40464.01

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Project: Design Verification and Precast Construction Details
7X7 Precast Catch Basin as Alternate TDOT STD. D-CB-12SD

Location: Tennessee

Sheets: Sheets 1-6

CHECKED FOR ✓
CONFORMANCE
KSM
12/14/15

TOP SLAB

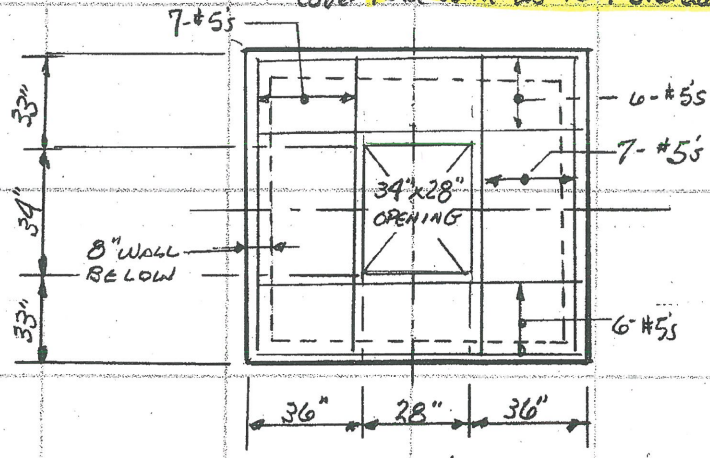
TOP SLAB WILL BE REINFORCED THE SAME AS TDOT'S D-CB-12SD WITH f'_c & F_y matching TDOT requirements. Calculations provided to verify Top design for HL-93 LOADING:

MATERIALS PROPERTIES:

Concrete, 28 day compressive strength, f'_c = 4KSI minimum.

re-inforcing steel, as re-bar, $F_{y\,min}$ = 60 KSI

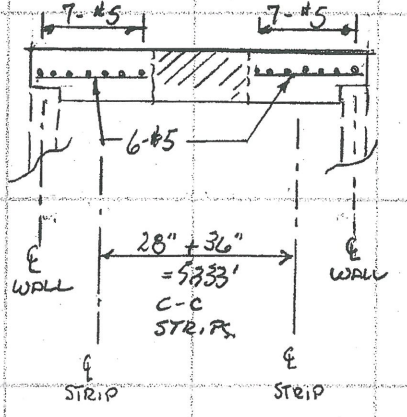
Configuration of Top & re-bar: Configuration of top along with design thicknesses & re-bar sizes and spacing and clear cover to be same as TDOT standard D-CB-12SD



TOP PLAN: W/D-CB-12SD MAIN LOAD-CARRYING RE-STEEL

Note that the out-out of SDCI lid is actually 2" less since walls are less than TDOT's by 1" all around.

Since this design is in accordance w/TDOT STD D-CB-12SD will check Flexural Strength I & shear Strength I only - just to verify the main strength limit states.



Review the span direction with 6-#5's.

To simply Eq calcs - neglect support of side wall
- use $b_{des.} = 33"$
- take design span c-c slab strips = 5.333'
- Check at soil cover = 2.0',
- but, take 1m reduction only as if 1" min. cover ($=33(1-.125(.92))$ $=.292$
- $\phi_F = 1.0$; $\phi_V = 0.90$ per table 12.5.5.1 For precast.
- Load Factors; LL=1.75/EV=1.30/DC=1.25

actions;

$w_{EV} = (2)(3)(.120) = .72^K/F$ $M_{EV} = .72(5.33)^2/8 = 2.56^{'K}$

$w_{DC} = (.9167)(3)(.15) = .413^K/F$ $M_{DC} = 1.47^{'K}$

$P_{HL-93} = 16^K$ $M_{HL93} = (16)(5.333)/4 = 21.33^{'K}$

$M_{FACT} = 1.3(2.56) + 1.25(1.47) + (1.2)(1.75)(1.292)(21.33) = 63.04^{'K}$

(MULT. PRES. FACTOR)

Flexural Strength;

$w/b = 33"$; $d_{min.} = 10 - 1 - .625 - .625/2 = 8.0625"$; $A_s = 6\text{-}\#5 = 1.86in^2$

$M_{cap} = 70.36^{'K} > 63.04^{'K}$; FLEXURE-STRENGTH OK

Shear Strength;

check using $b = 33"$, here count upon the wall support at edge and review w/ $\frac{1}{3}$ WHEEL LOAD TAKEN INTO WALL.

