Harding Lawson Associates, Inc.

Building, Engineering, Environmental, Planning & Construction Services

LETTER OF TRANSMITTAL

To:	James Taillon	Date:	March 26, 1999
	WOOD/PATEL	Project:	Orangewood Ave Storm Drain, Sub-Phase "C" , Phase II
	1550 East Missouri, Suite 203	Our No:	40049.3
	Phoenix, AZ 85014	VIA:	Delivery

We are enclosing:

No. of Copies	DWG. or Other Number	Title or Description, Remarks
1	SHEET 49 to 54 of 63	One set sealed and signed full size mylors for the Structures @ STA 92+64.00, STA. 22+11.91, STA. 33+89.45, STA 81+55.00, SAT. 12+49.60 and STA 10+66.18, Orangewood Ave Storm Drains.
1	SHEET 49 to 54 of 63	One set of half size of above mentioned plans
1	SHEET 49 to 54 of 63	A floppy disk with electronic files of the above mentioned plans
1		Structural Calculations

Remarks:

James

Please call us if we can be of further assistance.

Thank you.

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Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009

Copies to: file

S. Sivaji

Sivaji Senapathi, P.E.

234 North Central Ave., Suite 600
Phoenix, Arizona 85004
Tel: (602) 252-4105
Fax: (602) 252-4162

Harding Lawson Associates
Engineering
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Environmental Services

SHEET 1 OF
JOB NO. 40049.3
DATE 1/25/99
PROJECT ORANGEWOOD STORM DRAIN - SUB-PHASE 'C'
COMPUTED BY S.S.
SUBJECT STRUCTURE #1 @ STA 92+64.
CHECKED BY DKE

ROADWAY ELEVATION ≈ 1130'

INVERT ELEVATION OF 66" PIPE (NORTH) = 1117.50

ELEVATION @ BOTTOM OF TOP SLAB

$$= 1117.50 + \frac{(66+6.5)}{12} \times \frac{1}{\cos(28.2669)} + 1.635' = 1126.00$$

6.8596

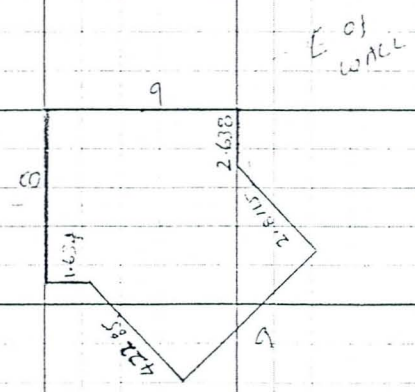
FLOOR SLAB ELEV = 1113.00

HEIGHT OF WALL BETWEEN SLABS = 1126.00 - 1113.00

= 13.00

FILL HEIGHT OVER THE BOX : 1130 - 1126.00 - 12" (Top Slab)

= 3.0' (OR) 36"



Harding Lawson Associates
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SHEET _____ OF _____
JOB NO. 40049.3
DATE 2/7/99
COMPUTED BY Sivai
CHECKED BY [illegible]

PROJECT ORANGWOOD AVE STORM DRAIN
SUBJECT STRUCTURE #1

CONCRETE:

PERIMETER LENGTH ALONG ℄ WALL = 9 + 8 + 2.64 + 2.81 + 9 + 4.23 + 1.63

= 37.31'

HEIGHT OF WALL (EXCLUDING TOP & BOTTOM SLABS)

= 13.00'

BEARING AREA OF BOX ≈ $10' * 10 + \frac{(4.6)^2}{2}$

≈ 111 SQ.FT.

THICKNESS OF TOP SLAB = 12"

THICKNESS OF BOT SLAB = 12"

VOLUME OF CONCRETE EXCLUDING OPENINGS.

= 37.31' * 13.00' + 111 * 1' + 111 * 1' = 707.03 C.F.

VOLUME OF OPENINGS:

$= \frac{\pi}{4}\left[(5.5)^2 + (5.5)^2 + (3.5)^2\right] * 1 + 4 * 2.5 * 1$

= 67.14 CF.

DROP FOOTING

Net Quantity: 707.03 − 67.14 + (9+10+10)(15")(6")

= 658.015 CF (or) 24.37 CY

≈ 25 CY (Including 6"×6" Fillets)

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SHEET 1 OF
JOB NO. 4-0049.3
DATE ~~2/8/99~~ 3/10/99
PROJECT ORANGEWOOD AVE STORM DRAIN
COMPUTED BY S.S.
SUBJECT STRUCTURE #1 @ STA 92+64.
CHECKED BY RE

STEEL:			
TOP SLAB:			
#6 @ 6"	LENGTH: (1'-9")+3.5= 5.25'		
	WEIGHT: 1.502 Lbs/Ft	= 283.87 LBS.	
	# of BARS: 36		
#5 @ 6"	LENGTH: 3.5'		
	WEIGHT: 1.043 lb/'	= 131.42 LBS.	
	# OF BRS: 36		
6-#6 T&B:	LENGTH: 10'		
BEAM.	WEIGHT: 1.502 lb/'	= 540 LBS.	
	# OF BARS: 36		
WALL			
#7 @ 12" E.F.	LENGTH: 14.65'		
	WEIGHT: 1.502 lb/'	= 1760.34 Lbs	
	# OF BARS: 80		
#5 @ 15" E.F.	LENGTH: 60'		
	WEIGHT: 1.043 lb/'	= 1376.76 LBS.	
	# OF BARS: 22		

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SHEET 2 OF
JOB NO. 40049.3
DATE 3/10/99
COMPUTED BY S.S.
CHECKED BY DLC

PROJECT ORANGEWOOD AVE. STORM DRAIN
SUBJECT STRUCTURE # 1

FLOOR SLAB:

#6 @ 12" EW : LENGTH ≈ 15'
WEIGHT = 1.502 lb/' = 405.54 lb.
# of BARS = 18

#6 @ 6" EW : LENGTH = 2*6 = 12'
WEIGHT = 1.502 lb/' = 540.72 lbs.
# OF BARS = 30

2-#6 in DROP FOOT. LENGTH ≈ 15'
WEIGHT = 1.502 lb/' = 135 lbs
# of BARS = 6

#4 CLOSED STIRRUPS: LENGTH: 5.25'
WEIGHT: 0.668 lb/' = 315.63 lbs
OF BARS: 90

#4 CLOSED STIRRUPS IN WALL : LENGTH ≈ 5.5'
WEIGHT = 0.668 lb/' = 36.74 lbs
# OF BARS: 10

TOTAL = 5526 ✓

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $kft \equiv kip \cdot ft$

STRUCTURE #1 @ STA. 92+64

Dimensions

Clear height between top and bottom slabs: $H_c := 12.12 \cdot ft$

Thickness of top slab: $t_{ts} := 12 \cdot in$

Thickness of the bottom slab: $t_{bs} := 12 \cdot in$

Active Equivalent fluid pressure at rest: $EFP := 55 \cdot pcf$

Passive Equivalent fluid pressure: $EFP_p := 0 \cdot pcf$

Depth of surcharge: $SD := 46.56 \cdot in + t_{ts}$ $SD = 4.88 \cdot ft$

Total height of wall : $h_{aw} := H_c + t_{ts} + t_{bs}$ $h_{aw} = 14.12 \cdot ft$

Coefficient of friction for sliding: $\mu := 0.40$

wall thickness : $tw := 12 \cdot in$

Soil Forces on Wall

Height of soil pressure prism along the wall: $H := H_c$ $H = 12.12 \cdot ft$

Active soil force along the wall pre LF: $q := SD \cdot EFP \cdot H + EFP \cdot H^2 \cdot \frac{1}{2}$ $q = 7.293 \cdot klf$

Passive soil force along the wall pre LF: $q_p := EFP_p \cdot H^2 \cdot \frac{1}{2}$ $q_p = 0 \cdot klf$

From PCI Design Hand Book, Edition 4, Design Aid 11.1.5 (10)

Moment along wall per LF (As a beam): $M_s := SD \cdot EFP \cdot \frac{H^2}{12} + EFP \cdot \frac{H^2}{2} \cdot \frac{H}{10}$ $M_s = 8.182 \cdot ft^{-1} \cdot kft$

HLA Infrastructure, Inc.

Sheet No._2_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #1 @ STA. 92+64

File :_Wal-str1.mcd_

Subject: Wall Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by DLE Date: 3/99

Material Properties

Allowable stress in reinforcing steel: $F_s = 24000 \cdot psi$

Elastic modulus of reinforcement: $E_s = 29 \cdot 10^6 \cdot psi$

Allowable stress in concrete: $f_{c28} = 3000 \cdot psi$ $\quad F_c = 0.4 \cdot f_{c28}$

Allowable working stress in concrete: $f_c = 0.4 \cdot f_{c28}$ $\quad f_c = 1200 \cdot psi$

Elastic modulus of concrete: $E_c = 57000 \cdot \sqrt{f_{c28} \cdot psi}$ $\quad E_c = 3122.02 \cdot ksi$

Modular ratio: $n = \frac{E_s}{E_c}$ $\quad k = \frac{f_c}{f_c + \frac{F_s}{n}}$ $\quad n = 9.289$

$k = 0.317$

Effective depth factor: $j = 1 - \frac{k}{3}$ $\quad j = 0.894$

Unit weight of concrete: $\gamma_c = 150 \cdot pcf$

Moment due to soil pressure on wall: $M_{s1} = M_s$ $\quad M_{s1} = 8.182 \cdot ft^{-1} \cdot kft$

Design

Moment due to soil pressure on wall at bottom slab:

$$M_{s2} = SD \cdot EFP \cdot \frac{H^2}{12} + EFP \cdot \frac{H^2}{2} \cdot \frac{H}{10}$$

$M_{s2} = 8.182 \cdot ft^{-1} \cdot kft$

Cover to main reinforcment: $d_c = 2 \cdot in$

Diameter of main reinforcement (#6): $d_b = 0.75 \cdot in$ $\quad A_b = 0.44 \cdot in^2$

Depth to main reinforcement: $d = tw - d_c - \frac{d_b}{2}$ $\quad d = 9.625 \cdot in$

Steel required per LF: $Ast = \frac{M_{s2}}{F_s \cdot j \cdot d}$ $\quad Ast = 0.475 \cdot ft^{-1} \cdot in^2$

provide #6 bars @ 12"

Design width: $b \quad 12 \cdot in$

Spacing of bars: $s \quad 6 \cdot in$

Area of reinforcing steel per design width: $A_s \quad A_b \cdot \frac{b}{s}$ $\qquad A_s = 0.88 \cdot in^2$

Reinforcement ratio: $\rho \quad \frac{A_s}{b \cdot d}$ $\qquad \rho = 0.7619 \cdot \%$

Balanced ratio: $\rho_b \quad \frac{1}{2} \cdot \frac{F_c}{F_s} \cdot \left(1 + \frac{F_s}{n \cdot F_c}\right)^{-1}$ $\qquad \rho_b = 0.793 \cdot \%$

(If RHO < RHO.b, Steel stress governs, otherwise concrete stress governs)

CHECK REQ'D CRACKING MOMENT CAPACITY

$f_r \quad 7.5 \cdot \sqrt{f_{c28}} \cdot psi$ $\qquad f_r = 410.792 \cdot psi$

$I \quad \frac{b \cdot tw^3}{12}$ $\qquad I = 1728 \cdot in^4$

$M_{cr} \quad \frac{I \cdot f_r}{0.5 \cdot tw \cdot b}$ $\qquad 1.2 \cdot M_{cr} = 11.83 \cdot \frac{kft}{ft}$ $\qquad M_{s2} = 8.182 \cdot ft^{-1} \cdot kft$

DESIGN STRESSES AASHTO 8.17.1.2

$k \quad (n \cdot \rho)^2 \quad 2 \cdot n \cdot \rho \quad n \cdot \rho$ $\qquad k = 0.454$

$mmax \quad if(M_{s2} > 1.2 \cdot M_{cr}, M_{s2}, 1.3 \cdot M_{s2})$ $\qquad mmax = 10.64 \cdot \frac{kft}{ft}$

$f_s \quad \frac{mmax \cdot b}{A_s \cdot j \cdot d}$ $\qquad f_s = 16850 \cdot psi$ $\qquad F_s = 24000 \cdot psi$

$f_c \quad \frac{2 \cdot mmax}{k \cdot j \cdot d^2}$ $\qquad f_c = 566.06 \cdot psi$ $\qquad F_c = 1200 \cdot psi$

CHECK SHEARING STRESSES

$q = 7.293 \cdot ft^{-1} \cdot kip$

$v_c \quad \frac{q}{b \cdot d}$ $\qquad v_c = 63.14 \cdot \frac{psi}{ft}$ $\qquad \frac{v_c}{f_{c28}} = 1.153 \cdot \frac{psi}{psi \cdot ft}$

Allowable Shearing Stress

$v_{all} \quad 0.9 \cdot \sqrt{f_{c28}} \cdot psi \quad 1100 \cdot \rho \cdot \frac{q \cdot d}{M_s} \cdot psi$ $\qquad v_{all} = 55.29 \cdot psi$

$v_{all} = 0.95 \cdot \sqrt{f_{c28}} \cdot psi$ $\qquad v_{all} = 52.03 \cdot psi$

HLA Infrastructure, Inc.

Sheet No_1_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #1 @ STA 92+64

File :_FLR-STR1.MCD_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by_OLE_ Date:_3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$ $ft \equiv 12.0 \cdot in$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$kft \equiv kip \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $CY := 27 \cdot ft^3$

Design of FLoor Slab for Structure #1 at Sta. 92+64

Span length c/c: $GS := 10.0 \cdot ft$ $GS = 120 \cdot in$

Wall width: $TW := 12 \cdot in$

Effective span between walls (AASHTO_9.6): $S := GS - TW$ $S = 9 \cdot ft$

Actual thickness of the Floor slab: (From BDDM Section 1.3.2) $ST := 12 \cdot in$

Design thickness of the Floor slab: $DS := ST - 0 \cdot in$

Depth of soil cover over box: $SD := 46.56 \cdot in$

Actual thickness of the top slab: $TS := 12 \cdot in$

Height of wall(between slabs): $HW := 12.12 \cdot ft$

Perimeter Length of the box: $PL := (8 \cdot ft + 9 \cdot ft + 2.638 \cdot ft + 2.8115 \cdot ft + 9 \cdot ft + 4.2285 \cdot ft + 1.634 \cdot ft)$

$PL = 37.31 \cdot ft$

Total bearing area of the box: $BA := 10 \cdot ft \cdot 9 \cdot ft + 0.5 \cdot (4.5918 \cdot ft)^2$ $BA = 100.54 \cdot ft^2$

DEAD LOAD MOMENTS

Concrete dead weight from slabs: $DL_{SL} := (TS + ST) \cdot BA \cdot 0.15 \cdot kcf$ $DL_{SL} = 30.16 \cdot kip$

Concrete wall: $DL_{wl} := PL \cdot TW \cdot HW \cdot 0.15 \cdot kcf$ $DL_{wl} = 67.83 \cdot kip$

Weight soil replaced by shaft: $DL_{WS} := SD \cdot \frac{\pi}{4} \cdot (5 \cdot ft)^2 \cdot 0.125 \cdot kcf$ $DL_{WS} = 9.52 \cdot kip$

Soil cover over the top slab: $DL_{soil} := SD \cdot BA \cdot 0.125 \cdot kcf$ $DL_{soil} = 48.76 \cdot kip$

Total dead load: $DL := DL_{SL} + DL_{wl} - DL_{WS} + DL_{soil}$ $DL = 137.24 \cdot kip$

HLA Infrastructure, Inc.

Sheet No_2_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #1 @ STA 92+64

File :_FLR-STR1.MCD_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by_OKE_ Date:_3/99_

Total weight of water in the box: $HL := BA \cdot HW \cdot 64 \cdot pcf - PL \cdot HW \cdot TW \cdot 64 \cdot pcf$ $HL = 49.05 \cdot kip$

Live Load moment paralle to Traffic:
(From AASHTO Sections 3.24.3 & 3.24.3.1) : $P_{L1} := 16000 \cdot lbf$ (Load on one rear wheel of truck)

Total DL Bearing pressure on floor slab per unit width: $W := \frac{DL + HL + P_{L1}}{BA}$ $W = 2.01 \cdot ksf$ < 1.5 ksf O.K.

(From LRFD-AISC 3-143)

Negative moment: $M_N := \frac{1}{12} \cdot W \cdot S^2$ $M_N = 13.58 \cdot kft \cdot ft^{-1}$

Positive moment: $M_P := \frac{1}{24} \cdot W \cdot S^2$ $M_P = 6.79 \cdot kft \cdot ft^{-1}$

FLOOR SLAB:

Design Moments

Negative moment: $M_{NT} := -M_N$ $M_{NT} = -13.58 \cdot kft \cdot ft^{-1}$

Positive moment: $M_{PT} := M_P$ $M_{PT} = 6.79 \cdot kft \cdot ft^{-1}$

MATERIAL PROPERTIES

Characteristic strength of concrete at 28 days: $f_{c28} := 3000 \cdot psi$

Allowable stress in concrete: $F_c := 0.40 \cdot f_{c28}$
(From BDDM Section 1.3.2)
use $F_c := if(F_c < 1400 \cdot psi, F_c, 1400 \cdot psi)$ $F_c = 1200 \cdot psi$

Use Grade 60 steel: $F_s := 24000 \cdot psi$

Elastic modulus of concrete: $E_c := 57000 \cdot \sqrt{f_{c28}} \cdot \sqrt{psi}$ $E_c = 3.12 \cdot 10^6 \cdot psi$

Elastic modulus of steel: $E_s := 29000 \cdot ksi$

Modular ratio: $n := \frac{E_s}{E_c}$ $n = 9.29$ $k := \frac{F_c}{F_c + \frac{F_s}{n}}$ $k = 0.32$

Effective depth factor: $j := 1 - \frac{k}{3}$ $j = 0.89$

HLA Infrastructure, Inc.

