^2)}\left[(r^2bh_1 + s(0.5b)^2 + r^2sh_1^2) + 4\left\{r^2b\left(\frac{h_1+h_2}{2}\right) + s(0.5b)^2 + r^2s\left(\frac{h_1+h_2}{2}\right)^2\right\} + (r^2bh_2 + s(0.5b)^2 + r^2sh_2^2)\right]$$

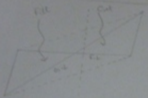
So, Prismoidal Correction, $C_P = V_T - V_P$

$$= \frac{L}{r^2-s^2}\left[\frac{r^2bh_1}{2} + \frac{s(0.5b)^2}{2} + \frac{r^2sh_1^2}{2} + \frac{r^2bh_2}{2} + \frac{s(0.5b)^2}{2} + \frac{r^2sh_2^2}{2} - \frac{r^2bh_1}{6} - \frac{s(0.5b)^2}{6} - \frac{r^2sh_1^2}{6} - \frac{1}{3}r^2bh_1 - \frac{1}{3}r^2bh_2 - \frac{s}{6}(0.5b)^2 - \frac{r^2}{6}sh_1^2 - \frac{r^2}{6}sh_2^2 - \frac{r^2bh_2}{6} - \frac{s}{6} - \frac{r^2sh_2^2}{6}\right]$$

$\therefore$ We get,

Prismoidal Correction, $C_p = \frac{LS}{6} \frac{r^2}{r^2 - S^2} (h_1 - h_2)^2$

So, the expression is derived.



the road is with a side hill two level
ction, so, we have to determine both the
lume of cut and fill.

m the given data, $L = 30\,m$, $n = 5$, $s = 3$, $b = 10\,m$,
$= 0.40\,m$, $h_2 = 0.60\,m$, $h_m = \frac{h_1 + h_2}{2} = 0.5\,m$

$$\text{olume (cut)} = \frac{30}{6}\left[\frac{1}{2}\left\{\frac{(0.5\times10 + 5\times0.40)^2}{5-3}\right\} + \frac{4}{2}\left\{\frac{(0.5\times10 + 5\times0.5)^2}{5-3}\right\} + \frac{1}{2}\left\{\frac{(0.5\times10 + 5\times0.60)^2}{5-3}\right\}\right]$$

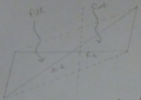
$$= 422.5\,ft^3$$

$$\text{olume (fill)} = \frac{30}{6}\left[\frac{1}{2}\left\{\frac{(0.5\times10 - 5\times0.40)^2}{5-3}\right\} + \frac{4}{2}\left\{\frac{(0.5\times10 - 5\times0.5)^2}{5-3}\right\} + \frac{1}{2}\left\{\frac{(0.5\times10 - 5\times0.60)^2}{5-3}\right\}\right]$$

$$= 47.5\,ft^3$$

(Ans)

(10)



As the road is with a side hill two level section, so, we have to determine both the volume of cut and fill.

From the given data, $L = 30\,m$, $n = 5$, $s = 3$, $b = 10\,m$,

$h_1 = 0.40\,m$, $h_2 = 0.60\,m$; $h_m = \frac{h_1 + h_2}{2} = 0.5\,m$

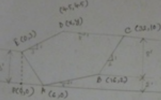
$$\therefore \text{Volume (cut)} = \frac{30}{6}\left[\frac{1}{2}\left\{\frac{(0.5\times10+5\times0.40)^2}{5-3}\right\} + 4/2\left\{\frac{(0.5\times10+5\times\ldots}{5-3}\right.\right.$$
$$\left.+\frac{1}{2}\left\{\frac{(0.5\times10+5\times0.60)^2}{5-3}\right\}\right]$$

$$= 422.5\,ft^3$$

$$\therefore \text{Volume (fill)} = \frac{30}{6}\left[\frac{1}{2}\left\{\frac{(0.5\times10-5\times0.40)^2}{5-3}\right\} + 4/2\left\{\frac{(0.5\times10-5\times\ldots}{5-3}\right.\right.$$
$$+\frac{1}{2}\left\{\frac{(0.5\times10-5\times0.60)^2}{5-3}\right.$$

$$= 47.5\,ft^3$$

(Ans)



Let, the origin point is P(0,0). So, we get the co-ordinates A(6,0), B(16,2), C(32,10), E(0,3). Assume D(x,y).

