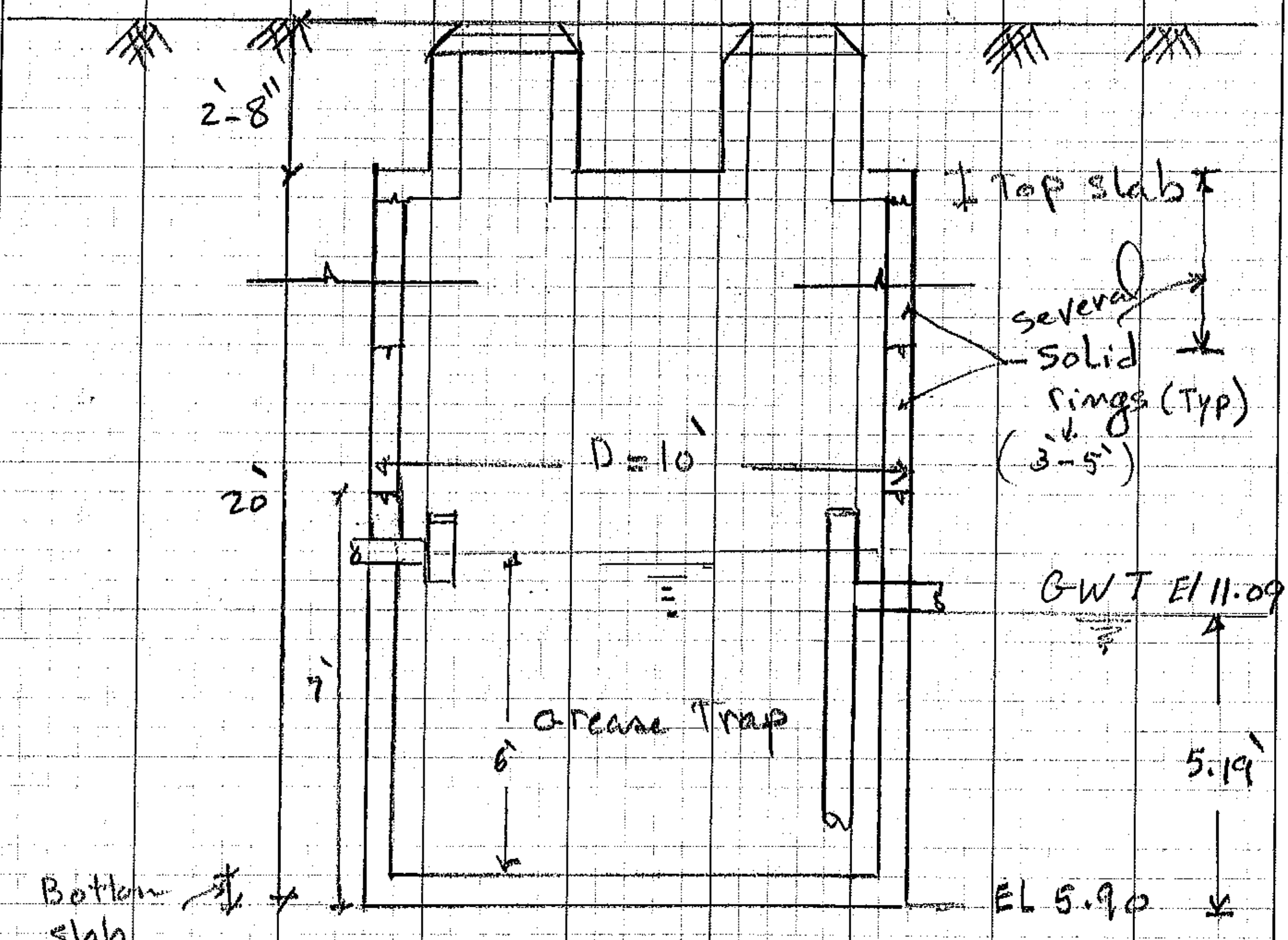
SUFFOLK COUNTY DEPARTMENT OF PUBLIC WORKS
SANITATION DIVISION

By .... Sheet No. ....

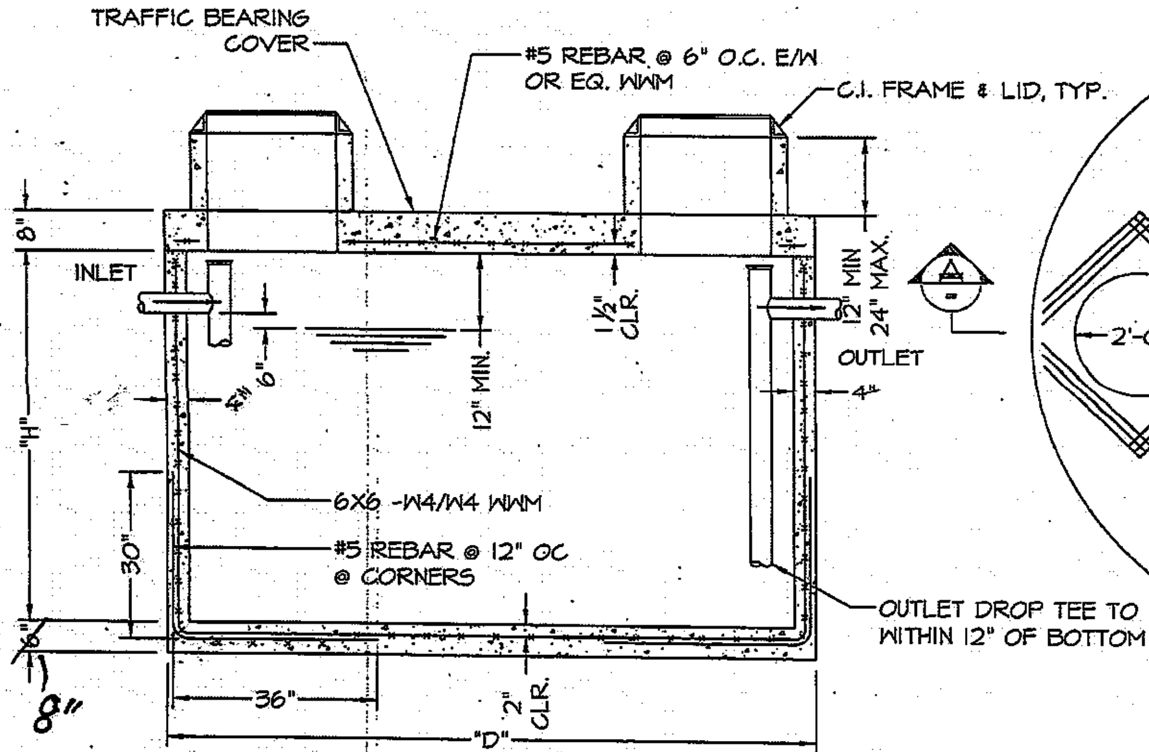
Checked By .... Bristal @ Sayville Date 3-24-14



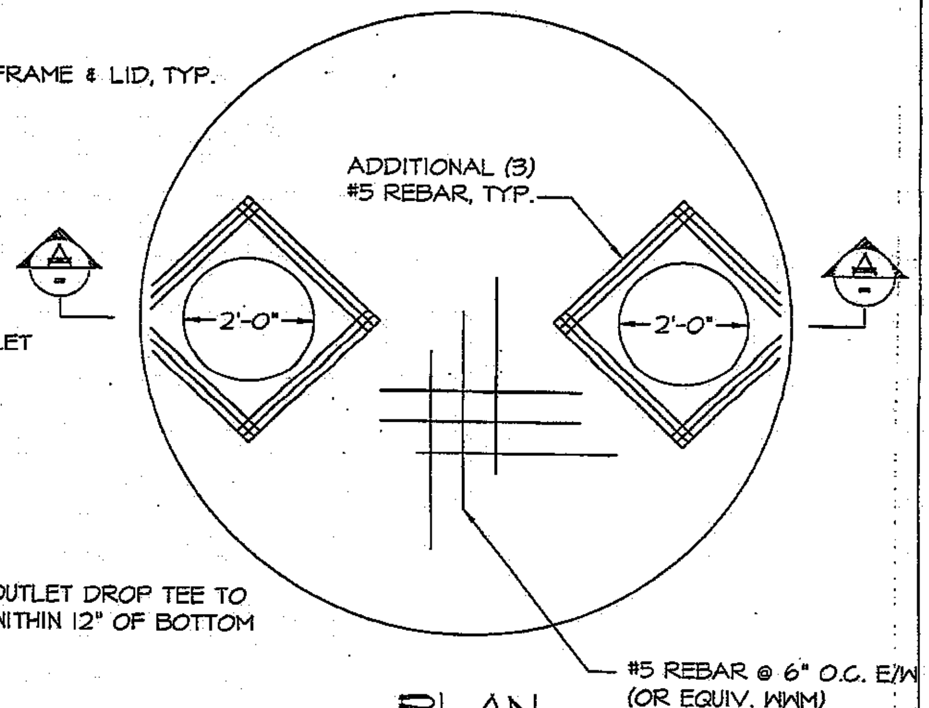
Precast Grease trap

*Note:
* Top slab & walls must be designed based on H20 loading.

