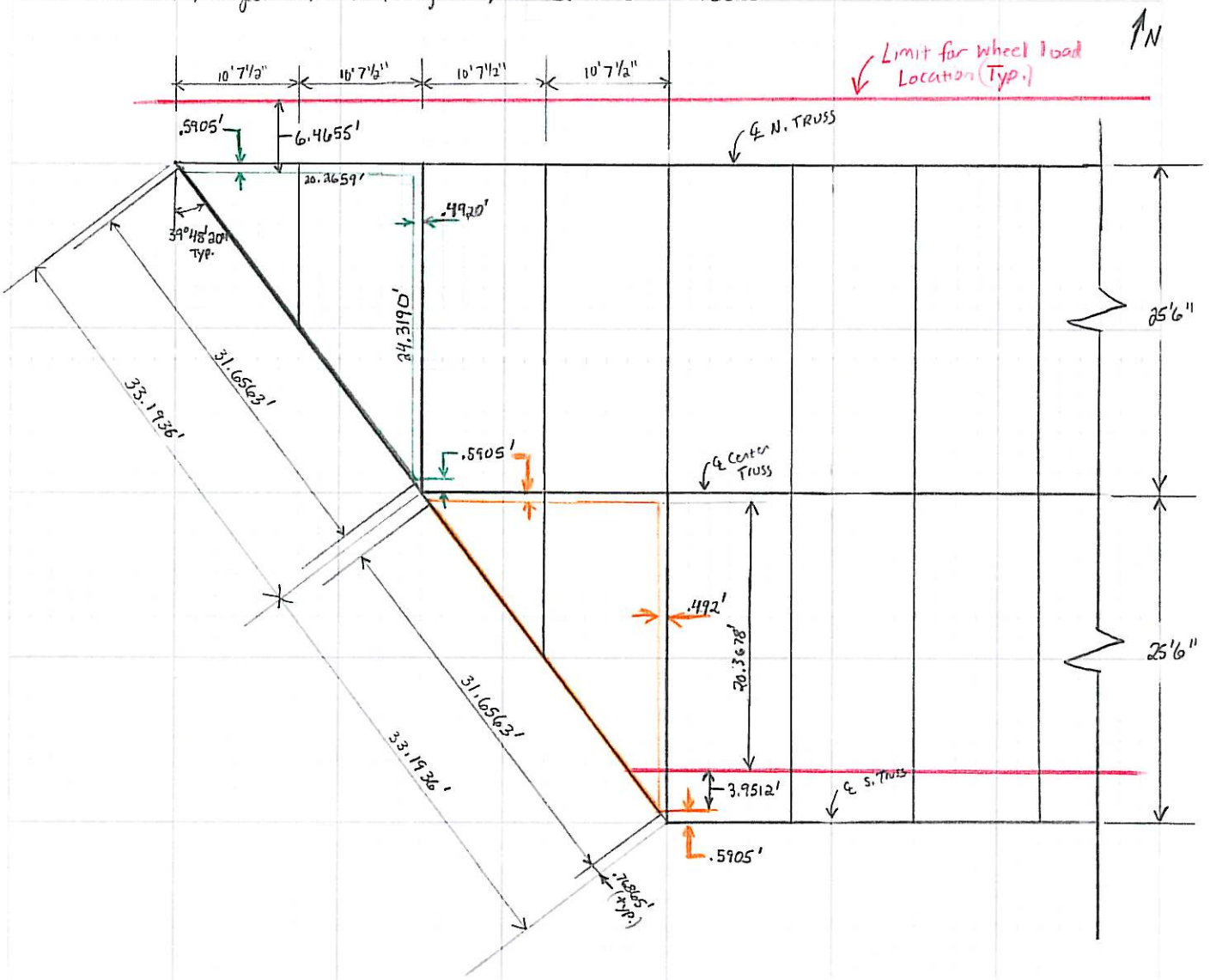
# End Floorbeams

# End (Exterior) Floorbeams

- Floorbeams are skewed at 39°48'20" to vertical (transverse direction of bridge)
- North and South may have different loadings because of different allowable wheel placement areas
- All 30WF124, Longest B1, B2 (shop dwg) say $L = 31'\,7\,7/8" = 31.6563'$



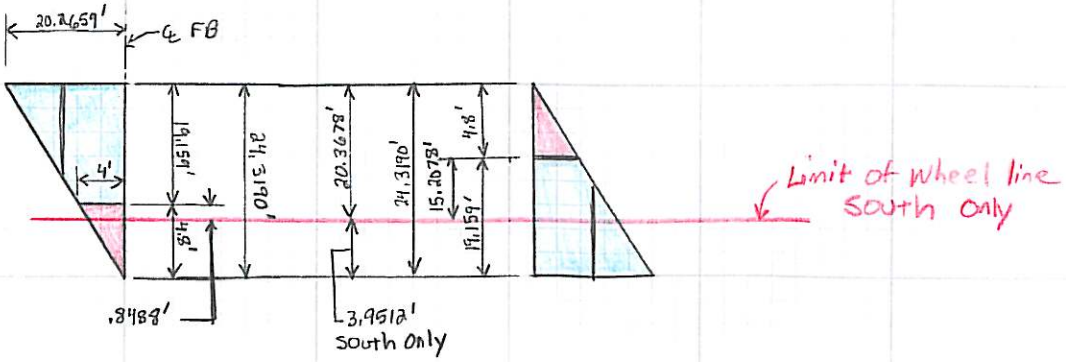

⇒ Available Roadway Width { North: 24.3190' ; South: 20.4038'

For Both:

4' min axle spa.

$\frac{20.2659'}{24.3190'} = \frac{4'}{y}$

$\Rightarrow y = 4.8'$

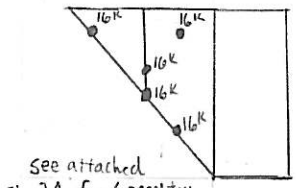


# End Floorbeams Live Loads - North

⇒ Maximize R ▽ + △ orientation doesn't matter → same loading possible

## HS20:

Worst case for moment




See attached Sh. 2A for Geometry and force labels

$A = 16^K$

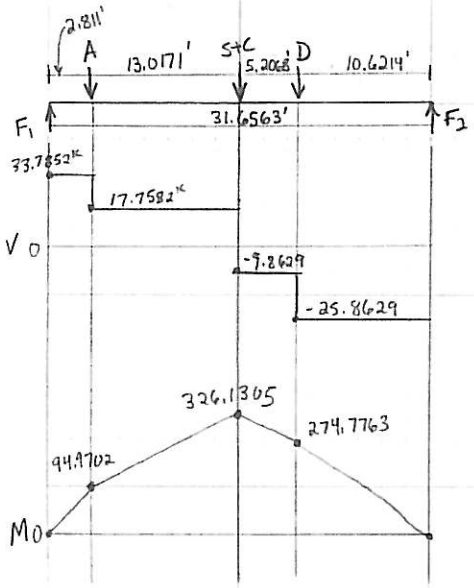
$A' = 16^K\left(\frac{4.9584'}{10.6251'}\right) = 7.4668^K$

$B' = 16^K$

$C = 16^K$

$D = 16^K$

$$S = \frac{2.3125'(A') + 6.3125'(B')}{11.875'} = 11.6211^K$$




$$F_2 = \frac{2.811'(16^K) + 15.8281'(16^K + 11.6211^K) + 21.0349'(16^K)}{31.6563'}$$

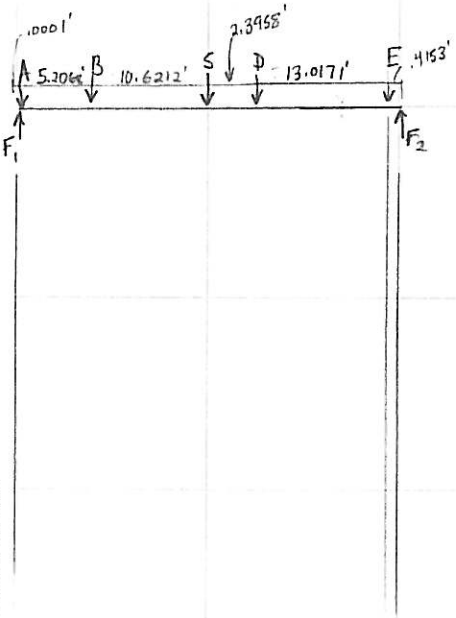
$F_2 = 25.8629^K$

$\therefore F_1 = 33.7582^K$

$\Rightarrow M_{max} = 326.1305$ k-ft

Worst Case for Shear

See attached Page 2B




$A = B = 16^K$

$A' = 16^K\left(\frac{6.7579'}{10.6251'}\right) = 10.1766^K$

$B' = 16^K\left(\frac{3.4246'}{10.6251'}\right) = 5.157^K$

$C' = B' = 5.157^K$

$D = 16^K$

$E = 16^K$

$$S = \frac{.153'(A') + 4.153'(B') + 10.153'(C')}{11.875'}$$

$S = 6.3438^K$

Let A be .0001' from support

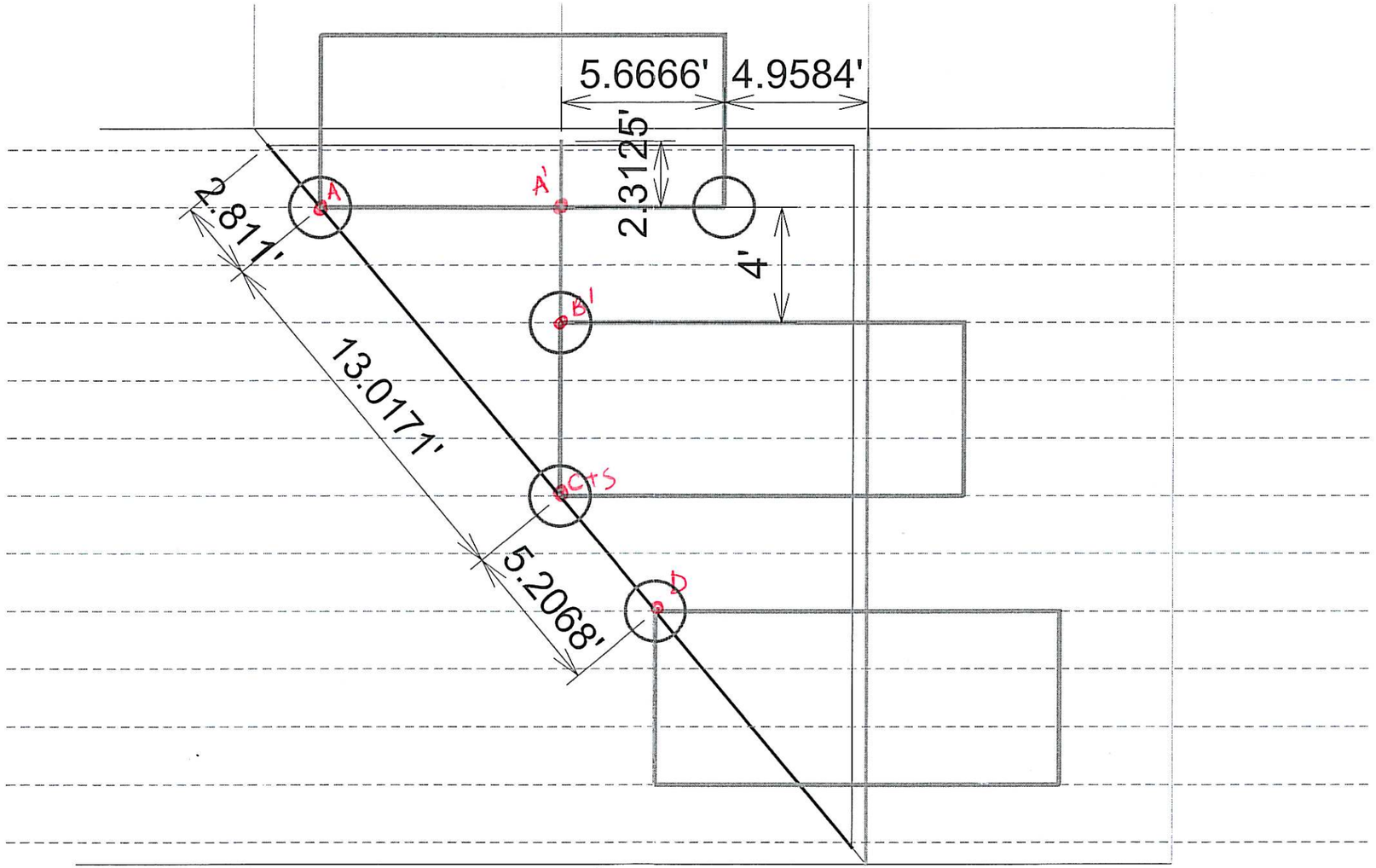
Then Max Shear = $F_1$

$$V_{max} = \frac{.4513'(16^K) + 13.4324'(16^K) + 15.8282(6.3438^K) + 26.4494(16^K) + 31.6562'(16^K)}{31.6563'}$$

$\Rightarrow V_{max} = 39.5392^K$

Calculations for 1/8 US Grid

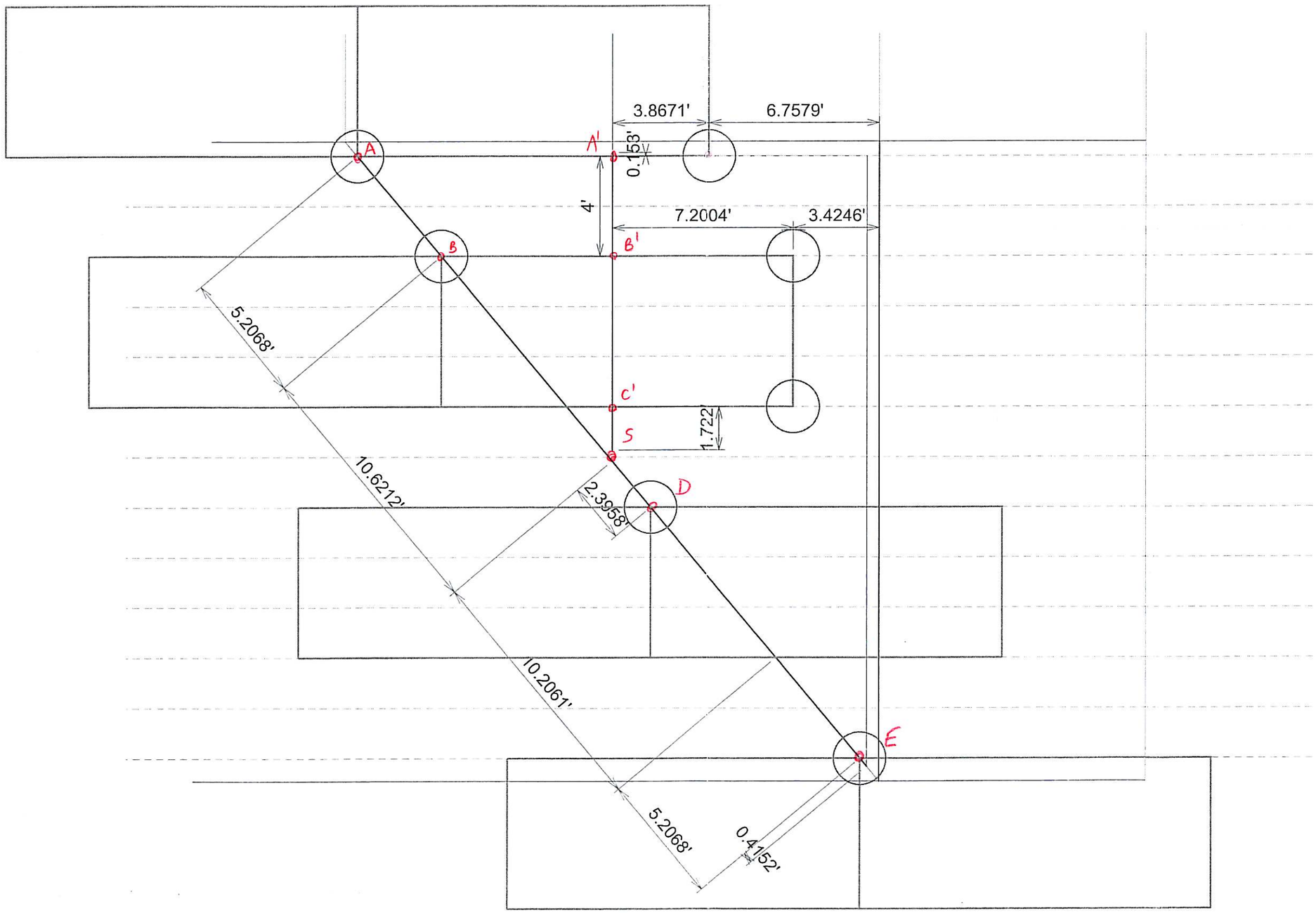
# WHEEL LINE ALIGNED WITH CENTER



# WHEEL LINE ALIGNED WITH NORTH END FB

2B

All loads 16 K



## End Floorbeams - Live Load - North

DF1:

See Attached Trial and error for Max Moment

Worst Case Page 3B $\Rightarrow M_{max} = 198.4346$ k-Ft

Max Shear:

See attached sheet 3F For Geometry

$A = 10^k + 5^k\left(\frac{.1329'}{10.1329'}\right) = 10.0656^k$

$A' = 5^k\left(\frac{10'}{10.1329'}\right) = 4.9344^k$

$B = 10^k$

$B' = 5^k\left(\frac{7.4246'}{10.625'}\right) = 3.4939^k$

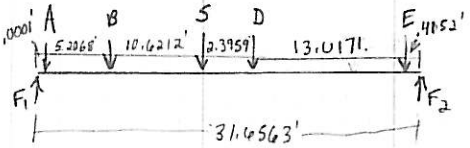
$C' = B' = 3.4939^k$

$D = 10^k$

$E = 10^k$

$S = \frac{.153'(A') + 4.153'(B') + 10.153'(C')}{11.875'}$

$S = 4.3388^k$




Let A be .0001' from support so $F_1$ is max shear

$$V_{max} = \frac{.4152(10^k) + 13.4223'(10^k) + 15.8182'(4.3388^k) + 26.4394'(10^k) + 31.6562'(10.0656^k)}{31.6563'}$$

$V_{Max} = 24.9568^k$

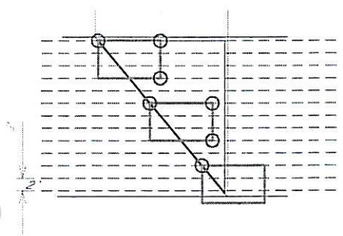
Calculations for 1/8 US Grid

A few possibilities!

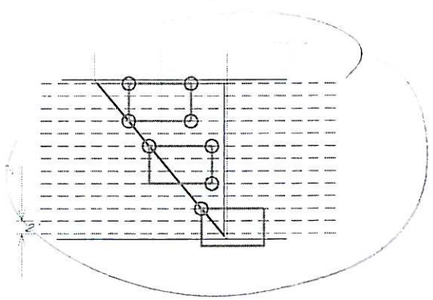
Ack some to see results

○CONTRIBUTING WHEELS

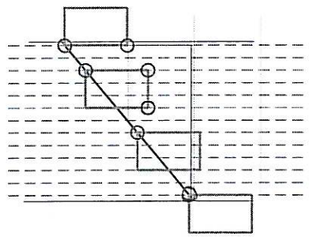
WHEEL LINE ALIGNED WITH NORTH END OF FB

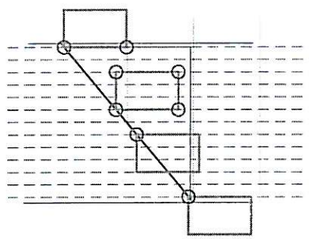


I



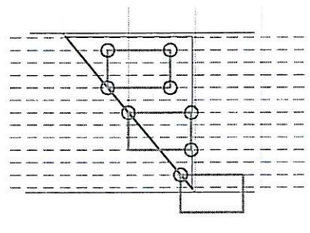
WHEEL LINE ALIGNED WITH NORTH END OF FB

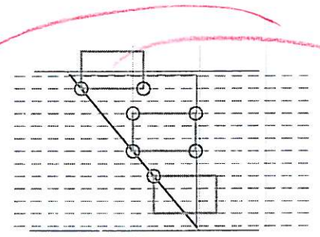




II

WHEEL LINE ALIGNED WITH CENTER OF FB

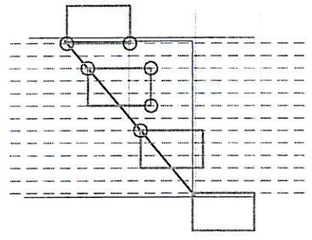




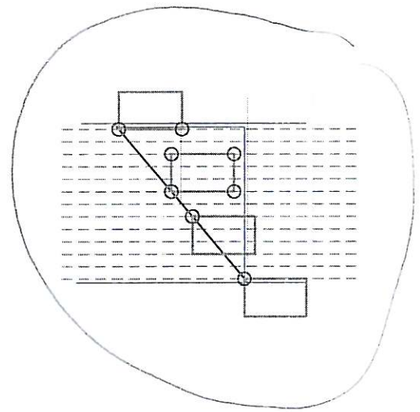
worst case

II is worst case so see if other Center is worse

WHEEL LINE ALIGNED WITH SOUTH END OF FB



III



yes it is

Try with

$A = 10^K$

$A' = \frac{5(10.6625 - 1.66666')}{10.6625'} = 4.2157^K$

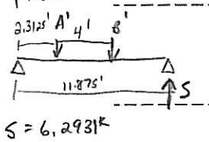
$B = 0$

$B' = 10^K + \frac{5(1.625)}{10.6625} = 10.2941^K$

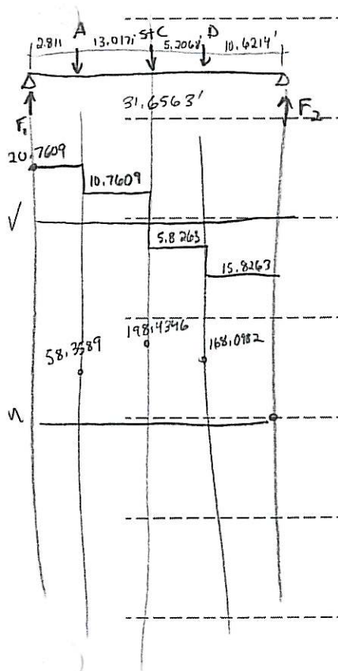
$C = 10^K + \frac{5(1.625)}{10.6625} = 10.2941^K$

