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JOB STRUCTURE QUANTITIES
SHEET NO. 1 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

ITEM 202E11203 - PORTIONS OF STRUCTURES REMOVED, OVER 20' SPAN, AS PER PLAN (LS)

LUMP SUM

Calculations to establish Lump Sum

$A_{deck\_ex} := 11479.90\ ft^2 + 13530.95\ ft^2 + 81.3\ ft^2$ (Measured in CAD; Units 4BE, 3BE, 2BE respectively)

$Cost_{deck\_removal} := A_{deck\_ex} \cdot \frac{15}{ft^2} = 3.7638 \cdot 10^5$

ITEM 202E22900 - APPROACH SLAB REMOVED (SY)

$L_{ex\_as} := 25\ ft$ (From Existing Plans)

$A_{AS\_remove} := 1028\ ft^2 = 114.2222\ yd^2$ (As drawn in / estimated in OpenRoads)

ITEM 202E23500 - WEARING COURSE REMOVED (SY)

$A_{WS\_remove} := A_{AS\_remove} = 114.2222\ yd^2$

ITEM 503E11100 COFFERDAMS AND EXCAVATION BRACING (LS)

LUMP SUM

NOTE: This item has been removed. All unclassified excavation to be paid under ITEM 503E21301 Unclassified Excavation, APP

ITEM 503E21100 UNCLASSIFIED EXCAVATION (CY)

Forward Abut. BE and Wingwalls: Excavate behind abutment to footing for 2'-0" Porous Backfill.

(Volume of excavation behind abutment stem; Excludes plan area of existing wingwalls to be removed)

$A_{UE\_plan\_full\_depth} := 123\ ft^2$

(Assume depth of excavation to be average of [Top of backwall] - [approach slab thickness] - [Top of Foundation])

$h_{UE\_avg\_full\_depth} := \left(\frac{681.39\ ft + 681.06\ ft}{2}\right) - 15\ in - (669.36\ ft + 3.25\ ft) = 7.365\ ft$

$V_{UE\_Abut} := \left(A_{UE\_plan\_full\_depth} \cdot h_{UE\_avg\_full\_depth}\right) = 33.5517\ yd^3$

(Volume of excavation behind wingwalls: cantilever portion. Subtract slab depth.)

$h_{UE\_WW\_L\_avg\_cant\_depth} := \left(\frac{3.33\ ft + 5.66\ ft}{2} - 15\ in\right) = 3.245\ ft$

$h_{UE\_WW\_R\_avg\_cant\_depth} := \left(\frac{4.17\ ft + 6.85\ ft}{2} - 15\ in\right) = 4.26\ ft$

(Plan area measured behind wingwall cantilever sections in ORD. Excludes plan area of existing wingwalls to be removed.)

$A_{UE\_WW\_L\_cantilever\_back} := 10.5\ ft^2$

$A_{UE\_WW\_R\_cantilever\_back} := 10.5\ ft^2$

$V_{UE\_WW\_Cant\_back} := A_{UE\_WW\_L\_cantilever\_back} \cdot h_{UE\_WW\_L\_avg\_cant\_depth} + = 2.9186\ yd^3$
$+ A_{UE\_WW\_R\_cantilever\_back} \cdot h_{UE\_WW\_R\_avg\_cant\_depth}$

(Average height of wingwall stem minus slab)

$h_{UE\_WW\_L\_Stem} := \frac{8.9\ ft + 8.5\ ft}{2} = 8.7\ ft$

$h_{UE\_WW\_R\_Stem} := \frac{8.8\ ft + 8.8\ ft}{2} = 8.8\ ft$

(Plan area measured behind wingwall stem- Excludes existing wingwall and area already measured behind abutment stem)

$A_{UE\_WW\_L\_Stem} := 13.98\ ft^2$

$A_{UE\_WW\_R\_Stem} := 13.8\ ft^2$

$V_{UE\_WW\_stem} := A_{UE\_WW\_L\_Stem} \cdot h_{UE\_WW\_L\_Stem} + A_{UE\_WW\_R\_Stem} \cdot h_{UE\_WW\_R\_Stem} = 9.0024\ yd^3$

(Height at tip of wingwall)

$h_{UE\_WW\_L\_Tip} := 3.33\ ft$

$h_{UE\_WW\_R\_Tip} := 4.167\ ft$

(Volume of UE at wingwall tips)

$V_{UE\_WW\_Tips} := 5.5\ ft \cdot 1\ ft \cdot \left(h_{UE\_WW\_L\_Tip} + h_{UE\_WW\_R\_Tip}\right) = 1.5272\ yd^3$

(Elevation area of excavation in front of wingwall)

$A_{UE\_WW\_L\_Front} := 68.1\ ft^2$

$A_{UE\_WW\_R\_Front} := 57.4\ ft^2$

$V_{UE\_WW\_Front} := \left(A_{UE\_WW\_L\_Front} + A_{UE\_WW\_R\_Front}\right) \cdot 1\ ft = 4.6481\ yd^3$

$V_{UE\_WW} := V_{UE\_WW\_Cant\_back} + V_{UE\_WW\_stem} + V_{UE\_WW\_Tips} + V_{UE\_WW\_Front} = 18.0964\ yd^3$

Pier 11

Assuming constant width of excavation for pier wall. Measuring area of the elevation bound by the bottom and sides of the proposed wall, and the existing ground line from survey.

$A_{UE\_Wall} := 489.2\ ft^2$

$w_{UE\_Wall} := 3\ ft + 1\ ft \cdot 2 = 5\ ft$

$V_{UE\_Wall} := A_{UE\_Wall} \cdot w_{UE\_Wall} = 90.5926\ yd^3$

$V_{UE} := V_{UE\_Abut} + V_{UE\_WW} + V_{UE\_Wall} = 142.2406\ yd^3$

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JOB STRUCTURE QUANTITIES
SHEET NO. 3 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

ITEM 503E21301 UNCLASSIFIED EXCAVATION, AS PER PLAN (LS)

LUMP SUM

ITEM 509E10000 - EPOXY COATED REINFORCING STEEL (LB)

See Reinforcing Steel List (Superstructure)

$W_{reinf} := 248138\ lbf = 248138\ lbf$

ITEM 509E25000 - UNCOATED REINFORCING STEEL (LB)

See Reinforcing Steel List (All substructure)

$W_{REINF\_UNCOATED} := (4492 + 6965 + 3901)\ lbf = 15358\ lbf$

ITEM 509E30020 - NO. 4 GFRP DEFORMED BARS (FT)

