

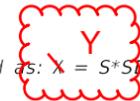
| ROUND CONCRETE AND CORRUGATED METAL PIPE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--------|-------------------|-------|-------|-------|------------|--------|-------|--------|-------|-------|--------|--------|--------|---------|--------|-----------------------|--------|-------|-------|-------|--------|-------|-------|-------|-----------|-------|--------|-------|-----|
| Pipe | Dia. D | Opening Area (SF) | | | | Dimensions | | | | | | | | | | | Class I Concrete (CY) | | | | | | | | | | | Dia. D | | |
| | | Number Of Pipes | | | | A | B | C | E | F | G | Y | X | | | | Single 0° | Double | | | | Triple | | | | Quadruple | | | | |
| | | 1 | 2 | 3 | 4 | | | | | | | | 0° | 15° | 30° | 45° | | 0° | 15° | 30° | 45° | 0° | 15° | 30° | 45° | 0° | 15° | | 30° | 45° |
| Concrete | 15" | 1.23 | 2.46 | 3.69 | 4.92 | 1'-11" | 1'-2" | 4'-0" | 1'-10" | 1'-2" | 0'-6" | 2'-7" | 2'-7" | 2'-8" | 3'-0" | 3'-8" | 1.23 | 1.59 | 1.60 | 1.65 | 1.74 | 1.94 | 1.96 | 2.05 | 2.23 | 2.30 | 2.34 | 2.47 | 2.74 | 15" |
| | 18" | 1.77 | 3.54 | 5.31 | 7.08 | 2'-2" | 1'-3" | 4'-6" | 1'-11" | 1'-3" | 1'-0" | 2'-10" | 2'-10" | 2'-11" | 3'-3" | 4'-0" | 1.56 | 1.99 | 2.01 | 2.06 | 2.17 | 2.43 | 2.46 | 2.56 | 2.79 | 2.86 | 2.91 | 3.06 | 3.40 | 18" |
| | 21" | 2.41 | 4.82 | 7.23 | 9.64 | 2'-5" | 1'-4" | 5'-0" | 2'-0" | 1'-4" | 1'-6" | 3'-2" | 3'-2" | 3'-3" | 3'-8" | 4'-6" | 1.97 | | | | | | | | | | | | | 21" |
| | 24" | 3.14 | 6.28 | 9.42 | 12.56 | 2'-8" | 1'-4" | 5'-6" | 2'-0" | 1'-4" | 2'-0" | 3'-5" | 3'-5" | 3'-6" | 3'-11" | 4'-10" | 2.24 | 2.82 | 2.84 | 2.91 | 3.06 | 3.39 | 3.43 | 3.57 | 3.87 | 3.97 | 4.03 | 4.24 | 4.69 | 24" |
| | 27" | 3.98 | 7.96 | 11.94 | 15.92 | 2'-11" | 1'-5" | 6'-0" | 2'-1" | 1'-5" | 2'-6" | 3'-10" | 3'-10" | 4'-0" | 4'-5" | 5'-5" | 2.73 | | | | | | | | | | | | | 27" |
| | 30" | 4.91 | 9.82 | 14.73 | 19.64 | 3'-2" | 1'-6" | 6'-6" | 2'-2" | 1'-6" | 3'-0" | 4'-3" | 4'-3" | 4'-5" | 4'-11" | 6'-0" | 3.26 | 4.13 | 4.16 | 4.26 | 4.49 | 4.98 | 5.04 | 5.25 | 5.69 | 5.84 | 5.93 | 6.24 | 6.91 | 30" |
| | 36" | 7.07 | 14.14 | 21.21 | 28.28 | 3'-8" | 1'-8" | 7'-6" | 2'-4" | 1'-8" | 4'-0" | 5'-1" | 5'-1" | 5'-3" | 5'-10" | 7'-2" | 4.53 | 5.73 | 5.77 | 5.92 | 6.23 | 6.92 | 7.00 | 7.29 | 7.91 | 8.13 | 8.26 | 8.69 | 9.62 | 36" |
| | 42" | 9.62 | 19.24 | 28.86 | 38.48 | 4'-2" | 1'-10" | 8'-6" | 2'-6" | 2'-0" | 5'-0" | 6'-0" | 6'-0" | 6'-3" | 6'-11" | 8'-6" | 6.33 | 8.11 | 8.17 | 8.39 | 8.85 | 9.90 | 10.02 | 10.45 | 11.38 | 11.68 | 11.87 | 12.51 | 13.89 | 42" |
