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STRUCTURAL DESIGN OF GUNITE SWIMMING POOLS

by

Daniel Tobar

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COLLEGE OF
ENGINEERING AND TECHNOLOGY
BRIGHAM YOUNG UNIVERSITY
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MASTERS PROJECT

Structural Design of Gunite Swimming Pools

Submitted to

Dr. Kyle Rollins

7/6/93

Prepared by

Daniel Tobar

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INTRODUCTION

Project Goal. The goal of this project is to produce generalized structural plans for a typical in-ground gunite pool. It is divided into two main areas, load analysis and structural design.

Backround. At first glance, an in-ground swimming pool may appear to be a very simple structure. However, structural design of a pool encompasses the disciplines of reinforced concrete, soil mechanics, hydraulics, and construction methods. Furthermore, a pool is not a small investment. A typical residential pool costs $20,000.

Loading. There are two types of load which act on an in-ground pool, lateral earth pressures and hydrostatic pressures. The lateral earth pressures can be further divided into geostatic and induced lateral earth pressures as a function of simple general soil classifications and expected surface loads. A key aspect of this project is the selection of appropriate loading combinations. It is also assumed that the water table is below the pool.

Structural Design. Once the controlling load cases are established the structural design can be completed. The structure derives it's strength from two sources. The first source is obvious, reinforced concrete designed for shear and moment capacity. The second source is more subtle, it is the shape of the structural shell.

The structure is typically a 6" thick gunite shell with #3 bar at 12" on center each way. The rim of the pool is referred to as the bond beam. It is 12" thick with extra horizontal steel. It's purpose is to stiffen the entire structure in the same way that a paper cup is stiffened with a small paper rim. Other details are included on the plans or discussed in the text of the paper.

Methodology. Geostatic analysis of lateral earth pressures is based upon Rankine theory which has been modified over time in light of empirical data. Induced lateral earth pressures are determined in a similar manner with the assumption that soil behavior can be modeled by elastic theory. The hydrostatic loads are analyzed using well established principles of hydraulics. The reinforced concrete design method used is the ultimate strength method as outlined by the American Concrete Institute code.

Computer Program. The loading is merged with the structural design through a spreadsheet program. A disk is included which contains the spreadsheet program on QuatroPro. In the program changes can be easily made to soil types, point loads, and structural parameters. The program will calculate the net moment at a given depth acting on the structure due to induced and geostatic lateral earth pressures as well as the weight and shape of the structure.

CONSTRUCTION METHODS

Excavation. To discuss the structural design of a pool, one must first understand how it is built. First, the site is brought to the correct grade. Excavation is done by a backhoe or a bobcat. A backhoe will excavate from the exterior of a pool. A bobcat must actually drive into the pool using an earthen ramp. The ramp begins at grade outside of the pool and descends to the floor of the pool, preferably on the shallow end. The shape of the pool is continuously fine tuned by pick and shovel working with the bobcat or backhoe.

Unsupported Slopes. In general, the excavation is unsupported. In cohesive soils, the vertical walls usually will not fail. Cohesionless soils, however, must be saturated and allowed to begin to drain shortly before excavation. This yields negative pore pressures which give an apparent cohesion to the soil which will last for a few days. If the surface of the excavation is kept moist and undisturbed the soil will not sluff off.

Structural Steel. Structural steel is bent by hand in the pool following the shape of the excavation. #3 GR 40 deformed bars are usually placed at twelve inches on center each way. Once the steel is tied together it is raised up off the soil and placed on small concrete blocks called chairs. The chairs are 2" x 2" to give adequate ground clearance.

Concrete. The structural shell is completed by shooting gunite or shotcrete directly onto the soil. Shotcrete is ready mix concrete pneumatically shot onto the intended surface. Gunite is also pneumatically shot. Gunite, however, is a dry mix of sand and cement. Water is added at the nozzle and mixes with the sand and cement as it leaves the nozzle. No formwork is required for either gunite or shotcrete other than a surface upon which to shoot. Finally, the gunite or shotcrete is finished to prepare for plaster.

LOADING

Induced Loads. Pools are usually designed only for geostatic lateral earth pressures. Yet, heavy equipment is routinely driven right next to pools. The pool walls are *not failing*. This is due to the factors of safety which an engineer is legally obligated to incorporate into the design. An engineer cannot encroach upon that factor of safety without exposing himself to charges of negligence and the resulting financial liability. But, a contractor or homeowner can encroach on the factor of safety , and, they do it all the time. Furthermore, clients are not willing to pay for a traffic rated structure unless it is absolutely unavoidable.

Therefore, surface loads will only be considered for wall segments near excavation ramps. Recall that ramps are sometimes needed to drive a bobcat into the pool excavation. These ramps are backfilled after the gunite is shot.

The induced lateral stress from a point load, such as a bobcat, is approximately modeled by elastic theory. The only soil parameter required is Poisson's Ratio. This is a conservative design since soils are not perfectly elastic. The solution to this load case is incorporated into the spreadsheet program. It would require considerable effort through finite element analysis and extensive soils testing to get a more accurate analysis.

Geostatic Loads. Geostatic loads are a function of the soil type and soil-structure interaction. The soil-structure interaction for a pool can only be active state or at-rest conditions. Cohesive soils are assumed to be in the at-rest state due to their plastic behavior over time. Cohesionless soils are assumed to be in the active state based upon expected wall movements. This load case is also handled by the spreadsheet program.

Soil Classifications. Assumptions must be made for the properties of each soil classification so that each soil can be identified quickly and inexpensively. Cohesionless soil is lumped into one class with no testing required. Cohesive soils will require determination of plasticity index, PI and over-consolidation ratio, OCR. The assumptions are :

Sand - $\gamma = 120$ pcf $\phi = 32°$ $c = 0$ $\nu = 0.3$ (Poisson)

Active earth pressure conditions, Ka

Clay - PI < 21 $\gamma = 110$ $c = 0$ $\nu = 0.4$ (Poisson)

At rest earth pressure conditions, Ko = 0. 5

OCR = 1 If pool depth > 5' verify OCR by lab test.

Most granular soils will fall within the assumptions listed. Many clays will not. The difficulty with clay is the lateral earth pressure coefficient, K. It has a very broad range, which in turn gives a wide range to the base moment, routinely doubling it. K is a function of ϕ and OCR where :

$$K_{o(\text{ over consolidated })} = K_{o(\text{ nc })} (\text{OCR})^{0.5} \qquad K_{o(\text{ nc })} = 0.95 - \sin (\phi)$$

Recall that induced moment at depth for a wall loaded by soil is :

$$M_{base} = (K_o \gamma \; z^3)/ 6$$

To limit the moment range K_o , z , and ϕ must be limited. Kenney (1959), correlated the sin (ϕ) with PI (see figure on opposite page). When PI > 21, the sin (ϕ) drops below 0.5 giving a $K_o < 0.5$. Therefore PI > 21 is not allowed.

OCR is limited to 1 and checked at 5 feet because it becomes critical to the magnitude of the moment with increasing depth. All this is done to allow optimization of general plans.

Loading Combinations. The design must anticipate conditions that will occur during construction and the life of the pool. The pool may be empty or it may be full. The top few feet of soil may be temporarily removed. Heavy equipment may operate near the pool. The following are the critical load cases.

Load Case 1 During construction or maintenance the pool will be empty. The walls must be able to carry the geostatic and induced lateral earth pressure.

Load Case 2 The exterior wall of the pool must be able to hold water in the pool without soil support to a depth of 3 feet.

Load Case 3 There may be an attached spa with a wall common to the pool and the spa. The design should allow for the spa to be empty when the pool is full, or vice-versa.

Load Case 4 During excavation of the pool a ramp may be needed in the side of the pool to drive a bobcat down into the pool. The ramp will need to be backfilled and compacted.

Load Case 5 Details such as skimmers, lights and spas must tie into the pool so that it is one structural unit.

All the loading schemes are based upon a one foot wide vertical beam in the wall of the pool.

STRUCTURAL DESIGN

Reinforced Concrete. Given the critical loading combinations, the moment capacity of the wall is the main concern, particularly at the base of the wall just above the floor. As previously mentioned, all structural design is based on a one foot wide slab with the applied loads. Other assumptions include:

1) The structure is a structural slab, thus lowering the minimum reinforcement ratio
2) The floor is fully supported
3) A pool can only fill to the top before it spills. It will only be filled with water. Since the load is well established, it can be treated as a dead load.
4) The soil is a dead load
5) The bobcat is a live load

Given these assumptions, the moment capacity is calculated based on ultimate strength as outlined in ACI code. Sample calculations for several cross sections are in the appendix.

Optimizing Shape. The other source of strength is the weight and shape of the pool wall. The parameters which can be varied to optimize the structural shape are the radius, depth to center, and wall thickness. The opposite page depicts calculation of the net moment at depth z acting on the wall. The maximum driving moment occurs near the bottom of the curve, but it is not always in the same spot. The weight of the wall resists the soil load. As the radius of the wall increases ,so does the resisting moment due to the weight of the wall. However, there is a limit to the radius. The wall at the top of the pool must be vertical for a minimum of 3 feet so people don't hit the wall as they jump into the pool.

Spreadsheet Program. The spreadsheet program calculates the following versus depth in 6" increments:

1) Factored moment due to lateral geostatic load
2) Factored moment due to induced lateral load
3) Resisting moment due to weight and shape of structure

The program output gives the sum of the three parameters listed, or the net driving moment at a given depth on the wall. The user must search for and pick the maximum driving moment since it is not always at the base of the wall. It is possible to change the radius of curvature, center of radius, thickness of wall and soil parameters quickly with the program to determine the optimum shape for a given scenario.

Structural Plans. Structural plans have been prepared for a typical swimming pool. They can be found in the appendix of this paper.

Limitations. A generalized design cannot be economical if it allows for every potential scenario. Therefore, restricting assumptions are listed on the plans.

CONCLUSION

Clearly swimming pool structural design is more complex than most people realize. This project is a review of many geotechnical, reinforced concrete, hydraulics, and related principles. The results of this project, working plans and specifications, is where theory is turned into reality.

A user can run the spreadsheet program in a few minutes, optimizing shape. Output from the program can be scanned for the maximum driving moment. The user can then pick an appropriate reinforced concrete section for the pool from those which have been prepared. Finally, he can fill in the schedules on the plans. Fortunately, this has already been done by the author.

This project, by Daniel Lee Tobar, is accepted in its present form by the department of Civil Engineering of Brigham Young University as satisfying the project requirement of the degree of Master of Science.

T. Leslie Youd, Chair

Arnold Wilson, Committee Member

Woodruff Miller, Graduate Coordinator

S. Olani Durrant, Department Chair

Date

APPENDICES

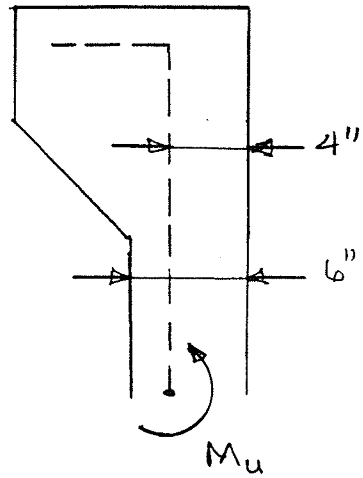
APPENDIX A

ULTIMATE MOMENT CAPACITY, M_u

1 - #3 @ 12" O.C.

$f'_c = 2000 \text{ psi}$ $\quad b = 12"$ $\quad A_s = 0.11 \text{ in}^2$

$f_y = 40{,}000 \text{ psi}$ $\quad d = 4"$



REINFORCEMENT RATIO, ρ

$$\rho = \frac{A_s}{bd} = \frac{0.11 \text{ in}^2}{(12")(4")} = 0.0023$$

$$\rho_{min} = \frac{200}{f_y} = 0.005 \quad \underline{\text{ACI 10.5.1}}$$

$\rho_{min} = 0.0020$ STRUCTURAL SLABS
GR 40 & GR 50 BARS
ACI 7.12 & 10.5.3

USE $\rho = 0.0023$

COEFFICIENT OF RESISTANCE, R_N

$$R_N = \rho f_y (1 - \tfrac{1}{2}\rho m) \quad \& \quad m = \frac{f_y}{0.85 f'_c} = \frac{40 \text{ ksi}}{.85 \; 2 \text{ ksi}} = 23.53$$

$$= .0023(40{,}000 \text{ psi})\left[1 - \tfrac{1}{2}(.0023)(23.53)\right]$$

$$= 89.5 \text{ psi}$$

ULTIMATE MOMENT CAPACITY, M_u

$$M_u = R_N \phi b d^2$$

$$= (89.5 \text{ psi})\, 0.9\, (12")(4")^2 \left(\frac{1 \text{ ft}}{12"}\right) = \underline{\underline{1288 \text{ ft} \cdot \text{lb}}}$$

ULTIMATE MOMENT CAPACITY, M_u — 1 - #3 @ 6" O.C.

$f'_c = 2000$ psi $b = 12''$ A_s 2 - #3 = $0.22\ in^2/ft$

$f_y = 40{,}000$ psi $d = 4''$ 6"

REINFORCEMENT RATIO, ρ

$\rho = A_s / bd$ & $\rho_{MIN} = 200/f_y$

$\rho = \frac{0.22\ in^2}{(12'')(4'')} = 0.004583$

$\rho_{MIN} = 0.002$

O.K. $\rho = 0.004583$

COEFFICIENT OF RESISTANCE, R_N

$R_N = \rho f_y (1 - \tfrac{1}{2}\rho m)$ & $m = f_y / .85 f'_c = 23.53$

$= 173.45$ psi

ULTIMATE MOMENT CAPACITY, M_u

$M_u = R_N \phi b d^2$

$= 173.45\ psi\ (0.9)\ 12''(4'')^2$

$= 29{,}972$ in.lb or $\underline{\underline{2497\ ft.lb}}$

ULTIMATE MOMENT CAPACITY, M_u — 1- #4 @ 12" o.c.

$f'_c = 2000 psi$ $\quad$ $b = 12"$ $\quad$ $A_s = 0.20 IN^2$

$f_y = 40{,}000 psi$ $\quad$ $d = 4"$

REINFORCEMENT RATIO, ρ

$$\rho = \frac{A_s}{bd} = \frac{0.20 IN^2}{(12")(4")} = 0.004167 \qquad \rho_{MIN} = 0.002 \qquad \text{O.K.}$$

COEF. OF RESISTANCE, R_N

$$R_N = \rho f_y (1 - \tfrac{1}{2}\rho m) \qquad m = \frac{f_y}{.85 f'_c} = 23.53$$

$= 158.50 psi$

ULTIMATE MOMENT CAPACITY, M_u

$$M_u = R_N \phi b d^2$$

$= (158.5 psi)(0.9)(12")(4")^2$

$= 27{,}388$ IN-lb or $\underline{\underline{2{,}282 \text{ ft-lb}}}$

ULTIMATE MOMENT CAPACITY, M_u — 1 - #4 @ 6" O.C.

$f'_c = 2000$ psi $b = 12"$ $\beta_1 = 0.85$ $A_s = 0.40 \text{ in}^2/\text{ft}$

$f_y = 40{,}000$ psi $d = 4"$

REINFORCEMENT RATIO, ρ

$$\rho = .40 \text{ in}^2 / (12)(4) = 0.00833 < \rho_{MAX} \quad \text{o.k.}$$

$$\rho_{MAX} = 0.75 \rho_b \qquad \rho_b = \frac{0.85 f'_c}{f_y} \beta_1 \left(\frac{87{,}000}{87{,}000 + f_y} \right)$$

f_y & f'_c in psi

$$= .75(.02475) \qquad = 0.02475$$

$$= 0.01856$$

COEF. OF RESISTANCE, R_N

$$R_N = \rho f_y (1 - \tfrac{1}{2} \rho m) \qquad m = f_y / .85 f'_c = 23.53$$

$$= 300.65 \text{ psi}$$

ULTIMATE MOMENT CAPACITY, M_u

$$M_u = R_N \phi b d^2 = 300.65 \text{ psi} \; (.9) \; (12") \; (4")^2$$

$$= 51{,}952 \text{ in.lb} \quad \text{or} \quad \underline{\underline{4{,}329 \text{ ft.lb}}}$$

d = 6"

d = 7"

ULTIMATE MOMENT CAPACITY, M_u — 1 - #4 & #3 @ 12" o.c.

f'_c = 2000 psi   b = 12" A_s = 0.31 in^2

f_y = 40,000 psi   d = 4"

REINFORCEMENT RATIO, ρ

$\rho = A_s/bd = 0.006458$ $\rho_{min} = 0.002$ ACI 7.12 & 10.5.3

COEF. OF RESISTANCE, R_N

$R_N = \rho f_y (1 - \tfrac{1}{2} \rho m)$ $m = 23.53$

= 238.7 psi

ULTIMATE MOMENT CAPACITY, M_u

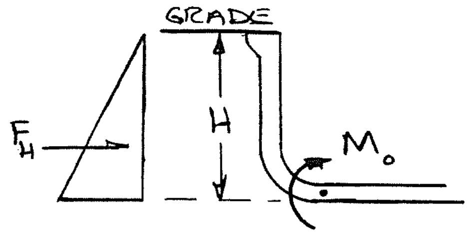
$M_u = R_N \phi b d^2 = 238.7 (.9)(12")(4)^2 = 41,248$ in. lb

or

3,437 ft. lb

b = 6"   5301

LOAD CASE #1 GRANULAR SOIL



$$K_A = \frac{1-\sin\phi}{1+\sin\phi} = 0.3073$$

$$F_H = K_A \tfrac{1}{2} \gamma h^2$$

$$M_o = K_A \frac{\gamma h^3}{6}$$

ASSUME:

SOIL: GRANULAR

γ : 120 pcf

ϕ : 32°

C : 0

H (ft)	M_o (ft·lb)	$1.4 M_o$
2	50	69
3	165	232
		369
4	395	550
		784
5	770	1075
		1431
6	1330	1858
		2362
7	2110	2951
		3630
8	3150	4405
		5234
9	4480	6272

TABLE 6.6 APPROXIMATE MAGNITUDES OF MOVEMENTS REQUIRED TO REACH MINIMUM ACTIVE AND MAXIMUM PASSIVE EARTH PRESSURE CONDITIONS.

	Values of Δ/H[a]	
Type of Backfill	*Active*	*Passive*
Dense sand	0.001	0.01
Medium-dense sand	0.002	0.02
Loose sand	0.004	0.04
Compacted silt	0.002	0.02
Compacted lean clay	0.01[b]	0.05[b]
Compacted fat clay	0.01[b]	0.05[b]

[a] Δ = movement of top of wall required to reach minimum active or maximum passive pressure, by tilting or lateral translation. H = height of wall.
[b] Under stress conditions close to the minimum active or maximum passive earth pressures, cohesive soils creep continually. The movements shown would produce active or passive pressures only temporarily. With time, the movements will continue if pressures remain constant. If movement remains constant, active pressures will increase with time and passive pressures will decrease with time.

EARTH PRESSURE CONDITIONS, K_A

FOR MEDIUM SAND:

$$\Delta_{REQ'D} = H_{MAX}(0.002)$$

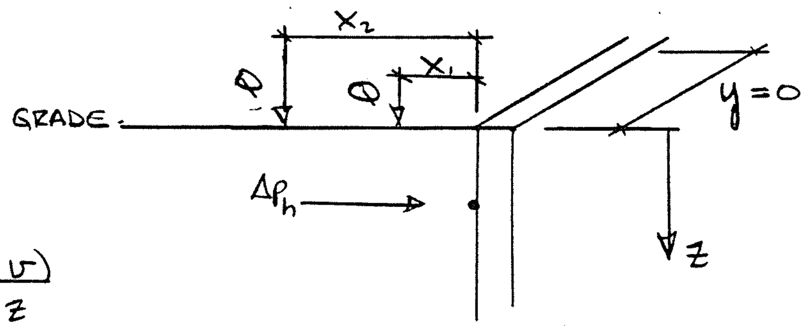
$$= 108''(.002)$$

$$= 0.216''$$

$$\Delta_{REQ'D} \simeq 1/4''$$

$\therefore$ USE K_A

LATERAL LOAD DUE TO POINT LOADS

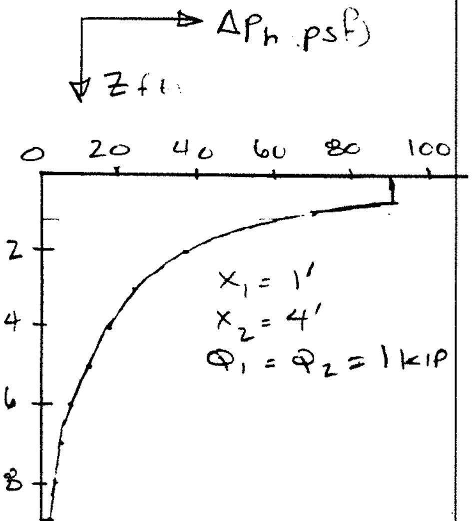


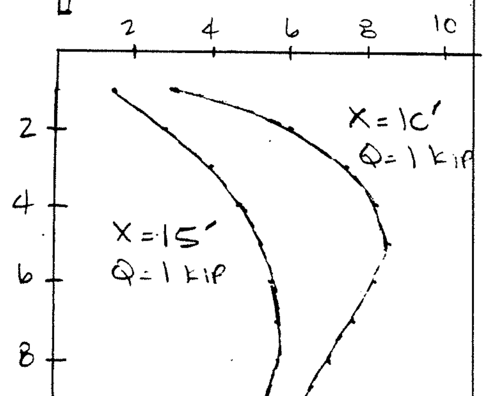
FROM TERZAGHI:

$$\Delta p_h = \frac{Q}{\pi R} \frac{3zx^2}{R^3} \frac{R(1-2\nu)}{R+z}$$

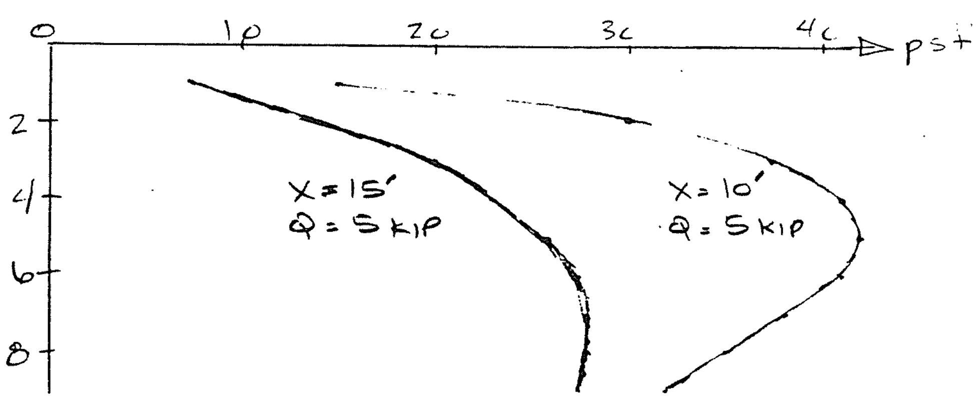
WHERE: $R^2 = x^2 + y^2 + z^2$, $y = 0$

Z ft	X_1 ft	X_2 ft	Δp_{h_1} psf	Δp_{h_2} psf	Δp_{h_T} psf	
1	1	4	56	17	72	122
2			16	21	37	63
3			6	18	24	41
4			3	14	17	29
5			1.4	10.2	12	20
6			0.8	7.4	8	[illegible]
7			.5	5.4	6	10
8			.4	4	4	7
9			.2	3	3	5
1	10	15	3	1.5		
2			6	2.8		
3			7.5	4		
4			8.2	4.7		
5			8.4	5.2		
6			8.1	5.5		
7			7.6	5.6		
8			7	5.6		
9			6.3	5.5		





15	7.5
30	14
37.5	20
41	23
42	26
41	27.5
38	28
35	28
32	27.5



APPENDIX B

GEO STATIC ONLY – SAND

$3' \leq Z \leq 9.5'$

Gunite Pool Design

Engineer: Dan Tobar

Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Radius: 1
Z to CTR : 2
Unit wt. concrete: 150

Pool Depth = 3

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.5	0.52	0.26	0.17	0.12	0.0	49.1	31.4	6.1	37.5	96.9	2.5
3	165.9	232	1.0	1.57	0.79	1.25	0.88	0.0	147.3	234.4	130.2	364.5	-132.2	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	550.6	4
4.5	560.0	784	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	784.0	4.5
5	768.2	1075	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1075.4	5
5.5	1022.4	1431	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1431.4	5.5
6	1327.4	1858	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1858.3	6
6.5	1687.7	2363	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2362.7	6.5
7	2107.8	2951	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2951.0	7
7.5	2592.6	3630	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3629.6	7.5
8	3146.4	4405	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4405.0	8
8.5	3774.0	5284	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5283.6	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Radius: 1
Z to CTR : 2.5
Unit wt. concrete: 150

Pool Depth = 3.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.5	0.52	0.26	0.17	0.12	0.0	49.1	37.7	6.1	43.8	188.5	3
3.5	263.5	369	1.0	1.57	0.79	1.25	0.88	0.0	147.3	281.3	130.2	411.4	-42.5	3.5
4	393.3	551	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	550.6	4
4.5	560.0	784	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	784.0	4.5
5	768.2	1075	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1075.4	5
5.5	1022.4	1431	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1431.4	5.5
6	1327.4	1858	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1858.3	6
6.5	1687.7	2363	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2362.7	6.5
7	2107.8	2951	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2951.0	7
7.5	2592.6	3630	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3629.6	7.5
8	3146.4	4405	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4405.0	8
8.5	3774.0	5284	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5283.6	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gunite Pool Design | Engineer: Dan Tobar

Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Radius: 1
Z to CTR : 3
Unit wt. concrete: 150

Pool Depth = 4

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.5	0.52	0.26	0.17	0.12	0.0	49.1	44.0	6.1	50.1	318.8	3.5
4	393.3	551	1.0	1.57	0.79	1.25	0.88	0.0	147.3	328.1	130.2	458.3	92.3	4
4.5	560.0	784	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	784.0	4.5
5	768.2	1075	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1075.4	5
5.5	1022.4	1431	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1431.4	5.5
6	1327.4	1858	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1858.3	6
6.5	1687.7	2363	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2362.7	6.5
7	2107.8	2951	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2951.0	7
7.5	2592.6	3630	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3629.6	7.5
8	3146.4	4405	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4405.0	8
8.5	3774.0	5284	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5283.6	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Radius: 1
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 4.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.5	0.52	0.26	0.17	0.12	0.0	49.1	50.2	6.1	56.4	494.2	4
4.5	560.0	784	1.0	1.57	0.79	1.25	0.88	0.0	147.3	375.0	130.2	505.2	278.8	4.5
5	768.2	1075	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1075.4	5
5.5	1022.4	1431	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1431.4	5.5
6	1327.4	1858	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1858.3	6
6.5	1687.7	2363	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2362.7	6.5
7	2107.8	2951	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2951.0	7
7.5	2592.6	3630	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3629.6	7.5
8	3146.4	4405	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4405.0	8
8.5	3774.0	5284	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5283.6	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gunite Pool Design Engineer: Dan Tobar

Gamma: 120 Radius: 1.5 Pool Depth = 5
phi: 32 Z to CTR : 3.5
radians: 0.558 Unit wt. concrete: 150
c: 0
Ka: 0.3073

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.5	0.34	0.17	0.10	0.07	0.0	44.6	30.0	3.3	33.4	517.3	4
4.5	560.0	784	1.0	0.73	0.36	0.45	0.33	0.0	95.8	133.7	31.6	165.3	618.7	4.5
5	768.2	1075	1.5	1.57	0.79	1.75	1.24	0.0	206.2	525.0	255.1	780.1	295.3	5
5.5	1022.4	1431	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1431.4	5.5
6	1327.4	1858	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1858.3	6
6.5	1687.7	2363	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2362.7	6.5
7	2107.8	2951	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2951.0	7
7.5	2592.6	3630	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3629.6	7.5
8	3146.4	4405	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4405.0	8
8.5	3774.0	5284	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5283.6	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gamma: 120 Radius: 2 Pool Depth = 5.5
phi: 32 Z to CTR : 3.5
radians: 0.558 Unit wt. concrete: 150
c: 0
Ka: 0.3073