$L_{gfrp\_bars} := 26083\ ft$

ITEM 510E10001 - DOWEL HOLES WITH NONSHRINK, NONMETALLIC GROUT, AS PER PLAN (EACH)

$n_{DOWEL\_WW} := 6 + 6 + 6 + 6 = 24$

$n_{ABUTMENT\_BE} := 31 \cdot 3 = 93$

$n_{DOWEL\_P11\_WALL} := 27 \cdot 2 + 4 + 4 + 15 + 4 = 81$

$n_{DOWEL\_P18} := 19 \cdot 2 = 38$

$n_{DOWEL\_P19} := 19 \cdot 2 = 38$

$n_{DOWEL\_P20\_21\_26} := 5 \cdot 2 \cdot 3 = 30$

$n_{DOWEL\_P22\_23\_25\_27} := 17 \cdot 2 \cdot 4 = 136$

$n_{DOWEL\_P24} := 20 \cdot 2 = 40$

$n_{DOWEL\_P28} := 16 \cdot 2 = 32$

$n_{DOWEL} := n_{ABUTMENT\_BE} + n_{DOWEL\_WW} + n_{DOWEL\_P11\_WALL} + n_{DOWEL\_P18} + n_{DOWEL\_P19} + n_{DOWEL\_P20\_21\_26} + n_{DOWEL\_P22\_23\_25\_27} + n_{DOWEL\_P24} + n_{DOWEL\_P28} = 512$

$n_{DOWEL} = 512$

ITEM 511E34446 - CLASS QC2 CONCRETE WITH QA/QC, BRIDGE DECK (CY)

$t_{DECK} := 8.5\ in$

$A_{DECK\_3BE} := 13246\ ft^2$ *Measured in CAD.*

$A_{DECK\_4BE} := 11202.13\ ft^2$ *Measured in CAD.*

$V_{DECK\_TYPICAL} := t_{DECK} \cdot \left(A_{DECK\_3BE} + A_{DECK\_4BE}\right) = 641.3861\ yd^3$

$A_{DECK\_2BE} := 0.973\ ft \cdot 1.833\ ft = 1.7835\ ft^2$

$L_{DECK\_2BE} := 16.333\ ft + 22\ ft = 38.333\ ft$

$V_{Deck\_2BE} := A_{DECK\_2BE} \cdot L_{DECK\_2BE} = 2.5321\ yd^3$

$V_{DECK} := V_{Deck\_2BE} + V_{DECK\_TYPICAL} = 643.9182\ yd^3$

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JOB STRUCTURE QUANTITIES
SHEET NO. 4 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

Due to complexity of varying flange widths, calculations for haunch quantities were performed in an excel spreadsheet titled "Structure Quantites Supplement". The spreadsheet references the "Geometry" spreadsheet for haunch dimensions.

$t_{flange} := \max([\,1.35\ 1.26\ 1.26\ 1.18\ 1.10\,]\ in) = 1.35\ in$

Conservatively assume largest flange thickness for overhangs.

$t_{Haunch\_beam\_G} := 4.16\ in$

$t_{Haunch\_beam\_L} := 2.95\ in$

Average value calculated in spreadsheet "Haunch Quantities", which is based on the spreadsheet "Geometry".

$A_{haunch\_beam\_G} := 1156.76\ ft^2 + 856.90\ ft^2 = 2013.66\ ft^2$

$A_{haunch\_beam\_L} := 1076.91\ ft^2 + 944.56\ ft^2 = 2021.47\ ft^2$

Plan view area from edge of deck to interior edge of beam flange, as measured in CAD.

$A_{haunch\_beam\_G\_add'l} := 638.24\ ft^2 + 452.53\ ft^2 = 1090.77\ ft^2$

$A_{haunch\_beam\_L\_add'l} := 559.07\ ft^2 + 542.86\ ft^2 = 1101.93\ ft^2$

Additional area of exterior haunch (corresponding to flange thickness). Measured in CAD.

$V_{HAUNCH\_beam\_H} := 1.28\ yd^3$

$V_{HAUNCH\_beam\_J} := 9.77\ yd^3$

$V_{HAUNCH\_beam\_K} := 9.77\ yd^3$

Interior beam volumes calculated in spreadsheet "Structure Supplemental Quantities", which is based on the spreadsheet "Geometry".

$V_{HAUNCH\_beam\_G} := A_{haunch\_beam\_G} \cdot t_{Haunch\_beam\_G} + A_{haunch\_beam\_G\_add'l} \cdot t_{flange} = 30.3993\ yd^3$

$V_{HAUNCH\_beam\_L} := A_{haunch\_beam\_L} \cdot t_{Haunch\_beam\_L} + A_{haunch\_beam\_L\_add'l} \cdot t_{flange} = 22.9967\ yd^3$

$V_{HAUNCH\_total} := V_{HAUNCH\_beam\_G} + V_{HAUNCH\_beam\_H} + V_{HAUNCH\_beam\_J} + = 74.216\ yd^3$
$+ V_{HAUNCH\_beam\_K} + V_{HAUNCH\_beam\_L}$

$V_{QC2\_Deck\_Conc} := V_{DECK} + V_{HAUNCH\_total} = 718.1343\ yd^3$

ITEM 511E344450 - CLASS QC2 CONCRETE WITH QA/QC, BRIDGE DECK (PARAPET) (CY)

$L_{trans\_deck\_L} := 14\ ft$

$L_{trans\_deck\_R} := 14\ ft$

$L_{trans\_as} := 14\ ft$

$L_{rail\_L} := (22\ ft - L_{trans\_deck\_L}) + (14\ ft + 3\ in) + 440\ ft + \quad = 830.3125\ ft$
$+ 340\ ft + (26\ ft + 2.75\ in) + (15\ ft + 10\ in - L_{trans\_as})$

$L_{rail\_R} := (15\ ft + 4\ in - L_{trans\_as}) + (14\ ft + 10\ in) + 350\ ft + \quad = 816.6667\ ft$
$+ 420\ ft + (28\ ft + 2\ in) + (16\ ft + 4\ in - L_{trans\_deck\_R})$

$L_{rail} := (L_{rail\_L} + L_{trans\_deck\_L} + L_{trans\_as}) + (L_{rail\_R} + L_{trans\_deck\_R} + L_{trans\_as}) = 1702.9792\ ft$

$A_{SBR\_1\_20} := 588.0\ in^2 = 4.0833\ ft^2$ (Area of typ. cross-section from SBR-1-20)