$D = 10^K$

Find S



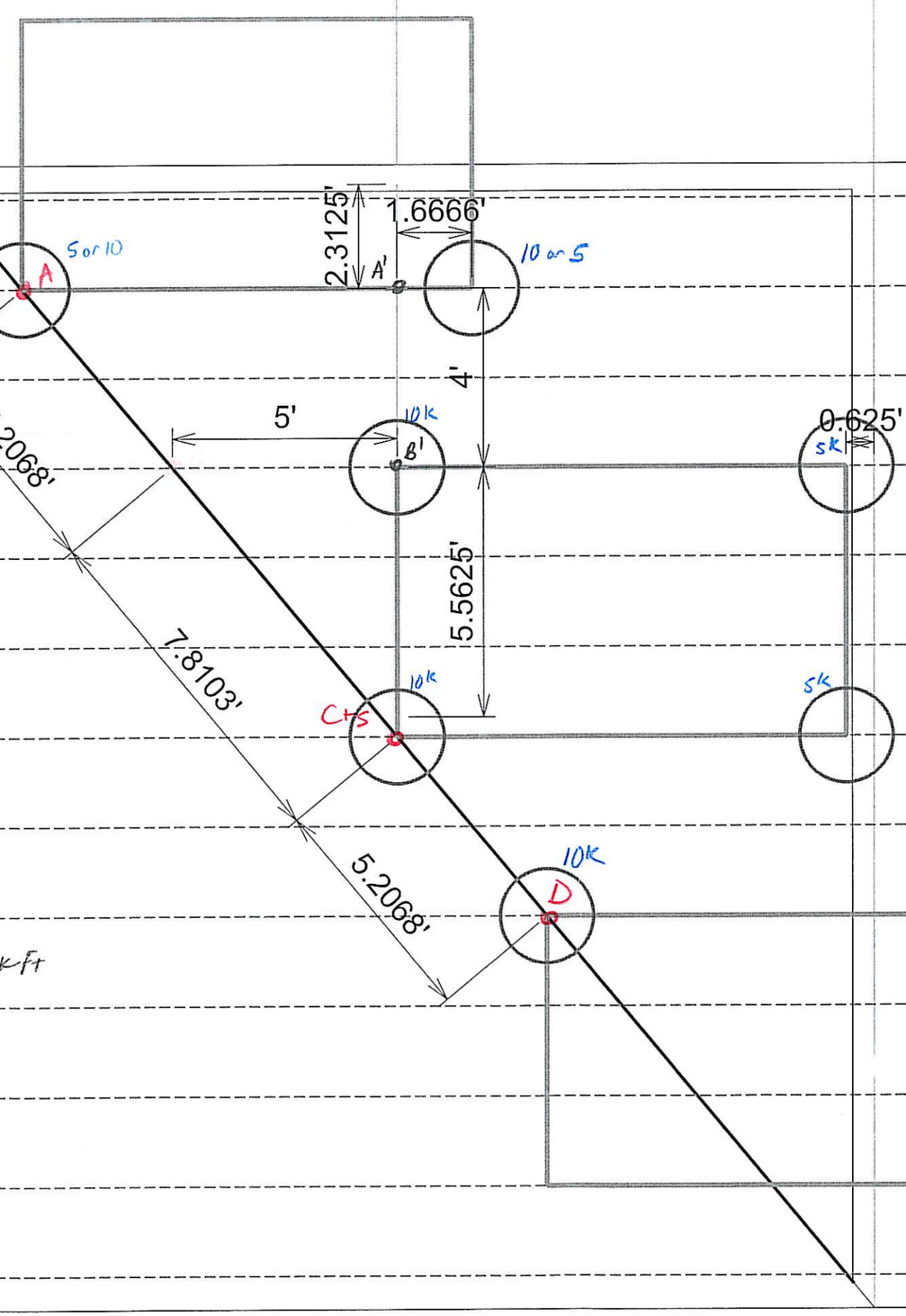

$S = 6.2931^K$




$F_2 = 15.8263^K$

$F_1 = 20.7609^K$

$M_{MAX} = 198.4346^{K\text{-}Ft}$



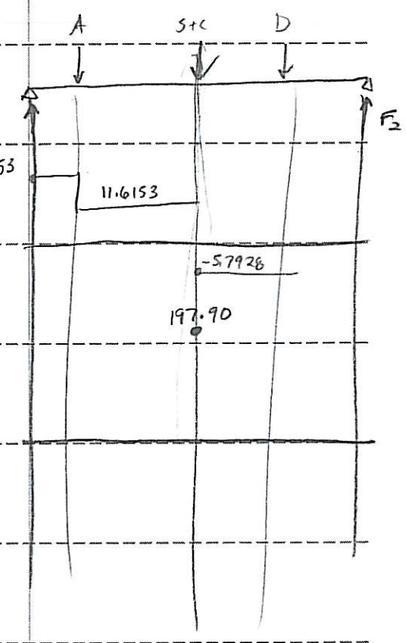

With $A = 5^K$

$A' = \frac{10(10.625 - 1.66666')}{10.625'} = 8.4314^K$

Then S $= 7.1140^K$

$F_2 = 15.7928$

$F_1 = 16.6153$



# I

$A = 10^K \left(\frac{5.1329'}{10.1329'}\right) = 5.0656^K$

$A' = 10^K - A + \frac{5(5.7579)}{10.625} = 7.1644^K$

$B = 10^K$

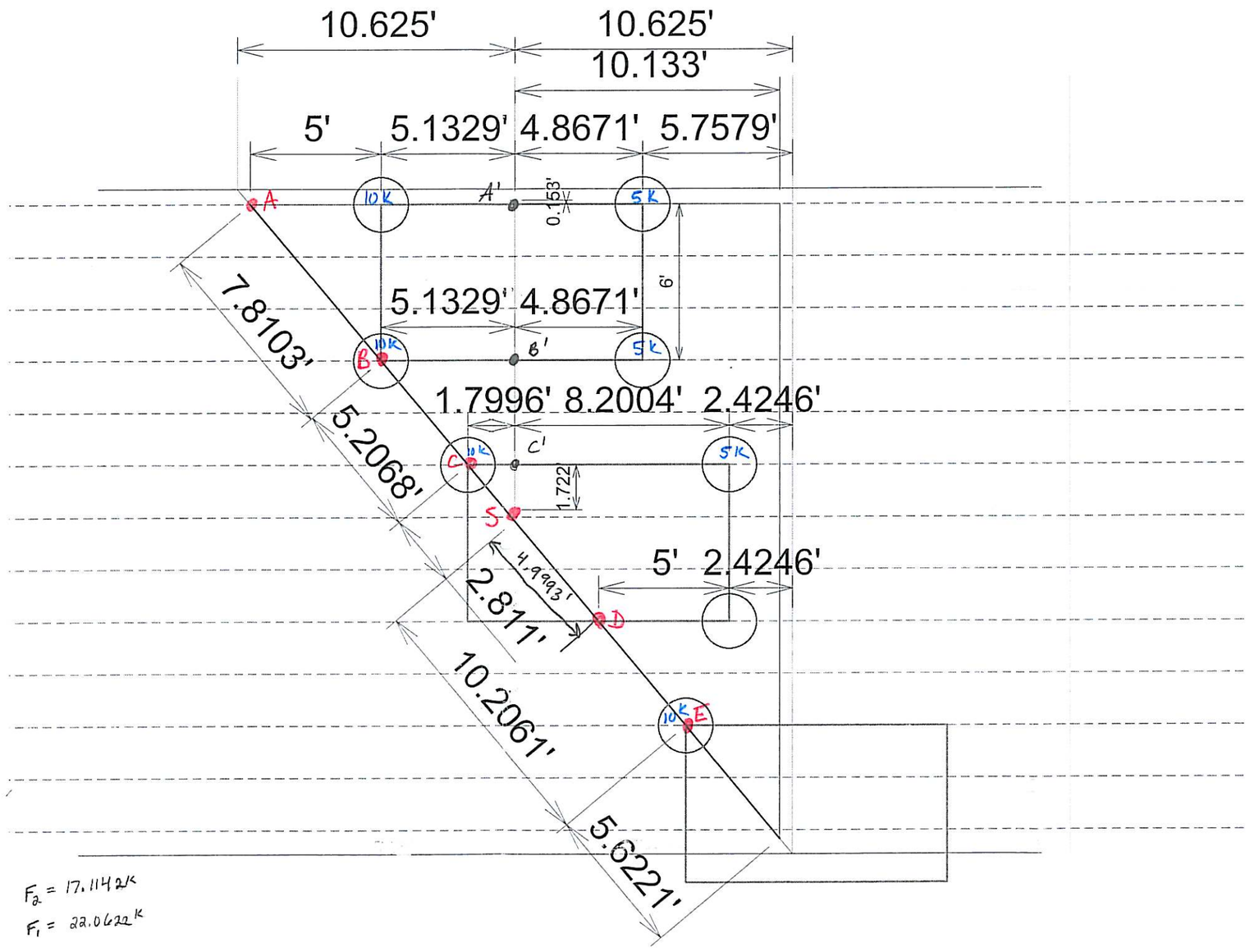
$B' = 5^K \frac{(10.625' - 4.8671')}{10.625'} = 2.7096^K$

$C = 10^K$

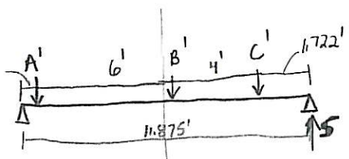
$C' = 5^K \left(\frac{2.4246'}{10.625'}\right) = 1.1410^K$

$D = 5^K \left(\frac{2.4246}{7.4246}\right) = 1.6328^K$

$E = 10^K$

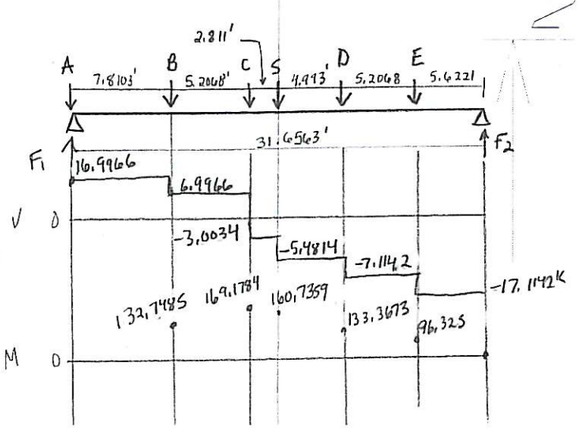



Find S




$S = \frac{.153(7.1644^K) + 6.153(2.7096) + 10.153(1.1410)}{11.875}$

$S = 2.478^K$




$F_2 = 17.1142^K$

$F_1 = 22.0622^K$

$\Rightarrow M_{max} = 169.1784^{K\text{-}Ft}$

# WHEEL LINE ALIGNED WITH CENTER OF FB

II

$A = \frac{10(3.3333)}{8.3333} = 4^K$

$A' = 10 - A + \frac{5(3.9583)}{10.625} = 7.8627^K$

$B = 10^K$

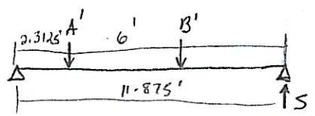
$B' = 5\left(\frac{3.9583}{10.625}\right) = 2.4215^K$

$C = 10^K + 5^K\left(\frac{.625'}{10.625'}\right) = 10.2941^K$

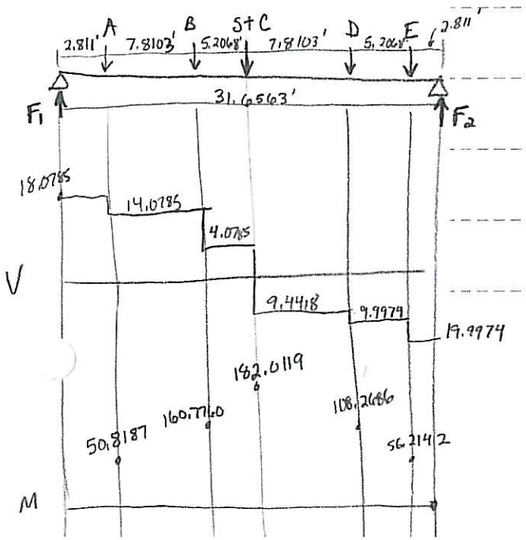
$D = 5^K\left(\frac{.625'}{5.625'}\right) = .5556^K$

$E = 10^K$

Find S

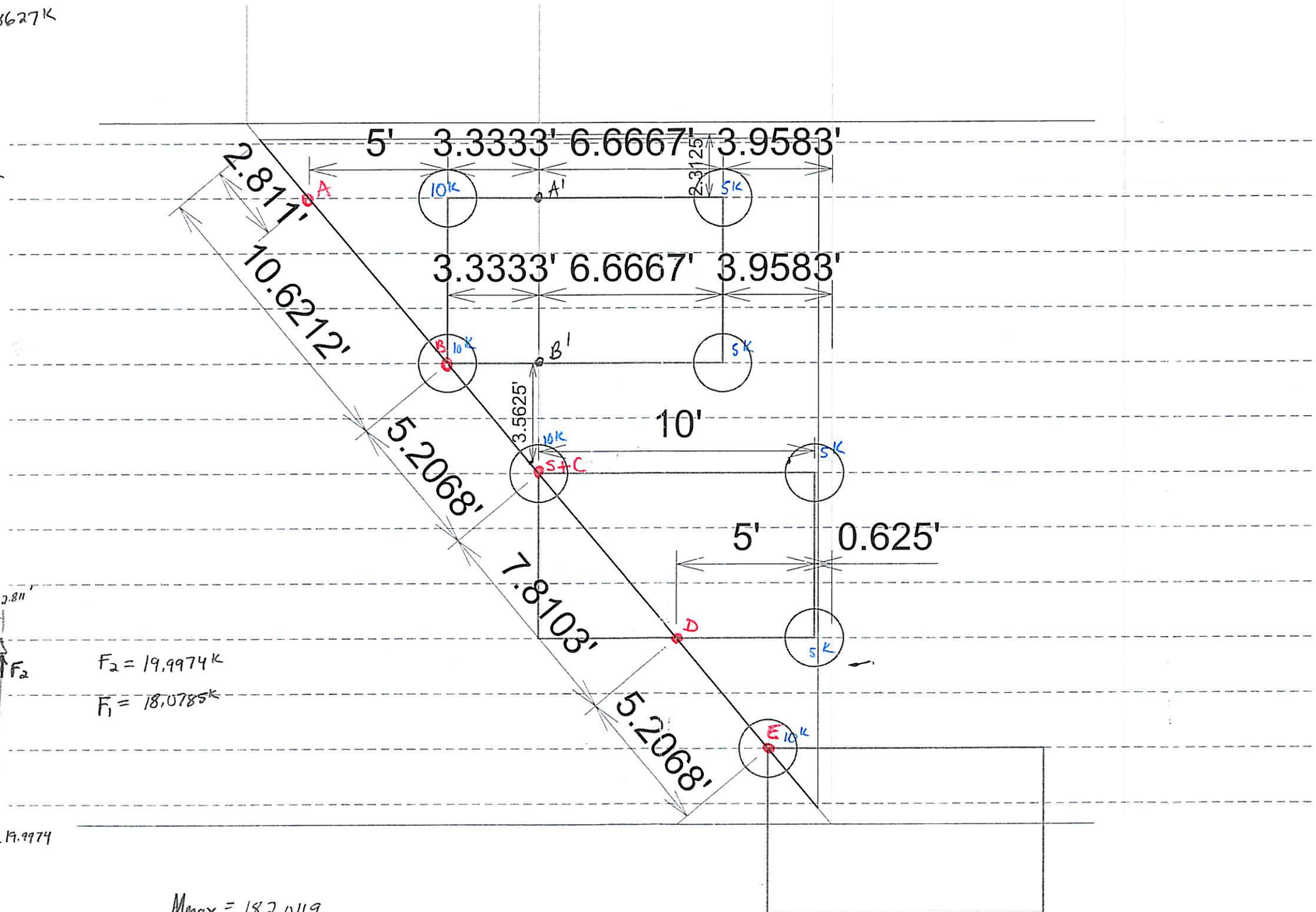



$S = 3.2262^K$




$F_2 = 19.9974^K$

$F_1 = 18.0785^K$




$M_{max} = 182.0119$

III

$A = 5^K$

$A' = 10\left(\frac{10.625 - .1329}{10.625}\right) = 9.8749^K$

$B = 10^K\left(\frac{1.5337'}{6.5337'}\right) = 2.3474^K$

$B' = 10 - B + 5\left(\frac{2.1587}{10.625}\right) = 8.6685^K$

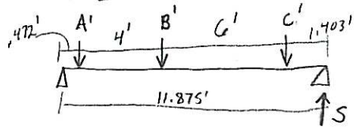
$C = 10^K$

$C' = 5^K\left(\frac{2.1587}{10.625}\right) = 1.0159^K$

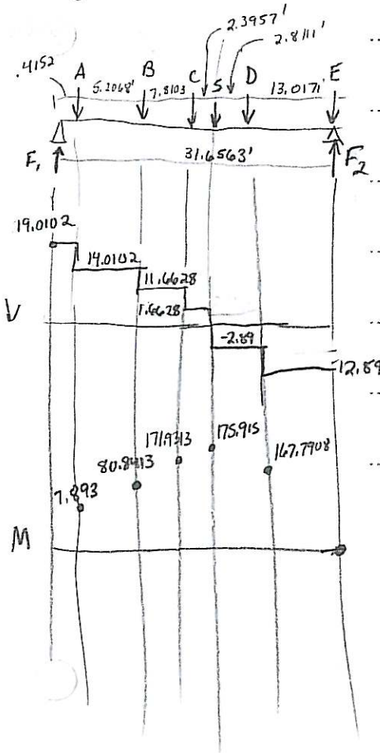
$D = 10^K$

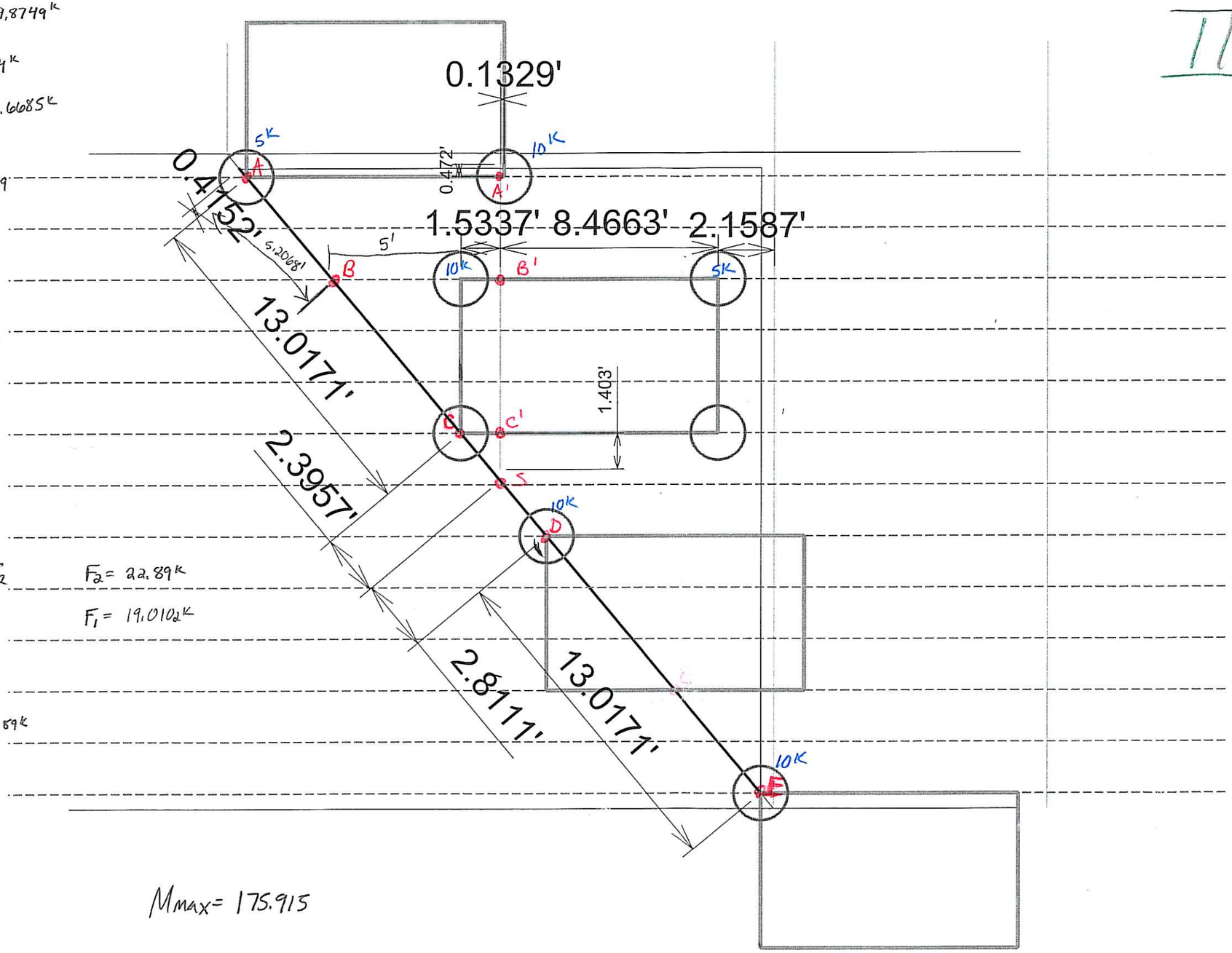
$E = 10^K$

Find S




$S = 4.5528^K$



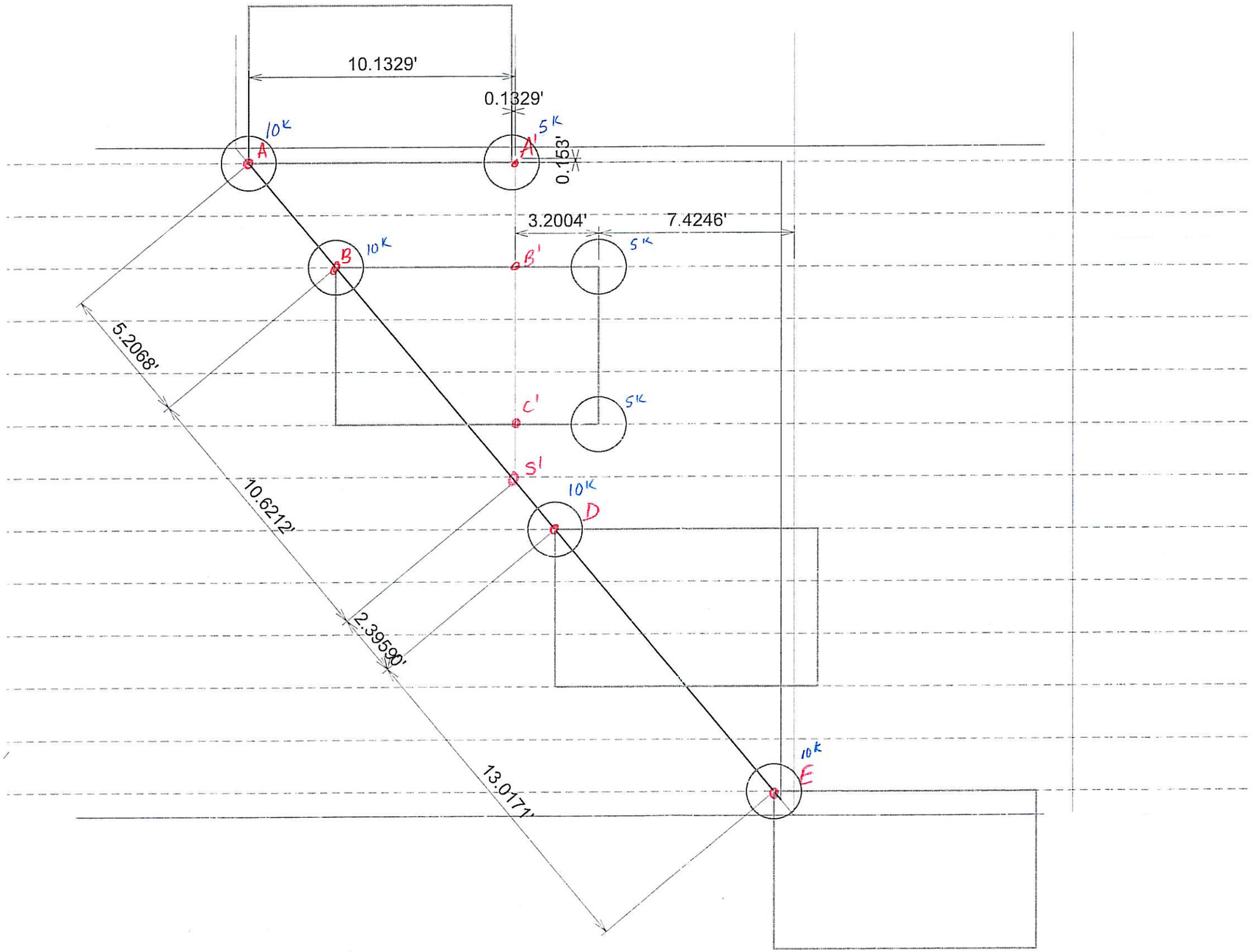

$F_2 = 22.89^K$

$F_1 = 19.0102^K$

$M_{MAX} = 175.915$

# WHEEL LINE ALIGNED WITH NORTH END OF FB

3F



# End FB's - Live Loads - North

## 3F1:

See attached sht 4A For Max Moment Layout

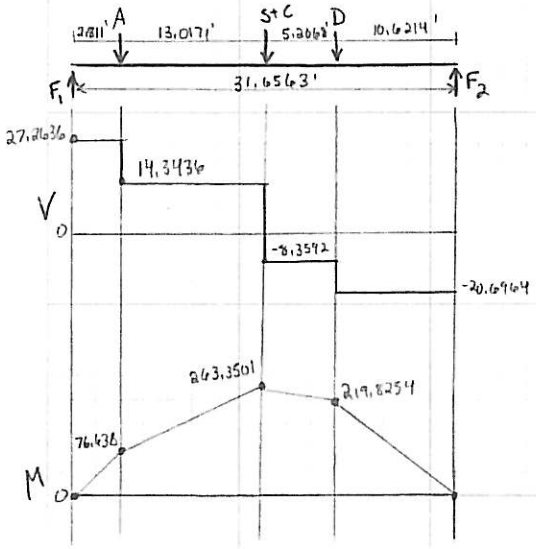
$A = 8.5^k + 8.5^k\left(\frac{4.3334'}{8.3334'}\right) = 12.92^k$