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.5	0.25	0.13	0.07	0.05	0.0	42.6	21.4	2.3	23.7	526.9	4
4.5	560.0	784	1.0	0.52	0.26	0.30	0.22	0.0	88.4	90.4	19.9	110.3	673.7	4.5
5	768.2	1075	1.5	0.85	0.42	0.76	0.56	0.0	143.1	228.5	80.5	309.0	766.4	5
5.5	1022.4	1431	2.0	1.57	0.79	2.25	1.59	0.0	265.1	675.0	421.7	1096.7	334.7	5.5
6	1327.4	1858	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1858.3	6
6.5	1687.7	2363	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2362.7	6.5
7	2107.8	2951	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2951.0	7
7.5	2592.6	3630	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3629.6	7.5
8	3146.4	4405	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4405.0	8
8.5	3774.0	5284	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5283.6	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gunite Pool Design Engineer: Dan Tobar

Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Radius: 2.5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 6

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.5	0.20	0.10	0.06	0.04	0.0	41.5	16.7	1.7	18.4	532.2	4
4.5	560.0	784	1.0	0.41	0.21	0.23	0.17	0.0	84.9	68.9	14.6	83.4	700.5	4.5
5	768.2	1075	1.5	0.64	0.32	0.55	0.41	0.0	132.7	165.0	54.3	219.3	856.2	5
5.5	1022.4	1431	2.0	0.93	0.46	1.10	0.81	0.0	191.3	330.0	154.9	484.9	946.5	5.5
6	1327.4	1858	2.5	1.57	0.79	2.75	1.94	0.0	324.0	825.0	630.0	1455.0	403.4	6
6.5	1687.7	2363	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2362.7	6.5
7	2107.8	2951	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2951.0	7
7.5	2592.6	3630	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3629.6	7.5
8	3146.4	4405	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4405.0	8
8.5	3774.0	5284	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5283.6	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Radius: 3
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 6.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.5	0.17	0.08	0.05	0.03	0.0	40.8	13.6	1.4	15.0	535.6	4
4.5	560.0	784	1.0	0.34	0.17	0.19	0.14	0.0	82.8	55.8	11.5	67.3	716.7	4.5
5	768.2	1075	1.5	0.52	0.26	0.44	0.32	0.0	127.6	130.6	41.4	172.1	903.4	5
5.5	1022.4	1431	2.0	0.73	0.36	0.83	0.61	0.0	177.9	248.3	109.2	357.4	1074.0	5.5
6	1327.4	1858	2.5	0.99	0.49	1.45	1.07	0.0	240.1	436.0	256.2	692.3	1166.0	6
6.5	1687.7	2363	3.0	1.57	0.79	3.25	2.30	0.0	382.9	975.0	879.9	1854.9	507.8	6.5
7	2107.8	2951	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2951.0	7
7.5	2592.6	3630	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3629.6	7.5
8	3146.4	4405	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4405.0	8
8.5	3774.0	5284	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5283.6	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gunite Pool Design   Engineer: Dan Tobar

Gamma: 120   Radius: 3.5   Pool Depth = 7
phi: 32   Z to CTR : 3.5
radians: 0.558   Unit wt. concrete: 150
c: 0
Ka: 0.3073

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.5	0.14	0.07	0.04	0.03	0.0	40.3	11.5	1.2	12.7	537.9	4
4.5	560.0	784	1.0	0.29	0.14	0.16	0.12	0.0	81.5	46.9	9.5	56.4	727.6	4.5
5	768.2	1075	1.5	0.44	0.22	0.36	0.27	0.0	124.6	108.6	33.7	142.2	933.2	5
5.5	1022.4	1431	2.0	0.61	0.30	0.67	0.50	0.0	171.1	201.8	85.6	287.4	1144.0	5.5
6	1327.4	1858	2.5	0.80	0.40	1.13	0.83	0.0	223.8	337.7	186.3	524.0	1334.3	6
6.5	1687.7	2363	3.0	1.03	0.51	1.82	1.33	0.0	289.6	545.5	385.8	931.4	1431.3	6.5
7	2107.8	2951	3.5	1.57	0.79	3.75	2.65	0.0	441.8	1125.0	1171.5	2296.5	654.5	7
7.5	2592.6	3630	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3629.6	7.5
8	3146.4	4405	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4405.0	8
8.5	3774.0	5284	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5283.6	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gamma: 120   Radius: 4   Pool Depth = 7.5
phi: 32   Z to CTR : 3.5
radians: 0.558   Unit wt. concrete: 150
c: 0
Ka: 0.3073

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.5	0.13	0.06	0.03	0.02	0.0	39.9	10.0	1.0	11.0	539.6	4
4.5	560.0	784	1.0	0.25	0.13	0.13	0.10	0.0	80.5	40.5	8.1	48.6	735.4	4.5
5	768.2	1075	1.5	0.38	0.19	0.31	0.23	0.0	122.5	93.0	28.4	121.5	954.0	5
5.5	1022.4	1431	2.0	0.52	0.26	0.57	0.42	0.0	166.9	170.8	70.9	241.7	1189.7	5.5
6	1327.4	1858	2.5	0.68	0.34	0.93	0.69	0.0	215.2	279.7	149.0	428.7	1429.6	6
6.5	1687.7	2363	3.0	0.85	0.42	1.44	1.06	0.0	270.3	431.7	287.2	718.9	1643.8	6.5
7	2107.8	2951	3.5	1.07	0.53	2.19	1.60	0.0	339.6	657.7	544.6	1202.3	1748.7	7
7.5	2592.6	3630	4.0	1.57	0.79	4.25	3.01	0.0	500.7	1275.0	1504.7	2779.7	849.9	7.5
8	3146.4	4405	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4405.0	8
8.5	3774.0	5284	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5283.6	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gunite Pool Design Engineer: Dan Tobar

Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Radius: 4.5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 8

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.5	0.11	0.06	0.03	0.02	0.0	39.7	8.8	0.9	9.7	540.9	4
4.5	560.0	784	1.0	0.22	0.11	0.12	0.09	0.0	79.8	35.6	7.1	42.7	741.3	4.5
5	768.2	1075	1.5	0.34	0.17	0.27	0.20	0.0	121.1	81.5	24.6	106.1	969.3	5
5.5	1022.4	1431	2.0	0.46	0.23	0.49	0.37	0.0	164.1	148.5	60.6	209.1	1222.3	5.5
6	1327.4	1858	2.5	0.59	0.29	0.80	0.60	0.0	209.8	240.1	125.1	365.2	1493.1	6
6.5	1687.7	2363	3.0	0.73	0.36	1.21	0.90	0.0	260.0	362.9	233.2	596.0	1766.7	6.5
7	2107.8	2951	3.5	0.89	0.45	1.76	1.30	0.0	317.5	529.3	412.9	942.3	2008.7	7
7.5	2592.6	3630	4.0	1.09	0.55	2.57	1.88	0.0	390.1	772.2	733.2	1505.4	2124.2	7.5
8	3146.4	4405	4.5	1.57	0.79	4.75	3.36	0.0	559.6	1425.0	1879.5	3304.5	1100.4	8
8.5	3774.0	5284	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5283.6	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Radius: 5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 8.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.5	0.10	0.05	0.03	0.02	0.0	39.4	7.9	0.8	8.7	541.9	4
4.5	560.0	784	1.0	0.20	0.10	0.11	0.08	0.0	79.3	31.8	6.3	38.1	745.9	4.5
5	768.2	1075	1.5	0.30	0.15	0.24	0.18	0.0	120.0	72.5	21.7	94.3	981.2	5
5.5	1022.4	1431	2.0	0.41	0.21	0.44	0.33	0.0	162.0	131.5	53.1	184.6	1246.8	5.5
6	1327.4	1858	2.5	0.52	0.26	0.70	0.52	0.0	206.2	211.0	108.1	319.1	1539.2	6
6.5	1687.7	2363	3.0	0.64	0.32	1.05	0.78	0.0	253.4	315.0	197.8	512.8	1849.9	6.5
7	2107.8	2951	3.5	0.78	0.39	1.50	1.11	0.0	305.3	450.2	339.2	789.5	2161.5	7
7.5	2592.6	3630	4.0	0.93	0.46	2.10	1.55	0.0	365.1	630.0	564.4	1194.4	2435.2	7.5
8	3146.4	4405	4.5	1.12	0.56	2.96	2.16	0.0	440.9	888.5	952.4	1840.8	2564.1	8
8.5	3774.0	5284	5.0	1.57	0.79	5.25	3.71	0.0	618.5	1575.0	2296.1	3871.1	1412.5	8.5
9	4479.9	6272	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6271.9	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gunite Pool Design Engineer: Dan Tobar

Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Radius: 4.5
Z to CTR : 4.5
Unit wt. concrete: 150

Pool Depth = 9

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.0	0.00	0.00	0.00	0.00	337.5	0.0	0.0	0.0	0.0	550.6	4
4.5	560.0	784	0.0	0.00	0.00	0.00	0.00	375.0	0.0	0.0	0.0	0.0	784.0	4.5
5	768.2	1075	0.5	0.11	0.06	0.03	0.02	0.0	39.7	11.0	0.9	11.9	1063.5	5
5.5	1022.4	1431	1.0	0.22	0.11	0.12	0.09	0.0	79.8	44.5	7.1	51.6	1379.8	5.5
6	1327.4	1858	1.5	0.34	0.17	0.27	0.20	0.0	121.1	101.9	24.6	126.5	1731.9	6
6.5	1687.7	2363	2.0	0.46	0.23	0.49	0.37	0.0	164.1	185.6	60.6	246.2	2116.5	6.5
7	2107.8	2951	2.5	0.59	0.29	0.80	0.60	0.0	209.8	300.2	125.1	425.2	2525.7	7
7.5	2592.6	3630	3.0	0.73	0.36	1.21	0.90	0.0	260.0	453.6	233.2	686.7	2942.8	7.5
8	3146.4	4405	3.5	0.89	0.45	1.76	1.30	0.0	317.5	661.7	412.9	1074.6	3330.4	8
8.5	3774.0	5284	4.0	1.09	0.55	2.57	1.88	0.0	390.1	965.2	733.2	1698.4	3585.2	8.5
9	4479.9	6272	4.5	1.57	0.79	4.75	3.36	0.0	559.6	1781.3	1879.5	3660.8	2611.1	9
9.5	5268.8	7376	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7376.4	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Radius: 5
Z to CTR : 4.5
Unit wt. concrete: 150

Pool Depth = 9.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	-0.0	0
0.5	0.8	1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	8.6	1
1.5	20.7	29	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	29.0	1.5
2	49.2	69	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	68.8	2
2.5	96.0	134	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	134.4	2.5
3	165.9	232	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	232.3	3
3.5	263.5	369	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	368.9	3.5
4	393.3	551	0.0	0.00	0.00	0.00	0.00	337.5	0.0	0.0	0.0	0.0	550.6	4
4.5	560.0	784	0.0	0.00	0.00	0.00	0.00	375.0	0.0	0.0	0.0	0.0	784.0	4.5
5	768.2	1075	0.5	0.10	0.05	0.03	0.02	0.0	39.4	9.9	0.8	10.6	1064.8	5
5.5	1022.4	1431	1.0	0.20	0.10	0.11	0.08	0.0	79.3	39.8	6.3	46.1	1385.3	5.5
6	1327.4	1858	1.5	0.30	0.15	0.24	0.18	0.0	120.0	90.7	21.7	112.4	1745.9	6
6.5	1687.7	2363	2.0	0.41	0.21	0.44	0.33	0.0	162.0	164.4	53.1	217.4	2145.3	6.5
7	2107.8	2951	2.5	0.52	0.26	0.70	0.52	0.0	206.2	263.8	108.1	371.9	2579.1	7
7.5	2592.6	3630	3.0	0.64	0.32	1.05	0.78	0.0	253.4	393.8	197.8	591.5	3038.0	7.5
8	3146.4	4405	3.5	0.78	0.39	1.50	1.11	0.0	305.3	562.8	339.2	902.0	3502.9	8
8.5	3774.0	5284	4.0	0.93	0.46	2.10	1.55	0.0	365.1	787.5	564.4	1351.9	3931.7	8.5
9	4479.9	6272	4.5	1.12	0.56	2.96	2.16	0.0	440.9	1110.6	952.4	2063.0	4208.9	9
9.5	5268.8	7376	5.0	1.57	0.79	5.25	3.71	0.0	618.5	1968.8	2296.1	4264.8	3111.5	9.5
10	6145.3	8603	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8603.4	10

APPENDIX C

GEO STATIC ONLY - CLAY

$3' \le z \le 9.5'$

Gunite Pool Design

Engineer: Dan Tobar

Gamma: 110
phi: 30
radians: 0.524
c: 0
Ko: 0.5000

Radius: 1
Z to CTR : 2
Unit wt. concrete: 150

Pool Depth = 3

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.5	0.52	0.26	0.17	0.12	0.0	49.1	31.4	6.1	37.5	163.0	2.5
3	247.5	347	1.0	1.57	0.79	1.25	0.88	0.0	147.3	234.4	130.2	364.5	-18.0	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	550.2	3.5

Gamma: 110
phi: 30
radians: 0.524

Radius: 1
Z to CTR : 2.5
Unit wt. concrete: 150

Pool Depth = 3.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.5	0.52	0.26	0.17	0.12	0.0	49.1	37.7	6.1	43.8	302.7	3
3.5	393.0	550	1.0	1.57	0.79	1.25	0.88	0.0	147.3	281.3	130.2	411.4	138.8	3.5
4	586.7	821	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	821.3	4

Gamma: 110
phi: 30
radians: 0.524

Radius: 1
Z to CTR : 3
Unit wt. concrete: 150

Pool Depth = 4

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.5	0.52	0.26	0.17	0.12	0.0	49.1	44.0	6.1	50.1	500.1	3.5
4	586.7	821	1.0	1.57	0.79	1.25	0.88	0.0	147.3	328.1	130.2	458.3	363.0	4
4.5	835.3	1169	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1169.4	4.5

Gamma: 110
phi: 30
radians: 0.524

Radius: 1
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 4.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	550.2	3.5
4	586.7	821	0.5	0.52	0.26	0.17	0.12	0.0	49.1	50.2	6.1	56.4	765.0	4
4.5	835.3	1169	1.0	1.57	0.79	1.25	0.88	0.0	147.3	375.0	130.2	505.2	664.3	4.5
5	1145.8	1604	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1604.2	5

Gunite Pool Design Engineer: Dan Tobar

Gamma: 110
phi: 30
radians: 0.524
c: 0
Ko: 0.5000

Radius: 1.5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	550.2	3.5
4	586.7	821	0.5	0.34	0.17	0.10	0.07	0.0	44.6	30.0	3.3	33.4	788.0	4
4.5	835.3	1169	1.0	0.73	0.36	0.45	0.33	0.0	95.8	133.7	31.6	165.3	1004.1	4.5
5	1145.8	1604	1.5	1.57	0.79	1.75	1.24	0.0	206.2	525.0	255.1	780.1	824.0	5
5.5	1525.1	2135	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2135.1	5.5
6	1980.0	2772	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2772.0	6
6.5	2517.4	3524	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3524.4	6.5
7	3144.2	4402	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4401.8	7
7.5	3867.2	5414	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5414.1	7.5
8	4693.3	6571	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6570.7	8
8.5	5629.5	7881	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7881.3	8.5
9	6682.5	9356	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9355.5	9
9.5	7859.3	11003	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	9.5
10	9166.7	12833	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	10

Gamma: 110
phi: 30
radians: 0.524
c: 0
Ko: 0.5000

Radius: 2
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 5.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	550.2	3.5
4	586.7	821	0.5	0.25	0.13	0.07	0.05	0.0	42.6	21.4	2.3	23.7	797.6	4
4.5	835.3	1169	1.0	0.52	0.26	0.30	0.22	0.0	88.4	90.4	19.9	110.3	1059.1	4.5
5	1145.8	1604	1.5	0.85	0.42	0.76	0.56	0.0	143.1	228.5	80.5	309.0	1295.1	5
5.5	1525.1	2135	2.0	1.57	0.79	2.25	1.59	0.0	265.1	675.0	421.7	1096.7	1038.4	5.5
6	1980.0	2772	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2772.0	6

Gunite Pool Design Engineer: Dan Tobar

Gamma: 110 Radius: 2.5 Pool Depth = 6
phi: 30 Z to CTR : 3.5
radians: 0.524 Unit wt. concrete: 150
c: 0
Ko: 0.5000

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	550.2	3.5
4	586.7	821	0.5	0.20	0.10	0.06	0.04	0.0	41.5	16.7	1.7	18.4	802.9	4
4.5	835.3	1169	1.0	0.41	0.21	0.23	0.17	0.0	84.9	68.9	14.6	83.4	1086.0	4.5
5	1145.8	1604	1.5	0.64	0.32	0.55	0.41	0.0	132.7	165.0	54.3	219.3	1384.9	5
5.5	1525.1	2135	2.0	0.93	0.46	1.10	0.81	0.0	191.3	330.0	154.9	484.9	1650.3	5.5
6	1980.0	2772	2.5	1.57	0.79	2.75	1.94	0.0	324.0	825.0	630.0	1455.0	1317.0	6
6.5	2517.4	3524	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3524.4	6.5
7	3144.2	4402	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4401.8	7
7.5	3867.2	5414	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5414.1	7.5
8	4693.3	6571	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6570.7	8
8.5	5629.5	7881	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7881.3	8.5
9	6682.5	9356	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9355.5	9
9.5	7859.3	11003	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	9.5
10	9166.7	12833	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	10

Gamma: 110 Radius: 3 Pool Depth = 6.5
phi: 30 Z to CTR : 3.5
radians: 0.524 Unit wt. concrete: 150
c: 0
Ko: 0.5000

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	550.2	3.5
4	586.7	821	0.5	0.17	0.08	0.05	0.03	0.0	40.8	13.6	1.4	15.0	806.3	4
4.5	835.3	1169	1.0	0.34	0.17	0.19	0.14	0.0	82.8	55.8	11.5	67.3	1102.2	4.5
5	1145.8	1604	1.5	0.52	0.26	0.44	0.32	0.0	127.6	130.6	41.4	172.1	1432.1	5
5.5	1525.1	2135	2.0	0.73	0.36	0.83	0.61	0.0	177.9	248.3	109.2	357.4	1777.7	5.5
6	1980.0	2772	2.5	0.99	0.49	1.45	1.07	0.0	240.1	436.0	256.2	692.3	2079.7	6
6.5	2517.4	3524	3.0	1.57	0.79	3.25	2.30	0.0	382.9	975.0	879.9	1854.9	1669.5	6.5
7	3144.2	4402	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4401.8	7
7.5	3867.2	5414	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5414.1	7.5

Gunite Pool Design Engineer: Dan Tobar

Gamma: 110
phi: 30
radians: 0.524
c: 0
Ko: 0.5000

Radius: 3.5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 7

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	550.2	3.5
4	586.7	821	0.5	0.14	0.07	0.04	0.03	0.0	40.3	11.5	1.2	12.7	808.6	4
4.5	835.3	1169	1.0	0.29	0.14	0.16	0.12	0.0	81.5	46.9	9.5	56.4	1113.0	4.5
5	1145.8	1604	1.5	0.44	0.22	0.36	0.27	0.0	124.6	108.6	33.7	142.2	1461.9	5
5.5	1525.1	2135	2.0	0.61	0.30	0.67	0.50	0.0	171.1	201.8	85.6	287.4	1847.8	5.5
6	1980.0	2772	2.5	0.80	0.40	1.13	0.83	0.0	223.8	337.7	186.3	524.0	2248.0	6
6.5	2517.4	3524	3.0	1.03	0.51	1.82	1.33	0.0	289.6	545.5	385.8	931.4	2593.0	6.5
7	3144.2	4402	3.5	1.57	0.79	3.75	2.65	0.0	441.8	1125.0	1171.5	2296.5	2105.4	7
7.5	3867.2	5414	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5414.1	7.5
8	4693.3	6571	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6570.7	8
8.5	5629.5	7881	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7881.3	8.5
9	6682.5	9356	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9355.5	9
9.5	7859.3	11003	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	9.5
10	9166.7	12833	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	10

Gamma: 110
phi: 30
radians: 0.524
c: 0
Ko: 0.5000

Radius: 4
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 7.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	550.2	3.5
4	586.7	821	0.5	0.13	0.06	0.03	0.02	0.0	39.9	10.0	1.0	11.0	810.3	4
4.5	835.3	1169	1.0	0.25	0.13	0.13	0.10	0.0	80.5	40.5	8.1	48.6	1120.8	4.5
5	1145.8	1604	1.5	0.38	0.19	0.31	0.23	0.0	122.5	93.0	28.4	121.5	1482.7	5
5.5	1525.1	2135	2.0	0.52	0.26	0.57	0.42	0.0	166.9	170.8	70.9	241.7	1893.5	5.5
6	1980.0	2772	2.5	0.68	0.34	0.93	0.69	0.0	215.2	279.7	149.0	428.7	2343.3	6
6.5	2517.4	3524	3.0	0.85	0.42	1.44	1.06	0.0	270.3	431.7	287.2	718.9	2805.5	6.5
7	3144.2	4402	3.5	1.07	0.53	2.19	1.60	0.0	339.6	657.7	544.6	1202.3	3199.5	7
7.5	3867.2	5414	4.0	1.57	0.79	4.25	3.01	0.0	500.7	1275.0	1504.7	2779.7	2634.4	7.5
8	4693.3	6571	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6570.7	8

Gunite Pool Design   Engineer: Dan Tobar

Gamma: 110
phi: 30
radians: 0.524
c: 0
Ko: 0.5000

Radius: 4.5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 8

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	550.2	3.5
4	586.7	821	0.5	0.11	0.06	0.03	0.02	0.0	53.8	8.8	1.2	10.0	811.3	4
4.5	835.3	1169	1.0	0.22	0.11	0.12	0.09	0.0	108.3	35.6	9.6	45.3	1124.2	4.5
5	1145.8	1604	1.5	0.34	0.17	0.27	0.20	0.0	164.3	81.5	33.4	114.9	1489.3	5
5.5	1525.1	2135	2.0	0.46	0.23	0.49	0.37	0.0	222.6	148.5	82.3	230.7	1904.4	5.5
6	1980.0	2772	2.5	0.59	0.29	0.80	0.60	0.0	284.7	240.1	169.7	409.8	2362.2	6
6.5	2517.4	3524	3.0	0.73	0.36	1.21	0.90	0.0	352.7	362.9	316.3	679.2	2845.2	6.5
7	3144.2	4402	3.5	0.89	0.45	1.76	1.30	0.0	430.7	529.3	560.2	1089.6	3312.3	7
7.5	3867.2	5414	4.0	1.09	0.55	2.57	1.88	0.0	529.2	772.2	994.8	1766.9	3647.1	7.5
8	4693.3	6571	4.5	1.57	0.79	4.75	3.36	0.0	759.2	1425.0	2550.0	3975.0	2595.6	8
8.5	5629.5	7881	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7881.3	8.5
9	6682.5	9356	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9355.5	9
9.5	7859.3	11003	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	9.5
10	9166.7	12833	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	10

Gamma: 110
phi: 30
radians: 0.524
c: 0
Ko: 0.5000

Radius: 5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 8.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	.0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	550.2	3.5
4	586.7	821	0.5	0.10	0.05	0.03	0.02	0.0	53.4	7.9	1.1	8.9	812.4	4
4.5	835.3	1169	1.0	0.20	0.10	0.11	0.08	0.0	107.4	31.8	8.5	40.4	1129.1	4.5
5	1145.8	1604	1.5	0.30	0.15	0.24	0.18	0.0	162.5	72.5	29.4	102.0	1502.2	5
5.5	1525.1	2135	2.0	0.41	0.21	0.44	0.33	0.0	219.5	131.5	71.9	203.4	1931.8	5.5
6	1980.0	2772	2.5	0.52	0.26	0.70	0.52	0.0	279.3	211.0	146.5	357.5	2414.5	6
6.5	2517.4	3524	3.0	0.64	0.32	1.05	0.78	0.0	343.2	315.0	267.9	582.9	2941.5	6.5
7	3144.2	4402	3.5	0.78	0.39	1.50	1.11	0.0	413.5	450.2	459.5	909.7	3492.1	7
7.5	3867.2	5414	4.0	0.93	0.46	2.10	1.55	0.0	494.6	630.0	764.5	1394.5	4019.6	7.5
8	4693.3	6571	4.5	1.12	0.56	2.96	2.16	0.0	597.2	888.5	1290.0	2178.4	4392.2	8
8.5	5629.5	7881	5.0	1.57	0.79	5.25	3.71	0.0	837.8	1575.0	3110.0	4685.0	3196.2	8.5
9	6682.5	9356	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9355.5	9
9.5	7859.3	11003	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	9.5
10	9166.7	12833	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	10

Gunite Pool Design Engineer: Dan Tobar

Gamma: 110 Radius: 4.5 Pool Depth = 9
phi: 30 Z to CTR : 4.5
radians: 0.524 Unit wt. concrete: 150
c: 0
Ko: 0.5000

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	550.2	3.5
4	586.7	821	0.0	0.00	0.00	0.00	0.00	337.5	0.0	0.0	0.0	0.0	821.3	4
4.5	835.3	1169	0.0	0.00	0.00	0.00	0.00	375.0	0.0	0.0	0.0	0.0	1169.4	4.5
5	1145.8	1604	0.5	0.11	0.06	0.03	0.02	0.0	53.8	11.0	1.2	12.2	1592.0	5
5.5	1525.1	2135	1.0	0.22	0.11	0.12	0.09	0.0	108.3	44.5	9.6	54.2	2081.0	5.5
6	1980.0	2772	1.5	0.34	0.17	0.27	0.20	0.0	164.3	101.9	33.4	135.3	2636.7	6
6.5	2517.4	3524	2.0	0.46	0.23	0.49	0.37	0.0	222.6	185.6	82.3	267.9	3256.5	6.5
7	3144.2	4402	2.5	0.59	0.29	0.80	0.60	0.0	284.7	300.2	169.7	469.8	3932.0	7
7.5	3867.2	5414	3.0	0.73	0.36	1.21	0.90	0.0	352.7	453.6	316.3	769.9	4644.1	7.5
8	4693.3	6571	3.5	0.89	0.45	1.76	1.30	0.0	430.7	661.7	560.2	1221.9	5348.8	8
8.5	5629.5	7881	4.0	1.09	0.55	2.57	1.88	0.0	529.2	965.2	994.8	1960.0	5921.3	8.5
9	6682.5	9356	4.5	1.57	0.79	4.75	3.36	0.0	759.2	1781.3	2550.0	4331.3	5024.2	9
9.5	7859.3	11003	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	9.5
10	9166.7	12833	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	10

Gamma: 110 Radius: 5 Pool Depth = 9.5
phi: 30 Z to CTR : 4.5
radians: 0.524 Unit wt. concrete: 150
c: 0
Ko: 0.5000

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	1.1	2	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6	0.5
1	9.2	13	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.8	1
1.5	30.9	43	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.3	1.5
2	73.3	103	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.7	2
2.5	143.2	201	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	200.5	2.5
3	247.5	347	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	346.5	3
3.5	393.0	550	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	550.2	3.5
4	586.7	821	0.0	0.00	0.00	0.00	0.00	337.5	0.0	0.0	0.0	0.0	821.3	4
4.5	835.3	1169	0.0	0.00	0.00	0.00	0.00	375.0	0.0	0.0	0.0	0.0	1169.4	4.5
5	1145.8	1604	0.5	0.10	0.05	0.03	0.02	0.0	53.4	9.9	1.1	10.9	1593.2	5
5.5	1525.1	2135	1.0	0.20	0.10	0.11	0.08	0.0	107.4	39.8	8.5	48.3	2086.8	5.5
6	1980.0	2772	1.5	0.30	0.15	0.24	0.18	0.0	162.5	90.7	29.4	120.1	2651.9	6
6.5	2517.4	3524	2.0	0.41	0.21	0.44	0.33	0.0	219.5	164.4	71.9	236.3	3288.1	6.5
7	3144.2	4402	2.5	0.52	0.26	0.70	0.52	0.0	279.3	263.8	146.5	410.2	3991.6	7
7.5	3867.2	5414	3.0	0.64	0.32	1.05	0.78	0.0	343.2	393.8	267.9	661.6	4752.4	7.5
8	4693.3	6571	3.5	0.78	0.39	1.50	1.11	0.0	413.5	562.8	459.5	1022.3	5548.4	8
8.5	5629.5	7881	4.0	0.93	0.46	2.10	1.55	0.0	494.6	787.5	764.5	1552.0	6329.3	8.5
9	6682.5	9356	4.5	1.12	0.56	2.96	2.16	0.0	597.2	1110.6	1290.0	2400.6	6954.9	9
9.5	7859.3	11003	5.0	1.57	0.79	5.25	3.71	0.0	837.8	1968.8	3110.0	5078.8	5924.2	9.5
10	9166.7	12833	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	********	10