| 48" | 12.57 | 25.14 | 37.71 | 50.28 | 4'-8" | 2'-1" | 9'-6" | 2'-9" | 2'-0" | 6'-0" | 6'-9" | 6'-9" | 7'-0" | 7'-10" | 9'-7" | 8.15 | 10.40 | 10.48 | 10.75 | 11.33 | 12.64 | 12.80 | 13.34 | 14.50 | 14.89 | 15.13 | 15.93 | 17.68 | 48" | |
| 54" | 15.90 | 31.80 | 47.70 | 63.60 | 5'-2" | 2'-6" | 10'-6" | 3'-2" | 2'-3" | 7'-0" | 7'-8" | 7'-8" | 7'-11" | 8'-10" | 10'-10" | 11.71 | 15.23 | 15.35 | 15.78 | 16.69 | 18.77 | 19.02 | 19.86 | 21.69 | 22.29 | 22.66 | 23.93 | 26.67 | 54" | |
| Corrugated Metal | 15" | 1.23 | 2.46 | 3.69 | 4.92 | 1'-11" | 1'-2" | 4'-0" | 1'-10" | 1'-2" | 0'-6" | 2'-7" | 2'-7" | 2'-8" | 3'-0" | 3'-8" | 1.24 | 1.62 | 1.63 | 1.68 | 1.78 | 1.99 | 2.02 | 2.11 | 2.30 | 2.37 | 2.41 | 2.75 | 2.84 | 15" |
| | 18" | 1.77 | 3.54 | 5.31 | 7.08 | 2'-2" | 1'-3" | 4'-6" | 1'-11" | 1'-3" | 1'-0" | 2'-10" | 2'-10" | 2'-11" | 3'-3" | 4'-0" | 1.59 | 2.04 | 2.06 | 2.11 | 2.23 | 2.51 | 2.54 | 2.65 | 2.89 | 2.96 | 3.01 | 3.17 | 3.53 | 18" |
| | 21" | 2.41 | 4.82 | 7.23 | 9.64 | 2'-5" | 1'-4" | 5'-0" | 2'-0" | 1'-4" | 1'-6" | 3'-2" | 3'-2" | 3'-3" | 3'-8" | 4'-6" | | | | | | | | | | | | | | 21" |
| | 24" | 3.14 | 6.28 | 9.42 | 12.56 | 2'-8" | 1'-4" | 5'-6" | 2'-0" | 1'-4" | 2'-0" | 3'-5" | 3'-5" | 3'-6" | 3'-11" | 4'-10" | 2.29 | 2.91 | 2.93 | 3.01 | 3.17 | 3.52 | 3.56 | 3.71 | 4.03 | 4.14 | 4.20 | 4.43 | 4.91 | 24" |
| | 27" | 3.98 | 7.96 | 11.94 | 15.92 | 2'-11" | 1'-5" | 6'-0" | 2'-1" | 1'-5" | 2'-6" | 3'-10" | 3'-10" | 4'-0" | 4'-5" | 5'-5" | | | | | | | | | | | | | | 27" |
| | 30" | 4.91 | 9.82 | 14.73 | 19.64 | 3'-2" | 1'-6" | 6'-6" | 2'-2" | 1'-6" | 3'-0" | 4'-3" | 4'-3" | 4'-5" | 4'-11" | 6'-0" | 3.34 | 4.28 | 4.31 | 4.43 | 4.67 | 5.20 | 5.27 | 5.49 | 5.97 | 6.13 | 6.23 | 6.56 | 7.29 | 30" |
| | 36" | 7.07 | 14.14 | 21.21 | 28.28 | 3'-8" | 1'-8" | 7'-6" | 2'-4" | 1'-8" | 4'-0" | 5'-1" | 5'-1" | 5'-3" | 5'-10" | 7'-2" | 4.64 | 5.95 | 6.00 | 6.15 | 6.49 | 7.25 | 7.34 | 7.65 | 8.33 | 8.57 | 8.71 | 9.18 | 10.20 | 36" |
| | 42" | 9.62 | 19.24 | 28.86 | 38.48 | 4'-2" | 1'-10" | 8'-6" | 2'-6" | 2'-0" | 5'-0" | 6'-0" | 6'-0" | 6'-3" | 6'-11" | 8'-6" | 6.49 | 8.43 | 8.50 | 8.73 | 9.23 | 10.38 | 10.52 | 10.98 | 11.99 | 12.32 | 12.52 | 13.22 | 14.73 | 42" |
| 48" | 12.57 | 25.14 | 37.71 | 50.28 | 4'-8" | 2'-1" | 9'-6" | 2'-9" | 2'-0" | 6'-0" | 6'-9" | 6'-9" | 7'-0" | 7'-10" | 9'-7" | 8.38 | 10.85 | 10.94 | 11.23 | 11.87 | 13.34 | 13.51 | 14.11 | 15.39 | 15.82 | 16.08 | 16.97 | 18.90 | 48" | |
| 54" | 15.90 | 31.80 | 47.70 | 63.60 | 5'-2" | 2'-6" | 10'-6" | 3'-2" | 2'-3" | 7'-0" | 7'-8" | 7'-8" | 7'-11" | 8'-10" | 10'-10" | 11.77 | 15.35 | 15.48 | 15.90 | 16.83 | 18.93 | 19.18 | 20.04 | 21.89 | 22.51 | 22.89 | 24.17 | 26.96 | 54" | |

