FORM DQP 2.01-1
LEVEL 1 CHECK PRINT SIGN-OFF SHEET

Client Name:	**Ohio Department of Transportation**
Job Title:	**Cleveland Innerbelt Design-Build Contract**
Job Number:	**CUY-90-14.90**
Document Title:	LIGHTING BRACKET @ TOP OF DELTA FRAME

Check Level (Mark One):

- [X] 1A 100% Document Check
- [ ] 1B 100% Input Check

Enter description below:

	Print Name	Signature	Date
[X] Originator	David Glastetter		9/6/11
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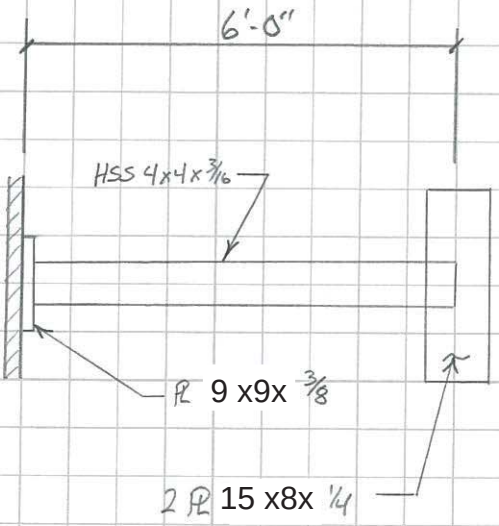
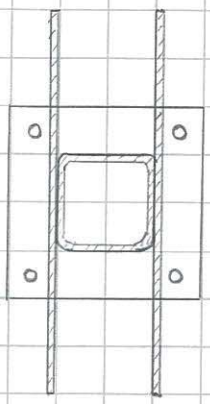
Insert an "X" in the box to indicate a required QC activity.

Form DQP 2.01-1

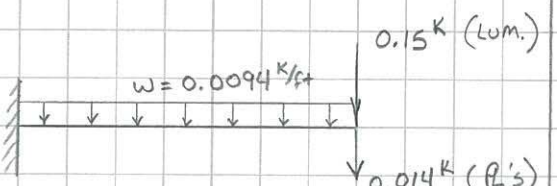
For	Cleveland Innerbelt	Job no.	49633	Sheet no.	1
Made by	DJG	Checked by	LER	Backchecked by	DJG
Date	8/25/11	Date	9/7/11	Date	9/8/11

HNTB

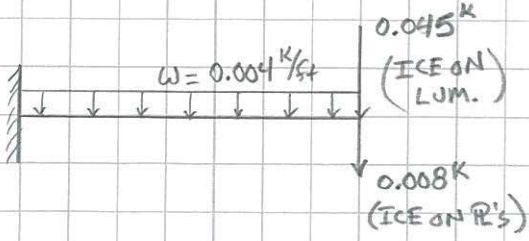




LUMINAIRE WT: 0.075^K EACH



APPLY ICE LOAD OF 3 PSF



WTS.

HSS 4x4x3/16 = 9.4#/ft = .0094 K/ft

15 x 8 x 1/4" PL's

$[0.25\ (15)(8)\ (2)/12^3](0.49\ ^K/_{ft^3}) = 0.014$

LUMINAIRES: 75# EACH (Product Literature)

ICE WTS.

HSS: (0.333ft)(4)(3psf) = 4#/ft

PLATES: (2)(15)(6.5)(2)(3psf)/144

= 8#

LUMINAIRES: (2)(30")(18")(2)(3psf)/144

= 45#

FYI: TREAT ICE AS A DC DL

WIND UPLIFT OR DOWN FORCE

ASSUME P = 50 psf

$w = .05^{ksf}(0.33') = 0.016\ ^K/_{ft}$

$F_{Lum} = \frac{(2)(5")(18")}{144}(.05\ ^K/_{ft^2}) = 0.0625^K$

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MAX MOMENT

DC

$$M_{DC} = 1.25\left[\left(0.0094^{K/ft} + 0.004^{K/ft}\right)\frac{(6')^2}{2} + \left(.15^K + .014^K + .045^K + .008^K\right)(6')\right]$$