APPENDIX D

Gunite Pool Design

Soil Parameters — Gamma: 110; phi: 8.2; radians: 0.143; c: 0; Ka: 0.7504

Point Loading — Q (lbs): 0; Poisson: 0.3; X 1: 1; X 2: 5; Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments: Radius: 5; Z to CTR : 3.5; Unit wt. concrete: 150

Pool Depth = 8.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)
0	0.0	0
0.5	1.7	2
1	13.8	19
1.5	46.4	65
2	110.1	154
2.5	214.9	301
3	371.4	520
3.5	589.8	826
4	880.4	1233
4.5	1253.6	1755
5	1719.6	2407
5.5	2288.7	3204
6	2971.4	4160
6.5	3777.9	5289
7	4718.5	6606
7.5	5803.5	8125
8	7043.3	9861
8.5	8448.2	11827
9	10028.5	14040
9.5	11794.5	16512
10	13756.5	19259
10.5	15924.8	22295

Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)
0	1.00	5.00	0.00	0.00	0	0	0	0	0
0.25	1.03	5.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5	1.12	5.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.75	1.25	5.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.41	5.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.25	1.60	5.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.5	1.80	5.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.75	2.02	5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	2.24	5.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.25	2.46	5.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	2.69	5.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.75	2.93	5.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	3.16	5.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	3.40	5.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.5	3.64	6.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.75	3.88	6.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	4.12	6.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.25	4.37	6.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.5	4.61	6.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.75	4.85	6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	5.10	7.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.25	5.34	7.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.5	5.59	7.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.75	5.84	7.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	6.08	7.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.25	6.33	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.5	6.58	8.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.75	6.82	8.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	7.07	8.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.25	7.32	8.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.5	7.57	9.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.75	7.81	9.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	8.06	9.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.25	8.31	9.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.5	8.56	9.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.75	8.81	10.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	9.06	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.25	9.30	10.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.5	9.55	10.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.75	9.80	10.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	10.05	11.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.25	10.30	11.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Z (ft)	F horiz. (lbs.)	Induced moment (ft - lb)	1.7 Mo (ft - lb)	Total Factored driving moment (ft - lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)
0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.5	0.00	0.0	0	2.4	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	2.4
1	0.00	0.0	0	19.3	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	19.3
1.5	0.00	0.0	0	65.0	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	65.0
2	0.00	0.0	0	154.1	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	154.1
2.5	0.00	0.0	0	300.9	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	300.9
3	0.00	0.0	0	520.0	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	520.0
3.5	0.00	0.0	0	825.7	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	825.7
4	0.00	0.0	0	1232.6	0.5	0.10	0.05	0.03	0.02	0.0	39.4	7.9	0.8	8.7	1223.9
4.5	0.00	0.0	0	1755.0	1.0	0.20	0.10	0.11	0.08	0.0	79.3	31.8	6.3	38.1	1716.9
5	0.00	0.0	0	2407.4	1.5	0.30	0.15	0.24	0.18	0.0	120.0	72.5	21.7	94.3	2313.1
5.5	0.00	0.0	0	3204.2	2.0	0.41	0.21	0.44	0.33	0.0	162.0	131.5	53.1	184.6	3019.7
6	0.00	0.0	0	4160.0	2.5	0.52	0.26	0.70	0.52	0.0	206.2	211.0	108.1	319.1	3840.8
6.5	0.00	0.0	0	5289.0	3.0	0.64	0.32	1.05	0.78	0.0	253.4	315.0	197.8	512.8	4776.2
7	0.00	0.0	0	6605.9	3.5	0.78	0.39	1.50	1.11	0.0	305.3	450.2	339.2	789.5	5816.4
7.5	0.00	0.0	0	8124.9	4.0	0.93	0.46	2.10	1.55	0.0	365.1	630.0	564.4	1194.4	6930.5
8	0.00	0.0	0	9860.6	4.5	1.12	0.56	2.96	2.16	0.0	440.9	888.5	952.4	1840.8	8019.8
8.5	0.00	0.0	0	11827.5	5.0	1.57	0.79	5.25	3.71	0.0	618.5	1575.0	2296.1	3871.1	7956.4
9	0.00	0.0	0	14039.9	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	14039.9
9.5	0.00	0.0	0	16512.2	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	16512.2
10	0.00	0.0	0	19259.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	19259.1

CLAYS GEOSTATIC

K_o	OCR
0.75	2.25
0.50	1
0.40	0.64

Gunite Pool Design

Soil Parameters — Gamma: 110; phi: 19.4; radians: 0.339; c: 0; Ka: 0.5013

Point Loading — Q (lbs): 0; Poisson: 0.3; X 1: 1; X 2: 5; Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments: Radius: 5; Z to CTR : 3.5; Unit wt. concrete: 150

Pool Depth = 8.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)
0	0.0	0
0.5	1.1	2
1	9.2	13
1.5	31.0	43
2	73.5	103
2.5	143.6	201
3	248.2	347
3.5	394.1	552
4	588.2	824
4.5	837.5	1173
5	1148.9	1608
5.5	1529.1	2141
6	1985.3	2779
6.5	2524.1	3534
7	3152.5	4414
7.5	3877.4	5428
8	4705.8	6588
8.5	5644.4	7902
9	6700.2	9380
9.5	7880.1	11032
10	9191.0	12867
10.5	10639.7	14896

Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)
0	1.00	5.00	0.00	0.00	0	0	0	0	0
0.25	1.03	5.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5	1.12	5.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.75	1.25	5.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.41	5.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.25	1.60	5.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.5	1.80	5.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.75	2.02	5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	2.24	5.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.25	2.46	5.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	2.69	5.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.75	2.93	5.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	3.16	5.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	3.40	5.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.5	3.64	6.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.75	3.88	6.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	4.12	6.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.25	4.37	6.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.5	4.61	6.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.75	4.85	6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	5.10	7.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.25	5.34	7.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.5	5.59	7.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.75	5.84	7.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	6.08	7.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.25	6.33	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.5	6.58	8.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.75	6.82	8.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	7.07	8.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.25	7.32	8.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.5	7.57	9.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.75	7.81	9.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	8.06	9.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.25	8.31	9.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.5	8.56	9.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.75	8.81	10.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	9.06	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.25	9.30	10.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.5	9.55	10.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.75	9.80	10.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	10.05	11.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.25	10.30	11.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Z (ft)	F horiz. (lbs.)	Induced moment (ft - lb)	1.7 Mo (ft - lb)	Total Factored driving moment (ft - lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)
0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.5	0.00	0.0	0	1.6	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.6
1	0.00	0.0	0	12.9	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	12.9
1.5	0.00	0.0	0	43.4	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	43.4
2	0.00	0.0	0	102.9	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	102.9
2.5	0.00	0.0	0	201.1	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	201.1
3	0.00	0.0	0	347.4	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	347.4
3.5	0.00	0.0	0	551.7	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	551.7
4	0.00	0.0	0	823.5	0.5	0.10	0.05	0.03	0.02	0.0	39.4	7.9	0.8	8.7	814.8
4.5	0.00	0.0	0	1172.5	1.0	0.20	0.10	0.11	0.08	0.0	79.3	31.8	6.3	38.1	1134.4
5	0.00	0.0	0	1608.4	1.5	0.30	0.15	0.24	0.18	0.0	120.0	72.5	21.7	94.3	1514.2
5.5	0.00	0.0	0	2140.8	2.0	0.41	0.21	0.44	0.33	0.0	162.0	131.5	53.1	184.6	1956.2
6	0.00	0.0	0	2779.4	2.5	0.52	0.26	0.70	0.52	0.0	206.2	211.0	108.1	319.1	2460.2
6.5	0.00	0.0	0	3533.7	3.0	0.64	0.32	1.05	0.78	0.0	253.4	315.0	197.8	512.8	3020.9
7	0.00	0.0	0	4413.5	3.5	0.78	0.39	1.50	1.11	0.0	305.3	450.2	339.2	789.5	3624.0
7.5	0.00	0.0	0	5428.4	4.0	0.93	0.46	2.10	1.55	0.0	365.1	630.0	564.4	1194.4	4234.0
8	0.00	0.0	0	6588.1	4.5	1.12	0.56	2.96	2.16	0.0	440.9	888.5	952.4	1840.8	4747.3
8.5	0.00	0.0	0	7902.2	5.0	1.57	0.79	5.25	3.71	0.0	618.5	1575.0	2296.1	3871.1	4031.1
9	0.00	0.0	0	9380.3	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9380.3
9.5	0.00	0.0	0	11032.2	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	11032.2
10	0.00	0.0	0	12867.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	12867.4

Gunite Pool Design

Soil Parameters

Gamma: 110
phi: 25.4
radians: 0.443
c: 0
Ka: 0.3997

Point Loading

Q (lbs): 0
Poisson: 0.3
X 1: 1
X 2: 5
Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments:

Radius: 5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 8.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)
0	0.0	0
0.5	0.9	1
1	7.3	10
1.5	24.7	35
2	58.6	82
2.5	114.5	160
3	197.8	277
3.5	314.1	440
4	468.9	656
4.5	667.7	935
5	915.9	1282
5.5	1219.0	1707
6	1582.6	2216
6.5	2012.2	2817
7	2513.1	3518
7.5	3091.0	4327
8	3751.4	5252
8.5	4499.6	6300
9	5341.3	7478
9.5	6281.9	8795
10	7326.9	10258
10.5	8481.8	11875

Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)
0	1.00	5.00	0.00	0.00	0	0	0	0	0
0.25	1.03	5.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5	1.12	5.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.75	1.25	5.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.41	5.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.25	1.60	5.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.5	1.80	5.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.75	2.02	5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	2.24	5.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.25	2.46	5.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	2.69	5.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.75	2.93	5.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	3.16	5.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	3.40	5.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.5	3.64	6.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.75	3.88	6.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	4.12	6.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.25	4.37	6.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.5	4.61	6.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.75	4.85	6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	5.10	7.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.25	5.34	7.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.5	5.59	7.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.75	5.84	7.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	6.08	7.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.25	6.33	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.5	6.58	8.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.75	6.82	8.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	7.07	8.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.25	7.32	8.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.5	7.57	9.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.75	7.81	9.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	8.06	9.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.25	8.31	9.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.5	8.56	9.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.75	8.81	10.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	9.06	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.25	9.30	10.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.5	9.55	10.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.75	9.80	10.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	10.05	11.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.25	10.30	11.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Z (ft)	F horiz. (lbs.)	Induced moment (ft - lb)	1.7 Mo (ft - lb)	Total Factored driving moment (ft - lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)
0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.5	0.00	0.0	0	1.3	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.3
1	0.00	0.0	0	10.3	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	10.3
1.5	0.00	0.0	0	34.6	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	34.6
2	0.00	0.0	0	82.1	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	82.1
2.5	0.00	0.0	0	160.3	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	160.3
3	0.00	0.0	0	277.0	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	277.0
3.5	0.00	0.0	0	439.8	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	439.8
4	0.00	0.0	0	656.5	0.5	0.10	0.05	0.03	0.02	0.0	39.4	7.9	0.8	8.7	647.8
4.5	0.00	0.0	0	934.7	1.0	0.20	0.10	0.11	0.08	0.0	79.3	31.8	6.3	38.1	896.6
5	0.00	0.0	0	1282.2	1.5	0.30	0.15	0.24	0.18	0.0	120.0	72.5	21.7	94.3	1187.9
5.5	0.00	0.0	0	1706.6	2.0	0.41	0.21	0.44	0.33	0.0	162.0	131.5	53.1	184.6	1522.1
6	0.00	0.0	0	2215.7	2.5	0.52	0.26	0.70	0.52	0.0	206.2	211.0	108.1	319.1	1896.5
6.5	0.00	0.0	0	2817.0	3.0	0.64	0.32	1.05	0.78	0.0	253.4	315.0	197.8	512.8	2304.2
7	0.00	0.0	0	3518.4	3.5	0.78	0.39	1.50	1.11	0.0	305.3	450.2	339.2	789.5	2728.9
7.5	0.00	0.0	0	4327.5	4.0	0.93	0.46	2.10	1.55	0.0	365.1	630.0	564.4	1194.4	3133.1
8	0.00	0.0	0	5251.9	4.5	1.12	0.56	2.96	2.16	0.0	440.9	888.5	952.4	1840.8	3411.1
8.5	0.00	0.0	0	6299.5	5.0	1.57	0.79	5.25	3.71	0.0	618.5	1575.0	2296.1	3871.1	2428.4
9	0.00	0.0	0	7477.9	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7477.9
9.5	0.00	0.0	0	8794.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8794.7
10	0.00	0.0	0	10257.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10257.7

APPENDIX E

Gunite Pool Design

Soil Parameters — Gamma: 120; phi: 32; radians: 0.558; c: 0; Ka: 0.3073

Point Loading — Q (lbs): 2000; Poisson: 0.3; X 1: 1; X 2: 5; Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments: Radius: 1; Z to CTR : 2; Unit wt. concrete: 150

Pool Depth = 3

Z (ft)	Geostatic Moment (ft-lb)	Factored Moment (1.4 Mo)	Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)	Z (ft)	F horiz. (lbs.)	Induced moment (ft-lb)	1.7 Mo (ft-lb)	Total Factored driving moment (ft-lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft-lb)	Mr 2 (ft-lb)	Total Resisting Moment (ft-lb)	Net Moment (ft-lb)	Z (ft)
0	0.0	0	0	1.00	5.00	0.00	0.00	0	0	0	0	0	0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.25	1.03	5.01	217.43	-5.88	217.43	0.00	217.43	0.00	217.43	0.5	174.85	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.5	1.12	5.02	405.87	-1.72	405.87	0.00	405.87	0.00	405.87	1	135.89	87.4	149	157.2	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	157.2	1
1.5	20.7	29	0.75	1.25	5.06	367.51	2.16	367.51	2.16	367.51	2.16	369.67	1.5	62.24	242.8	413	441.8	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	441.8	1.5
2	49.2	69	1	1.41	5.10	263.03	5.66	263.03	5.66	263.03	5.66	268.70	2	29.20	429.3	730	798.6	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	798.6	2
2.5	96.0	134	1.25	1.60	5.15	171.32	8.70	171.32	8.70	171.32	8.70	180.01	2.5	16.29	630.4	1072	1206.1	0.5	0.52	0.26	0.17	0.12	0.0	49.1	31.4	6.1	37.5	1168.5	2.5
3	165.9	232	1.5	1.80	5.22	107.68	11.22	107.68	11.22	107.68	11.22	118.90	3	10.83	839.6	1427	1659.6	1.0	1.57	0.79	1.25	0.88	0.0	147.3	234.4	130.2	364.5	1295.1	3
3.5	263.5	369	1.75	2.02	5.30	66.92	13.21	66.92	13.21	66.92	13.21	80.13	3.5	8.14	1054.3	1792	2161.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2161.1	3.5
4	393.3	551	2	2.24	5.39	41.45	14.68	41.45	14.68	41.45	14.68	56.13	4	6.95	1273.0	2164	2714.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2714.7	4
4.5	560.0	784	2.25	2.46	5.48	25.54	15.67	25.54	15.67	25.54	15.67	41.21	4.5	6.11	1495.2	2542	3325.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3325.8	4.5
5	768.2	1075	2.5	2.69	5.59	15.52	16.23	15.52	16.23	15.52	16.23	31.76	5	5.26	1720.4	2925	4000.2	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4000.2	5
5.5	1022.4	1431	2.75	2.93	5.71	9.15	16.42	9.15	16.42	9.15	16.42	25.57	5.5	4.47	1948.3	3312	4743.5	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4743.5	5.5
6	1327.4	1858	3	3.16	5.83	5.05	16.31	5.05	16.31	5.05	16.31	21.36	6	3.75	2178.4	3703	5561.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5561.7	6
6.5	1687.7	2363	3.25	3.40	5.96	2.39	15.94	2.39	15.94	2.39	15.94	18.33	6.5	3.13	2410.4	4098	6460.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6460.4	6.5
7	2107.8	2951	3.5	3.64	6.10	0.66	15.39	0.66	15.39	0.66	15.39	16.05	7	2.60	2644.0	4495	7445.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7445.8	7
7.5	2592.6	3630	3.75	3.88	6.25	-0.46	14.70	0.00	14.70	0.00	14.70	14.70	7.5	2.16	2878.9	4894	8523.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8523.6	7.5
8	3146.4	4405	4	4.12	6.40	-1.19	13.92	0.00	13.92	0.00	13.92	13.92	8	1.79	3114.8	5295	9700.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9700.1	8
8.5	3774.0	5284	4.25	4.37	6.56	-1.65	13.09	0.00	13.09	0.00	13.09	13.09	8.5	1.48	3351.6	5698	10981.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10981.4	8.5

Gunite Pool Design

Soil Parameters — Gamma: 120; phi: 32; radians: 0.558; c: 0; Ka: 0.3073

Point Loading — Q (lbs): 2000; Poisson: 0.3; X 1: 1; X 2: 5; Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments: Radius: 1; Z to CTR : 2.5; Unit wt. concrete: 150

Pool Depth = 3.5

Z (ft)	Geostatic Moment (ft-lb)	Factored Moment (1.4 Mo)	Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)	Z (ft)	F horiz. (lbs.)	Induced moment (ft-lb)	1.7 Mo (ft-lb)	Total Factored driving moment (ft-lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft-lb)	Mr 2 (ft-lb)	Total Resisting Moment (ft-lb)	Net Moment (ft-lb)	Z (ft)
0	0.0	0	0	1.00	5.00	0.00	0.00	0	0	0	0	0	0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.25	1.03	5.01	217.43	-5.88	217.43	0.00	217.43	0.00	217.43	0.5	174.85	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.5	1.12	5.02	405.87	-1.72	405.87	0.00	405.87	0.00	405.87	1	135.89	87.4	149	157.2	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	157.2	1
1.5	20.7	29	0.75	1.25	5.06	367.51	2.16	367.51	2.16	367.51	2.16	369.67	1.5	62.24	242.8	413	441.8	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	441.8	1.5
2	49.2	69	1	1.41	5.10	263.03	5.66	263.03	5.66	263.03	5.66	268.70	2	29.20	429.3	730	798.6	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	798.6	2
2.5	96.0	134	1.25	1.60	5.15	171.32	8.70	171.32	8.70	171.32	8.70	180.01	2.5	16.29	630.4	1072	1206.1	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	1206.1	2.5
3	165.9	232	1.5	1.80	5.22	107.68	11.22	107.68	11.22	107.68	11.22	118.90	3	10.83	839.6	1427	1659.6	0.5	0.52	0.26	0.17	0.12	0.0	49.1	37.7	6.1	43.8	1615.8	3
3.5	263.5	369	1.75	2.02	5.30	66.92	13.21	66.92	13.21	66.92	13.21	80.13	3.5	8.14	1054.3	1792	2161.1	1.0	1.57	0.79	1.25	0.88	0.0	147.3	281.3	130.2	411.4	1749.7	3.5
4	393.3	551	2	2.24	5.39	41.45	14.68	41.45	14.68	41.45	14.68	56.13	4	6.95	1273.0	2164	2714.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2714.7	4
4.5	560.0	784	2.25	2.46	5.48	25.54	15.67	25.54	15.67	25.54	15.67	41.21	4.5	6.11	1495.2	2542	3325.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3325.8	4.5
5	768.2	1075	2.5	2.69	5.59	15.52	16.23	15.52	16.23	15.52	16.23	31.76	5	5.26	1720.4	2925	4000.2	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4000.2	5
5.5	1022.4	1431	2.75	2.93	5.71	9.15	16.42	9.15	16.42	9.15	16.42	25.57	5.5	4.47	1948.3	3312	4743.5	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4743.5	5.5
6	1327.4	1858	3	3.16	5.83	5.05	16.31	5.05	16.31	5.05	16.31	21.36	6	3.75	2178.4	3703	5561.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5561.7	6
6.5	1687.7	2363	3.25	3.40	5.96	2.39	15.94	2.39	15.94	2.39	15.94	18.33	6.5	3.13	2410.4	4098	6460.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6460.4	6.5
7	2107.8	2951	3.5	3.64	6.10	0.66	15.39	0.66	15.39	0.66	15.39	16.05	7	2.60	2644.0	4495	7445.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7445.8	7
7.5	2592.6	3630	3.75	3.88	6.25	-0.46	14.70	0.00	14.70	0.00	14.70	14.70	7.5	2.16	2878.9	4894	8523.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8523.6	7.5
8	3146.4	4405	4	4.12	6.40	-1.19	13.92	0.00	13.92	0.00	13.92	13.92	8	1.79	3114.8	5295	9700.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9700.1	8
8.5	3774.0	5284	4.25	4.37	6.56	-1.65	13.09	0.00	13.09	0.00	13.09	13.09	8.5	1.48	3351.6	5698	10981.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10981.4	8.5
9	4479.9	6272	4.5	4.61	6.73	-1.94	12.23	0.00	12.23	0.00	12.23	12.23	9	1.22	3589.2	6102	12373.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	12373.6	9

$3' \leq Z \leq 7'$

SAIL RAMP AREA

GEO STATIC & INDUCED

Gunite Pool Design

Soil Parameters — Gamma: 120; phi: 32; radians: 0.558; c: 0; Ka: 0.3073

Point Loading — Q (lbs): 2000; Poisson: 0.3; X 1: 1; X 2: 5; Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments: Radius: 1; Z to CTR: 3; Unit wt. concrete: 150

Pool Depth = 4

Z (ft)	Geostatic Moment (ft-lb)	Factored Moment (1.4 Mo)	Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)	Z (ft)	F horiz. (lbs.)	Induced moment (ft-lb)	1.7 Mo (ft-lb)	Total Factored driving moment (ft-lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft-lb)	Mr 2 (ft-lb)	Total Resisting Moment (ft-lb)	Net Moment (ft-lb)	Z (ft)
0	0.0	0	0	1.00	5.00	0.00	0.00	0	0	0	0	0	0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.25	1.03	5.01	217.43	-5.88	217.43	0.00	217.43	0.00	217.43	0.5	174.85	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.5	1.12	5.02	405.87	-1.72	405.87	0.00	405.87	0.00	405.87	1	135.89	87.4	149	157.2	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	157.2	1
1.5	20.7	29	0.75	1.25	5.06	367.51	2.16	367.51	2.16	367.51	2.16	369.67	1.5	62.24	242.8	413	441.8	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	441.8	1.5
2	49.2	69	1	1.41	5.10	263.03	5.66	263.03	5.66	263.03	5.66	268.70	2	29.20	429.3	730	798.6	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	798.6	2
2.5	96.0	134	1.25	1.60	5.15	171.32	8.70	171.32	8.70	171.32	8.70	180.01	2.5	16.29	630.4	1072	1206.1	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	1206.1	2.5
3	165.9	232	1.5	1.80	5.22	107.68	11.22	107.68	11.22	107.68	11.22	118.90	3	10.83	839.6	1427	1659.6	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	1659.6	3
3.5	263.5	369	1.75	2.02	5.30	66.92	13.21	66.92	13.21	66.92	13.21	80.13	3.5	8.14	1054.3	1792	2161.1	0.5	0.52	0.26	0.17	0.12	0.0	49.1	44.0	6.1	50.1	2111.0	3.5
4	393.3	551	2	2.24	5.39	41.45	14.68	41.45	14.68	41.45	14.68	56.13	4	6.95	1273.0	2164	2714.7	1.0	1.57	0.79	1.25	0.88	0.0	147.3	328.1	130.2	458.3	2256.4	4
4.5	560.0	784	2.25	2.46	5.48	25.54	15.67	25.54	15.67	25.54	15.67	41.21	4.5	6.11	1495.2	2542	3325.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3325.8	4.5
5	768.2	1075	2.5	2.69	5.59	15.52	16.23	15.52	16.23	15.52	16.23	31.76	5	5.26	1720.4	2925	4000.2	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4000.2	5
5.5	1022.4	1431	2.75	2.93	5.71	9.15	16.42	9.15	16.42	9.15	16.42	25.57	5.5	4.47	1948.3	3312	4743.5	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4743.5	5.5
6	1327.4	1858	3	3.16	5.83	5.05	16.31	5.05	16.31	5.05	16.31	21.36	6	3.75	2178.4	3703	5561.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5561.7	6
6.5	1687.7	2363	3.25	3.40	5.96	2.39	15.94	2.39	15.94	2.39	15.94	18.33	6.5	3.13	2410.4	4098	6460.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6460.4	6.5
7	2107.8	2951	3.5	3.64	6.10	0.66	15.39	0.66	15.39	0.66	15.39	16.05	7	2.60	2644.0	4495	7445.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7445.8	7
7.5	2592.6	3630	3.75	3.88	6.25	-0.46	14.70	0.00	14.70	0.00	14.70	14.70	7.5	2.16	2878.9	4894	8523.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8523.6	7.5
8	3146.4	4405	4	4.12	6.40	-1.19	13.92	0.00	13.92	0.00	13.92	13.92	8	1.79	3114.8	5295	9700.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9700.1	8
8.5	3774.0	5284	4.25	4.37	6.56	-1.65	13.09	0.00	13.09	0.00	13.09	13.09	8.5	1.48	3351.6	5698	10981.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10981.4	8.5
9	4479.9	6272	4.5	4.61	6.73	-1.94	12.23	0.00	12.23	0.00	12.23	12.23	9	1.22	3589.2	6102	12373.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	12373.6	9

