

STRUCTURAL CALCULATIONS
for
Xcel Fernbrook Lane Duct Line
Maple Grove, Minnesota

MBJ Commission No: 24.324.0

Prepared for:
Xcel Energy

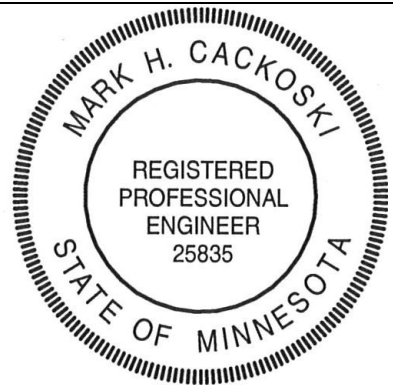
March 6, 2024

MBJ

Meyer Borgman Johnson
510 Marquette Ave S, Suite 900
Minneapolis, MN 55402

PROFESSIONAL CERTIFICATION

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of minnesota.



Mark Cackoski, PE

March 6, 2024

License Number: 25835

STRUCTURE THAT SHAPES

SCOPE OF PROJECT:

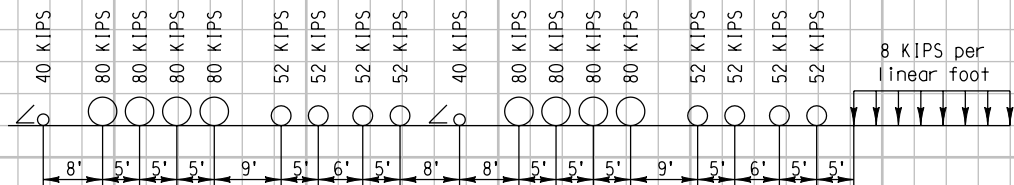
DESIGN CONCRETE ENCASED DUCT LINE FOR RAILROAD TRACK LOAD

DESIGN CODES:

 AREMA MANUAL FOR RAILWAY ENGINEERING
 ACI 318 - BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE

DESIGN CRITERIA:

LIVE LOAD - COOPER E-80


LIVE LOAD LATERAL DISTRIBUTION:

TIE LENGTH (ASSUMED) = 8'-6"

 DEPTH OF FILL $H = 5'-0"$

 LATERAL DISTRIBUTION $L_d = 8.5 + 5.0 = 13.5 \text{ FT}$

LONGITUDINAL DISTRIBUTION = 5'-0"

LIVE LOAD IMPACT FACTOR:

$$IM = (10 - H)(40/8.5 \cdot 100)$$

$$IM = (10 - 5)(40/8.5 \cdot 100) = 0.24$$

DESIGN LOADS:

 SUPERIMPOSED DEAD LOAD: TRACK - 200 lb/ft
 PAVEMENT and BALLAST - 1,150 lb/ft

SOIL WEIGHT = 120 pcf

DUCT SELF WEIGHT = 2,350 lb/ft (conservative)

DEAD LOAD BEARING PRESSURE:

$$q(dl) = (200 + 1,150)/ld + 120 \cdot 5 + 2,350/3.96 = 1,294 \text{ psf}$$

LIVE LOAD = 80k

LIVE LOAD BEARING PRESSURE:

$$q(ll) = 80,000/5ld = 1,185 \text{ psf}$$

LIVE LOAD BEARING PRESSURE DUE TO IMPACT:

$$q(im) = 0.24(80,000)/5ld = 284 \text{ psf}$$



FACTORED BEARING PRESSURE:

LOAD CASES:

GROUP 1: $1.4(DL + 5/3(LL + IM)) = 1.4(1,294 + 5/3(1,185 + 284)) = 5,526$ psf

GROUP 1a: $1.8(DL + LL + IM) = 1.8(1,294 + 1,185 + 284) = 4,973$ psf

GROUP 2: $1.4DL = 1.4(1,294) = 1,812$ psf

GROUP 3: $1.4(DL + LL + IM) = 1.4(1,294 + 1,185 + 284) = 3,868$ psf

GROUP 4: $1.4(DL + LL + IM) = 1.4(1,294 + 1,185 + 284) = 3,868$ psf

GROUP 7: $1.4DL = 1.4(1,294) = 1,812$ psf

GROUP 8: $1.4(DL + LL + IM) = 1.4(1,294 + 1,185 + 284) = 3,868$ psf

GROUP 9: $1.2DL = 1.2(1,294) = 1,553$ psf

GROUP 1 CONTROLS - $q_u = 5,526$ psf

DUCT LINE DESIGN:

CHECK CAPACITY OF 6" SLAB OVER CONDUITS

FROM ANALYSIS: DESIGN MOMENT: $-M_u = 0.41$ ft-k (controls)

DESIGN SHEAR: $V_u = 2.69$ k (at face of support)

DESIGN FOR MOMENT: $d = 2.69$ in

$b = 12$ in

$K_u = 57$

USE $p = 0.0033$

$A_s = 0.0033(12)(2.69)^2 = 0.29$ in² (#5 at 12" oc)

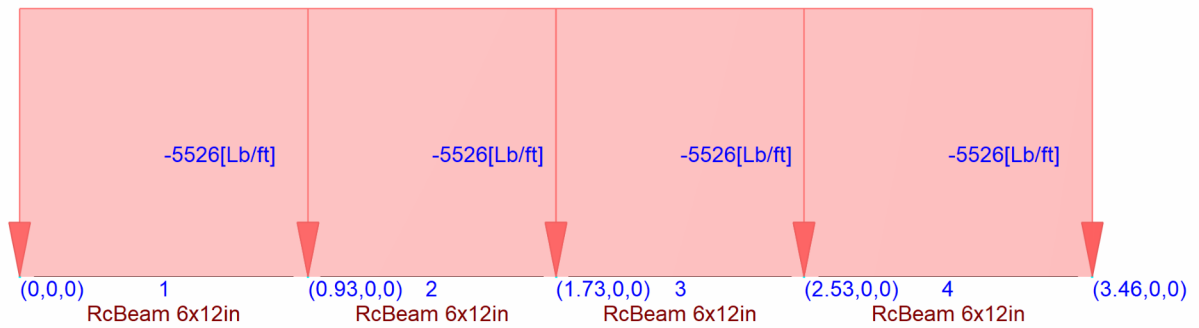
CHECK SHEAR: $\phi V_c = 0.75(2)(4000)^{1/2} (12)(2.69) = 3.06$ k ok



Loads

■ Distributed user loads - Members

Beam Diagram





Current Date: 2/29/2024 11:07 PM

Units system: English

File name: E:_Projects\2024\24-324 Xcel Fernbrook Lane Duct Line\Calculations\24.324 slab analysis.retx

Analysis result

Forces diagram printout

Load conditions:

CL1=DL+LL

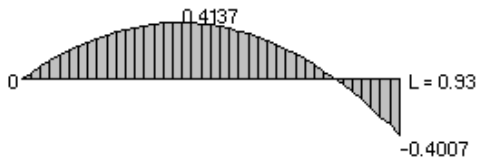
MEMBER	:	1	Length	:	0.930 [ft]	Node J	:	1
Material	:	C 4-60	Section	:	RcBeam 6x12in	Node K	:	2

Condition : CL1=DL+LL

M22 bending moment

Moments [Kip*ft], Length [ft]

Max: 0.4137[Kip*ft] at 0.40[ft] from J



Min: -0.4007[Kip*ft] at 0.93[ft] from J

MEMBER	:	2	Length	:	0.800 [ft]	Node J	:	2
Material	:	C 4-60	Section	:	RcBeam 6x12in	Node K	:	3

Condition : CL1=DL+LL

M22 bending moment

Moments [Kip*ft], Length [ft]

Max: 0.1054[Kip*ft] at 0.42[ft] from J



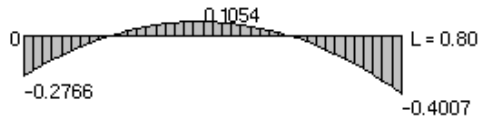
Min: -0.4007[Kip*ft] at 0.00[ft] from J

MEMBER : 3 Length : 0.800 [ft] Node J : 3
Material : C 4-60 Section : RcBeam 6x12in Node K : 4