$A' = 8.5^k\left(\frac{4'}{8.3334'}\right) + 8.5^k\left(\frac{4.9584'}{10.6625'}\right) = 8.0467^k$

$B' = C = 8.5^k + 8.5^k\left(\frac{6.1625'}{10.6625'}\right) = 13.8^k$

$D = 8.5^k + 8.5^k\left(\frac{3.2917'}{7.2917'}\right) = 12.3372^k$

$\therefore S = \frac{2.3125'A' + 6.3125'B'}{11.875'} = 8.9028^k$




$F_2 = \frac{2.811'(12.92^k) + 15.8281'(13.8^k + 8.9028^k) + 21.0349'(12.3372^k)}{31.6563'}$

$F_2 = 20.6964^k$

$\therefore F_1 = 27.2636^k$

$\Rightarrow M_{max} = 263.3501\ K\text{-Ft}$

## Max Shear

See sheet 4B

$A = 8.5 + 8.5\left(\frac{6.1329'}{10.1329'}\right) = 13.6446^k$

$A' = 8.5\left(\frac{4}{10.1329}\right) + 6\left(\frac{6.7579}{10.6625}\right) = 7.1716^k$

$B = 8.5 + 8.5\left(\frac{2.7496}{6.7996}\right) = 11.9997^k$

$B' = 8.5\left(\frac{4}{6.7996}\right) + 6\left(\frac{3.4246}{10.6625}\right) = 6.9342^k$

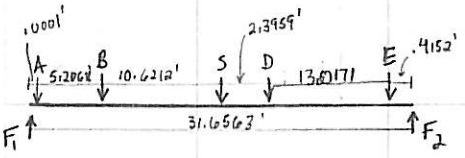
$E = 8.5^k$

$C' = 6\left(\frac{3.4246}{10.6625}\right) = 1.9339^k$

$D = 8.5\left(\frac{5.0912'}{9.0912'}\right) + 8.5 = 13.2601^k$

$S = \frac{.153'A' + 4.153'B' + 10.153'C'}{11.875'} = 4.1709^k$

Let A be .0001' From support so $F_1$ is max shear

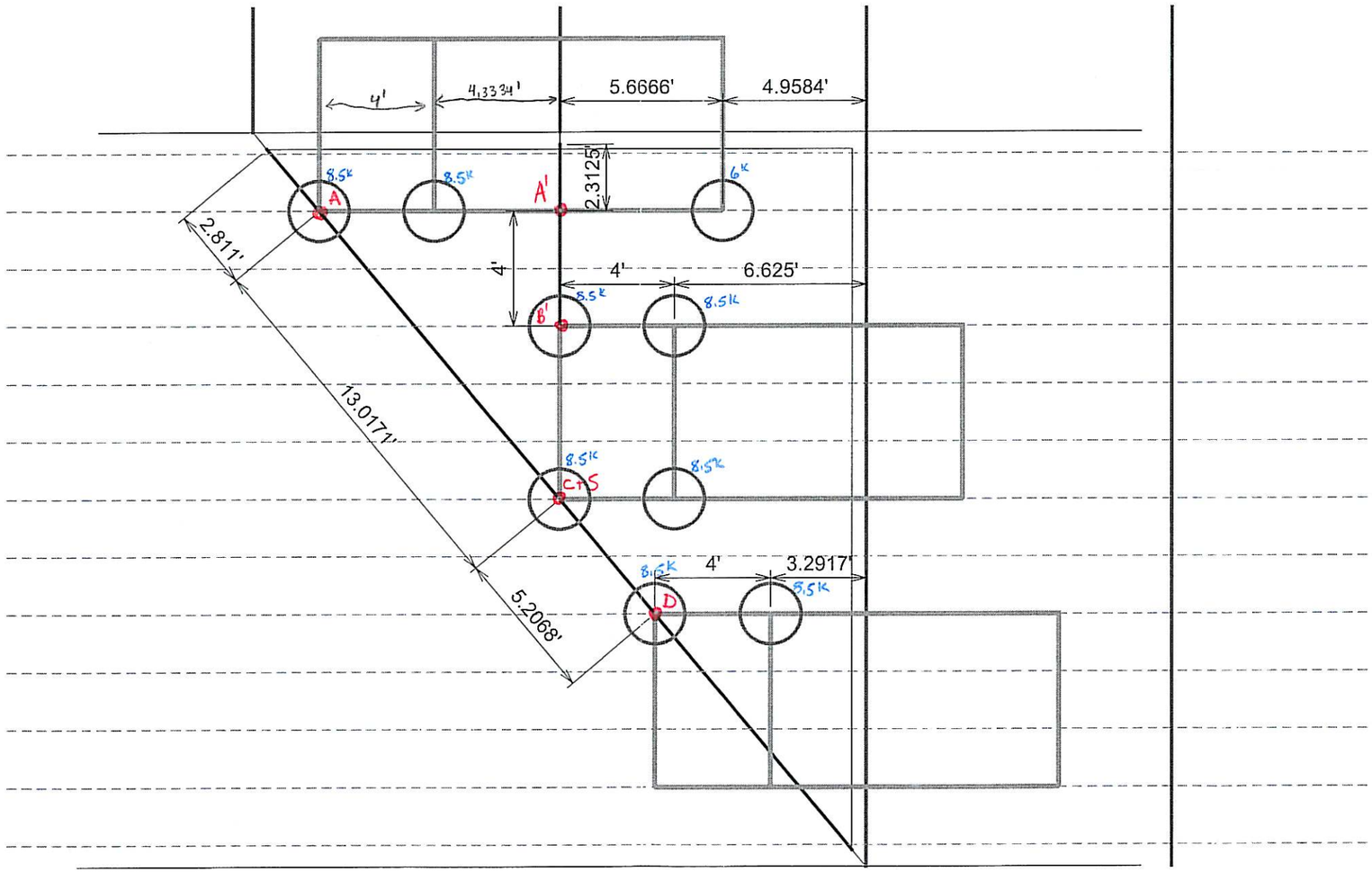



$F_1 = \frac{.4152'(8.5^k) + 13.4323'(13.2601^k) + 15.8282(4.1709^k) + 26.4494(11.9997^k) + 31.6562'(13.6446^k)}{31.6563}$

$V_{max} = 31.4939^k$

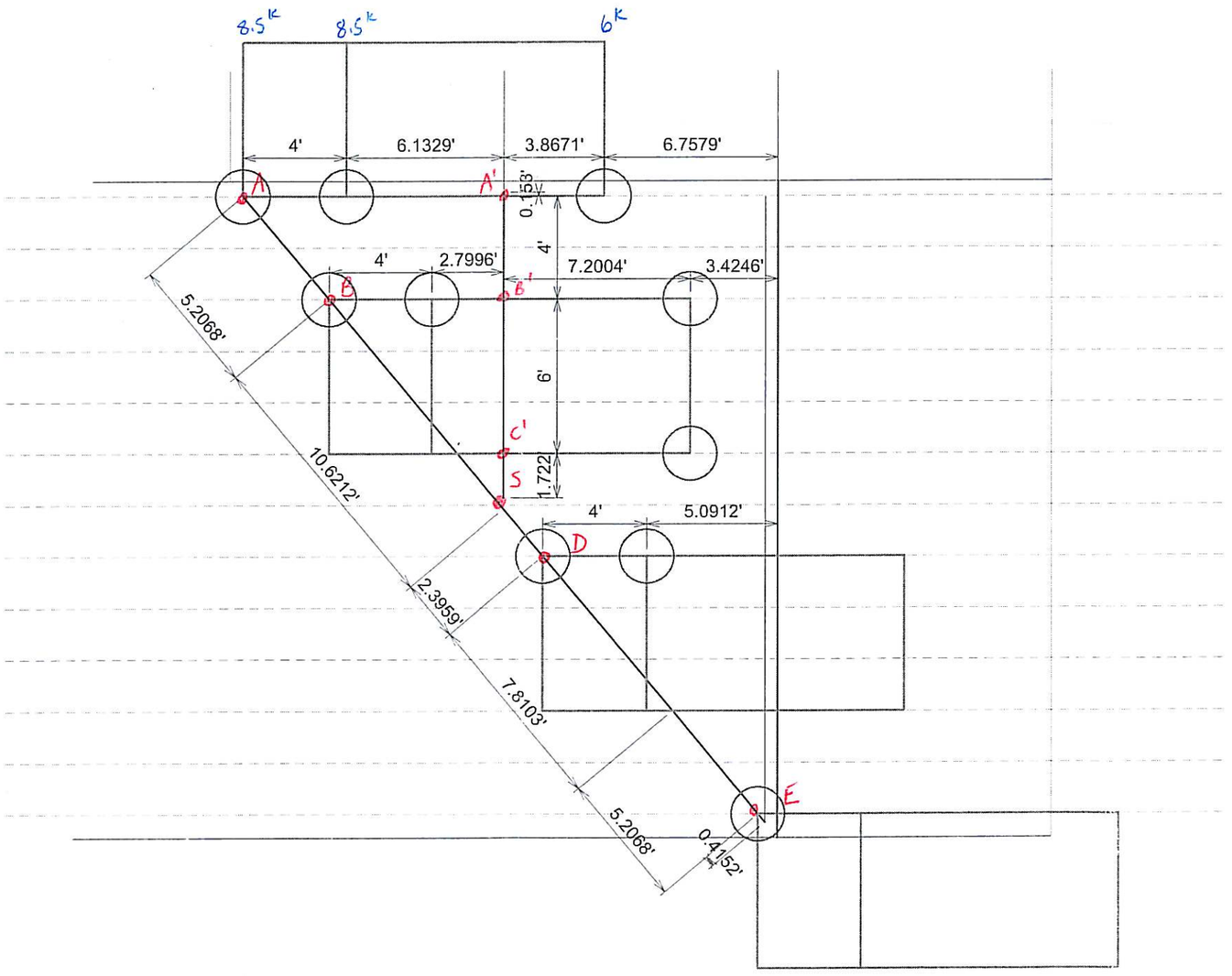
Moment

# WHEEL LINE ALIGNED WITH CENTER OF FB



# SHEAR

# WHEEL LINE ALIGNED WITH NORTH END FB



# End Floorbeams - Live Load - North

## 4F1:

### Max moment

See Sheet 5A For Geometry and Load Layout

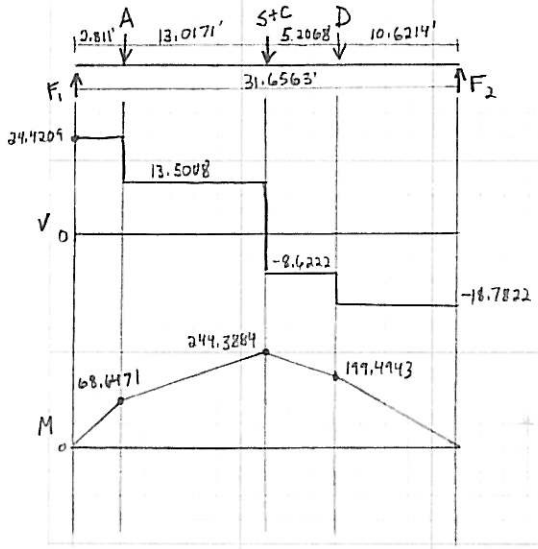
$A = 7^k + 7^k\left(\frac{4.3334'}{8.3334'}\right) + 7^k\left(\frac{.3334'}{8.3334'}\right) = 10.9201^k$

$A' = 7^k\left(\frac{4'}{8.3334'}\right) + 7^k\left(\frac{8'}{8.3334'}\right) + 6^k\left(\frac{.9584'}{10.6625'}\right) = 10.6211^k$

$B' = C = 7 + 7\left(\frac{6.625}{10.625}\right) + 7\left(\frac{2.1625}{10.625}\right) = 13.0941^k$

$D = 7^k + 7^k\left(\frac{3.2917'}{7.2917'}\right) = 10.1600^k$

$\therefore S = \frac{2.3125'A' + 6.3125'B'}{11.875'} = 9.0289^k$




$F_2 = \frac{2.811'(10.9201^k) + 15.8281'(9.0289^k + 13.0941^k) + 21.0349'(10.16^k)}{31.6563'}$

$F_2 = 18.7822^k$

$\therefore F_1 = 34.4209^k$

$\Rightarrow M_{max} = 244.3884\ k\text{-}ft$

### Max Shear · see sheet 5B

$A = 7^k + 7^k\left(\frac{6.1329}{10.1329}\right) + 7^k\left(\frac{2.1329'}{10.1329'}\right) = 12.7102^k$

$A' = 7^k\left(\frac{4}{10.1329}\right) + 7^k\left(\frac{8}{10.1329}\right) + 6^k\left(\frac{2.7579}{10.625}\right) = 9.8472^k$

$B = 7^k + 7^k\left(\frac{2.7996'}{4.7996'}\right) = 9.8821^k$

$B' = 7^k\left(\frac{4'}{4.7996'}\right) + 7^k\left(\frac{9.4146'}{10.625'}\right) = 10.3270^k$

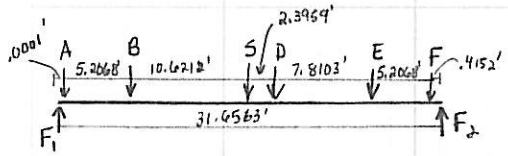
$C' = 7^k\left(\frac{10.625' - 4.2004'}{10.625'}\right) = 6.2091^k$

$D = 7 + 7^k\left(\frac{5.0912'}{9.0912'}\right) + 7^k\left(\frac{1.0912'}{9.0912'}\right) = 11.7603^k$

$E = 7^k\left(\frac{1.0912'}{4.0912'}\right) = 1.8670^k$

$F = 7^k$

$S = \frac{.153'A' + 4.153'B' + 10.153'C'}{11.875'} = 9.0472^k$



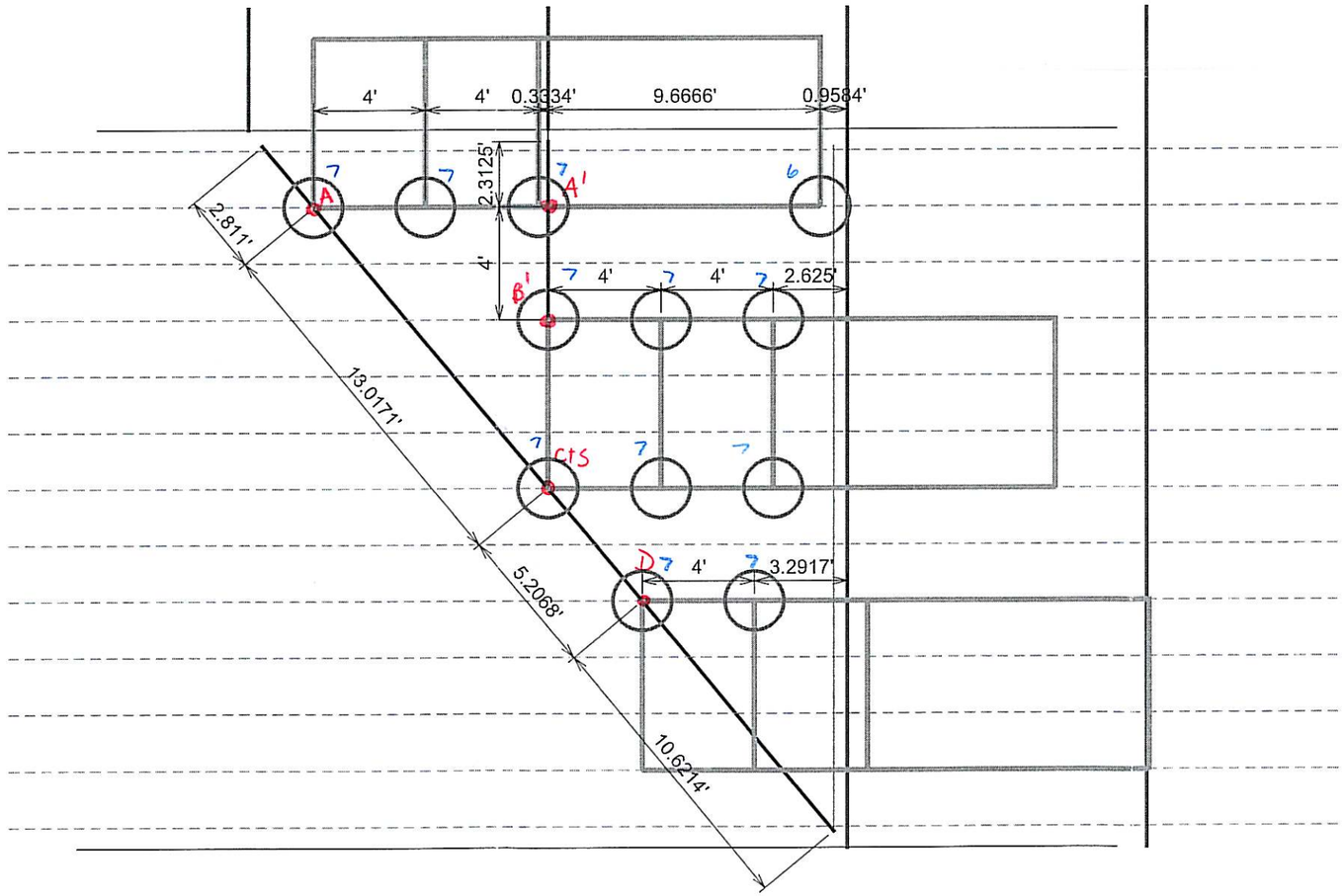

Let A be .0001' from support so $F_1$ is max shear

$F_1 = \frac{.4152'(7^k) + 5.622'(1.8670^k) + 13.4323'(11.7603^k) + 15.8282(9.0472^k) + 26.4494'(9.8821^k) + 31.6562'(12.7102^k)}{31.6563'}$

$\therefore V_{max} = 30.9039^k$

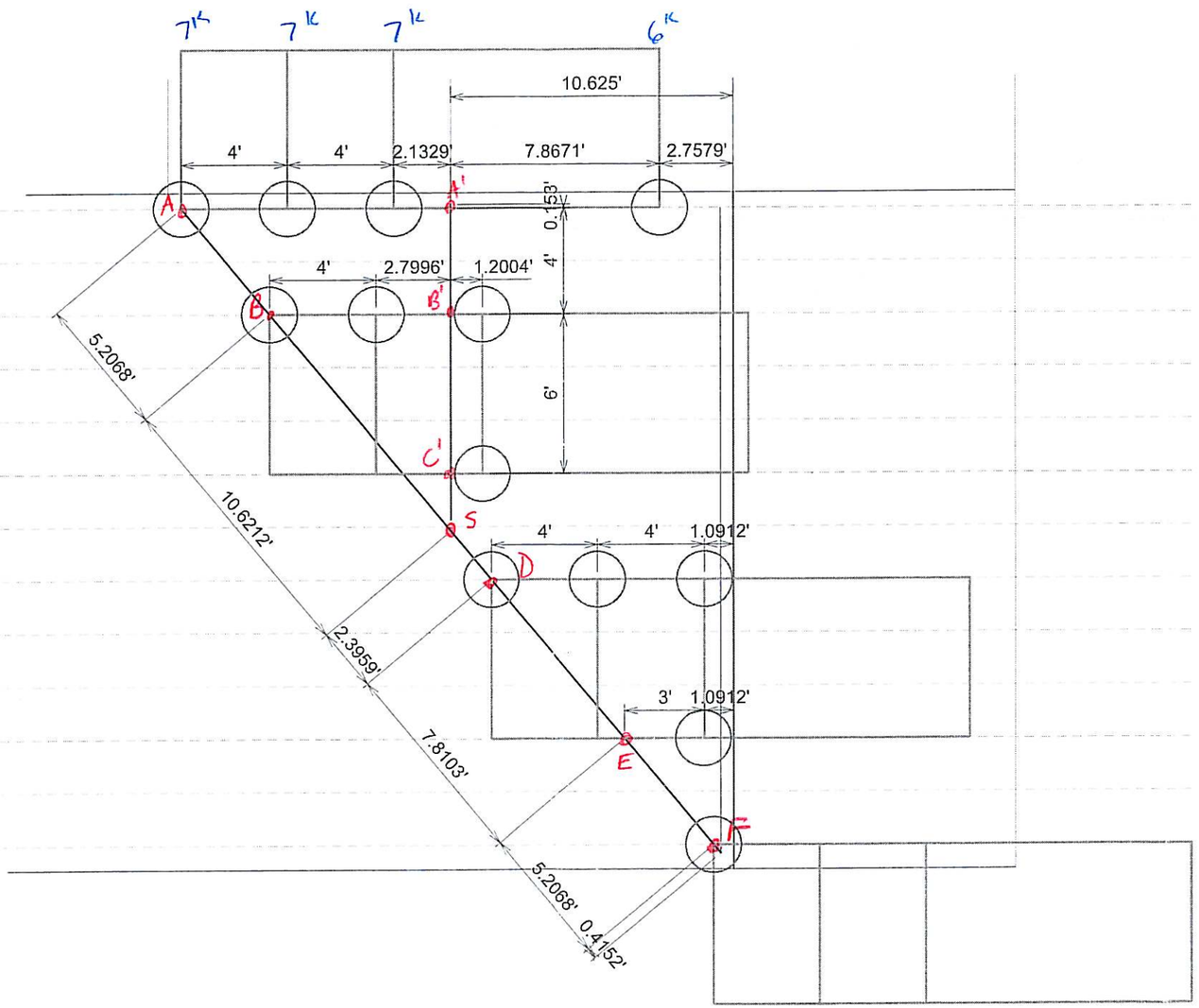
# MOMENT

# WHEEL LINE ALIGNED WITH CENTER OF FB



# SHEAR

# WHEEL LINE ALIGNED WITH NORTH END FB



## End FB's - Live Load - North

### SC1:

**Max Moment - see sheet 6A**

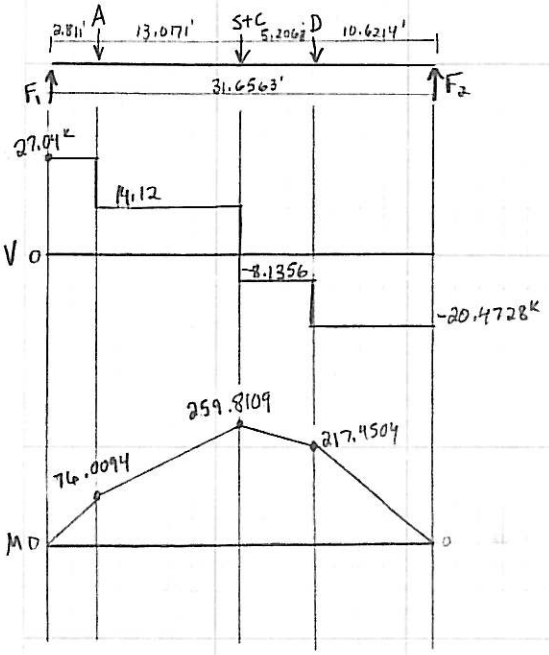
$A = 8.5^k + 8.5^k\left(\frac{4.3334'}{8.3334'}\right) = 13.9200^k$

$A' = 8.5^k\left(\frac{4'}{8.3334'}\right) + 6^k\left(\frac{2.9584'}{10.6625'}\right) = 5.7506^k$

$B' = C = 8.5^k + 8.5^k\left(\frac{6.6625'}{10.6625'}\right) = 13.8^k$

$D = 8.5^k + 8.5^k\left(\frac{3.2917'}{7.2917'}\right) = 12.3372^k$

$S = \frac{2.3125'A' + 6.3125'B'}{11.875'} = 8.4556^k$




$F_2 = \frac{2.811'(12.92^k) + 15.8281'(13.8^k + 8.4556^k) + 21.0349'(12.3372^k)}{31.6563'}$