Sheet No_3_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #1 @ STA 92+64

File :_FLR-STR1.MCD_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by_[illegible]_ Date:_3/99_

Diameter of top main bars (#6): $\phi_t := 0.75 \cdot in$ $A_t := 0.44 \cdot in^2$

Diameter of bottom main bars (#6): $\phi_b := 0.75 \cdot in$ $A_b := 0.44 \cdot in^2$

Clear Cover to top reinforcement: $C_t := 2.0 \cdot in$

Clear Cover to bottom reinforcement: $C_b := 3.0 \cdot in$

Effective depth to top main steel: $d_t := ST - C_t - \frac{\phi_t}{2}$ $d_t = 9.62 \cdot in$

Effective depth to bottom main steel: $d_b := ST - C_b - \frac{\phi_b}{2}$ $d_b = 8.63 \cdot in$

Area of steel required at top: $Ast := \frac{|M_{PT}|}{F_s \cdot j \cdot d_t} \cdot ft$ $Ast = 0.39 \cdot in^2$

Number of bars at top: $NB_T := \frac{Ast}{A_t}$ $NB_T = 0.9$

Provide #6 bars @ 12" spacing at top.

Area of steel required at bottom: $Asb := \frac{|M_{NT}|}{F_s \cdot j \cdot d_b} \cdot ft$ $Asb = 0.88 \cdot in^2$

Number of bars at bottom: $NB_B := \frac{Asb}{A_b}$ $NB_B = 2$

Provide #6 bars @ 6" spacing at bottom.

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SHEET 2 OF
JOB NO. 40049.3
DATE 3/10/99
PROJECT ORANGEWOOD STORM DRAIN - SUB PHASE C
COMPUTED BY S. S.
SUBJECT STRUCTURE # 2 @ STA 22 + 11.91, RT
CHECKED BY

ROADWAY ELEVATION : 1144.80

INVERT ELEVATION OF 60" SD (NW-SIDE) = 1129.40

54" SD (SE-SIDE) = 1132.40

ELEVATION AT THE BOTTOM OF TOP SLAB.

$= 1132.40 + 4.5' + \left(\frac{5.5''}{12}\right) + 1'$

$= 1138.3583$

ASSUMING 12" THICK TOP SLAB

ELEVATION AT TOP OF TOP SLAB = 1139.3583.

FILL HEIGHT OVER TOP SLAB = 1144.80 − 1139.36

= 5.4417' (OT) 65.300"

WALL HEIGHT ON NW SIDE OF BOX :
(CLEAR BETW. TOP & BOTTOM SLABS)

= 1138.36 − 1129.40

= 8.9600'

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and
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SHEET _____ OF _____
JOB NO. 40049.3
DATE ~~2/7/99~~ 3/10/99
PROJECT ORANGEWOOD AVE. STORM DRAIN
COMPUTED BY Sivai
SUBJECT STRUCTURE #2, WEST BASIN OUTLET STRUCT.
CHECKED BY DC

CONCRETE

PERIMETER LENGTH ALONG ℄ OF WALL = 2(13 + 11.5) = 49"

HEIGT OF WALL ON NORTH SIDE = 8.96'

HEIGT OF WALL ON SOUTH SIDE = 5.96'

THICKNESS OF TOP SLAB = 12"

THICKNESS OF BOTTOM SLAB = 18"

CONCRETE VOLUME:

= (14)(12.5)(1') : TOP SLAB

+ (12.5)(8)(1.5) + (12.5)(7)(1.5) : BOT. SLAB

+ (8.96)(11.5 + 8 + 8)(1')
+ (5.96)(11.5 + 6 + 6)(1') : WALL

+ (10.5)(3.6)(1') : DIAPHRAGM

+ (11.5 + 7)(2)(1.25)(0.5) : DROP FOOTING.

= 903.64 CF.

VOLUME OF OPENINGS:

$= \frac{\pi}{4}\left[(3.5)^2 + (4.5)^2 + (3.5)^2 + (5)^2\right](1') = 54.78$ CF

NET CONCRETE: 903.64 − 54.78

= 848.86 CF (or) 31.44 CY ✓

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SHEET 1 OF
JOB NO. 40049.3
DATE ~~2/8/99~~ 3/10/99
PROJECT ORANGEWOOD STORM DRAIN.
COMPUTED BY S.S.
SUBJECT STRUCTURE #2
CHECKED BY OLE

STEEL				
TOP SLAB:				
#7@6' (AA)	LENGTH: 17'			
	WEIGHT: 2.044 lb/1		= 764.45 lbs.	
	# OF BARS: 22			
#7@6' (BB)	LENGTH: 15.5'			
	WEIGHT = 2.044 lb/1		= 792.05 lbs.	
	# OF BARS: 25			
#6@12" (AA)	LENGTH: 12'			
	WEIGHT: 1.502 lb/1		= 144.192 lbs.	
	# OF BARS: 8			
#5@6' (BB)	LENGTH: 13.5'			
	WEIGHT = 1.043 lb/1		= 309.77 lbs.	
	# of BARS: 22			
7-#6 T&B. (AA)	LENGTH: 12.5'			
	WEIGHT = 1.502 lb/1		= 262.85 lbs.	
	# OF BARS: 14			
7-#6 T&B (BB)	LENGTH: 13.5'			
	WEIGHT = 1.502		= 567.75 lbs.	
	# OF BARS: 28			

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SHEET 2 OF
JOB NO. 40049.3
DATE 3/10/99
PROJECT ORANGE WOOD AVE STORM DRAIN
COMPUTED BY S.S.
SUBJECT STRUCTURE #2
CHECKED BY

WALL						
#6 @ 12"		LENGTH = 11.5				
		WEIGHT = 1.502			932.74 lbs.	
		# of BARS : 54				
#6 @ 12"		LENGTH = 8.5'				
		WEIGHT = 1.502			= 587.28 lbs.	
		# of BARS = 46				
#5 @ 15"		LENGTH = 51				
		WEIGHT = 1.043 lb/1			= 957.48 lbs.	
		# OF BARS = 18				
#5 @ 12" (DIAPHRAM)		LENGTH: 12.5'				
		WEIGHT = 1.043			= 130.375 lbs.	
		# OF BARS : 10				
#6 @ 12" (DIAP.)		LENGTH: 5.5'				
		WEIGHT = 1.502 lb/1			= 90.87 lbs.	
		# OF BAR: 11				

Harding Lawson Associates
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Environmental Services

SHEET 3 OF
JOB NO. 400493
DATE 3/10/99
PROJECT ORANGEWOOD AVE STORM DRAIN
COMPUTED BY S.S.
SUBJECT STRUCTURE #2
CHECKED BY DLC

BOTTOM SLAB.			
#6 @ 6"	TOT LENGTH : 23'		
	WEIGHT = 1.502 lb/'	760.012	lbs.
	# of BARS : 22		
#6 @ 12" TOP MAT ALONG AA.	LENGTH : 13.5'		
	WEIGHT : 1.502 lb/'	223.05	lbs.
	# OF BARS : 11		
#6 @ 12" BOT MAT ALONG BB	LENGTH : 18'		
	WEIGHT = 1.502 lb/'	297.396	lbs.
	# OF BARS : 11		
#6 @ 12" TOP MAT ALONG BB :	LENGTH : 11.5		
	WEIGHT = 1.502	241.82	lbs.
	# OF BARS = 14		
#4 CLOSED STIRRUPS (Top Slab)	LENGTH ≈ 6'		
	WEIGHT = 0.668 lb/'	400.8	lbs.
	# OF BARS = 100		
	TOTAL = 7,462 lbs ✓		

HLA Infrastructure, Inc.

Sheet No_1_of__
Job No._40049.3_

Title: Orangwood Avenue Storm Drain
Structure #2 @ STA 22+11.91

File :_SL-STR2B.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_2/4/99_

Checked by OLE Date: 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$ $ft \equiv 12.0 \cdot in$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $kft \equiv kip \cdot ft$

$CY = 27 \cdot ft^3$

Design of Top Slab for Structure #2 at STA. 22+11.91 (Axis of Rotation is NW-SE)

Span length c/c: $GS := 11.5 \cdot ft$ $GS = 138 \cdot in$

Wall width: $TW := 12 \cdot in$

Effective span between walls (AASHTO_9.6): $S := GS - TW$ $S = 10.5 \cdot ft$

Actual thickness of the slab:
(From BDDM Section 1.3.2) $ST := 12 \cdot in$

Design thickness of the slab: $DS := ST - 0 \cdot in$

Depth of soil cover over box: $SD := 63.3 \cdot in$

Live Load moment paralle to Traffic:
(From AASHTO Sections 3.24.3 & 3.24.3.1) : $P_{L1} := 16000 \cdot lbf$ (Load on one rear wheel of truck)

Width of the distributed area on top of slab: $WD := 1.75 \cdot SD$ $WD = 9.23 \cdot ft$

Distribution Area for track wheel load (AASHTO 6.4.1): $A := (1.75 \cdot SD)^2$ $A = 85.22 \cdot ft^2$

Live load on slab per unit width of slab: $LL := \frac{P_{L1}}{A}$ $LL = 0.19 \cdot ft^{-1} \cdot klf$

Impact factor:
(From AASHTO Section 3.8.2.1) $I := 1.0$

From PCI Design Hand Book, Edition 4, Design Aid 11.1.5

Max. -ve Moment in lb-ft per unit width of slab:

Factor a is $a1 := \frac{WD}{S}$ $LLN := \left| \frac{LL \cdot S^2 \cdot a1 \cdot (6 - 8 \cdot a1 - 3 \cdot a1^2)}{12} \cdot I \right|$ $LLN = 5.08 \cdot ft^{-1} \cdot kft$

HLA Infrastructure, Inc.

Sheet No_2_of__
Job No._40049.3_

Title: Orangwood Avenue Storm Drain
Structure #2 @ STA 22+11.91

File :_SL-STR2B.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_2/4/99_

Checked by DLE Date: 3/99

Max. +ve Moment in lb-ft per unit width of slab:

Factor a is $a2 := \frac{S - WD}{2 \cdot S}$ $LLP := \left| \frac{LL \cdot S^2 \cdot (1 - 2 \cdot a2 + 4 \cdot a2^2)}{24} \cdot I \right|$ $LLP = 0.98 \cdot ft^{-1} \cdot kft$

DEAD LOAD MOMENTS

Concrete dead weight: $DL_{SL} := ST \cdot 0.15 \cdot kcf$ $DL_{SL} = 0.15 \cdot klf \cdot ft^{-1}$

Wearing Surface $DL_{WS} := 0 \cdot psf \cdot 1$ $DL_{WS} = 0 \cdot klf \cdot ft^{-1}$

Soil cover over the top slab: $DL_{soil} := SD \cdot 0.125 \cdot kcf$ $DL_{soil} = 0.66 \cdot ft^{-1} \cdot klf$

Total dead load: $W := DL_{SL} + DL_{WS} + DL_{soil}$ $W = 0.81 \cdot klf \cdot ft^{-1}$

(From LRFD-AISC 3-143)

Negative moment: $M_N := \frac{1}{12} \cdot W \cdot S^2$ $M_N = 7.44 \cdot kft \cdot ft^{-1}$

Positive moment: $M_P := \frac{1}{24} \cdot W \cdot S^2$ $M_P = 3.72 \cdot kft \cdot ft^{-1}$

TOP SLAB:

Design Moments

Negative moment: $M_{NT} := -LLN - M_N$ $M_{NT} = -12.52 \cdot kft \cdot ft^{-1}$

Positive moment: $M_{PT} := LLP + M_P$ $M_{PT} = 4.7 \cdot kft \cdot ft^{-1}$

MATERIAL PROPERTIES

Characteristic strength of concrete at 28 days: $f_{c28} := 3000 \cdot psi$

Allowable stress in concrete: $F_c := 0.40 \cdot f_{c28}$
(From BDDM Section 1.3.2)
use $F_c := if(F_c < 1400 \cdot psi, F_c, 1400 \cdot psi)$ $F_c = 1200 \cdot psi$

Use Grade 60 steel: $F_s := 20000 \cdot psi$

NOTE: BDDM Section 1.3.1 Reinforcement - All transverse deck reinforcing shall be designed using an allowable stress fs = 20000 psi. All other reinforcing bars shall be designed using an allowable stress fs = 24000 psi.

HLA Infrastructure, Inc.

Sheet No_3_of__
Job No._40049.3_

Title: Orangwood Avenue Storm Drain
Structure #2 @ STA 22+11.91

File :_SL-STR2B.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_2/4/99_

Checked by DLE Date: 3/99

Elastic modulus of concrete: $E_c := 57000 \cdot \sqrt{f_{c28} \cdot psi}$ $E_c = 3.12 \cdot 10^6 \cdot psi$

Elastic modulus of steel: $E_s := 29000 \cdot ksi$

Modular ratio: $n := \frac{E_s}{E_c}$ $n = 9.29$ $k := \frac{F_c}{F_c + \frac{F_s}{n}}$ $k = 0.36$

Effective depth factor: $j := 1 - \frac{k}{3}$ $j = 0.88$

Diameter of top main bars (#7): $\phi_t := 0.875 \cdot in$ $A_t := 0.60 \cdot in^2$

Diameter of bottom main bars (#6): $\phi_b := 0.75 \cdot in$ $A_b := 0.44 \cdot in^2$

Clear Cover to top reinforcement: $C_t := 2.0 \cdot in + 0.75 \cdot in$

Clear Cover to bottom reinforcement: $C_b := 1.0 \cdot in + 0.75 \cdot in$

Effective depth to top main steel: $d_t := ST - C_t - \frac{\phi_t}{2}$ $d_t = 8.81 \cdot in$

Effective depth to bottom main steel: $d_b := ST - C_b - \frac{\phi_b}{2}$ $d_b = 9.88 \cdot in$

Area of steel required at top: $Ast := \frac{|M_{NT}|}{F_s \cdot j \cdot d_t} \cdot ft$ $Ast = 0.97 \cdot in^2$

Number of bars at top: $NB_T := \frac{Ast}{A_t}$ $NB_T = 1.61$

Provide #7 bars @ 6" spacing at top.

Area of steel required at bottom: $Asb := \frac{|M_{PT}|}{F_s \cdot j \cdot d_b} \cdot ft$ $Asb = 0.32 \cdot in^2$

Number of bars at bottom: $NB_B := \frac{Asb}{A_b}$ $NB_B = 0.74$

Provide #6 bars @ 12" spacing at bottom.

HLA Infrastructure, Inc.

Sheet No_1_of__
Job No._40049.3_

Title: Orangwood Avenue Storm Drain
Structure #2 @ STA 22+11.91

File :_SLB-STR2.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_2/4/99_

Checked by AE Date: 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$ $ft \equiv 12.0 \cdot in$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $kft \equiv kip \cdot ft$

$CY = 27 \cdot ft^3$

Design of Top Slab for Structure #2 at STA. 22+11.91 (Axis of Rotation is NE-SW)

Span length c/c: $GS := 13.0 \cdot ft$ $GS = 156 \cdot in$

Wall width: $TW := 12 \cdot in$

Effective span between walls (AASHTO_9.6): $S := GS - TW$ $S = 12 \cdot ft$

Actual thickness of the slab:
(From BDDM Section 1.3.2) $ST := 12 \cdot in$

Design thickness of the slab: $DS := ST - 0 \cdot in$

Depth of soil cover over box: $SD := 63.3 \cdot in$

Live Load moment paralle to Traffic:
(From AASHTO Sections 3.24.3 & 3.24.3.1) : $P_{L1} := 16000 \cdot lbf$ (Load on one rear wheel of truck)

Width of the distributed area on top of slab: $WD := 1.75 \cdot SD$ $WD = 9.23 \cdot ft$

Distribution Area for track wheel load (AASHTO 6.4.1): $A := (1.75 \cdot SD)^2$ $A = 85.22 \cdot ft^2$

Live load on slab per unit width of slab: $LL := \frac{P_{L1}}{A}$ $LL = 0.19 \cdot ft^{-1} \cdot klf$

Impact factor:
(From AASHTO Section 3.8.2.1) $I := 1.0$

From PCI Design Hand Book, Edition 4, Design Aid 11.1.5

Max. -ve Moment in lb-ft per unit width of slab:

Factor a is $a1 := \frac{WD}{S}$ $LLN := \left| \frac{LL \cdot S^2 \cdot a1 \cdot (6 - 8 \cdot a1 - 3 \cdot a1^2)}{12} \cdot I \right|$ $LLN = 3.34 \cdot ft^{-1} \cdot kft$

HLA Infrastructure, Inc.