42-0107p. 03/08kd



SECTION A-A



PLAN

LIQUID CAPACITY	D (FEET)	H (FEET)	WT. (LBS.)
1200 GALLONS	8'-0"	5'-0"	9770
1500 GALLONS	8'-0"	6'-0"	10970
1800 GALLONS	8'-0"	7'-0"	12170
2000 GALLONS	10'-0"	5'-0"	13390
2500 GALLONS	10'-0"	6'-0"	14890
3000 GALLONS	10'-0"	7'-0"	16390

NOTES:

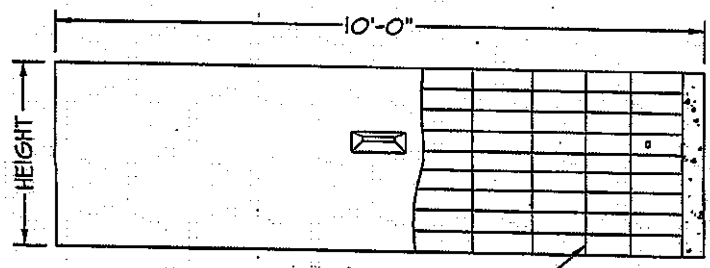
1. DESIGN LOAD: AASHTO H-20
2. CONCRETE 4,000 PSI @ 28 DAYS
2. REBAR TO BE ASTM A-615 GRADE 60
3. WELDED WIRE FABRIC ASTM A-185 (70KSI)
4. SOIL EQ. FLUID PRESSURE = 40 pcf
5. PROVIDE ADD'L REINFORCING EQUAL TO AREA OF CUT BARS IN EACH DIRECTION AROUND OPENINGS
6. PIPING AND TEES BY OTHERS

ADJO CONTRACTING
BRISTAL AT SAYVILLE

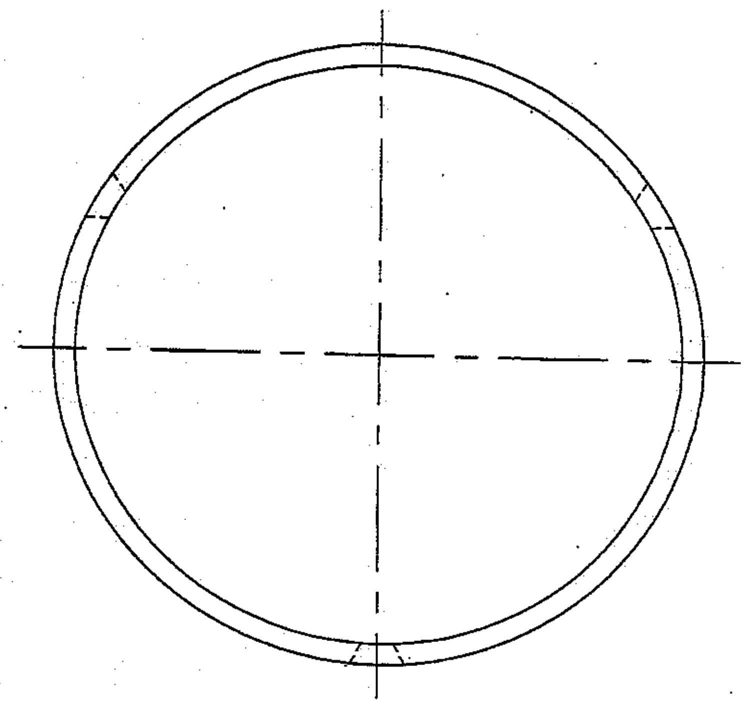
LONG ISLAND PRECAST
20 Stirz Road, Brookhaven, NY 11719
631-286-0240

MONOLITHIC PRECAST
CONCRETE GREASE TRAP

SCALE:	NONE
DATE:	9/04
DRAWING #:	SD-09



SECTION



PLAN

HEIGHT	WALL THK.	VOLUME		REINFORCEMENT W.W.M.	WEIGHT
		CF	GAL		
3'-0"	4"	205.3	1536	6x12, 6&8	4,600#
4'-0"	4"	273.7	2048	6x12, 6&8	6,100#
5'-0"	4"	342.1	2560	6x12, 6&8	7,600#

NOTES:

1. CONCRETE 4,000 PSI @ 28 DAYS
2. REBAR TO BE ASTM A-615 GRADE 60
3. WELDED WIRE FABRIC ASTM A-185

ADJO CONTRACTING
BRISTAL AT SAYVILLE

LONG ISLAND PRECAST
20 Stiriz Road, Brookhaven, NY 11719
631-286-0240

10' DIAMETER PRECAST SOLID RING

SCALE:	NONE
DATE:	12/03
DRAWING #:	PD-10-04

[redacted]

JOB BRISTAL AT SAYVILLE
SHEET NO. 1 OF 9
CALCULATED BY DRF DATE 3-11-14
CHECKED BY TFL DATE 3-11-14
SCALE

DESIGN CRITERIA

$F'_c = 4000$ PSI

$F_y = 70$ KSI WW FABRIC

$F_y = 60$ KSI REBAR

LOAD FACTOR DESIGN: 12" MIN FILL
24" MAX FILL
HS20 TRUCK

LOADS (12" FILL DEPTH)

SLAB: $.150\,(8''/12'')(1'\text{ STRIP}) = 0.100$
12" FILL: $.120\,(2.0\text{ DEEP})(1'\text{ STRIP}) = 0.240$
0.340 KLF (12" FILL)

LIVE LOAD DISTRIBUTION WIDTH (E) $= 4 + .06\,S$

10.0 FT DIA. COVER

SPAN (S) $= 2\sqrt{(10.0'/2)^2 - ((10.0'/2)/2)^2} = 8.66$ FT

$\therefore E = 4 + .06\,(8.66\text{ FT}) = 4.52$ FT

$P = \left[16K\,(1.2)(2.17)/4.52\text{ FT}\right]/2 = 4.61$ K/FT WIDTH (1.2 = IMPACT; 2.17 = LF)

$M_{DL} = 1.3\,wL^2/8 = 1.3\,(.34)(8.66)^2/8 = 4.14$ FT·K (1.3 = LF)
$M_{LL} = PL/4 = 4.61\,(8.66')/4 = 9.98$ FT·K

$M_{TOTAL} = 14.1$ FT·K

JOB: BRISTAL AT SAYVILLE
SHEET NO.: 2 OF 9
CALCULATED BY: DRF DATE: 3-11-14
CHECKED BY: TFC DATE: 3-11-14

(631) 427-5665 • FAX (631) 427-

SCALE:

COVER SLAB DESIGN (12" FILL, 10.0' DIA. SLAB

8" SLAB

TRY #5 @ 6" ⇒ 0.62 in^2/FT

$d = 8" - 1\frac{1}{2}"$ COVER $- .625/2$ (#5 BAR) $= 6.19$ in

$(d - a/2) = jd = .875d = 5.42$ in

$M_u = 14.1$ FT-K

$a = A_sF_y / (.85 \times F'c \times b)$

$\phi M_n = A_sF_y(d - a/2) \Rightarrow \phi M_n \geq M_u \Rightarrow M_n =$

A_s EST. 14.1 FT-K (12"/FT) / (.9 × 60 KSI × 5.42 in)

A_s EST. = 0.58 in^2/FT

CHECK IF STEEL YIELDS:

$a/d = .91 / 6.19$ in $= 0.147 < .75\, a_b/d = 0.377$ ✓ OK STEEL YIELDS

CHECK A_s MIN (AASHTO 8.17.1)

A_s MIN $= 1.67\sqrt{F'c}\, bh^2 / (F_y(d - a/2))$

A_s MIN $= 1.67(\sqrt{4000})\, 12 \times 8^2 / 60000(6.19 - .91/2)) = 0.24$ in^2/FT

$0.24 < 0.59$ ✓ OK

CON'T

COVER SLAB DESIGN CON'T:

CHECK $A_s = 0.62\ in^2/FT$ IS ADEQUATE:

$\phi M_n = .9(.62)(60)(6.19 - .9/2)/12\ in/FT$

$\phi M_n = 16.0\ FT\cdot K > M_U = 14.1\ FT\cdot K$ ✓ OK

CHECK SHEAR:

$V_U = 1.3\,(0.22\ K/FT)(8.66')/2 + 5.0^K/2 = 3.74\ ^K/LF$

$\phi V_c = .85(2)\sqrt{F'c}\,bd = .85(2)\sqrt{4000} \times 12 \times 6.19/1000$

$\phi V_c = 8.0^K > V_U = 3.74^K$ ✓ OK

CHECK STEEL DISTRIBUTION: AASHTO 8.16.8.4
(CRACK WIDTH)