| ELLIPTICAL CONCRETE AND CORRUGATED METAL PIPE ARCH | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--------|--------|-------------------|------|-------|-------|------------|------------|------------|--------|-----------|-----------|--------|---------|--------|--------|--------|-----------------------|--------|-------|-------|-------|--------|-------|-------|-------|-----------|-------|--------|--------|----------------------|-----|-----|
| Pipe | Rise R | Span S | Opening Area (SF) | | | | Dimensions | | | | | | | | | | | Class I Concrete (CY) | | | | | | | | | | | Rise R | Span S | Approx. Equiv. Round | | |
| | | | Number Of Pipes | | | | A | B | C | E | F | G | Y | X | | | | Single 0° | Double | | | | Triple | | | | Quadruple | | | | | | |
| | | | 1 | 2 | 3 | 4 | | | | | | | | 0° | 15° | 30° | 45° | | 0° | 15° | 30° | 45° | 0° | 15° | 30° | 45° | 0° | 15° | | | | 30° | 45° |
| Concrete | 12" | 18" | 1.3 | 2.6 | 3.9 | 5.2 | 1'-8" | 1'-2" | 3'-9" | 1'-10" | 1'-2" | 0'-3" | 2'-10" | 2'-10" | 2'-11" | 3'-3" | 4'-0" | 1.09 | 1.45 | 1.46 | 1.51 | 1.60 | 1.80 | 1.82 | 1.91 | 2.09 | 2.16 | 2.20 | 2.33 | 2.60 | 12" | 18" | 15" |
| | 14" | 23" | 1.8 | 3.6 | 5.4 | 7.2 | 1'-10" | 1'-3" | 4'-2 1/2" | 1'-11" | 1'-3" | 8 1/2" | 3'-5" | 3'-5" | 3'-6" | 3'-11" | 4'-10" | 1.36 | 1.82 | 1.84 | 1.89 | 2.01 | 2.29 | 2.32 | 2.43 | 2.68 | 2.75 | 2.80 | 2.97 | 3.33 | 14" | 23" | 18" |
| | 19" | 30" | 3.3 | 6.6 | 9.9 | 13.2 | 2'-3" | 1'-4" | 5'-1 1/2" | 2'-0" | 1'-4" | 1'-7 1/2" | 4'-2" | 4'-2" | 4'-4" | 4'-10" | 5'-11" | 1.89 | 2.55 | 2.57 | 2.65 | 2.82 | 3.22 | 3.27 | 3.43 | 3.77 | 3.88 | 3.95 | 4.19 | 4.70 | 19" | 30" | 24" |
| | 24" | 38" | 5.1 | 10.2 | 15.3 | 20.4 | 2'-8" | 1'-5" | 6'-3" | 2'-1" | 1'-5" | 2'-9" | 5'-2" | 5'-2" | 5'-4" | 6'-0" | 7'-4" | 2.64 | 3.55 | 3.58 | 3.69 | 3.93 | 4.48 | 4.54 | 4.77 | 5.24 | 5.39 | 5.49 | 5.82 | 6.53 | 24" | 38" | 30" |