Sheet No_2_of__
Job No._40049.3_

Title: Orangwood Avenue Storm Drain
Structure #2 @ STA 22+11.91

File :_SLB-STR2.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_2/4/99_

Checked by GLC Date: 3/99

Max. +ve Moment in lb-ft per unit width of slab:

Factor a is $a2 := \frac{S - WD}{2 \cdot S}$ $LLP := \left| \frac{LL \cdot S^2 \cdot (1 + 2 \cdot a2 + 4 \cdot a2^2)}{24} \cdot I \right|$ $LLP = 1.45 \cdot ft^{-1} \cdot kft$

DEAD LOAD MOMENTS

Concrete dead weight: $DL_{SL} := ST \cdot 0.15 \cdot kcf$ $DL_{SL} = 0.15 \cdot klf \cdot ft^{-1}$

Wearing Surface $DL_{WS} := 0 \cdot psf \cdot 1$ $DL_{WS} = 0 \cdot klf \cdot ft^{-1}$

Soil cover over the top slab: $DL_{soil} := SD \cdot 0.125 \cdot kcf$ $DL_{soil} = 0.66 \cdot ft^{-1} \cdot klf$

Total dead load: $W := DL_{SL} + DL_{WS} + DL_{soil}$ $W = 0.81 \cdot klf \cdot ft^{-1}$

(From LRFD-AISC 3-143)

Negative moment: $M_N := \frac{1}{12} \cdot W \cdot S^2$ $M_N = 9.71 \cdot kft \cdot ft^{-1}$

Positive moment: $M_P := \frac{1}{24} \cdot W \cdot S^2$ $M_P = 4.86 \cdot kft \cdot ft^{-1}$

TOP SLAB:

Design Moments

Negative moment: $M_{NT} := -LLN - M_N$ $M_{NT} = -13.06 \cdot kft \cdot ft^{-1}$

Positive moment: $M_{PT} := LLP + M_P$ $M_{PT} = 6.3 \cdot kft \cdot ft^{-1}$

MATERIAL PROPERTIES

Characteristic strength of concrete at 28 days: $f_{c28} := 3000 \cdot psi$

Allowable stress in concrete: $F_c := 0.40 \cdot f_{c28}$
(From BDDM Section 1.3.2)
use $F_c := if(F_c < 1400 \cdot psi, F_c, 1400 \cdot psi)$ $F_c = 1200 \cdot psi$

Use Grade 60 steel: $F_s := 20000 \cdot psi$

NOTE: BDDM Section 1.3.1 Reinforcement - All transverse deck reinforcing shall be designed using an allowable stress fs = 20000 psi. All other reinforcing bars shall be designed using an allowable stress fs = 24000 psi.

HLA Infrastructure, Inc.

Sheet No_3_of__
Job No._40049.3_

Title: Orangwood Avenue Storm Drain
Structure #2 @ STA 22+11.91

File :_SLB-STR2.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_2/4/99_

Checked by_DE_ Date:3/99

Elastic modulus of concrete: $E_c := 57000 \cdot \sqrt{f_{c28} \cdot psi}$ $E_c = 3.12 \cdot 10^6 \cdot psi$

Elastic modulus of steel: $E_s := 29000 \cdot ksi$

Modular ratio: $n = \frac{E_s}{E_c}$ $n = 9.29$ $k = \frac{F_c}{F_c + \frac{F_s}{n}}$ $k = 0.36$

Effective depth factor: $j := 1 - \frac{k}{3}$ $j = 0.88$

Diameter of top main bars (#7): $\phi_t := 0.875 \cdot in$ $A_t := 0.60 \cdot in^2$

Diameter of bottom main bars (#6): $\phi_b := 0.75 \cdot in$ $A_b := 0.44 \cdot in^2$

Clear Cover to top reinforcement: $C_t := 2.0 \cdot in$

Clear Cover to bottom reinforcement: $C_b := 1.0 \cdot in$

Effective depth to top main steel: $d_t := ST - C_t - \frac{\phi_t}{2}$ $d_t = 9.56 \cdot in$

Effective depth to bottom main steel: $d_b := ST - C_b - \frac{\phi_b}{2}$ $d_b = 10.63 \cdot in$

Area of steel required at top: $Ast := \frac{|M_{NT}|}{F_s \cdot j \cdot d_t} \cdot ft$ $Ast = 0.93 \cdot in^2$

Number of bars at top: $NB_T := \frac{Ast}{A_t}$ $NB_T = 1.55$

Provide #7 bars @ 6" spacing at top.

Area of steel required at bottom: $Asb := \frac{|M_{PT}|}{F_s \cdot j \cdot d_b} \cdot ft$ $Asb = 0.4 \cdot in^2$

Number of bars at bottom: $NB_B := \frac{Asb}{A_b}$ $NB_B = 0.92$

Provide #6 bars @ 12" spacing at bottom.

HLA Infrastructure, Inc.

Sheet No._1_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #2 @ STA. 22+11.91

File :_Wal-str2.mcd_

Subject: Wall Design

Designed by_Sivaji.S_ Date:_2/2/99_

Checked by DLE Date: 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $kft \equiv kip \cdot ft$

STRUCTURE #2 @ STA. 22+11.91

Dimensions

Clear height between top and bottom slabs: $H_c = 8.96 \cdot ft$

Thickness of top slab: $t_{ts} = 14 \cdot in$

Thickness of the bottom slab: $t_{bs} := 18 \cdot in$

Active Equivalent fluid pressure at rest: $EFP := 55 \cdot pcf$

Passive Equivalent fluid pressure: $EFP_p := 0 \cdot pcf$

Depth of surcharge: $SD := 65.3 \cdot in + t_{ts}$ $SD = 6.608 \cdot ft$

Total height of wall : $h_{aw} := H_c + t_{ts} + t_{bs}$ $h_{aw} = 11.627 \cdot ft$

Coefficient of friction for sliding: $\mu := 0.40$

wall thickness : $tw := 12 \cdot in$

Soil Forces on Wall

Height of soil pressure prism along the wall: $H := H_c$ $H = 8.96 \cdot ft$

Active soil force along the wall pre LF: $q := SD \cdot EFP \cdot H + EFP \cdot H^2 \cdot \frac{1}{2}$ $q = 5.464 \cdot klf$

Passive soil force along the wall pre LF: $q_p := EFP_p \cdot H^2 \cdot \frac{1}{2}$ $q_p = 0 \cdot klf$

From PCI Design Hand Book, Edition 4, Design Aid 11.1.5 (10)

Moment along wall per LF (As a beam): $M_s := SD \cdot EFP \cdot \frac{H^2}{12} + EFP \cdot \frac{H^2}{2} \cdot \frac{H}{10}$ $M_s = 4.41 \cdot ft^{-1} \cdot kft$

HLA Infrastructure, Inc.

Sheet No._1_of__
Job No._40049.1_

Title: Orangewood Avenue Storm Drain
Structure #2 @ STA. 22+11.91

File :_Wal-str2.mcd_

Subject: Wall Design

Designed by _Sivaji.S_ Date:_2/2/99_

Checked by DLE Date: 3/99

Material Properties

Allowable stress in reinforcing steel: $F_s \quad 24000 \cdot psi$

Elastic modulus of reinforcement: $E_s \quad 29 \cdot 10^6 \cdot psi$

Allowable stress in concrete: $f_{c28} \quad 3000 \cdot psi$ $\qquad F_c \quad 0.4 \cdot f_{c28}$

Allowable working stress in concrete: $f_c \quad 0.4 \cdot f_{c28}$ $\qquad f_c = 1200 \cdot psi$

Elastic modulus of concrete: $E_c \quad 57000 \cdot \sqrt{f_{c28}} \cdot psi$ $\qquad E_c = 3122.02 \cdot ksi$

Modular ratio: $n \quad \frac{E_s}{E_c}$ $\qquad k \quad \frac{f_c}{f_c + \frac{F_s}{n}}$ $\qquad n = 9.289$

$k = 0.317$

Effective depth factor: $j \quad 1 - \frac{k}{3}$ $\qquad j = 0.894$

Unit weight of concrete: $\gamma_c \quad 150 \cdot pcf$

Moment due to soil pressure on wall: $M_{s1} \quad M_s$ $\qquad M_{s1} = 4.41 \cdot ft^{-1} \cdot kft$

Design

Moment due to soil pressure on wall at bottom slab:

$$M_{s2} \quad SD \cdot EFP \cdot \frac{H^2}{12} \quad EFP \cdot \frac{H^2}{2} \cdot \frac{H}{10}$$

$M_{s2} = 4.41 \cdot ft^{-1} \cdot kft$

Cover to main reinforcment: $d_c \quad 2 \cdot in$

Diameter of main reinforcement (#5): $d_b \quad 0.625 \cdot in$ $\qquad A_b \quad 0.31 \cdot in^2$

Depth to main reinforcement: $d \quad tw - d_c - \frac{d_b}{2}$ $\qquad d = 9.688 \cdot in$

Steel required per LF: $Ast \quad \frac{M_{s2}}{F_s \cdot j \cdot d}$ $\qquad Ast = 0.255 \cdot ft^{-1} \cdot in^2$

provide #5 bars @ 12"

Design width: $b \quad 12 \cdot in$

Spacing of bars: $s \quad 12 \cdot in$

Area of reinforcing steel per design width: $A_s \quad A_b \cdot \frac{b}{s}$ $\qquad A_s = 0.31 \cdot in^2$

Reinforcement ratio: $\rho \quad \frac{A_s}{b \cdot d}$ $\qquad \rho = 0.2667 \cdot \%$

Balanced ratio: $\rho_b \quad \frac{1}{2} \cdot \frac{F_c}{F_s} \cdot \left(1 - \frac{F_s}{n \cdot F_c}\right)$ $\qquad \rho_b = 0.793 \cdot \%$

(If RHO < RHO.b, Steel stress governs, otherwise concrete stress governs)

CHECK REQ'D CRACKING MOMENT CAPACITY

$f_r \quad 7.5 \cdot \sqrt{f_{c28}} \cdot psi$ $\qquad f_r = 410.792 \cdot psi$

$I \quad \frac{b \cdot tw^3}{12}$ $\qquad I = 1728 \cdot in^4$

$M_{cr} \quad \frac{I \cdot f_r}{0.5 \cdot tw \cdot b}$ $\qquad 1.2 \cdot M_{cr} = 11.83 \cdot \frac{kft}{ft}$ $\qquad M_{s2} = 4.41 \cdot ft^{-1} \cdot kft$

DESIGN STRESSES AASHTO 8.17.1.2

$k \quad \sqrt{n \cdot \rho^2 + 2 \cdot n \cdot \rho} - n \cdot \rho$ $\qquad k = 0.249$

$mmax \quad \text{if } M_{s2} > 1.2 \cdot M_{cr}, M_{s2}, 1.3 \cdot M_{s2}$ $\qquad mmax = 5.73 \cdot \frac{kft}{ft}$

$f_s \quad \frac{mmax \cdot b}{A_s \cdot j \cdot d}$ $\qquad f_s = 25614.56 \cdot psi$ $\qquad F_s = 24000 \cdot psi$

$f_c \quad \frac{2 \cdot mmax}{k \cdot j \cdot d^2}$ $\qquad f_c = 549.25 \cdot psi$ $\qquad F_c = 1200 \cdot psi$

CHECK SHEARING STRESSES

$q = 5.464 \cdot ft^{-1} \cdot kip$

$v_c \quad \frac{q}{b \cdot d}$ $\qquad v_c = 47 \cdot \frac{psi}{ft}$ $\qquad \frac{v_c}{f_{c28}} = 0.858 \cdot \frac{psi}{psi \cdot ft}$

Allowable Shearing Stress

$v_{all} \quad 0.9 \cdot f_{c28} \cdot psi \quad 1100 \cdot \rho \cdot \frac{q \cdot d}{M_s} \cdot psi$ $\qquad v_{all} = 52.23 \cdot psi$

$v_{all} \quad 0.95 \cdot f_{c28} \cdot psi$ $\qquad v_{all} = 52.03 \cdot psi$

HLA Infrastructure, Inc.

Sheet No_1_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #2 @ STA 22+11.91

File :_Flr-str2.mcd_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/2/99_

Checked by DAE Date: 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$ $ft \equiv 12.0 \cdot in$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$kft \equiv kip \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $CY := 27 \cdot ft^3$

Design of FLoor Slab for Structure #2 at Sta. 22+11.91

Span length c/c: $GS := 13.0 \cdot ft$ $GS = 156 \cdot in$

Wall width: $TW := 12 \cdot in$

Effective span between walls (AASHTO_9.6): $S := GS - TW$ $S = 12 \cdot ft$

Actual thickness of the Floor slab: (From BDDM Section 1.3.2) $ST := 12 \cdot in$

Design thickness of the Floor slab: $DS := ST - 0 \cdot in$

Depth of soil cover over box: $SD := 65.3 \cdot in$

Actual thickness of the top slab: $TS := 12 \cdot in$

Height of wall(between slabs): $HW := 8.96 \cdot ft$

Perimeter Length of the box: $PL := (13 \cdot ft + 11.5 \cdot ft) \cdot 2$ $PL = 49 \cdot ft$

Total bearing area of the box: $BA := 14 \cdot ft \cdot 12.5 \cdot ft$ $BA = 175 \cdot ft^2$

DEAD LOAD MOMENTS

Concrete dead weight from slabs: $DL_{SL} := (TS + ST) \cdot BA \cdot 0.15 \cdot kcf$ $DL_{SL} = 52.5 \cdot kip$

Concrete wall: $DL_{wl} := PL \cdot TW \cdot HW \cdot 0.15 \cdot kcf$ $DL_{wl} = 65.86 \cdot kip$

Weight soil replaced by shaft: $DL_{WS} := SD \cdot \frac{\pi}{4} \cdot (4 \cdot ft)^2 \cdot 0.125 \cdot kcf$ $DL_{WS} = 8.55 \cdot kip$

Soil cover over the top slab: $DL_{soil} := SD \cdot BA \cdot 0.125 \cdot kcf$ $DL_{soil} = 119.04 \cdot kip$

Total dead load: $DL := DL_{SL} + DL_{wl} - DL_{WS} + DL_{soil}$ $DL = 228.84 \cdot kip$

HLA Infrastructure, Inc.

Sheet No_2_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #2 @ STA 22+11.91

File :_Flr-str2.mcd_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/2/99_

Checked by_DLE_ Date:3/99

Total weight of water in the box: $HL := BA \cdot HW \cdot 64 \cdot pcf - PL \cdot HW \cdot TW \cdot 64 \cdot pcf$ $HL = 72.25 \cdot kip$

Live Load moment paralle to Traffic:
(From AASHTO Sections 3.24.3 & 3.24.3.1) : $P_{L1} = 16000 \cdot lbf$ (Load on one rear wheel of truck)

Total DL Bearing pressure on floor slab per unit width: $W := \frac{DL + HL + P_{L1}}{BA}$ $W = 1.81 \cdot ksf$ < 1.5 ksf O.K.

(From LRFD-AISC 3-143)

Negative moment: $M_N := \frac{1}{12} \cdot W \cdot S^2$ $M_N = 21.74 \cdot kft \cdot ft^{-1}$

Positive moment: $M_P := \frac{1}{24} \cdot W \cdot S^2$ $M_P = 10.87 \cdot kft \cdot ft^{-1}$

FLOOR SLAB:

Design Moments

Negative moment: $M_{NT} := -M_N$ $M_{NT} = -21.74 \cdot kft \cdot ft^{-1}$

Positive moment: $M_{PT} := M_P$ $M_{PT} = 10.87 \cdot kft \cdot ft^{-1}$

MATERIAL PROPERTIES

Characteristic strength of concrete at 28 days: $f_{c28} := 3000 \cdot psi$

Allowable stress in concrete: $F_c := 0.40 \cdot f_{c28}$
(From BDDM Section 1.3.2) use $F_c := if(F_c < 1400 \cdot psi, F_c, 1400 \cdot psi)$ $F_c = 1200 \cdot psi$

Use Grade 60 steel: $F_s := 24000 \cdot psi$

Elastic modulus of concrete: $E_c := 57000 \cdot \sqrt{f_{c28}} \cdot \sqrt{psi}$ $E_c = 3.12 \cdot 10^6 \cdot psi$

Elastic modulus of steel: $E_s := 29000 \cdot ksi$

Modular ratio: $n := \frac{E_s}{E_c}$ $n = 9.29$ $k := \frac{F_c}{F_c + \frac{F_s}{n}}$ $k = 0.32$

Effective depth factor: $j := 1 - \frac{k}{3}$ $j = 0.89$

HLA Infrastructure, Inc.

Sheet No_3_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #2 @ STA 22+11.91

File :_Flr-str2.mcd_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/2/99_

Checked by_AE_ Date:_3/99_

Diameter of top main bars (#6): $\phi_t := 0.75 \cdot in$ $A_t := 0.44 \cdot in^2$

Diameter of bottom main bars (#6): $\phi_b := 0.75 \cdot in$ $A_b := 0.44 \cdot in^2$

Clear Cover to top reinforcement: $C_t := 2.0 \cdot in$

Clear Cover to bottom reinforcement: $C_b := 3.0 \cdot in$

Effective depth to top main steel: $d_t := ST - C_t - \frac{\phi_t}{2}$ $d_t = 9.62 \cdot in$

Effective depth to bottom main steel: $d_b := ST - C_b - \frac{\phi_b}{2}$ $d_b = 8.63 \cdot in$

Area of steel required at top: $Ast := \frac{|M_{PT}|}{F_s \cdot j \cdot d_t} \cdot ft$ $Ast = 0.63 \cdot in^2$

Number of bars at top: $NB_T := \frac{Ast}{A_t}$ $NB_T = 1.44$

Provide #6 bars @ 12" spacing at top.