$Z = f_y \sqrt[3]{d_c A}$

Z max ≈ 130 SEVERE EXPOSURE
$F_y = .60\,F_y = 36$ KSI

$d_c = 1.5 + .625/2 = 1.81$ in
$A = 2d_s = 2(1.81)(6\ in) = 21.75$

$Z = 36\sqrt[3]{1.81 \times 21.75}$

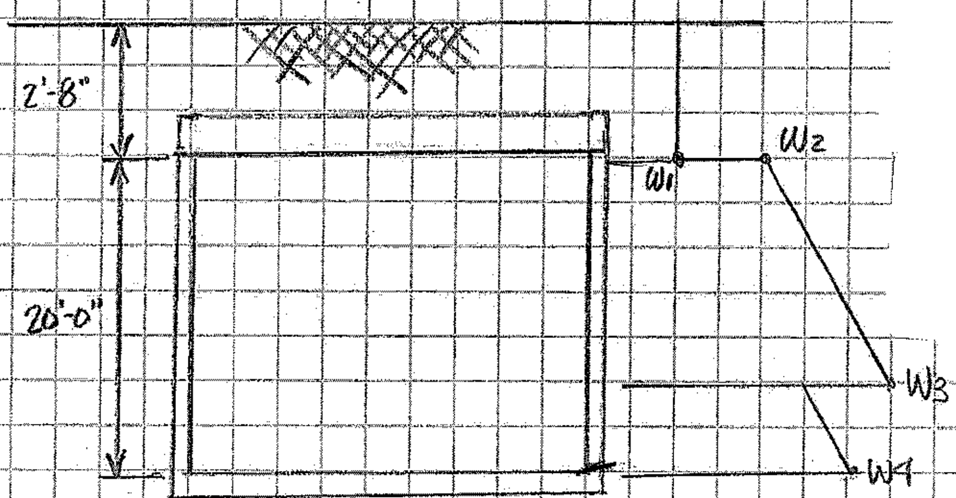
$Z = 122.5 < 130$ ✓ OK

∴ USE #5 @ 6" OCEW W/ THE EQUIVALENT AMOUNT OF STEEL AT THE EDGES OF THE OPENINGS

JOB	BRISTAL AT SAYVILLE
SHEET NO.	4 OF 9
CALCULATED BY	DBF DATE 3-14-14
CHECKED BY	TFL DATE 3-14-14
SCALE	

WALL DESIGN

DETERMINE MAX LATERAL PRESSURE ON GREASE TRAP WALLS



SOIL PROPERTIES:

$\phi = 30°$ $\gamma = 120\ \#/FT^3$ $Ka = \frac{1-\sin\theta}{1+\sin\theta} = \frac{1-\sin 30}{1+\sin 30} = 0.333$

$EP = 0.333\ (120\ PCF) = 40$

W_1 = SURCHARGE = 0.005 (16000) = 80 PSF / PER WHEEL x 6 WHEELS

$W1$ = 480 PSF (ASTM C890)

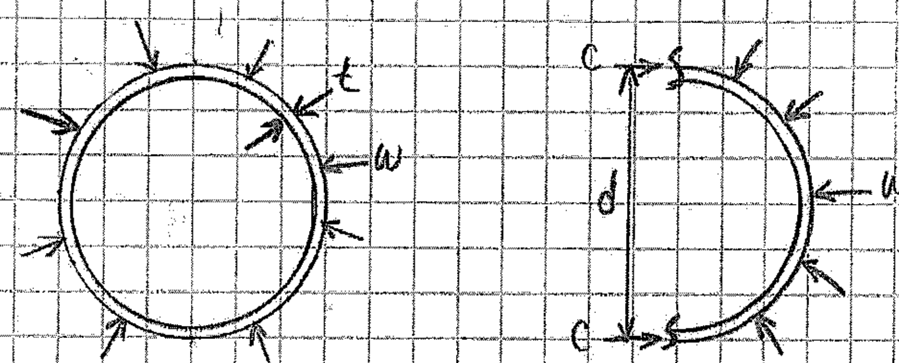
W_2 = 2.67' (40) + 480 PSF = 587 PSF

W_3 = 20' (40) + 480 PSF = 1,280 PSF - CONTROLS

W_4 = 22.67 (40) = 907 PSF

W_4 = 0.333 [120 x 17.5 + 57.6 x 5.20] + 480 + 62.4 x 5.20 = 1603.5

WALL DESIGN CON'T:



INNER DIA. = 9.33 FT } AVG = 9.67 FT.
OUTER DIA. = 10.00 FT
t = 4 in

$C = Wd^L/2$ L = UNIT LENGTH = 1.0 FT

C = 1280 (9.67) (1 FT) / 2

C = 6,189 # ⟹ PRESSURE = 6,189 / (12 × 4) = 129 PSI PSF

Fc = .50 (4000) = 2,000 PSI

FACTORED LOAD:

SOIL: .120 (2 FT) (π (5.33)²) = 21.4 K
COVER SLAB: .150 (0.67) (π (5.33)²) = 9.0 K
WALLS: .150π (5.33² - 5²) 20 ft = 32.1 K
DL = 62.5 K
TRUCK HS20: 2 WHEELS LL = 32.0 K

Pu = (1.4 (62.5) + 1.7 (32) / π × 5.33²) = 1.59 K-FT

CON'T

WALL DESIGN CON'T:

SANITARY COEFFICIENT:

RING TENSION = W_U = 1.65 x (1.7 x 62.5)(1.3) = 227.9 lbs/cu.ft

$W_U HR$ = 227.9 x 20 x 9.33/2 = 21,263 lb/ft (MAX RING TENSION)

AREA of TANK = $\pi r^2 h$ = $\pi(5)^2(20)$ = 1570 CU. FT.

EP = 0.333 (227.9 PCF) = 76

W = 20'(76) = 1520 PSF

C = 1520 (9.67)(1FT)/2 = 7,349#

C = 7,349# ⟹ PRESSURE = 7,349/(12x4) = 153 PSI

to resist ring tension As = $\frac{21,263}{0.9 \times 70,000}$ = 0.33 in^2/ft ; As = $\frac{T_{max}}{0.9 \times f_y}$

PROVIDE MINIMUM REINFORCEMENT:

As MIN. (for shrinkage) = 0.002 bh = .002(12x4) = 0.096 in^2

USE WELDED WIRE FABRIC f_y = 70 KSI (grade 60)

As MIN = 0.096 $\left(\frac{60}{70}\right)$ = 0.082 in^2/FT (0.9) = 0.9

USE WWF 6x6 - W4 x 4 (0.08)

not agreed

Uplift Calculations for Grease Trap in Groundwater

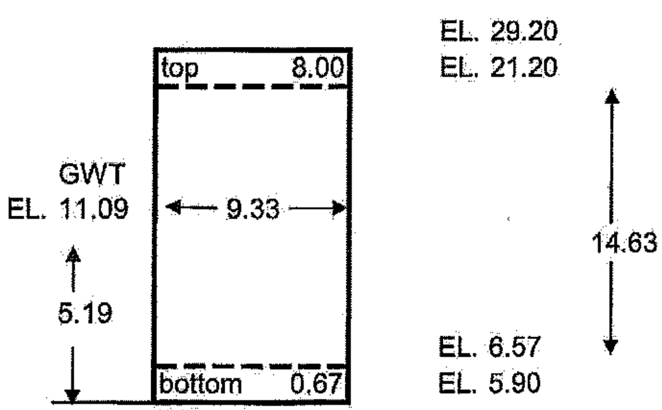
Job Name: **Bristal at Sayville**
N&P Job No.: **03282**
Engineer: **Daniel Felici**

Inside Diameter	9.33	Feet
Wall Thickness	4	Inches
Outside Diameter	10.00000	Feet
Thickness of Bottom	8	Inches
Thickness of Top	8	Inches
Top Elevation	29.2	Feet
Inside Bottom Elevation	6.57	Feet
Elevation of Groundwater	11.09	Feet
Manhole #1 Size (Diameter)	2	Feet
Manhole #2 Size (Diameter)	2	Feet

	Radius	Height	Pi	Vol.	T	Volume	Openings		Weight
Inside	4.67	14.63	3.14	1,000.94					
Outside	5.00	14.63	3.14	1,149.04		148.10		150.00	22,214.73
Bottom	5.00		3.14		0.67	52.36		150.00	7,853.98
Top	5.00		3.14		8.00	628.32	4.00	150.00	93,647.78
									123,716.49
Water	5.00	5.19	3.14			407.36		62.40	25,419.25

Safety	4.87

Actual Safety Factor 4.87 > Required Minimum Safety Factor of 1.5
Actual Safety Factor exceeds Required Min. Safety Factor, thus no fill required.