$A_{trans\_deck} := 4.5\ in \cdot 1.667\ ft + 10\ in \cdot \left(\frac{1.667\ ft + 13\ in}{2} \right) + 2.417\ ft \cdot \left(\frac{13\ in + 10\ in}{2} \right) = 588.584\ in^2$

$V_{trans\_as} := 1.82\ yd^3$ (volume of end transition section from SBR-1-20 on Approach Slab)

$V_{trans\_deck} := L_{trans\_deck\_L} \cdot \left(\frac{A_{trans\_deck} + A_{SBR\_1\_20}}{2} \right) = 2.1183\ yd^3$

$V_{par} := \left(A_{SBR\_1\_20} \cdot \left(L_{rail\_L} + L_{rail\_R} \right) + 2 \cdot V_{trans\_as} + 2 \cdot V_{trans\_deck} \right) = 256.9569\ yd^3$

Additional amount of concrete from Wrong Way Detection Supports:

NOTE: ADDITIONAL CONCRETE FOR WRONG WAY DETECTION SUPPORTS CHECKED BY JPR 7/12/24

$A_{WWDS\_parapet} := 1.75\ ft \cdot \left(\frac{4.333\ ft + 1.5\ ft}{2} \right) = 5.1039\ ft^2$

$A_{WWDS\_Deck} := 1.75\ ft \cdot \left(\frac{4.492\ ft + 1.654\ ft}{2} \right) = 5.3778\ ft^2$

$t_{WWDS\_parapet} := 3.5\ ft$

$t_{WWDS\_Deck} := 0.985\ ft$

$V_{WWDS} := A_{WWDS\_parapet} \cdot t_{WWDS\_parapet} + A_{WWDS\_Deck} \cdot t_{WWDS\_Deck} = 0.8578\ yd^3$

$V_{QC2\_par} := V_{par} + V_{WWDS} \cdot 4 = 260.3881\ yd^3$

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JOB STRUCTURE QUANTITIES
SHEET NO. 6 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

ITEM 511E40512 - CLASS QC1 CONCRETE WITH QC/QA, PIER ABOVE FOOTINGS (CY)

Pier 11 Web Wall

$t_{web\_wall} := 3\ ft$

$t_{web\_wall\_wide} := 6\ ft$

$h_{web\_wall\_wide} := 6\ in$

$t_{web\_wall\_fillet} := 1.5\ ft$

$L_{web\_wall\_fillet} := 55.34\ ft$

$A_{web\_wall} := 1154.55\ ft^2$

$A_{fillet} := \frac{1}{2} \cdot \left(\left(h_{web\_wall\_wide} + t_{web\_wall\_fillet} \right) + h_{web\_wall\_wide} \right) \cdot t_{web\_wall\_fillet} = 1.875\ ft^2$

$V_{web\_wall} := A_{web\_wall} \cdot t_{web\_wall} = 128.2833\ yd^3$

$V_{web\_wall\_fillet} := A_{fillet} \cdot L_{web\_wall\_fillet} = 3.8431\ yd^3$

$V_{pier\_11\_web\_wall} := V_{web\_wall} + 2 \cdot V_{web\_wall\_fillet} = 135.9694\ yd^3$

$V_{pier\_11\_web\_wall} = 135.9694\ yd^3$

ITEM 511E42513 - CLASS QC1 CONCRETE WITH QC/QA, PIER CAP, AS PER PLAN (CY)

Calculations for pier cap elevation areas can be found in spreadsheet "Structure Supplemental Quantities".

$w_{pier} := 4\ ft$

$A_{pier\_18BE} := 28.36\ ft^2$

$A_{pier\_19BE} := 36.0\ ft^2$ *Includes new light pole pilaster on Pier 19BE.*

$A_{pier\_20BE} := 12.13\ ft^2$

$A_{pier\_21BE} := 11.20\ ft^2$

$A_{pier\_22BE} := 23.17\ ft^2$

$A_{pier\_23BE} := 23.65\ ft^2$

$A_{pier\_24BE} := 26.14\ ft^2$

$A_{pier\_25BE} := 23.42\ ft^2$

$A_{pier\_26BE} := 10.50\ ft^2$

$A_{pier\_27BE} := 22.90\ ft^2$

$A_{pier\_28BE} := 24.92\ ft^2$

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JOB STRUCTURE QUANTITIES

SHEET NO. 7 OF 18

CALCULATED BY AJL DATE July 15, 2024

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PROJECT NO. CUY-176-13.34

(Assume contractor pours concrete for 1 pier at a time - round up volume to whole cu. yd. on each pier. SMath does not have a "roundup" command, truncate decimal volume and add 1 to round up.)

$$V_{pier\_18} := \text{trunc}\left(\frac{w_{pier} \cdot A_{pier\_18BE}}{yd^3}\right) yd^3 + 1\ yd^3 = 5\ yd^3$$

$$V_{pier\_19} := \text{trunc}\left(\frac{w_{pier} \cdot A_{pier\_19BE}}{yd^3}\right) yd^3 + 1\ yd^3 = 6\ yd^3$$

$$V_{pier\_20} := \text{trunc}\left(\frac{w_{pier} \cdot A_{pier\_20BE}}{yd^3}\right) yd^3 + 1\ yd^3 = 2\ yd^3$$

$$V_{pier\_21} := \text{trunc}\left(\frac{w_{pier} \cdot A_{pier\_21BE}}{yd^3}\right) yd^3 + 1\ yd^3 = 2\ yd^3$$

$$V_{pier\_22} := \text{trunc}\left(\frac{w_{pier} \cdot A_{pier\_22BE}}{yd^3}\right) yd^3 + 1\ yd^3 = 4\ yd^3$$

$$V_{pier\_23} := \text{trunc}\left(\frac{w_{pier} \cdot A_{pier\_23BE}}{yd^3}\right) yd^3 + 1\ yd^3 = 4\ yd^3$$

$$V_{pier\_24} := \text{trunc}\left(\frac{w_{pier} \cdot A_{pier\_24BE}}{yd^3}\right) yd^3 + 1\ yd^3 = 4\ yd^3$$

$$V_{pier\_25} := \text{trunc}\left(\frac{w_{pier} \cdot A_{pier\_25BE}}{yd^3}\right) yd^3 + 1\ yd^3 = 4\ yd^3$$

$$V_{pier\_26} := \text{trunc}\left(\frac{w_{pier} \cdot A_{pier\_26BE}}{yd^3}\right) yd^3 + 1\ yd^3 = 2\ yd^3$$

$$V_{pier\_27} := \text{trunc}\left(\frac{w_{pier} \cdot A_{pier\_27BE}}{yd^3}\right) yd^3 + 1\ yd^3 = 4\ yd^3$$

$$V_{pier\_28} := \text{trunc}\left(\frac{w_{pier} \cdot A_{pier\_28BE}}{yd^3}\right) yd^3 + 1\ yd^3 = 4\ yd^3$$

$$V_{pier\_caps} := V_{pier\_18} + V_{pier\_19} + V_{pier\_20} + V_{pier\_21} + V_{pier\_22} + V_{pier\_23} + V_{pier\_24} + V_{pier\_25} + V_{pier\_26} + V_{pier\_27} + V_{pier\_28} = 41\ yd^3$$

$$V_{pier\_caps} = 41\ yd^3$$

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JOB STRUCTURE QUANTITIES
SHEET NO. 8 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