Area of steel required at bottom: $Asb := \frac{|M_{NT}|}{F_s \cdot j \cdot d_b} \cdot ft$ $Asb = 1.41 \cdot in^2$

Number of bars at bottom: $NB_B := \frac{Asb}{A_b}$ $NB_B = 3.2$

Provide #6 bars @ 6" spacing at bottom.

Harding Lawson Associates
Engineering
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Environmental Services

SHEET 3 OF
JOB NO. 40049.3
DATE 2/1/99
PROJECT ORANGEWOOD STORM DRAIN - SUB-PASE C
COMPUTED BY S. Sivaji
SUBJECT STRUCTURE # 3 @ STA 33+89.45, RT
CHECKED BY

ROADWAY ELEVATION ≈ 1148'

INVERT ELEVATION OF 108" S.D. (SW-SIDE) : 1133.10

(NE-SIDE) : 1132.00

ELEVATION AT THE BOTTOM OF TOP SLAB:

$= 1133.10 + \left(\frac{108'}{12}\right) + \left(\frac{10''}{12}\right) + 1'$

$= 1143.933'$

ASSUMING 12" thick TOP SLAB

ELEVATION AT THE TOP OF TOP SLAB = 1144.933

Fill HEIGHT OVER TOP SLAB = 1148 − 1144.933 = 3.067'

or 36.804"

WALL HEIGHT ON NE SIDE = 1143.933 − 1132.0
(BETWEEN TOP & BOTTOM SLABS)
= 11.933'

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SHEET _____ OF _____
JOB NO. 40049.2
DATE 2/7/99
PROJECT ORANGEWOOD AVE. STORMDRAIN
COMPUTED BY Sivi
SUBJECT STRUCTURE #3, EAST BASIN JUNCTION STRUCT.
CHECKED BY DLE

CONCRETE

PERIMETER LENGTH ALONG ℄ OF WALL = 2(15.5 + 13.33) = 57.66'

HEIGHT OF WALL ON N-E SIDE = 11.933'

HEIGHT OF WALL ON S-W SIDE = 10.833'

THICKNESS OF TOP SLAB = 12"

THICKNESS OF BOTTOM SLAB = 18"

CONCRETE VOLUME:

= (14)(16.5)(1') : TOP SLAB

+ (16.5)(8)(1.5) + (16.5)(7)(1.5) : BOT. SLAB

+ (11.933)(12.833 + 8 + 8)(1')
+ (10.833)(12.833 + 6 + 6)(1') } : WALL

+ (10.5)(2.6)(1') : DIAPHRAGM

+ (11.5 + 7)(2)(1.25)(0.5) : DROP FOOTING

= 1265.76 CF.

VOLUME OF OPENINGS:

$= \frac{\pi}{4}\left[9^2 + 9^2 + 3.5^2\right](1') = 136.85$ CF

NET CONCRETE = 1265.76 − 136.85

= 1128.91 CF (or) 42 CY ✓

Harding Lawson Associates
Engineering
and
Environmental Services

SHEET 1 OF
JOB NO. 40049.3
DATE 3/10/99
PROJECT ORANGEWOOD STORM DRAIN - SUBPHASE 'C'
COMPUTED BY SRE
SUBJECT STRUCTURE #3 @ STA 33+89.45
CHECKED BY DRE

STEEL						
TOP SLAB:						
#7 @ 6" (Top Mat)		LENGTH : 17'				
		WEIGHT = 2.044 lb/'			1077.19	Lbs.
		# of BARS = 31				
#6 @ 6" (Top Mat)		LENGTH = 19.75'				
		WEIGHT = 1.502 lb/'			741.61	lbs.
		# OF BARS = 25				
#6 @ 6" (Bot MAT)		LENGTH : 16.33'				
		WEIGHT = 1.502 lb/'			613.19	lbs.
		# OF BARS : 25				
#5 @ 6" (BOT. MAT)		LENGTH : 13.5'				
		WEIGHT : 1.043 lb/'			436.495	lbs.
		# of BARS : 31				
7-#6 T & B (BEAM)		LENGTH : 16.5'				
		WEIGHT : 1.502			346.96	lbs.
		# of BARS : 14				
7-#6 T & B (BEAM)		LENGTH : 13.5				
		WEIGHT : 1.502			567.75	lbs.
		# OF BAR : 28				

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and
Environmental Services

SHEET 2 OF
JOB NO. 40049.3
DATE 3/11/99
COMPUTED BY SS
CHECKED BY DLE

PROJECT ORANGE WOOD AVE STORM DRAIN
SUBJECT STRUCTURE #3

WALL						
#6 @ 12"		LENGTH	14'			
		WEIGHT	1.502 lb/'		1430.00	lbs.
		# of BARS	68			
#6 @ 12"		LENGTH	13'			
		WEIGHT	1.502 lb/'		1015.35	lbs.
		# OF BARS	52			
#5 @ 15"		LENGTH ≃	69.66			
		WEIGHT	1.043 lb/'		1743.73	lbs.
		# OF BARS	24.			
#5 @ 12" (DIAPH)		LENGTH	16.5			
		WEIGHT	1.043 lb/'		137.68	lbs.
		# OF BARS	8			
#6 @ 12" (DIAPH)		LENGTH	5.5			
		WEIGHT	1.502		132.176	lbs.
		# OF BARS	16			

Harding Lawson Associates
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and
Environmental Services

SHEET 3 OF
JOB NO. 40049.3
DATE 3/11/99
COMPUTED BY S.S.
CHECKED BY

PROJECT ORANGEWOOD AVE STORM DRAIN
SUBJECT STRUCTURE #3

BOTTOM SLAB						
#6 @ 6"		TOT. LENGTH: 30'				
		WEIGHT: 1.502 lb/,			1396.86 lbs.	
		# OF BARS: 31				
#6 @ 12" (TOP MAT)		LENGTH: 14.5'				
		WEIGHT: 1.502			348.464 lbs.	
		# OF BAR: 16				
#6 @ 12" (TOP MAT)		LENGTH ≈ 15.5'				
		WEIGHT: 1.502			349.22 lbs	
		# OF BARS: 15				
#6 @ 12" (BOT MAT)		LENGTH: 19'				
		WEIGHT: 1.502			799.06 lbs	
		# OF BARS: 28				
#4 closed STIRRUPS.		: LENGTH ≈ 6'				
		WEIGHT: 0.668 lb/,			481.0 lbs	
		# of BAR: 120				
	TOTAL	: 11,616 lbs ✓				

HLA Infrastructure, Inc.

Sheet No_1_of__
Job No._40049.3_

Title: Orangwood Avenue Storm Drain
Structure #3 @ STA 33+89.45

File :_SL-STR3B.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_3/11/99_

Checked by DLE Date: 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$ $ft \equiv 12.0 \cdot in$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $kft \equiv kip \cdot ft$

$CY := 27 \cdot ft^3$

Design of Top Slab for Structure #3 at STA. 33+89.45 (Axis of Rotation is NW-SE)

Span length c/c: $GS := 13.3 \cdot ft$ $GS = 159.6 \cdot in$

Wall width: $TW := 12 \cdot in$

Effective span between walls (AASHTO_9.6): $S := GS - TW$ $S = 12.3 \cdot ft$

Actual thickness of the slab:
(From BDDM Section 1.3.2) $ST := 12 \cdot in$

Design thickness of the slab: $DS := ST - 0 \cdot in$

Depth of soil cover over box: $SD := 36.8 \cdot in$

Live Load moment paralle to Traffic:
(From AASHTO Sections 3.24.3 & 3.24.3.1) : $P_{L1} := 16000 \cdot lbf$ (Load on one rear wheel of truck)

Width of the distributed area on top of slab: $WD := 1.75 \cdot SD$ $WD = 5.37 \cdot ft$

Distribution Area for track wheel load (AASHTO 6.4.1): $A := (1.75 \cdot SD)^2$ $A = 28.8 \cdot ft^2$

Live load on slab per unit width of slab: $LL := \frac{P_{L1}}{A}$ $LL = 0.56 \cdot ft^{-1} \cdot klf$

Impact factor:
(From AASHTO Section 3.8.2.1) $I := 1.0$

From PCI Design Hand Book, Edition 4, Design Aid 11.1.5

Max. -ve Moment in lb-ft per unit width of slab:

Factor a is $a1 := \frac{WD}{S}$ $LLN := \left| \frac{LL \cdot S^2 \cdot a1 \cdot (6 - 8 \cdot a1 - 3 \cdot a1^2)}{12} \cdot I \right|$ $LLN = 5.92 \cdot ft^{-1} \cdot kft$

HLA Infrastructure, Inc.

Sheet No_2_of__
Job No._40049.3_

Title: Orangwood Avenue Storm Drain
Structure #3 @ STA 33+89.45

File :_SL-STR3B.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_3/11/99_

Checked by OLE Date: 3/99

Max. +ve Moment in lb-ft per unit width of slab:

Factor a is $a2 := \frac{S - WD}{2 \cdot S}$ $LLP := \left| \frac{LL \cdot S^2 \cdot (1 + 2 \cdot a2 + 4 \cdot a2^2)}{24} \cdot I \right|$ $LLP = 6.59 \cdot ft^{-1} \cdot kft$

DEAD LOAD MOMENTS

Concrete dead weight: $DL_{SL} := ST \cdot 0.15 \cdot kcf$ $DL_{SL} = 0.15 \cdot klf \cdot ft^{-1}$

Wearing Surface $DL_{WS} := 0 \cdot psf \cdot 1$ $DL_{WS} = 0 \cdot klf \cdot ft^{-1}$

Soil cover over the top slab: $DL_{soil} := SD \cdot 0.125 \cdot kcf$ $DL_{soil} = 0.38 \cdot ft^{-1} \cdot klf$

Total dead load: $W := DL_{SL} + DL_{WS} + DL_{soil}$ $W = 0.53 \cdot klf \cdot ft^{-1}$

(From LRFD-AISC 3-143)

Negative moment: $M_N := \frac{1}{12} \cdot W \cdot S^2$ $M_N = 6.72 \cdot kft \cdot ft^{-1}$

Positive moment: $M_P := \frac{1}{24} \cdot W \cdot S^2$ $M_P = 3.36 \cdot kft \cdot ft^{-1}$

TOP SLAB:

Design Moments

Negative moment: $M_{NT} := -LLN - M_N$ $M_{NT} = -12.65 \cdot kft \cdot ft^{-1}$

Positive moment: $M_{PT} := LLP + M_P$ $M_{PT} = 9.95 \cdot kft \cdot ft^{-1}$

MATERIAL PROPERTIES

Characteristic strength of concrete at 28 days: $f_{c28} := 3000 \cdot psi$

Allowable stress in concrete: $F_c := 0.40 \cdot f_{c28}$
(From BDDM Section 1.3.2)

use $F_c := if(F_c < 1400 \cdot psi, F_c, 1400 \cdot psi)$ $F_c = 1200 \cdot psi$

Use Grade 60 steel: $F_s := 20000 \cdot psi$

NOTE: BDDM Section 1.3.1 Reinforcement - All transverse deck reinforcing shall be designed using an allowable stress fs = 20000 psi. All other reinforcing bars shall be designed using an allowable stress fs = 24000 psi.

HLA Infrastructure, Inc.

Sheet No_3_of__
Job No._40049.3_

Title: Orangwood Avenue Storm Drain
Structure #3 @ STA 33+89.45

File :_SL-STR3B.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_3/11/99_

Checked by DLE Date: 3/99

Elastic modulus of concrete: $E_c := 57000 \cdot \sqrt{f_{c28} \cdot psi}$ $E_c = 3.12 \cdot 10^6 \cdot psi$

Elastic modulus of steel: $E_s := 29000 \cdot ksi$

Modular ratio: $n := \frac{E_s}{E_c}$ $n = 9.29$ $k := \frac{F_c}{F_c + \frac{F_s}{n}}$ $k = 0.36$

Effective depth factor: $j := 1 - \frac{k}{3}$ $j = 0.88$

Diameter of top main bars (#6): $\phi_t := 0.75 \cdot in$ $A_t := 0.44 \cdot in^2$

Diameter of bottom main bars (#5): $\phi_b := 0.625 \cdot in$ $A_b := 0.31 \cdot in^2$

Clear Cover to top reinforcement: $C_t := 2.0 \cdot in$

Clear Cover to bottom reinforcement: $C_b := 1.0 \cdot in$

Effective depth to top main steel: $d_t := ST - C_t - \frac{\phi_t}{2}$ $d_t = 9.62 \cdot in$

Effective depth to bottom main steel: $d_b := ST - C_b - \frac{\phi_b}{2}$ $d_b = 10.69 \cdot in$

Area of steel required at top: $Ast := \frac{|M_{NT}|}{F_s \cdot j \cdot d_t} \cdot ft$ $Ast = 0.9 \cdot in^2$

Number of bars at top: $NB_T := \frac{Ast}{A_t}$ $NB_T = 2.03$

Provide #6 bars @ 6" spacing at top.

Area of steel required at bottom: $Asb := \frac{|M_{PT}|}{F_s \cdot j \cdot d_b} \cdot ft$ $Asb = 0.63 \cdot in^2$

Number of bars at bottom: $NB_B := \frac{Asb}{A_b}$ $NB_B = 2.05$

Provide #5 bars @ 6" spacing at bottom.

HLA Infrastructure, Inc.

Sheet No._1_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #3 @ STA. 33+89.45

File :_Wal-str3.mcd_

Subject: Wall Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by_____ Date:_____

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $kft \equiv kip \cdot ft$

STRUCTURE #3 @ STA. 33+89.45

Dimensions

Clear height between top and bottom slabs: $H_c := 11.933 \cdot ft$

Thickness of top slab: $t_{ts} := 12 \cdot in$

Thickness of the bottom slab: $t_{bs} := 18 \cdot in$

Active Equivalent fluid pressure at rest: $EFP := 55 \cdot pcf$

Passive Equivalent fluid pressure: $EFP_p := 0 \cdot pcf$

Depth of surcharge: $SD := 36.8 \cdot in + t_{ts}$ $SD = 4.067 \cdot ft$

Total height of wall : $h_{aw} := H_c + t_{ts} + t_{bs}$ $h_{aw} = 14.433 \cdot ft$

Coefficient of friction for sliding: $\mu := 0.40$

wall thickness : $tw := 12 \cdot in$

Soil Forces on Wall

Height of soil pressure prism along the wall: $H := H_c$ $H = 11.933 \cdot ft$

Active soil force along the wall pre LF: $q := SD \cdot EFP \cdot H + EFP \cdot H^2 \cdot \frac{1}{2}$ $q = 6.585 \cdot klf$

Passive soil force along the wall pre LF: $q_p := EFP_p \cdot H^2 \cdot \frac{1}{2}$ $q_p = 0 \cdot klf$

From PCI Design Hand Book, Edition 4, Design Aid 11.1.5 (10)

Moment along wall per LF (As a beam): $M_s := SD \cdot EFP \cdot \frac{H^2}{12} + EFP \cdot \frac{H^2}{2} \cdot \frac{H}{10}$ $M_s = 7.327 \cdot ft^{-1} \cdot kft$

HLA Infrastructure, Inc.

Sheet No_2_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #3 @ STA. 33+89.45

File :_Wal-str3.mcd_

Subject: Wall Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by AE Date: 3/99

Material Properties

Allowable stress in reinforcing steel: $F_s = 24000 \cdot psi$

Elastic modulus of reinforcement: $E_s = 29 \cdot 10^6 \cdot psi$

Allowable stress in concrete: $f_{c28} = 3000 \cdot psi$ $\quad F_c = 0.4 \cdot f_{c28}$

Allowable working stress in concrete: $f_c = 0.4 \cdot f_{c28}$ $\quad f_c = 1200 \cdot psi$

Elastic modulus of concrete: $E_c = 57000 \cdot \sqrt{f_{c28} \cdot psi}$ $\quad E_c = 3122.02 \cdot ksi$

Modular ratio: $n = \frac{E_s}{E_c}$ $\quad k = \frac{f_c}{f_c + \frac{F_s}{n}}$ $\quad n = 9.289$ $\quad k = 0.317$

Effective depth factor: $j = 1 - \frac{k}{3}$ $\quad j = 0.894$

Unit weight of concrete: $\gamma_c = 150 \cdot pcf$

Moment due to soil pressure on wall: $M_{s1} = M_s$ $\quad M_{s1} = 7.327 \cdot ft^{-1} \cdot kft$

Design

Moment due to soil pressure on wall at bottom slab:

$$M_{s2} = SD \cdot EFP \cdot \frac{H^2}{12} + EFP \cdot \frac{H^2}{2} \cdot \frac{H}{10}$$

$M_{s2} = 7.327 \cdot ft^{-1} \cdot kft$

Cover to main reinforcment: $d_c = 2 \cdot in$

Diameter of main reinforcement (#6): $d_b = 0.75 \cdot in$ $\quad A_b = 0.44 \cdot in^2$

Depth to main reinforcement: $d = tw - d_c - \frac{d_b}{2}$ $\quad d = 9.625 \cdot in$

Steel required per LF: $Ast = \frac{M_{s2}}{F_s \cdot j \cdot d}$ $\quad Ast = 0.426 \cdot ft^{-1} \cdot in^2$

provide #6 bars @ 12"

HLA Infrastructure, Inc.