Condition : CL1=DL+LL

M22 bending moment
Moments [Kip*ft], Length [ft]

Max: 0.1054[Kip*ft] at 0.38[ft] from J



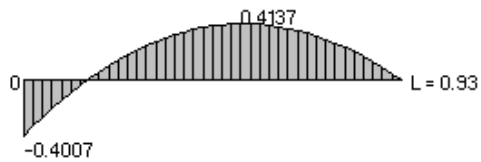
Min: -0.4007[Kip*ft] at 0.80[ft] from J

MEMBER : 4 Length : 0.930 [ft] Node J : 4
Material : C 4-60 Section : RcBeam 6x12in Node K : 5

Condition : CL1=DL+LL

M22 bending moment
Moments [Kip*ft], Length [ft]

Max: 0.4137[Kip*ft] at 0.53[ft] from J



Min: -0.4007[Kip*ft] at 0.00[ft] from J



Current Date: 2/29/2024 11:09 PM

Units system: English

File name: E:_Projects\2024\24-324 Xcel Fernbrook Lane Duct Line\Calculations\24.324 slab analysis.retx

Analysis result

Forces diagram printout

Load conditions:

CL1=DL+LL

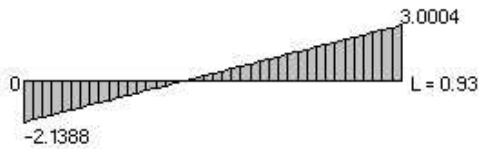
MEMBER	: 1	Length	: 0.930 [ft]	Node J	: 1
Material	: C 4-60	Section	: RcBeam 6x12in	Node K	: 2

Condition : CL1=DL+LL

V3 shear forces

Forces [Kip], Length [ft]

Max: 3.0004[Kip] at 0.93[ft] from J



Min: -2.1388[Kip] at 0.00[ft] from J

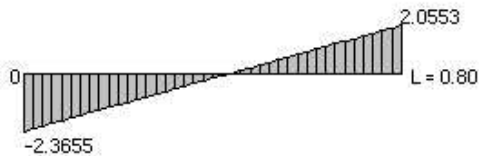
MEMBER	: 2	Length	: 0.800 [ft]	Node J	: 2
Material	: C 4-60	Section	: RcBeam 6x12in	Node K	: 3

Condition : CL1=DL+LL

V3 shear forces

Forces [Kip], Length [ft]

Max: 2.0553[Kip] at 0.80[ft] from J



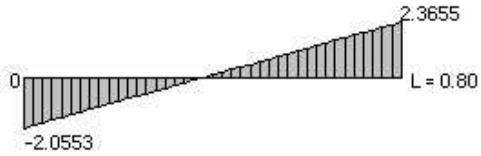
Min: -2.3655[Kip] at 0.00[ft] from J

MEMBER : 3 Length : 0.800 [ft] Node J : 3
Material : C 4-60 Section : RcBeam 6x12in Node K : 4

Condition : CL1=DL+LL

V3 shear forces
Forces [Kip], Length [ft]

Max: 2.3655[Kip] at 0.80[ft] from J



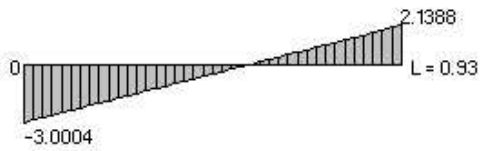
Min: -2.0553[Kip] at 0.00[ft] from J

MEMBER : 4 Length : 0.930 [ft] Node J : 4
Material : C 4-60 Section : RcBeam 6x12in Node K : 5

Condition : CL1=DL+LL

V3 shear forces
Forces [Kip], Length [ft]

Max: 2.1388[Kip] at 0.93[ft] from J



Min: -3.0004[Kip] at 0.00[ft] from J