ITEM 511E45712 - CLASS QC1 CONCRETE WITH QC/QA, ABUTMENT (CY)

- Covers replacement of portion of backwall to facilitate joint replacement, pedestal for bearing replacement and seismic pedestal

$A_{backwall} := 226\ ft^2$

$w_{backwall} := 1.75\ ft$

$V_{backwall} := A_{backwall} \cdot w_{backwall} = 14.6481\ yd^3$

$A_{backwall\_AS\_notch} := 65.175\ ft^2$

$w_{backwall\_AS\_notch} := 1.25\ ft$

$V_{backwall\_AS\_notch} := A_{backwall\_AS\_notch} \cdot w_{backwall\_AS\_notch} = 3.0174\ yd^3$

$A_{abut\_seat\_cap} := 30.9\ ft^2$

$w_{cap} := 2\ ft$

$V_{abut\_seat} := A_{abut\_seat\_cap} \cdot w_{cap} = 2.2889\ yd^3$

$A_{abut\_seis} := 4.857\ ft^2$

$w_{abut\_seis} := 2\ ft$

$V_{abut\_seis} := A_{abut\_seis} \cdot w_{abut\_seis} - 8\ ft \cdot 3\ in \cdot 1\ ft = 0.2857\ yd^3$

$A_{wing\_left} := 99.06\ ft^2$

$A_{wing\_right} := 105.78\ ft^2$

$w_{wing} := 1.5\ ft$

$V_{wings} := w_{wing} \cdot \left(A_{wing\_left} + A_{wing\_right}\right) = 11.38\ yd^3$

$V_{QC1\_abut} := V_{backwall} - V_{abut\_seat} + V_{abut\_seis} + V_{wings} + V_{backwall\_AS\_notch} = 27.0423\ yd^3$

ITEM 512E10100 - SEALING OF CONCRETE SURFACES (EPOXY-URETHANE) (SY)

Deck:

$P_{par} := \left(\sqrt{8^2 + 42^2}\right) in + 10\ in + 42\ in = 7.8963\ ft$

$P_{par\_deck} := P_{par} + t_{DECK} + \left(\frac{t_{Haunch\_beam\_G} + t_{Haunch\_beam\_L}}{2}\right) + 6\ in = 9.4008\ ft$

$A_{seal\_deck} := P_{par\_deck} \cdot \left(L_{rail\_L} + L_{rail\_R} + L_{trans\_deck\_L} + L_{trans\_deck\_R} + 2 \cdot L_{trans\_as}\right) = 1778.8267\ yd^2$

Palmer ENGINEERING
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JOB STRUCTURE QUANTITIES
SHEET NO. 9 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

Pier Patching:

From "Patching" spreadsheet (Not including areas of fiber wrap)

$A_{pier\_patching} := 981\ ft^2 = 109\ yd^2$

$A_{deck\_patching} := 150\ yd^2 + 15\ yd^2 + 50\ yd^2 + 10\ yd^2 = 225\ yd^2$

$A_{patching} := A_{pier\_patching} + A_{deck\_patching} = 334\ yd^2$

Pier Caps:

From "Structure Supplemental Quantities" spreadsheet (Not including areas of fiber wrap)

$A_{piers} := 612.69\ ft^2 = 68.0767\ yd^2$

Pier 11 Web Wall

(Assumes proposed ground line at existing ground line)

$A_{seal\_P11\_wall} := \left(566.07\ ft^2 + \left(\left(\sqrt{2}\cdot t_{web\_wall\_fillet} + h_{web\_wall\_wide}\right)\cdot L_{web\_wall\_fillet}\right)\right)\cdot 2 = 158.0297\ yd^2$

$A_{seal\_piers} := A_{piers} + A_{seal\_P11\_wall} = 226.1064\ yd^2$

Abutment:

$L_{abut\_seat\_perimeter} := 44.57\ ft$

$A_{seal\_seat} := L_{abut\_seat\_perimeter}\cdot 2\ ft = 89.14\ ft^2$

$A_{seal\_backwall} := 165.46\ ft^2$

$A_{seal\_abut\_face} := 67.97\ ft^2 + (2.04\ ft\cdot 1.075\ ft) + 2.01\ ft\cdot 1.904\ ft = 73.99\ ft^2$

$A_{seal\_ww} := 33.18\ ft^2 + 15.27\ ft\cdot 1.5\ ft + 4.66\ ft\cdot 1.5\ ft + \ldots = 146.472\ ft^2$
$\ldots + 15\ ft\cdot 1.5\ ft + 5.838\ ft\cdot 1.5\ ft + 1.0\ ft\cdot 1.5\ ft + 50.64\ ft^2$

$A_{abut} := A_{seal\_seat} + A_{seal\_backwall} + A_{seal\_abut\_face} + A_{seal\_ww} = 52.7847\ yd^2$

$A_{sealing} := A_{seal\_deck} + A_{patching} + A_{seal\_piers} + A_{abut} = 2391.7177\ yd^2$

ITEM 512E10600 - CONCRETE REPAIR BY EPOXY INJECTION (FT)

$L_{EPOXY\_INJ} := 9\ ft$

ITEM 512E33000 - TYPE 2 WATERPROOFING (SY)

$A_{TYPE2} := (43.9\ ft + (7.25 - 1.75)\ ft + (10.6 - 1.75)\ ft)\cdot 3\ ft = 19.4167\ yd^2$

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JOB STRUCTURE QUANTITIES
SHEET NO. 10 OF 18
CALCULATED BY AJL DATE July 15, 2024
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PROJECT NO. CUY-176-13.34

ITEM 512E71500 - SPECIAL - URETHANE TOP COAT SEALER (SY)

$A_{TOP\_COAT\_P13} := (7 \cdot 2 + 6)\ ft \cdot (22 + .5 - 6)\ ft + (3 \cdot 2 + \pi \cdot 3)\ ft \cdot (7 + .5 \cdot 2)\ ft = 453.3982\ ft^2$

$A_{TOP\_COAT\_P17} := \pi \cdot 6\ ft \cdot (13 + 1)\ ft = 263.8938\ ft^2$

$A_{TOP\_COAT\_1} := A_{TOP\_COAT\_P13} + A_{TOP\_COAT\_P17} = 79.6991\ yd^2$

Ramp J-14 Pier Retrofits (Lengths taken from OpenRoads (SI002.dgn) based on existing ground elevations. Conservatively assume longest length of exposed concrete columns at each pier.)