Sheet No_3_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #3 @ STA. 33+69.45

File :_Wal-str3.mcd_

Subject: Wall Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by GLC Date: 3/99

Design width: $b \quad 12 \cdot in$

Spacing of bars: $s \quad 12 \cdot in$

Area of reinforcing steel per design width: $A_s \quad A_b \cdot \frac{b}{s}$ $\qquad A_s = 0.44 \cdot in^2$

Reinforcement ratio: $\rho \quad \frac{A_s}{b \cdot d}$ $\qquad \rho = 0.381 \cdot \%$

Balanced ratio: $\rho_b \quad \frac{1}{2} \cdot \frac{F_c}{F_s} \cdot \left(1 - \frac{F_s}{n \cdot F_c}\right)$ $\qquad \rho_b = 0.793 \cdot \%$

(If RHO < RHO.b, Steel stress governs, otherwise concrete stress governs)

CHECK REQ'D CRACKING MOMENT CAPACITY

$f_r \quad 7.5 \cdot \sqrt{f_{c28}} \cdot psi$ $\qquad f_r = 410.792 \cdot psi$

$I \quad \frac{b \cdot tw^3}{12}$ $\qquad I = 1728 \cdot in^4$

$M_{cr} \quad \frac{I \cdot f_r}{0.5 \cdot tw \cdot b}$ $\qquad 1.2 \cdot M_{cr} = 11.83 \cdot \frac{kft}{ft}$ $\qquad M_{s2} = 7.327 \cdot ft^{-1} \cdot kft$

DESIGN STRESSES AASHTO 8.17.1.2

$k \quad \sqrt{(n \cdot \rho)^2 + 2 \cdot n \cdot \rho} - n \cdot \rho$ $\qquad k = 0.304$

$mmax \quad \text{if}\left(M_{s2} > 1.2 \cdot M_{cr}, M_{s2}, 1.3 \cdot M_{s2}\right)$ $\qquad mmax = 9.53 \cdot \frac{kft}{ft}$

$f_s \quad \frac{mmax \cdot b}{A_s \cdot j \cdot d}$ $\qquad f_s = 30180 \cdot psi$ $\qquad F_s = 24000 \cdot psi$

$f_c \quad \frac{2 \cdot mmax}{k \cdot j \cdot d^2}$ $\qquad f_c = 756.99 \cdot psi$ $\qquad F_c = 1200 \cdot psi$

CHECK SHEARING STRESSES

$q = 6.585 \cdot ft^{-1} \cdot kip$

$v_c \quad \frac{q}{b \cdot d}$ $\qquad v_c = 57.01 \cdot \frac{psi}{ft}$ $\qquad \frac{v_c}{f_{c28}} = 1.041 \cdot \frac{psi}{psi \cdot ft}$

Allowable Shearing Stress

$v_{all} \quad 0.9 \cdot f_{c28} \cdot psi \quad 1100 \cdot \rho \cdot \frac{q \cdot d}{M_s} \cdot psi$ $\qquad v_{all} = 52.32 \cdot psi$

$v_{all} \quad 0.95 \cdot f_{c28} \cdot psi$ $\qquad v_{all} = 52.03 \cdot psi$

HLA Infrastructure, Inc.

Sheet No_1_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #3 @ STA 33+89.45

File :_Flr-str3.mcd_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by JLE Date: 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$ $ft \equiv 12.0 \cdot in$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$kft \equiv kip \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $CY := 27 \cdot ft^3$

Design of FLoor Slab for Structure #3 at Sta. 33+89.45

Span length c/c: $GS := 13 \cdot ft$ $GS = 156 \cdot in$

Wall width: $TW := 12 \cdot in$

Effective span between walls (AASHTO_9.6): $S := GS - TW$ $S = 12 \cdot ft$

Actual thickness of the Floor slab: (From BDDM Section 1.3.2) $ST := 18 \cdot in$

Design thickness of the Floor slab: $DS := ST - 0 \cdot in$

Depth of soil cover over box: $SD := 36.8 \cdot in$

Actual thickness of the top slab: $TS := 12 \cdot in$

Height of wall(between slabs): $HW := 11.933 \cdot ft$

Perimeter Length of the box: $PL := (13 \cdot ft + 15.5 \cdot ft) \cdot 2$ $PL = 57 \cdot ft$

Total bearing area of the box: $BA := 14 \cdot ft \cdot 16.5 \cdot ft$ $BA = 231 \cdot ft^2$

DEAD LOAD MOMENTS

Concrete dead weight from slabs: $DL_{SL} := (TS + ST) \cdot BA \cdot 0.15 \cdot kcf$ $DL_{SL} = 86.62 \cdot kip$

Concrete wall: $DL_{wl} := PL \cdot TW \cdot HW \cdot 0.15 \cdot kcf$ $DL_{wl} = 102.03 \cdot kip$

Weight soil replaced by shaft: $DL_{WS} := SD \cdot \frac{\pi}{4} \cdot (4 \cdot ft)^2 \cdot 0.125 \cdot kcf$ $DL_{WS} = 4.82 \cdot kip$

Soil cover over the top slab: $DL_{soil} := SD \cdot BA \cdot 0.125 \cdot kcf$ $DL_{soil} = 88.55 \cdot kip$

Total dead load: $DL := DL_{SL} + DL_{wl} - DL_{WS} + DL_{soil}$ $DL = 272.39 \cdot kip$

HLA Infrastructure, Inc.

Sheet No_2_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #3 @ STA 33+89.45

File :_Flr-str3.mcd_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by GLE Date: 3/99

Total weight of water in the box: $HL := BA \cdot HW \cdot 64 \cdot pcf - PL \cdot HW \cdot TW \cdot 64 \cdot pcf$ $HL = 132.89 \cdot kip$

Live Load moment paralle to Traffic:
(From AASHTO Sections 3.24.3 & 3.24.3.1) : $P_{L1} := 16000 \cdot lbf$ (Load on one rear wheel of truck)

Total DL Bearing pressure on floor slab per unit width: $W := \frac{DL + HL + P_{L1}}{BA}$ $W = 1.82 \cdot ksf$

< 1.5 ksf O.K.

(From LRFD-AISC 3-143)

Negative moment: $M_N := \frac{1}{12} \cdot W \cdot S^2$ $M_N = 21.88 \cdot kft \cdot ft^{-1}$

Positive moment: $M_P := \frac{1}{24} \cdot W \cdot S^2$ $M_P = 10.94 \cdot kft \cdot ft^{-1}$

FLOOR SLAB:

Design Moments

Negative moment: $M_{NT} := -M_N$ $M_{NT} = -21.88 \cdot kft \cdot ft^{-1}$

Positive moment: $M_{PT} := M_P$ $M_{PT} = 10.94 \cdot kft \cdot ft^{-1}$

MATERIAL PROPERTIES

Characteristic strength of concrete at 28 days: $f_{c28} := 3000 \cdot psi$

Allowable stress in concrete: $F_c := 0.40 \cdot f_{c28}$
(From BDDM Section 1.3.2)
use $F_c := if(F_c < 1400 \cdot psi, F_c, 1400 \cdot psi)$ $F_c = 1200 \cdot psi$

Use Grade 60 steel: $F_s := 24000 \cdot psi$

Elastic modulus of concrete: $E_c := 57000 \cdot \sqrt{f_{c28}} \cdot \sqrt{psi}$ $E_c = 3.12 \cdot 10^6 \cdot psi$

Elastic modulus of steel: $E_s := 29000 \cdot ksi$

Modular ratio: $n := \frac{E_s}{E_c}$ $n = 9.29$ $k := \frac{F_c}{F_c + \frac{F_s}{n}}$ $k = 0.32$

Effective depth factor: $j := 1 - \frac{k}{3}$ $j = 0.89$

HLA Infrastructure, Inc.

Sheet No_3_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #3 @ STA 33+89.45

File :_Flr-str3.mcd_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by_QE_ Date:3/99

Diameter of top main bars (#6): $\phi_t := 0.75 \cdot in$ $A_t := 0.44 \cdot in^2$

Diameter of bottom main bars (#6): $\phi_b := 0.75 \cdot in$ $A_b := 0.44 \cdot in^2$

Clear Cover to top reinforcement: $C_t := 2.0 \cdot in$

Clear Cover to bottom reinforcement: $C_b := 3.0 \cdot in$

Effective depth to top main steel: $d_t := ST - C_t - \frac{\phi_t}{2}$ $d_t = 15.63 \cdot in$

Effective depth to bottom main steel: $d_b := ST - C_b - \frac{\phi_b}{2}$ $d_b = 14.63 \cdot in$

Area of steel required at top: $Ast := \frac{|M_{PT}|}{F_s \cdot j \cdot d_t} \cdot ft$ $Ast = 0.39 \cdot in^2$

Number of bars at top: $NB_T := \frac{Ast}{A_t}$ $NB_T = 0.89$

Provide #6 bars @ 12" spacing at top.

Area of steel required at bottom: $Asb := \frac{|M_{NT}|}{F_s \cdot j \cdot d_b} \cdot ft$ $Asb = 0.84 \cdot in^2$

Number of bars at bottom: $NB_B := \frac{Asb}{A_b}$ $NB_B = 1.9$

Provide #6 bars @ 6" spacing at bottom.

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SHEET _____ OF _____
JOB NO. 40049.3
DATE 2/7/99
PROJECT ORANGEWOOD AVE, STORM DRAIN
COMPUTED BY Sivaji
SUBJECT STRUCTURE #4. WEST BASIN OUTLET STRUCTURE
CHECKED BY ORL

CONCRETE

BASE AREA OF BASIN STRUCTURE: 6*7 = 42 SQFT.

AVERAGE HEIGHT OF WALL = $\frac{(4.5+3.0)}{2} = 3.75$

VOLUME OF CONCRETE EXCLUDING OPENINGS

$= (5+6)(2)(3.75)(\frac{10''}{12})$: WALL

$+ 42 * \frac{12''}{12}$: FLOOR

$+ (7+6)(1.25)(0.5)$: DROP FOOTING

$= 118.84$ CF.

VOLUME OF OPENINGS IN WALLS.

$= \frac{\pi}{4}\left[(3.5)^2 + (2.25)^2\right](0.833) = 11.326$ CF

NET CONCRETE : 118.84 − 11.326 = 107.52 CF

(or) 4 CY ✓

Orangewood Ave Storm Drain, Phase 3
Structure #4, @ STA 81+55.00

Item No.	Description	No. Bars	Length in mm	Length in ft	Weight per Lin feet	Total Wt. in Lbs	Weight in Kgs	Remarks
	Bottom Slab							
1	#5 @ 12 inches Top mat	6		5.00	1.043	31.29	14.19	E_W Dir.
2	#5 @ 12 inches Bot. mat	6		10.00	1.043	62.58	28.39	E_W Dir.
3	#5 @ 12 inches Top mat	4		6.50	1.043	27.12	12.30	N_S Dir.
4	#5 @ 12 inches Bot. mat	6		11.00	1.043	68.84	31.22	N_S Dir.
5	2-#6 in Drop Footing	4		10.00	1.502	60.08	27.25	E_W Dir. & N_W Dir.
	Wall							
1	#5 @ 12 inches on Wall to full Ht.	40		4.00	1.043	166.88	75.70	Vertical
2	#5 @ 15 inches in wall	10		38.00	1.043	396.34	179.78	
3	Hoop Bars at 42 "Pipe openings	2		17.18	1.502	51.61	23.41	
4	Hoop Bars at 27" Pipe openings	2		6.00	1.502	18.02	8.18	
	Grate						0.00	
1	2" x 1/5" Bars @ 6" Spacing	11		4.30	3.4	160.82	72.95	
2	ANGLES	6		5.00	7.2	216.00	97.98	
3	Miscellaneous					20.00	9.07	
	Total					1279.58	580.42	

HLA Infrastructure, Inc.

Sheet No. 1 of
Job No. 40049.3

Title: Orangewood Avenue Storm Drain
Structures #4 @ STA. 81+55

File : Wal-str4.mcd

Subject: Wall Design

Designed by Sivaji.S Date: 2/9/99

Checked by GRE Date: 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $kft \equiv kip \cdot ft$

STRUCTURE #4 WALL DESIGN @ STA. 81+55

Dimensions

Clear height top of bottom slab: $H_c := 4.50 \cdot ft$

Thickness of top slab: $t_{ts} := 0 \cdot in$

Thickness of the bottom slab: $t_{bs} := 12 \cdot in$

Active Equivalent fluid pressure at rest: $EFP := 55 \cdot pcf$

Passive Equivalent fluid pressure: $EFP_p := 0 \cdot pcf$

Depth of surcharge: $SD := 0 \cdot in + t_{ts}$ $SD = 0 \cdot ft$

Total height of wall : $h_{aw} := H_c + t_{ts} + t_{bs}$ $h_{aw} = 5.5 \cdot ft$

Coefficient of friction for sliding: $\mu := 0.40$

wall thickness : $tw := 10 \cdot in$

Soil Forces on Wall

Height of soil pressure prism along the wall: $H := H_c$ $H = 4.5 \cdot ft$

Active soil force along the wall pre LF: $q := SD \cdot EFP \cdot H + EFP \cdot H^2 \cdot \frac{1}{2}$ $q = 0.557 \cdot klf$

Passive soil force along the wall pre LF: $q_p := EFP_p \cdot H^2 \cdot \frac{1}{2}$ $q_p = 0 \cdot klf$

From PCI Design Hand Book, Edition 4, Design Aid 11.1.5

Moment along wall per LF
(As a cantilever beam): $M_s := SD \cdot EFP \cdot \frac{H^2}{12} + EFP \cdot \frac{H^2}{2} \cdot \frac{H}{3}$ $M_s = 0.835 \cdot ft^{-1} \cdot kft$

HLA Infrastructure, Inc.

Sheet No_2_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structures #4 @ STA. 81+55

File :_Wal-str4.mcd_

Subject: Wall Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by_____ Date:_____

Material Properties

Allowable stress in reinforcing steel: $F_s \quad 24000 \cdot psi$

Elastic modulus of reinforcement: $E_s \quad 29 \cdot 10^6 \cdot psi$

Allowable stress in concrete: $f_{c28} \quad 3000 \cdot psi$ $\qquad F_c \quad 0.4 \cdot f_{c28}$

Allowable working stress in concrete: $f_c \quad 0.4 \cdot f_{c28}$ $\qquad f_c = 1200 \cdot psi$

Elastic modulus of concrete: $E_c \quad 57000 \cdot \sqrt{f_{c28}} \cdot psi$ $\qquad E_c = 3122.02 \cdot ksi$

Modular ratio: $n \quad \frac{E_s}{E_c}$ $\qquad k \quad \frac{f_c}{f_c + \frac{F_s}{n}}$ $\qquad n = 9.289$

$k = 0.317$

Effective depth factor: $j \quad 1 - \frac{k}{3}$ $\qquad j = 0.894$

Unit weight of concrete: $\gamma_c \quad 150 \cdot pcf$

Moment due to soil pressure on wall: $M_{s1} \quad M_s$ $\qquad M_{s1} = 0.835 \cdot ft^{-1} \cdot kft$

Design

Moment due to soil pressure on wall at bottom slab:

$$M_{s2} \quad SD \cdot EFP \cdot \frac{H^2}{12} \quad EFP \cdot \frac{H^2}{2} \cdot \frac{H}{3}$$

$M_{s2} = 0.835 \cdot ft^{-1} \cdot kft$

Cover to main reinforcment: $d_c \quad 2 \cdot in$

Diameter of main reinforcement (#5): $d_b \quad 0.625 \cdot in$ $\qquad A_b \quad 0.31 \cdot in^2$

Depth to main reinforcement: $d \quad tw - d_c - \frac{d_b}{2}$ $\qquad d = 7.688 \cdot in$

Steel required per LF: $Ast \quad \frac{M_{s2}}{F_s \cdot j \cdot d}$ $\qquad Ast = 0.061 \cdot ft^{-1} \cdot in^2$

provide #4 bars @ 12"

Design width: $b \quad 12 \cdot in$

Spacing of bars: $s \quad 12 \cdot in$

Area of reinforcing steel per design width: $A_s \quad A_b \cdot \frac{b}{s}$ $\qquad A_s = 0.31 \cdot in^2$

Reinforcement ratio: $\rho \quad \frac{A_s}{b \cdot d}$ $\qquad \rho = 0.336 \cdot \%$

Balanced ratio: $\rho_b \quad \frac{1}{2} \cdot \frac{F_c}{F_s} \cdot \left(1 - \frac{F_s}{n \cdot F_c}\right)$ $\qquad \rho_b = 0.793 \cdot \%$

(If RHO < RHO.b, Steel stress governs, otherwise concrete stress governs)

CHECK REQ'D CRACKING MOMENT CAPACITY

$f_r \quad 7.5 \cdot \sqrt{f_{c28}} \cdot psi$ $\qquad f_r = 410.792 \cdot psi$

$I \quad \frac{b \cdot tw^3}{12}$ $\qquad I = 1000 \cdot in^4$

$M_{cr} \quad \frac{I \cdot f_r}{0.5 \cdot tw \cdot b}$ $\qquad 1.2 \cdot M_{cr} = 8.22 \cdot \frac{kft}{ft}$ $\qquad M_{s2} = 0.835 \cdot ft^{-1} \cdot kft$

DESIGN STRESSES AASHTO 8.17.1.2

$k \quad \sqrt{(n \cdot \rho)^2 + 2 \cdot n \cdot \rho} - n \cdot \rho$ $\qquad k = 0.283$

$mmax \quad \text{if } M_{s2} > 1.2 \cdot M_{cr}, M_{s2}, 1.3 \cdot M_{s2}$ $\qquad mmax = 1.09 \cdot \frac{kft}{ft}$

$f_s \quad \frac{mmax \cdot b}{A_s \cdot j \cdot d}$ $\qquad f_s = 6114.36 \cdot psi$ $\qquad F_s = 24000 \cdot psi$

$f_c \quad \frac{2 \cdot mmax}{k \cdot j \cdot d^2}$ $\qquad f_c = 145.2 \cdot psi$ $\qquad F_c = 1200 \cdot psi$

HLA Infrastructure, Inc.