Now from the equation of the straight line ED, we get,

$$\frac{x-0}{y-3} = 3$$

$$\Rightarrow x = 3y-9 \quad \text{—— (1)}$$

From the equation of straight line CD, we get,

$$\frac{x-32}{y-10} = 5$$

$$\Rightarrow \frac{3y-9-32}{y-10} = 5 \Rightarrow y = 4.5$$

So, $x = 3\times4.5-9 = 4.5$

The Point $D \equiv (4.5, 4.5)$

So, the Area ABCDE =

$\frac{1}{2}\left[6(2-3) + 16(10-0) + 32(4.5-2) + 4.5(3-10) + 0\right]$ ft^2

$= 101.25$ ft^2 (Ans)

(15) Here,

$L = 10\ ft = 3.048 \times 10^{-3}\ km = 1.8939 \times 10^{-3}$ mile

From the given data,

Area within C_1, $A_1 = 0.12$ Sq. mile

Area within C_2, $A_2 = 0.12 + 0.13 = 0.25$ sq. mile

Area within C_3, $A_3 = 0.25 + 0.2 = 0.45$ sq. mile

Area within C_4, $A_4 = 0.45 + 0.18 = 0.63$ sq. mile

Area within C_5, $A_5 = 0.63 + 0.24 = 0.87$ Sq. mile

Here, we have to apply trapezoidal rule.

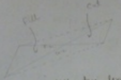
Then we get the volume =

$$\left(\frac{0.12 + 0.25}{2} + \frac{0.25 + 0.45}{2} + \frac{0.45 + 0.63}{2} + \frac{0.63 + 0.87}{2}\right)$$

$$\times\ 1.8939 \times 10^{-3}\ (\text{mile})^3$$

$$= 3.4563 \times 10^{-3}\ (\text{mile})^3$$

(2)



In case of side hill two level section, we have to determine both the volume of cut and fill for the chainage 0 to 100 and 100 to 200

From the given data, $L' = 200$ ft, $b = 50$ ft, $s = 2$, $n = 6$

For the chainage 0 to 100 →

$h_1 = 1$ ∴ $h_m = \frac{1+2}{2} = 1.5$, $L = \frac{200}{2} = 100$ ft

$h_2 = 2$

∴ Volume (cut) $= \frac{200}{6}\left[\frac{1}{2}\left\{\frac{(0.5\times 50+6\times 1)^2}{6-2}\right\} + \frac{4}{2}\left\{\frac{(0.5\times 50+6\times \ldots)^2}{6-2}\right\} + \left\{\frac{(0.5\times 50+6\times 2)^2}{6-2}\right\}\frac{1}{2}\right]$

$= \frac{28975}{2}\ ft^3 = 14487.5\ ft^3$

∴ Volume (fill) $= \frac{200}{6\times 2}\left[\frac{1}{2}\left\{\frac{(0.5\times 50-6\times 1)^2}{6-2}\right\} + \frac{4}{2}\left\{\frac{(0.5\times 50-6\times \ldots)^2}{6-2}\right\} + \left\{\frac{(0.5\times 50-6\times 2)^2}{6-2}\right\}\times\frac{1}{2}\right]$

$= \frac{6475}{2}\ ft^3 = 3237.5\ ft^3$

Now we have to determine the volume of cut and fill for the chainage 100 to 200 →

Now, $h_1 = 2$, $h_2 = 3$, $h_m = \frac{2+3}{2} = 2.5$, $L = 100$ ft

$\therefore$ Volume (cut) $= \frac{20}{2\times 6}\left[\frac{1}{2}\left\{\frac{(0.5\times 50+6\times 2)^2}{6-2}\right\} + \frac{4}{2}\left\{\frac{(0.5\times 50 \ldots}{6-2}\right.\right.$