| | 29" | 45" | 7.4 | 14.8 | 22.2 | 29.6 | 3'-1" | 1'-6" | 7'-0" | 2'-2" | 1'-6" | 3'-6" | 6'-0" | 6'-0" | 6'-3" | 6'-11" | 8'-6" | 3.32 | 4.48 | 4.52 | 4.66 | 4.96 | 5.64 | 5.72 | 6.00 | 6.60 | 6.80 | 6.92 | 7.34 | 8.24 | 29" | 45" | 36" |
| | 34" | 53" | 10.2 | 20.4 | 30.6 | 40.8 | 3'-6" | 1'-7" | 7'-11 1/2" | 2'-3" | 1'-7" | 4'-5 1/2" | 7'-1" | 7'-1" | 7'-4" | 8'-2" | 8'-0" | 4.24 | 5.76 | 5.81 | 6.00 | 6.39 | 7.29 | 7.40 | 7.76 | 8.55 | 8.81 | 8.97 | 9.52 | 10.70 | 34" | 53" | 42" |
| | 38" | 60" | 12.9 | 25.8 | 38.7 | 51.6 | 3'-10" | 1'-8" | 8'-9" | 2'-4" | 1'-8" | 5'-3" | 7'-11" | 7'-11" | 8'-2" | 9'-2" | 11'-2" | 5.22 | 7.16 | 7.23 | 7.46 | 7.96 | 9.10 | 9.24 | 9.70 | 10.71 | 11.05 | 11.25 | 11.95 | 13.46 | 38" | 60" | 48" |
| | 43" | 68" | 16.6 | 33.2 | 49.8 | 66.4 | 4'-3" | 1'-10" | 9'-8 1/2" | 2'-6" | 1'-10" | 6'-2 1/2" | 8'-10" | 8'-10" | 9'-2" | 10'-2" | 12'-6" | 6.63 | 9.01 | 9.09 | 9.38 | 10.00 | 11.39 | 11.56 | 12.13 | 13.36 | 13.77 | 14.02 | 14.88 | 16.73 | 43" | 68" | 54" |
| 48" | 76" | 20.5 | 41.0 | 61.5 | 82.0 | 4'-8" | 2'-1" | 10'-8" | 2'-9" | 2'-0" | 7'-2" | 9'-9" | 9'-9" | 10'-1" | 11'-3" | 13'-9" | 8.66 | 11.74 | 11.85 | 12.22 | 13.02 | 14.82 | 15.04 | 15.77 | 17.37 | 17.91 | 18.23 | 19.34 | 21.74 | 48" | 76" | 60" | |
| 53" | 83" | 24.8 | 49.6 | 74.4 | 99.2 | 5'-1" | 2'-6" | 11'-7" | 3'-2" | 2'-6" | 8'-1" | 10'-7" | 10'-7" | 10'-11" | 12'-3" | 15'-0" | 12.50 | 16.98 | 16.98 | 17.67 | 18.83 | 21.47 | 21.78 | 22.86 | 25.18 | 25.97 | 26.44 | 28.06 | 31.55 | 53" | 83" | 66" | |
| 58" | 91" | 29.5 | 59.0 | 88.5 | 118.0 | 5'-6" | 2'-10" | 12'-6 1/2" | 3'-6" | 2'-10" | 9'-0 1/2" | 11'-4" | 11'-4" | 11'-9" | 13'-1" | 16'-0" | 16.46 | 22.26 | 22.46 | 23.16 | 24.66 | 28.05 | 28.46 | 29.85 | 32.85 | 33.85 | 34.46 | 36.55 | 41.05 | 58" | 91" | 72" | |
| Corrugated Metal | 13" | 17" | 1.1 | 2.2 | 3.3 | 4.4 | 1'-9" | 1'-2" | 3'-10" | 1'-10" | 1'-2" | 0'-4" | 2'-6" | 2'-6" | 2'-7" | 2'-11" | 3'-6" | 1.16 | 1.47 | 1.48 | 1.52 | 1.60 | 1.78 | 1.80 | 1.88 | 2.04 | 2.09 | 2.12 | 2.23 | 2.48 | 13" | 17" | 15" |