$F_2 = 20.4728^k$

$F_1 = 27.04^k$

$\Rightarrow M_{max} = 259.8109\ k\text{-Ft}$

**Max Shear - see sheet 6B**

$A = 8.5^k + 8.5^k\left(\frac{6.1329'}{10.1329'}\right) = 13.6446^k$

$A' = 8.5^k\left(\frac{4'}{10.1329'}\right) + 8.5^k\left(\frac{4.7579'}{10.6625'}\right) = 7.1617^k$

$B = 8.5^k + 8.5^k\left(\frac{0.7996'}{6.7996'}\right) = 11.9997^k$

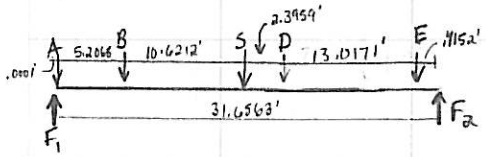
$B' = 8.5^k\left(\frac{4'}{6.7996'}\right) + 6^k\left(\frac{1.4246'}{10.6625'}\right) = 5.8048^k$

$C' = 6^k\left(\frac{1.4246}{10.6625}\right) = .8045^k$

$D = 8.5^k\left(\frac{5.3912}{9.0912}\right) + 8.5^k = 13.2601^k$

$E = 8.5^k$

$S = \frac{.153'A' + 4.153'B' + 10.153'C'}{11.875'} = 2.8102^k$



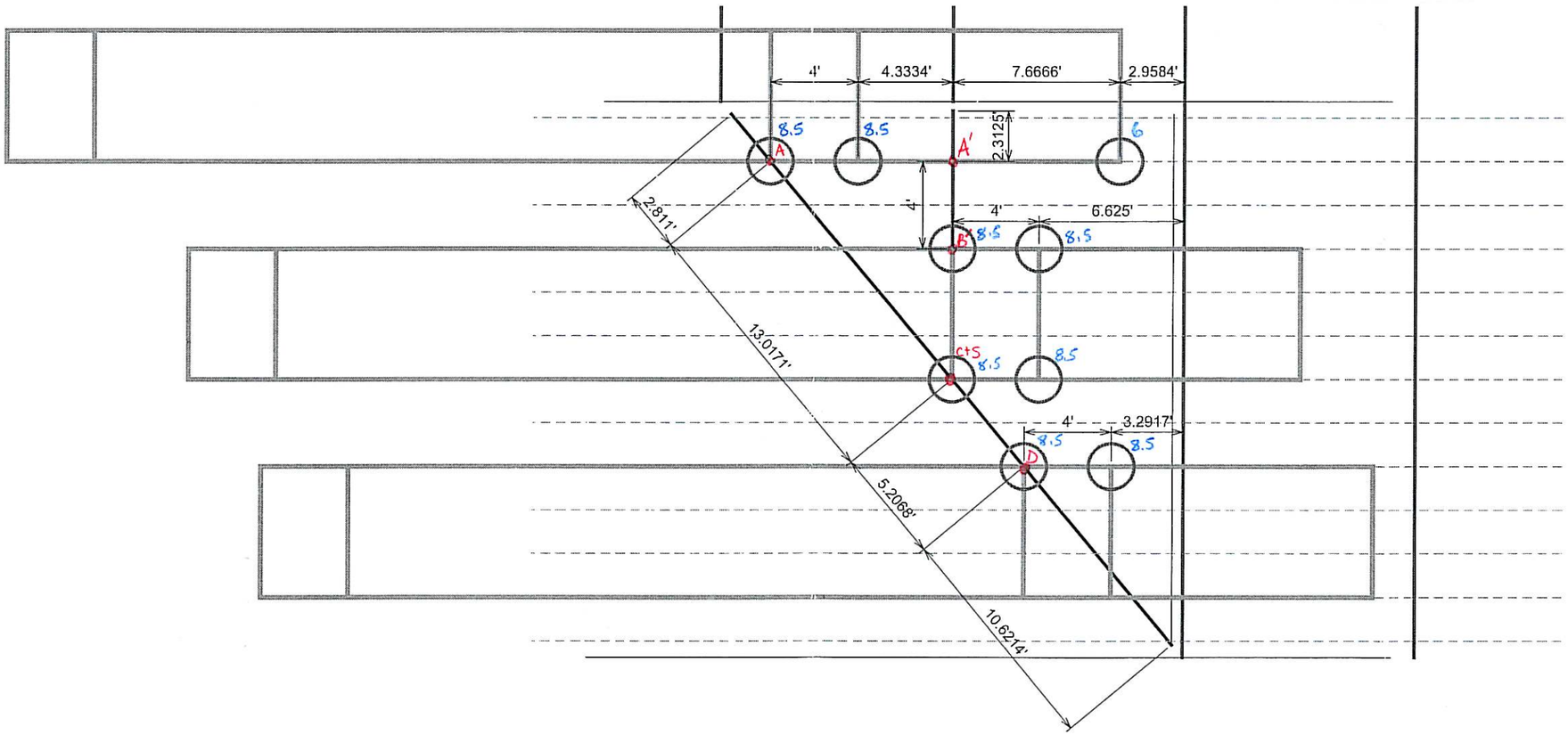

Let A be .0001' from support so $F_1$ is Max

$F_1 = \frac{.4152'(8.5^k) + 13.4323'(13.2601^k) + 15.8282'(2.8102^k) + 26.4494'(11.9997^k) + 31.6562'(13.6446^k)}{31.6563}$

$\therefore V_{max} = 30.8136^k$

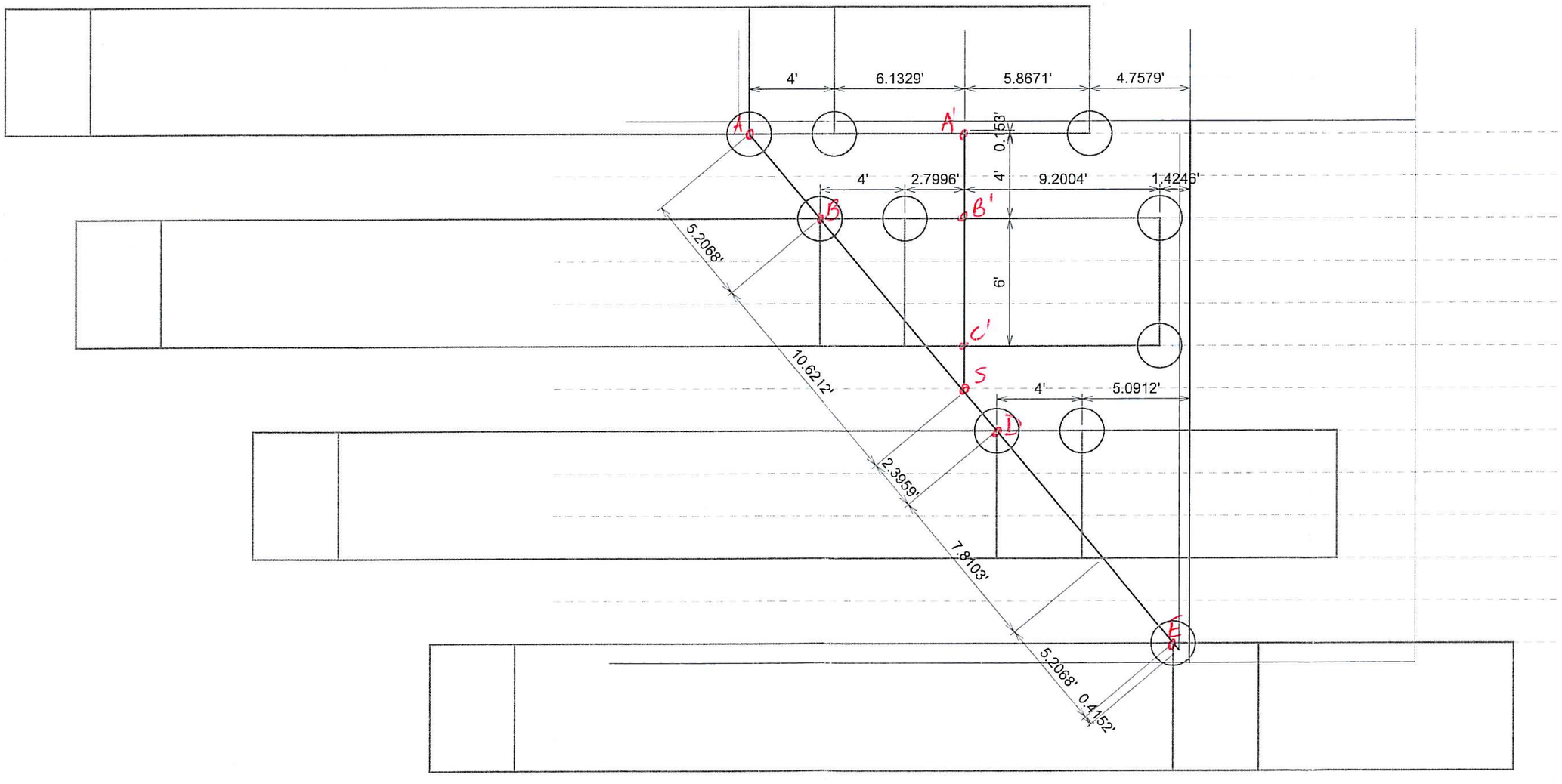
# MOMENT

# WHEEL LINE ALIGNED WITH CENTER OF FB



# SHEAR

# WHEEL LINE ALIGNED WITH NORTH END FB



# End FB's - Live Load - South FB's

→ orientation ( West ▽ or East ◺ ) of FB will matter

Start with West

## HS20:

### Max Moment - see sheet 7A for geometry

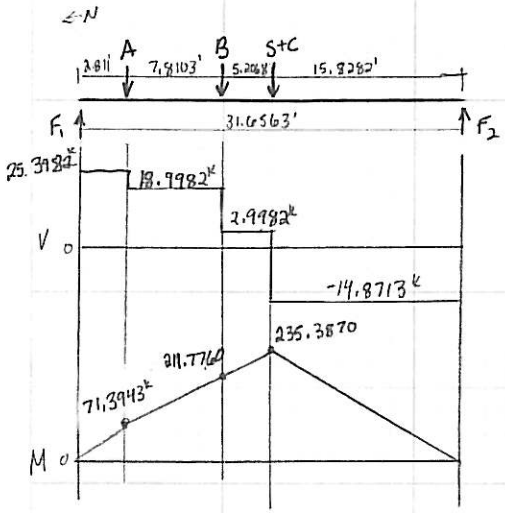
$A = 16^k \left(\frac{3.3333'}{8.3333'}\right) = 6.4^k$

$B = 16^k$

$C = 16^k$

$A' = 16^k \left(\frac{5'}{8.3333'}\right) = 9.60^k$

$S = \frac{2.3125'(9.60^k)}{11.875'} = 1.8695^k$




$F_2 = \frac{2.811'(6.4^k) + 10.6213'(16^k) + 15.8281'(16^k + 1.8695^k)}{31.6563'}$

$F_2 = 14.8713^k$

$F_1 = 25.3982^k$

$\Rightarrow M_{max} = 235.3870$ k-ft

### Max Shear - see sheet 7B for geometry

$A = 16^k$

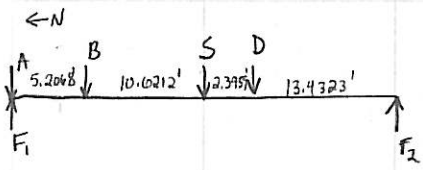
$A' = 16^k \left(\frac{6.7579}{10.625}\right) = 10.1766$

$B = 16^k$

$B' = C' = 16^k \left(\frac{3.4246}{10.625}\right) = 5.1570^k$

$D = 16^k$

$S = \frac{1.153'(A') + 4.153'(B') + 10.153'(C')}{11.875'} = 6.3438^k$

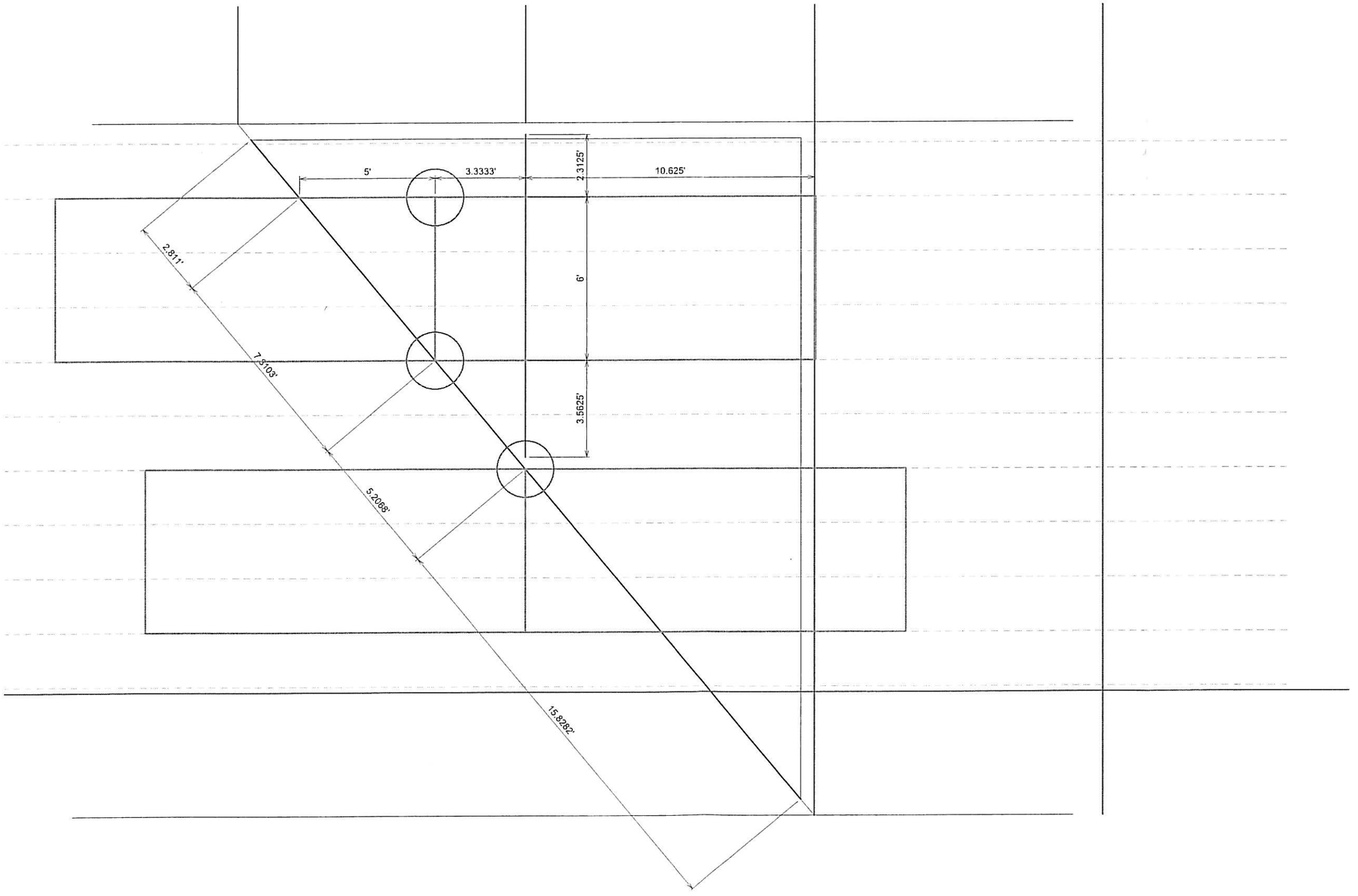



$F_1 = V_{max} = \frac{13.4323'(16^k) + 15.8282'(6.3438^k) + 26.4494'(16^k) + 31.6563'(16^k)}{31.6563'}$

$\Rightarrow V_{max} = 39.3293^k$

# WHEEL LINE ALIGNED WITH CENTER OF FB

7A

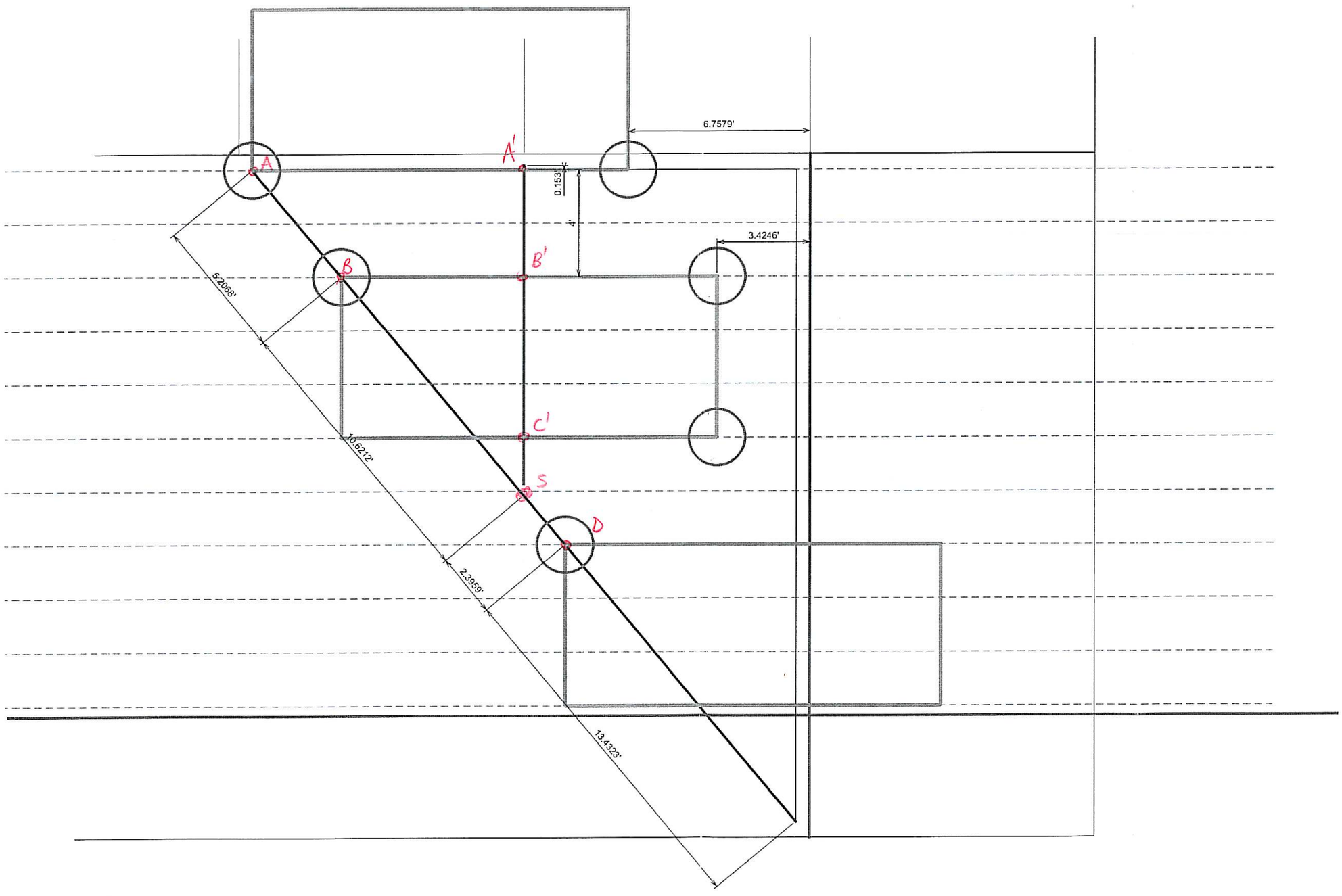


Shear

7B

# WHEEL LINE ALIGNED WITH NORTH END FB

All 16 K



# End FB's - Live Load - South FB - West

## 2F1:

### Max Moment - sheet 8A for geometry

$A = 10^K \left(\frac{3.3333'}{8.3333'}\right) = 4^K$

$A' = 10 - A + 5^K \left(\frac{3.9583'}{10.1625'}\right) = 7.8627^K$

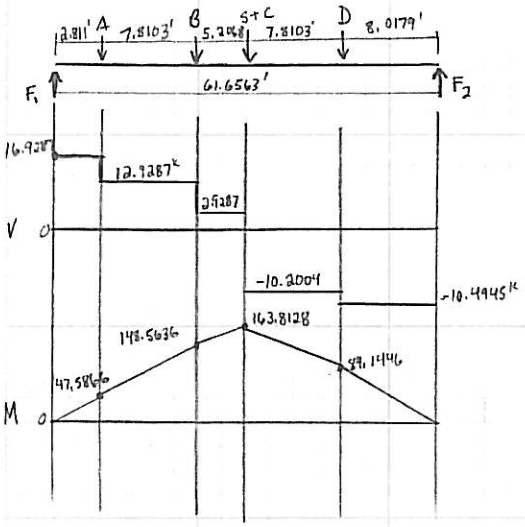
$B = 10^K$

$B' = 5^K \left(\frac{3.9583'}{10.1625'}\right) = 1.8627^K$

$C = 10^K + 5^K \left(\frac{.1625'}{10.1625'}\right) = 10.2941^K$

$D = 5^K \left(\frac{.1625'}{10.1625'}\right) = .2941^K$

$S = \frac{2.3125'A' + 8.3125'B'}{11.875'} = 2.8350^K$




$F_2 = \frac{2.811'(4^K) + 10.6213'(10^K) + 15.8281'(2.8350^K + 10.2941^K) + 23.6384'(.2941^K)}{31.6563'}$

$F_2 = 10.4945^K$

$\therefore F_1 = 16.9287^K$

$\Rightarrow M_{max} = 163.8128$ K-Ft

### Max Shear - see sheet 8B

$A = 10^K + 5^K \left(\frac{.1329}{10.1329}\right) = 10.0656^K$

$A' = 5^K \left(\frac{10}{10.1329}\right) = 4.9344^K$

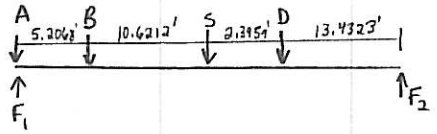
$B = 10^K$

$B' = 5^K \left(\frac{7.4246'}{10.625'}\right) = 3.4939^K$

$C' = B' = 3.4939^K$

$D = 10^K$

$S = \frac{.153'A' + 4.153'B' + 10.153'C'}{11.875'} = 4.2727^K$

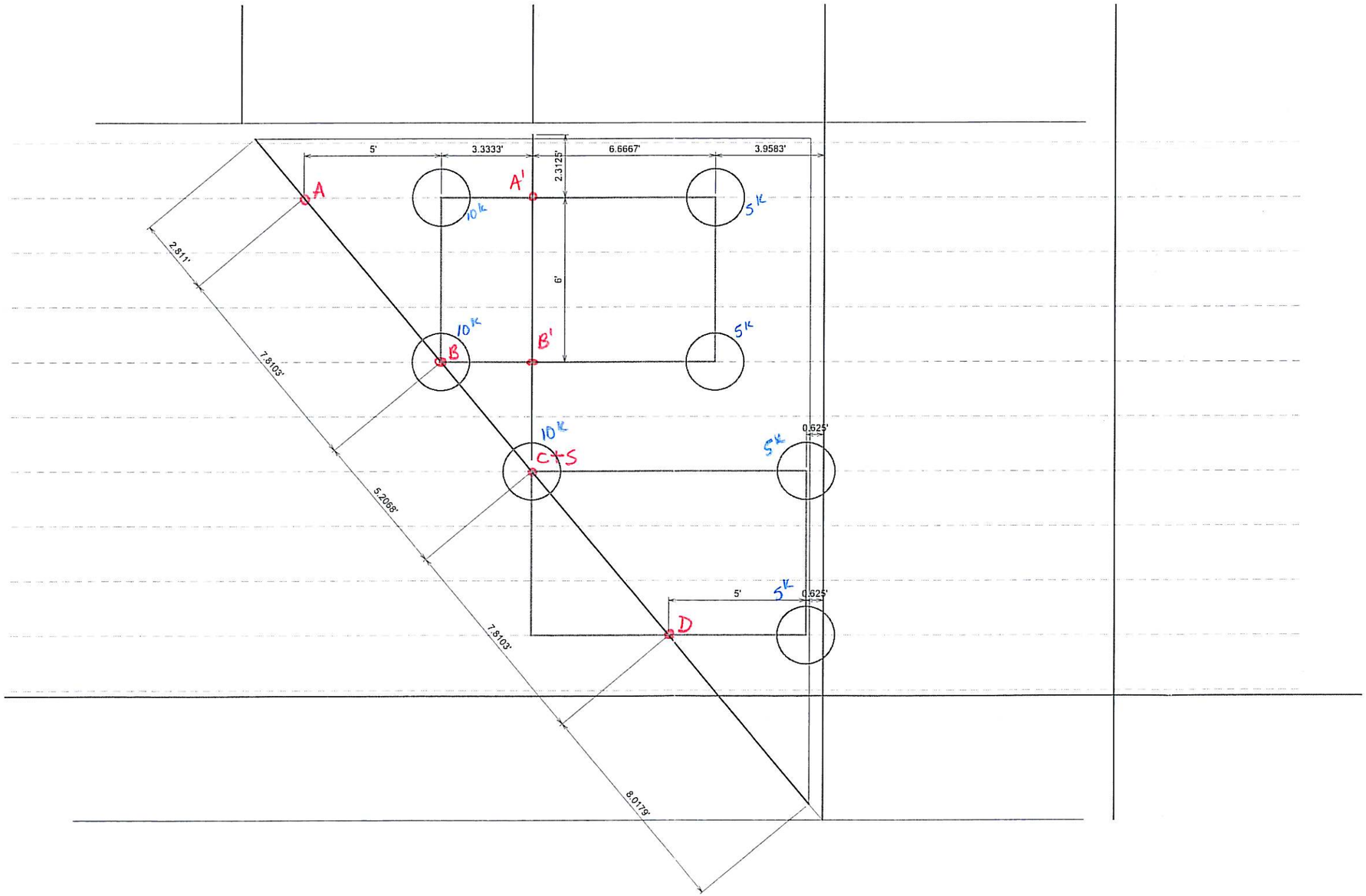



$F_1 = V_{max} = \frac{13.4323'(10^K) + 15.8282'(4.2727^K) + 26.4494'(10^K) + 31.6563(10.0656^K)}{31.6563'}$