$L_{18BE} := 37.620\ ft$

$L_{20BE} := 42.941\ ft$

$L_{21BE} := 47.290\ ft$

$L_{24BE} := 34.210\ ft$

$L_{26BE} := 15.510\ ft$

$L_{RAMP\_Piers} := \left(L_{18BE} + L_{20BE} + L_{21BE} + L_{24BE} + L_{26BE}\right) \cdot 2 = 355.142\ ft$

$C_{RAMP\_PIERS} := \pi \cdot 4\ ft = 12.5664\ ft$

$A_{TOP\_COAT\_2} := L_{RAMP\_Piers} \cdot C_{RAMP\_PIERS} = 495.8718\ yd^2$

$A_{URETHANE} := A_{TOP\_COAT\_1} + A_{TOP\_COAT\_2} = 575.5709\ yd^2$

ITEM 512E74000 - REMOVAL OF EXISTING COATINGS FROM CONCRETE SURFACES (SY)

(Forward Abutment)

$A_{remove\_seal} := 33.8\ ft^2 + .35\ ft \cdot 2.044\ ft + 1.2\ ft \cdot 1.090\ ft = 35.8234\ ft^2$

$A_{remove\_seal} = 3.9804\ yd^2$

IEM 513E102001 - STRUCTURAL STEEL MEMBERS, LEVEL UF, AS PER PLAN (LB)

$W_{steel} := 490\ \frac{lbf}{ft^3}$

$V_{cf\_A} := 2.40\ in^2 \cdot (8.5\ ft) = 0.1417\ ft^3$

$V_{cf\_B} := 2.40\ in^2 \cdot ((8\ ft + 8.875\ in) + 5\ ft) = 0.229\ ft^3$

$P_{steel\_UF} := \left(V_{cf\_A} \cdot 3 + V_{cf\_B}\right) \cdot W_{steel} = 320.4566\ lbf$

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JOB STRUCTURE QUANTITIES
SHEET NO. 11 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

ITEM 513E20000 - WELDED STUD SHEAR CONNECTORS (EACH)

$N_{studs} := 3$

$N_{studs\_G\_3BE} := 61+12+18+40+26+10+15+13+20+33+10+13+53+43+36+51+10+13+88 = 565$
$N_{studs\_J\_3BE} := 61+12+18+39+26+10+14+13+20+33+10+12+53+43+36+51+10+13+88 = 562$
$N_{studs\_K\_3BE} := 61+12+18+38+26+10+14+13+20+33+10+11+53+43+36+51+10+13+88 = 560$
$N_{studs\_L\_3BE} := 61+12+18+37+26+10+14+13+20+33+10+10+53+43+36+51+10+13+88 = 558$

$N_{studs\_G\_4BE} := 11+23+35+23+19+21+35+57+41+61+28+04+16+31+40 = 445$
$N_{studs\_J\_4BE} := 11+23+35+23+19+21+35+57+41+61+28+04+16+32+38 = 444$
$N_{studs\_K\_4BE} := 11+23+35+23+19+21+35+57+41+61+28+04+16+32+38 = 444$
$N_{studs\_L\_4BE} := 11+23+35+23+19+21+35+57+41+61+28+04+16+32+38 = 444$

$N_{studs\_H\_4BE} := 10+26+09+12+51 = 108$

$N_{studs\_G} := \left(N_{studs\_G\_3BE}+N_{studs\_G\_4BE}\right)\cdot N_{studs} = 3030$
$N_{studs\_J} := \left(N_{studs\_J\_3BE}+N_{studs\_J\_4BE}\right)\cdot N_{studs} = 3018$
$N_{studs\_K} := \left(N_{studs\_K\_3BE}+N_{studs\_K\_4BE}\right)\cdot N_{studs} = 3012$
$N_{studs\_L} := \left(N_{studs\_L\_3BE}+N_{studs\_L\_4BE}\right)\cdot N_{studs} = 3006$
$N_{studs\_H} := \left(N_{studs\_H\_4BE}\right)\cdot N_{studs} = 324$

$N_{SHEAR\_STUDS} := N_{studs\_G}+N_{studs\_H}+N_{studs\_J}+N_{studs\_K}+N_{studs\_L} = 12390$

$\boxed{N_{SHEAR\_STUDS} = 12390}$

IEM 513E90000 - STRUCTURAL STEEL, MISC.: LATERAL RESTRAINT BLOCKS (LB)

$V_{RESTR.\_PLATES} := (12\cdot 20\cdot 0.5)\,in^3+(12\cdot 14.5\cdot 0.5)\,in^3+\left(\frac{1}{2}\cdot(20-.5)\cdot 14.5\cdot 0.75\right)in^3\cdot 2 = 0.2425\,ft^3$

$L_{RESTR.\_BOLT} := .576\,in+.5\,in+.177\,in+1.25\,in = 2.503\,in$

$P_{RESTR.\_BOLTS} := 6\cdot 2\cdot 2\cdot\frac{130}{100}\,lbf = 31.2\,lbf$

$W_{STEEL} := 490\,\frac{lbf}{ft^3}$

$N_{RESTR.\_LOCATIONS} := 2$

$P_{RESTR.\_BLOCK} := V_{RESTR.\_PLATES}\cdot 2\cdot N_{RESTR.\_LOCATIONS}\cdot W_{STEEL} += 537.7255\,lbf$
$+P_{RESTR.\_BOLTS}\cdot N_{RESTR.\_LOCATIONS}$

$\boxed{P_{RESTR.\_BLOCK} = 537.7255\,lbf}$

IEM 513E90030 - STRUCTURAL STEEL, MISC.: CABLE RESTRAINERS (EACH)

$\boxed{N_{CABLE} := 4\cdot 2 = 8}$

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JOB STRUCTURE QUANTITIES
SHEET NO. 12 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

ITEM 514E00050 - SURFACE PREPARATION OF EXISTING STRUCTURAL STEEL (SF)

Following ODOT CMS method of measurement for painted areas.