| | 15" | 21" | 1.6 | 3.2 | 4.8 | 6.4 | 1'-11" | 1'-2" | 4'-3" | 1'-10" | 1'-2" | 0'-9" | 2'-10" | 2'-10" | 2'-11" | 3'-3" | 4'-0" | 1.33 | 1.69 | 1.70 | 1.75 | 1.84 | 2.04 | 2.06 | 2.15 | 2.33 | 2.40 | 2.44 | 2.57 | 2.84 | 15" | 21" | 18" |
| | 20" | 28" | 2.8 | 5.6 | 8.4 | 11.2 | 2'-4" | 1'-3" | 5'-2" | 1'-11" | 1'-3" | 1'-8" | 3'-5" | 3'-5" | 3'-6" | 3'-11" | 4'-10" | 1.78 | 2.31 | 2.33 | 2.39 | 2.53 | 2.83 | 2.87 | 2.99 | 3.26 | 3.36 | 3.42 | 3.60 | 4.01 | 20" | 28" | 24" |
| | 24" | 35" | 4.3 | 8.6 | 12.9 | 17.2 | 2'-8" | 1'-4" | 5'-11 1/2" | 2'-0" | 1'-4" | 2'-5 1/2" | 4'-0" | 4'-0" | 4'-2" | 4'-7" | 5'-8" | 2.34 | 3.03 | 3.05 | 3.14 | 3.32 | 3.72 | 3.77 | 3.93 | 4.29 | 4.40 | 4.47 | 4.72 | 5.25 | 24" | 35" | 30" |
| | 29" | 42" | 5.9 | 11.8 | 17.7 | 23.6 | 3'-1" | 1'-5" | 6'-10 1/2" | 2'-1" | 1'-5" | 3'-4 1/2" | 4'-9" | 4'-9" | 4'-11" | 5'-6" | 6'-9" | 3.13 | 4.06 | 4.09 | 4.20 | 4.45 | 4.99 | 5.06 | 5.28 | 5.76 | 5.93 | 6.03 | 6.36 | 7.09 | 29" | 42" | 36" |
| | 33" | 49" | 8.4 | 16.8 | 25.2 | 33.6 | 3'-5" | 1'-6" | 7'-8" | 2'-2" | 1'-6" | 4'-2" | 5'-6" | 5'-6" | 5'-8" | 6'-4" | 7'-9" | 3.83 | 5.00 | 5.04 | 5.18 | 5.48 | 6.16 | 6.24 | 6.52 | 7.12 | 7.32 | 7.44 | 7.86 | 8.76 | 33" | 49" | 42" |
| | 38" | 57" | 10.6 | 21.2 | 31.8 | 42.4 | 3'-10" | 1'-7" | 8'-7 1/2" | 2'-3" | 1'-7" | 5'-1 1/2" | 6'-4" | 6'-4" | 6'-7" | 7'-4" | 8'-11" | 4.87 | 6.31 | 6.36 | 6.53 | 6.91 | 7.74 | 7.84 | 8.18 | 8.93 | 9.18 | 9.33 | 9.85 | 10.96 | 38" | 57" | 48" |
| | 43" | 64" | 13.2 | 26.4 | 39.6 | 52.8 | 4'-3" | 1'-8" | 9'-6 1/2" | 2'-4" | 1'-8" | 6'-0 1/2" | 7'-1" | 7'-1" | 7'-4" | 8'-2" | 10'-0" | 5.88 | 7.64 | 7.70 | 7.91 | 8.37 | 9.40 | 9.52 | 9.94 | 10.86 | 11.15 | 11.33 | 11.97 | 13.33 | 43" | 64" | 54" |
| 47" | 71" | 16.9 | 33.8 | 50.7 | 67.6 | 4'-7" | 1'-10" | 10'-4" | 2'-6" | 2'-0" | 6'-10" | 7'-10" | 7'-10" | 8'-1" | 9'-1" | 11'-1" | 7.80 | 10.15 | 10.23 | 10.51 | 11.12 | 12.49 | 12.65 | 13.22 | 14.43 | 14.85 | 15.10 | 15.94 | 17.77 | 47" | 71" | 60" | |