Sheet No_4_of__
Job No._48049.3_

Title: Orangewood Avenue Storm Drain
Structures #4 @ STA. 81+55

File :_Wal-str4.mcd_

Subject: Wall Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by GLE Date: 3/99

CHECK SHEARING STRESSES

$q = 0.557 \cdot ft^{-1} \cdot kip$

$v_c \quad \frac{q}{b \cdot d}$ $\qquad v_c = 6.04 \frac{psi}{ft}$ $\qquad \frac{v_c}{f_{c28}} = 0.11 \cdot \frac{psi}{psi \cdot ft}$

Allowable Shearing Stress

$v_{all} \quad 0.9 \cdot f_{c28} \cdot psi \quad 1100 \cdot \rho \cdot \frac{q \cdot d}{M_s} \cdot psi$ $\qquad v_{all} = 50.87 \cdot psi$

$v_{all} \quad 0.95 \cdot f_{c28} \cdot psi$ $\qquad v_{all} = 52.03 \cdot psi$

HLA Infrastructure, Inc.

Sheet No_1_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #4 @ STA 81+55

File :_FLR-STR4.MCD_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by GLE Date 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$ $ft \equiv 12.0 \cdot in$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$kft \equiv kip \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $CY := 27 \cdot ft^3$

Design of FLoor Slab for Structure #4 at Sta. 81+55

Span length c/c: $GS := 5.0 \cdot ft$ $GS = 60 \cdot in$

Wall width: $TW := 10 \cdot in$

Effective span between walls (AASHTO_9.6): $S := GS - TW$ $S = 4.17 \cdot ft$

Actual thickness of the Floor slab:
(From BDDM Section 1.3.2) $ST := 10 \cdot in$

Design thickness of the Floor slab: $DS := ST - 0 \cdot in$

Depth of soil cover over box: $SD := 0.0 \cdot in$

Actual thickness of the top slab: $TS := 0 \cdot in$

Average Height of wall (between slabs): $HW := 4.0 \cdot ft$

Perimeter Length of the box: $PL := (4.833 \cdot ft + 5.833 \cdot ft) \cdot 2$ $PL = 21.33 \cdot ft$

Total bearing area of the box: $BA := (5.667 \cdot ft) \cdot (6.667 \cdot ft)$ $BA = 37.78 \cdot ft^2$

DEAD LOAD MOMENTS

Concrete dead weight from slabs: $DL_{SL} := (TS + ST) \cdot BA \cdot 0.15 \cdot kcf$ $DL_{SL} = 4.72 \cdot kip$

Concrete wall: $DL_{wl} := PL \cdot TW \cdot HW \cdot 0.15 \cdot kcf$ $DL_{wl} = 10.67 \cdot kip$

Weight soil replaced by shaft: $DL_{WS} := SD \cdot \frac{\pi}{4} \cdot (5 \cdot ft)^2 \cdot 0.125 \cdot kcf$ $DL_{WS} = 0 \cdot kip$

Soil cover over the top slab: $DL_{soil} := SD \cdot BA \cdot 0.125 \cdot kcf$ $DL_{soil} = 0 \cdot kip$

Total dead load: $DL := DL_{SL} + DL_{wl} - DL_{WS} + DL_{soil}$ $DL = 15.39 \cdot kip$

HLA Infrastructure, Inc.

Sheet No_2_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #4 @ STA 81+55

File :_FLR-STR4.MCD_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by_____ Date:3/99

Total weight of water in the box: $HL := BA \cdot HW \cdot 64 \cdot pcf - PL \cdot HW \cdot TW \cdot 64 \cdot pcf$ $HL = 5.12 \cdot kip$

Total DL Bearing pressure on floor slab per unit width: $W := \frac{DL + HL}{BA}$ $W = 0.54 \cdot ksf$ < 1.5 ksf O.K.

(From LRFD-AISC 3-143)

Negative moment: $M_N := \frac{1}{12} \cdot W \cdot S^2$ $M_N = 0.79 \cdot kft \cdot ft^{-1}$

Positive moment: $M_P := \frac{1}{24} \cdot W \cdot S^2$ $M_P = 0.39 \cdot kft \cdot ft^{-1}$

FLOOR SLAB:

Design Moments

Negative moment: $M_{NT} := -M_N$ $M_{NT} = -0.79 \cdot kft \cdot ft^{-1}$

Positive moment: $M_{PT} := M_P$ $M_{PT} = 0.39 \cdot kft \cdot ft^{-1}$

MATERIAL PROPERTIES

Characteristic strength of concrete at 28 days: $f_{c28} := 3000 \cdot psi$

Allowable stress in concrete: $F_c := 0.40 \cdot f_{c28}$
(From BDDM Section 1.3.2)
use $F_c := if(F_c < 1400 \cdot psi, F_c, 1400 \cdot psi)$ $F_c = 1200 \cdot psi$

Use Grade 60 steel: $F_s := 24000 \cdot psi$

Elastic modulus of concrete: $E_c := 57000 \cdot \sqrt{f_{c28}} \cdot \sqrt{psi}$ $E_c = 3.12 \cdot 10^6 \cdot psi$

Elastic modulus of steel: $E_s := 29000 \cdot ksi$

Modular ratio: $n := \frac{E_s}{E_c}$ $n = 9.29$ $k := \frac{F_c}{F_c + \frac{F_s}{n}}$ $k = 0.32$

Effective depth factor: $j := 1 - \frac{k}{3}$ $j = 0.89$

HLA Infrastructure, Inc.

Sheet No_3_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #4 @ STA 81+55

File :_FLR-STR4.MCD_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/9/99_

Checked by DE Date: 3/99

Diameter of top main bars (#5): $\phi_t := 0.625 \cdot in$ $A_t := 0.31 \cdot in^2$

Diameter of bottom main bars (#5): $\phi_b := 0.625 \cdot in$ $A_b := 0.31 \cdot in^2$

Clear Cover to top reinforcement: $C_t := 2.0 \cdot in$

Clear Cover to bottom reinforcement: $C_b := 3.0 \cdot in$

Effective depth to top main steel: $d_t := ST - C_t - \frac{\phi_t}{2}$ $d_t = 7.69 \cdot in$

Effective depth to bottom main steel: $d_b := ST - C_b - \frac{\phi_b}{2}$ $d_b = 6.69 \cdot in$

Area of steel required at top: $Ast := \frac{|M_{PT}|}{F_s \cdot j \cdot d_t} \cdot ft$ $Ast = 0.03 \cdot in^2$

Number of bars at top: $NB_T := \frac{Ast}{A_t}$ $NB_T = 0.09$

Provide #5 bars @ 12" spacing at top.

Area of steel required at bottom: $Asb := \frac{|M_{NT}|}{F_s \cdot j \cdot d_b} \cdot ft$ $Asb = 0.07 \cdot in^2$

Number of bars at bottom: $NB_B := \frac{Asb}{A_b}$ $NB_B = 0.21$

Provide #5 bars @ 12" spacing at bottom.

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SHEET _____ OF _____
JOB NO. 40049.3
DATE 2/7/99
COMPUTED BY Sivaji
CHECKED BY [illegible]

PROJECT ORANGEWOOD AVE. STORM DRAIN
SUBJECT STRUCTURE #6, EAST BASIN OUTLET STRUCTURE

CONCRETE

BOTTOM SLAB: $(12)(25)(1) + (12)(3.4)(1) + \left(\frac{12+20}{2}\right)(10)(1)$

$+ (8)(2' + 0.75')(1')$

$= 550$ CF

WALLS: $(2)\left[(11.98)(7) + (8)(9) + \left(\frac{8.5+4.65}{2}\right)(19)\right.$

$\left. - (10)(2.4)\right](1') + (10)(11.98)(1') + (9.98)(1')(10)$

$= 773.17$ CF.

TOP SLAB: $(10)(8)(1') = 80$ CF

VOLUME OF OPENINGS: $\frac{\pi}{4}\left[5^2 + 5^2 + 6^2\right](1) = 67.54$ CF

NET CONCRETE $= 550 + 773.17 + 80 - 67.54$

$= 1335.6258$ CF (OR) $\underline{49.5}$ CY ✓

Orangewood Ave Storm Drain, Phase 3
Structure #6, @ STA 12+49.60

Item No.	Description	No. Bars	Length in mm	Length in ft	Weight per Lin feet	Total Wt. in Lbs	Weight in Kgs	Remarks
	Top Slab							
1	#5 @ 12 inches T&B	18		15.00	1.043	281.61	127.74	SE_NW Dir.
2	#5 @ 12 inches T&B	22		10.50	1.043	240.93	109.29	NE_SW Dir.
3	#5 @ 12 in 1 foot wall	5		11.75	1.043	61.28	27.79	SE_NW Dir.
4	#6 @ 6 inches T&B at Opening	0		0.00	1.502	0.00	0.00	Top Slab
5	Edge Beam Adjacent to shaft	0		0.00	1.502	0.00	0.00	Top Slab
6	3-#6 @ T&B on two walls	12		11.00	1.502	198.26	89.93	
7	#4-Closed ties	11		4.00	0.668	29.39	13.33	edge beam East
8	#4-Closed ties	11		4.00	0.668	29.39	13.33	edge beam West
	Lower Floor Slab							
1	#5 @ 12 inches Top mat	24		11.75	1.043	294.13	133.42	SE_NW Dir.
2	#6 @ 6 inches Bot. mat	48		13.00	1.502	937.25	425.14	SE_NW Dir.
3	#5 @ 12 inches Bot mat	24		5.00	1.043	125.16	56.77	SE_NW Dir.
4	#5 @ 12 inches Top & Bot mats	21		19.00	1.043	416.16	188.77	NE_SW Dir.
6	#6 @ 6 inches at Drop Footing	21		6.50	1.043	142.37	64.58	NE_SW Dir.
	Upper Floor Slab							
1	#5 @ 12 inches Top mat	11		16.00	1.043	183.57	83.27	SE_NW Dir.
2	#6 @ 12 inches Bot. mat	10		16.00	1.502	240.32	109.01	SE_NW Dir.
3	#5 @ 12 inches Bot mat	16		12.00	1.043	200.26	90.84	NE_SW Dir.
4	#5 @ 12 inches Top	16		13.00	1.043	216.94	98.41	NE_SW Dir.
	SE_NW Walls							
1	#6 @ 12 inches on Wall to full Ht.	21		13.00	1.502	410.05	186.00	Vertical
2	#5 @ 12 inches in External Wall	11		12.00	1.043	137.68	62.45	Vertical
3	#5 @ 12 inches in Inter. Wall	22		10.00	1.043	229.46	104.08	Vertical
4	#6 @ 12 inches in wall	26		14.50	1.502	566.25	256.85	Horizontal SE-NW
5	#5 @12 inches in inter. wall	20		14.50	1.043	302.47	137.20	Horizontal E-W

Orangewood Ave Storm Drain, Phase 3
Structure #6, @ STA 12+49.60

Item No.	Description	No. Bars	Length in mm	Length in ft	Weight per Lin feet	Total Wt. in Lbs	Weight in Kgs	Remarks
	NE_SW Walls							
1	#6 @ 12 inches on Wall to full Ht.	28		13.00	1.502	546.73	248.00	Vertical
2	#6 @ 12 inches in Side Walls	144		9.00	1.502	1946.59	882.97	Vertical
3	#5 @ 12 inches in Inter. Wall	39		35.00	1.043	1423.70	645.79	Horizontal
4	#6 @ 12 inches in wall	28		14.50	1.502	609.81	276.61	Horizontal NE-SW
5	2-#6 Hoop Bars @ Each Opening	4		42.00	1.502	252.34	114.46	
6	2-#5 x 3'-0" Diagonal Bars	8		3.00	1.043	25.03	11.35	
7	2-#4 Bars around Square Opening	8		4.25	0.668	22.71	10.30	
	Step & Cut-off Walls							
1	9-#4 Bars	9		16.00	0.668	96.19	43.63	Horizontal
2	#4 @ 12" 'S' Shape	24		5.40	0.668	86.57	39.27	Vertical
	Flat Grate						0.00	
1	2" x 1/5" Bars @ 6" Spacing	30		5.25	3.4	535.50	242.90	
2	ANGLES	1		50.00	7.2	360.00	163.30	
3	Miscellaneous					20.00	9.07	
	Sloped Grate						0.00	
1	2" x 1/5" Bars @ 6" Spacing	21		8.00	3.4	571.20	259.10	
2	ANGLES	1		47.00	7.2	338.40	153.50	
3	Miscellaneous					20.00	9.07	
	Total					12097.69	5487.51	

HLA Infrastructure

Sheet No_1_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #6 @ STA. 12+49.6

File :_Wal-str6.mcd_

Subject: Wall Design

Designed by_Sivaji.S_ Date:_2/2/99_ Checked by DAE Date: 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $kft \equiv kip \cdot ft$

JUNCTION STRUCTURE #6 @ STA. 12+49.6

Dimensions

Height above the bottom slab: $H_c := 11.98 \cdot ft$

Thickness of top slab: $t_{ts} := 0 \cdot in$

Thickness of the bottom slab: $t_{bs} := 12 \cdot in$

Active Equivalent fluid pressure at rest: $EFP := 55 \cdot pcf$

Passive Equivalent fluid pressure: $EFP_p := 0 \cdot pcf$

Depth of surcharge: $SD := 0 \cdot in + t_{ts}$ $SD = 0 \cdot ft$

Total height of wall : $h_{aw} := H_c + t_{ts} + t_{bs}$ $h_{aw} = 12.98 \cdot ft$

Coefficient of friction for sliding: $\mu := 0.40$

wall thickness : $tw := 12 \cdot in$

Soil Forces on Wall

Height of soil pressure prism along the wall: $H := H_c$ $H = 11.98 \cdot ft$

Active soil force along the wall pre LF: $q := SD \cdot EFP \cdot H + EFP \cdot H^2 \cdot \frac{1}{2}$ $q = 3.947 \cdot klf$

Passive soil force along the wall pre LF: $q_p := EFP_p \cdot H^2 \cdot \frac{1}{2}$ $q_p = 0 \cdot klf$

From PCI Design Hand Book, Edition 4, Design Aid 11.1.5 (10)

Moment along wall per LF (As a beam): $M_s := SD \cdot EFP \cdot \frac{H^2}{2} + EFP \cdot \frac{H^2}{2} \cdot \frac{H}{3}$ $M_s = 15.761 \cdot ft^{-1} \cdot kft$

HLA Infrastructure, Inc.