$+ \frac{1}{2}\left\{\frac{(0.5\times 50+6\times 3)^2}{6-2}\right\}\Big]$

$= \frac{40{,}075}{2}\ ft^3 = 20{,}037.5\ ft^3$

$\therefore$ Volume (fill) $= \frac{20}{6\times 2}\left[\frac{1}{2}\left\{\frac{(0.5\times 50-6\times 2)^2}{6-2}\right\} + \frac{4}{2}\left\{\frac{(0.5\times 50 \ldots}{6-2}\right\}\right.$

$+ \frac{1}{2}\left\{\frac{(0.5\times 50-6\times 3)^2}{6-2}\right\}\Big]$

$= \frac{2575}{2}\ ft^3 = 1287.5\ ft^3$

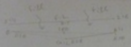
$\therefore$ Total Volume (cut) $= \frac{1}{2}(28975 + 40075)\ ft^3$

$= \frac{69050}{2}\ ft^3 = 34525\ ft^3$

$\therefore$ Total Volume (fill) $= \frac{1}{2}(2575 + 6475)\ ft^3$

$= \frac{9050}{2}\ ft^3$

$= 4525\ ft^3$ (Ans)



From the given data, Side, $s = 2$, $n = 6$, Radius of curvature, $R = 1600$ ft, $b = 32$ ft

Now, for the chainage 0 to 100 ft, $L = 100$ ft

Here, $h_1 = (214-210)$ ft $= 4$ ft

$h_2 = (215-208)$ ft $= 7$ ft

$h_3 = (216-211)$ ft $= 5$ ft

As it is a two-level section,

Area, $A_1 = \left[\dfrac{6^2 \times 32 \times 4 + 2(0.5 \times 32)^2 + 6^2 \times 2 \times 4^2}{6^2 - 2^2}\right]$

$= \cancel{67.125\ ft^2}\ 196\ ft^2$

So, the Real Area, $A_1' = A_1 \left(1 + \dfrac{e_1}{R}\right)$

$= 196 \left(1 + \dfrac{1}{1600}\right) ft^2$ [Here, $e_1 = 1$]

$= 196.1225\ ft^2$

Area, $A_2 = \left[\dfrac{6^2 \times 32 \times 7 + 2(0.5 \times 32)^2 + 6^2 \times 2 \times 7^2}{6^2 - 2^2}\right]$

$= 378.25\ ft^2$

The real Area, $A_2' = A_2 \left(1 + \dfrac{e_2}{R}\right)$

$= 378.25 \left(1 + \dfrac{1.25}{1600}\right) ft^2$ [Here, $e_2 = 1.25$]

$= 378.545\ ft^2$

Area, $A_3 = \left[\frac{6^2 \times 31 \times 5 + 2(0.5 \times 32)^2 + 6^2 \times 2 \times 5^2}{6^2 - 2^2}\right]$

$= 252.25 \text{ ft}^2$

The real Area, $A_3' = A_3\left(1 + \frac{e_1}{R}\right)$

$= 252.25\left(1 + \frac{1445.2}{1600}\right)$ [Here, $e_1 = 2$]

$= 252.565 \text{ ft}^2$

As, Radius of curvature is applied, we can use trapezoidal rule here.

For the chainage 0 to 100 →

Volume (fill) $= \frac{100}{2}[176.1225 + 378.545] \text{ ft}^3$

$= 28733.375 \text{ ft}^3$

For the chainage 100 to 200 →

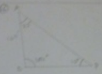
Volume (fill) $= \frac{100}{2}[378.545 + 252.565] \text{ ft}^3$

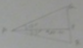
$= 31555.5 \text{ ft}^3$

∴ Total Volume (fill) $= 60288.875 \text{ ft}^3$

(Ans)

(6)





