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:	Unit 2 Structural Steel Light Bracket Fatigue Analysis

Check Level (Mark One):

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

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For	Cleveland Innerbelt	Job no.	49633	Sheet no.	
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HNTB

Check Fatigue on lighting brackets

Use Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, Fifth Edition.

Section 11 - Fatigue design

Per Sec. 11.6 these Light Brackets will be Fatigue Category III.

Fatigue Design for Natural Wind Gusts
Sec. 11.7.3

Design to Resist Equivalant static wind gust Pressure range of:

$P_{NW} = 5.2\ C_d\ I_f$ (psf) (11-5)

$C_d = 1.7$ (Table 3-6)

$I_f = 0.5$ (Table 11-1)

$P_{NW} = 5.2(1.7)(0.5) = 4.42$ psf

Upper lighting Bracket

find Moment at Base of HSS.

Conservitively calculate Moment at base plate HSS connection due to 2 light fixtures with wind on full EPA and wind on HSS.

Fixture: EPA = 4.52 ft^2

$$M_{Fix} = 2(4.52)(4.42)(6')\left(\frac{12''}{1'}\right) = 2{,}879\ \#\cdot in$$

HSS: Area = (0.333)(6) = 2 ft^2

$$M_{HSS} = 2(4.42)(3')\frac{12''}{ft} = 318\ \#\cdot in$$

$$M_{Total} = 2{,}879 + 318 = 3{,}195\ \#\cdot in$$

$$S_{weld} = bd + \frac{d^2}{3} = 4(4) + \frac{(4)^2}{3} = 21.33\ in^3$$

$b = d = 4''$

$$\sigma = \frac{M}{S} = \frac{2.9\ k\cdot in}{21.33} = 0.14\ ksi$$

Tables 11-2 and 11-3

Weld of HSS to Base plate is a Detail Category E'

Allowable stress Range for E' = 2.6 ksi

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Upper light Bracket (Cont.)

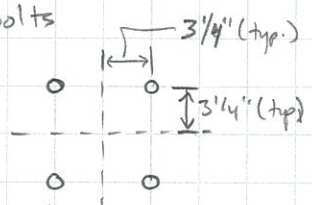
Bolted Connection of Base Plate to Web.

$M = 3{,}195$ #·in

find Section Modulus for Bolt group

3/4" ϕ Bolts

$A = 0.44\ in^2$



Moment of Inertia of group about centroid

$$I = \Sigma A d^2 = 4(0.44\ in^2)(3.25")^2 = 18.6\ in^4$$

$$S_{bolt} = 18.6 / 3.25 = 5.72\ in^3$$

$$\sigma = \frac{M}{S} = \frac{3.2\ k\cdot in}{5.72\ in^3} = 0.56\ ksi$$

Bolted Connection is a Category D Fatigue

Allowable Stress Range = 7 ksi

Upper lighting Bracket details are Ok for fatigue.

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Light Bracket at Stiffener

Check connection of Plate to Channel.

Fixture:

$$M_{Fix} = 4.52\ ft^2 (4.42\ psf)(1.5')\frac{12''}{1'}$$
$$= 360\ \#\cdot in$$

Plate:

$$M_{Plate} = (2')(0.5')(4.42\ psf)(1')\frac{12''}{1'}$$
$$= 53\ \#\cdot in$$

$M_{total} = 360 + 53 = 413\ \#\cdot in$

from Light Bracket Calcs.: $S_{weld} = 16\ in^3$

$$\sigma = \frac{0.413\ k\cdot in}{16\ in^3} = 0.026\ ksi$$

This is a Detail category E'

Allowable Stress Range for E' = 2.6 ksi

∴ Plate to Channel weld is OK for fatigue

Check connection of Channel to Stiffener

$$M_{Fixture} = (4.52\ ft^2)(4.42 psf)(6.5')\frac{12}{1}$$
$$= 1558\ \#\cdot in$$

$$M_{plate} = (2')(0.5')(6.5')(4.42\ psf)\frac{12}{1}$$
$$= 345\ \#\cdot in$$

$$M_{channel} = (0.583')(6.5')(4.42\ psf)(3.25')\frac{12}{1}$$
$$= 654\ \#\cdot in$$

$M_{Total} = 1558 + 345 + 654 = 2,557\ \#\cdot in$

Section Modulus of two Bolt, 1" ϕ $A = 0.785\ in^2$

Moment of Inertia about Centroid of Group

$$I = \Sigma A d^2 = 2(0.785)(1.5'')^2$$
$$= 3.53\ in^4$$

$$S_{bolt} = 3.53/1.5 = 2.36\ in^3$$

$$\sigma = \frac{M}{S} = \frac{2.6\ k\cdot in}{2.36} = 1.1\ ksi$$

Channel Bolted to Stiffener is a Category D Fatigue Detail

Allowable Range of Stress = 7 ksi

∴ Channel to Stiffener Bolted connection is ok for fatigue

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Light bracket at Stiffener (Cont)

Check fatigue Stress in Web of Channel bearing on Bolts

Conservitively use same moment previously calculated for Bolts.

$$M = 2.6 \text{ k·in}$$

$$I = 2(1.5^2) = 4.5$$

$$F = \frac{Mc}{I} = \frac{2.6(1.5)}{4.5} = 0.87 \text{ k}$$

$$\sigma = \frac{0.87 \text{ k}}{(1'')(0.419'')} = 2.08 \text{ ksi}$$

This is a Category D Fatigue Detail Allowable Stress Range = 7ksi

∴ Web of Channel in Bearing is Ok for Fatigue