Sheet No._2_of__
Job No._[illegible]_

Title: Orangewood Avenue Storm Drain
Structure #6 @ STA. 12+49.8

File :_Wal-str6.mcd_

Subject: Wall Design

Designed by_Sivaji.S_ Date:_2/2/99_

Checked by: [illegible] Date: 3/99

Material Properties

Allowable stress in reinforcing steel: $F_s = 24000 \cdot psi$

Elastic modulus of reinforcement: $E_s = 29 \cdot 10^6 \cdot psi$

Allowable stress in concrete: $f_{c28} = 3000 \cdot psi$ $\quad F_c = 0.4 \cdot f_{c28}$

Allowable working stress in concrete: $f_c = 0.4 \cdot f_{c28}$ $\quad f_c = 1200 \cdot psi$

Elastic modulus of concrete: $E_c = 57000 \cdot \sqrt{f_{c28}} \cdot psi$ $\quad E_c = 3122.02 \cdot ksi$

Modular ratio: $n = \frac{E_s}{E_c}$ $\quad k = \frac{f_c}{f_c + \frac{F_s}{n}}$ $\quad n = 9.289$

$k = 0.317$

Effective depth factor: $j = 1 - \frac{k}{3}$ $\quad j = 0.894$

Unit weight of concrete: $\gamma_c = 150 \cdot pcf$

Moment due to soil pressure on wall: $M_{s1} = M_s$ $\quad M_{s1} = 15.761 \cdot ft^{-1} \cdot kft$

Design

Moment due to soil pressure on wall at bottom slab:

$$M_{s2} = SD \cdot EFP \cdot \frac{H^2}{2} + EFP \cdot \frac{H^2}{2} \cdot \frac{H}{3}$$

$M_{s2} = 15.761 \cdot ft^{-1} \cdot kft$

Cover to main reinforcment: $d_c = 2 \cdot in$

Diameter of main reinforcement (#9): $d_b = 1.128 \cdot in$ $\quad A_b = 1.00 \cdot in^2$

Depth to main reinforcement: $d = tw - d_c - \frac{d_b}{2}$ $\quad d = 9.436 \cdot in$

Steel required per LF: $Ast = \frac{M_{s2}}{F_s \cdot j \cdot d}$ $\quad Ast = 0.934 \cdot ft^{-1} \cdot in^2$

provide #9 bars @ 12"

Design width: $b \quad 12 \cdot in$

Spacing of bars: $s \quad 12 \cdot in$

Area of reinforcing steel per design width: $A_s \quad A_b \cdot \frac{b}{s}$ $\qquad A_s = 1 \cdot in^2$

Reinforcement ratio: $\rho \quad \frac{A_s}{b \cdot d}$ $\qquad \rho = 0.8831 \cdot \%$

Balanced ratio: $\rho_b \quad \frac{1}{2} \cdot \frac{F_c}{F_s} \cdot \left(1 - \frac{F_s}{n \cdot F_c}\right)^{-1}$ $\qquad \rho_b = 0.793 \cdot \%$

(If RHO < RHO.b, Steel stress governs, otherwise concrete stress governs)

CHECK REQ'D CRACKING MOMENT CAPACITY

$f_r \quad 7.5 \cdot \sqrt{f_{c28} \cdot psi}$ $\qquad f_r = 410.792 \cdot psi$

$I \quad \frac{b \cdot tw^3}{12}$ $\qquad I = 1728 \cdot in^4$

$M_{cr} \quad \frac{I \cdot f_r}{0.5 \cdot tw \cdot b}$ $\qquad 1.2 \cdot M_{cr} = 11.83 \cdot \frac{kft}{ft}$ $\qquad M_{s2} = 15.761 \cdot ft^{-1} \cdot kft$

DESIGN STRESSES AASHTO 8.17.1.2

$k \quad \sqrt{(n \cdot \rho)^2 + 2 \cdot n \cdot \rho} - n \cdot \rho$ $\qquad k = 0.495$

$mmax \quad \text{if}\left(M_{s2} > 1.2 \cdot M_{cr}, M_{s2}, 1.3 \cdot M_{s2}\right)$ $\qquad mmax = 15.76 \cdot \frac{kft}{ft}$

$f_s \quad \frac{mmax \cdot b}{A_s \cdot j \cdot d}$ $\qquad f_s = 22412.98 \cdot psi$ $\qquad F_s = 24000 \cdot psi$

$f_c \quad \frac{2 \cdot mmax}{k \cdot j \cdot d^2}$ $\qquad f_c = 799.25 \cdot psi$ $\qquad F_c = 1200 \cdot psi$

CHECK SHEARING STRESSES

$q = 3.947 \cdot ft^{-1} \cdot kip$

$v_c \quad \frac{q}{b \cdot d}$ $\qquad v_c = 34.86 \cdot \frac{psi}{ft}$ $\qquad \frac{v_c}{f_{c28}} = 0.636 \cdot \frac{psi}{psi \cdot ft}$

Allowable Shearing Stress

$v_{all} \quad 0.9 \cdot \sqrt{f_{c28} \cdot psi} \quad 1100 \cdot \rho \cdot \frac{q \cdot d}{M_s} \cdot psi$ $\qquad v_{all} = 51.21 \cdot psi$

$v_{all} = 0.95 \cdot \sqrt{f_{c28} \cdot psi}$ $\qquad v_{all} = 52.03 \cdot psi$

HLA Infrastructure, Inc.

Sheet No_1_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #6 @ STA 12+40.60

File :_Flr-str6.mcd_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/2/99_

Checked by_DLB_ Date:3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$ $ft \equiv 12.0 \cdot in$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$kft \equiv kip \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $CY := 27 \cdot ft^3$

Design of FLoor Slab for Structure #6 at Sta. 12+49.60

Span length c/c:	$GS := 11 \cdot ft$	$GS = 132 \cdot in$
Wall width:	$TW := 12 \cdot in$	
Effective span between walls (AASHTO_9.6):	$S := GS - TW$	$S = 10 \cdot ft$
Actual thickness of the Floor slab: (From BDDM Section 1.3.2)	$ST := 12 \cdot in$	
Design thickness of the Floor slab:	$DS := ST - 0 \cdot in$	
Depth of soil cover over box:	$SD := 0.0 \cdot in$	
Actual thickness of the top slab:	$TS := 12 \cdot in$	
Height of wall(between slabs):	$HW := 9 \cdot ft$	
Perimeter Length of the box:	$PL := (11 \cdot ft + 23 \cdot ft) \cdot 2$	$PL = 68 \cdot ft$
Total bearing area of the box:	$BA := 12 \cdot ft \cdot 24 \cdot ft$	$BA = 288 \cdot ft^2$

DEAD LOAD MOMENTS

Concrete dead weight from slabs:	$DL_{SL} := (TS + ST) \cdot BA \cdot 0.15 \cdot kcf$	$DL_{SL} = 86.4 \cdot kip$
Concrete wall:	$DL_{wl} := PL \cdot TW \cdot HW \cdot 0.15 \cdot kcf$	$DL_{wl} = 91.8 \cdot kip$
Weight soil replaced by shaft:	$DL_{WS} := SD \cdot \frac{\pi}{4} \cdot (4 \cdot ft)^2 \cdot 0.125 \cdot kcf$	$DL_{WS} = 0 \cdot kip$
Soil cover over the top slab:	$DL_{soil} := SD \cdot BA \cdot 0.125 \cdot kcf$	$DL_{soil} = 0 \cdot kip$
Total dead load:	$DL := DL_{SL} + DL_{wl} - DL_{WS} + DL_{soil}$	$DL = 178.2 \cdot kip$

HLA Infrastructure, Inc.

Sheet No_2_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #6 @ STA 12+40.60

File :_Flr-str6.mcd_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/2/99_

Checked by DK Date: 3/99

Total weight of water in the box: $HL := BA \cdot HW \cdot 64 \cdot pcf - PL \cdot HW \cdot TW \cdot 64 \cdot pcf$ $HL = 126.72 \cdot kip$

Live Load moment paralle to Traffic:
(From AASHTO Sections 3.24.3 & 3.24.3.1) : $P_{L1} := 16000 \cdot lbf$ (Load on one rear wheel of truck)

Total DL Bearing pressure on floor slab per unit width: $W := \frac{DL + HL + P_{L1}}{BA}$ $W = 1.11 \cdot ksf$

< 1.5 ksf O.K.

(From LRFD-AISC 3-143)

Negative moment: $M_N := \frac{1}{12} \cdot W \cdot S^2$ $M_N = 9.29 \cdot kft \cdot ft^{-1}$

Positive moment: $M_P := \frac{1}{24} \cdot W \cdot S^2$ $M_P = 4.64 \cdot kft \cdot ft^{-1}$

FLOOR SLAB:

Design Moments

Negative moment: $M_{NT} := -M_N$ $M_{NT} = -9.29 \cdot kft \cdot ft^{-1}$

Positive moment: $M_{PT} := M_P$ $M_{PT} = 4.64 \cdot kft \cdot ft^{-1}$

MATERIAL PROPERTIES

Characteristic strength of concrete at 28 days: $f_{c28} := 3000 \cdot psi$

Allowable stress in concrete: $F_c := 0.40 \cdot f_{c28}$
(From BDDM Section 1.3.2)
use $F_c := if(F_c < 1400 \cdot psi, F_c, 1400 \cdot psi)$ $F_c = 1200 \cdot psi$

Use Grade 60 steel: $F_s := 24000 \cdot psi$

Elastic modulus of concrete: $E_c := 57000 \cdot \sqrt{f_{c28}} \cdot \sqrt{psi}$ $E_c = 3.12 \cdot 10^6 \cdot psi$

Elastic modulus of steel: $E_s := 29000 \cdot ksi$

Modular ratio: $n := \frac{E_s}{E_c}$ $n = 9.29$ $k := \frac{F_c}{F_c + \frac{F_s}{n}}$ $k = 0.32$

Effective depth factor: $j := 1 - \frac{k}{3}$ $j = 0.89$

HLA Infrastructure, Inc.

Sheet No_3_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Structure #6 @ STA 12+40.60

File :_Flr-str6.mcd_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/2/99_

Checked by_____ Date:_3/99_

Diameter of top main bars (#6): $\phi_t := 0.75 \cdot in$ $A_t := 0.44 \cdot in^2$

Diameter of bottom main bars (#6): $\phi_b := 0.75 \cdot in$ $A_b := 0.44 \cdot in^2$

Clear Cover to top reinforcement: $C_t := 2.0 \cdot in$

Clear Cover to bottom reinforcement: $C_b := 3.0 \cdot in$

Effective depth to top main steel: $d_t := ST - C_t - \frac{\phi_t}{2}$ $d_t = 9.62 \cdot in$

Effective depth to bottom main steel: $d_b := ST - C_b - \frac{\phi_b}{2}$ $d_b = 8.63 \cdot in$

Area of steel required at top: $Ast := \frac{|M_{PT}|}{F_s \cdot j \cdot d_t} \cdot ft$ $Ast = 0.27 \cdot in^2$

Number of bars at top: $NB_T := \frac{Ast}{A_t}$ $NB_T = 0.61$

Provide #6 bars @ 12" spacing at top.

Area of steel required at bottom: $Asb := \frac{|M_{NT}|}{F_s \cdot j \cdot d_b} \cdot ft$ $Asb = 0.6 \cdot in^2$

Number of bars at bottom: $NB_B := \frac{Asb}{A_b}$ $NB_B = 1.37$

Provide #6 bars @ 6" spacing at bottom.

Harding Lawson Associates
Engineering
and
Environmental Services

SHEET _____ OF _____
JOB NO. 40049.3
DATE 2/24/99
PROJECT ORANGEWOOD AVE STORM DRAIN-SUB-PHASE 2 COMPUTED BY S.S.
SUBJECT STRUCTURE #9 @ STA. 10+61.22 CHECKED BY

Roadway ELEVATION: 1142.75

INVERT ELEVATION OF 60" PIPE: 1134.48

ELEVATION @ BOTTOM OF TOP SLAB

$= 1134.48 + \frac{(60+6)}{12} + 0.4167 = 1140.40$

CLEAR HEIGHT OF WALL BETWEEN SLABS

$= 1140.40 - 1134.48 = 5.92'$

FILL HEIGHT OVER BOX: $1142.75 - 12'' - 1140.40$

$= 1.35'$ (or) $16.2'' \approx 16'' - 1/5''$ ✓

Harding Lawson Associates
Engineering
and
Environmental Services

SHEET _____ OF _____
JOB NO. 40049.3
DATE 3/19/99
PROJECT Orangewood Ave. Storm Drain Project
COMPUTED BY Sivaji S
SUBJECT STRUCTURE #9
CHECKED BY DRE

CONCRETE

PERIMETER LENGTH ALONG ℄ WALL:

$= 2(1' + 6.54' + 7.02' + 6.86' + 3.54' + 7') = 64'$

CLEAR HEIGHT OF WALL $= 5.92'$

BEARING AREA OF BOX: $(7.02' + 6.86')(10.16') + \left(\frac{10.16 + 9}{2}\right)(7.34 + 4.17)$

$= 251.29\ FT^2$

Thickness of Top Slab: 1'-0"

Thickness of Bot Slab: 1'-0"

Volume of Concrete (Excluding Opening)

$= (64)(5.92)(1) + (251.29)(1+1) + (64)\left(\frac{1+1.5'}{2}\right)(0.5')$

$= 921.46\ CF$ (or) $34.13\ CY$.

Volume of Openings: $(2)\left[\frac{\pi}{4}(5)^2 + \frac{\pi}{4}(1.5)^2\right](1') = 42.804\ CF$

(or) $1.585\ CY$.

Net Quantity of Concrete: $34.13 - 1.585$

$= \underline{32.54\ CY}$

USE $= 33\ CY$ (INCLUDING FILLETS)

Orangewood Ave Storm Drain, Phase 3
Structure #9, @ STA 10+66.18

Item No.	Description	No. Bars	Length in mm	Length in ft	Weight per Lin feet	Total Wt. in Lbs	Weight in Kgs	Remarks
	Top Slab							
1	#6 @ 6 inches Top	48		13.50	1.502	973.30	441.49	NE_SW Dir.
2	#6 @ 6 inches Top	48		10.00	1.502	720.96	327.03	NE_SW Dir.
3	#6 @ 6 inches T&B	34		25.00	1.502	1276.70	579.11	NW_SE Dir.
4	Beam Adjacent to shaft	28		10.00	1.502	420.56	190.77	Top Slab
5	#4-Closed ties for 7-#6s	80		6.50	0.668	347.36	157.56	edge beam
6	3-#6 @ T&B on two walls	12		10.00	1.502	180.24	81.76	
7	#4-Closed ties	10		4.00	0.668	26.72	12.12	edge beam East
8	#4-Closed ties	10		4.00	0.668	26.72	12.12	edge beam West
	Bottom Slab							
1	#6 @ 12 inches Top mat	24		10.00	1.502	360.48	163.51	NE_SW Dir.
2	#5 @ 6 inches Bot. Mat at walls	96		7.00	1.043	700.90	317.93	NE_SW Dir.
3	#6 @ 12 inches Top mat	9		23.00	1.502	310.91	141.03	NW_SE Dir.
4	#5 @ 12 inches Bot. mat	14		24.00	1.043	350.45	158.96	NW_SE Dir.
5	#5 @ 12 inches in drop footing	22		6.60	1.043	151.44	68.69	N_S Dir.
	Wall							
1	#5 @ 12 inches on Wall to full Ht.	104		8.00	1.043	867.78	393.62	Vertical
2	#5 @ 15 inches in wall	14		89.00	1.043	1299.58	589.49	Horizontal
3	Hoop Bars at Pipe openings	4		39.00	1.502	234.31	106.28	
	Total					8248.40	3741.48	

HLA Infrastructure, Inc.

Sheet No_1_of__
Job No._40049.3_

Title: orangewood Avenue Storm Drain
Conflict Structure @ STA 10+66.18

File :_SLB-STR9.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_2/24/99_

Checked by DE Date: 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$ $ft \equiv 12.0 \cdot in$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$kft \equiv kip \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $CY := 27 \cdot ft^3$

Design of Slab for Conflict Structure No.9 at STA. 10+66.18

Span length c/c: $GS := 10.16 \cdot ft$ $GS = 121.92 \cdot in$

Wall width: $TW := 12 \cdot in$

Effective span between walls (AASHTO_9.6): $S := GS - TW$ $S = 9.16 \cdot ft$

Actual thickness of the slab:
(From BDDM Section 1.3.2) $ST := 12 \cdot in$

Design thickness of the slab: $DS := ST - 0 \cdot in$

Depth of soil cover over box: $SD := 14.00 \cdot in$

Live Load moment paralle to Traffic:
(From AASHTO Sections 3.24.3 & 3.24.3.1) : $P_{L1} := 16000 \cdot lbf$ (Load on one rear wheel of truck)

Main reinforcement perpendicular to traffic for HS 20 Loading:

$$LLM := \left(\frac{S \cdot ft^{-1} + 2}{32}\right) \cdot P_{L1} \qquad LLM = 5.58 \cdot ft^{-1} \cdot kft$$

Impact factor:
(From AASHTO Section 3.8.2.3) $I := 1.30$

Live load moment perpendicular to bridge:

$$M_{LLI} := LLM \cdot I \qquad M_{LLI} = 7.25 \cdot ft^{-1} \cdot kft$$

HLA Infrastructure, Inc.

Sheet No_2_of__
Job No._40049.3_

Title: orangewood Avenue Storm Drain
Conflict Structure @ STA 10+66.18

File :_SLB-STR9.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_2/24/99_

Checked by QLB Date: 3/99

DEAD LOAD MOMENTS

Concrete dead weight: $DL_{SL} := ST \cdot 0.15 \cdot kcf$ $DL_{SL} = 0.15 \cdot klf \cdot ft^{-1}$

Wearing Surface $DL_{WS} := 0 \cdot psf \cdot 1$ $DL_{WS} = 0 \cdot klf \cdot ft^{-1}$

Soil cover over the top slab: $DL_{soil} := SD \cdot 0.125 \cdot kcf$ $DL_{soil} = 0.15 \cdot ft^{-1} \cdot klf$

Total dead load: $W := DL_{SL} + DL_{WS} + DL_{soil}$ $W = 0.3 \cdot klf \cdot ft^{-1}$

(From LRFD-AISC 3-143)

Negative moment: $M_N := \frac{1}{12} \cdot W \cdot S^2$ $M_N = 2.07 \cdot kft \cdot ft^{-1}$

Positive moment: $M_P := \frac{1}{24} \cdot W \cdot S^2$ $M_P = 1.03 \cdot kft \cdot ft^{-1}$

TOP SLAB:

Design Moments

Negative moment: $M_{NT} := -M_{LLI} - M_N$ $M_{NT} = -9.32 \cdot kft \cdot ft^{-1}$

Positive moment: $M_{PT} := M_{LLI} + M_P$ $M_{PT} = 8.29 \cdot kft \cdot ft^{-1}$

MATERIAL PROPERTIES

Characteristic strength of concrete at 28 days: $f_{c28} := 3000 \cdot psi$

Allowable stress in concrete: $F_c := 0.40 \cdot f_{c28}$
(From BDDM Section 1.3.2) use $F_c := if(F_c < 1400 \cdot psi, F_c, 1400 \cdot psi)$ $F_c = 1200 \cdot psi$

Use Grade 60 steel: $F_s := 20000 \cdot psi$

NOTE: BDDM Section 1.3.1 Reinforcement - All transverse deck reinforcing shall be designed using an allowable stress fs = 20000 psi. All other reinforcing bars shall be designed using an allowable stress fs = 24000 psi.

Elastic modulus of concrete: $E_c := 57000 \cdot \sqrt{f_{c28}} \cdot \sqrt{psi}$ $E_c = 3.12 \cdot 10^6 \cdot psi$

Elastic modulus of steel: $E_s := 29000 \cdot ksi$

HLA Infrastructure, Inc.