From the figure,
we get →

$\underline{\Delta ABP} \rightarrow$

$$\frac{AP}{\sin 150} = \frac{AB}{\sin 10}$$

$$\Rightarrow AP = 160 \times \frac{\sin 100}{\sin 10}$$

$$\therefore AP = 907.41 \text{ ft}$$

Let, QPR be the tower

$\underline{\Delta APQ} \rightarrow$

$$PQ = 907.41 \tan 12^\circ$$
$$\therefore PQ = 192.88 \text{ ft}$$

$\underline{\Delta APR} \rightarrow$

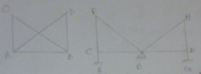
$$PR = 907.41 \tan 3^\circ$$
$$\therefore PR = 47.56 \text{ ft}$$

$\therefore$ The tower height $= PQ + PR$
$= 192.88 + 47.56$
$= 240.44 \text{ ft}$

$\therefore$ R.L. of ground at P $= (47.56 - 25)$ ft

$= 22.56$ ft

(Ans)



Given, the height of the instrument at both stations A and B is 5 ft. Base line, AB = 120 ft

$\angle BAC = 80^\circ 30'$, $\angle BAD = 50^\circ 30'$, $\angle ABC = 33^\circ 10'$, $\angle ABD = 76^\circ 20'$, $\angle CBF = 20^\circ 35'$, $\angle DBH = 14^\circ 25'$

From $\Delta ABC \Rightarrow$

$$\frac{BC}{\sin 80^\circ 30'} = \frac{AB}{\sin \angle ACB}$$

$$\Rightarrow BC = \frac{120}{\sin 66^\circ 20'} \times \sin 80^\circ 30'$$

$$\therefore BC = 129.22'$$

$\Delta ABD \Rightarrow$

$$\frac{BD}{\sin 50^\circ 30'} = \frac{AB}{\sin \angle ADB}$$

$$\Rightarrow BD = \frac{120}{\sin 53^\circ 10'} \times \sin 50^\circ 30'$$

$$\therefore BD = 115.69'$$

$\Delta BCD \Rightarrow$

$$CD^2 = BD^2 + BC^2 - 2 BD \cdot BC \cos \angle CBD$$

$$\Rightarrow CD^2 = 115.69^2 + 129.22^2 - 2(115.69)(129.22) \cos(43^\circ 10')$$

$$\therefore CD = 90.971 \text{ ft}$$

ΔBCF →

$$\tan 20^\circ 35' = \frac{CF}{BC}$$

$$\Rightarrow CF = BC \tan 20^\circ 25'$$

$$\therefore CF = 48.53 \text{ ft}$$

ΔBDH → $DH = 115.67 \tan 10^\circ 25'$

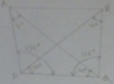
$$\therefore DH = 21.27 \text{ ft}$$

∴ Top of tower at EF is $(48.53 - 21.27)$ or 27.26 ft higher than top of tower at GH.

∴ Aerial distance, $FH = \sqrt{(90.77)^2 + (27.26)^2}$ ft

$$= 94.77 \text{ ft}$$

(Ans)



From the given data of the whole circle bearing, we can compute $\angle BPQ = 50°$, $\angle APQ = 130°$, $\angle PAQ = 5°$, $\angle AQP = 45°$, $\angle BQP = 116°$, $\angle PBQ = 14°$

$PQ = 120$ ft

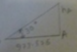
From $\triangle APQ$, $\dfrac{AP}{\sin 45°} = \dfrac{PQ}{\sin 5°}$

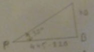
$\therefore AP = 120 \times \dfrac{\sin 45°}{\sin 5°}$

$= 973.576$ ft

From $\triangle BPQ$, $PQ = 120 \times \dfrac{\sin 116}{\sin 14}$

$= 445.826$ ft





Here, $h_A = 973.576 \tan 30° = 562.094$ ft

$h_B = 278.583$ ft

From the Given data, $S_A = S_B = 250$ ft

We have to determine R.L of the base of tower at A and B.

We know that,

$$R.L_A = h_A - S_A$$
$$= (562.094 - 250) ft + 20 ft$$
$$= 312.0943 ft + 20 ft = 332.0945 ft$$

similarly, $R.L_B = h_B - S_A$
$$= (278.583 - 250) ft$$
$$= 28.583 ft + 20 ft = 48.583 ft$$

(Ans)