Soil Parameters — Gamma: 120; phi: 32; radians: 0.558; c: 0; Ka: 0.3073

Point Loading — Q (lbs): 2000; Poisson: 0.3; X 1: 1; X 2: 5; Y: 3

r 1 = 3.16
r 2 = 5.83

Resisting moments: Radius: 1; Z to CTR: 3; Unit wt. concrete: 150

Pool Depth = 4

Z (ft)	Geostatic Moment (ft-lb)	Factored Moment (1.4 Mo)	Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)	Z (ft)	F horiz. (lbs.)	Induced moment (ft-lb)	1.7 Mo (ft-lb)	Total Factored driving moment (ft-lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft-lb)	Mr 2 (ft-lb)	Total Resisting Moment (ft-lb)	Net Moment (ft-lb)	Z (ft)
0	0.0	0	0	3.16	5.83	0.00	0.00	0	0	0	0	0	0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.25	3.17	5.84	-8.59	-4.77	0.00	0.00	0.00	0.00	0.00	0.5	1.38	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.5	3.20	5.85	6.90	-2.12	6.90	0.00	2.18	0.00	2.18	1	5.73	0.7	1	9.8	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	9.8	1
1.5	20.7	29	0.75	3.25	5.88	19.92	0.40	19.92	0.40	6.30	0.34	6.64	1.5	9.06	4.2	7	36.2	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	36.2	1.5
2	49.2	69	1	3.32	5.92	29.80	2.74	29.80	2.74	9.42	2.35	11.77	2	10.37	12.3	21	89.8	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	89.8	2
2.5	96.0	134	1.25	3.40	5.96	36.41	4.84	36.41	4.84	11.51	4.15	15.67	2.5	10.35	25.6	44	177.9	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	177.9	2.5
3	165.9	232	1.5	3.50	6.02	39.99	6.69	39.99	6.69	12.65	5.73	18.38	3	9.63	44.0	75	307.1	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	307.1	3
3.5	263.5	369	1.75	3.61	6.09	41.06	8.25	41.06	8.25	12.98	7.08	20.06	3.5	8.62	67.3	114	483.3	0.5	0.52	0.26	0.17	0.12	0.0	49.1	44.0	6.1	50.1	433.2	3.5
4	393.3	551	2	3.74	6.16	40.23	9.53	40.23	9.53	12.72	8.17	20.89	4	7.54	94.9	161	711.9	1.0	1.57	0.79	1.25	0.88	0.0	147.3	328.1	130.2	458.3	253.6	4
4.5	560.0	784	2.25	3.88	6.25	38.10	10.53	38.10	10.53	12.05	9.03	21.08	4.5	6.50	126.2	215	998.5	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	998.5	4.5
5	768.2	1075	2.5	4.03	6.34	35.18	11.26	35.18	11.26	11.13	9.65	20.78	5	5.55	160.8	273	1348.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1348.8	5
5.5	1022.4	1431	2.75	4.19	6.45	31.88	11.74	31.88	11.74	10.08	10.07	20.15	5.5	4.71	198.2	337	1768.3	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	1768.3	5.5
6	1327.4	1858	3	4.36	6.56	28.47	12.00	28.47	12.00	9.00	10.29	19.30	6	3.97	237.9	404	2262.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2262.7	6
6.5	1687.7	2363	3.25	4.53	6.68	25.16	12.08	25.16	12.08	7.96	10.36	18.31	6.5	3.34	279.6	475	2838.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	2838.0	6.5
7	2107.8	2951	3.5	4.72	6.80	22.05	11.99	22.05	11.99	6.97	10.28	17.25	7	2.80	323.0	549	3500.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	3500.0	7
7.5	2592.6	3630	3.75	4.91	6.93	19.22	11.77	19.22	11.77	6.08	10.09	16.17	7.5	2.34	367.7	625	4254.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4254.7	7.5
8	3146.4	4405	4	5.10	7.07	16.67	11.44	16.67	11.44	5.27	9.81	15.08	8	1.96	413.7	703	5108.2	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5108.2	8
8.5	3774.0	5284	4.25	5.30	7.22	14.42	11.03	14.42	11.03	4.56	9.46	14.02	8.5	1.64	460.6	783	6066.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6066.6	8.5
9	4479.9	6272	4.5	5.50	7.37	12.45	10.57	12.45	10.57	3.94	9.06	13.00	9	1.37	508.4	864	7136.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7136.1	9

d = 6''

Gunite Pool Design

Soil Parameters — Gamma: 120; phi: 32; radians: 0.558; c: 0; Ka: 0.3073

Point Loading — Q (lbs): 2000; Poisson: 0.3; X 1: 1; X 2: 5; Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments: Radius: 1; Z to CTR : 3.5; Unit wt. concrete: 150

Pool Depth = 4.5

Z (ft)	Geostatic Moment (ft-lb)	Factored Moment (1.4 Mo)	Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)	Z (ft)	F horiz. (lbs.)	Induced moment (ft-lb)	1.7 Mo (ft-lb)	Total Factored driving moment (ft-lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft-lb)	Mr 2 (ft-lb)	Total Resisting Moment (ft-lb)	Net Moment (ft-lb)	Z (ft)
0	0.0	0	0	1.00	5.00	0.00	0.00	0	0	0	0	0	0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.25	1.03	5.01	217.43	-5.88	217.43	0.00	217.43	0.00	217.43	0.5	174.85	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.5	1.12	5.02	405.87	-1.72	405.87	0.00	405.87	0.00	405.87	1	135.89	87.4	149	157.2	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	157.2	1
1.5	20.7	29	0.75	1.25	5.06	367.51	2.16	367.51	2.16	367.51	2.16	369.67	1.5	62.24	242.8	413	441.8	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	441.8	1.5
2	49.2	69	1	1.41	5.10	263.03	5.66	263.03	5.66	263.03	5.66	268.70	2	29.20	429.3	730	798.6	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	798.6	2
2.5	96.0	134	1.25	1.60	5.15	171.32	8.70	171.32	8.70	171.32	8.70	180.01	2.5	16.29	630.4	1072	1206.1	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	1206.1	2.5
3	165.9	232	1.5	1.80	5.22	107.68	11.22	107.68	11.22	107.68	11.22	118.90	3	10.83	839.6	1427	1659.6	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	1659.6	3
3.5	263.5	369	1.75	2.02	5.30	66.92	13.21	66.92	13.21	66.92	13.21	80.13	3.5	8.14	1054.3	1792	2161.1	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	2161.1	3.5
4	393.3	551	2	2.24	5.39	41.45	14.68	41.45	14.68	41.45	14.68	56.13	4	6.95	1273.0	2164	2714.7	0.5	0.52	0.26	0.17	0.12	0.0	69.8	50.2	8.7	59.0	2655.7	4
4.5	560.0	784	2.25	2.46	5.48	25.54	15.67	25.54	15.67	25.54	15.67	41.21	4.5	6.11	1495.2	2542	3325.8	1.0	1.57	0.79	1.25	0.88	0.0	209.4	375.0	185.1	560.1	2765.7	4.5
5	768.2	1075	2.5	2.69	5.59	15.52	16.23	15.52	16.23	15.52	16.23	31.76	5	5.26	1720.4	2925	4000.2	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4000.2	5
5.5	1022.4	1431	2.75	2.93	5.71	9.15	16.42	9.15	16.42	9.15	16.42	25.57	5.5	4.47	1948.3	3312	4743.5	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4743.5	5.5
6	1327.4	1858	3	3.16	5.83	5.05	16.31	5.05	16.31	5.05	16.31	21.36	6	3.75	2178.4	3703	5561.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5561.7	6
6.5	1687.7	2363	3.25	3.40	5.96	2.39	15.94	2.39	15.94	2.39	15.94	18.33	6.5	3.13	2410.4	4098	6460.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6460.4	6.5
7	2107.8	2951	3.5	3.64	6.10	0.66	15.39	0.66	15.39	0.66	15.39	16.05	7	2.60	2644.0	4495	7445.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7445.8	7
7.5	2592.6	3630	3.75	3.88	6.25	-0.46	14.70	0.00	14.70	0.00	14.70	14.70	7.5	2.16	2878.9	4894	8523.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8523.6	7.5
8	3146.4	4405	4	4.12	6.40	-1.19	13.92	0.00	13.92	0.00	13.92	13.92	8	1.79	3114.8	5295	9700.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9700.1	8
8.5	3774.0	5284	4.25	4.37	6.56	-1.65	13.09	0.00	13.09	0.00	13.09	13.09	8.5	1.48	3351.6	5698	10981.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10981.4	8.5
9	4479.9	6272	4.5	4.61	6.73	-1.94	12.23	0.00	12.23	0.00	12.23	12.23	9	1.22	3589.2	6102	12373.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	12373.6	9
9.5	5268.8	7376	4.75	4.85	6.90	-2.10	11.37	0.00	11.37	0.00	11.37	11.37	9.5	1.01	3827.4	6507	13882.9	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	13882.9	9.5
10	6145.3	8603	5	5.10	7.07	-2.17	10.52	0.00	10.52	0.00	10.52	10.52	10	0.83	4066.1	6912	15515.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	15515.8	10

Soil Parameters — Gamma: 120; phi: 32; radians: 0.558; c: 0; Ka: 0.3073

Point Loading — Q (lbs): 2000; Poisson: 0.3; X 1: 1; X 2: 5; Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments: Radius: 1.5; Z to CTR : 3.5; Unit wt. concrete: 150

Pool Depth = 5

Z (ft)	Geostatic Moment (ft-lb)	Factored Moment (1.4 Mo)	Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)	Z (ft)	F horiz. (lbs.)	Induced moment (ft-lb)	1.7 Mo (ft-lb)	Total Factored driving moment (ft-lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft-lb)	Mr 2 (ft-lb)	Total Resisting Moment (ft-lb)	Net Moment (ft-lb)	Z (ft)
0	0.0	0	0	1.00	5.00	0.00	0.00	0	0	0	0	0	0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.25	1.03	5.01	217.43	-5.88	217.43	0.00	217.43	0.00	217.43	0.5	174.85	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.5	1.12	5.02	405.87	-1.72	405.87	0.00	405.87	0.00	405.87	1	135.89	87.4	149	157.2	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	157.2	1
1.5	20.7	29	0.75	1.25	5.06	367.51	2.16	367.51	2.16	367.51	2.16	369.67	1.5	62.24	242.8	413	441.8	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	441.8	1.5
2	49.2	69	1	1.41	5.10	263.03	5.66	263.03	5.66	263.03	5.66	268.70	2	29.20	429.3	730	798.6	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	798.6	2
2.5	96.0	134	1.25	1.60	5.15	171.32	8.70	171.32	8.70	171.32	8.70	180.01	2.5	16.29	630.4	1072	1206.1	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	1206.1	2.5
3	165.9	232	1.5	1.80	5.22	107.68	11.22	107.68	11.22	107.68	11.22	118.90	3	10.83	839.6	1427	1659.6	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	1659.6	3
3.5	263.5	369	1.75	2.02	5.30	66.92	13.21	66.92	13.21	66.92	13.21	80.13	3.5	8.14	1054.3	1792	2161.1	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	2161.1	3.5
4	393.3	551	2	2.24	5.39	41.45	14.68	41.45	14.68	41.45	14.68	56.13	4	6.95	1273.0	2164	2714.7	0.5	0.34	0.17	0.10	0.07	0.0	62.3	30.0	4.7	34.7	2680.0	4
4.5	560.0	784	2.25	2.46	5.48	25.54	15.67	25.54	15.67	25.54	15.67	41.21	4.5	6.11	1495.2	2542	3325.8	1.0	0.73	0.36	0.45	0.33	0.0	133.8	133.7	44.2	177.9	3147.9	4.5
5	768.2	1075	2.5	2.69	5.59	15.52	16.23	15.52	16.23	15.52	16.23	31.76	5	5.26	1720.4	2925	4000.2	1.5	1.57	0.79	1.75	1.24	0.0	288.0	525.0	356.3	881.3	3118.8	5
5.5	1022.4	1431	2.75	2.93	5.71	9.15	16.42	9.15	16.42	9.15	16.42	25.57	5.5	4.47	1948.3	3312	4743.5	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	4743.5	5.5
6	1327.4	1858	3	3.16	5.83	5.05	16.31	5.05	16.31	5.05	16.31	21.36	6	3.75	2178.4	3703	5561.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5561.7	6
6.5	1687.7	2363	3.25	3.40	5.96	2.39	15.94	2.39	15.94	2.39	15.94	18.33	6.5	3.13	2410.4	4098	6460.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6460.4	6.5
7	2107.8	2951	3.5	3.64	6.10	0.66	15.39	0.66	15.39	0.66	15.39	16.05	7	2.60	2644.0	4495	7445.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7445.8	7
7.5	2592.6	3630	3.75	3.88	6.25	-0.46	14.70	0.00	14.70	0.00	14.70	14.70	7.5	2.16	2878.9	4894	8523.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8523.6	7.5
8	3146.4	4405	4	4.12	6.40	-1.19	13.92	0.00	13.92	0.00	13.92	13.92	8	1.79	3114.8	5295	9700.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9700.1	8
8.5	3774.0	5284	4.25	4.37	6.56	-1.65	13.09	0.00	13.09	0.00	13.09	13.09	8.5	1.48	3351.6	5698	10981.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10981.4	8.5
9	4479.9	6272	4.5	4.61	6.73	-1.94	12.23	0.00	12.23	0.00	12.23	12.23	9	1.22	3589.2	6102	12373.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	12373.6	9
9.5	5268.8	7376	4.75	4.85	6.90	-2.10	11.37	0.00	11.37	0.00	11.37	11.37	9.5	1.01	3827.4	6507	13882.9	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	13882.9	9.5
10	6145.3	8603	5	5.10	7.07	-2.17	10.52	0.00	10.52	0.00	10.52	10.52	10	0.83	4066.1	6912	15515.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	15515.8	10
10.5	7114.0	9960	5.25	5.34	7.25	-2.20	9.70	0.00	9.70	0.00	9.70	9.70																	
			5.5	5.59	7.43	-2.18	8.92	0.00	8.92	0.00	8.92	8.92																	
			5.75	5.84	7.62	-2.14	8.19	0.00	8.19	0.00	8.19	8.19																	
			6	6.08	7.81	-2.09	7.50	0.00	7.50	0.00	7.50	7.50																	

d = 6"

Gunite Pool Design

Soil Parameters — Gamma: 120; phi: 32; radians: 0.558; c: 0; Ka: 0.3073

Point Loading — Q (lbs): 2000; Poisson: 0.3; X 1: 1; X 2: 5; Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments: — Radius: 2; Z to CTR : 3.5; Unit wt. concrete: 150

Pool Depth = 5.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)	Z (ft)	F horiz. (lbs.)	Induced moment (ft - lb)	1.7 Mo (ft - lb)	Total Factored driving moment (ft - lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0	1.00	5.00	0.00	0.00	0	0	0	0	0	0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.25	1.03	5.01	217.43	-5.88	217.43	0.00	217.43	0.00	217.43	0.5	174.85	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.5	1.12	5.02	405.87	-1.72	405.87	0.00	405.87	0.00	405.87	1	135.89	87.4	149	157.2	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	157.2	1
1.5	20.7	29	0.75	1.25	5.06	367.51	2.16	367.51	2.16	367.51	2.16	369.67	1.5	62.24	242.8	413	441.8	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	441.8	1.5
2	49.2	69	1	1.41	5.10	263.03	5.66	263.03	5.66	263.03	5.66	268.70	2	29.20	429.3	730	798.6	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	798.6	2
2.5	96.0	134	1.25	1.60	5.15	171.32	8.70	171.32	8.70	171.32	8.70	180.01	2.5	16.29	630.4	1072	1206.1	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	1206.1	2.5
3	165.9	232	1.5	1.80	5.22	107.68	11.22	107.68	11.22	107.68	11.22	118.90	3	10.83	839.6	1427	1659.6	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	1659.6	3
3.5	263.5	369	1.75	2.02	5.30	66.92	13.21	66.92	13.21	66.92	13.21	80.13	3.5	8.14	1054.3	1792	2161.1	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	2161.1	3.5
4	393.3	551	2	2.24	5.39	41.45	14.68	41.45	14.68	41.45	14.68	56.13	4	6.95	1273.0	2164	2714.7	0.5	0.25	0.13	0.07	0.05	0.0	59.0	21.4	3.2	24.6	2690.1	4
4.5	560.0	784	2.25	2.46	5.48	25.54	15.67	25.54	15.67	25.54	15.67	41.21	4.5	6.11	1495.2	2542	3325.8	1.0	0.52	0.26	0.30	0.22	0.0	122.2	90.4	27.5	117.9	3207.9	4.5
5	768.2	1075	2.5	2.69	5.59	15.52	16.23	15.52	16.23	15.52	16.23	31.76	5	5.26	1720.4	2925	4000.2	1.5	0.85	0.42	0.76	0.56	0.0	197.9	228.5	111.3	339.8	3660.3	5
5.5	1022.4	1431	2.75	2.93	5.71	9.15	16.42	9.15	16.42	9.15	16.42	25.57	5.5	4.47	1948.3	3312	4743.5	2.0	1.57	0.79	2.25	1.59	0.0	366.5	675.0	583.1	1258.1	3485.4	5.5
6	1327.4	1858	3	3.16	5.83	5.05	16.31	5.05	16.31	5.05	16.31	21.36	6	3.75	2178.4	3703	5561.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	5561.7	6
6.5	1687.7	2363	3.25	3.40	5.96	2.39	15.94	2.39	15.94	2.39	15.94	18.33	6.5	3.13	2410.4	4098	6460.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6460.4	6.5
7	2107.8	2951	3.5	3.64	6.10	0.66	15.39	0.66	15.39	0.66	15.39	16.05	7	2.60	2644.0	4495	7445.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7445.8	7
7.5	2592.6	3630	3.75	3.88	6.25	-0.46	14.70	0.00	14.70	0.00	14.70	14.70	7.5	2.16	2878.9	4894	8523.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8523.6	7.5
8	3146.4	4405	4	4.12	6.40	-1.19	13.92	0.00	13.92	0.00	13.92	13.92	8	1.79	3114.8	5295	9700.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9700.1	8
8.5	3774.0	5284	4.25	4.37	6.56	-1.65	13.09	0.00	13.09	0.00	13.09	13.09	8.5	1.48	3351.6	5698	10981.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10981.4	8.5
9	4479.9	6272	4.5	4.61	6.73	-1.94	12.23	0.00	12.23	0.00	12.23	12.23	9	1.22	3589.2	6102	12373.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	12373.6	9
9.5	5268.8	7376	4.75	4.85	6.90	-2.10	11.37	0.00	11.37	0.00	11.37	11.37	9.5	1.01	3827.4	6507	13882.9	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	13882.9	9.5
10	6145.3	8603	5	5.10	7.07	-2.17	10.52	0.00	10.52	0.00	10.52	10.52	10	0.83	4066.1	6912	15515.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	15515.8	10
10.5	7114.0	9960	5.25	5.34	7.25	-2.20	9.70	0.00	9.70	0.00	9.70	9.70																	
			5.5	5.59	7.43	-2.18	8.92	0.00	8.92	0.00	8.92	8.92																	

Gunite Pool Design

Soil Parameters — Gamma: 120; phi: 32; radians: 0.558; c: 0; Ka: 0.3073

Point Loading — Q (lbs): 2000; Poisson: 0.3; X 1: 1; X 2: 5; Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments: — Radius: 2.5; Z to CTR : 3.5; Unit wt. concrete: 150

Pool Depth = 6

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)	Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)	Z (ft)	F horiz. (lbs.)	Induced moment (ft - lb)	1.7 Mo (ft - lb)	Total Factored driving moment (ft - lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)	Z (ft)
0	0.0	0	0	1.00	5.00	0.00	0.00	0	0	0	0	0	0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	0.8	1	0.25	1.03	5.01	217.43	-5.88	217.43	0.00	217.43	0.00	217.43	0.5	174.85	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	6.1	9	0.5	1.12	5.02	405.87	-1.72	405.87	0.00	405.87	0.00	405.87	1	135.89	87.4	149	157.2	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	157.2	1
1.5	20.7	29	0.75	1.25	5.06	367.51	2.16	367.51	2.16	367.51	2.16	369.67	1.5	62.24	242.8	413	441.8	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	441.8	1.5
2	49.2	69	1	1.41	5.10	263.03	5.66	263.03	5.66	263.03	5.66	268.70	2	29.20	429.3	730	798.6	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	798.6	2
2.5	96.0	134	1.25	1.60	5.15	171.32	8.70	171.32	8.70	171.32	8.70	180.01	2.5	16.29	630.4	1072	1206.1	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	1206.1	2.5
3	165.9	232	1.5	1.80	5.22	107.68	11.22	107.68	11.22	107.68	11.22	118.90	3	10.83	839.6	1427	1659.6	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	1659.6	3
3.5	263.5	369	1.75	2.02	5.30	66.92	13.21	66.92	13.21	66.92	13.21	80.13	3.5	8.14	1054.3	1792	2161.1	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	2161.1	3.5
4	393.3	551	2	2.24	5.39	41.45	14.68	41.45	14.68	41.45	14.68	56.13	4	6.95	1273.0	2164	2714.7	0.5	0.20	0.10	0.06	0.04	0.0	57.1	16.7	2.4	19.0	2695.6	4
4.5	560.0	784	2.25	2.46	5.48	25.54	15.67	25.54	15.67	25.54	15.67	41.21	4.5	6.11	1495.2	2542	3325.8	1.0	0.41	0.21	0.23	0.17	0.0	116.6	68.9	20.0	88.9	3236.9	4.5
5	768.2	1075	2.5	2.69	5.59	15.52	16.23	15.52	16.23	15.52	16.23	31.76	5	5.26	1720.4	2925	4000.2	1.5	0.64	0.32	0.55	0.41	0.0	182.3	165.0	74.5	239.5	3760.6	5
5.5	1022.4	1431	2.75	2.93	5.71	9.15	16.42	9.15	16.42	9.15	16.42	25.57	5.5	4.47	1948.3	3312	4743.5	2.0	0.93	0.46	1.10	0.81	0.0	262.7	330.0	212.7	542.7	4200.8	5.5
6	1327.4	1858	3	3.16	5.83	5.05	16.31	5.05	16.31	5.05	16.31	21.36	6	3.75	2178.4	3703	5561.7	2.5	1.57	0.79	2.75	1.94	0.0	445.1	825.0	865.4	1690.4	3871.3	6
6.5	1687.7	2363	3.25	3.40	5.96	2.39	15.94	2.39	15.94	2.39	15.94	18.33	6.5	3.13	2410.4	4098	6460.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6460.4	6.5
7	2107.8	2951	3.5	3.64	6.10	0.66	15.39	0.66	15.39	0.66	15.39	16.05	7	2.60	2644.0	4495	7445.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7445.8	7
7.5	2592.6	3630	3.75	3.88	6.25	-0.46	14.70	0.00	14.70	0.00	14.70	14.70	7.5	2.16	2878.9	4894	8523.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8523.6	7.5
8	3146.4	4405	4	4.12	6.40	-1.19	13.92	0.00	13.92	0.00	13.92	13.92	8	1.79	3114.8	5295	9700.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9700.1	8
8.5	3774.0	5284	4.25	4.37	6.56	-1.65	13.09	0.00	13.09	0.00	13.09	13.09	8.5	1.48	3351.6	5698	10981.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10981.4	8.5
9	4479.9	6272	4.5	4.61	6.73	-1.94	12.23	0.00	12.23	0.00	12.23	12.23	9	1.22	3589.2	6102	12373.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	12373.6	9
9.5	5268.8	7376	4.75	4.85	6.90	-2.10	11.37	0.00	11.37	0.00	11.37	11.37	9.5	1.01	3827.4	6507	13882.9	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	13882.9	9.5
10	6145.3	8603	5	5.10	7.07	-2.17	10.52	0.00	10.52	0.00	10.52	10.52	10	0.83	4066.1	6912	15515.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	15515.8	10
10.5	7114.0	9960	5.25	5.34	7.25	-2.20	9.70	0.00	9.70	0.00	9.70	9.70																	
			5.5	5.59	7.43	-2.18	8.92	0.00	8.92	0.00	8.92	8.92																	
			5.75	5.84	7.62	-2.14	8.19	0.00	8.19	0.00	8.19	8.19																	
			6	6.08	7.81	-2.09	7.50	0.00	7.50	0.00	7.50	7.50																	
			6.25	6.33	8.00	-2.02	6.85	0.00	6.85	0.00	6.85	6.85																	
			6.5	6.58	8.20	-1.95	6.26	0.00	6.26	0.00	6.26	6.26																	

d = 6'

Gunite Pool Design

Soil Parameters — Gamma: 120; phi: 32; radians: 0.558; c: 0; Ka: 0.3073

Point Loading — Q (lbs): 2000; Poisson: 0.3; X 1: 1; X 2: 5; Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments: Radius: 3; Z to CTR: 3.5; Unit wt. concrete: 150

Pool Depth = 6.5

Z (ft)	Geostatic Moment (ft-lb)	Factored Moment (1.4 Mo)
0	0.0	0
0.5	0.8	1
1	6.1	9
1.5	20.7	29
2	49.2	69
2.5	96.0	134
3	165.9	232
3.5	263.5	369
4	393.3	551
4.5	560.0	784
5	768.2	1075
5.5	1022.4	1431
6	1327.4	1858
6.5	1687.7	2363
7	2107.8	2951
7.5	2592.6	3630
8	3146.4	4405
8.5	3774.0	5284
9	4479.9	6272
9.5	5268.8	7376
10	6145.3	8603
10.5	7114.0	9960

Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)
0	1.00	5.00	0.00	0.00	0	0	0	0	0
0.25	1.03	5.01	217.43	-5.88	217.43	0.00	217.43	0.00	217.43
0.5	1.12	5.02	405.87	-1.72	405.87	0.00	405.87	0.00	405.87
0.75	1.25	5.06	367.51	2.16	367.51	2.16	367.51	2.16	369.67
1	1.41	5.10	263.03	5.66	263.03	5.66	263.03	5.66	268.70
1.25	1.60	5.15	171.32	8.70	171.32	8.70	171.32	8.70	180.01
1.5	1.80	5.22	107.68	11.22	107.68	11.22	107.68	11.22	118.90
1.75	2.02	5.30	66.92	13.21	66.92	13.21	66.92	13.21	80.13
2	2.24	5.39	41.45	14.68	41.45	14.68	41.45	14.68	56.13
2.25	2.46	5.48	25.54	15.67	25.54	15.67	25.54	15.67	41.21
2.5	2.69	5.59	15.52	16.23	15.52	16.23	15.52	16.23	31.76
2.75	2.93	5.71	9.15	16.42	9.15	16.42	9.15	16.42	25.57
3	3.16	5.83	5.05	16.31	5.05	16.31	5.05	16.31	21.36
3.25	3.40	5.96	2.39	15.94	2.39	15.94	2.39	15.94	18.33
3.5	3.64	6.10	0.66	15.39	0.66	15.39	0.66	15.39	16.05
3.75	3.88	6.25	-0.46	14.70	0.00	14.70	0.00	14.70	14.70
4	4.12	6.40	-1.19	13.92	0.00	13.92	0.00	13.92	13.92
4.25	4.37	6.56	-1.65	13.09	0.00	13.09	0.00	13.09	13.09
4.5	4.61	6.73	-1.94	12.23	0.00	12.23	0.00	12.23	12.23
4.75	4.85	6.90	-2.10	11.37	0.00	11.37	0.00	11.37	11.37
5	5.10	7.07	-2.17	10.52	0.00	10.52	0.00	10.52	10.52
5.25	5.34	7.25	-2.20	9.70	0.00	9.70	0.00	9.70	9.70
5.5	5.59	7.43	-2.18	8.92	0.00	8.92	0.00	8.92	8.92
5.75	5.84	7.62	-2.14	8.19	0.00	8.19	0.00	8.19	8.19
6	6.08	7.81	-2.09	7.50	0.00	7.50	0.00	7.50	7.50
6.25	6.33	8.00	-2.02	6.85	0.00	6.85	0.00	6.85	6.85
6.5	6.58	8.20	-1.95	6.26	0.00	6.26	0.00	6.26	6.26
6.75	6.82	8.40	-1.88	5.70	0.00	5.70	0.00	5.70	5.70
7	7.07	8.60	-1.80	5.20	0.00	5.20	0.00	5.20	5.20

Z (ft)	F horiz. (lbs.)	Induced moment (ft-lb)	1.7 Mo (ft-lb)	Total Factored driving moment (ft-lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft-lb)	Mr 2 (ft-lb)	Total Resisting Moment (ft-lb)	Net Moment (ft-lb)	Z (ft)
0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	174.85	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	135.89	87.4	149	157.2	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	157.2	1
1.5	62.24	242.8	413	441.8	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	441.8	1.5
2	29.20	429.3	730	798.6	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	798.6	2
2.5	16.29	630.4	1072	1206.1	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	1206.1	2.5
3	10.83	839.6	1427	1659.6	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	1659.6	3
3.5	8.14	1054.3	1792	2161.1	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	2161.1	3.5
4	6.95	1273.0	2164	2714.7	0.5	0.17	0.08	0.05	0.03	0.0	55.8	13.6	1.9	15.5	2699.1	4
4.5	6.11	1495.2	2542	3325.8	1.0	0.34	0.17	0.19	0.14	0.0	113.3	55.8	15.8	71.5	3254.3	4.5
5	5.26	1720.4	2925	4000.2	1.5	0.52	0.26	0.44	0.32	0.0	174.5	130.6	56.7	187.3	3812.9	5
5.5	4.47	1948.3	3312	4743.5	2.0	0.73	0.36	0.83	0.61	0.0	243.2	248.3	149.3	397.5	4346.0	5.5
6	3.75	2178.4	3703	5561.7	2.5	0.99	0.49	1.45	1.07	0.0	328.4	436.0	350.4	786.5	4775.2	6
6.5	3.13	2410.4	4098	6460.4	3.0	1.57	0.79	3.25	2.30	0.0	523.6	975.0	1203.3	2178.3	4282.2	6.5
7	2.60	2644.0	4495	7445.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7445.8	7
7.5	2.16	2878.9	4894	8523.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8523.6	7.5
8	1.79	3114.8	5295	9700.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9700.1	8
8.5	1.48	3351.6	5698	10981.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10981.4	8.5
9	1.22	3589.2	6102	12373.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	12373.6	9
9.5	1.01	3827.4	6507	13882.9	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	13882.9	9.5
10	0.83	4066.1	6912	15515.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	15515.8	10