JOB BRISTAL AT SKYVILLE
SHEET NO. 8 OF 9
CALCULATED BY DRF DATE 3-11-14
CHECKED BY TFL DATE 3-11-14
SCALE

BASE SLAB DESIGN:

LOADS: SOIL: $.120 (2\ FT)(\pi(5.33)^2)$ = 21.
COVER SLAB: $.150 (0.67)(\pi(5.33)^2)$ = 9.
WALLS: $.150\pi(5.33^2 - 5^2)\ 20\ FT$ = 32.
DL = 62.5

TRUCK HS20: 2 WHEELS LL = 32.0 K

BEARING PRESSURE = $(1.3(62.5) + 2.17(32)) / (\pi \times 5.33^2)$
= 1.69 K/FT

SIMPLE SPAN MOMENT $M = WL^2/8 = (1.69(8.66)^2/8)/2$ = 7.92 FT·K

FIXED END MOMENT $M = WL^2/12\ (1.69(8.66)^2/12)/2$ = 5.28 FT·K

$+M_c$ CENTER OF BOT. SLAB = 7.92 − 5.28 = 2.64 FT·K

FOR MOMENT REACTION:
TO USE #5 @ 12" OCEW (A_s = 0.20 in²/FT) FOR M = −5.28 FT·K,
DETERMINE REQ'D 'd'.

$a = A_s F_y / (.85 f'_c b) = .31(60) / .85 \times (4 \times 12) = 0.46$ in

$\phi M_n = .9 A_s F_y (d - a/2)$
$\phi M_n = M_u \rightarrow M_n = M_u/.9 = 5.28/.9 = 5.86$ FT·K

$5.86^{FK} (12"/FT) / (.31 \times 60) + .46/2 = d$

d REQ'D = 4.0 in USE 8 − 2 − .625/2 = 5.68 ✓
(#5)

JOB	BRISTOL AT SKYVILLE
SHEET NO.	9 OF 9
CALCULATED BY	DRF DATE 3-11-14
CHECKED BY	TFL DATE 3-11-14
SCALE	

BASE SLAB DESIGN CON'T.

CHECK $A_s = 0.31\ in^2/FT$ FOR ^-M REACTION

$\phi M_n = (.9(.31)(60)(5.68" - .46/2))/12$

$\phi M_n = 7.60\ FT\cdot K > M_u = 5.28\ FT\cdot K$

CHECK IF STEEL YIELDS:

$a/d = .46/5.68 = 0.081 < .75\, a_b/d = 0.377$ ✓ OK STEEL YIELDS

CHECK SHEAR:

$V_u = (1.41\ K/SF)(\pi \times 5.0^2)/(\pi \cdot 10\ FT) = 3.53^K$

$\phi V_c = .85 \times 2 \times \sqrt{4000} \times 12 \times 3.69 = 4.76^K$ ✓ OK

DETERMINE STEEL REQ'D FOR $^+$MOMENT REACTION

$M_u = 2.69\ FT\cdot K$

$d = 3 + .5/2 = 3.25\ in$ TRY #5 @ 12" $A_s = 0.31\ in^2/FT$

$a = .31(60)/(.85 \times 4 \times 12) = 0.46$

$\phi M_n = (.9(.31)(60)(3.25 - .46/2))/12$

$\phi M_n = 4.21\ FT\cdot K > M_u = 2.20\ FT\cdot K$ ✓ OK

∴ USE #5 @ 12"

CODE

1.1.1 — Except for primary containment of hazardous materials, this code provides minimum requirements for the design and construction of reinforced concrete structural elements of any environmental engineering concrete structure erected under the requirements of the legally adopted building code where this code has been adopted to be a part of such code. In areas without a legally adopted building code, this code defines minimum acceptable standards of design and construction practice.

For structural concrete, the specified concrete strength shall not be less than 4000 psi. No maximum specified compressive strength shall apply unless restricted by a specific code provision.

1.1.1.1 — Environmental engineering concrete structures are defined as concrete structures intended for conveying, storing, or treating water, wastewater, or other liquids and non-hazardous materials such as solid waste, and for secondary containment of hazardous liquids or solid waste. Ancillary structures for which liquid-tightness, gas-tightness, or enhanced durability are essential design considerations shall also conform to requirements of environmental engineering concrete structures. Precast concrete environmental structures designed and constructed in accordance with ASTM or AWWA standards, with the exception of circular tanks, are not covered in this code.

1.1.2 — This code supplements the general building code and shall govern in all matters pertaining to design and construction of reinforced concrete structural elements of any environmental engineering concrete structure, except wherever this code is in conflict with requirements in legally-adopted applicable codes addressing environmental engineering concrete structures.

1.1.3 — This code shall apply in all matters pertaining to design, construction, and material properties wherever this code is in conflict with requirements contained in other standards referenced in this code.

1.1.4 — The provisions of this code shall govern for tanks, reservoirs, and other reinforced concrete elements of any environmental engineering concrete structure. Special structures such as arches, bins and silos, blast-resistant structures, and chimneys are not covered in this code.

COMMENTARY

based on the body of the code, provided the provisions of Appendix C are used in their entirety.

Appendix D contains provisions for anchoring to concrete.

R1.1.1 — A hazardous material is defined as having one or more of the following characteristics: ignitable (NFPA 49), corrosive, reactive, or toxic. The Environmental Protection Agency (EPA)-listed wastes are organized into three categories under RCRA: source specific wastes, generic wastes, and commercial chemical products. Source specific wastes include sludges and wastewaters from treatment and production processes in specific industries such as petroleum refining and wood preserving. The list of generic wastes includes wastes from common manufacturing and industrial processes such as solvents used in degreasing operations. The third list contains specific chemical products such as benzine, creosote, mercury, and various pesticides.

Below-grade structures, such as pump stations and pipe galleries, which are part of treatment facilities and which may be exposed to external groundwater pressures, generally are designed as environmental concrete structures. Above-grade building structures that are not directly exposed to liquids, solid wastes, corrosive chemicals, corrosive gases, or high humidity associated with treatment facilities generally may be designed in accordance with the general building code or applicable industry standards. Nevertheless, consideration of corrosive effects on such structures may still be advisable.

R1.1.2 — The American Concrete Institute recommends that the code be adopted in its entirety; however, it is recognized that when the code is made a part of a legally adopted general building code, that general building code may modify some provisions of this code.

R1.1.4 — Environmental engineering projects can contain several types of structures. For example, a treatment plant can contain environmental engineering concrete structures such as tanks and reservoirs, as well and building structures. The ACI 350 code would apply to the environmental structures, while the ACI 318 code or the following ACI publications could apply to the other structures.

"Design and Construction of Reinforced Concrete Chimneys" reported by ACI Committee 307.[1.1] (Gives

Designation: C1613 – 10

Standard Specification for Precast Concrete Grease Interceptor Tanks[1]

This standard is issued under the fixed designation C1613; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers design requirements, manufacturing practices, and performance requirements for monolithic or sectional precast concrete grease interceptor tanks.

1.2 This specification describes precast concrete tanks installed to separate fats, oils, grease, soap scum, and other typical kitchen wastes associated with the food service industry.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A82/A82M Specification for Steel Wire, Plain, for Concrete Reinforcement

A184/A184M Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement

A185/A185M Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

A496/A496M Specification for Steel Wire, Deformed, for Concrete Reinforcement

A497/A497M Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete

A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A706/A706M Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

C33 Specification for Concrete Aggregates

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C94/C94M Specification for Ready-Mixed Concrete

C125 Terminology Relating to Concrete and Concrete Aggregates

C150 Specification for Portland Cement

C260 Specification for Air-Entraining Admixtures for Concrete

C330 Specification for Lightweight Aggregates for Structural Concrete

C494/C494M Specification for Chemical Admixtures for Concrete

C595 Specification for Blended Hydraulic Cements

C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

C685/C685M Specification for Concrete Made by Volumetric Batching and Continuous Mixing

C890 Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures

C923 Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

C990 Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

C1116 Specification for Fiber-Reinforced Concrete and Shotcrete

C1602/C1602M Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

2.2 *ACI Standard:*[3]

ACI 318 Building Code Requirements for Reinforced Concrete

2.3 *IAPMO Documents:*[4]

Uniform Plumbing Code

IAPMO PS-80 Grease Interceptors and Clarifiers

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[1] This specification is under the jurisdiction of ASTM Committee C27 on Precast Concrete Products and is the direct responsibility of Subcommittee C27.30 on Water and Wastewater Containers.

Current edition approved Jan. 1, 2010. Published January 2010. Originally approved in 2006. Last previous edition approved in 2009 as C1613 – 09. DOI: 10.1520/C1613-10.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.