Sheet No_3_of__
Job No._40049.3_

Title: orangewood Avenue Storm Drain
Conflict Structure @ STA 10+66.18

File :_SLB-STR9.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_2/24/99_

Checked by DE Date: 3/99

Modular ratio: $n := \frac{E_s}{E_c}$ $n = 9.29$ $k := \frac{F_c}{F_c + \frac{F_s}{n}}$ $k = 0.36$

Effective depth factor: $j := 1 - \frac{k}{3}$ $j = 0.88$

Diameter of top main bars (#6): $\phi_t := 0.75 \cdot in$ $A_t := 0.44 \cdot in^2$

Diameter of bottom main bars (#6): $\phi_b := 0.75 \cdot in$ $A_b := 0.44 \cdot in^2$

Clear Cover to top reinforcement: $C_t := 2.0 \cdot in$

Clear Cover to bottom reinforcement: $C_b := 1.0 \cdot in$

Effective depth to top main steel: $d_t := ST - C_t - \frac{\phi_t}{2}$ $d_t = 9.62 \cdot in$

Effective depth to bottom main steel: $d_b := ST - C_b - \frac{\phi_b}{2}$ $d_b = 10.63 \cdot in$

Area of steel required at top: $Ast := \frac{|M_{NT}|}{F_s \cdot j \cdot d_t} \cdot ft$ $Ast = 0.66 \cdot in^2$

Number of bars at top: $NB_T := \frac{Ast}{A_t}$ $NB_T = 1.5$

Provide #6 bars @ 6" spacing at top.

Area of steel required at bottom: $Asb := \frac{|M_{PT}|}{F_s \cdot j \cdot d_b} \cdot ft$ $Asb = 0.53 \cdot in^2$

Number of bars at bottom: $NB_B := \frac{Asb}{A_b}$ $NB_B = 1.21$

Provide #6 bars @ 6" spacing at bottom.

HLA Infrastructure, Inc.

Sheet No_4_of__
Job No._40049.3_

Title: orangewood Avenue Storm Drain
Conflict Structure @ STA 10+66.18

File :_SLB-STR9.MCD_

Subject: 12" Top Slab Design

Designed by_Sivaji.S_ Date:_2/24/99_

Checked by DLE Date: 3/99

DISTRIBUTION REINFORCEMENT: AASHTO SECTION 3.24.10

For main steel parallel to traffic:

Percentage of main steel: $r := \left(\frac{220}{\sqrt{S}} \cdot \sqrt{ft}\right) \cdot \%$ $\quad r = 72.69 \cdot \%$

$r := if(r \le 50 \cdot \%, r, 50 \cdot \%)$ $\quad r = 50 \cdot \%$

Distribution steel: $Asd := r \cdot Asb$ $\quad Asd = 0.27 \cdot in^2$

Total number of bars required in single span:

$NB_D := \frac{Asd}{A_t} \cdot \frac{S}{ft}$ $\quad NB_D = 5.53$

NOTE: BDDM Section 1.3.1 Reinforcement - All transverse deck reinforcing shall be designed using an allowable stress fs = 20000 psi. All other reinforcing bars shall be designed using an allowable stress fs = 24000 psi.

$NB_D := NB_D \cdot \frac{F_s}{24000 \cdot psi}$ $\quad NB_D = 4.61$

HLA Infrastructure, Inc.

Sheet No_1_of__
Job No._40049.2_

Title: Glendale Avenue Storm Drain
Conflict Structures @ STA. 10+66.18

File :_WAL-STR9.MCD_

Subject: Wall Design

Designed by_Sivaji.S_ Date:_3/11/99_

Checked by ERE Date: 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $kft \equiv kip \cdot ft$

CONFLICT JUNCTION BOX WALL DESIGN @ STA. 10+66.18

Dimensions

Clear height between top and bottom slabs: $H_c := 5.92 \cdot ft$

Thickness of top slab: $t_{ts} := 12 \cdot in$

Thickness of the bottom slab: $t_{bs} := 12 \cdot in$

Active Equivalent fluid pressure at rest: $EFP := 55 \cdot pcf$

Passive Equivalent fluid pressure: $EFP_p := 0 \cdot pcf$

Depth of surcharge: $SD := 14 \cdot in + t_{ts}$ $SD = 2.167 \cdot ft$

Total height of wall : $h_{aw} := H_c + t_{ts} + t_{bs}$ $h_{aw} = 7.92 \cdot ft$

Coefficient of friction for sliding: $\mu := 0.40$

wall thickness : $tw := 12 \cdot in$

Soil Forces on Wall

Height of soil pressure prism along the wall: $H := H_c$ $H = 5.92 \cdot ft$

Active soil force along the wall pre LF: $q := SD \cdot EFP \cdot H + EFP \cdot H^2 \cdot \frac{1}{2}$ $q = 1.669 \cdot klf$

Passive soil force along the wall pre LF: $q_p := EFP_p \cdot H^2 \cdot \frac{1}{2}$ $q_p = 0 \cdot klf$

From PCI Design Hand Book, Edition 4, Design Aid 11.1.5

Moment along wall per LF (As a beam): $M_s := SD \cdot EFP \cdot \frac{H^2}{12} + EFP \cdot \frac{H^2}{2} \cdot \frac{H}{10}$ $M_s = 0.919 \cdot ft^{-1} \cdot kft$

Material Properties

Allowable stress in reinforcing steel: $F_s = 24000 \cdot psi$

Elastic modulus of reinforcement: $E_s = 29 \cdot 10^6 \cdot psi$

Allowable stress in concrete: $f_{c28} = 3000 \cdot psi$ $\quad F_c = 0.4 \cdot f_{c28}$

Allowable working stress in concrete: $f_c = 0.4 \cdot f_{c28}$ $\quad f_c = 1200 \cdot psi$

Elastic modulus of concrete: $E_c = 57000 \cdot \sqrt{f_{c28}} \cdot psi$ $\quad E_c = 3122.02 \cdot ksi$

Modular ratio: $n = \frac{E_s}{E_c}$ $\quad k = \frac{f_c}{f_c + \frac{F_s}{n}}$ $\quad n = 9.289$

$k = 0.317$

Effective depth factor: $j = 1 - \frac{k}{3}$ $\quad j = 0.894$

Unit weight of concrete: $\gamma_c = 150 \cdot pcf$

Moment due to soil pressure on wall: $M_{s1} = M_s$ $\quad M_{s1} = 0.919 \cdot ft^{-1} \cdot kft$

Design

Moment due to soil pressure on wall at bottom slab:

$$M_{s2} = SD \cdot EFP \cdot \frac{H^2}{12} = EFP \cdot \frac{H^2}{2} \cdot \frac{H}{10}$$

$M_{s2} = 0.919 \cdot ft^{-1} \cdot kft$

Cover to main reinforcment: $d_c = 2 \cdot in$

Diameter of main reinforcement (#5): $d_b = 0.625 \cdot in$ $\quad A_b = 0.31 \cdot in^2$

Depth to main reinforcement: $d = tw - d_c - \frac{d_b}{2}$ $\quad d = 9.688 \cdot in$

Steel required per LF: $Ast = \frac{M_{s2}}{F_s \cdot j \cdot d}$ $\quad Ast = 0.053 \cdot ft^{-1} \cdot in^2$

provide #5 bars @ 12"

Design width: $b \quad 12 \cdot in$

Spacing of bars: $s \quad 12 \cdot in$

Area of reinforcing steel per design width: $A_s \quad A_b \cdot \frac{b}{s}$ $\qquad A_s = 0.31 \cdot in^2$

Reinforcement ratio: $\rho \quad \frac{A_s}{b \cdot d}$ $\qquad \rho = 0.2667 \cdot \%$

Balanced ratio: $\rho_b \quad \frac{1}{2} \cdot \frac{F_c}{F_s} \cdot \left(1 - \frac{F_s}{n \cdot F_c}\right)$ $\qquad \rho_b = 0.793 \cdot \%$

(If RHO < RHO.b, Steel stress governs, otherwise concrete stress governs)

CHECK REQ'D CRACKING MOMENT CAPACITY

$f_r \quad 7.5 \cdot \sqrt{f_{c28}} \cdot psi$ $\qquad f_r = 410.792 \cdot psi$

$I \quad \frac{b \cdot tw^3}{12}$ $\qquad I = 1728 \cdot in^4$

$M_{cr} \quad \frac{I \cdot f_r}{0.5 \cdot tw \cdot b}$ $\qquad 1.2 \cdot M_{cr} = 11.83 \cdot \frac{kft}{ft}$ $\qquad M_{s2} = 0.919 \cdot ft^{-1} \cdot kft$

DESIGN STRESSES AASHTO 8.17.1.2

$k \quad \sqrt{(n \cdot \rho)^2 - 2 \cdot n \cdot \rho} - n \cdot \rho$ $\qquad k = 0.249$

$mmax \quad if(M_{s2} > 1.2 \cdot M_{cr}, M_{s2}, 1.3 \cdot M_{s2})$ $\qquad mmax = 1.19 \cdot \frac{kft}{ft}$

$f_s \quad \frac{mmax \cdot b}{A_s \cdot j \cdot d}$ $\qquad f_s = 5335.75 \cdot psi$ $\qquad F_s = 24000 \cdot psi$

$f_c \quad \frac{2 \cdot mmax}{k \cdot j \cdot d^2}$ $\qquad f_c = 114.41 \cdot psi$ $\qquad F_c = 1200 \cdot psi$

HLA Infrastructure, Inc.

Sheet No_4_of__
Job No._40049.2_

Title: Glendale Avenue Storm Drain
Conflict Structures @ STA. 10+66.18

File :_WAL-STR9.MCD_

Subject: Wall Design

Designed by_Sivaji.S_ Date:_3/11/99_

Checked by DJE Date: 3/99

CHECK SHEARING STRESSES

$q = 1.669 \cdot ft^{-1} \cdot kip$

$v_c = \frac{q}{b \cdot d}$ $\quad v_c = 14.36 \cdot \frac{psi}{ft}$ $\quad \frac{v_c}{f_{c28}} = 0.262 \cdot \frac{psi}{psi \cdot ft}$

Allowable Shearing Stress

$v_{all} = 0.9 \cdot f_{c28} \cdot psi = 1100 \cdot \rho \cdot \frac{q \cdot d}{M_s} \cdot psi$ $\quad v_{all} = 53.6 \cdot psi$

$v_{all} = 0.95 \cdot \sqrt{f_{c28} \cdot psi}$ $\quad v_{all} = 52.03 \cdot psi$

HLA Infrastructure, Inc.

Sheet No_1_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Conflict Structure @ STA 10+66.18

File :_FLR-STR9.MCD_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/24/99_

Checked by DHE Date: 3/99

UNITS: $kip \equiv 1000 \cdot lbf$ $TOL \equiv 0.01$ $ft \equiv 12.0 \cdot in$

$plf \equiv \frac{lbf}{ft}$ $psf \equiv \frac{lbf}{ft^2}$ $pcf \equiv \frac{lbf}{ft^3}$ $psi \equiv \frac{lbf}{in^2}$ $pci \equiv \frac{lbf}{in^3}$ $pft \equiv lbf \cdot ft$

$kft \equiv kip \cdot ft$

$klf \equiv \frac{kip}{ft}$ $ksf \equiv \frac{kip}{ft^2}$ $kcf \equiv \frac{kip}{ft^3}$ $ksi \equiv \frac{kip}{in^2}$ $kci \equiv \frac{kip}{in^3}$ $CY := 27 \cdot ft^3$

Design of FLoor Slab for Coflict Structure at Sta. 10+66.18

Span length c/c: $GS := 10.16 \cdot ft$ $GS = 121.92 \cdot in$

Wall width: $TW := 12 \cdot in$

Effective span between walls (AASHTO_9.6): $S := GS - TW$ $S = 9.16 \cdot ft$

Actual thickness of the Floor slab:
(From BDDM Section 1.3.2) $ST := 12 \cdot in$

Design thickness of the Floor slab: $DS := ST - 0 \cdot in$

Depth of soil cover over box: $SD := 14.00 \cdot in$

Actual thickness of the top slab: $TS := 12 \cdot in$

Height of wall(between slabs): $HW := 8.708 \cdot ft$

Perimeter Length of the box: $PL := (8.0 \cdot ft + 6.535 \cdot ft + 7.02 \cdot ft + 6.86 \cdot ft + 3.544 \cdot ft) \cdot 2$ $PL = 63.92 \cdot ft$

Total bearing area of the box: $BA := (7.02 \cdot ft + 6.86 \cdot ft) \cdot 10.16 \cdot ft + \frac{(8 \cdot ft + 10.16 \cdot ft) \cdot (6.34 \cdot ft + 3.17 \cdot ft)}{2}$

$BA = 227.37 \cdot ft^2$

DEAD LOAD MOMENTS

Concrete dead weight from slabs: $DL_{SL} := (TS + ST) \cdot BA \cdot 0.15 \cdot kcf$ $DL_{SL} = 68.21 \cdot kip$

Concrete wall: $DL_{wl} := PL \cdot TW \cdot HW \cdot 0.15 \cdot kcf$ $DL_{wl} = 83.49 \cdot kip$

Weight soil replaced by shaft: $DL_{WS} := SD \cdot \frac{\pi}{4} \cdot (5 \cdot ft)^2 \cdot 0.125 \cdot kcf$ $DL_{WS} = 2.86 \cdot kip$

Soil cover over the top slab: $DL_{soil} := SD \cdot BA \cdot 0.125 \cdot kcf$ $DL_{soil} = 33.16 \cdot kip$

Total dead load: $DL := DL_{SL} + DL_{wl} - DL_{WS} + DL_{soil}$ $DL = 182 \cdot kip$

Total weight of water in the box: $HL := BA \cdot HW \cdot 64 \cdot pcf - PL \cdot HW \cdot TW \cdot 64 \cdot pcf$ $HL = 91.09 \cdot kip$

Live Load moment paralle to Traffic:
(From AASHTO Sections 3.24.3 & 3.24.3.1) : $P_{L1} := 16000 \cdot lbf$ (Load on one rear wheel of truck)

Total DL Bearing pressure on floor slab per unit width: $W := \frac{DL + P_{L1} + HL}{BA}$ $W = 1.27 \cdot ksf$ < 1.5 ksf O.K.

(From LRFD-AISC 3-143)

Negative moment: $M_N := \frac{1}{12} \cdot W \cdot S^2$ $M_N = 8.89 \cdot kft \cdot ft^{-1}$

Positive moment: $M_P := \frac{1}{24} \cdot W \cdot S^2$ $M_P = 4.45 \cdot kft \cdot ft^{-1}$

FLOOR SLAB:

Design Moments

Negative moment: $M_{NT} := -M_N$ $M_{NT} = -8.89 \cdot kft \cdot ft^{-1}$

Positive moment: $M_{PT} := M_P$ $M_{PT} = 4.45 \cdot kft \cdot ft^{-1}$

MATERIAL PROPERTIES

Characteristic strength of concrete at 28 days: $f_{c28} := 3000 \cdot psi$

Allowable stress in concrete: $F_c := 0.40 \cdot f_{c28}$
(From BDDM Section 1.3.2)
use $F_c := if(F_c < 1400 \cdot psi, F_c, 1400 \cdot psi)$ $F_c = 1200 \cdot psi$

Use Grade 60 steel: $F_s := 24000 \cdot psi$

Elastic modulus of concrete: $E_c := 57000 \cdot \sqrt{f_{c28}} \cdot \sqrt{psi}$ $E_c = 3.12 \cdot 10^6 \cdot psi$

Elastic modulus of steel: $E_s := 29000 \cdot ksi$

Modular ratio: $n := \frac{E_s}{E_c}$ $n = 9.29$ $k := \frac{F_c}{F_c + \frac{F_s}{n}}$ $k = 0.32$

Effective depth factor: $j := 1 - \frac{k}{3}$ $j = 0.89$

HLA Infrastructure, Inc.

Sheet No_3_of__
Job No._40049.3_

Title: Orangewood Avenue Storm Drain
Conflict Structure @ STA 10+66.18

File :_FLR-STR9.MCD_

Subject: Floor Slab Design

Designed by_Sivaji.S_ Date:_2/24/99_

Checked by DLE Date: 3/99

Diameter of top main bars (#5): $\phi_t := 0.625 \cdot in$ $A_t := 0.31 \cdot in^2$

Diameter of bottom main bars (#5): $\phi_b := 0.625 \cdot in$ $A_b := 0.31 \cdot in^2$

Clear Cover to top reinforcement: $C_t := 2.0 \cdot in$

Clear Cover to bottom reinforcement: $C_b := 3.0 \cdot in$

Effective depth to top main steel: $d_t := ST - C_t - \frac{\phi_t}{2}$ $d_t = 9.69 \cdot in$

Effective depth to bottom main steel: $d_b := ST - C_b - \frac{\phi_b}{2}$ $d_b = 8.69 \cdot in$

Area of steel required at top: $Ast := \frac{|M_{PT}|}{F_s \cdot j \cdot d_t} \cdot ft$ $Ast = 0.26 \cdot in^2$

Number of bars at top: $NB_T := \frac{Ast}{A_t}$ $NB_T = 0.83$

Provide #5 bars @ 12" spacing at top.

Area of steel required at bottom: $Asb := \frac{|M_{NT}|}{F_s \cdot j \cdot d_b} \cdot ft$ $Asb = 0.57 \cdot in^2$

Number of bars at bottom: $NB_B := \frac{Asb}{A_b}$ $NB_B = 1.85$

Provide #5 bars @ 6" spacing at bottom.