Gunite Pool Design

Soil Parameters — Gamma: 120; phi: 32; radians: 0.558; c: 0; Ka: 0.3073

Point Loading — Q (lbs): 2000; Poisson: 0.3; X 1: 1; X 2: 5; Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments: Radius: 3.5; Z to CTR: 3.5; Unit wt. concrete: 150

Pool Depth = 7

Z (ft)	Geostatic Moment (ft-lb)	Factored Moment (1.4 Mo)
0	0.0	0
0.5	0.8	1
1	6.1	9
1.5	20.7	29
2	49.2	69
2.5	96.0	134
3	165.9	232
3.5	263.5	369
4	393.3	551
4.5	560.0	784
5	768.2	1075
5.5	1022.4	1431
6	1327.4	1858
6.5	1687.7	2363
7	2107.8	2951
7.5	2592.6	3630
8	3146.4	4405
8.5	3774.0	5284
9	4479.9	6272
9.5	5268.8	7376
10	6145.3	8603
10.5	7114.0	9960

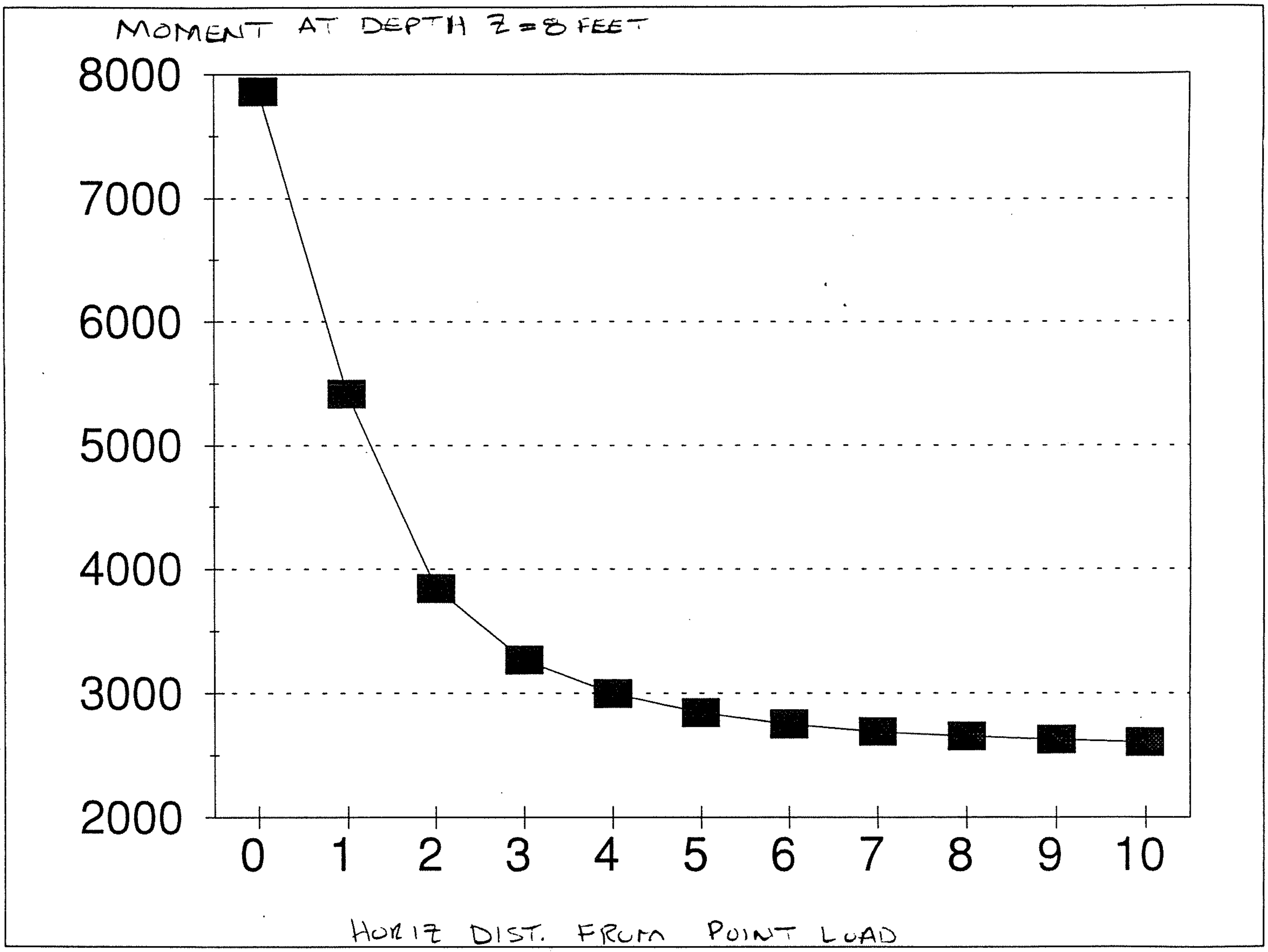
Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)
0	1.00	5.00	0.00	0.00	0	0	0	0	0
0.25	1.03	5.01	217.43	-5.88	217.43	0.00	217.43	0.00	217.43
0.5	1.12	5.02	405.87	-1.72	405.87	0.00	405.87	0.00	405.87
0.75	1.25	5.06	367.51	2.16	367.51	2.16	367.51	2.16	369.67
1	1.41	5.10	263.03	5.66	263.03	5.66	263.03	5.66	268.70
1.25	1.60	5.15	171.32	8.70	171.32	8.70	171.32	8.70	180.01
1.5	1.80	5.22	107.68	11.22	107.68	11.22	107.68	11.22	118.90
1.75	2.02	5.30	66.92	13.21	66.92	13.21	66.92	13.21	80.13
2	2.24	5.39	41.45	14.68	41.45	14.68	41.45	14.68	56.13
2.25	2.46	5.48	25.54	15.67	25.54	15.67	25.54	15.67	41.21
2.5	2.69	5.59	15.52	16.23	15.52	16.23	15.52	16.23	31.76
2.75	2.93	5.71	9.15	16.42	9.15	16.42	9.15	16.42	25.57
3	3.16	5.83	5.05	16.31	5.05	16.31	5.05	16.31	21.36
3.25	3.40	5.96	2.39	15.94	2.39	15.94	2.39	15.94	18.33
3.5	3.64	6.10	0.66	15.39	0.66	15.39	0.66	15.39	16.05
3.75	3.88	6.25	-0.46	14.70	0.00	14.70	0.00	14.70	14.70
4	4.12	6.40	-1.19	13.92	0.00	13.92	0.00	13.92	13.92
4.25	4.37	6.56	-1.65	13.09	0.00	13.09	0.00	13.09	13.09
4.5	4.61	6.73	-1.94	12.23	0.00	12.23	0.00	12.23	12.23
4.75	4.85	6.90	-2.10	11.37	0.00	11.37	0.00	11.37	11.37
5	5.10	7.07	-2.17	10.52	0.00	10.52	0.00	10.52	10.52
5.25	5.34	7.25	-2.20	9.70	0.00	9.70	0.00	9.70	9.70
5.5	5.59	7.43	-2.18	8.92	0.00	8.92	0.00	8.92	8.92
5.75	5.84	7.62	-2.14	8.19	0.00	8.19	0.00	8.19	8.19
6	6.08	7.81	-2.09	7.50	0.00	7.50	0.00	7.50	7.50
6.25	6.33	8.00	-2.02	6.85	0.00	6.85	0.00	6.85	6.85
6.5	6.58	8.20	-1.95	6.26	0.00	6.26	0.00	6.26	6.26
6.75	6.82	8.40	-1.88	5.70	0.00	5.70	0.00	5.70	5.70
7	7.07	8.60	-1.80	5.20	0.00	5.20	0.00	5.20	5.20
7.25	7.32	8.81	-1.73	4.73	0.00	4.73	0.00	4.73	4.73
7.5	7.57	9.01	-1.66	4.31	0.00	4.31	0.00	4.31	4.31

Z (ft)	F horiz. (lbs.)	Induced moment (ft-lb)	1.7 Mo (ft-lb)	Total Factored driving moment (ft-lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft-lb)	Mr 2 (ft-lb)	Total Resisting Moment (ft-lb)	Net Moment (ft-lb)	Z (ft)
0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0
0.5	174.85	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1	0.5
1	135.89	87.4	149	157.2	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	157.2	1
1.5	62.24	242.8	413	441.8	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	441.8	1.5
2	29.20	429.3	730	798.6	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	798.6	2
2.5	16.29	630.4	1072	1206.1	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	1206.1	2.5
3	10.83	839.6	1427	1659.6	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	1659.6	3
3.5	8.14	1054.3	1792	2161.1	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	2161.1	3.5
4	6.95	1273.0	2164	2714.7	0.5	0.14	0.07	0.04	0.03	0.0	54.9	11.5	1.6	13.1	2701.6	4
4.5	6.11	1495.2	2542	3325.8	1.0	0.29	0.14	0.16	0.12	0.0	111.1	46.9	13.0	59.9	3265.9	4.5
5	5.26	1720.4	2925	4000.2	1.5	0.44	0.22	0.36	0.27	0.0	169.8	108.6	45.9	154.4	3845.7	5
5.5	4.47	1948.3	3312	4743.5	2.0	0.61	0.30	0.67	0.50	0.0	233.2	201.8	116.7	318.5	4425.1	5.5
6	3.75	2178.4	3703	5561.7	2.5	0.80	0.40	1.13	0.83	0.0	305.0	337.7	254.0	591.6	4970.1	6
6.5	3.13	2410.4	4098	6460.4	3.0	1.03	0:51	1.82	1.33	0.0	394.7	545.5	525.9	1071.4	5389.0	6.5
7	2.60	2644.0	4495	7445.8	3.5	1.57	0.79	3.75	2.65	0.0	602.1	1125.0	1598.6	2721.6	4724.1	7
7.5	2.16	2878.9	4894	8523.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8523.6	7.5
8	1.79	3114.8	5295	9700.1	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9700.1	8
8.5	1.48	3351.6	5698	10981.4	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10981.4	8.5
9	1.22	3589.2	6102	12373.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	12373.6	9
9.5	1.01	3827.4	6507	13882.9	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	13882.9	9.5
10	0.83	4066.1	6912	15515.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	15515.8	10

APPENDIX F

LATERAL DISTRIBUTION OF

INDUCED MOMENT AT DEPTH Z = 8 FEET



Gunite Pool Design

Soil Parameters
Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Point Loading
Q (lbs): 2000
Poisson: 0.3
X 1: 1
X 2: 5
Y: 4

r 1 = 4.12
r 2 = 6.40

Resisting moments:
Radius: 5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 8.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)
0	0.0	0
0.5	0.8	1
1	6.1	9
1.5	20.7	29
2	49.2	69
2.5	96.0	134
3	165.9	232
3.5	263.5	369
4	393.3	551
4.5	560.0	784
5	768.2	1075
5.5	1022.4	1431
6	1327.4	1858
6.5	1687.7	2363
7	2107.8	2951
7.5	2592.6	3630
8	3146.4	4405
8.5	3774.0	5284
9	4479.9	6272
9.5	5268.8	7376
10	6145.3	8603
10.5	7114.0	9960

Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)
0	4.12	6.40	0.00	0.00	0	0	0	0	0
0.25	4.13	6.41	-7.32	-4.16	0.00	0.00	0.00	0.00	0.00
0.5	4.15	6.42	-0.04	-2.14	0.00	0.00	0.00	0.00	0.00
0.75	4.19	6.45	6.54	-0.21	6.54	0.00	1.59	0.00	1.59
1	4.24	6.48	12.17	1.60	12.17	1.60	2.95	1.25	4.20
1.25	4.31	6.52	16.70	3.26	16.70	3.26	4.05	2.55	6.60
1.5	4.39	6.58	20.10	4.75	20.10	4.75	4.87	3.71	8.59
1.75	4.48	6.64	22.39	6.06	22.39	6.06	5.43	4.73	10.16
2	4.58	6.71	23.69	7.17	23.69	7.17	5.75	5.60	11.34
2.25	4.70	6.79	24.15	8.08	24.15	8.08	5.86	6.31	12.17
2.5	4.82	6.87	23.93	8.80	23.93	8.80	5.80	6.87	12.68
2.75	4.96	6.97	23.19	9.34	23.19	9.34	5.63	7.30	12.92
3	5.10	7.07	22.09	9.71	22.09	9.71	5.36	7.58	12.94
3.25	5.25	7.18	20.75	9.93	20.75	9.93	5.03	7.75	12.79
3.5	5.41	7.30	19.27	10.01	19.27	10.01	4.67	7.82	12.49
3.75	5.57	7.42	17.74	9.98	17.74	9.98	4.30	7.79	12.10
4	5.74	7.55	16.21	9.85	16.21	9.85	3.93	7.69	11.62
4.25	5.92	7.69	14.73	9.64	14.73	9.64	3.57	7.53	11.10
4.5	6.10	7.83	13.32	9.36	13.32	9.36	3.23	7.31	10.54
4.75	6.29	7.97	12.00	9.04	12.00	9.04	2.91	7.06	9.97
5	6.48	8.12	10.78	8.68	10.78	8.68	2.61	6.77	9.39
5.25	6.68	8.28	9.66	8.29	9.66	8.29	2.34	6.47	8.82
5.5	6.87	8.44	8.64	7.89	8.64	7.89	2.10	6.16	8.25
5.75	7.08	8.61	7.72	7.48	7.72	7.48	1.87	5.84	7.71
6	7.28	8.77	6.89	7.07	6.89	7.07	1.67	5.52	7.19
6.25	7.49	8.95	6.15	6.66	6.15	6.66	1.49	5.20	6.69
6.5	7.70	9.12	5.48	6.26	5.48	6.26	1.33	4.89	6.22
6.75	7.91	9.30	4.88	5.88	4.88	5.88	1.18	4.59	5.77
7	8.12	9.49	4.35	5.50	4.35	5.50	1.05	4.30	5.35
7.25	8.34	9.67	3.87	5.15	3.87	5.15	0.94	4.02	4.96
7.5	8.56	9.86	3.45	4.81	3.45	4.81	0.84	3.76	4.59
7.75	8.78	10.05	3.07	4.49	3.07	4.49	0.74	3.50	4.25
8	9.00	10.25	2.73	4.18	2.73	4.18	0.66	3.27	3.93
8.25	9.22	10.44	2.43	3.90	2.43	3.90	0.59	3.04	3.63
8.5	9.45	10.64	2.17	3.63	2.17	3.63	0.53	2.83	3.36
8.75	9.67	10.84	1.93	3.37	1.93	3.37	0.47	2.63	3.10
9	9.90	11.05	1.71	3.14	1.71	3.14	0.42	2.45	2.86
9.25	10.13	11.25	1.52	2.92	1.52	2.92	0.37	2.28	2.65
9.5	10.36	11.46	1.35	2.71	1.35	2.71	0.33	2.12	2.44
9.75	10.59	11.66	1.20	2.52	1.20	2.52	0.29	1.96	2.26
10	10.82	11.87	1.06	2.34	1.06	2.34	0.26	1.82	2.08
10.25	11.05	12.09	0.94	2.17	0.94	2.17	0.23	1.69	1.92

Z (ft)	F horiz. (lbs.)	Induced moment (ft - lb)	1.7 Mo (ft - lb)	Total Factored driving moment (ft - lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)
0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.5	3.25	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1
1	4.24	1.6	3	11.4	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	11.4
1.5	5.03	5.4	9	38.2	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	38.2
2	5.63	11.6	20	88.6	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	88.6
2.5	6.31	20.7	35	169.6	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	169.6
3	6.45	32.9	56	288.3	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	288.3
3.5	6.23	48.4	82	451.1	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	451.1
4	5.80	66.9	114	664.4	0.5	0.10	0.05	0.03	0.02	0.0	39.4	7.9	0.8	8.7	655.8
4.5	5.27	88.4	150	934.3	1.0	0.20	0.10	0.11	0.08	0.0	79.3	31.8	6.3	38.1	896.2
5	4.69	112.5	191	1266.7	1.5	0.30	0.15	0.24	0.18	0.0	120.0	72.5	21.7	94.3	1172.5
5.5	4.13	139.0	236	1667.7	2.0	0.41	0.21	0.44	0.33	0.0	162.0	131.5	53.1	184.6	1483.1
6	3.60	167.5	285	2143.1	2.5	0.52	0.26	0.70	0.52	0.0	206.2	211.0	108.1	319.1	1823.9
6.5	3.11	197.8	336	2699.0	3.0	0.64	0.32	1.05	0.78	0.0	253.4	315.0	197.8	512.8	2186.2
7	2.68	229.7	390	3341.4	3.5	0.78	0.39	1.50	1.11	0.0	305.3	450.2	339.2	789.5	2552.0
7.5	2.30	262.9	447	4076.5	4.0	0.93	0.46	2.10	1.55	0.0	365.1	630.0	564.4	1194.4	2882.1
8	1.97	297.3	505	4910.3	4.5	1.12	0.56	2.96	2.16	0.0	440.9	888.5	952.4	1840.8	3069.5
8.5	1.68	332.6	565	5849.0	5.0	1.57	0.79	5.25	3.71	0.0	618.5	1575.0	2296.1	3871.1	1977.9
9	1.43	368.8	627	6898.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	6898.8
9.5	1.22	405.7	690	8066.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8066.0
10	1.04	443.2	753	9356.9	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9356.9

SAND,

BA[illegible] [illegible] WH[illegible] NO [illegible] [illegible] ALL[illegible]'D

Gunite Pool Design

Soil Parameters
Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Point Loading
Q (lbs): 2000
Poisson: 0.3
X 1: 1
X 2: 5
Y: 3

r 1 = 3.16
r 2 = 5.83

Resisting moments:
Radius: 5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 8.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)
0	0.0	0
0.5	0.8	1
1	6.1	9
1.5	20.7	29
2	49.2	69
2.5	96.0	134
3	165.9	232
3.5	263.5	369
4	393.3	551
4.5	560.0	784
5	768.2	1075
5.5	1022.4	1431
6	1327.4	1858
6.5	1687.7	2363
7	2107.8	2951
7.5	2592.6	3630
8	3146.4	4405
8.5	3774.0	5284
9	4479.9	6272
9.5	5268.8	7376
10	6145.3	8603
10.5	7114.0	9960

Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)
0	3.16	5.83	0.00	0.00	0	0	0	0	0
0.25	3.17	5.84	-8.59	-4.77	0.00	0.00	0.00	0.00	0.00
0.5	3.20	5.85	6.90	-2.12	6.90	0.00	2.18	0.00	2.18
0.75	3.25	5.88	19.92	0.40	19.92	0.40	6.30	0.34	6.64
1	3.32	5.92	29.80	2.74	29.80	2.74	9.42	2.35	11.77
1.25	3.40	5.96	36.41	4.84	36.41	4.84	11.51	4.15	15.67
1.5	3.50	6.02	39.99	6.69	39.99	6.69	12.65	5.73	18.38
1.75	3.61	6.09	41.06	8.25	41.06	8.25	12.98	7.08	20.06
2	3.74	6.16	40.23	9.53	40.23	9.53	12.72	8.17	20.89
2.25	3.88	6.25	38.10	10.53	38.10	10.53	12.05	9.03	21.08
2.5	4.03	6.34	35.18	11.26	35.18	11.26	11.13	9.65	20.78
2.75	4.19	6.45	31.88	11.74	31.88	11.74	10.08	10.07	20.15
3	4.36	6.56	28.47	12.00	28.47	12.00	9.00	10.29	19.30
3.25	4.53	6.68	25.16	12.08	25.16	12.08	7.96	10.36	18.31
3.5	4.72	6.80	22.05	11.99	22.05	11.99	6.97	10.28	17.25
3.75	4.91	6.93	19.22	11.77	19.22	11.77	6.08	10.09	16.17
4	5.10	7.07	16.67	11.44	16.67	11.44	5.27	9.81	15.08
4.25	5.30	7.22	14.42	11.03	14.42	11.03	4.56	9.46	14.02
4.5	5.50	7.37	12.45	10.57	12.45	10.57	3.94	9.06	13.00
4.75	5.71	7.52	10.73	10.06	10.73	10.06	3.39	8.63	12.02
5	5.92	7.68	9.23	9.53	9.23	9.53	2.92	8.17	11.09
5.25	6.13	7.85	7.94	8.99	7.94	8.99	2.51	7.71	10.22
5.5	6.34	8.02	6.83	8.44	6.83	8.44	2.16	7.24	9.40
5.75	6.56	8.19	5.87	7.91	5.87	7.91	1.86	6.78	8.64
6	6.78	8.37	5.05	7.39	5.05	7.39	1.60	6.33	7.93
6.25	7.00	8.55	4.34	6.88	4.34	6.88	1.37	5.90	7.27
6.5	7.23	8.73	3.72	6.40	3.72	6.40	1.18	5.49	6.67
6.75	7.45	8.92	3.20	5.94	3.20	5.94	1.01	5.09	6.11
7	7.68	9.11	2.74	5.51	2.74	5.51	0.87	4.72	5.59
7.25	7.91	9.30	2.35	5.10	2.35	5.10	0.74	4.37	5.12
7.5	8.14	9.50	2.01	4.72	2.01	4.72	0.64	4.04	4.68
7.75	8.37	9.70	1.72	4.36	1.72	4.36	0.54	3.74	4.28
8	8.60	9.90	1.46	4.03	1.46	4.03	0.46	3.45	3.91
8.25	8.84	10.10	1.24	3.72	1.24	3.72	0.39	3.19	3.58
8.5	9.07	10.31	1.05	3.43	1.05	3.43	0.33	2.94	3.27
8.75	9.30	10.51	0.88	3.16	0.88	3.16	0.28	2.71	2.99
9	9.54	10.72	0.74	2.92	0.74	2.92	0.23	2.50	2.73
9.25	9.78	10.93	0.61	2.69	0.61	2.69	0.19	2.31	2.50
9.5	10.01	11.15	0.50	2.48	0.50	2.48	0.16	2.13	2.28
9.75	10.25	11.36	0.40	2.28	0.40	2.28	0.13	1.96	2.09
10	10.49	11.58	0.32	2.10	0.32	2.10	0.10	1.80	1.91
10.25	10.73	11.79	0.25	1.94	0.25	1.94	0.08	1.66	1.74

Z (ft)	F horiz. (lbs.)	Induced moment (ft - lb)	1.7 Mo (ft - lb)	Total Factored driving moment (ft - lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)
0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.5	7.69	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1
1	9.06	3.8	7	15.1	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	15.1
1.5	9.92	12.2	21	49.8	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	49.8
2	10.37	25.6	43	112.3	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	112.3
2.5	10.35	44.1	75	209.3	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	209.3
3	9.63	67.8	115	347.5	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	347.5
3.5	8.62	96.3	164	532.5	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	532.5
4	7.54	129.1	219	770.1	0.5	0.10	0.05	0.03	0.02	0.0	39.4	7.9	0.8	8.7	761.4
4.5	6.50	165.7	282	1065.6	1.0	0.20	0.10	0.11	0.08	0.0	79.3	31.8	6.3	38.1	1027.5
5	5.55	205.5	349	1424.8	1.5	0.30	0.15	0.24	0.18	0.0	120.0	72.5	21.7	94.3	1330.6
5.5	4.71	248.1	422	1853.2	2.0	0.41	0.21	0.44	0.33	0.0	162.0	131.5	53.1	184.6	1668.7
6	3.97	293.1	498	2356.6	2.5	0.52	0.26	0.70	0.52	0.0	206.2	211.0	108.1	319.1	2037.5
6.5	3.34	340.1	578	2940.9	3.0	0.64	0.32	1.05	0.78	0.0	253.4	315.0	197.8	512.8	2428.1
7	2.80	388.7	661	3611.8	3.5	0.78	0.39	1.50	1.11	0.0	305.3	450.2	339.2	789.5	2822.3
7.5	2.34	438.7	746	4375.4	4.0	0.93	0.46	2.10	1.55	0.0	365.1	630.0	564.4	1194.4	3181.0
8	1.96	489.9	833	5237.8	4.5	1.12	0.56	2.96	2.16	0.0	440.9	888.5	952.4	1840.8	3397.0
8.5	1.64	542.1	922	6205.2	5.0	1.57	0.79	5.25	3.71	0.0	618.5	1575.0	2296.1	3871.1	2334.1
9	1.37	595.1	1012	7283.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	7283.6
9.5	1.14	648.8	1103	8479.3	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8479.3
10	0.95	703.1	1195	9798.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9798.6

Gunite Pool Design

Soil Parameters
Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Point Loading
Q (lbs): 2000
Poisson: 0.3
X 1: 1
X 2: 5
Y: 2

r 1 = 2.24
r 2 = 5.39

Resisting moments:
Radius: 5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 8.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)
0	0.0	0
0.5	0.8	1
1	6.1	9
1.5	20.7	29
2	49.2	69
2.5	96.0	134
3	165.9	232
3.5	263.5	369
4	393.3	551
4.5	560.0	784
5	768.2	1075
5.5	1022.4	1431
6	1327.4	1858
6.5	1687.7	2363
7	2107.8	2951
7.5	2592.6	3630
8	3146.4	4405
8.5	3774.0	5284
9	4479.9	6272
9.5	5268.8	7376
10	6145.3	8603
10.5	7114.0	9960

Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)
0	2.24	5.39	0.00	0.00	0	0	0	0	0
0.25	2.25	5.39	-3.87	-5.33	0.00	0.00	0.00	0.00	0.00
0.5	2.29	5.41	35.79	-1.98	35.79	0.00	16.00	0.00	16.00
0.75	2.36	5.44	63.41	1.17	63.41	1.17	28.36	1.09	29.45
1	2.45	5.48	78.15	4.06	78.15	4.06	34.95	3.77	38.72
1.25	2.56	5.53	82.12	6.61	82.12	6.61	36.72	6.14	42.86
1.5	2.69	5.59	78.65	8.79	78.65	8.79	35.17	8.16	43.34
1.75	2.84	5.66	71.00	10.58	71.00	10.58	31.75	9.83	41.58
2	3.00	5.74	61.62	11.98	61.62	11.98	27.56	11.13	38.68
2.25	3.17	5.84	52.09	13.01	52.09	13.01	23.29	12.08	35.37
2.5	3.35	5.94	43.27	13.69	43.27	13.69	19.35	12.71	32.06
2.75	3.54	6.05	35.53	14.06	35.53	14.06	15.89	13.05	28.94
3	3.74	6.16	28.97	14.16	28.97	14.16	12.96	13.15	26.10
3.25	3.94	6.29	23.51	14.04	23.51	14.04	10.51	13.04	23.55
3.5	4.15	6.42	19.03	13.74	19.03	13.74	8.51	12.76	21.27
3.75	4.37	6.56	15.38	13.30	15.38	13.30	6.88	12.35	19.23
4	4.58	6.71	12.43	12.76	12.43	12.76	5.56	11.85	17.41
4.25	4.80	6.86	10.03	12.15	10.03	12.15	4.49	11.28	15.77
4.5	5.02	7.02	8.09	11.49	8.09	11.49	3.62	10.67	14.29
4.75	5.25	7.18	6.52	10.81	6.52	10.81	2.92	10.03	12.95
5	5.48	7.35	5.25	10.12	5.25	10.12	2.35	9.39	11.74
5.25	5.71	7.52	4.21	9.43	4.21	9.43	1.88	8.76	10.64
5.5	5.94	7.70	3.37	8.77	3.37	8.77	1.51	8.14	9.65
5.75	6.17	7.88	2.68	8.12	2.68	8.12	1.20	7.54	8.74
6	6.40	8.06	2.12	7.51	2.12	7.51	0.95	6.97	7.92
6.25	6.64	8.25	1.65	6.93	1.65	6.93	0.74	6.43	7.17
6.5	6.87	8.44	1.27	6.38	1.27	6.38	0.57	5.93	6.50
6.75	7.11	8.63	0.96	5.87	0.96	5.87	0.43	5.45	5.88
7	7.35	8.83	0.70	5.39	0.70	5.39	0.32	5.01	5.32
7.25	7.59	9.03	0.49	4.95	0.49	4.95	0.22	4.60	4.82
7.5	7.83	9.23	0.32	4.54	0.32	4.54	0.14	4.22	4.36
7.75	8.07	9.44	0.17	4.16	0.17	4.16	0.08	3.87	3.94
8	8.31	9.64	0.05	3.82	0.05	3.82	0.02	3.54	3.57
8.25	8.55	9.85	-0.05	3.50	0.00	3.50	0.00	3.25	3.25
8.5	8.79	10.06	-0.13	3.20	0.00	3.20	0.00	2.97	2.97
8.75	9.03	10.27	-0.19	2.93	0.00	2.93	0.00	2.72	2.72
9	9.27	10.49	-0.25	2.68	0.00	2.68	0.00	2.49	2.49
9.25	9.52	10.70	-0.29	2.45	0.00	2.45	0.00	2.28	2.28
9.5	9.76	10.92	-0.33	2.25	0.00	2.25	0.00	2.09	2.09
9.75	10.00	11.14	-0.36	2.06	0.00	2.06	0.00	1.91	1.91
10	10.25	11.36	-0.38	1.88	0.00	1.88	0.00	1.75	1.75
10.25	10.49	11.58	-0.40	1.72	0.00	1.72	0.00	1.60	1.60