[4] Available from International Association of Plumbing and Mechanical Officials (IAPMO), 5001 E. Philadelphia St., Ontario, CA 91761.

2.4 *AASHTO Standard:*[5]
Standard Specifications for Highway Bridges

3. Terminology

3.1 For definitions of terms relating to concrete, see Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *access opening, n*—a hole in the top slab used to gain access to the inside of the tank for the purpose of cleaning and removing grease, floating scum and sludge without a person actually having to enter the tank.

3.2.2 *air scum volume, n*—the number of cubic inches (centimeters) in the space between the liquid surface and the underside of the top slab.

3.2.3 *baffle, n*—a device, such as a sanitary tee or other deflector, used to direct the flow of influent down below the separated layer and prevent floating layer of fats, oils, or grease from exiting the tank through the outlet.

3.2.4 *grease interceptor capacity, n*—the volume of liquid the tank is designed to hold.

3.2.5 *grease interceptor tank system, n*—a single tank or series of tanks in which wastes from a kitchen or food service establishment containing no sanitary discharges from toilets, urinals and other similar fixtures are received and retained, and from which the liquid effluent, which is comparatively free from fats, oils, greases and settleable and/or floating solids, is then discharged to a public sewer, septic or other approved treatment system.

3.2.6 *inspection opening, n*—a hole in the top slab used for the purpose of observing conditions inside the tank.

3.2.7 *joint, n*—a physical separation where two pieces of precast concrete are in contact.

3.2.8 *non-sealed joint, n*—a joint where sealant is not used but where a machined fit will minimize the movement of liquid from one side of a precast concrete wall to the opposite side.

3.2.9 *owner, n*—is by definition end user, customer, or purchaser.

3.2.10 *sealed joint, n*—a joint that is sealed to prevent liquid passing from one side of a precast concrete wall to the opposite side.

3.2.11 *tank dividing wall, n*—a partition across the width of the tank that extends partially between the top and bottom intended to deflect influent downward and increase the length of the flow path of the liquid as it travels through the tank.

4. Ordering Information

4.1 The purchaser shall include the following information in bidding documents and on the purchase order, as applicable to the units being ordered:

4.1.1 Reference to this specification, and date of issue.

4.1.2 Quantity, that is, number of units ordered.

4.1.3 Capacity of tank in gallons or litres.

4.1.4 Special cement requirements including moderate sulfate-resisting cement, Specification C150 Type II, or highly sulfate-resisting cement, Specification C150, Type V. If the purchaser does not stipulate, the manufacturer shall use any cement meeting the requirements of Specification C150 or C595 (Type IS or Type IP only).

4.1.5 Acceptance will be based on a review of the calculations or on proof tests.

4.1.6 Design requirements such as depth of earth cover, live load applied at the surface, and ground water level.

4.1.7 Testing for water leakage shall not be required at the job site unless specifically required by the owner at the time of ordering.

4.1.8 Manufacturer is permitted to require testing at the job site prior to backfill in accordance with section 9.1.2.

5. Materials and Manufacture

5.1 *Cement*—Portland cement shall conform to the requirements of Specification C150 or shall be portland blast-furnace slag cement (Type IS) or portland-pozzolan cement (Type IP) conforming to the requirements of Specification C595.

5.2 *Aggregates*—Aggregates shall conform to Specification C33 and lightweight aggregates shall conform to Specification C330, except that the requirements for grading shall not apply.

5.3 *Water*—Water used in mixing concrete shall meet the requirements of Specification C1602/C1602M.

5.4 *Admixtures*—Admixtures, when used, shall conform to Specification C494/C494M, Specification C618, or Specification C260 and shall not be detrimental to other products used in the concrete.

5.5 *Steel Reinforcement*—Steel reinforcement shall conform to Specification A82/A82M or A496/A496M for wire; Specification A185/A185M or A497/A497M for wire fabric; or Specification A184/A184M, A615/A615M, or A706/A706M for bars.

5.5.1 *Locating Reinforcement*—Reinforcement shall be placed in the forms as required by the design.

5.5.2 *Holding Reinforcement in Position During Pouring Placement*—Reinforcement must be securely tied in place to maintain position during concrete placing operations. Chairs, bolsters, braces, and spacers in contact with forms shall have a corrosion-resistant surface.

5.6 *Concrete Mixtures*—The aggregates, cement, and water shall be proportioned and mixed to produce a homogeneous concrete meeting the requirements of this specification, and in accordance with Specification C94/C94M or Specification C685/C685M.

5.7 *Forms*—The forms used in manufacture shall be sufficiently rigid and accurate to maintain the dimensions of the grease interceptor tank within the stated tolerances. All casting surfaces shall be of smooth nonporous material. Form releasing agents used shall not be injurious to the concrete.

5.8 *Concrete Placement*—Concrete shall be placed in the forms and consolidated such that all reinforcement steel and fixtures are embedded without segregation of materials or voids in the concrete.

[5] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

5.9 *Curing*—The precast concrete sections shall be cured by any method or combination of methods that will develop the specified compressive strength at 28 days or less.

5.10 *Concrete Quality*—The quality of the concrete shall be in accordance with the chapter on concrete quality in ACI 318, except for frequency of tests, which shall be specified by the purchaser. Concrete compressive strength tests shall be conducted in accordance with Test Method C39/C39M.

5.11 *Fibers*—Polypropylene or polyolefin fibers are only permitted as a secondary reinforcing material, at the manufacturer's option, in precast concrete grease interceptor tanks. For the purposes of this standard, secondary reinforcing material is only used to resist temperature and shrinkage effects. Only Type III conforming to the requirements of Specification C1116 shall be accepted.

5.12 *Pipe Connections*—Pipe-to-tank connections shall employ flexible connectors conforming to the requirements of Specification C923. Materials for the connectors shall have demonstrated resistance to the effects of fats, oils, grease, and fluid temperatures of at least 160°F (70°C).

5.13 *Sealants*—Flexible sealants employed in the manufacture or installation of tanks shall conform to Specification C990. Rigid (mortar) sealing of tank sections is not permitted.

6. Structural Design Requirements

6.1 Structural design of grease interceptor tanks shall be by calculation or by performance.

6.1.1 Design by calculation shall be completed using the Strength Design Method (ultimate strength theory) or the Alternate Design Method (working stress theory) outlined in ACI 318.

6.1.2 Design by performance requires the manufacturer to demonstrate that failure will not occur by physically applying loads to the product. The load applied shall be 2.2 times the design live load or 1.5 times the design dead load, whichever is greater. Such testing shall be witnessed and certified by a registered professional engineer.

NOTE 1—When synthetic fibers are used to replace some or all of the secondary steel reinforcement in the grease interceptor, equivalent performance criteria can be found in section 5.4 of IAPMO PS-80.

NOTE 2—Vacuum testing may be used to simulate uniform loads. It is not possible to simulate concentrated loads, such as wheel loads, using vacuum testing.

6.1.3 Tanks shall be designed so that they will not collapse or rupture when subjected to anticipated earth and hydrostatic pressures when the tanks are either full or empty.

6.1.4 At a minimum, loads from Practice C890 designation A-16 (AASHTO HS20-44) shall be used for design.

6.1.5 The live loads imposed at lifting points shall be considered in the design of the grease interceptor tank.

6.1.6 Inserts embedded in the concrete (including embedded lifting devices) shall be designed and used according to all federal, state, and local regulations.

NOTE 3—Lift inserts are typically manufactured with an integral factor of safety of 4, which is already accounted for in their rated load.

6.2 *Concrete Strength*—The minimum compressive strength (f'c) for designs shall be 4000 psi (28 MPa) at 28 days of age.

6.3 *Reinforcing Steel Placement*—The concrete cover for reinforcing bars, mats, or fabric shall not be less than 1 in. (25 mm).

6.4 *Openings*—The structural design shall take into consideration the number, placement, and size of all openings.

6.5 *Lift Equipment*—All equipment used to handle the precast concrete tank shall be designed and used according to all federal, state, and local regulations.

7. Physical Design Requirements

7.1 *Capacity*—Sizes are generally specified by local regulations and they shall supersede the following requirements. When local regulations are not available, grease interceptor capacity may be determined by use of one of the sizing criteria provided in the Appendix.

7.2 *Shape*—Grease interceptor shapes are generally specified by local regulations and they shall supersede the following requirements.

7.2.1 The air scum volume above the liquid shall be at least 12.5 % of the volume of liquid but not less than 9 in. (230 mm) high for entire surface above liquid.

7.2.2 Minimum liquid depth shall be 30 in. (760 mm) unless otherwise approved by local regulations or the authority having jurisdiction.

7.2.3 Maximum liquid depth shall be 72 in. (1800 mm) unless otherwise approved or required by local regulations, the authority having jurisdiction, or the design engineer.