Nominal measurement of beams (2 x beam depth + 3 x flange width) (dimensions from AISC Shapes Database):

$L_{p\_36WF230} := 2 \cdot 35.88\ in + 3 \cdot 16.471\ in = 10.0978\ ft$

$L_{p\_36WF245} := 2 \cdot 36.06\ in + 3 \cdot 16.512\ in = 10.138\ ft$

Nominal measurement of beams at hinge:

$L_{p\_36WF230\_hinge} := 2 \cdot 12\ in + 2 \cdot 16.471\ in = 4.7452\ ft$

$L_{p\_36WF245\_hinge} := 2 \cdot 12\ in + 2 \cdot 16.512\ in = 4.752\ ft$

$L_{paint\_hinge} := 1\ ft + 2.25\ in$

$L_{paint\_36WF230} := 10\ ft - L_{paint\_hinge} = 8.8125\ ft$

$L_{paint\_36WF245} := 10\ ft - L_{paint\_hinge} = 8.8125\ ft$

$A_{paint\_beams} := L_{p\_36WF230} \cdot L_{paint\_36WF230} + L_{p\_36WF245} \cdot L_{paint\_36WF245} + L_{p\_36WF230\_hinge} \cdot L_{paint\_hinge} + L_{p\_36WF245\_hinge} \cdot L_{paint\_hinge} = 189.6054\ ft^2$

$A_{paint\_nom} := A_{paint\_beams} \cdot 4 = 758.4217\ ft^2$

Area of incidental items (i.e. stiffeners, cross frames, 12WF45) used to establish additional percentage:

$A_{p\_L4x4x5\_16} := (5\ ft \cdot 2 + 8\ ft) \cdot (4\ in \cdot 2 + 4\ in \cdot 2) \cdot 3 = 72\ ft^2$

$A_{p\_12WF85} := (2 \cdot 12.06\ in + 3 \cdot 8.042\ in) \cdot 7\ ft \cdot 3 = 84.4305\ ft^2$

$A_{p\_vert\_stiff} := (36.06\ in - 2 \cdot 1.35\ in - 1\ in) \cdot (5\ in \cdot 2 + .5\ in) \cdot 2 = 4.7192\ ft^2$

$A_{p\_horiz\_stiff} := (3.188\ ft) \cdot (12\ in \cdot 2 + 1\ in) \cdot 2 = 13.2833\ ft^2$

$A_{p\_incidentals} := A_{p\_L4x4x5\_16} + A_{p\_12WF85} + A_{p\_horiz\_stiff} + A_{p\_vert\_stiff} = 174.433\ ft^2$

$n_{p\_addl} := 1.25$ *to account for roller and other parts*

$\frac{n_{p\_addl} \cdot A_{p\_incidentals}}{A_{paint\_nom}} = 0.2875$ *Try 30% for incidentals*

$n_{p\_incidentals} := 30\ \%$

Assume 5SF per pier at bearing locations and north abutment.

$A_{surface\_prep} := A_{paint\_nom} \cdot \left(1 + n_{p\_incidentals}\right) \cdot 2 + 5\ ft^2 \cdot 11 + 5\ ft^2 = 2031.8965\ ft^2$

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JOB STRUCTURE QUANTITIES
SHEET NO. 13 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

ITEM 514E00056 - FIELD PAINTING OF EXISTING STRUCTURAL STEEL, PRIME COAT (SF)

$A_{paint\_prime} := A_{surface\_prep} = 2031.8965\ ft^2$

ITEM 514E00060 - FIELD PAINTING STRUCTURAL STEEL, INTERMEDIATE COAT (SF)

Include new steel such as load plates, crossframes, lateral restraint blocks and cable restrainer anchor blocks

$A_{lat\_rest\_block} := (12 \cdot 14.5 \cdot 2 + (14.5 \cdot 2 + 12) \cdot 0.5)\ in^2 + 2 \cdot \left(\frac{1}{2} \cdot 14.5 \cdot 19.5 \cdot 2 + 24.3 \cdot .75\right) in^2 + (12 \cdot 20 + (20 \cdot 2 + 12 \cdot 2) \cdot .5)\ in^2 = 8.6281\ ft^2$

Add 15% to account for bolts. 2 blocks per bay, 1 bay, 2 joints.

$A_{lat\_rest\_block\_total} := 1.15 \cdot A_{lat\_rest\_block} \cdot 2 \cdot 1 \cdot 2 = 39.6894\ ft^2$

$A_{cable\_block} := 12.6\ in^2 \cdot 2 + 18\ in \cdot 28\ in \cdot 2 - 12\ in \cdot 18\ in + 3.95\ in \cdot 28\ in \cdot 2 + (18\ in - 2 \cdot .625\ in) \cdot (3.95\ in - .45\ in) \cdot 2 \cdot 4 = 10.4681\ ft^2$

$A_{cable\_block\_total} := 1.15 \cdot A_{cable\_block} \cdot 2 \cdot 4 \cdot 2 = 192.6122\ ft^2$

Load Plates: Assume 8 SF total per pier, 20 SF total at north abutment (based on measurements in OpenRoads)

$A_{load\_plates} := 8\ ft^2 \cdot 11 + 20\ ft^2 = 108\ ft^2$

$A_{paint\_int} := A_{paint\_prime} + A_{lat\_rest\_block\_total} + A_{cable\_block\_total} + A_{load\_plates} = 2372.1981\ ft^2$

$A_{paint\_int} = 2372.1981\ ft^2$

ITEM 514E00066 - FIELD PAINTING STRUCTURAL STEEL, FINISH COAT (SF)

$A_{paint\_finish} := A_{paint\_int} = 2372.1981\ ft^2$

ITEM 516E11210 STRUCTURAL EXPANSION JOINT INCLUDING ELASTOMERIC STRIP SEAL (FT)

$L_{exj} := 43\ ft$

ITEM 516E11211 STRUCTURAL EXPANSION JOINT INCLUDING ELASTOMERIC STRIP SEAL, AS PER PLAN (FT)

$L_{exj} := 29.833\ ft + 29.333\ ft = 59.17\ ft$

ITEM 516E13900 - 2" PREFORMED EXPANSION JOINT FILLER (SF)

$t_{app\_slab} := 15\ in$

$L_{PEJF\_2} := t_{app\_slab} \cdot (15.25\ ft + 15\ ft) = 37.81\ ft^2$

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JOB STRUCTURE QUANTITIES
SHEET NO. 14 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