Z (ft)	F horiz. (lbs.)	Induced moment (ft - lb)	1.7 Mo (ft - lb)	Total Factored driving moment (ft - lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)
0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.5	20.97	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1
1	21.39	10.5	18	26.4	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	26.4
1.5	20.65	31.7	54	82.9	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	82.9
2	19.29	63.2	107	176.2	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	176.2
2.5	16.05	104.3	177	311.8	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	311.8
3	13.09	153.5	261	493.2	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	493.2
3.5	10.67	209.2	356	724.5	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	724.5
4	8.73	270.3	459	1010.1	0.5	0.10	0.05	0.03	0.02	0.0	39.4	7.9	0.8	8.7	1001.4
4.5	7.16	335.7	571	1354.7	1.0	0.20	0.10	0.11	0.08	0.0	79.3	31.8	6.3	38.1	1316.5
5	5.88	404.7	688	1763.4	1.5	0.30	0.15	0.24	0.18	0.0	120.0	72.5	21.7	94.3	1669.1
5.5	4.83	476.6	810	2241.7	2.0	0.41	0.21	0.44	0.33	0.0	162.0	131.5	53.1	184.6	2057.1
6	3.97	551.0	937	2795.0	2.5	0.52	0.26	0.70	0.52	0.0	206.2	211.0	108.1	319.1	2475.9
6.5	3.26	627.3	1066	3429.2	3.0	0.64	0.32	1.05	0.78	0.0	253.4	315.0	197.8	512.8	2916.4
7	2.67	705.3	1199	4150.0	3.5	0.78	0.39	1.50	1.11	0.0	305.3	450.2	339.2	789.5	3360.5
7.5	2.18	784.6	1334	4963.4	4.0	0.93	0.46	2.10	1.55	0.0	365.1	630.0	564.4	1194.4	3769.0
8	1.79	865.0	1470	5875.4	4.5	1.12	0.56	2.96	2.16	0.0	440.9	888.5	952.4	1840.8	4034.6
8.5	1.49	946.3	1609	6892.3	5.0	1.57	0.79	5.25	3.71	0.0	618.5	1575.0	2296.1	3871.1	3021.2
9	1.25	1028.3	1748	8020.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	8020.0
9.5	1.04	1111.0	1889	9265.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9265.0
10	0.87	1194.2	2030	10633.5	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10633.5

Gunite Pool Design

Soil Parameters
Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Point Loading
Q (lbs): 2000
Poisson: 0.3
X 1: 1
X 2: 5
Y: 1

r 1 = 1.41
r 2 = 5.10

Resisting moments:
Radius 5
Z to CTR : 3.5
Unit wt. concrete. 150

Pool Depth = 8.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)
0	0.0	0
0.5	0.8	1
1	6.1	9
1.5	20.7	29
2	49.2	69
2.5	96.0	134
3	165.9	232
3.5	263.5	369
4	393.3	551
4.5	560.0	784
5	768.2	1075
5.5	1022.4	1431
6	1327.4	1858
6.5	1687.7	2363
7	2107.8	2951
7.5	2592.6	3630
8	3146.4	4405
8.5	3774.0	5284
9	4479.9	6272
9.5	5268.8	7376
10	6145.3	8603
10.5	7114.0	9960

Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)
0	1.41	5.10	0.00	0.00	0	0	0	0	0
0.25	1.44	5.11	51.15	-5.73	51.15	0.00	36.17	0.00	36.17
0.5	1.50	5.12	166.62	-1.81	166.62	0.00	117.82	0.00	117.82
0.75	1.60	5.15	204.87	1.87	204.87	1.87	144.87	1.84	146.70
1	1.73	5.20	191.22	5.20	191.22	5.20	135.21	5.10	140.31
1.25	1.89	5.25	156.32	8.10	156.32	8.10	110.53	7.94	118.48
1.5	2.06	5.32	119.19	10.53	119.19	10.53	84.28	10.33	94.60
1.75	2.25	5.39	87.63	12.47	87.63	12.47	61.96	12.23	74.19
2	2.45	5.48	63.27	13.93	63.27	13.93	44.74	13.66	58.40
2.25	2.66	5.57	45.31	14.94	45.31	14.94	32.04	14.65	46.69
2.5	2.87	5.68	32.34	15.54	32.34	15.54	22.87	15.23	38.10
2.75	3.09	5.79	23.05	15.78	23.05	15.78	16.30	15.47	31.77
3	3.32	5.92	16.40	15.73	16.40	15.73	11.60	15.42	27.02
3.25	3.54	6.05	11.62	15.44	11.62	15.44	8.22	15.14	23.35
3.5	3.77	6.18	8.17	14.96	8.17	14.96	5.78	14.67	20.44
3.75	4.01	6.33	5.66	14.34	5.66	14.34	4.00	14.06	18.06
4	4.24	6.48	3.83	13.63	3.83	13.63	2.71	13.36	16.07
4.25	4.48	6.64	2.49	12.85	2.49	12.85	1.76	12.60	14.36
4.5	4.72	6.80	1.50	12.05	1.50	12.05	1.06	11.81	12.88
4.75	4.96	6.97	0.77	11.23	0.77	11.23	0.55	11.02	11.56
5	5.20	7.14	0.24	10.43	0.24	10.43	0.17	10.23	10.39
5.25	5.44	7.32	-0.16	9.65	0.00	9.65	0.00	9.46	9.46
5.5	5.68	7.50	-0.45	8.90	0.00	8.90	0.00	8.72	8.72
5.75	5.92	7.69	-0.67	8.18	0.00	8.18	0.00	8.03	8.03
6	6.16	7.87	-0.82	7.51	0.00	7.51	0.00	7.37	7.37
6.25	6.41	8.07	-0.93	6.88	0.00	6.88	0.00	6.75	6.75
6.5	6.65	8.26	-1.00	6.30	0.00	6.30	0.00	6.18	6.18
6.75	6.90	8.46	-1.05	5.76	0.00	5.76	0.00	5.65	5.65
7	7.14	8.66	-1.08	5.26	0.00	5.26	0.00	5.16	5.16
7.25	7.39	8.86	-1.10	4.80	0.00	4.80	0.00	4.70	4.70
7.5	7.63	9.07	-1.10	4.38	0.00	4.38	0.00	4.29	4.29
7.75	7.88	9.28	-1.09	3.99	0.00	3.99	0.00	3.91	3.91
8	8.12	9.49	-1.08	3.63	0.00	3.63	0.00	3.56	3.56
8.25	8.37	9.70	-1.06	3.31	0.00	3.31	0.00	3.25	3.25
8.5	8.62	9.91	-1.04	3.02	0.00	3.02	0.00	2.96	2.96
8.75	8.86	10.13	-1.02	2.75	0.00	2.75	0.00	2.69	2.69
9	9.11	10.34	-1.00	2.50	0.00	2.50	0.00	2.45	2.45
9.25	9.36	10.56	-0.97	2.28	0.00	2.28	0.00	2.23	2.23
9.5	9.60	10.78	-0.94	2.07	0.00	2.07	0.00	2.03	2.03
9.75	9.85	11.00	-0.92	1.89	0.00	1.89	0.00	1.85	1.85
10	10.10	11.22	-0.89	1.72	0.00	1.72	0.00	1.68	1.68
10.25	10.35	11.45	-0.86	1.56	0.00	1.56	0.00	1.53	1.53

Z (ft)	F horiz. (lbs.)	Induced moment (ft - lb)	1.7 Mo (ft - lb)	Total Factored driving moment (ft - lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)
0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.5	58.98	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1
1	47.73	29.5	50	58.7	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	58.7
1.5	37.67	82.9	141	169.9	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	169.9
2	29.71	155.0	264	332.4	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	332.4
2.5	19.33	242.1	412	546.0	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	546.0
3	13.65	338.8	576	808.3	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	808.3
3.5	10.29	442.3	752	1120.9	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	1120.9
4	8.07	551.0	937	1487.4	0.5	0.10	0.05	0.03	0.02	0.0	39.4	7.9	0.8	8.7	1478.7
4.5	6.46	663.7	1128	1912.4	1.0	0.20	0.10	0.11	0.08	0.0	79.3	31.8	6.3	38.1	1874.2
5	5.23	779.7	1325	2400.9	1.5	0.30	0.15	0.24	0.18	0.0	120.0	72.5	21.7	94.3	2306.7
5.5	4.37	898.3	1527	2958.4	2.0	0.41	0.21	0.44	0.33	0.0	162.0	131.5	53.1	184.6	2773.9
6	3.69	1019.0	1732	3590.6	2.5	0.52	0.26	0.70	0.52	0.0	206.2	211.0	108.1	319.1	3271.5
6.5	3.09	1141.6	1941	4303.4	3.0	0.64	0.32	1.05	0.78	0.0	253.4	315.0	197.8	512.8	3790.6
7	2.58	1265.7	2152	5102.7	3.5	0.78	0.39	1.50	1.11	0.0	305.3	450.2	339.2	789.5	4313.3
7.5	2.15	1391.2	2365	5994.5	4.0	0.93	0.46	2.10	1.55	0.0	365.1	630.0	564.4	1194.4	4800.1
8	1.79	1517.7	2580	6985.0	4.5	1.12	0.56	2.96	2.16	0.0	440.9	888.5	952.4	1840.8	5144.1
8.5	1.48	1645.0	2797	8080.2	5.0	1.57	0.79	5.25	3.71	0.0	618.5	1575.0	2296.1	3871.1	4209.1
9	1.23	1773.2	3014	9286.3	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9286.3
9.5	1.02	1901.9	3233	10609.7	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	10609.7
10	0.84	2031.2	3453	12056.5	0.0	0.00	.0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	12056.5

Gunite Pool Design

Soil Parameters

Gamma: 120
phi: 32
radians: 0.558
c: 0
Ka: 0.3073

Point Loading

Q (lbs): 2000
Poisson: 0.3
X 1: 1
X 2: 5
Y: 0

r 1 = 1.00
r 2 = 5.00

Resisting moments:

Radius: 5
Z to CTR : 3.5
Unit wt. concrete: 150

Pool Depth = 8.5

Z (ft)	Geostatic Moment (ft - lb)	Factored Moment (1.4 Mo)
0	0.0	0
0.5	0.8	1
1	6.1	9
1.5	20.7	29
2	49.2	69
2.5	96.0	134
3	165.9	232
3.5	263.5	369
4	393.3	551
4.5	560.0	784
5	768.2	1075
5.5	1022.4	1431
6	1327.4	1858
6.5	1687.7	2363
7	2107.8	2951
7.5	2592.6	3630
8	3146.4	4405
8.5	3774.0	5284
9	4479.9	6272
9.5	5268.8	7376
10	6145.3	8603
10.5	7114.0	9960

Z (ft)	R 1 (ft)	R 2 (ft)	sigma r 1 (psf)	sigma r 2 (psf)	Corrected sigma r 1	Corrected sigma r 2	sigma h 1 (psf)	sigma h 2 (psf)	sigma h total (psf)
0	1.00	5.00	0.00	0.00	0	0	0	0	0
0.25	1.03	5.01	217.43	-5.88	217.43	0.00	217.43	0.00	217.43
0.5	1.12	5.02	405.87	-1.72	405.87	0.00	405.87	0.00	405.87
0.75	1.25	5.06	367.51	2.16	367.51	2.16	367.51	2.16	369.67
1	1.41	5.10	263.03	5.66	263.03	5.66	263.03	5.66	268.70
1.25	1.60	5.15	171.32	8.70	171.32	8.70	171.32	8.70	180.01
1.5	1.80	5.22	107.68	11.22	107.68	11.22	107.68	11.22	118.90
1.75	2.02	5.30	66.92	13.21	66.92	13.21	66.92	13.21	80.13
2	2.24	5.39	41.45	14.68	41.45	14.68	41.45	14.68	56.13
2.25	2.46	5.48	25.54	15.67	25.54	15.67	25.54	15.67	41.21
2.5	2.69	5.59	15.52	16.23	15.52	16.23	15.52	16.23	31.76
2.75	2.93	5.71	9.15	16.42	9.15	16.42	9.15	16.42	25.57
3	3.16	5.83	5.05	16.31	5.05	16.31	5.05	16.31	21.36
3.25	3.40	5.96	2.39	15.94	2.39	15.94	2.39	15.94	18.33
3.5	3.64	6.10	0.66	15.39	0.66	15.39	0.66	15.39	16.05
3.75	3.88	6.25	-0.46	14.70	0.00	14.70	0.00	14.70	14.70
4	4.12	6.40	-1.19	13.92	0.00	13.92	0.00	13.92	13.92
4.25	4.37	6.56	-1.65	13.09	0.00	13.09	0.00	13.09	13.09
4.5	4.61	6.73	-1.94	12.23	0.00	12.23	0.00	12.23	12.23
4.75	4.85	6.90	-2.10	11.37	0.00	11.37	0.00	11.37	11.37
5	5.10	7.07	-2.17	10.52	0.00	10.52	0.00	10.52	10.52
5.25	5.34	7.25	-2.20	9.70	0.00	9.70	0.00	9.70	9.70
5.5	5.59	7.43	-2.18	8.92	0.00	8.92	0.00	8.92	8.92
5.75	5.84	7.62	-2.14	8.19	0.00	8.19	0.00	8.19	8.19
6	6.08	7.81	-2.09	7.50	0.00	7.50	0.00	7.50	7.50
6.25	6.33	8.00	-2.02	6.85	0.00	6.85	0.00	6.85	6.85
6.5	6.58	8.20	-1.95	6.26	0.00	6.26	0.00	6.26	6.26
6.75	6.82	8.40	-1.88	5.70	0.00	5.70	0.00	5.70	5.70
7	7.07	8.60	-1.80	5.20	0.00	5.20	0.00	5.20	5.20
7.25	7.32	8.81	-1.73	4.73	0.00	4.73	0.00	4.73	4.73
7.5	7.57	9.01	-1.66	4.31	0.00	4.31	0.00	4.31	4.31
7.75	7.81	9.22	-1.59	3.92	0.00	3.92	0.00	3.92	3.92
8	8.06	9.43	-1.52	3.56	0.00	3.56	0.00	3.56	3.56
8.25	8.31	9.65	-1.45	3.24	0.00	3.24	0.00	3.24	3.24
8.5	8.56	9.86	-1.39	2.95	0.00	2.95	0.00	2.95	2.95
8.75	8.81	10.08	-1.33	2.68	0.00	2.68	0.00	2.68	2.68
9	9.06	10.30	-1.28	2.43	0.00	2.43	0.00	2.43	2.43
9.25	9.30	10.51	-1.22	2.21	0.00	2.21	0.00	2.21	2.21
9.5	9.55	10.74	-1.17	2.01	0.00	2.01	0.00	2.01	2.01
9.75	9.80	10.96	-1.12	1.83	0.00	1.83	0.00	1.83	1.83
10	10.05	11.18	-1.08	1.66	0.00	1.66	0.00	1.66	1.66
10.25	10.30	11.40	-1.03	1.51	0.00	1.51	0.00	1.51	1.51

Z (ft)	F horiz. (lbs.)	Induced moment (ft - lb)	1.7 Mo (ft - lb)	Total Factored driving moment (ft - lb)	Z' 1 (ft)	Alpha 1 (radians)	Alpha 2 (radians)	Resisting Moment Arm 1 (ft)	Resisting Moment Arm 2 (ft)	W 1 (lbs.)	W 2 (lbs.)	Mr 1 (ft - lb)	Mr 2 (ft - lb)	Total Resisting Moment (ft - lb)	Net Moment (ft - lb)
0	0	0.0	0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.5	93.45	0.0	0	1.1	0.0	0.00	0.00	0.00	0.00	75.0	0.0	0.0	0.0	0.0	1.1
1	62.24	46.7	79	88.0	0.0	0.00	0.00	0.00	0.00	112.5	0.0	0.0	0.0	0.0	88.0
1.5	41.91	124.6	212	240.8	0.0	0.00	0.00	0.00	0.00	150.0	0.0	0.0	0.0	0.0	240.8
2	29.20	223.4	380	448.6	0.0	0.00	0.00	0.00	0.00	187.5	0.0	0.0	0.0	0.0	448.6
2.5	16.29	336.8	573	707.0	0.0	0.00	0.00	0.00	0.00	225.0	0.0	0.0	0.0	0.0	707.0
3	10.83	458.3	779	1011.4	0.0	0.00	0.00	0.00	0.00	262.5	0.0	0.0	0.0	0.0	1011.4
3.5	8.14	585.3	995	1363.9	0.0	0.00	0.00	0.00	0.00	300.0	0.0	0.0	0.0	0.0	1363.9
4	6.95	716.3	1218	1768.4	0.5	0.10	0.05	0.03	0.02	0.0	39.4	7.9	0.8	8.7	1759.7
4.5	6.11	850.8	1446	2230.4	1.0	0.20	0.10	0.11	0.08	0.0	79.3	31.8	6.3	38.1	2192.3
5	5.26	988.4	1680	2755.7	1.5	0.30	0.15	0.24	0.18	0.0	120.0	72.5	21.7	94.3	2661.4
5.5	4.47	1128.6	1919	3350.0	2.0	0.41	0.21	0.44	0.33	0.0	162.0	131.5	53.1	184.6	3165.4
6	3.75	1271.0	2161	4019.1	2.5	0.52	0.26	0.70	0.52	0.0	206.2	211.0	108.1	319.1	3699.9
6.5	3.13	1415.3	2406	4768.8	3.0	0.64	0.32	1.05	0.78	0.0	253.4	315.0	197.8	512.8	4256.0
7	2.60	1561.2	2654	5605.0	3.5	0.78	0.39	1.50	1.11	0.0	305.3	450.2	339.2	789.5	4815.6
7.5	2.16	1708.4	2904	6533.8	4.0	0.93	0.46	2.10	1.55	0.0	365.1	630.0	564.4	1194.4	5339.4
8	1.79	1856.6	3156	7561.2	4.5	1.12	0.56	2.96	2.16	0.0	440.9	888.5	952.4	1840.8	5720.4
8.5	1.48	2005.8	3410	8693.4	5.0	1.57	0.79	5.25	3.71	0.0	618.5	1575.0	2296.1	3871.1	4822.3
9	1.22	2155.7	3665	9936.5	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	9936.5
9.5	1.01	2306.2	3920	11296.8	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	11296.8
10	0.83	2457.2	4177	12780.6	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	12780.6

APPENDIX G

6 EARTH PRESSURES

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Design of earth-retaining structures requires knowledge of the earth and water loads that will be exerted on them. The first methods for determination of earth loads acting on retaining structures were developed in the eighteenth and nineteenth centuries by Coulomb and Rankine. These were based on idealized concepts where the retaining structure is rigid and moves as a unit. Also, the soil that loads the wall is assumed to be "wished in place," and to undergo systematic, prescribed failure patterns as the wall displaces. These assumptions ignore the true effects of soil–structure interaction, and the processes of construction of the system. Nonetheless, the Coulomb and Rankine methods provide simple and reasonably accurate means for estimating earth loads, and remain useful tools today.

During this century, new, and often complex retaining structures have been developed. These structures lead to questions about the effects of variable system flexibility, and alternative forms of rigid body rotation relative to simpler structures. The result is a redistribution of earth loads from the more flexible to the stiffer portions of the system, and other forms of stress transfer. In spite of the complexity of the actual problems, design solutions to predict earth pressures for the new structures have tended to be based on empirical modifications of the Rankine and Coulomb theories.

Examples of common earth-retaining structures are shown in Figure 6.1. The simplest form is the gravity wall, which has enough rigidity to avoid bending deformations but which can, and typically does, move as a unit. Flexible walls such as the bulkhead or the excavation support wall undergo bending deformations such that the earth pressures are described according to the relative flexibilities within the system. Buried structures such as the U-frame lock or the culvert bring into play vertical earth loads as well as lateral earth pressures. Internal earth pressures are important to cofferdams and silos, systems that confine earth within the structure. Finally, there are the "self-contained" earth-retention structures of the reinforced-earth type, which are acted upon by internal and external earth loads.

Most conventional methods for predicting earth pressures produce a diagram with a linear or some slightly more complicated regular geometric shape. In actuality, we know from physical measurements and recent numerical computations that even in the case of the simplest structure, earth pressure distributions are not linear (Handy, 1985; Clough and Duncan, 1971). However, for design purposes, geometrically uncomplicated shapes are preferred in the interest of ease of calculations. The development of such diagrams usually incorporates an attempt to build in a degree of conservatism, and leads to the neglect of certain parts of the problem in the interest of simplicity. Over time, the use of such diagrams often leads to a lack of understanding of the principles used to develop them. Further, the overlapping of factors of safety used on the geotechnical side, combined with those used in the structural side, blurs the specific role of important parameters. In many cases our present practice leads to designs that are conservative, but there are instances where they can be unconservative. Thus, we arrive at the incongruous situation where we have earth-retaining structures standing that in theory should fail, or we have structures failing, usually owing to excessive deformation, that in theory should not fail. In this chapter we will take the approach that we are concerned primarily with practical design, but that we also need to understand the fundamentals of the earth pressure problem for improved design. In the period since the first edition of this handbook was published, new developments have been made, and we will attempt to integrate these into the basic approach where appropriate.

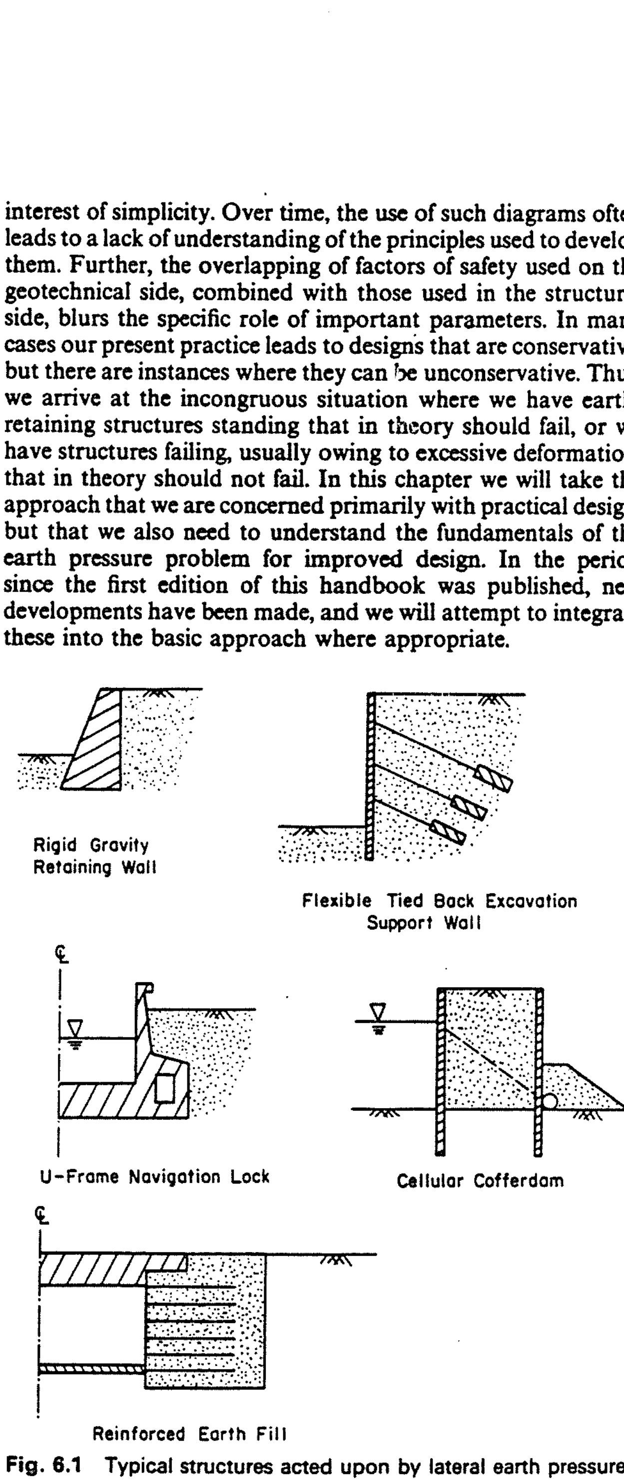


Fig. 6.1 Typical structures acted upon by lateral earth pressures.

6.1 AT-REST LATERAL PRESSURES

At-rest pressures exist in level ground, and develop under long-term conditions as the soil is deposited and acted upon by changes in the loading environment as caused by erosion, glaciers, and physicochemical processes. At-rest pressures rigorously only apply for walls that are placed into the ground with a minimum of disturbance and that remain unmoved during loading, or for unmoving, frictionless walls with a backfill placed with a minimum of compactive effort. In practice such conditions are rarely achieved. However, at-rest pressures are still useful in design as either a baseline against which other pressure states can be judged or as an assumed conservative choice for the design loading.

At-rest effective lateral pressures are often assumed to follow a linear distribution (Fig. 6.2), with the effective lateral pressure σ'_x taken as a simple multiple of the vertical effective pressure σ'_z:

$$\sigma'_x = K_0(\sigma'_z) \tag{6.1}$$

In homogeneous, dry soil with a constant K_0 and unit weight, both the vertical and lateral pressures are linearly distributed. With the presence of a water table, the at-rest pressure distribution exhibits a break in slope at the water table, reflecting the use of submerged unit weights to determine vertical effective stresses (Fig. 6.2).

Our early concepts of the parameter K_0 were formed on the basis of normally consolidated soils. Jaky (1944) proposed a relationship between K_0 and the drained friction angle ϕ' for normally consolidated soils:

$$K_0 = 1 - \sin\phi' \tag{6.2}$$

Numerous studies have confirmed the general validity of this empirical equation (Brooker and Ireland, 1965; Mayne and Kulhawy, 1982). However, results from laboratory experiments and in-situ tests have shown that the K_0 value also varies as a function of overconsolidation ratio (OCR) and stress history. For the case of a soil that has been subjected to one or more cycles of unloading, Schmidt (1966) proposed that K_0 can be determined as a function of its value in the normally consolidated state using the relationship

$$K_{0u} = K_{0nc}(\text{OCR})^{\alpha} \tag{6.3}$$

in which K_{0u} is the coefficient for unloading, K_{0nc} is the coefficient for the normally consolidated soil, and α is a dimensionless coefficient. Experimental data have confirmed this relationship, and Mayne and Kulhawy (1982) showed that, for most soils, α can be taken as $\sin\phi'$.

Soils that are overconsolidated and are in the process of being reloaded pose a difficulty in that Equation 6.3 does not apply. For this condition, a more complex equation is needed as well as a full knowledge of the stress history of the soil (Mayne and Kulhawy, 1982). For practical purposes, it may be enough to know that the K_0 during reloading falls about halfway between that for unloading and normally consolidated conditions. Also, K_0 might be directly determined through in-situ testing methods.