$V_{HL93} = 10.67^K$ $V_{DC} = .15(3.00)(.92)(2.333/2) = .48^K$

$V_{EV} = .12(3.0)(2)(2.333/2) = .84^K$

$V_{FACT} = 1.3(.84) + 1.2(.48) + (1.2)(1.75)(1.292)(10.67) = 30.6^K$

$d_v = .72(11) = 7.92"$ or, $d_v = .9(8.0625) = 7.26"$

↑ USE.

$V_{cap} = 0.9(.0316)(2)(\sqrt{4})(33)(7.92) = 29.73^K$ ~ 30.6 over by 3% - acceptable since the method was general.

(β = 2)

Conclusion for TOP SLAB;

* USE Same configuration, re-steel, and material strengths as the TDOT standard drawing.

Sidewalls; TDOT STD D-CB-12SD has sidewalls 9" thick w/ horizontal #5's @ 6" at the inside face for flexural strength to span wall to wall.
TDOT vertical bars are #5's @ 8".

The SDCI standard form has 8" walls. Therefore adjustments will be necessary. ① There will be an adjustment for the difference in the constant "d" resulting in increased reinforcement horizontally. ② There will also be an adjustment for matching the shear capacity of the TDOT standard by increasing f'_c as needed.

Final design will be reviewed at maximum burial depth per TDOT Standard of 28.00 feet.

① Change in horizontal reinforcement to achieve same flexural capacity, STR I as TDOT STD D-CB-12SD;

TDOT WALL CAPACITY: $H = 9"$, $d = 9 - 2 - .625/2 = 6.6875"$, $b = 12"$, $\phi_f = 1.0$, $f'_c = 4^{ksi}$, $f_y = 60$,
$A_{s_{prov.}} = \#5@6" = .62 in^2/ft$

$M_{cap_{WALL}}$ STD D-CB-12SD $= 19.32^{'-k}/'$

Area of Steel required to match TDOT STD with SDCI 8" WALL:
$d = 5.6875"$ with other factors being same;
$A_{s_{REQ'D}} = .753 in^2/ft$: roughly #5@ 4.94" → However, since f'_c will have an increase to match shear requirements: re-evaluate w/the revised f'_c from shear calculation.

② Revision to f'_c to match STD D-CB-12SD wall in shear capacity:
V_{cap} for TDOT STD; $d_v = .72(9")$ OR $= .9(6.6875)$
6.48" ← 6.02"

$V_{cap} = (.9)(.0316)(2)(\sqrt{4})(6.48)(12) = 8.85^k/ft.$

For SDCI, 8" WALL; $d_v = .72(8) = 5.76"$ ← OR $= .9(5.6875) = 5.12"$
to match TDOT standard; $8.85 = (.9)(.0316)(2)(\sqrt{f'_{c_{min.}}})(5.76)(12)$
$5.06^k/_{ksi} = f'_{c\,min.}$
raise $f'_{c\,min.}$ to 5100 psi: $V_{cap_{SDCI}} = (.9)(.0316)(2)(\sqrt{5.10})(5.76)(12) = 8.88^k/f > 8.85^k/ft$ O.K.

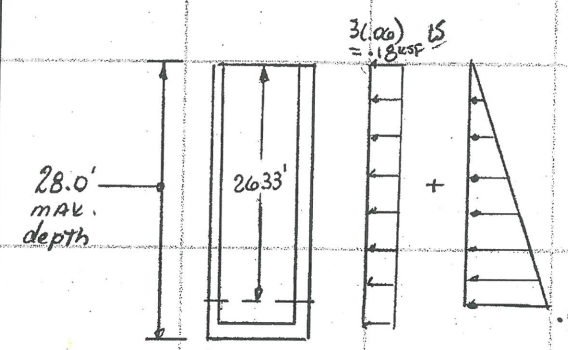
Revisit flexural w/ $f'_c = 5{,}100$; A_{SR} now $= .734 in^2/ft$ USE #5@5", $A_s = .744 in^2/ft$
$M_{cap} = 19.56^{'-k}/' > 19.32^{'-k}/'$ O.K.