$\Rightarrow V_{max} = 24.8003^K$

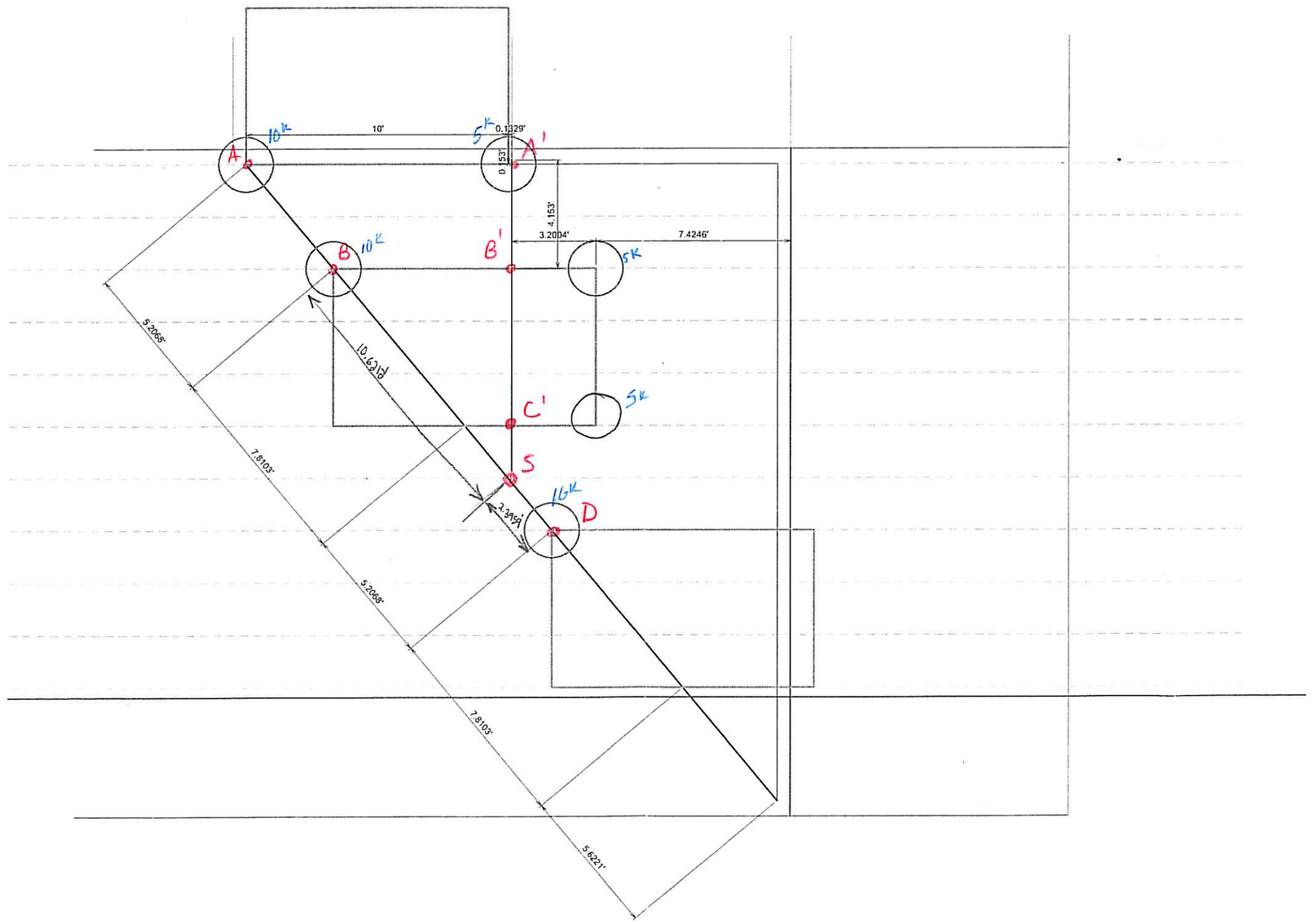
# 2F1 SOUTH
# WHEEL LINE ALIGNED WITH CENTER OF FB

Moment



Sheet

# 2F1 SOUTH
# WHEEL LINE ALIGNED WITH NORTH END FB



## End FB's - Live Load - South FB (West)

### 3F1:

**Max Moment - see sheet 9A for Geometry**

$A = 8.5\left(\frac{3.3333}{8.3333}\right) = 3.4^K$

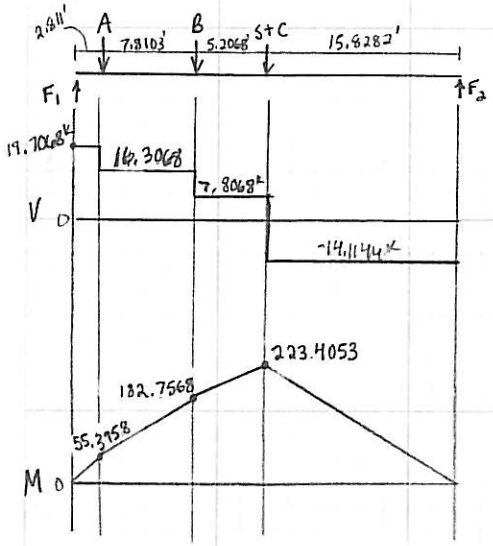
$A' = 8.5 - A + 8.5\left(\frac{9.9583}{10.625}\right) = 13.0666^K$

$B = 8.5^K$

$B' = 8.5\left(\frac{9.9583}{10.625}\right) = 7.9666^K$

$C = 8.5 + 8.5\left(\frac{6.625}{10.625}\right) = 13.8^K$

$S = \frac{2.3125'(A') + 8.3125'(B')}{11.875'} = 8.1212^K$




$F_2 = \frac{2.811'(3.4^K) + 10.6213'(8.5^K) + 15.9281'(8.1212^K + 13.8^K)}{31.6563'}$

$F_2 = 14.1144^K$

$\therefore F_1 = 19.7068^K$

$\Rightarrow M_{max} = 223.4053$ K-Ft

**Max Shear - see sheet 9B**

$A = 8.5^K + 8.5^K\left(\frac{6.1329'}{10.1329'}\right) = 13.6446^K$

$A' = 8.5^K\left(\frac{4'}{10.1329'}\right) + 6^K\left(\frac{6.7579'}{10.625'}\right) = 7.1716^K$

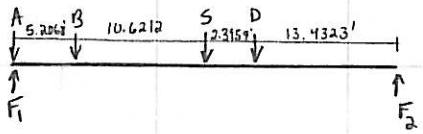
$B = 8.5^K + 8.5^K\left(\frac{2.7996'}{6.7996'}\right) = 11.9997^K$

$B' = 8.5^K\left(\frac{4'}{6.7996'}\right) + 6^K\left(\frac{3.4246'}{10.625'}\right) = 6.9342^K$

$C' = 6^K\left(\frac{3.4246}{10.1625}\right) = 1.9339^K$

$D = 8.5^K + 8.5\left(\frac{5.0912^K}{9.0912^K}\right) = 13.2601^K$

$S = \frac{.153'A' + 4.153'B' + 10.153'C'}{11.875'} = 4.1709^K$



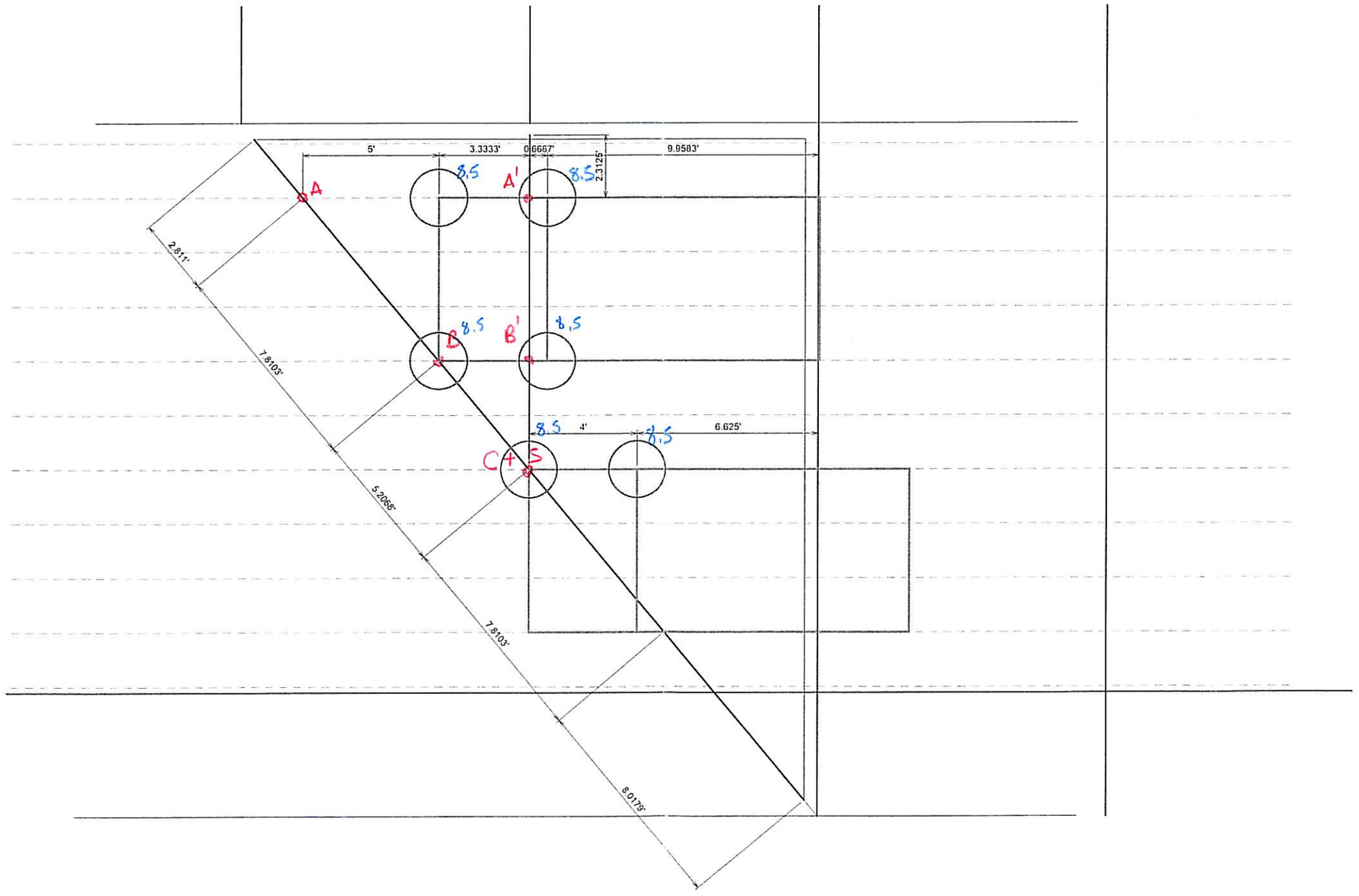

$F_1 = V_{max} = \frac{13.4323'(13.2601^K) + 15.8282'(4.1709^K) + 26.4494'(11.9997^K) + 31.6563'(13.6446^K)}{31.6563'}$

$\Rightarrow V_{max} = 31.3825^K$

# 3F1 SOUTH

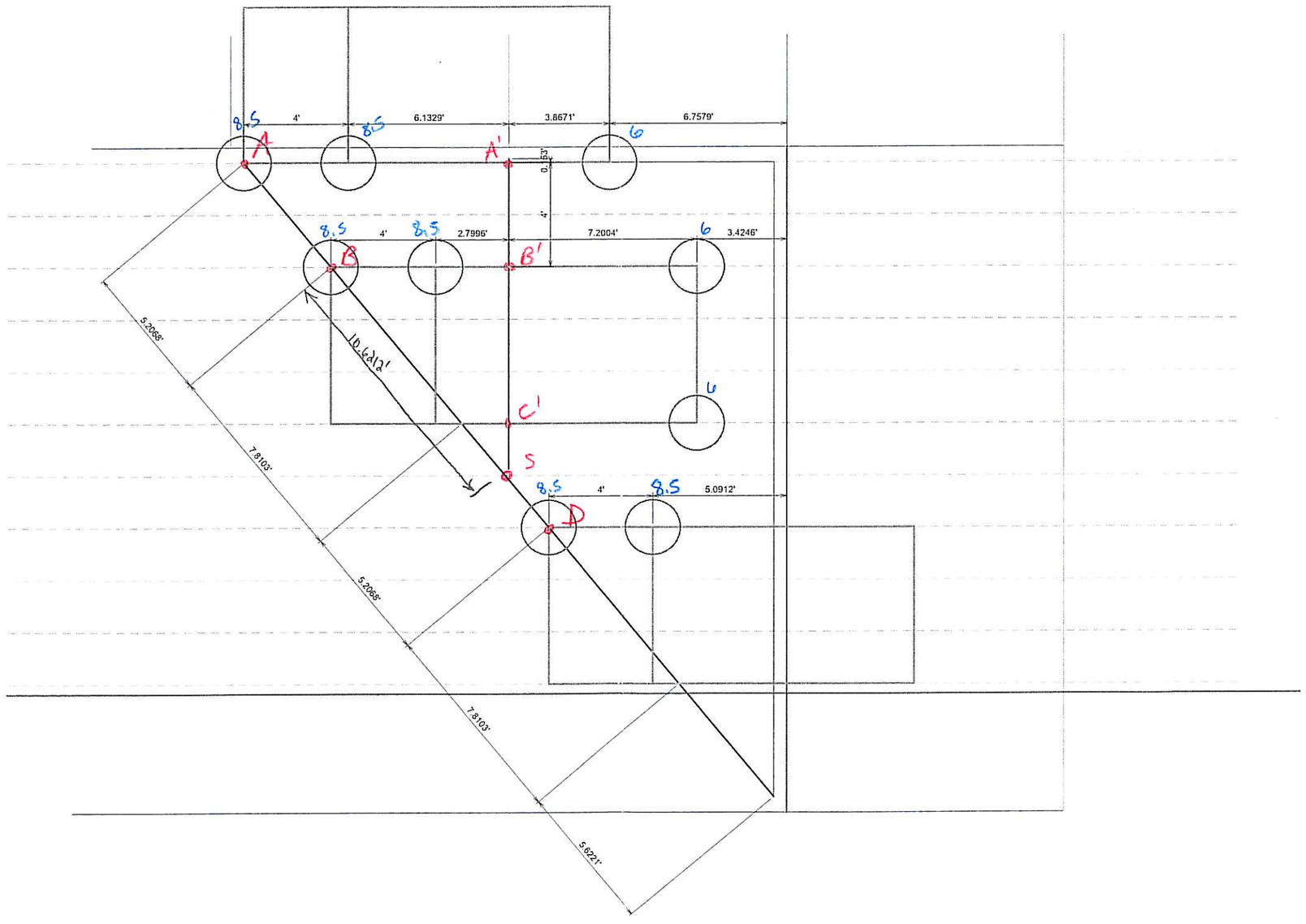
Moved

# WHEEL LINE ALIGNED WITH CENTER OF FB



# 3F1 SOUTH
# WHEEL LINE ALIGNED WITH NORTH END FB

shear



# End FB's - Live Load - South FB's (West)

## 4F1:

### Max Moment - see geometry on sheet 10A

$A = 7^K\left(\frac{3.3333}{8.3333}\right) = 2.8^K$

$A' = 7^K\left(\frac{9.9583'}{10.6625'}\right) + 7^K\left(\frac{5.9583'}{10.6625'}\right) + 7^K - 2.8^K = 14.6862^K$

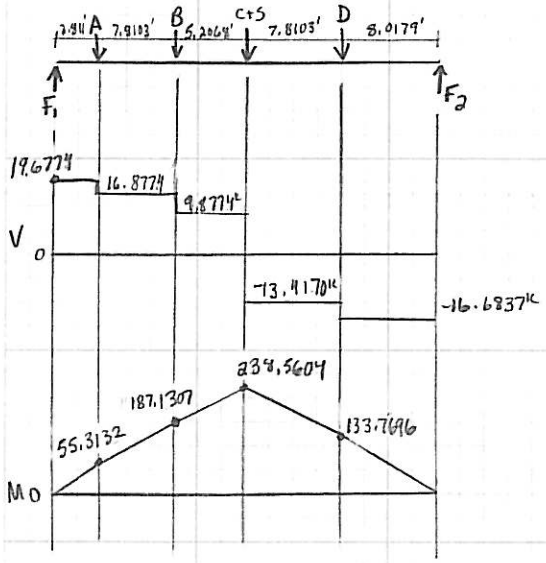
$B = 7^K$

$B' = 7^K\left(\frac{5.9583}{10.625}\right) + 7^K\left(\frac{9.9583}{10.625}\right) = 10.4862^K$

$C = 7^K + 7^K\left(\frac{6.625}{10.625}\right) + 7^K\left(\frac{2.625}{10.625}\right) = 13.0941^K$

$D = 7^K\left(\frac{2.625}{5.625}\right) = 3.2667^K$

$S = \frac{2.3125'A' + 8.3125'B'}{11.8751} = 10.2003^K$




$F_2 = \frac{2.811'(28^K) + 10.6213'(7^K) + 15.8281'(13.0941^K + 10.2003^K) + 23.6384'(3.2667^K)}{31.6563'}$

$F_2 = 16.6837^K$

$\therefore F_1 = 19.6774^K$

$\Rightarrow M_{max} = 238.5604^{K\text{-}Ft}$

### Max Shear - See Page 10B

$A = 7^K + 7^K\left(\frac{6.1329}{10.1329}\right) + 7^K\left(\frac{2.1329}{10.1329}\right) = 12.7102^K$

$A' = 21^K - A + 6^K\left(\frac{2.7579}{10.625}\right) = 9.8472^K$

$B = 7^K + 7^K\left(\frac{2.7996'}{6.7996}\right) = 9.8821^K$

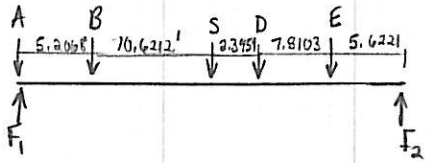
$B' = 14^K - B + 7^K\left(\frac{9.4246}{10.625}\right) = 10.3270^K$

$C' = 7^K\left(\frac{9.4246}{10.625}\right) = 6.2091^K$

$D = 7^K + 7^K\left(\frac{5.0912}{9.0912}\right) + 7^K\left(\frac{1.0912}{9.0912}\right) = 11.7603^K$

$E = 7^K\left(\frac{1.0912}{4.0912}\right) = 1.8670^K$

$S = \frac{.153'A' + 4.153'B' + 10.153'C'}{11.875'} = 9.0472^K$




$F_1 = V_{max} = \frac{5.6221(1.8670^K) + 13.4324'(11.7603^K) + 15.8283'(9.0472^K) + 26.4495'(9.8821^K) + 31.6563'(12.7102^K)}{31.6563^K}$