TABLE 6.1 TYPICAL COEFFICIENTS OF LATERAL EARTH PRESSURE AT REST.

	Coefficient of Lateral Earth Pressure			
Soil type	*OCR = 1*	*OCR = 2*[a]	*OCR = 5*[a]	*OCR = 10*[a]
Loose sand	0.45	0.65	1.10	1.50
Medium sand	0.40	0.60	1.05	1.55
Dense sand	0.35	0.55	1.00	1.50
Silt	0.50	0.70	1.10	1.60
Lean clay, CL	0.60	0.80	1.20	1.65
Highly plastic clay, CH	0.65	0.80	1.10	1.40

[a] Unloading cycle.

Table 6.1 presents typical values for K_0 for a subset of soils. For other conditions, K_0 values can be determined directly from Equations 6.2 and 6.3, and/or using in-situ testing techniques.

Because the K_0 value in a given soil often varies with depth, and the soil types themselves may change with depth, the at-rest lateral pressure distribution is typically not linear as shown in Figure 6.2. Self-boring pressuremeter tests in clays with overconsolidated profiles induced by desiccation have demonstrated that the K_0 under such conditions decreases with depth in the soil deposit and reaches a steady state where the desiccation effects are no longer present (Clough and Denby, 1980).

6.2 ACTIVE AND PASSIVE LATERAL EARTH PRESSURES

Most walls move, either by global shifting or by local deformations. These movements cause adjustments to occur in the earth loads and the pressure distributions. Conventional means for assessing the effects of system movements are to set them into the context of extreme conditions. These are referred to as the active and passive earth pressure loadings.

6.2.1 Active Pressure

Assuming that a gravity wall with no friction on its face is translated away from a soil mass that is initially at the at-rest condition, then the soil mass adjacent to the wall will pass into a failure state as shown in Figure 6.3. At this stage, the

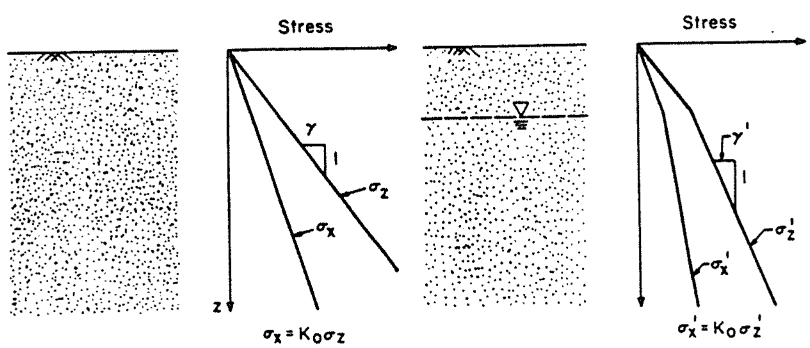


Fig. 6.2 At-rest earth pressure distribution—homogeneous soil.

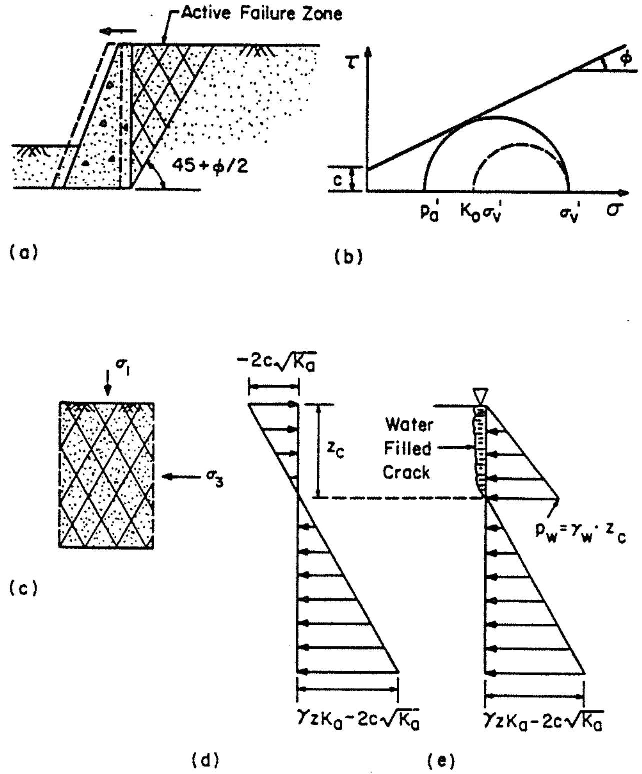


Fig. 6.3 Active pressure—frictionless wall. (a) Frictionless wall moves away from backfill. (b) Stress state in active failure. (c) Active failure zone. (d) Theoretical active pressure distribution. (e) Water-filled crack in tension zone.

soil fails with the vertical stress unchanged from its original value, but with the lateral pressure decreased to a minimum value that can be defined using the Mohr–Coulomb failure criterion. The minimum lateral pressure is known as the active pressure, and denoted by the symbol p_a. It is desirable to reach this condition if possible, since it reduces the amount of load that the wall will have to carry while allowing the soil to share in the load-bearing process.

For the frictionless wall with a level backfill, the active pressure can be calculated from the geometry of the Mohr diagram in Figure 6.3 by the equation

$$p_a = k_a \gamma z - 2c\sqrt{k_a} \tag{6.4}$$

where $k_a = \tan^2(45° - \phi/2)$, and is referred to as the active pressure coefficient. Other terms are γ, the unit weight; ϕ, the friction angle; c, the cohesion; and z, the depth below the ground surface. The distribution of active pressure as shown in Figure 6.3 is linear. If the soil has a cohesion component, the soil is in a state of tension of a depth of $2c/\gamma\sqrt{k_a}$. Ordinarily, it should not be assumed that this portion of the diagram will act on a wall, but rather that a tension crack will form to this depth, and fill with water, which then exerts a positive pressure on the wall.

Equivalent Fluid Unit Weight If the backfill is composed of cohesionless soil, as is often the case, then the active earth pressure equation reduces to

$$p_a = k_a \gamma z \tag{6.5}$$

This can also be written as:

$$p_a = \gamma_{eq} z \tag{6.6}$$

where the term γ_{eq} is known as the equivalent fluid unit weight for active pressure loading, and equals $k_a\gamma$. This term is often used in design, and it should be realized in using it that the simplifying assumptions used in the derivations of this point are also incorporated in the equivalent fluid unit weight concept.

Surcharge and Nonhomogeneous Conditions Design conditions often call for incorporation of a surcharge on the ground surface adjacent to the wall. In the case of a frictionless wall, the active pressure due to soil weight and surcharge, as shown in Figure 6.4, can be calculated using the equation

$$p_a = k_a(\gamma z + q_s) \tag{6.7}$$

where q_s is the surcharge pressure.

Where a water table is situated above the bottom of the wall, or the soil involved is nonhomogeneous, Equations 6.4 and 6.7 can be used if the proper allowance is made for the submergence effect and the changing properties for the soil layers. Figure 6.5 illustrates these considerations for cohesionless soil.

Force Polygon Solution for Active Loadings The equations presented to this point are limited to consideration of relatively simple conditions. More complex conditions can be included using a force polygon analysis based on assumed kinematic failure mechanisms developing in the soil. One of the more important conditions that can be considered in this way is the case of friction developing between the wall and the soil as a result of relative movements between them. Figure 6.6 illustrates this situation for the case of a wall translating away from a homogeneous soil.

Assuming a straight-line failure surface in the backfill as the wall moves away from the soil, the equilibrium of the soil wedge bounded by the wall and the backfill failure surface can be examined in the force polygon in Figure 6.6. The force E required to maintain equilibrium is exerted by the wall. In the most general situation, the critical value of the force between the wall and the soil is found by working with trial slopes of failure wedge until the maximum value of the stabilizing force E is obtained.

For relatively simple conditions where the soil backfill is level, and the wall face is vertical, the inclination of the failure surface in the soil that yields the minimum earth loading is $45° + \phi/2$ to the horizontal. Under these conditions, if wall friction is zero, then the kinematic force polygon procedure yields the same answer for the active load as Equation 6.4. If the wall friction is positive in the sense shown in Figure 6.6, then the active loading for most cases is slightly reduced from the case of no friction. More importantly, the vertical shear

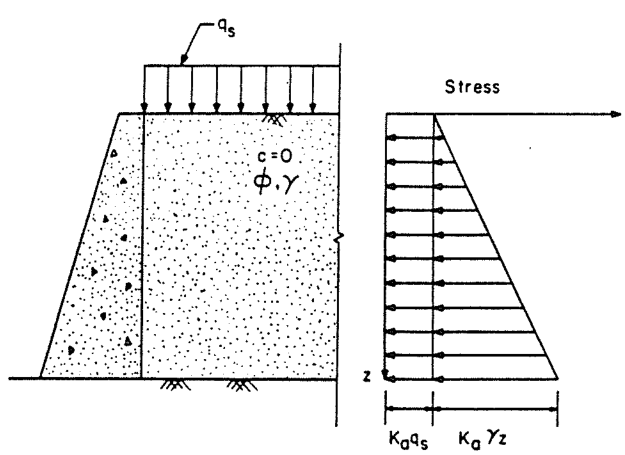


Fig. 6.4 Frictionless wall with surcharge.

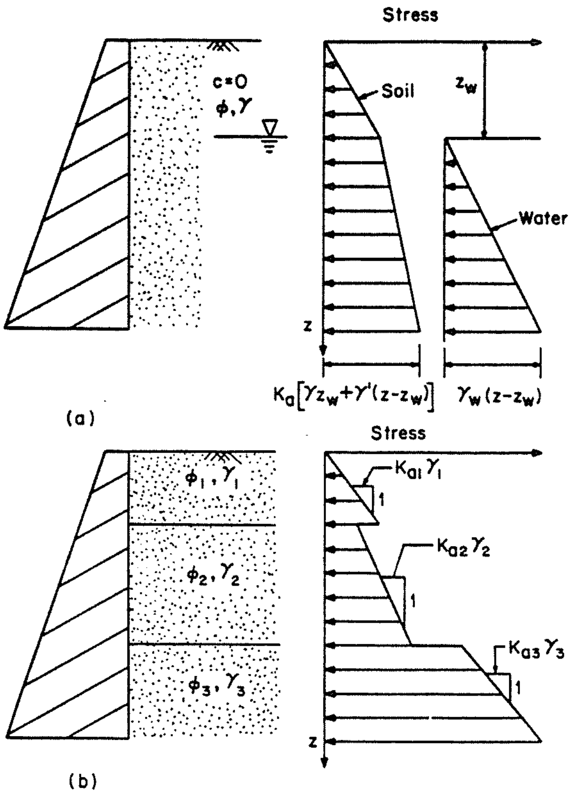


Fig. 6.5 Active pressures for frictionless wall in presence of groundwater table and nonhomogeneous soil conditions. (a) Groundwater table. (b) Nonhomogeneous cohesionless soil.

force that is generated helps to combat overturning and increases the resistance against sliding of the wall.

A general formula can be developed for active earth load acting on a wall for the case of a homogeneous soil backfill with arbitrary degrees of wall friction, wall slope, and backfill surface slope. Assuming that the failure surface in the backfill is a straight line, the formula is as shown in Figure 6.7. In the

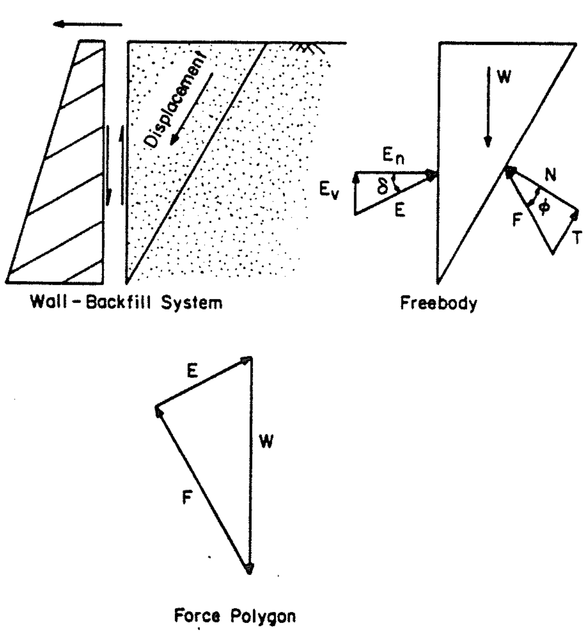
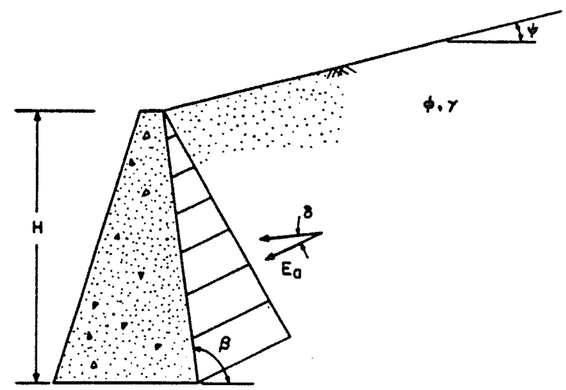


Fig. 6.6 Force polygon solution for active loading.



$$E_a = \frac{\gamma H^2}{2}\left\{\frac{\csc\beta\sin(\beta-\phi)}{\left[\sin(\beta+\delta)\right]+\left[\frac{\sin(\delta+\phi)\sin(\phi-\psi)}{\sin(\beta-\psi)}\right]}\right\}$$

Fig. 6.7 Closed-form solution for active earth loading, rough wall, sloping wall face, and backfill.

event of relatively complex backfill or wall geometries or surcharge conditions, then the exact failure surface that yields the minimum earth load can be found by a trial procedure. A number of references describe this process, and examples can be found in the original edition to this handbook.

Further Comments on Active Load Determinations The kinematic analysis in Figure 6.6 assumes that the failure surface is a straight line. In fact, in the most general case of a soil whose failure is governed by a Mohr–Coulomb criterion, and which has a friction component, the correct failure surface under active conditions consists of a log spiral, as shown in Figure 6.8. However, in the active state, the log-spiral shape is reasonably approximated by a straight line, and the resultant load predicted using the simple straight-line failure mechanism is within 10 percent of that obtained with the more exact log-spiral mechanism.

Table 6.2 presents values for the active pressure coefficient that allow calculation of the active loading resultant as shown for conditions where wall friction, sloping backfill, and a sloping wall face exist. These coefficients are based on the log-spiral failure surface assumption. A graphical format for the active pressure coefficient from the log-spiral analysis that is useful for many practical problems is given in Figure 6.9. It assumes a vertical wall face and horizontal backfill. For conditions encountered that deviate from those described in Table 6.2 or in Figure 6.9, the trial procedure can be used assuming straight-line failure surfaces in the soil.

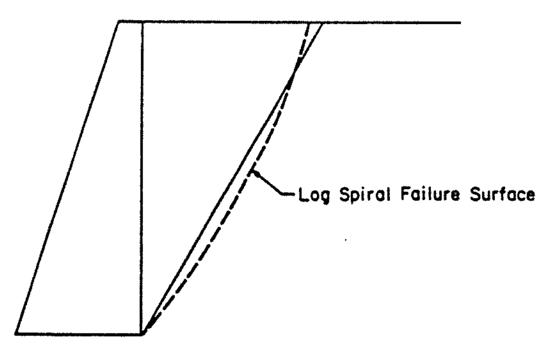
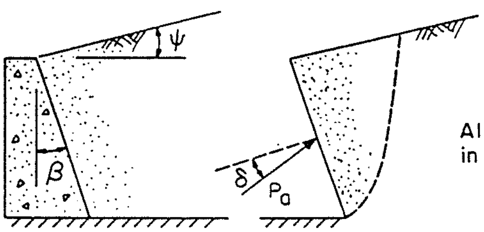


Fig. 6.8 Comparison of log-spiral and straight-line failure surfaces for active conditions.

TABLE 6.2 VALUES OF k_a FOR LOG SPIRAL FAILURE SURFACE.

δ, deg	ψ, deg	β, deg	ϕ, deg 20	25	30	35	40	45
		−10	0.37	0.30	0.24	0.19	0.14	0.11
	−15	0	0.42	0.35	0.29	0.24	0.19	0.16
		10	0.45	0.39	0.34	0.29	0.24	0.21
		−10	0.42	0.34	0.27	0.21	0.16	0.12
0	0	0	0.49	0.41	0.33	0.27	0.22	0.17
		10	0.55	0.47	0.40	0.34	0.28	0.24
		−10	0.55	0.41	0.32	0.23	0.17	0.13
	15	0	0.65	0.51	0.41	0.32	0.25	0.20
		10	0.75	0.60	0.49	0.41	0.34	0.28
		−10	0.31	0.26	0.21	0.17	0.14	0.11
	−15	0	0.37	0.31	0.26	0.23	0.19	0.17
		10	0.41	0.36	0.31	0.27	0.25	0.23
		−10	0.37	0.30	0.24	0.19	0.15	0.12
$\phi°$	0	0	0.44	0.37	0.30	0.26	0.22	0.19
		10	0.50	0.43	0.38	0.33	0.30	0.26
		−10	0.50	0.37	0.29	0.22	0.17	0.14
	15	0	0.61	0.48	0.37	0.32	0.25	0.21
		10	0.72	0.58	0.46	0.42	0.35	0.31

*After Caquot and Kerisel (1948).



6.2.2 Passive Pressures

Passive pressure conditions develop where a structure is forced into a soil mass. This situation is most commonly associated with the soil located on the opposite side of the wall from the backfill (Fig. 6.10). Assuming that a frictionless wall is forced into a soil mass that is originally at-rest, the end result will be that a portion of the soil mass will pass into a passive failure condition as shown in Figure 6.11. The soil fails with the vertical stress unchanged from its original value, but with the horizontal stress increased to a maximum value as defined by the Mohr–Coulomb failure criterion. The maximum pressure is denoted by the symbol p_p, and it is defined from the geometry of the Mohr diagram in Figure 6.10 by the equation

$$p_p = \gamma z k_p + 2c\sqrt{k_p} \tag{6.8}$$

where k_p is the passive pressure coefficient, and can be expressed as follows:

$$k_p = \tan^2\left(45° + \frac{\phi}{2}\right) \tag{6.9}$$

In Figure 6.10, the passive pressure distribution defined by Equation 6.8 is shown to be linear, and in compression throughout.

A uniform surcharge for cohesionless soils can be incorporated into Equation 6.8 in the form

$$p_p = k_p(\gamma z + q_s) \tag{6.10}$$

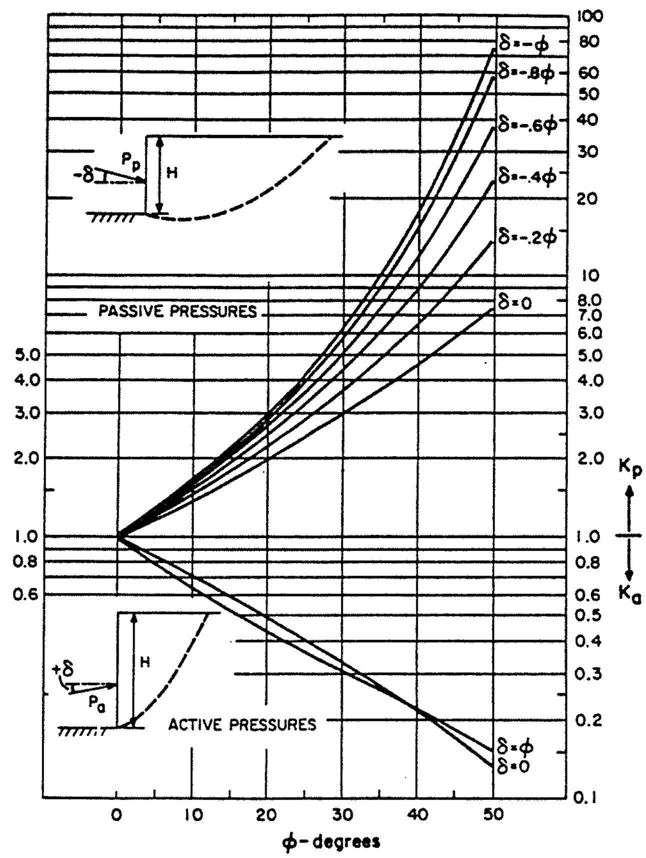


Fig. 6.9 Active and passive pressure coefficients for vertical wall and horizontal backfill, based on log-spiral failure surfaces. (*After Caquot and Kerisel, 1948.*)

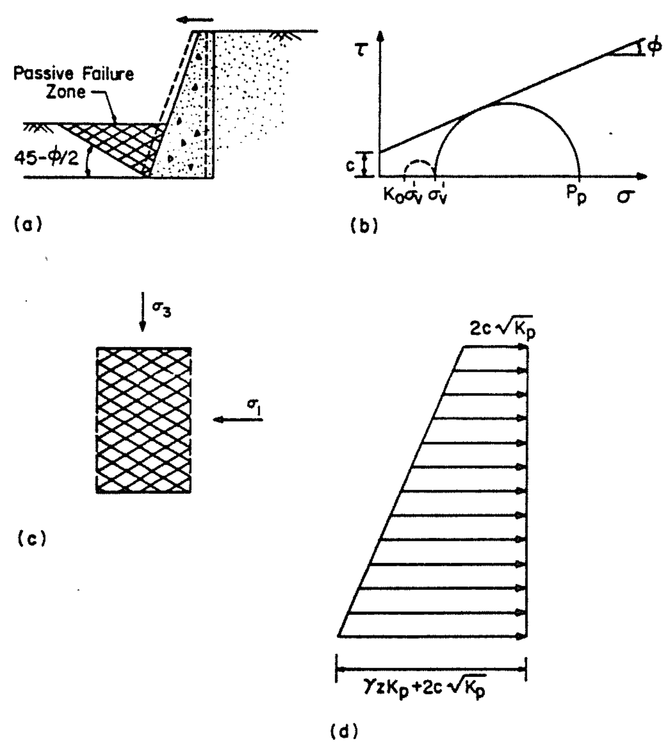


Fig. 6.10 Passive pressure—active wall. (a) Frictionless wall moves into soil. (b) Stress state in passive failure. (c) Passive failure zone. (d) Theoretical pressure distribution.

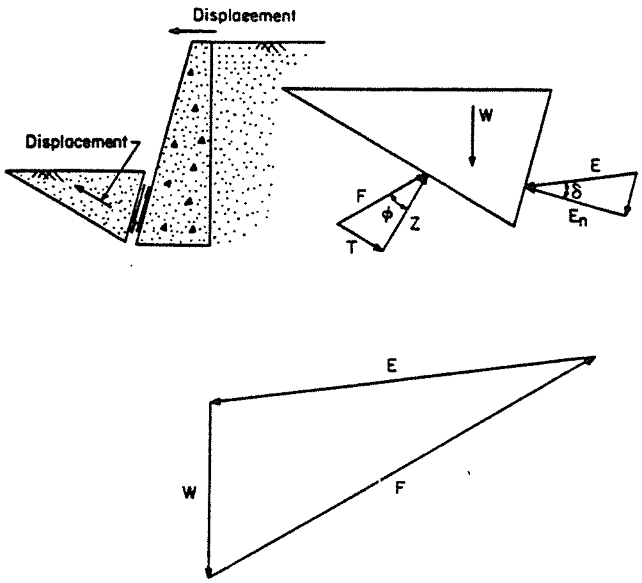


Fig. 6.11 Force polygon solution for passive conditions.

Force Polygon Solution For Passive Loads The flexibility of the force polygon solution for the active loading cases was seen earlier. This solution allows accommodation of the effects of wall friction, sloping wall faces, sloping soil surfaces, and other factors. A similar approach can be used for the passive case, as illustrated in Figure 6.11, using the assumption that the failure surfaces in the soil for the passive state are straight lines. However, except for the case of a frictionless wall, the actual failure surface for passive failure is markedly nonlinear, and is displaced well below the most critical plane failure surface (Fig. 6.12). As a result, the passive resistances calculated using the straight line can be much higher than those calculated using log-spiral surfaces, and should not be used for values of wall friction angle (δ) greater than half of ϕ.

General Comments on Passive Load Determinations Table 6.3 presents passive pressure coefficients that are derived from analyses with log-spiral surfaces. The table allows passive loads to be determined for a range of wall friction angles, wall slopes, and backfill slopes. Figure 6.9 also includes passive pressure coefficients based on the log-spiral theory in the simplified condition of vertical wall face and horizontal backfill.

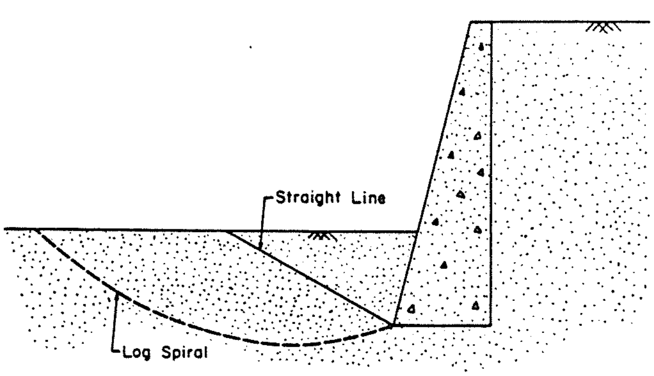
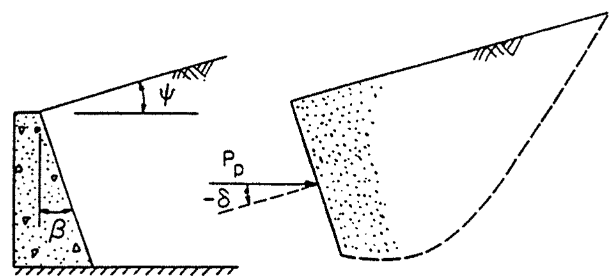


Fig. 6.12 Comparison of straight-line and log-spiral failure surfaces for passive conditions.

TABLE 6.3 VALUES OF k_p FOR LOG-SPIRAL FAILURE SURFACE.

δ, deg	ψ, deg	β, deg	ϕ, deg 20	25	30	35	40	45
		−10	1.32	1.66	2.05	2.52	3.09	3.95
	−15	0	1.09	1.33	1.56	1.82	2.09	2.48
		10	0.87	1.03	1.17	1.30	1.33	1.54
		−10	2.33	2.96	3.82	5.00	6.68	9.20
0	0	0	2.04	2.46	3.00	3.69	4.59	5.83
		10	1.74	1.89	2.33	2.70	3.14	3.69
		−10	3.36	4.56	6.30	8.98	12.2	20.0
	15	0	2.99	3.86	5.04	6.72	10.4	12.8
		10	2.63	3.23	3.97	4.98	6.37	8.2
		−10	1.95	2.90	4.39	6.97	11.8	22.7
	−15	0	1.62	2.31	3.35	5.04	7.99	14.3
		10	1.29	1.79	2.50	3.58	5.09	8.86
		−10	3.45	5.17	8.17	13.8	25.5	52.9
$-\phi°$	0	0	3.01	4.29	6.42	10.2	17.5	33.5
		−10	2.57	3.50	4.98	7.47	12.0	21.2
		−10	4.95	7.95	13.5	24.8	50.4	11.5
	15	0	4.42	6.72	10.8	18.6	39.6	73.6
		10	3.88	5.62	8.51	13.8	24.3	46.9

[a] After Caquot and Kerisel (1948).



6.3 SOIL–STRUCTURE INTERACTION FOR UNMOVING WALLS

Conventional thought has it that when at-rest earth pressures are assumed to act on a wall, then there is no need to consider the possibility of wall-to-soil shear, or downdrag. In fact, downdrag will naturally develop in certain situations, one of the more prominent being when backfill is placed in layers behind a wall. During placement, the soil will settle relative to the wall under its own weight, and mobilize a downdrag force. This force will act to stabilize the wall in that it resists overturning, and it adds to the normal force acting on the base of the wall, helping to prevent sliding of the wall. The role of the downdrag force is important because, for many problems, the designer conservatively assumes at-rest pressures as the lateral loading, and then neglects the downdrag force. Thus, a double factor of safety is added into the design, leading to excessive conservatism. This helps explain why many existing walls stand when theoretical analyses suggest they should fail.