7.2.4 Tank length shall be greater that the width.

7.3 *Compartments:*

7.3.1 Grease interceptor tank systems shall include single and multi-compartment units unless otherwise approved by local codes or jurisdiction. In multi-compartment tanks the dividing walls shall be monolithically cast or placed secondarily utilizing a non-sealed joint with the tank body, or any combination thereof.

7.3.2 Multiple units installed in series are acceptable.

7.3.3 The transfer port between compartments shall be sized to maintain a low velocity as liquid moves between compartments. A minimum of 50 in.^{2} (320 cm^2) shall be used where local codes do not specify otherwise.

7.3.4 The transfer port between compartments shall be in the middle 25 % of the distance from the bottom of the tank to the water line.

7.3.5 No tee, outlet filter unit, or tank-dividing wall shall extend to the interior roof without providing for venting. The cross-sectional area of a vent shall be at least equivalent to a 4 in. (100 mm) diameter pipe. Poured-in-place inlet and/or outlet baffles are not permitted.

7.4 *Inlet and Outlet Pipes:*

7.4.1 The inlet pipe shall be no less than 4 in. (100 mm) in diameter.

7.4.2 The difference between the invert of the inlet pipe and the invert of the outlet pipe shall be a minimum of 2 in. (50 mm) and a maximum of 4 in. (100 mm).

7.5 *Baffles and Outlet Devices:*

7.5.1 Baffles or tees shall be placed at the inlet pipe. Baffles, tees or outlet filters shall be placed at the outlet pipe.

7.5.2 Baffles, tees or outlet filters shall be made of noncorrosive materials and be permanently connected with noncorrosive fasteners to either the inside of the tank or the outlet pipe.

7.5.3 The inlet baffle or tee shall be submerged to a depth located in the middle 25 % of the distance from the bottom of the tank to the water line and at least 5 in. (125 mm) above the liquid level.

7.5.4 The outlet baffle, tee or filter shall be submerged to a depth 6 in. (150 mm) to 12 in. (300 mm) above the tank floor. It shall extend a minimum of 5 in. (125 mm) above the liquid level.

7.5.5 Outlet filter, when used, shall be maintained in accordance with manufacturer's recommendations or requirements of regulating agencies, or both.

7.5.5.1 Outlet filters, when used, shall be sized using the estimated daily sewage flow through the tank and the rated capacity of the filter, per the filter manufacturer's specifications.

7.5.5.2 When used, the manufacturer of the outlet filter must specify suitability for grease, oil, scum and solids removal for this type of waste.

7.5.5.3 When used, the minimum required filtration surface of an outlet filter shall be based upon the estimated daily waste water volume from the kitchen or food service establishment and the recommendations of the unit manufacturer or regulating agencies, or both.

7.6 *Openings in Top Slab:*

7.6.1 All access openings and inspection openings shall be brought to grade using risers or other assemblies.

7.6.2 An access opening shall be located over the inlet baffle or tee and the outlet baffle or tee.

7.6.3 An access opening or openings 20 in. or greater shall be provided to permit pumping of all compartments and for each 10-ft increment of tank length for tanks longer than 20 ft.

7.6.4 An access opening or inspection opening located over the tank-dividing wall shall not be prohibited.

7.6.5 All access opening covers and inspection opening covers shall have a permanent means to permit authorized access. Handles, when used, shall be made of corrosion-resistant material and be capable of supporting the weight of the cover.

7.6.6 Handles are not required when the access opening cover sits on top of the slab. The cover must be prevented from moving laterally if sitting on top of the slab.

7.6.7 Each access opening and inspection opening shall be provided with a cover. The cover shall be provided with a means to prevent unauthorized entrance.

7.6.8 All openings, joints, risers, and covers shall be watertight.

8. Quality Control and Sampling

8.1 The manufacturer shall certify that the product meets three criteria: *(1)* watertightness, *(2)* physical dimensions, and *(3)* strength of grease interceptor tank.

8.2 Installation shall be in accordance with manufacturer's instructions.

9. Watertightness Test Methods

9.1 Testing for watertightness shall be performed using either vacuum testing or hydrostatic testing.

9.1.1 *Vacuum Testing*—Seal the empty tank and apply a vacuum to 4 in. (100 mm) of mercury. Hold the vacuum for 5 minutes. During this initial 5 minute period, the vacuum shall not drop more than ½ in. (13 mm) of mercury, which allows for a pressure equalization loss from equipment seating, and so forth. If the vacuum drops, it shall be brought back up to 4 in. (100 mm) of mercury and held for a further 5 minutes with no vacuum loss. If the tank fails the test, it shall be repaired and retested.

9.1.2 *Hydrostatic Testing*—Seal the tank, fill with water to its operational level, and let stand for 8 to 10 h. If there is a measurable drop in the water surface elevation, refill the tank and let stand for another 8 to 10 h. There shall be no further measurable drop in the water surface elevation. Tanks shall not be rejected for damp spots on the exterior concrete surface. If water is dripping in a steady stream, the tank shall be repaired and retested.

10. Dimensions and Permissible Variations

10.1 *Dimensional Tolerances*—The length, width, height, or diameter measurements of the grease interceptor tank when measured on the inside surface shall not deviate from the design dimensions more than the following:

Dimension	Tolerance
0 to less than 5 ft (0 to 1.5 m)	±¼ in. (±6 mm)
5 to less than 10 ft (1.5 to 3.0 m)	±⅜ in. (±10 mm)
10 to less than 20 ft (3.0 to 6.1 m)	±½ in. (±13 mm)
20 ft (6.1 m) and over	±¾ in. (±19 mm)

10.2 *Squareness Tolerance*—The inside of the rectangular precast concrete component shall be square as determined by diagonal measurements. The difference between such measurements shall not exceed:

Measured Length	Allowance Difference
0 to less than 5 ft (0 to 1.5 m)	±½ in. (±13 mm)
5 to less than 10 ft (1.5 to 3.0 m)	±¾ in. (±19 mm)
10 ft to less than 20 ft (3.0 m to 6.1 m)	±1 in. (±25 mm)
20 ft (6.1 m) and over	±1½ in. (±38 mm)

10.3 *Joint Surfaces*—The joint tolerances for sealed joint gap between two mating joint surfaces shall not exceed ⅜ in. (10 mm) before the joint sealant is applied.

10.4 *Reinforcement Location*—With reference to thickness of wall or slab, reinforcement shall be within ±¼ in. (6 mm) of the design location, but in no case shall the cover be less than 1 in. (25 mm). The variation in reinforcement spacing shall not be more than one tenth of the designed bar spacing nor exceed 1½ in. (38 mm). The total number of bars shall not be less than that computed using the design spacing.

11. Repairs

11.1 Repairs of precast concrete grease interceptors, when required shall be performed by the manufacturer in a manner ensuring that the repaired grease interceptor tank will conform to the requirements of this specification.

12. Rejection

12.1 Precast concrete grease interceptor tanks or sections of grease interceptor tanks shall be subject to rejection because of failure to conform after repairs to any of the requirements contained in this specification.

13. Product Marking

13.1 Each grease interceptor tank shall be clearly marked within 2 ft (6 m) of the inlet to the tank by indentation or other approved means with *(1)* date manufactured, *(2)* name or trademark of the manufacturer, *(3)* tank capacity, *(4)* minimum and maximum amount of earth cover in feet (or meters), unless required otherwise by local codes.

13.2 Each grease interceptor tank cover shall be clearly marked by indentation, or other approved means with *(1)* date of manufacture, *(2)* name or trademark of the manufacturer, and *(3)* indication of external loads for which the grease interceptor tank is designed to resist, including the minimum and maximum amount of earth cover in feet (or meters) above top slab and surface load from Practice C890 (A-16), unless required otherwise by local codes.

13.2.1 When all the requirements of this specification are met, the product shall be so stamped.

NOTE 4—Where an access opening or an inspection opening has a dimension greater than 8 in. (200 mm) a confined space warning label should be placed in a prominent place.

14. Keywords

14.1 fats, oils and greases; grease interceptor tank; liquid kitchen waste; precast concrete; wastewater pretreatment

APPENDIX

(Nonmandatory Information)

X1. OPTIONAL PRECAST CONCRETE GREASE INTERCEPTOR SIZING CRITERIA

X1.1 The grease interceptor tank may be sized in accordance with Appendix H of the 2003 Uniform Plumbing Code or Chapter 10 of the 2006 Uniform Plumbing Code.

X1.2 The grease interceptor tank may be sized for an existing facility by using the actual average daily-metered water-use figures from the facility multiplied by a safety factor of 1.5. A minimum retention time of 30 minutes shall be used to size the grease interceptor tank.

X1.3 The grease interceptor tank may be sized by using the peak design flow rates for all fixtures leading to the grease interceptor. A minimum retention time of 30 minutes shall be used to size the grease interceptor tank.

Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures[1]

This standard is issued under the fixed designation C890; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes the minimum loads to be applied when designing monolithic or sectional precast concrete water and wastewater structures with the exception of concrete pipe, box culverts, utility structures, and material covered in Specification C478.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C478 Specification for Precast Reinforced Concrete Manhole Sections

2.2 *AASHTO Standard:*

Standard Specifications for Highway Bridges, 16th Edition[3]

2.3 *ACI Standard:*

ACI 318 Building Code Requirements for Reinforced Concrete[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *above ground structures*—all structures with their base at or above ground.

3.1.2 *bearing loads*—the foundation pressure reaction to all other loads acting on the structure.

3.1.3 *below ground structures*—all structures other than those with their base at or above ground.

3.1.4 *dead loads*—the mass of the structure and all permanent loads imposed on the structure.

3.1.5 *equipment loads*—loads induced into the structure by equipment installed on mounting devices cast into the structure.

3.1.6 *hydrostatic loads*—all pressures due to the weight of water or other liquids.

3.1.7 *lateral earth loads*—the lateral pressure due to the effective weight of adjacent earth backfill.

3.1.8 *lifting loads*—the forces induced into the structure during handling at the precast plant and the construction site.

3.1.9 *surcharge loads*—the lateral pressure due to vertical loads superimposed on the adjacent earth backfill.

3.1.10 *traffic loads*—all loads superimposed on the structure or adjacent earth backfill due to vehicles or pedestrians.

3.1.11 *water and wastewater structures*—solar heating reservoirs, septic tanks, cisterns, holding tanks, leaching tanks, extended aeration tanks, wet wells, pumping stations, grease traps, distribution boxes, oil-water separators, treatment plants, manure pits, catch basins, drop inlets, and similar structures.

4. Significance and Use

4.1 This practice is intended to standardize the minimum loads to be used to structurally design a precast product.

4.2 The user is cautioned that he must properly correlate the anticipated field conditions and requirements with the design loads. Field conditions may dictate loads greater than minimum.

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[1] This practice is under the jurisdiction of ASTM Committee C27 on Precast Concrete Products and is the direct responsibility of Subcommittee C27.30 on Water and Wastewater Containers.

Current edition approved Jan. 15, 2013. Published February 2013. Originally approved in 1978. Last previous edition approved in 2012 as C890– 12. DOI: 10.1520/C0890-13.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

[4] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.

5. Design Loads

5.1 *Dead Loads:*

5.1.1 Permanent vertical loads typically include the weight of the road bed, walkways, earth backfill, and access opening covers.

5.1.2 Recommended unit weights of materials for design are shown in Table 1.

5.2 *Traffic Loads:*

5.2.1 The vehicle and pedestrian loadings are shown in Table 2.

5.2.2 The arrangement and spacing of vehicle wheels are shown in Fig. 1 and Fig. 2.

5.2.3 *Distribution of Wheel Loads through Earth Fills:*

5.2.3.1 For structures where vehicle wheels contact the top surface of the structure, the vehicle wheel loads will be distributed over an area as shown in Fig. 3. The loaded area will be:

$$A = W \times L \quad (1)$$

where:

A = wheel load area, ft^2 (m^2),
W = wheel width, ft (m), and
L = wheel length, ft (m).

5.2.3.2 For below ground structures where backfill separates the vehicle wheels and the top surface of the structure, the vehicle wheel loads will be distributed as a truncated pyramid as shown in Fig. 4.

The loaded area will be:

$$A = (W + 1.75\,H) \times (L + 1.75\,H) \quad (2)$$

where:

A = wheel load area, ft^2 (m^2),
W = wheel width, ft (m),
L = wheel length, ft (m), and
H = height of backfill between wheels and structure, ft (m).

5.2.3.3 When several distributed wheel load areas overlap, the total wheel load will be uniformly distributed over a composite area defined by the outside limits of the individual areas. Such a wheel load distribution is shown in Fig. 5.

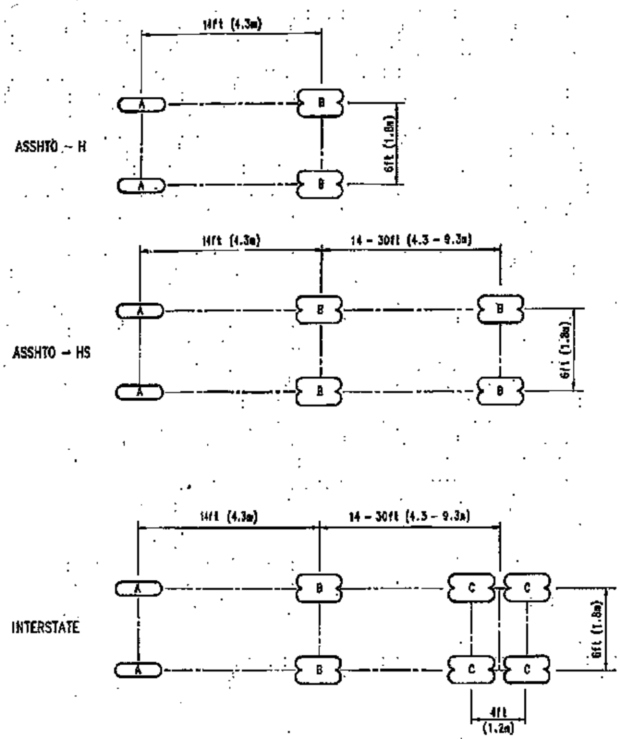
TABLE 1 Unit Weights of Materials

Material	Weight, lbf/ft³ (N/m³)
Concrete (plain or reinforced)	150 (23 600)
Lightweight Concrete (reinforced)	100 to 130 (15 700 to 20 400)
Cast Iron	450 (70 700)
Steel	490 (77 000)
Aluminum	175 (27 500)
Earth Fill	100 to 150 (15 700 to 23 600)
Macadam	140 (22 000)

TABLE 2 Vehicle and Pedestrian Load Designations

Designation	Load, max	Uses
A-16 (HS20-44)[A]	16 000 lbf (71 200 N) per wheel	heavy traffic
A-12 (HS15-44)[A]	12 000 lbf (53 400 N) per wheel	medium traffic
A-8 (H10-44)[A]	8 000 lbf (35 600 N) per wheel	light traffic
A-03	300 lbf/ft² (14 400 Pa)	walkways

[A] The designations in parentheses are corresponding ASSHTO designations.



Designation	Load at A		Load at B		Load at C	
	lbf	N	lbf	N	lbf	N
A-16 (HS20-44)[A]	4 000	17 800	16 000	71 200	12 000	53 400
A-12 (HS15-44)[A]	3 000	13 300	12 000	53 400	8 000	35 600
A-8 (H10-44)[A]	2 000	8 900	8 000	35 600	6 000	26 700

[A] The designations in parentheses are corresponding ASSHTO designations.

FIG. 1 Single Vehicle Traffic Loads and Spacing

5.2.3.4 When the dimensions of the distributed load area or the composite distributed load area exceed the top surface area of the structure, only that portion of the distributed load within the top surface area will be considered in the design.

5.2.4 The effects of impact will increase the live wheel loads designated as A-16, A-12, and A-8 as shown in Table 3.

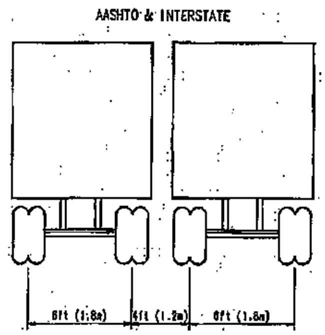


FIG. 2 Multiple Vehicle Spacing

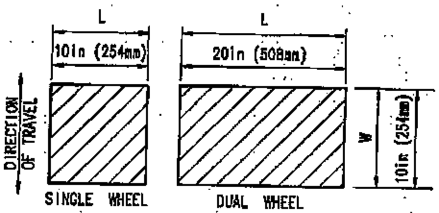


FIG. 3 Wheel Load Area

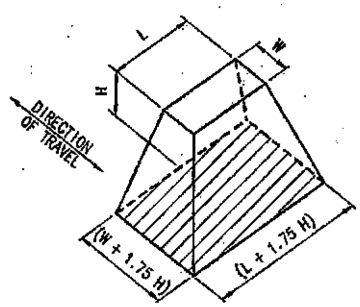


FIG. 4 Distributed Load Area

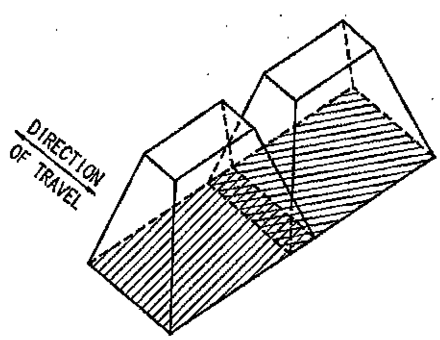


FIG. 5 Composite Distributed Load Area

5.3 *Hydrostatic Loads:*

5.3.1 The water pressure acting on any point on the outside surface of the structure is:

$$P_W = W_W \times H_W \quad (3)$$

TABLE 3 Wheel Load Increases for Impact

Height of Backfill Between Wheel and Structure	Increase
0 to 12 in. (0 to 305 mm)	30 %
13 to 24 in. (330 to 610 mm)	20 %
25 to 35 in. (635 to 890 mm)	10 %
36 in. (915 mm) or greater	0 %

where:

P_W = hydrostatic pressure, lbf/ft^2 (Pa),
W_W = unit weight of water, lbf/ft^3 (N/m^3), and
H_W = distance from the ground water surface to the point on the structure under consideration, ft (m).