Review max. depth this wall should go w/o stirrups;

will look at capacity as being that as a concrete box-Type structure under Section 5.14.5.3. (The 5.1 min. requirent still stands)

$V_{cap} = (.9)(.0948)(\sqrt{f'_c})(b)d_e = .9(.0948)(\sqrt{5.1})(12)(5.6875)$
$= 13.15^{k}/f$

assuming 3' surcharge as LL & taking wall design at 1' above base due to Fixity.
slab neglected; assume 120pcf soil w/ $K_a = .5_{at\text{-}rest}$; $\rho_{effective} = .5(.120) = .060$ kcf



@ design depth of 26.33';

		Load Factor	
intensity, EH =	1.58ksf	#1.5	= 2.37ksf
intensity, LS =	.18ksf	#1.75	= .32ksf
			$w_{fact} = 2.69^{ksf}$

$V_{fact\ per\ ft} = 2.69[7 - \frac{5.69}{12}](1/2)$
vertical = $8.78^{k}/f$ < 13.15
near base < 8.88
(@ "d" from face)

shear is good - even without using box culvert slab provision.

Flexure @ design depth; $M_{fact} = 2.69(7.67)^2/8 = 19.78^{\frac{in\text{-}k}{'}}$; $M_{cap\ \#5@5''} = 19.56^{\frac{in\text{-}k}{'}}$
in 8" SDCI wall
(over by 1.12%; but over by less than TDOT M_{cap} of $19.32^{\frac{in\text{-}k}{'}}$ (over by 2.9%)

Conclusions for Wall;

28'

- ★ Wall thickness = 8" for SDCI Standard Forms for 7'x7'.
- ★ Increase f'c to 5.1 ksi for SDCI 8" walls.
- ★ Revise re-steel vs. TDOT's D-CB-12SD from #5@6" to #5@5" to account for SDCI walls
- ★ TDOT & SDCI Designs are ok to the 58' depth as currently shown on the TDOT standard.

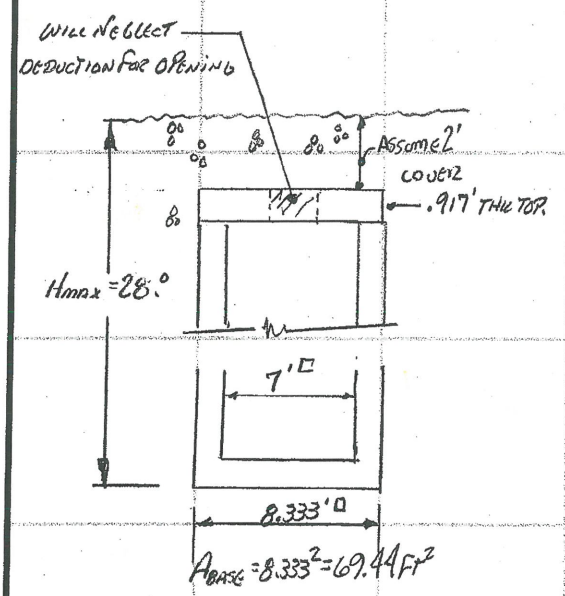
ADD'L FOR SIDEWALL; SDCI Production doesn't allow for install of type "L" bars. Will use two "U-shaped" bars spliced in place of each "L" bar needed.

Use a class "C" splice No. 5 $= 1.7\ell_d = 1.7(1.25)(.31)(60)/\sqrt{5.1}$
$= 17.5'' \rightarrow$ use 2'-0" splices.

BASE DESIGN CONSIDERATIONS:

Since the SDCI base thickness matches TDOT D-CB-12SD, and the required concrete strength due to wall considerations has been raised to $f'c = 5.1$ ksi, the SDCI design will use the same reinforcement as the TDOT design and will provide greater shear and moment capacities as compared to the TDOT Standard.

The maximum depth to bottom should be independently determined;
$H_{max} = 58.00'$ from fig.
28'
assumptions: * check max. upward pressure with structure as empty.
* base slab design checked for two-way action.