$$M_{DC} = 1.93^{'K}$$

WIND

$$M_W = 1.4\left(\frac{.016^{K/ft}(6')^2}{2} + 0.0625^K(6')\right)$$

$$M_W = 0.928^{'K}$$

TOTAL VERTICAL MOMENT

$$M_u = 1.93^{'K} + 0.928^{'K} = 2.86^{'K} \times \frac{1.05}{3.0^{'K}}$$

Max Shear

DC:

$$V_{DC} = 1.25\left[\left(0.0094^{K/ft} + 0.004^{K/ft}\right)(6') + \left(.15^K + .014^K + .045^K + .008^K\right)\right]$$

$$V_{DC} = 0.37^K$$

WIND

$$V_W = 1.4\left[(.016^{K/ft})(6') + 0.0625^K\right]$$

$$V_W = 0.222^K$$

TOTAL VERTICAL SHEAR

$$V = 0.37^K + 0.222^K = 0.592^K \times \frac{1.05}{0.62^K}$$

$\phi M_n = 12.7^{'K}$ PER MANUAL OF STEEL CONSTRUCTION TABLE 3-13 Pg 3-145

$\phi M_n >> M_u$

$$M_n = M_p = F_y Z = 46^{ksi}(3.67in^3) = 168.82^{"-K}$$

$$\lambda_f = \frac{b_{fc}}{t_{fc}} = 20 < \lambda_{pf}$$

$$\lambda_{pf} = 1.12\sqrt{\frac{29000}{47}} = 27.82$$

$$\lambda_{rf} = 1.40\sqrt{\frac{29000}{47}} = 34.78$$

$$M_n = 172.49^{"-K} - \left(172.49^{"-K} - 47^{ksi}(3.10in^3)\right) \times \left(3.57(20)\sqrt{\frac{47}{29000}} - 4\right)$$

$$= 172.49^{"-K} - (33.79)(-1.126)$$

$$= 210.1^{"-K} > M_p$$

A.6.12.2.2.2

USE $M_n = 168.82^{"-K}$

$$\lambda_{pw} = 2.42\sqrt{\frac{29000}{46}} = 60.8$$

$$\frac{D}{t_w} = 20 < 60.8$$

$$\frac{0.07E}{f_y} = \frac{.07(29000)}{47} = 43.2 > \frac{D}{t_w}$$

Local Buckling check Not Required.

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Web Slenderness does not exceed λ_{pw}, web local buckling check not required

Shear Resistance

$A_w = 3.1875"(2)(0.174") = 1.11\ in^2$ (0.174" = Nominal Wall Thickness)

$V_n = V_{cr} = C V_p$

$V_p = 0.58\ F_{yw}\ D\ t_w$

$= 0.58\ (46^{ksi})(1.11 in^2)$

$= 29.61^K$

$\frac{D}{t_w} = 20$

$1.12\sqrt{\frac{29000(5)}{47}} = 62.2$

$\frac{D}{t_w} < 1.12\sqrt{\frac{EK}{F_{yw}}}$

$C = 1.0$

$V_n = 1.0\ (29.61^K) = 29.61^K$

$\phi V_n = 1.0\ (29.61^K) = 29.61^K$

$29.61^K \gg 0.62^K$

OK

Check Shear on Weld To Bolt PL

Try 3/16" Fillet Weld E60

$\phi_{e2} = 0.80$

$R_r = 0.6\ (0.80)\ (60^{ksi})$

$R_r = 28.8^{ksi}$

Unit Weld Capacity $= 28.8^{ksi}(0.707)(3/16")$

$= 3.82^K/in$

TOTAL Capacity:

$2(3.1875")(3.82^K/in)$

$= 24.4^K$

Check Weld for shear & moment components using the elastic vector method.