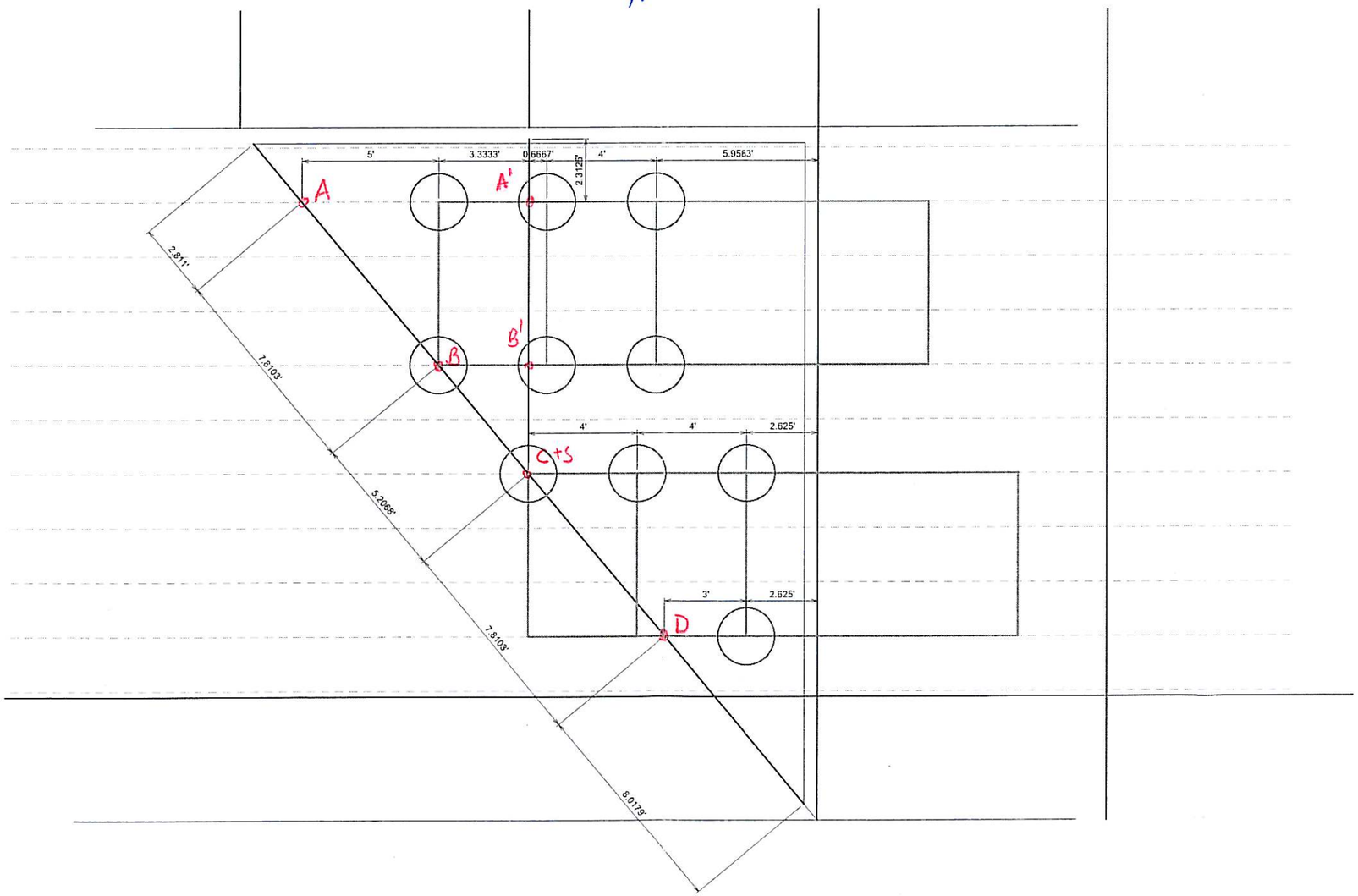
$\Rightarrow V_{max} = 30.8122^K$

# 4F1 SOUTH

Moment

# WHEEL LINE ALIGNED WITH CENTER OF FB

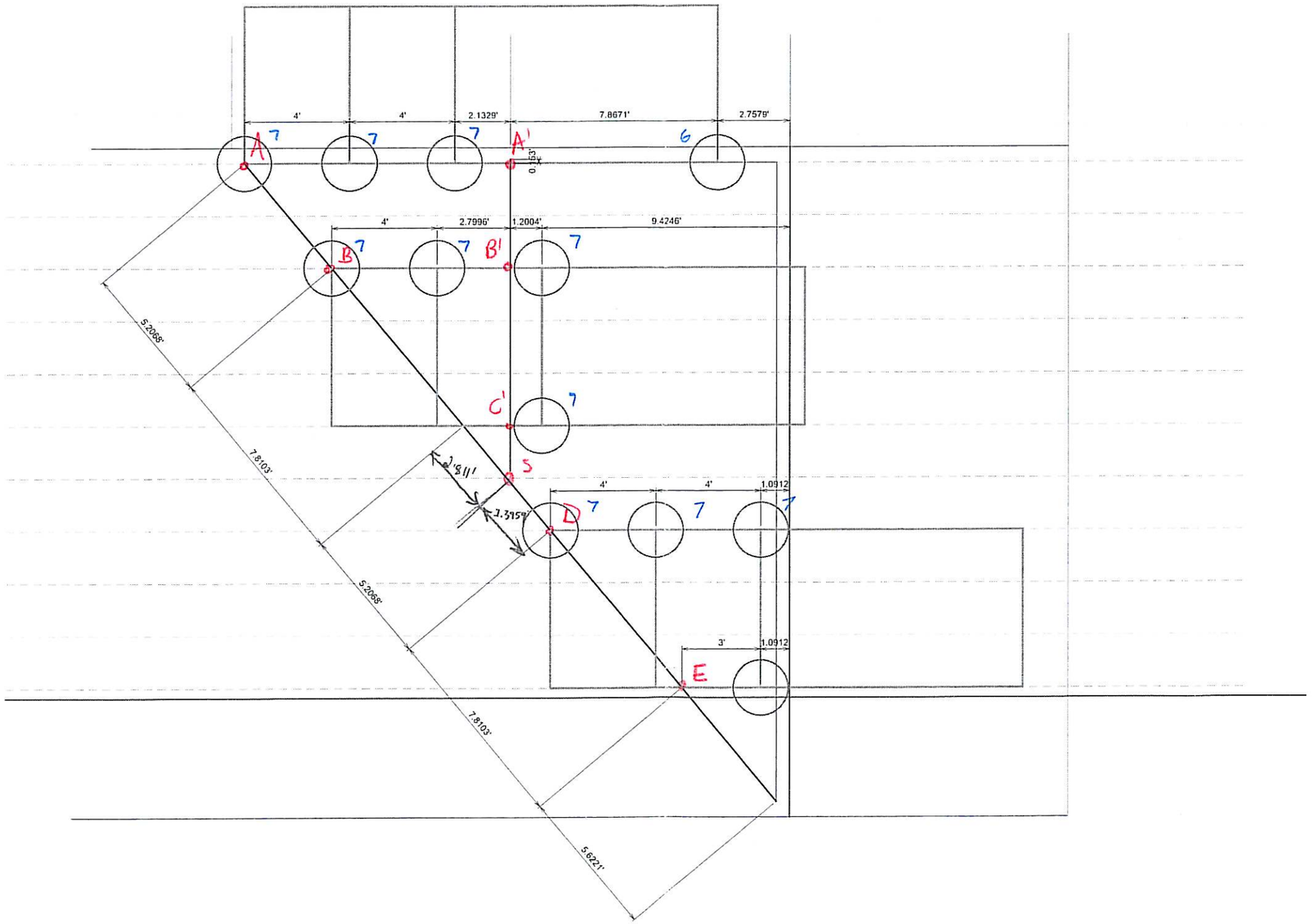
All loads 7K



# 4F1 SOUTH

Shear

# WHEEL LINE ALIGNED WITH NORTH END FB



## End FB's - Live Load - South FB's West

### SC1:

Max Momut - see sheet 11A for geometry

$A = 8.5^K \left(\frac{3.3333'}{8.3333'}\right) = 3.4^K$

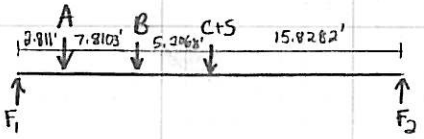
$A' = 8.5^K - A + 8.5^K \left(\frac{9.9583'}{10.625'}\right) = 13.0666^K$

$B = 8.5^K$

$B' = 8.5^K \left(\frac{9.9583}{10.625}\right) = 7.9666^K$

$C = 8.5^K + 8.5^K \left(\frac{6.625'}{10.625'}\right) = 13.8^K$

$S = \frac{2.3125'(A') + 8.3125'(B')}{11.875'} = 8.1212^K$




$F_1 = \frac{2.811^K(3.4) + 10.6213'(8.5^K) + 15.8281'(13.8^K + 8.1212^K)}{31.6563^K}$

$F_2 = 14.1144^K$

$\therefore F_1 = 19.7068^K$

$\Rightarrow M_{max} = 223.4053$ k-ft (See 3F1 calcs)

Max Shear - see sheet 11B

$A = 8.5^K + 8.5^K \left(\frac{6.1329'}{10.1329'}\right) = 13.6446^K$

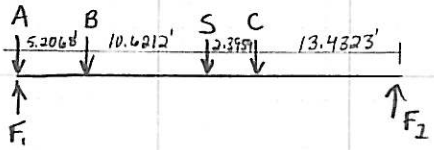
$A' = 17^K - A + 6^K \left(\frac{4.7579'}{10.625'}\right) = 6.0422^K$

$B = 8.5^K + 8.5^K \left(\frac{8.7996'}{6.7996'}\right) = 11.9997^K$

$B' = 17^K - B + 6^K \left(\frac{1.4246}{10.625}\right) = 5.8048^K$

$C = 8.5^K + 8.5^K \left(\frac{5.0912'}{9.0912'}\right) = 13.2601^K$

$S = \frac{.153'A' + 4.153'B'}{11.875'} = 2.1079^K$



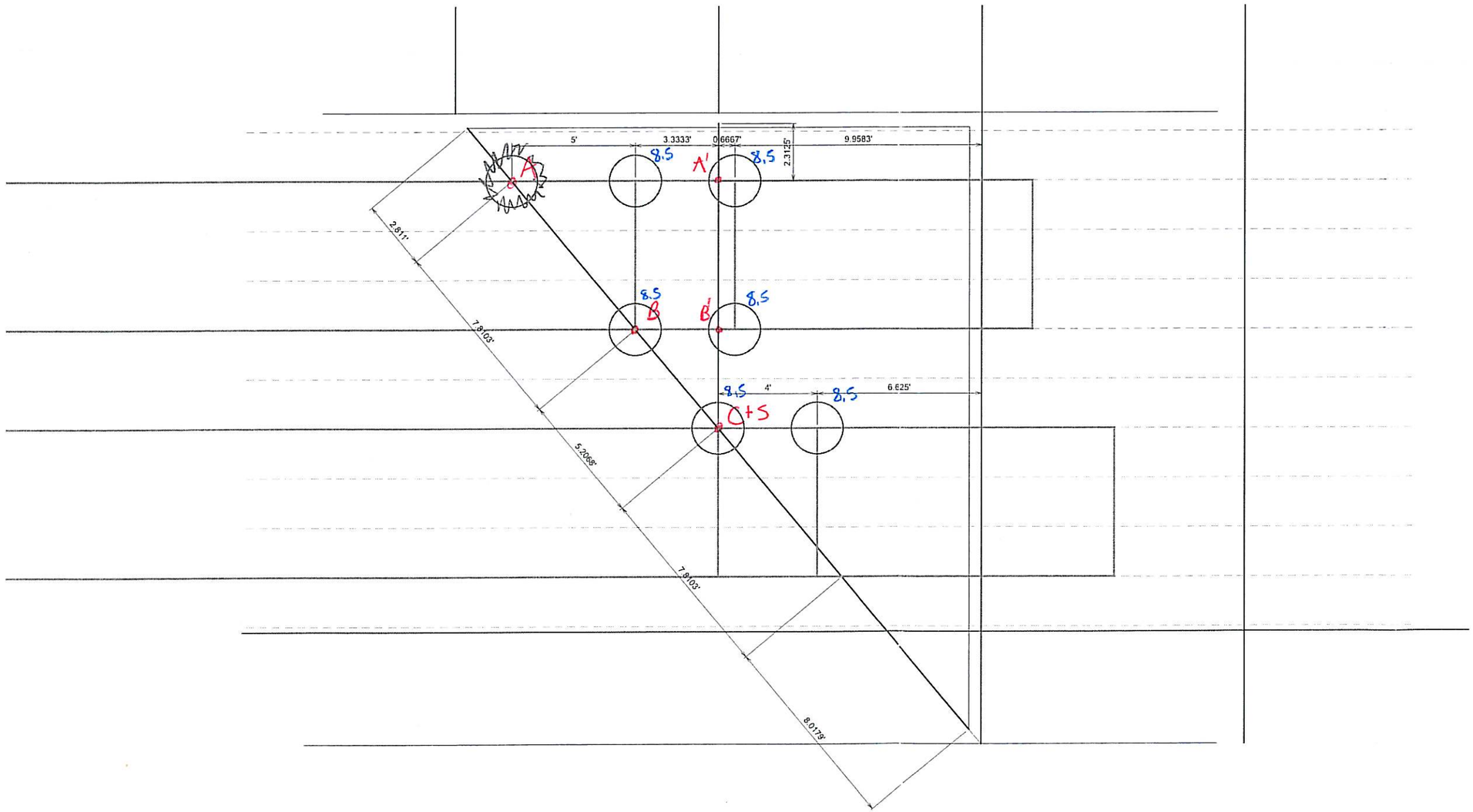

$F_1 = V_{max} = \frac{13.4323'(13.2601^K) + 15.8282'(2.1079^K) + 26.4494'(11.9997^K) + 31.6563(13.6446^K)}{31.6563'}$

$\Rightarrow V_{max} = 30.3510^K$

# 5C1 SOUTH

Moment

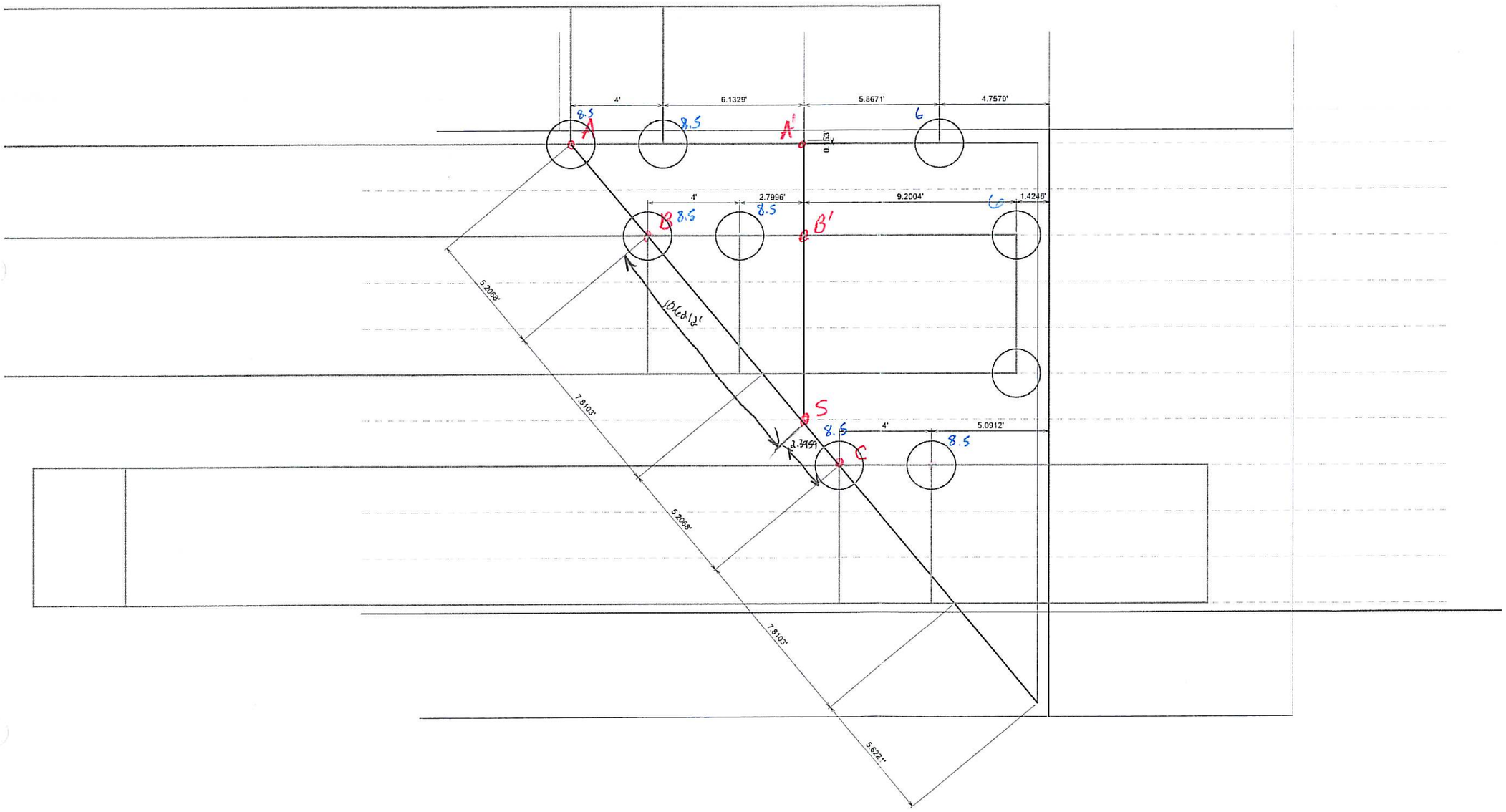
# WHEEL LINE ALIGNED WITH CENTER OF FB



# 5C1 SOUTH

Shear

# WHEEL LINE ALIGNED WITH NORTH END FB



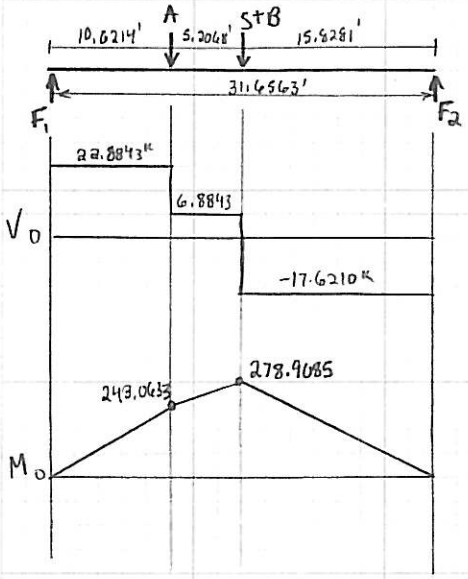
## End FB's - Live Load - South FB's East

These FB's will have different moments + shears than the "west FB's" due to geometry

### Check HS20:

#### Max Moment Geometry - see sheet 12A

$A = B = C' = 16^K$ $\quad S = 16^K\left(\frac{6.3125'}{11.875'}\right) = 8.5053^K$




$$F_2 = \frac{10.6214'(16^K) + 15.8282'(16^K + 8.5053^K)}{31.6563'}$$

$F_2 = 17.6210^K$

$\therefore F_1 = 22.8843^K$

$\Rightarrow M_{max} = 278.9085\ k\text{-}ft$

#### Max Shear Geometry - see Sheet 12B

$A = 16^K$

$B = 16^K\left(\frac{5.492'}{5.492'}\right) = 1.4334^K$

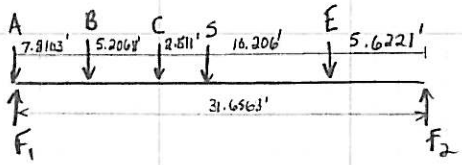
$C = 16^K$

$D' = 16^K\left(\frac{8.8254'}{10.625'}\right) = 13.29^K$

$E = 16^K$

$E' = 16^K\left(\frac{3.1587'}{10.625'}\right) = 4.7566^K$

$$S = \frac{4.472'(E') + 8.472'(D')}{11.875'} = 11.2728^K$$

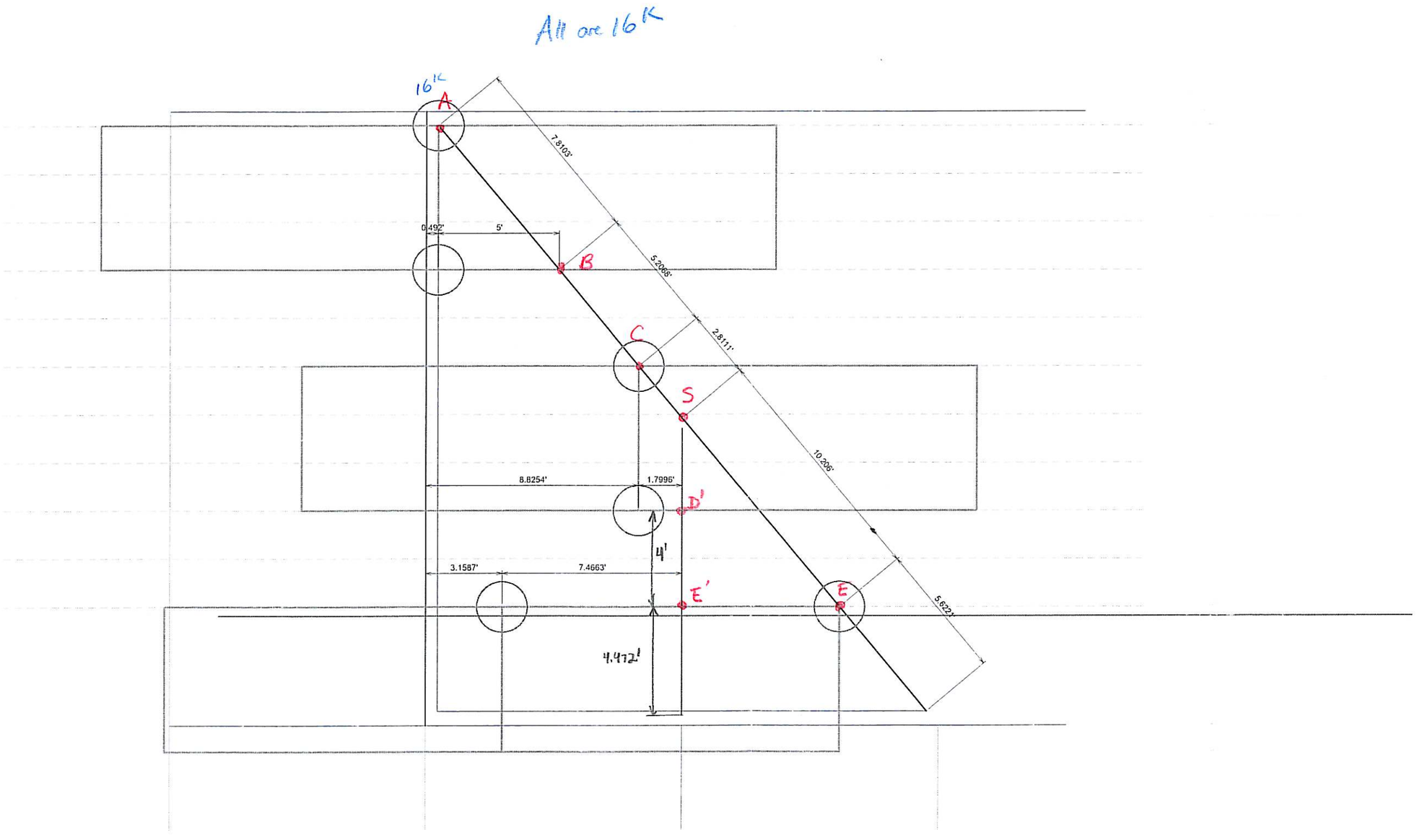



$$F_1 = V_{max} = \frac{5.6221'(16^K) + 15.8281'(11.2728^K) + 18.6391'(16^K) + 23.8459'(1.4334^K) + 31.6563'(16^K)}{31.6563'}$$

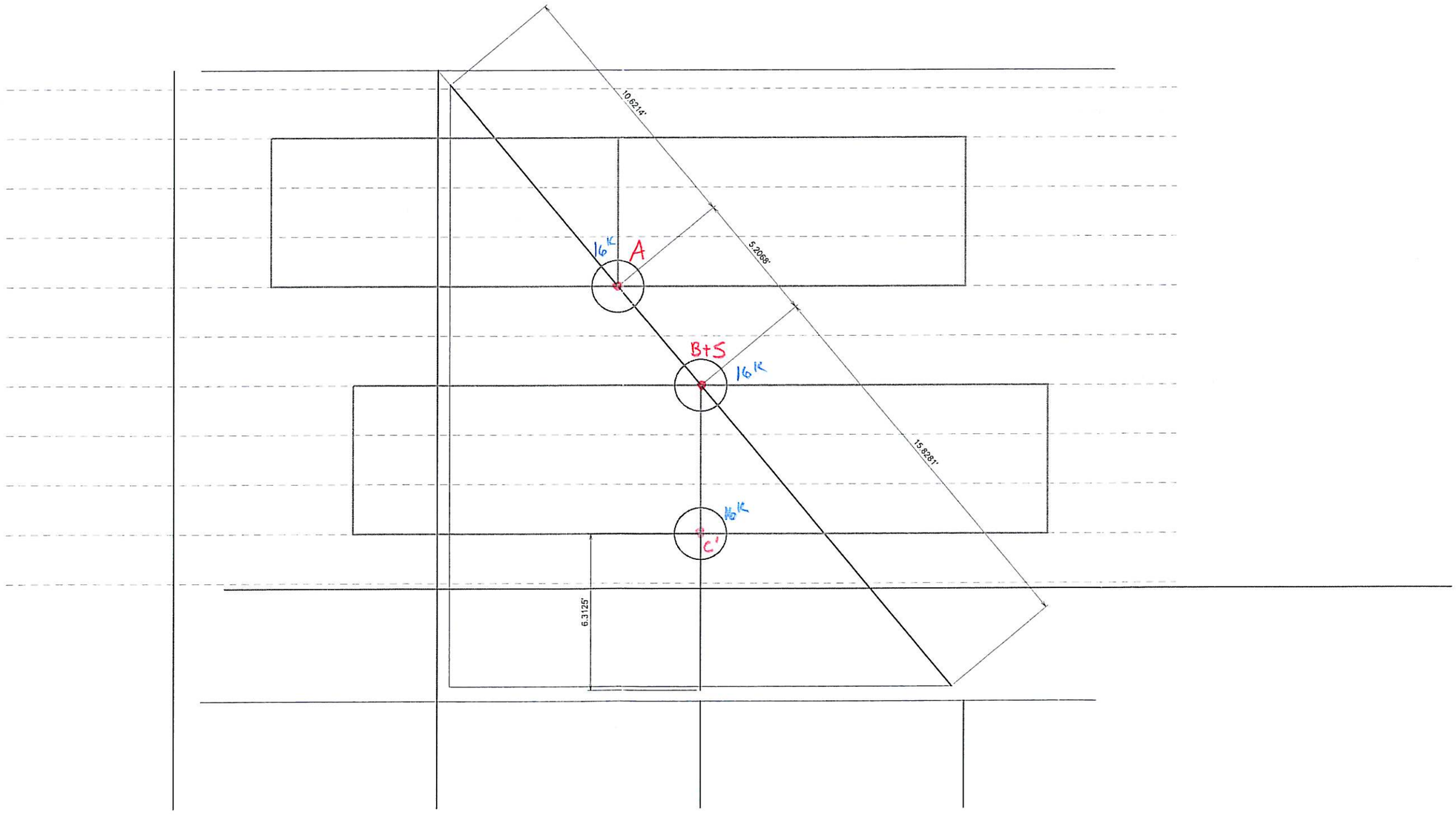
$\Rightarrow V_{max} = 34.9784^K$

Calculations for 1/8 US Grid

# HS20 SOUTH EAST
# WHEEL LINE ALIGNED WITH NORTH END FB



# HS20 SOUTH EAST
# WHEEL LINE ALIGNED WITH CENTER OF FB



## End FB's - Live Load - South FB's East

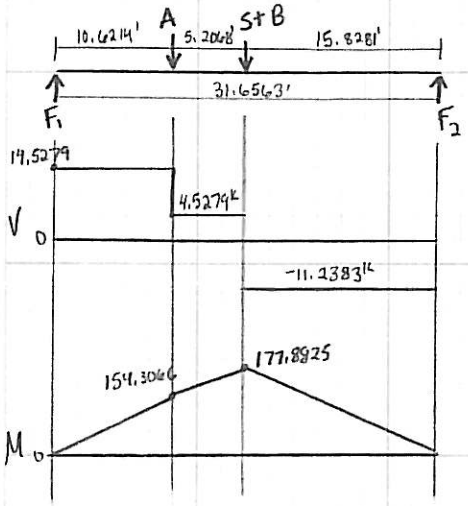
### 2FI:

**Max Moment** - see sheet 13A for geometry

$A = 10^K$

$B = C' = 10^K + 5^K\left(\frac{.625'}{10.625'}\right) = 10.2941^K$

$S = \frac{6.3125'(10.2941^K)}{11.875'} = 5.4721^K$




$F_2 = \frac{10.6214(10^K) + 15.8282'(10.2941^K + 5.4721^K)}{31.6563'}$

$F_2 = 11.2383^K$

$\therefore F_1 = 14.5279^K$

$\Rightarrow M_{max} = 177.8825\ k\text{-}Ft$

**Max Shear** - See Sheet 13B for geometry

$A = B = 10^K$

$C = 10^K\left(\frac{3.8254'}{8.8254'}\right) = 4.3345^K$

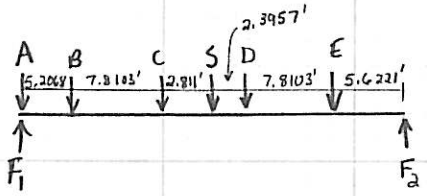
$D = 10^K$

$D' = 5^K\left(\frac{2.1587'}{10.625'}\right) = 1.0159^K$

$E = 10^K\left(\frac{1.5337'}{6.5337'}\right) = 2.3474^K$

$E' = 10^K - E + 5^K\left(\frac{2.1587'}{10.625'}\right) = 8.6685^K$

$S = \frac{4.472'E' + 10.472'D'}{11.875'} = 4.1603^K$

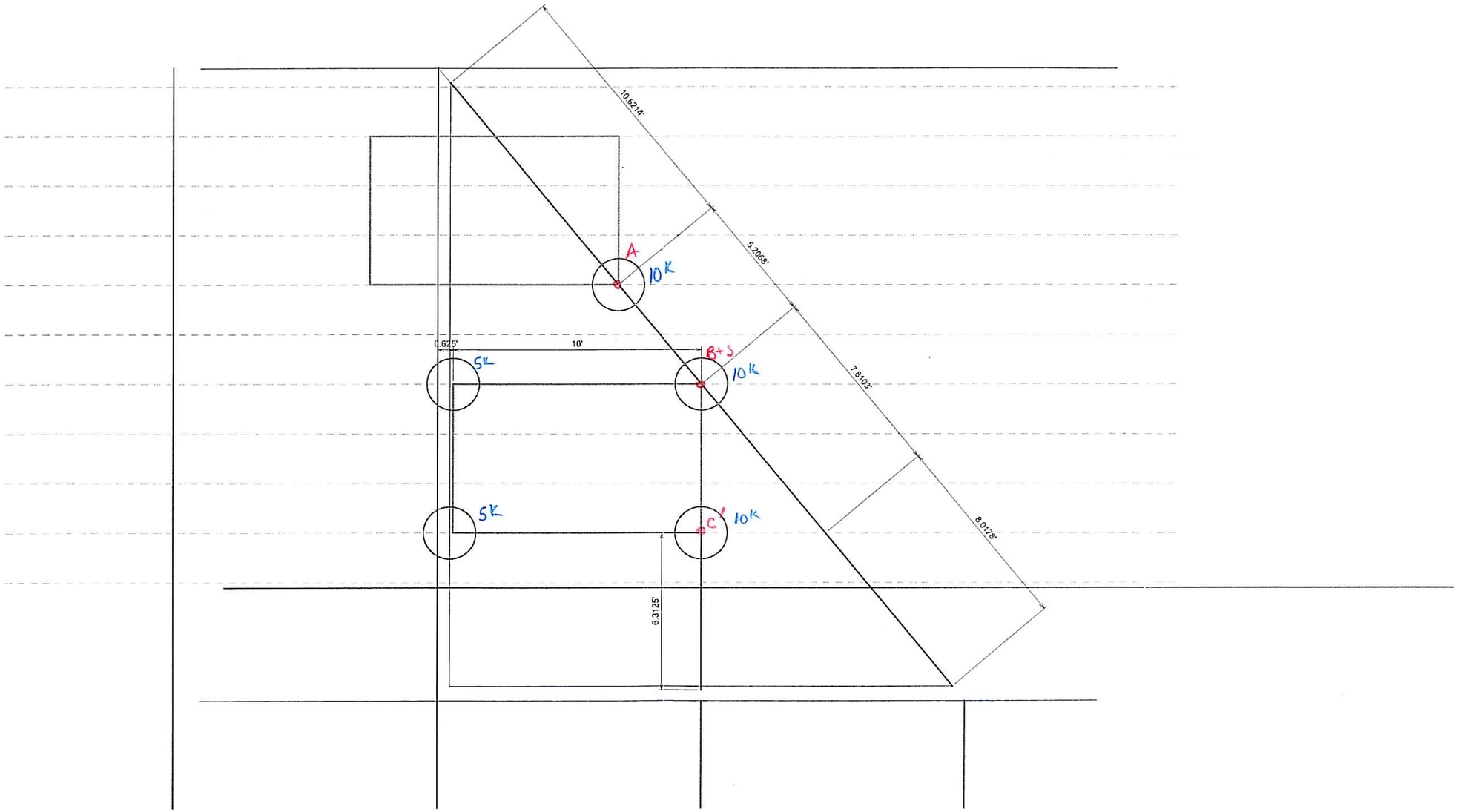



$F_1 = V_{max} = \frac{5.6221'(2.3474^K) + 13.4324'(10^K) + 15.8281'(4.1603^K) + 18.6391'(4.3345^K) + 26.4494(10^K) + 31.6563(10^K)}{31.6563'}$

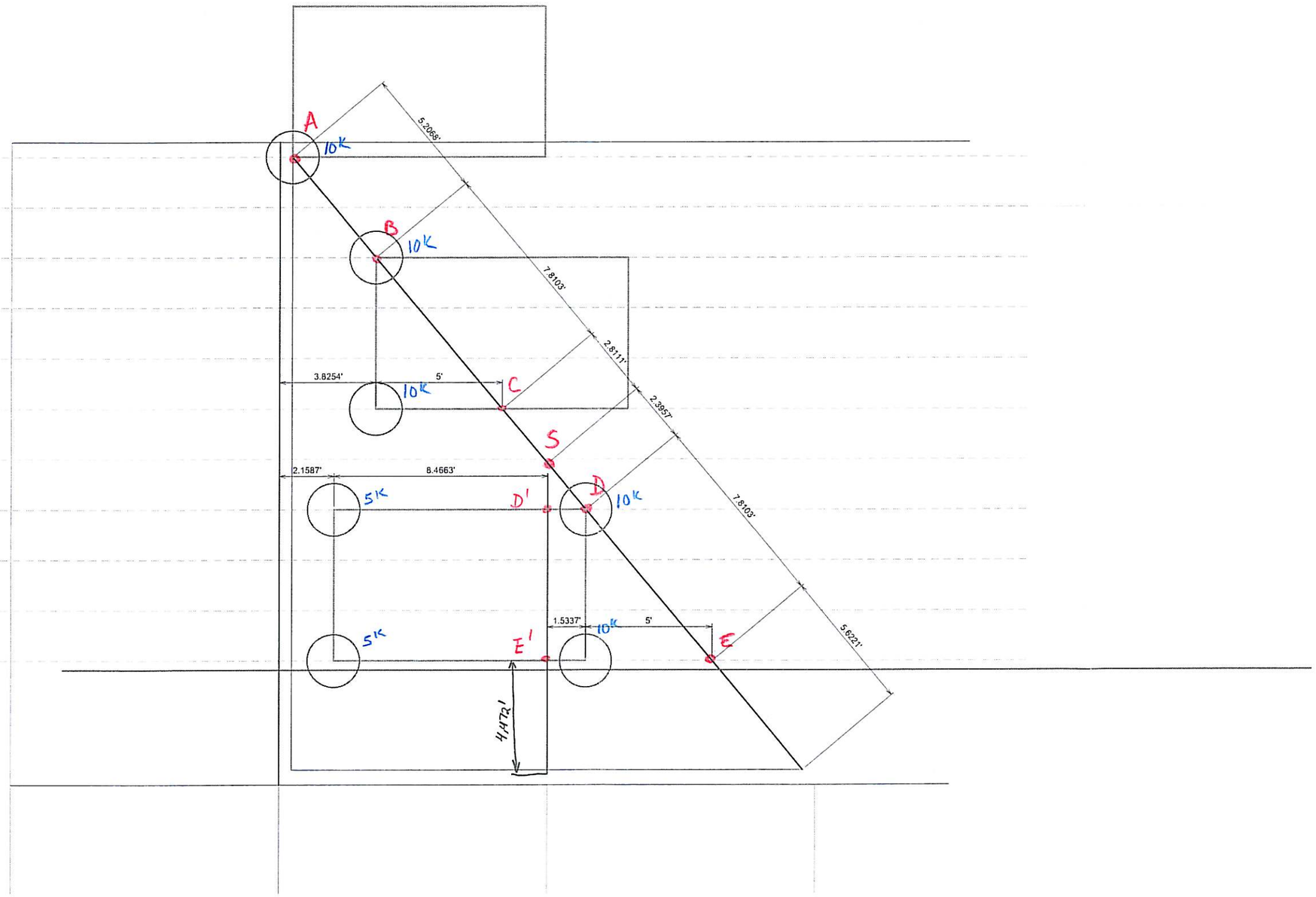
$\Rightarrow V_{max} = 27.6476^K$

Calculations for 1/8 US Grid

# 2F1 SOUTH
# WHEEL LINE ALIGNED WITH CENTER OF FB



# 2F1 SOUTH
# WHEEL LINE ALIGNED WITH NORTH END FB



# End FB's - Live Load - South FB's East

## 3FI:

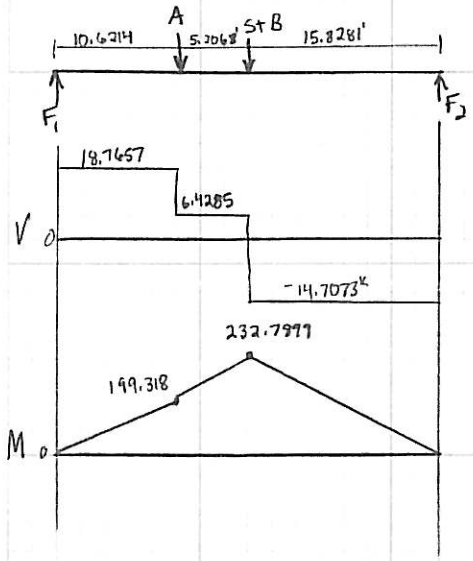
### Max Moment - see sheet 14A for geometry

$A = 8.5^K + 8.5^K \left(\frac{3.2917'}{7.2917'}\right) = 12.3372^K$

$B = 8.5^K + 8.5^K \left(\frac{6.4251'}{10.6251'}\right) = 13.8^K$

$C' = B = 13.8^K$

$S = 13.8^K \left(\frac{6.3125'}{11.875'}\right) = 7.3358^K$




$F_2 = \dfrac{10.6214\,(12.3372^K) + 15.8282'\,(7.3358^K + 13.8^K)}{31.6563'}$

$F_2 = 14.7073^K$

$F_1 = 18.7657^K$

$\Rightarrow M_{max} = 232.7899\ K\text{-}Ft$

### Max Shear - see sheet 14B for geometry

$A = B = 8.5^K$

$C = 8.5^K \left(\frac{3.8254'}{8.8254'}\right) + 8.5^K \left(\frac{7.8254'}{8.8254'}\right) = 11.2212^K$

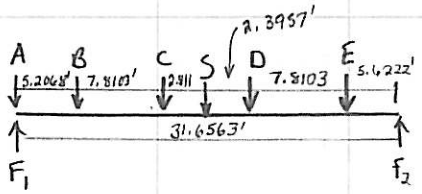
$D = 8.5^K$

$D' = 8.5^K \left(\frac{8.1587'}{10.625'}\right) = 6.5270^K$

$E = 8.5^K \left(\frac{1.5337'}{6.5337'}\right) = 1.9953^K$

$E' = 8.5^K - E + D' = 13.0317^K$

$S = \dfrac{4.472'(E') + 10.472'(D')}{11.875'} = 10.6635^K$



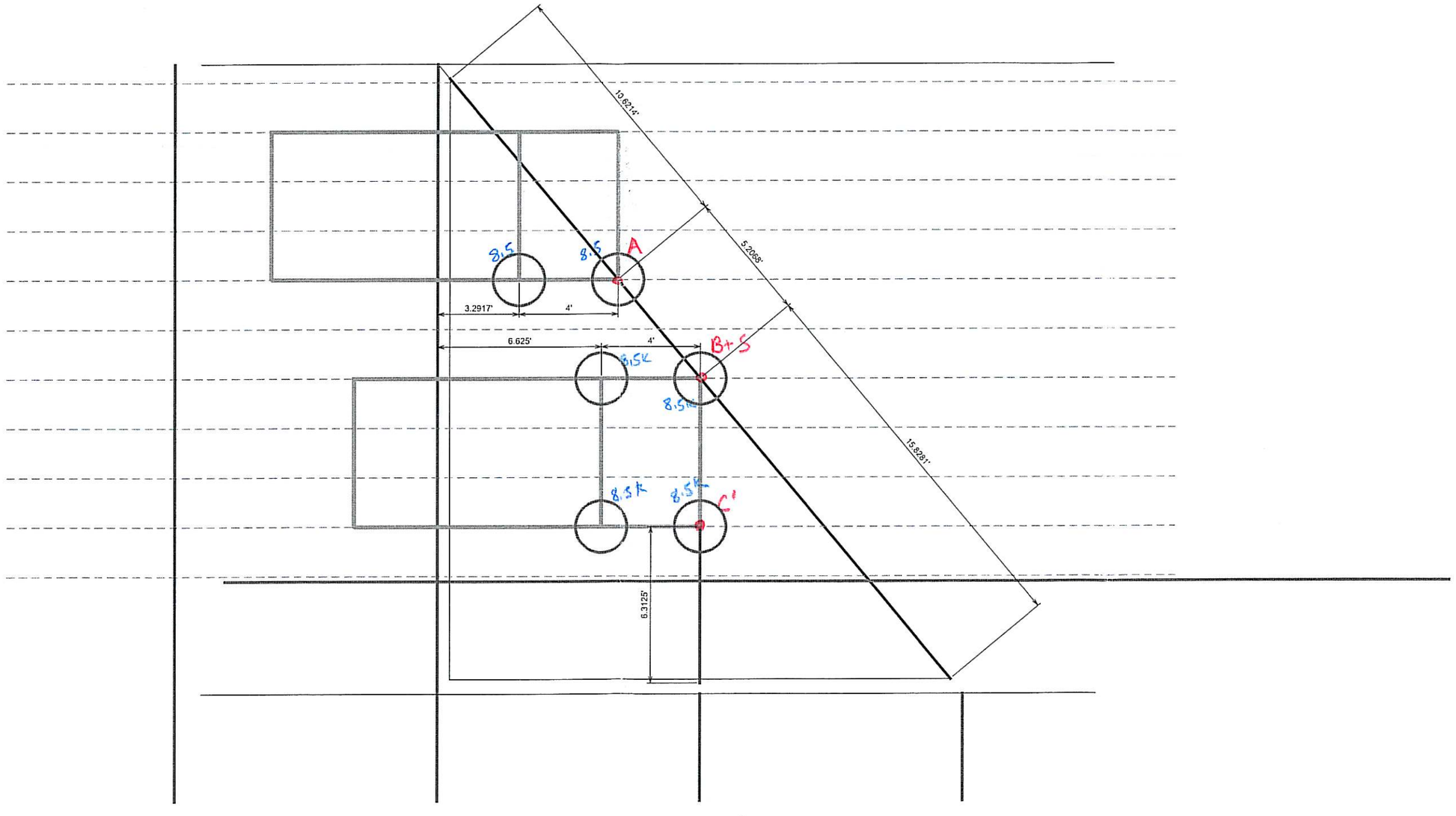

$F_1 = V_{max} = \dfrac{5.6222'(1.9953^K) + 13.4325'(8.5^K) + 15.8282'(10.6635^K) + 18.6392'(11.2212^K) + 26.4495(8.5^K) + 31.6563(8.5^K)}{31.6563'}$

$\Rightarrow V_{max} = 31.5018^K$

Calculations for 1/8 US Grid

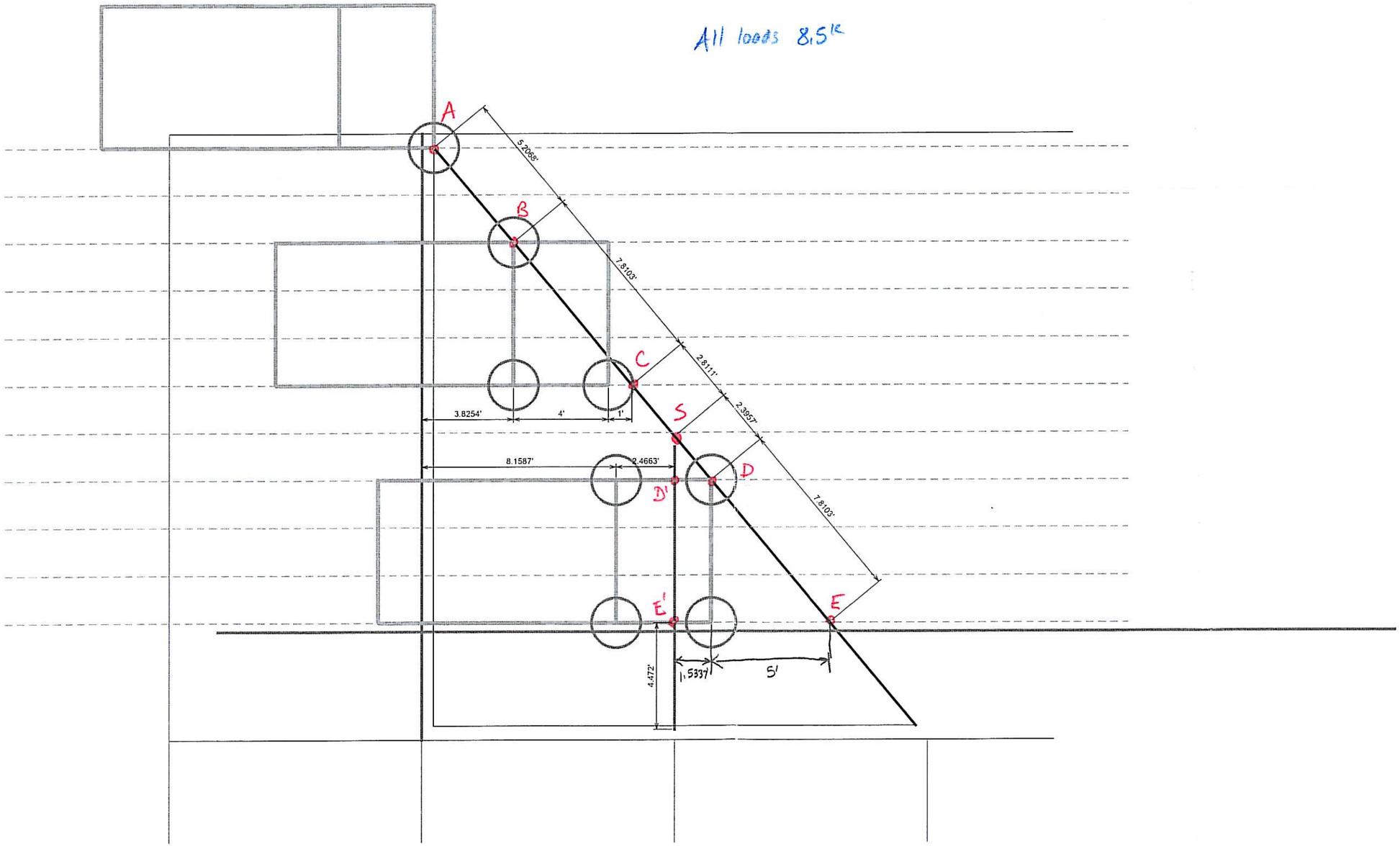
# 3F1 SOUTH

# WHEEL LINE ALIGNED WITH CENTER OF FB



# 3F1 SOUTH

# WHEEL LINE ALIGNED WITH NORTH END FB



## End FB's - Live Load - South FB's East

### 4EL:

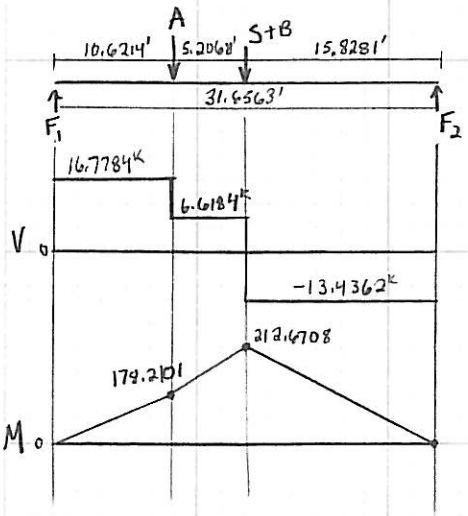
Max Moment - see sheet 15A for geometry

$A = 7^K + 7^K\left(\frac{3.2917'}{7.2917'}\right) = 10.16^K$

$B = 7^K + 7^K\left(\frac{2.1625'}{10.6251'}\right) + 7^K\left(\frac{6.6251'}{10.6251'}\right) = 13.0941^K$

$C' = B = 13.0941^K$

$S = \frac{6.3125'(13.0941^K)}{11.875'} = 6.9605^K$




$F_2 = \frac{10.6214'(10.16^K) + 15.8282'(6.9605^K + 13.0941^K)}{31.6563'}$

$F_2 = 13.4362^K$

$\therefore F_1 = 16.7784^K$

$\Rightarrow M_{max} = 212.6708\ K\text{-}Ft$

Max Shear - See Sheet 15B

$A = 7^K$

$B = 7^K$

$C = 7^K\left(\frac{3.8254'}{8.8254'}\right) + 7^K\left(\frac{7.8254'}{8.8254'}\right) = 9.241^K$

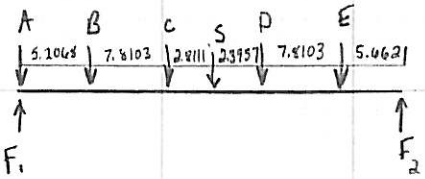
$D = 7^K$

$D' = 7^K\left(\frac{4.1587'}{10.6251'}\right) + 7^K\left(\frac{8.1587'}{10.6251'}\right) = 8.1150^K$