FACTORED;

$P_{DL\ TO\ BASE}$; $P_{EV} = (.12)(2)(8.333)^2 = 16.67^k * 1.3 = 21.67^k$

$P_{LL} = 16^k * 1.2 * 1.75 = 33.60^k$

$P_{DC} = 26(8.333^2 - 7^2)(.15)$
$= 79.711 * 1.25 = 99.64^k$

$P_{FACT} = 154.91^k$

$W_{FACT} = 154.91/69.44$
$= 2.23$ ksf

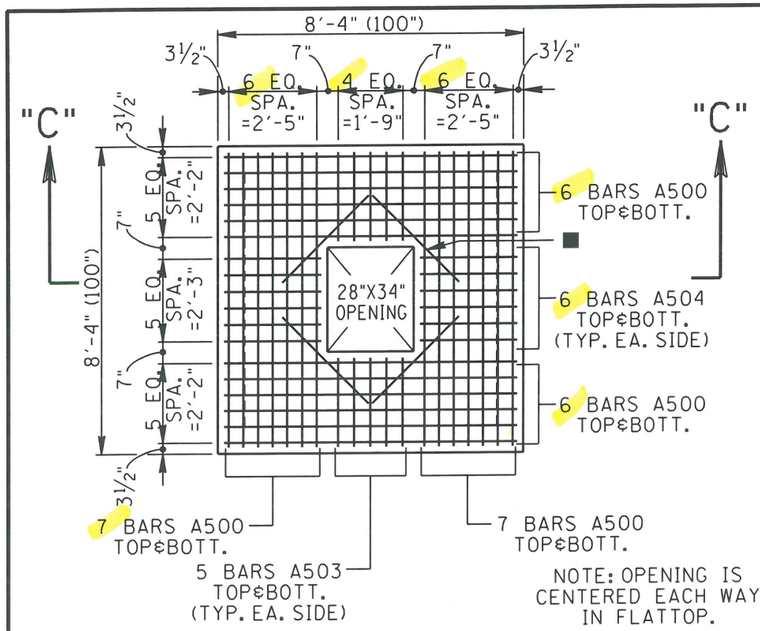
Looking at potential hydrostatic;
$W_{FACT_{H_2O}} = 1.75 * 1.3 = 2.28$ ksf ← USE.

Flexure; check as simple span to ℄ WDLS; $S_{des} = 7.67'$ $M_{FACT} = (2.28)(7.67)^2/8 \div 2$ WAY ACTION $= 8.4$ ft-k/ft EA. WAY.
As provided = #5@8" = .465 in²/ft; $d_{min} = 8 - 2 - .625 - .625/2 = 5.0625"$; $f'c = 5.1$ ksi; $\phi_{prec.} = 1.0$

$M_{cap} = 10.03$ ft-k/ft EA. WAY > 8.4 ft-k/ft ok.

Shear; b_o; $d_v = .72(8) = 5.76"$ perimeter at $d_v/2$, ea side $= 84" - 5.76" = 78.24" * 4 = 312.96"$
P_{FACT} within design perimeter $= (6.52)^2(2.28\ ksf) = 96.92^k$
eq. 5.13.3.6.3-1, w/ $\beta_c = 1.0$, $P_{cap} = .126(\sqrt{5.1})(312.96)(5.76) = 513^k >> 96.92^k$ ok/

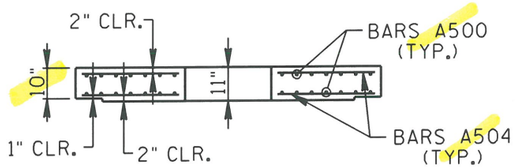
BASE DESIGN CONCLUSION: SDCI Thickness = 8" = TDOT D-CB-12SD. USE SAME REINFORCEMENT. IS GOOD TO THE 28' DEPTH NOTED ON TDOT STD.



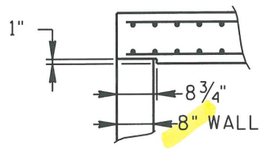
NOTE: OPENING IS CENTERED EACH WAY IN FLATTOP.

PLAN VIEW OF FLATTOP

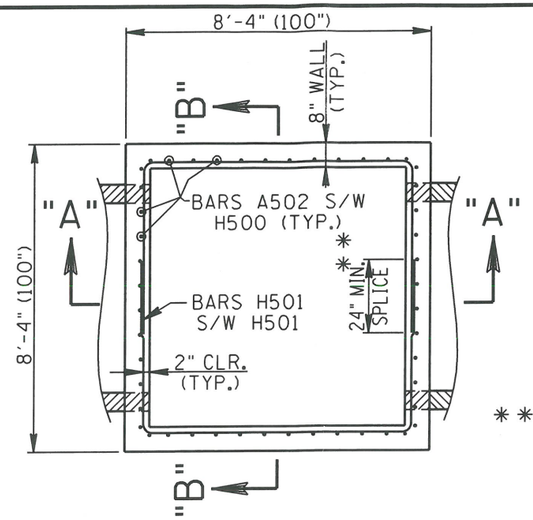
■: INDICATES DIAGONAL BAR A501 OVER BOTTOM MAT OF REINFORCEMENT (TYP.-EA. CORNER OF OPENING)