ITEM 516E44301 - ELASTOMERIC BEARINGS WITH INTERNAL LAMINATES AND LOAD PLATE (NEOPRENE), AS PER PLAN (15"x15"x4.691" BEARING WITH 17"x16" x 1.875"(MAX) LOAD PLATE) (EACH)

$N_{BRG\_ABUT} := 5$

ITEM 516E44301 - ELASTOMERIC BEARINGS WITH INTERNAL LAMINATES AND LOAD PLATE (NEOPRENE), AS PER PLAN (18"x16"x5.046" BEARING WITH VARYING WIDTH x 17"x 2.375"(MAX) LOAD PLATE) (EACH)

$N_{BRG\_PIER} := 33$

ITEM 516E47001 - JACKING AND TEMPORARY SUPPORT OF SUPERSTRUCTURE, AS PER PLAN (LUMP)

LUMP SUM

ITEM 518E12200 - SCUPPERS, INCLUDING SUPPORTS (EACH)

$N_{SCUPPERS} := 6$

ITEM 518E21200 - POROUS BACKFILL WITH GEOTEXTILE FABRIC (CY)

$L_{PB\_backwall} := 37.289\ ft$

$T_{app\_slab} := 15\ in$

$T_{PB\_backwall} := 2\ ft$

$h_{PB\_backwall\_R} := 9.012\ ft - T_{app\_slab} = 7.762\ ft$

$h_{PB\_backwall\_L} := 8.716\ ft - T_{app\_slab} = 7.466\ ft$

As measured in OpenRoads

$V_{PB\_backwall} := \frac{1}{2} \cdot \left(h_{PB\_backwall\_R} + h_{PB\_backwall\_L} \right) \cdot T_{PB\_backwall} \cdot L_{PB\_backwall} = 21.031\ yd^3$

Wingwalls have varying depth of backfill. The backfill is thicker at the footing. Split wingwall into 3 sections: 1) Base of wingwall up to const. jt.; 2) Area of wingwall directly above (1); 3) Cantilevered section of wingwall.

$T_{PB\_WW\_L\_1} := 3.5\ ft$

$T_{PB\_WW\_L\_2} := 2\ ft$

$T_{PB\_WW\_L\_3} := 2\ ft$

$L_{PB\_ww\_foot\_L} := 7.25\ ft$

$h_{PB\_ww\_L\_const\_jt} := 3.74\ ft$

$A_{PB\_ww\_L\_1} := L_{PB\_ww\_foot\_L} \cdot h_{PB\_ww\_L\_const\_jt} = 27.115\ ft^2$

$h_{PB\_ww\_L\_2a} := 5.155\ ft$

$h_{PB\_ww\_L\_2b} := 4.99\ ft$

Palmer ENGINEERING
www.palmernet.com

JOB STRUCTURE QUANTITIES
SHEET NO. 15 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

$A_{PB\_ww\_L\_2} := \left(\frac{h_{PB\_ww\_L\_2a} + h_{PB\_ww\_L\_2b}}{2} - T_{app\_slab} \right) \cdot L_{PB\_ww\_foot\_L} = 27.7131\ ft^2$

$A_{PB\_ww\_L\_3} := 32.609\ ft^2 - T_{app\_slab} \cdot 8\ ft = 22.609\ ft^2$

$V_{PB\_ww\_L} := A_{PB\_ww\_L\_1} \cdot T_{PB\_WW\_L\_1} + A_{PB\_ww\_L\_2} \cdot T_{PB\_WW\_L\_2} + A_{PB\_ww\_L\_3} \cdot T_{PB\_WW\_L\_3} = 7.2425\ yd^3$

$L_{PB\_ww\_foot\_R} := 7\ ft$

$h_{PB\_ww\_R\_const\_jt} := 4.09\ ft$

$A_{PB\_ww\_R\_1} := L_{PB\_ww\_foot\_R} \cdot h_{PB\_ww\_R\_const\_jt} = 28.63\ ft^2$

$h_{PB\_ww\_R\_2a} := 4.96\ ft$

$h_{PB\_ww\_R\_2b} := 5.10\ ft$

$A_{PB\_ww\_R\_2} := \left(\frac{h_{PB\_ww\_R\_2a} + h_{PB\_ww\_R\_2b}}{2} - T_{app\_slab} \right) \cdot L_{PB\_ww\_foot\_R} = 26.46\ ft^2$

$A_{PB\_ww\_R\_3} := 32.40\ ft^2 - T_{app\_slab} \cdot 8\ ft = 22.4\ ft^2$

$V_{PB\_ww\_R} := A_{PB\_ww\_R\_1} \cdot T_{PB\_WW\_L\_1} + A_{PB\_ww\_R\_2} \cdot T_{PB\_WW\_L\_2} + A_{PB\_ww\_R\_3} \cdot T_{PB\_WW\_L\_3} = 7.3306\ yd^3$

$V_{PB} := V_{PB\_backwall} + V_{PB\_ww\_L} + V_{PB\_ww\_R} = 35.604\ yd^3$

ITEM 518E40000 - 6" PERFORATED CORRUGATED PLASTIC PIPE (FT)

$L_{PCPP} := 11.5\ ft + 2.5\ ft + 52.9\ ft + 11.5\ ft + 2.5\ ft = 80.9\ ft$

$L_{PCPP} = 80.9\ ft$

ITEM 518E40010 - 6" NON-PERFORATED CORRUGATED PLASTIC PIPE, INCLUDING SPECIALS (FT)

Estimate is based on 1% slope of outlet, average ground slopes as measured in ORD using survey terrain model. Assuming pipes have a length perpendicular to the wingwalls equal to wingwall thickness + 1ft, and then bend 90 parallel to the wingwall.*

$EL_{outlet} := 672.61\ ft$

$EL_{NPCPP\_Left\_surf} := 679.5\ ft$

$EL_{NPCPP\_Right\_surf} := 678\ ft$

$s_{slope\_outlet} := 1\ \%$

$s_{slope\_left} := \frac{679.5\ ft - 670.9\ ft}{35.9\ ft} \cdot 100\ \% = 23.9554\ \%$

$s_{slope\_right} := \frac{678\ ft - 667\ ft}{22.6\ ft} \cdot 100\ \% = 48.6726\ \%$

Left wingwall:

$$x_{NPCPP\_Left} := \frac{\left(EL_{NPCPP\_Left\_surf} - EL_{outlet}\right)}{\left(s_{slope\_left} - s_{slope\_outlet}\right)} + 1.5\ ft + 1\ ft = 32.5147\ ft$$ *Say 40-ft*