$E = 7^K\left(\frac{1.5337'}{6.5337'}\right) = 1.6432^K$

$E' = D' + 7^K - E = 13.4718^K$

$S = \frac{4.472'E' + 10.472'D'}{11.875'} = 12.2296^K$

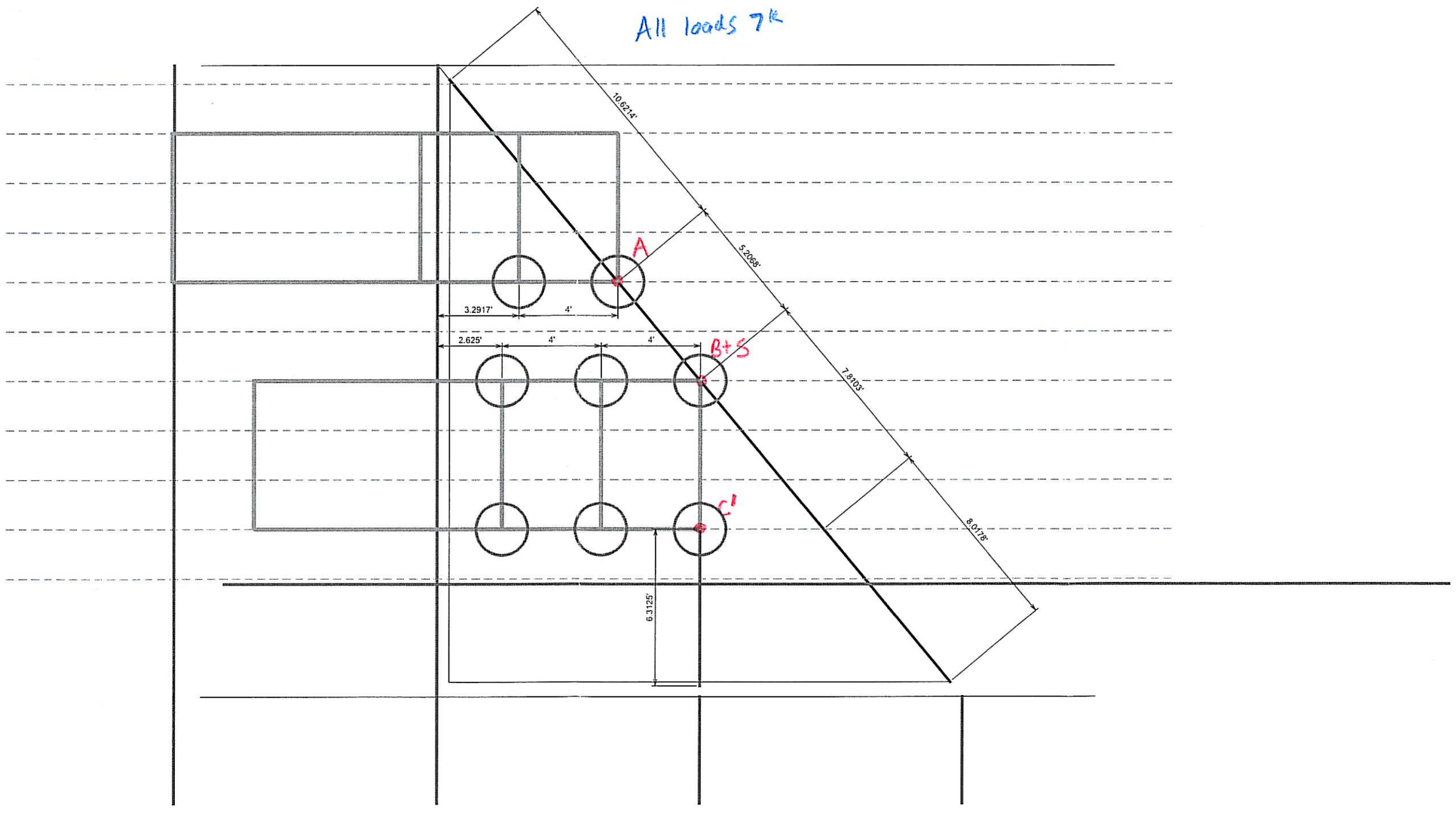



$F_1 = V_{max} = \frac{5.4621(1.6432^K) + 13.4324'(7^K) + 15.8281'(12.2296^K) + 18.6392(9.241^K) + 26.4495(7^K) + 31.6563'(7^K)}{31.6563'}$

$\Rightarrow V_{max} = 27.6687^K$

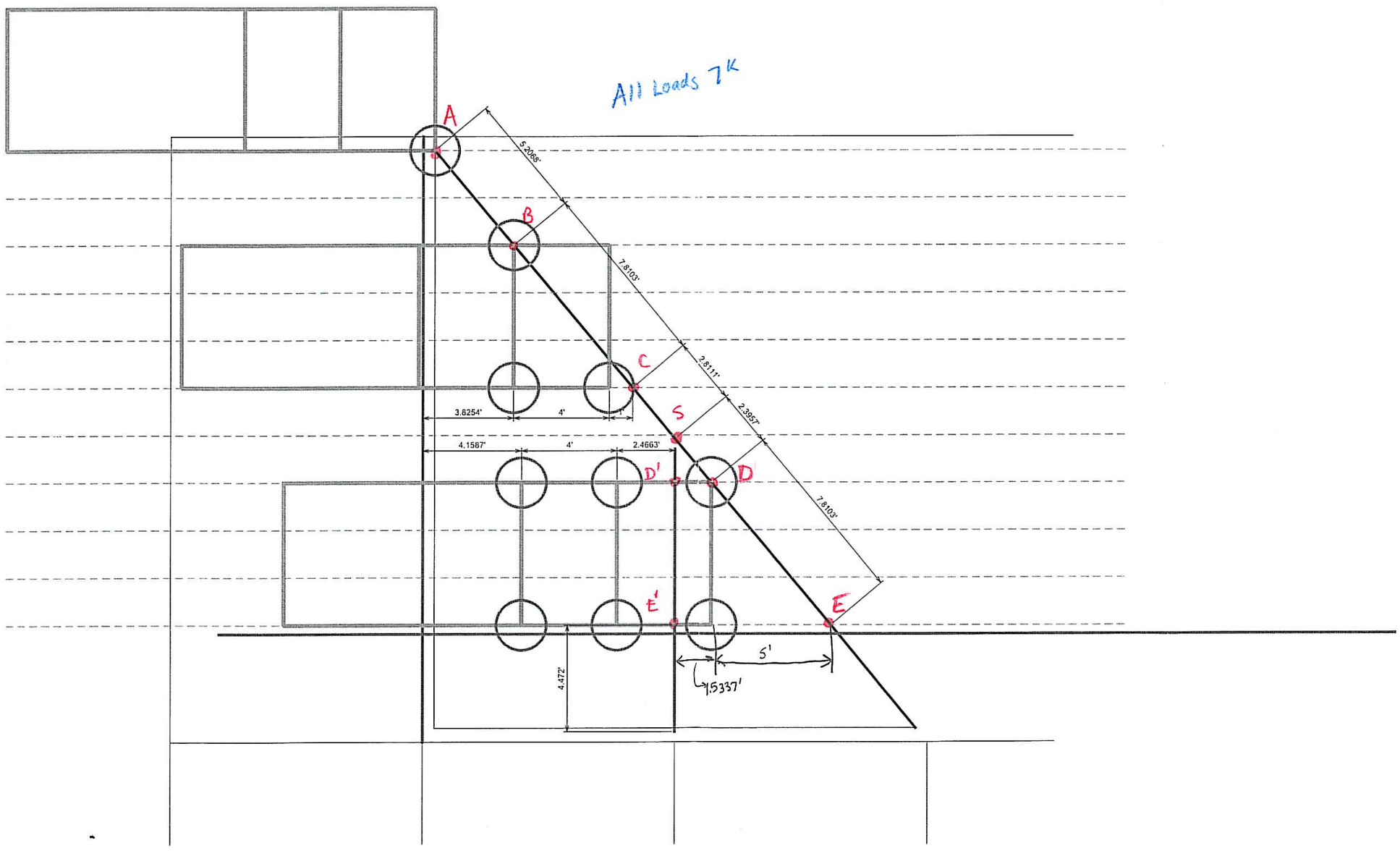
# 4F1 SOUTH

# WHEEL LINE ALIGNED WITH CENTER OF FB



# 4F1 SOUTH

# WHEEL LINE ALIGNED WITH NORTH END FB



End FB's - Live Load - South FB's "East"

SC 1:

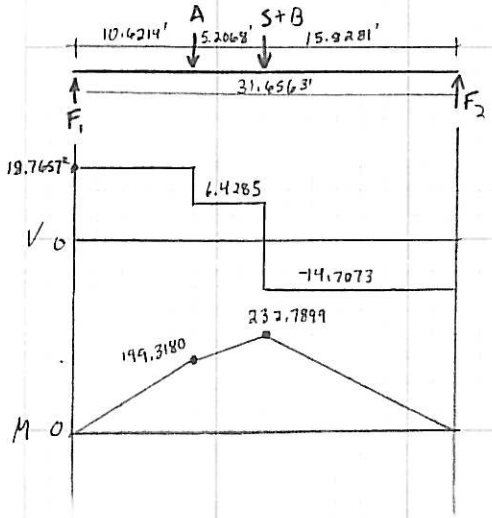
Max Moment - see sheet 16A for geometry

$A = 8.5^K + 8.5^K\left(\frac{3.2917'}{7.2917'}\right) = 12.3372^K$

$B = 8.5^K + 8.5^K\left(\frac{6.4625'}{10.4625'}\right) = 13.8^K$

$C' = B = 13.8^K$

$S = 6.3125'(C')/11.875' = 7.3358^K$




$F_2 = \frac{10.6214'(12.3372^K) + 15.8282'(13.8^K + 7.3358^K)}{31.6563'}$

$F_2 = 14.7073^K$

$\therefore F_1 = 18.7657^K$

$\Rightarrow M_{Max} = 232.7899\ K\text{-}ft$

Max Shear - see sheet 16B

$A = B = 8.5^K$

$C = 8.5\left(\frac{3.8254}{8.8254}\right) + 8.5\left(\frac{7.8254}{8.8254}\right) = 11.2212^K$

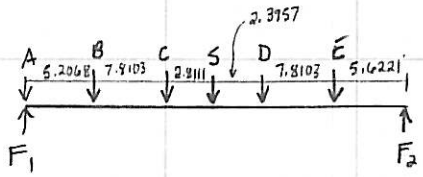
$D = 8.5^K$

$D' = 8.5^K\left(\frac{8.1587'}{10.6625'}\right) = 6.527^K$

$E = 8.5^K\left(\frac{1.5337'}{6.5337'}\right) = 1.9953^K$

$E' = 8.5^K - E + D' = 13.0317^K$

$S = \frac{4.472'E' + 10.472'D'}{11.875'} = 10.6635^K$

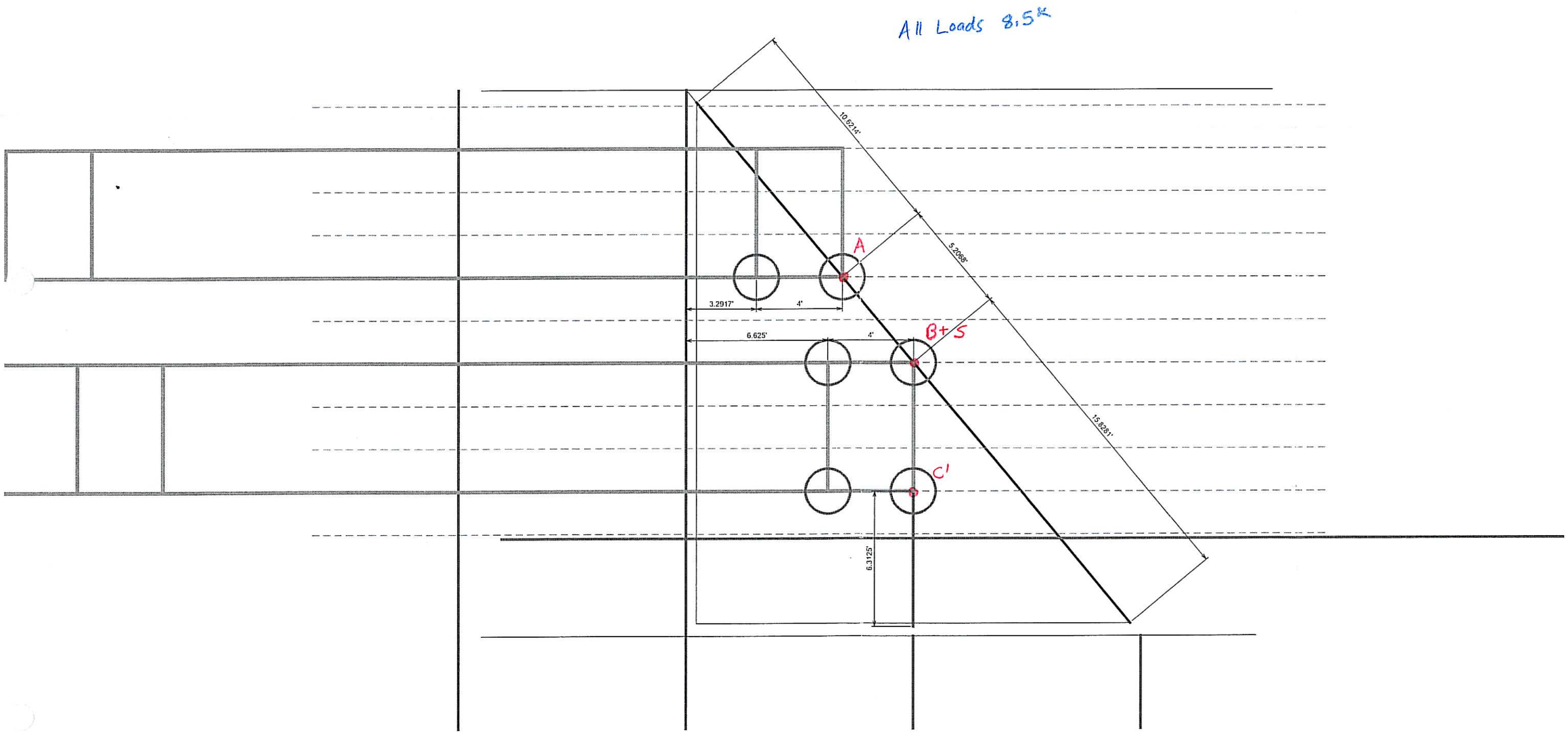



$F_1 = V_{max} = \frac{5.622'(1.9953^K) + 13.4324'(8.5^K) + 15.8281'(10.6635^K) + 18.6342(11.2212^K) + 26.4995'(8.5^K) + 31.6563'(8.5^K)}{31.6563'}$

$\Rightarrow V_{max} = 31.5018^K$

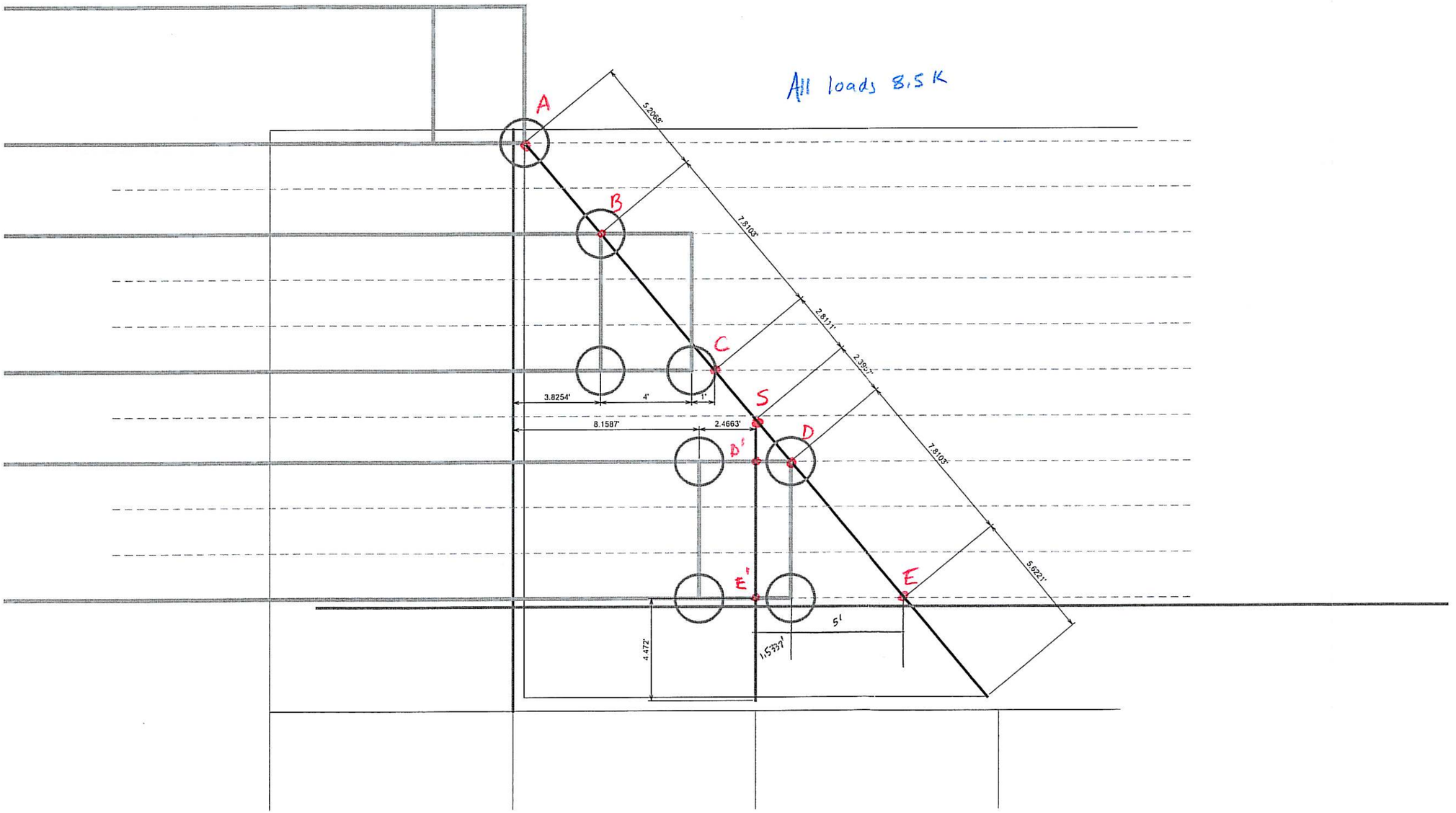
# 5C1 SOUTH

# WHEEL LINE ALIGNED WITH CENTER OF FB



# 5C1 SOUTH

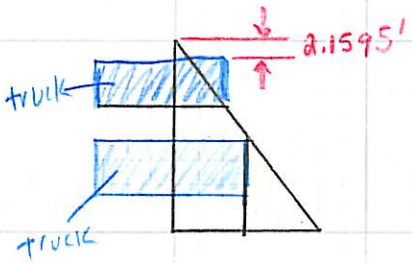
## WHEEL LINE ALIGNED WITH NORTH END FB



# End FB's - Live Load - South

All moments except 4F1 are higher on the "East" south FB's

Check if truck arrangements from "East" can fit on "west"




$2.1595' < 3.9512'$

∴ same configuration is not possible

Max Moments are different

★ Any loading on South FB's is possible on North FB's therefore supercede North Moments and Shears with South values if they are higher

# End FB's - Live Load - Summary

| | | End FB North | End FB South "West" | End FB South "East" |
|---|---|---|---|---|
| HS20 | Vmax | 39.5392 K | 39.3293 K | 34.9784 K |
| | Mmax | 326.1305 K-Ft | 235.3982 K-Ft | 278.9085 K-Ft |
| 2F1 | Vmax | 27.6476 K * | 24.8003 K | 27.6476 K |
| | Mmax | 198.4346 K-Ft | 163.8128 K-Ft | 177.8825 K-Ft |
| 3F1 | Vmax | 31.4939 K | 31.3825 K | 31.5018 K |
| | Mmax | 263.3501 K-Ft | 223.4053 K-Ft | 232.7899 K-Ft |
| 4F1 | Vmax | 30.9039 K | 30.8122 K | 27.6687 K |
| | Mmax | 244.3884 K-Ft | 238.5604 K-Ft | 212.6708 K-Ft |
| 5C1 | Vmax | 31.5018 K * | 30.3510 K | 31.5018 K |
| | Mmax | 259.8109 K Ft | 223.4053 K Ft | 232.7899 K-Ft |

* superceded by south (see sheet 17)

# End Floorbeams - Dead Loads

North + South should be similar

* See Dead Load Calc binder

## Self Weight

→ All 30WF124 → 4.5919$^{K}$ * / 31.6563' = .1451 $^{K}/_{Ft}$

## Deck

From Spreadsheet (Sht )

Load = 0.88 $^{K}/_{Ft}$

→ Total W = 1.0251 $^{K}/_{Ft}$

## Point Load From "Short FB's"

Depending on location it will be 27WF91 or 18WF50

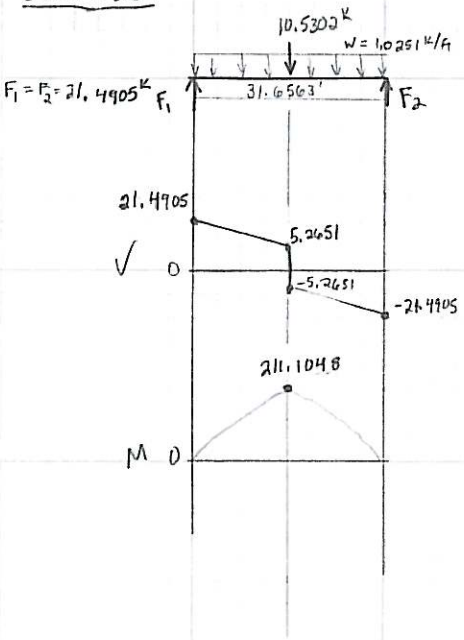
Use reactions from "Short FB" calcs

For 27WF91 → 10.5302 K

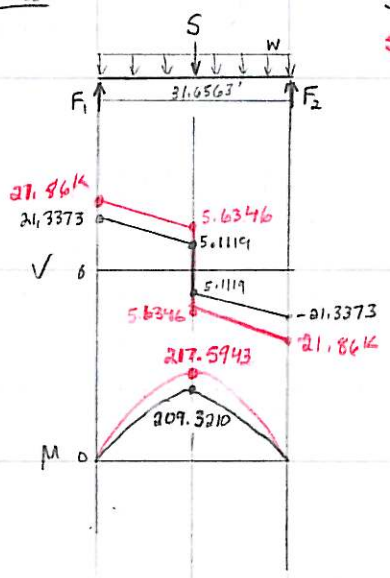
For 18 WF 50 North → 10.2238 K

For 18 WF 50 South → 11.2692 K

27WF91 Case:




18WF50 Case:




SNorth = 10.2238 K

SSouth = 11.2692 K

North F1 = F2 = 21.3373 K

South F1 = F2 = 21.8600 K

Vmax = 21.4905 K

Mmax = 211.1048 K-Ft

North: Vmax = 21.3373 K

Mmax = 209.3210 K-Ft

South: Vmax = 21.86 K

Mmax = 217.5943 K-Ft

Made By BKC Date 3/25/2009 Job No. P410070010

Checked By CJM Date 3/26/2009 Sheet No.

*Calculations For:* ***Columbis Parkway, Dead Load Calculations***

| | Uniform Floorbeam Dead Loads | | | | | |
|---|---|---|---|---|---|---|
| | Deck and Haunch | North Rail | Curb Rail | Side Walk Distribute | Light Pole Distribute | Total |
| Interior FB Spans 5-7 | 1.368 | 0.071 | 0.067 | 0.148 | 0.001 | 1.66 k/ft |
| Exterior FB Spans 5-7 | 0.737 | 0.035 | 0.034 | 0.074 | 0.001 | 0.88 k/ft |
| Interior FB Spans 7-10 | 1.368 | 0.074 | 0.067 | 0.148 | 0.001 | 1.66 k/ft |
| Exterior FB Spans 7-10 | 0.737 | 0.037 | 0.034 | 0.074 | 0.001 | 0.88 k/ft |
| Interior FB Spans 10-12 | 1.368 | 0.074 | 0.067 | 0.148 | 0.001 | 1.66 k/ft |
| Exterior FB Spans 10-12 | 0.737 | 0.037 | 0.034 | 0.074 | 0.001 | 0.88 k/ft |

600 TO 620 700 TO 720 801 TO 819
800 820 900 TO 907
621 TO 665 721 TO 765 821 TO 864
821 865 910 TO 917
666 TO 686 766 TO 786 867 TO 885
866 886 920 TO 927