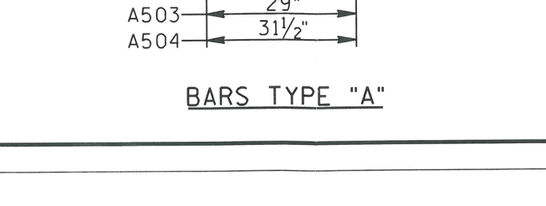
SECTION "C-C"-THRU FLATTOP



FLATTOP DETAIL AT EDGE



SECTION "E-E" THRU TOP OF BASE UNIT WALLS



SECTION "A-A"

A500	96"
A501	40"
A502	VARIES
A503	29"
A504	31½"

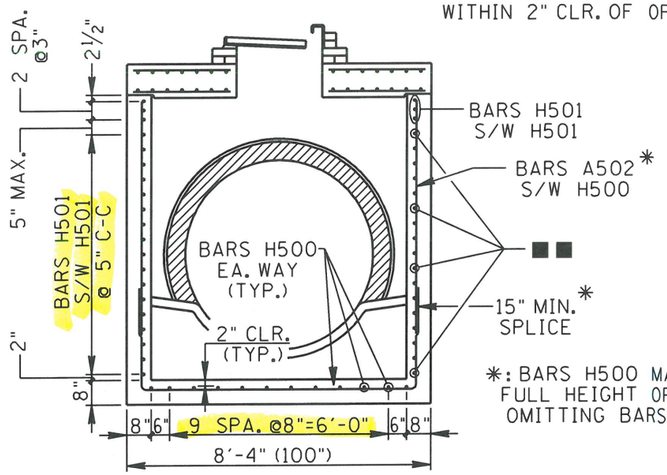
BARS TYPE "A"

GENERAL NOTES

1. THIS PRECAST DESIGN IS PRESENTED AS AN ALTERNATE TO TDOT STANDARD DRAWING NO.D-CB-12SD. SEE STD. D-CB-12SD AND D-CB-99 FOR ADDITIONAL FUNCTIONAL AND INSTALLATION REQUIREMENTS AND FOR ADDITIONAL REINFORCEMENT AROUND OPENINGS.
2. THE FOLLOWING MATERIALS PROPERTIES WILL BE REQUIRED FOR THIS PRECAST ALTERNATE:
   CONCRETE:
   FLAT-TOP: f'_c= 4,000 POUNDS PER SQUARE INCH AT 28 DAYS.
   BASE UNIT: f'_c= 5,100 POUND PER SQUARE INCH AT 28 DAYS.
   REINFORCING STEEL: ASTM A615, F_Y= 60,000 POUNTS PER SQUARE INCH.
3. THIS PRECAST ALTERNATE SHALL BE AS CONSTRUCTED BY SHERMAN-DIXIE CONCRETE INDUSTRIES, INC. (SDCI).

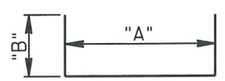
**: BAR H501 SPLICES TO BE STAGGERED BY ROTATING EACH HORIZONTAL SET OF H501'S BY 90°.

■■: USE BARS H501 S/W H501'S ADJACENT TO CUT-OUTS FOR OPENINGS AND CUT BARS TO WITHIN 2" CLR. OF OPENING.



*: BARS H500 MAY RUN FULL HEIGHT OF BASE, OMITTING BARS A502.

SECTION "B-B"



	"A"	"B"
H500	90½"	VARIES, (32" MIN.)
H501	89¼"	57"

BARS TYPE "H"

7' X 7' SHERMAN-DIXIE CONCRETE INDUSTRIES (SDCI) PRECAST ALTERNATE TO TDOT STANDARD NO. 12 CATCH BASIN

NO.	DESCRIPTION	DATE	BY
1			BWP
2			BWP
3			

ISSUE / REVISIONS

SHEET 1 OF 1