NOTES:

- Dimension X is calculated as: $X = S \cdot \sec \alpha$
- Select tabular quantities using skew values as follows:

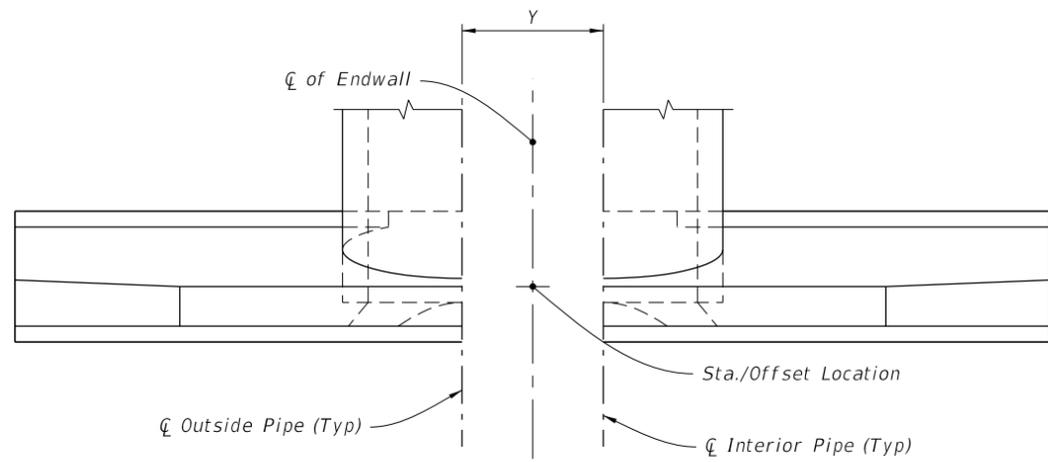
| | |
|------------------|---------------------|
| End Skew to Pipe | Use Tabulated Value |
| 0° to 5° | 0° |
| 6° to 15° | 15° |
| 16° to 30° | 30° |
| 31° or Over | 45° |



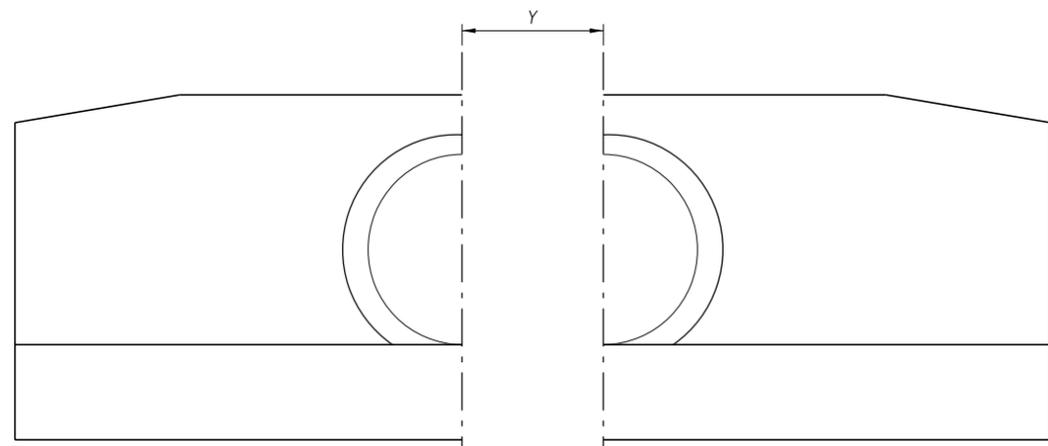
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10/12/2020 7:18:54 AM