Right wingwall:

$$x_{NPCPP\_Right} := \frac{\left(EL_{NPCPP\_Right\_surf} - EL_{outlet}\right)}{\left(s_{slope\_right} - s_{slope\_outlet}\right)} + 1.5\ ft + 1\ ft = 13.8063\ ft$$ *Say 20-ft*

$$L_{NPCPP} := 40\ ft + 20\ ft = 60\ ft$$

ITEM 518E51300, DOWNSPOUT MODIFICATION, 10" (EACH)

$$N_{scupp\_mod} := 3$$

ITEM 518E62200 - STRUCTURE DRAINAGE, MISC.: REMOVE AND REMOUNT EXISTING DOWNSPOUTS (EACH)

$$N_{DRAIN} := N_{scupp\_mod} = 3$$

ITEM 518E62200, STRUCTURE DRAINAGE, MISC.: PLUGGING EXISTING WEEPHOLES (EACH)

$$N_{weep\_holes} := 3$$

ITEM 518E63300, STRUCTURE DRAINAGE, MISC.: CLEANING EXISTING DOWNSPOUTS (LS)

LUMP SUM

ITEM 519E00100 - SPECIAL - COMPOSITE FIBER WRAP SYSTEM (SEISMIC RETROFITS)(SF)

$$L_{18BE} := 51.83\ ft$$

$$L_{20BE} := 47.92\ ft$$

$$L_{21BE} := 51.5\ ft$$

$$L_{24BE} := 38\ ft$$

$$L_{26BE} := 19.92\ ft$$

$$L_{FRP\_Seismic} := \left(L_{18BE} + L_{20BE} + L_{21BE} + L_{24BE} + L_{26BE}\right) \cdot 2 = 418.34\ ft$$

$$A_{FRP\_Seismic} := L_{FRP\_Seismic} \cdot C_{RAMP\_PIERS} = 5257.0155\ ft^2$$

ITEM 519E00100 - SPECIAL - COMPOSITE FIBER WRAP SYSTEM (PIER REPAIRS)(SF)

Includes an Estimating Factor of 1.25. Areas calculated in spreadsheet named "Patching.xlsx".

$$A_{FRP} := (535 + 308)\ ft^2 = 843\ ft^2$$

$$A_{FRP} = 843\ ft^2$$

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JOB STRUCTURE QUANTITIES
SHEET NO. 17 OF 18
CALCULATED BY AJL DATE July 15, 2024
CHECKED BY RJB DATE June 21, 2024
PROJECT NO. CUY-176-13.34

ITEM 526E25011 - REINFORCED CONCRETE APPROACH SLABS WITH QA/QC (T=15"), AS PER PLAN (SY)

$A_{A\_Slab} := 1112.7\ ft^2$ (Measured in CAD)

$A_{A\_Slab} = 123.63\ yd^2$

ITEM 601E21050 - TIED CONCRETE BLOCK MAT WITH TYPE 1 UNDERLAYMENT (SY)

$A_{TIED\_CONC\_MAT} := 4\ ft \cdot 4\ ft \cdot N_{scupp\_mod} + 8\ ft \cdot 8\ ft \cdot \left(N_{SCUPPERS} - N_{scupp\_mod}\right) = 26.6667\ yd^2$

$A_{TIED\_CONC\_MAT} = 26.6667\ yd^2$

ITEM 844E10000 - CONCRETE PATCHING WITH GALVANIC ANODE PROTECTION (SF)

Areas taken from Table in plans for Item 844 - Concrete Patching with Galvanic Anode Protection.

RAMP

$A_{PATCH\_18BE\_24BE} := 8\ ft^2 + 3\ ft^2 = 11\ ft^2$

MAINLINE

$A_{PATCH\_MAIN\_P8\_P9} := (29 + 57)\ ft^2 = 86\ ft^2$

$A_{PATCH\_MAIN\_P10} := (51)\ ft^2 = 51\ ft^2$

$A_{PATCH\_MAIN\_P11} := (306)\ ft^2 = 306\ ft^2$

$A_{PATCH\_MAIN\_P12} := (30)\ ft^2 = 30\ ft^2$

$A_{PATCH\_MAIN\_P13} := (155)\ ft^2 = 155\ ft^2$

$A_{PATCH\_MAIN\_P14} := (273)\ ft^2 = 273\ ft^2$

$A_{PATCH\_MAIN\_P15} := (249)\ ft^2 = 249\ ft^2$

$A_{PATCH\_MAIN\_P16} := (87)\ ft^2 = 87\ ft^2$

$A_{PATCH\_MAIN\_P17B} := (9)\ ft^2 = 9\ ft^2$

$A_{PATCH\_MAIN\_P18AE\_BW} := (15 + 27)\ ft^2 = 42\ ft^2$

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JOB STRUCTURE QUANTITIES

SHEET NO. 18 OF 18

CALCULATED BY AJL DATE July 15, 2024

CHECKED BY RJB DATE June 21, 2024

PROJECT NO. CUY-176-13.34

TOTALS

$A_{PATCH\_A} := A_{PATCH\_18BE\_24BE} + A_{PATCH\_MAIN\_P8\_P9} + A_{PATCH\_MAIN\_P10} + A_{PATCH\_MAIN\_P11} + A_{PATCH\_MAIN\_P12} = 484\ ft^2$

$A_{PATCH\_B} := A_{PATCH\_MAIN\_P13} + A_{PATCH\_MAIN\_P14} + A_{PATCH\_MAIN\_P15} + A_{PATCH\_MAIN\_P16} + A_{PATCH\_MAIN\_P17B} + A_{PATCH\_MAIN\_P18AE\_BW} = 815\ ft^2$

$A_{PATCH} := A_{PATCH\_A} + A_{PATCH\_B}$

$A_{PATCH\_Total} := A_{PATCH} = 1299\ ft^2$

ITEM 844E10001 - CONCRETE PATCHING WITH GALVANIC ANODE PROTECTION, AS PER PLAN A(SY)

$A_{deck\_patching\_Type\_B} := 50\ yd^2$

ITEM 844E10001 - CONCRETE PATCHING WITH GALVANIC ANODE PROTECTION, AS PER PLAN B(SY)

$A_{deck\_patching\_Type\_B} := 10\ yd^2$

ITEM 844E10001 - CONCRETE PATCHING WITH GALVANIC ANODE PROTECTION, AS PER PLAN C(SY)

$A_{deck\_patching\_silica} := 150\ yd^2$

ITEM 844E10001 - CONCRETE PATCHING WITH GALVANIC ANODE PROTECTION, AS PER PLAN D(SY)

$A_{deck\_patching\_silica} := 15\ yd^2$