5.3.2 The liquid pressure acting on any point on the inside surface of the structure is:

$$P_L = W_L \times H_L \quad (4)$$

where:

P_L = liquid pressure, lbf/ft^2 (Pa),
W_L = unit weight of the liquid, lbf/ft^3 (N/m^3), and
H_L = distance from the liquid surface to the point on the structure under consideration, ft (m).

5.4 *Lateral Earth Loads:*

5.4.1 The lateral earth pressure on the walls of a buried structure for the portion of the walls above the ground water surface will be:

$$P_E = K \times W_E \times H_E \quad (5)$$

where:

P_E = lateral earth pressure, lbf/ft^2 (Pa),
K = coefficient of lateral earth pressure,
W_E = unit weight of the earth backfill, lbf/ft^3 (N/m^3), and
H_E = distance from the surface of the earth backfill to the point on the structure walls under consideration, ft (m).

5.4.2 The lateral earth pressure on the walls of a buried structure for the portion of the walls below the ground water surface will be:

$$P_E = [K \times W_E \times (H_E - H_W)] + [K \times (W_E - W_W) \times H_W] \quad (6)$$

where:

P_E = lateral earth pressure, lbf/ft^2 (Pa),
K = lateral earth pressure coefficient,
W_E = unit weight of the earth backfill, lbf/ft^3 (N/m^3),
H_E = distance from the surface of the earth backfill to the point on the structure under consideration, ft (m),
W_W = unit weight of water, lbf/ft^3 (N/m^3), and
H_W = the distance from the surface of the ground water table to the point on the structure under consideration, ft (m).

5.4.3 Laboratory and field testing has shown that the value of the lateral earth pressure coefficient depends on the yielding of the wall of the structure relative to the earth backfill. Walls of sectional precast concrete structures can yield by rotating, translating, or deflecting. Walls of monolithic precast concrete structures can yield by deflecting. The lateral earth pressure on a structure where the walls can yield sufficiently will be considered as the active pressure. The value of the lateral earth pressure coefficient for this condition can be estimated by Rankine's equation of:

$$K_A = [1 - \sin \varphi]/[1 + \sin \varphi] \quad (7)$$

where:

K_A = active earth pressure coefficient, and
φ = internal friction angle of the earth backfill, degrees.

The value of K_A shall be as computed or 0.30, whichever is greater.

5.5 *Surcharge Loads:*

5.5.1 When traffic can come within a horizontal distance from the structure equal to one half of the height of the structure, a lateral surcharge pressure will be applied to the wall of the structure. Lateral surcharge pressures for the designated vehicle wheel loads are shown in Table 4.

5.5.2 Lateral surcharge loads from traffic will be considered negligible below a vertical distance 8 ft (2.4 m) below the wheel.

5.6 *Lifting Loads:*

5.6.1 The lifting load induced into the structure will be not less than the total dead weight of the precast unit distributed over not more than three lifting points.

5.7 *Cumulative Loadings:*

5.7.1 The cumulative vertical loading possible on the top or base of a structure are shown schematically in Fig. 6 and Fig. 7, respectively.

5.7.2 The cumulative horizontal loadings possible on the walls of a structure are shown schematically in Fig. 8.

6. Loading Combinations for Above Ground Structures

6.1 The design load for the top of the structure will consider the cumulative effects of dead loads, snow loads, and either a pedestrian live load if applicable, or a nominal live load of 20 lbf/ft^2 (958 Pa). Local area building codes will be used for snow loads.

6.2 The design load for the walls of the structure will consider both of two individual load cases.

6.2.1 *Load Case A*— Load Case A will consider a structure full condition and will include only the internal hydrostatic loads.

6.2.2 *Load Case B*— Load Case B will consider a structure empty condition and will include either the effects of wind load or horizontal vehicle impact if applicable. Local area building codes or a nominal external pressure of 30 lbf/ft^2 (1436 Pa) will be used for wind loads.

TABLE 4 Lateral Surcharge Pressures

Designation	Lateral Surcharge Pressure
A-16 (HS20-44)[A]	80 lbf/ft^2 (3830 Pa) per wheel
A-12 (HS15-44)[A]	60 lbf/ft^2 (2873 Pa) per wheel
A-8 (H10-44)[A]	40 lbf/ft^2 (1915 Pa) per wheel

[A] The designations in parentheses are corresponding ASSHTO designations.

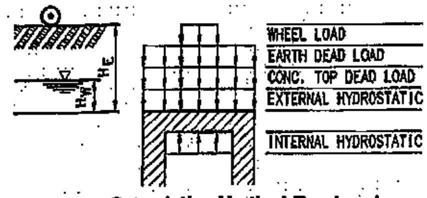


FIG. 6 Cumulative Vertical Top Loads

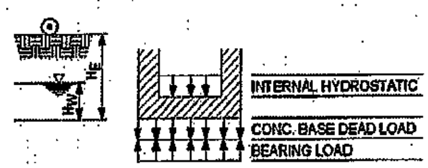


FIG. 7 Cumulative Vertical Base Loads

6.3 The design load for the base of the structure will consider the applicable individual load case.

6.3.1 *Load Case A*— Load Case A is an empty structure resting on the ground and will consist of a bearing load uniformly distributed over the base.

6.3.2 *Load Case B*— Load Case B is a full structure raised above the ground and will include the cumulative effects of dead loads and internal hydrostatic loads.

7. Loading Combinations for Below Ground Structure

7.1 The design load for the top of the structure will consider the cumulative effects of dead loads, snow loads, and traffic loads. Local area building codes will be used for snow loads.

7.2 The design load for the walls of the structure will consider both of two independent load cases.

7.2.1 *Load Case A*— Load Case A is a structure full condition and will include the cumulative effects of maximum internal hydrostatic loads, minimum external hydrostatic loads, and minimum lateral earth pressure loads.

7.2.2 *Load Case B*— Load Case B is a structure empty condition and will include the cumulative effects of maximum external hydrostatic loads, maximum lateral earth pressures, and lateral surcharge loads.

7.3 The design load for the base of the structure will consider the cumulative effects of the bearing load and the external hydrostatic load.

8. Special Loading Considerations

8.1 The structural design loading for unique applications will also consider thrust, vibration, and ice loads applicable.

8.2 The structural design for below ground structures will also consider buoyancy effects, if applicable, and proportion the structure to assure an adequate flotation safety factor.

8.3 The structural design loading will also consider the stresses due to the effects of concrete shrinkage and thermal movement. The reinforcing steel provided in areas of the structure subject to such stresses will equal or exceed the minimum amounts required by the referenced reinforced concrete design standards in Section 4.

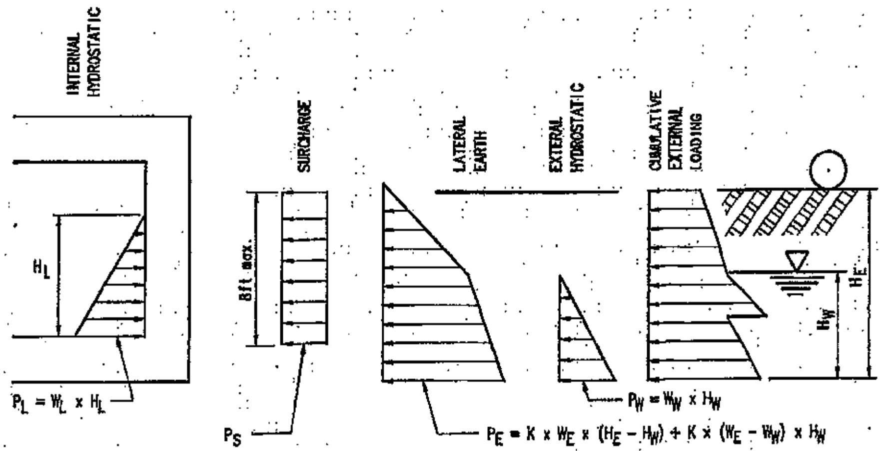


FIG. 8 Cumulative Horizontal Wall Loads

8.4 Lifting inserts which are embedded or otherwise attached to the structure will be designed for four times the maximum load transmitted to the inserts.