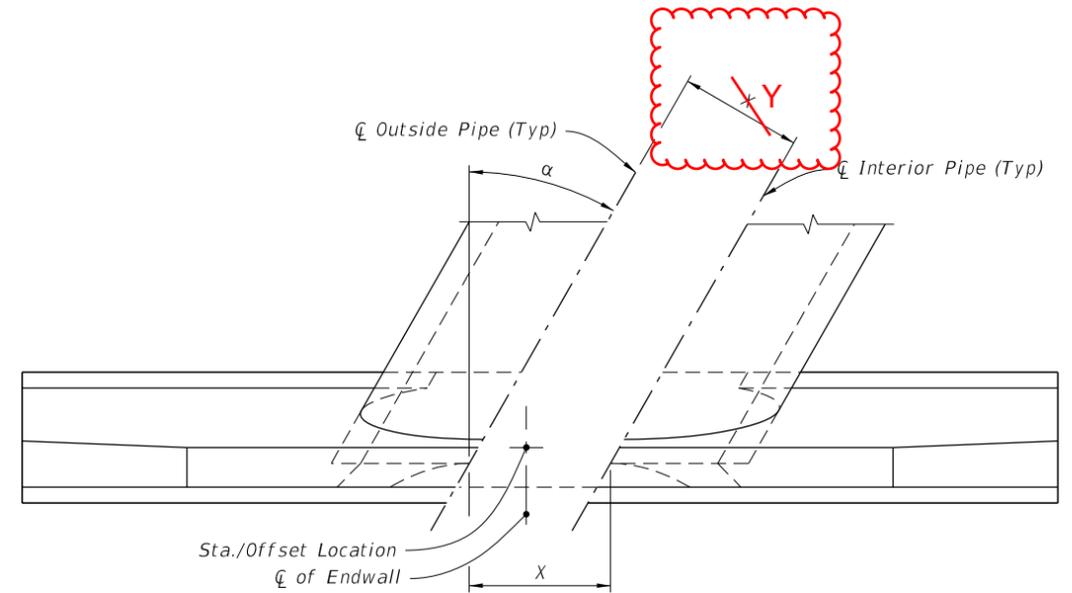


PLAN

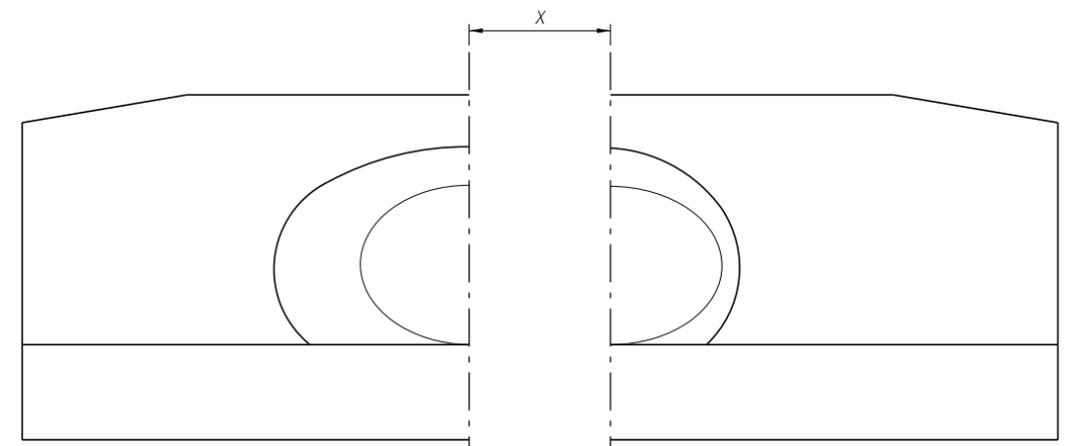


FRONT ELEVATION

NORMAL PIPE



PLAN



FRONT ELEVATION

SKewed PIPE

(Multiple Pipe Shown, Single Pipe Similar)

LEGEND:

- α Pipe Skew Angle
- Y Center to Center between pipes
- X Center to Center along front of Headwall

SPACING FOR MULTIPLE PIPES

| | |
|---------------------------|--------------|
| LAST REVISION 11/01/19 | DESCRIPTION: |
|---------------------------|--------------|



FY 2021-22
STANDARD PLANS

STRAIGHT CONCRETE ENDWALLS
SINGLE AND MULTIPLE PIPE

INDEX
430-030

SHEET
4 of 4