$(R_n)_v = \frac{P}{4L} = \frac{0.62^K}{4(3.1875")} = 0.049^K/in$

$I_x = \frac{2(3.1875")^3}{12} + (3.1875")(2)^2$

($\frac{2(3.1875")^3}{12}$: vertical welds; $(3.1875")(2)^2$: TOP HORIZ. WELD)

NOTE: Neglect welds around corners

$I_x = 18.15 in^3$

$(R_n)_t = \frac{34.32^{"-K}(2")}{18.15 in^3} = 3.78^K/in$

ME101-1204

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Required Weld Capacity

$$\sqrt{(0.093^{K}/_{in})^2 + (3.78^{K}/_{in})^2}$$

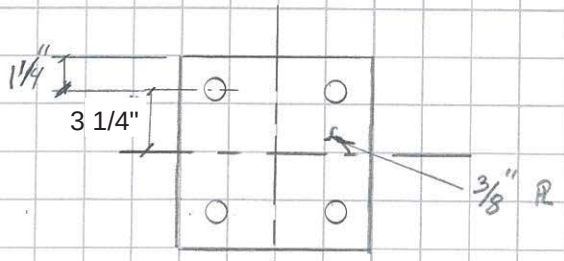
$$= 3.78^{K}/_{in} < 3.82^{K}/_{in}$$

OK

Weld from Arm to Base Plate OK. Welds from Bracket PL to Arm OK by Inspection.

DESIGN END PLATE CONNECTION

Use 3/4" ϕ Bolts



Shear Resistance

$$\phi R_{n_v} = 0.80(0.38)(0.442\,in^2)(120^{Ksi})(1)$$

$$= 16.12^{K}/_{bolt}$$

$$\times 4\,\text{Bolts} = 64.5^{K}$$

Bearing Resistance on Bolt Hole

$$\phi R_{n_{bb}} = 0.8(1.2)(0.844")(0.375")(65^{Ksi})$$

$$\phi R_{n_{bb}} = 19.75\,/\,\text{Bolt Hole}$$

Both shear & bearing resistances are much higher than the factored load case.

CALC TENSION ON BOLTS DUE TO MOMENT

$$I_b = 4(2.75")^2 = 30.25\,in^2$$

$$T = \frac{2.86^{K}(12)(2.75")}{30.25\,in^2} = 3.12^{K}$$

$$\phi R_{n_t} = 0.8(0.76)A_b F_{ub}$$

$$= 0.8(0.76)\left(\frac{\pi(3/4")^2}{4}\right)(120^{Ksi})$$

$$= 32.2^{K} \gg 3.12^{K}$$

OK

FOR SHEAR

$$\frac{P_u}{R_n} = \frac{0.62^{K}}{4(16.12)} = 0.009 < 0.33$$

so check of

$$\phi R_{nt} = \phi(0.76)A_b F_{ub} \text{ is OK}$$

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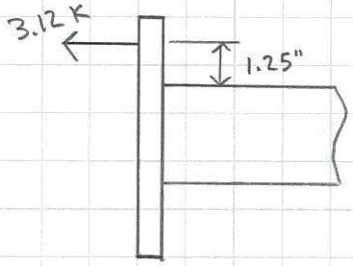
HNTB

Check Bending in Base Plate



$M = 3.12^{K}(1.25")(2) = 7.8\ k\cdot in$

Flexural Resistance

Sec. 6.12.2.2.7

$L_b = 6.5"$
$d = 3/8"$
$t = 9"$

$$\frac{L_b d}{t^2} = \frac{6.5\,(0.375)}{9^2} = 0.0301$$

$$\frac{0.08\,E}{F_y} = \frac{0.08\,(29000)}{36} = 64.44$$

$$\frac{L_b d}{t^2} < \frac{0.08\,E}{F_y}$$

$M_n = M_p = F_y Z < 1.6\,M_y$

$Z = \frac{bh^2}{4} = \frac{9(0.375)^2}{4} = 0.316\ in^3$

$M_n = M_p = 36\ ksi\ (0.316\ in^3)$

$= 11.38\ k\cdot in$

$\leq 1.6\,M_y = 1.6\,(36)(0.1875)$

$= \underline{10.8\ k\cdot in}$ ⇐ Controls

$10.8\ k\cdot in > 7.8\ k\cdot in$

Ok