The amount of the downdrag force that actually develops is a function of the friction between the wall and the soil. Typically, the friction force is mobilized with very small movements. Consideration should be given to the effects that such a force will have on wall safety, when assessment is made of the degree of conservatism to be used in design of new structures or evaluation of the safety of existing structures.

6.4 EARTH PRESSURES DUE TO SURFACE LOADS

Vertical loads on the surface of the ground increase both the vertical and lateral pressures in the ground. Loads on the backfill surface near an earth-retaining structure cause increased earth pressures on the structure.

6.4.1 Uniform Surcharge Loads

A uniform surcharge pressure applied to the ground surface over a large area causes a uniform increase in vertical pressure of the same amount,

$$\Delta p_v = q_s \tag{6.11}$$

in which Δp_v = increase in vertical pressure due to surcharge, and q_s = surcharge pressure. The surcharge pressure also causes an increase in lateral pressure,

$$\Delta p_h = kq_s \tag{6.12}$$

in which Δp_h = increase in horizontal pressure due to surcharge, and k is an earth pressure coefficient. For active earth pressure conditions, $k = k_a$; for at-rest conditions, $k = k_0$; and for passive earth pressure conditions, $k = k_p$.

Owing to the fact that the surcharge loading is applied over a large area (theoretically, an infinitely large area) both the vertical pressure due to the surcharge (Eq. 6.11) and the horizontal pressure due to the surcharge (Eq. 6.12) are constant at all depths.

6.4.2 Point Loads, Line Loads, and Strip Loads

When the surface loading is not uniform, or does not act over a large area, more complex calculations are needed to estimate the magnitude of the induced lateral stresses. As shown in Figure 6.13, the horizontal pressure induced by a vertical point load varies with depth and distance along the wall.

Although exact solutions to the problem shown in Figure 6.13 have not been developed, a simple approximation has been found that is accurate enough for practical purposes. Boussinesq developed expressions for the stresses induced within an elastic mass by a point load acting on the surface. According to this solution, the horizontal stress can be expressed as

RADIAL STRESS

$$\Delta p_h = \frac{Q}{2\pi R^2}\left[\frac{3zr^2}{R^3} - \frac{R(1-2\nu)}{R+z}\right] \tag{6.13}$$

in which Q = the magnitude of the point load, expressed in units of force; $R^2 = x^2 + y^2 + z^2$; $r^2 = x^2 + y^2$; x and y are horizontal distances from the load to the stress point; z = depth of stress point below surface; and ν = Poisson's ratio.

Boussinesq's solution can be used to develop an expression for the horizontal stress on a wall due to point load on the surface if two simplifying assumptions are made: (1) the wall does not move, and (2) the wall is perfectly smooth (there is no shear stress between the wall and the soil). Under these conditions the stress induced on the wall would be the same as the stress induced in an elastic half-space by two loads of equal magnitude situated as shown in Figure 6.14. The second load (called the image or imaginary load) would cause equal and opposite normal displacements on a plane midway between it and the real load, thus enforcing the zero-horizontal-displacement boundary condition at the wall. Thus, the horizontal pressures on the wall are twice as large as the horizontal stress induced in an elastic half-space, and can be calculated from the expression

wrong

$$\Delta p_h = \frac{Q}{\pi R^2}\left[\frac{3zx^2}{R^3} - \frac{R(1-2\nu)}{R+z}\right] \tag{6.14}$$

in which x = horizontal distance from load to wall, $y = 0$, and the other terms are as defined for Equation 6.13.

Spangler (1938) and Terzaghi (1954) performed experiments to compare measured and calculated pressures on walls due to point loads. These experiments confirmed the fact that doubling the free-field stress (i.e., using the stress calculated from Equation 6.14), provides a good approximation to measured values of earth pressures on walls.

The same procedure has been used to develop expressions for stresses due to line loads and strip loads. For an infinitely

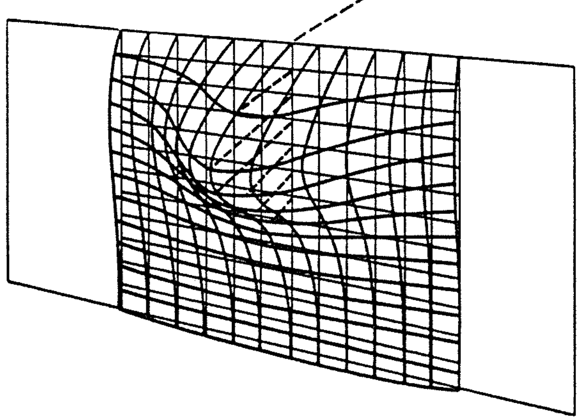


Fig. 6.13 Earth pressure data due to a point load. (*After Spangler, 1938.*)

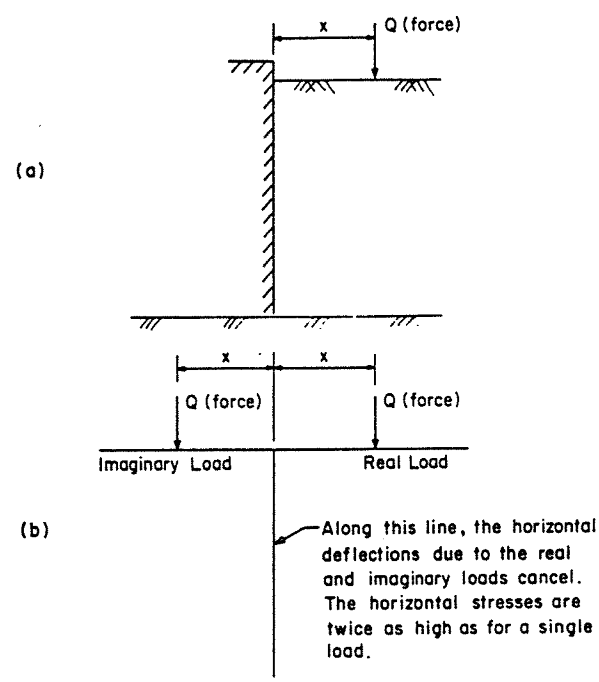


Fig. 6.14 Use of an imaginary load to enforce a zero-displacement condition at a wall. (a) A point load near a wall. (b) Two point loads on an elastic half-space.

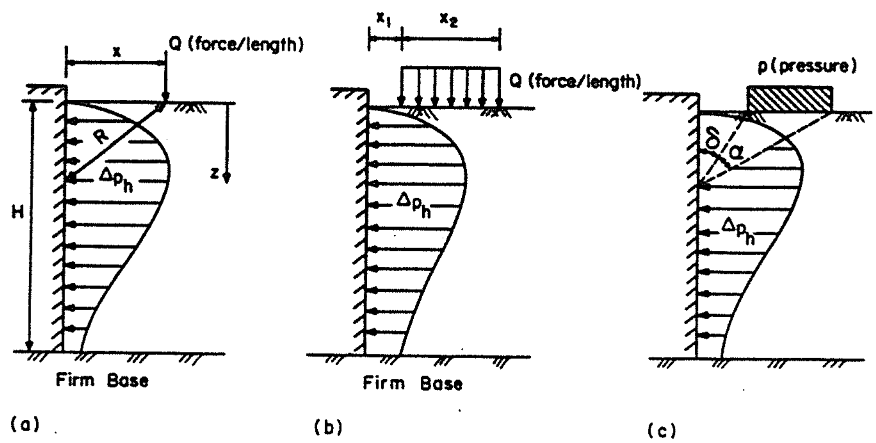


Fig. 6.15 Earth pressures due to line loads and strip loads. (a) Infinitely long line load parallel to wall. (b) Finite line load perpendicular to wall. (c) Uniformly loaded strip parallel to wall.

long line load parallel to the wall, as shown in Figure 6.15a, Scott (1963) developed the expression

$$\Delta p_h = \frac{4p}{\pi}\frac{x^2 z}{R^4} \tag{6.15}$$

in which p = magnitude of line load, x = distance from line load to wall, z = depth below surface, and $R^4 = x^4 + z^4$.

For a line load of finite length oriented perpendicular to a wall, as shown in Figure 6.15b, Peck and Mesri (1987) have derived the expression

$$\Delta p_h = \frac{Q}{\pi z}\left(\frac{1}{\left[1+\left(\frac{z}{x_2}\right)^2\right]^{3/2}} - \frac{1-2\nu}{\left[1+\left(\frac{z}{x_2}\right)^2\right]^{1/2}+\frac{z}{x_2}} - \frac{1}{\left[1+\left(\frac{z}{x_1}\right)^2\right]^{3/2}} + \frac{1-2\nu}{\left[1+\left(\frac{z}{x_1}\right)^2\right]^{1/2}+\frac{z}{x_1}}\right) \tag{6.16}$$

in which x_1 = distance from near end of line load to wall, x_2 = distance from far end of line load to wall, and the other terms are as defined previously.

Scott (1963) developed the following expression for the stress on a wall due to a vertically loaded strip of infinite length oriented parallel to a wall, as shown in Figure 6.15c:

$$\Delta p_h = \frac{2p}{\pi}[\alpha - \sin\alpha\cos(\alpha + 2\delta)] \tag{6.17}$$

in which α and δ are the angles shown in Figure 6.14c.

6.5 EARTH PRESSURES DUE TO COMPACTION

When compaction equipment moves across the backfill adjacent to a wall, it induces added earth pressures on the wall. These added pressures can be estimated using procedures described in the previous section. When the compaction equipment moves away, a portion of the added earth pressure continues to act on the wall owing to the inelastic behavior of the soil. The magnitudes of these residual horizontal earth pressures have been studied by Broms (1971), Broms and Ingleson (1971), Rehnman and Broms (1972), Coyle et al. (1974), Coyle et al. (1976), and Carder et al. (1977, 1980).

Duncan and Seed (1986) developed a procedure for estimating the magnitudes of residual earth pressures due to compaction. A typical distribution of these pressures with depth is shown in Figure 6.16. It can be seen that the residual earth pressure increases rapidly with depth in the upper 5 ft, and less rapidly at greater depths. At depths below about 25 ft in this particular example, there is no residual earth pressure due to compaction. Below about 25 ft the earth pressure is equal to the normal earth pressure at rest.

Williams et al. (1987) have used the analytical procedures developed by Duncan and Seed (1986) to develop earth pressure charts and tables of adjustment factors that can be used to make estimates of residual earth pressures due to compaction. These charts and tables make the computations easier, and they provide insight into the importance of the various factors that govern the magnitudes of compaction-induced earth pressures.

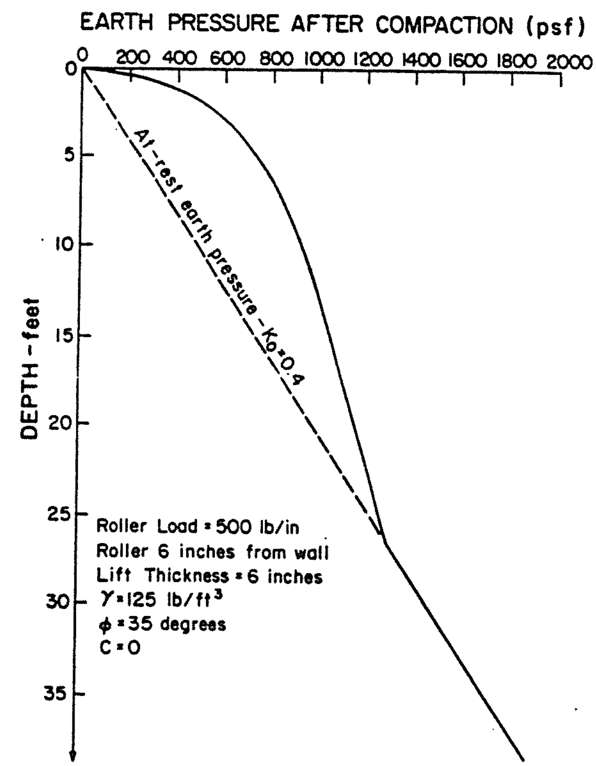


Fig. 6.16 Residual earth pressure after compaction of backfill behind an unyielding wall.

Charts for earth pressures due to compaction by rollers, vibratory plates, and rammers are shown in Figures 6.17, 6.18, and 6.19, respectively. The pressures in these figures were calculated using the procedures developed by Duncan and Seed (1986). The linear pressure variations in the lower parts of the diagrams correspond to various values of earth pressure at rest. To estimate the distribution of residual earth pressures following compaction using these charts, select the appropriate curve in the upper portion of the figure, and continue it until it meets the appropriate K_0 line. The resulting distribution has the form shown in Figure 6.16.

It may be seen that a number of parameter values were held constant in developing the design charts shown in Figures 6.17, 6.18, and 6.19. Variations in the values of these parameters have some influence on the calculated values of compaction-induced earth pressures. The effects of deviations from the standard values of these parameters can be taken into account through the adjustment factors in Tables 6.4 and 6.5. In cases where the actual conditions differ from those considered in developing the design charts, the earth pressures obtained from the charts are multiplied by correction factors from Table 6.4 or 6.5.

To illustrate the use of these earth pressure charts and correction factors, consider this example. Estimate the horizontal earth pressure at a depth of 5 ft below the surface after compaction in 6-in lifts by multiple passes of a Bomag BW 35 walk-behind vibratory roller. The static weight on one drum is 628 lb, and the centrifugal force on one drum is 2000 lb. The length of the drum is 15.4 inches. Thus $q = 2628/15.4 = 171$ lb/in.

From Figure 6.17, at a depth of 5.0 ft, find $p_h = 340$ psf. Adjustments must be made to this value, however, to account for the facts that: (1) the ϕ for the soil is 40° rather than the standard 35°, (2) the length of the roller is 15.4 inches rather than the standard 84 inches, and (3) the roller approaches within 0.2 ft of the wall rather than the standard 0.5 ft. The adjustment

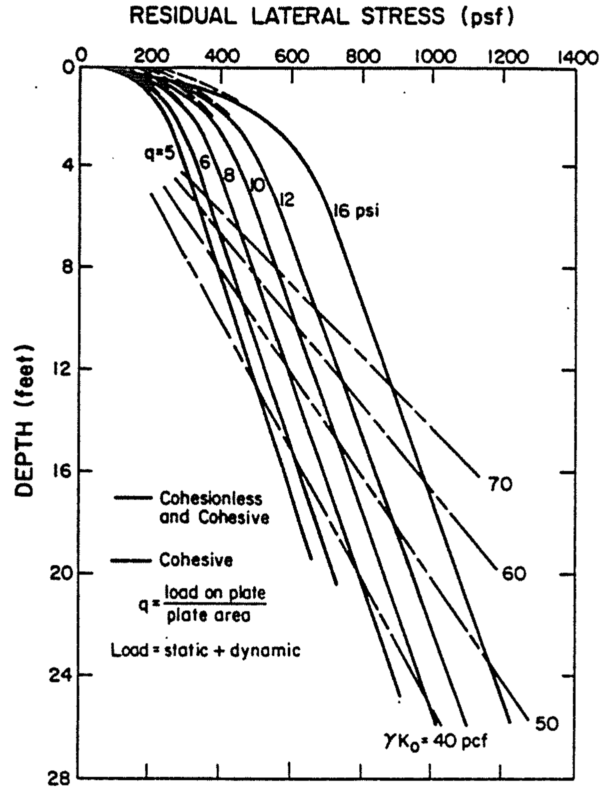


Fig. 6.18 Earth pressures due to compaction by vibratory plates.

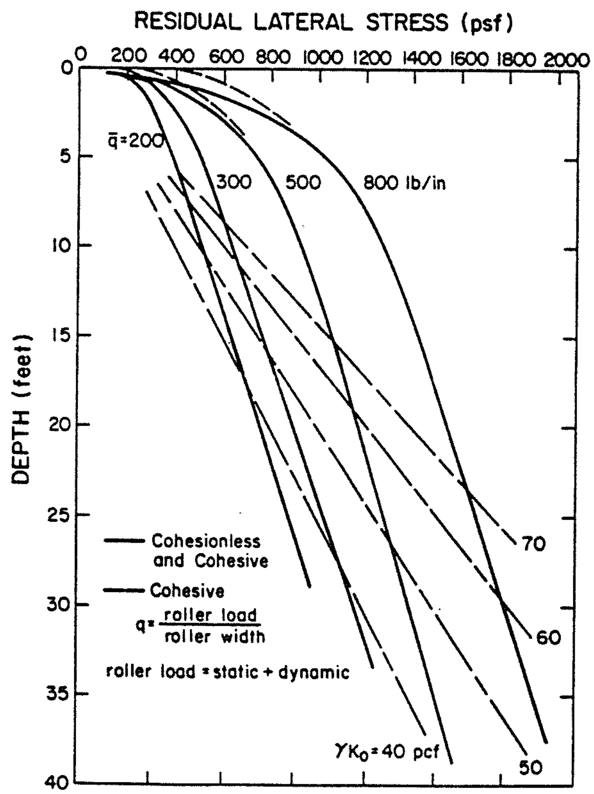


Fig. 6.17 Earth pressures due to compaction by rollers.

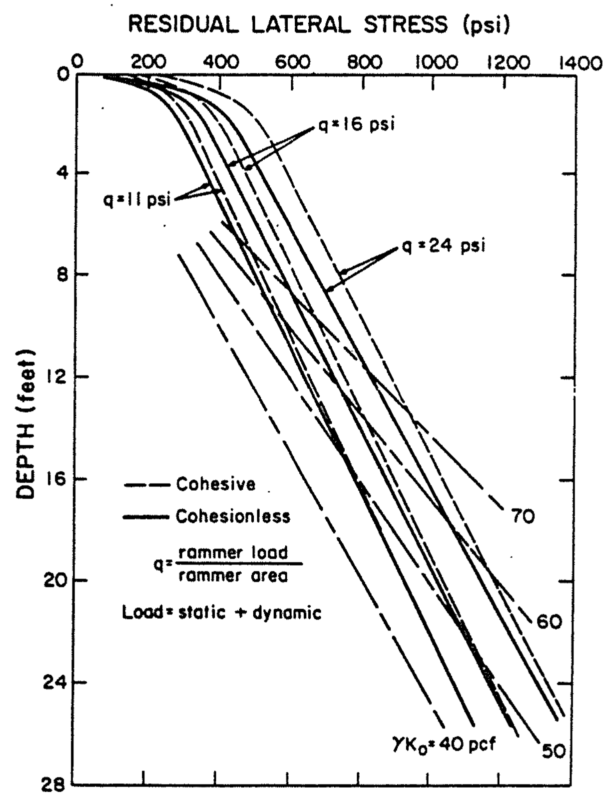


Fig. 6.19 Earth pressures due to compaction by rammer plates.

TABLE 6.4 ADJUSTMENT FACTORS FOR EARTH PRESSURES INDUCED BY COMPACTION WITH ROLLERS.

Variables			Multiplier Factors for z = 2 ft	4 ft	8 ft	16 ft
Lift thickness and distance from wall (x) (adjustments for these two factors are combined)	6-in lifts	$x = 0$	1.70	2.00	1.90	1.85
		$x = 0.2$ ft	1.50	1.85	1.70	1.65
		$x = 0.5$ ft	1.00	1.00	1.00	1.00
		$x = 1.0$ ft	0.85	0.86	0.87	0.88
	12-in lifts	$x = 0$	1.05	1.10	1.15	1.20
		$x = 0.2$ ft	1.00	1.05	1.10	1.10
		$x = 0.5$ ft	0.90	0.94	0.98	1.00
		$x = 1.0$ ft	0.70	0.70	0.70	0.70
Roller width (w)		$w = 15$ in	0.90	0.85	0.85	0.90
		$w = 42$ in	0.95	0.95	0.95	0.95
		$w = 84$ in	1.00	1.00	1.00	1.00
		$w = 120$ in	1.00	1.00	1.00	1.00
Friction angle (ϕ)		$\phi = 25°$	0.70	0.80	0.90	1.10
		$\phi = 30°$	0.85	0.90	0.95	1.05
		$\phi = 35°$	1.00	1.00	1.00	1.00
		$\phi = 40°$	1.25	1.15	1.10	1.00

TABLE 6.5 ADJUSTMENT FACTORS FOR EARTH PRESSURES INDUCED BY COMPACTION WITH VIBRATING PLATES AND RAMMERS.

Variables			Multiplier Factors for z = 2 ft	4 ft	8 ft	16 ft
Lift thickness and distance from wall (x) (adjustments for these two factors are combined)	4-in lifts	$x = 0$	1.00	1.00	1.00	1.00
		$x = 0.5$ ft	0.79	0.81	0.82	0.83
	6-in lifts	$x = 0$	0.83	0.85	0.87	0.90
		$x = 0.5$ ft	0.66	0.69	0.71	0.75
Vibrating plate area		240 in^2	0.85	0.85	0.90	0.95
		480 in^2	1.00	1.00	1.00	1.00
		960 in^2	1.15	1.15	1.15	1.10
Rammer plate area		72 in^2	0.85	0.85	0.90	0.95
		144 in^2	1.00	1.00	1.00	1.00
		288 in^2	1.15	1.15	1.15	1.10
Friction angle (ϕ)		$\phi = 25°$	0.80	0.90	1.05	1.25
		$\phi = 30°$	0.85	0.95	1.00	1.10
		$\phi = 35°$	1.00	1.00	1.00	1.00
		$\phi = 40°$	1.15	1.10	1.00	0.90

factors for these non-standard values are estimated using the values summarized in Table 6.4. The values of the adjustment factors (called R) are: $R_x = 1.8$, $R_w = 0.85$, $R_\phi = 1.14$.

Using this information from Figure 6.17 and Table 6.4, it is estimated that the postcompaction lateral earth pressure is equal to $p_h = (340\ \text{psf})(1.8)(0.85)(1.14) = 590$ psf. This value compares to a value of 570 psf calculated by means of detailed computer analyses performed using the methods developed by Duncan and Seed (1986).

By using the same procedure to estimate pressures at other depths, the distribution of earth pressures after compaction can be estimated. At the depth where these become smaller than the estimated at-rest pressures, the lateral pressures are equal to the at-rest values, as shown in Figure 6.16.

Postcompaction earth pressures estimated using Figures 6.17, 6.18, and 6.19 and Tables 6.4 and 6.5 apply to conditions where the wall is stiff and nonyielding. These pressures would provide a conservative (high) estimate of pressures on flexible walls or massive walls whose foundation support conditions allow them to shift laterally or tilt away from the backfill during compaction. Such movements would reduce the earth pressures. The reduction would be expected to be less near the surface, where the compaction-induced loads would tend to "follow" the wall as it deflected or yielded.

6.6 RELATION BETWEEN EARTH PRESSURES AND WALL MOVEMENTS

As a wall moves toward the backfill, the earth pressures increase; as it moves away from the backfill, the earth pressures decrease. Ultimately, after sufficiently large movements, the limiting

TABLE 6.6 APPROXIMATE MAGNITUDES OF MOVEMENTS REQUIRED TO REACH MINIMUM ACTIVE AND MAXIMUM PASSIVE EARTH PRESSURE CONDITIONS.

	Values of Δ/H[a]	
Type of Backfill	*Active*	*Passive*
Dense sand	0.001	0.01
Medium-dense sand	0.002	0.02
Loose sand	0.004	0.04
Compacted silt	0.002	0.02
Compacted lean clay	0.01[b]	0.05[b]
Compacted fat clay	0.01[b]	0.05[b]

[a] Δ = movement of top of wall required to reach minimum active or maximum passive pressure, by tilting or lateral translation. H = height of wall.
[b] Under stress conditions close to the minimum active or maximum passive earth pressures, cohesive soils creep continually. The movements shown would produce active or passive pressures only temporarily. With time, the movements will continue if pressures remain constant. If movement remains constant, active pressures will increase with time and passive pressures will decrease with time.

conditions of maximum passive and minimum active earth pressures are reached. If the movements continue after the maximum passive or minimum active pressures are reached, the earth pressures remain constant. Eventually, with sufficiently large movements, the pressure would change further as a result of the altered geometric conditions. The movements required to reach the minimum active or maximum passive pressures, however, do not result in appreciable changes in geometry.

The amount of movement required to reach the limiting conditions has been investigated experimentally, and by means of the finite-element method. A number of these investigations are summarized in Table 6.6. The results in Table 6.6 show:

- The movements required to reach the extreme pressures are proportional to the height of the wall, at least to a first approximation.
- The movement required to reach the maximum passive earth pressure is of the order of ten times as large as the movement required to reach the minimum active earth pressure.
- The movements required to reach the extreme pressures are larger for loose, compressible soils than for dense, incompressible soils. For any cohesionless backfill the movement required to reach the minimum active condition is no more than about 1 inch in 20 feet ($\Delta/H = 0.004$). The movement required to reach the maximum passive conditions is no more than about 1 inch in 2 feet ($\Delta/H = 0.04$). These criteria (1 inch in 20 feet and 1 inch in 2 feet) provide simple, easy-to-remember guidelines for the amounts of movement required to reach the pressure extremes, and in most cases they are conservative.

Variations of the value of the earth pressure coefficient k with wall movement are shown in Figure 6.20 for dense and loose sand. The figure is drawn for the ideal condition where the backfill begins from at-rest pressures, with $K_0 = 1 - \sin\phi'$. This would be the case for a wall or a backfill that was "wished" into place.

Beginning from the at-rest condition, with $K_0 = 0.5$ for the loose sand and $K_0 = 0.29$ for the dense sand, the pressures increase as the wall moves toward the backfill and decrease as the wall moves away. Because the dense sand is stiffer than the loose sand, the pressures change more rapidly with wall movement for the dense sand.

A similar diagram is shown in Figure 6.21 for a compacted-sand backfill behind a wall. The figure applies to a backfill compacted to a medium-dense condition with no movement of the wall. The average value of K_0 after compaction, which would vary with compaction procedure and wall height, has been assumed to be 1.00 in Figure 6.21. Because the value of K_0 is increased as compared to the conditions shown in Figure 6.20, the movement required to reach the minimum active earth pressure condition is increased, and the movement required to reach the maximum passive pressure is decreased. Even though compaction has an effect on the amount of movement required to reach the extremes, the rules of thumb of 1 inch in 20 feet for active and 1 inch in 2 feet for passive still provide reasonable estimates of the movements required to reach the extreme pressure conditions.

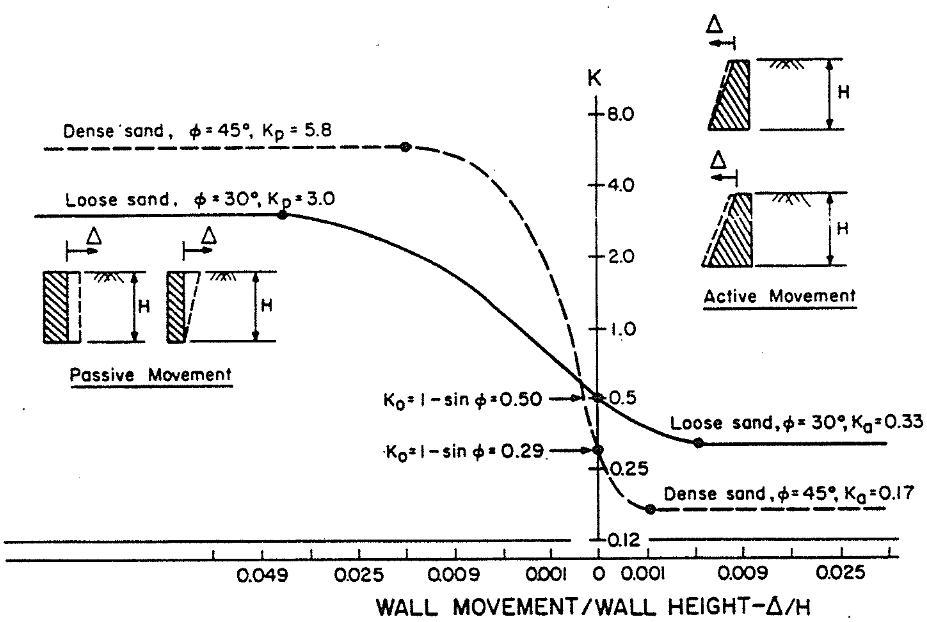


Fig. 6.20 Relationship between wall movement and earth pressure for ideal cases of walls that are "wished" into place.

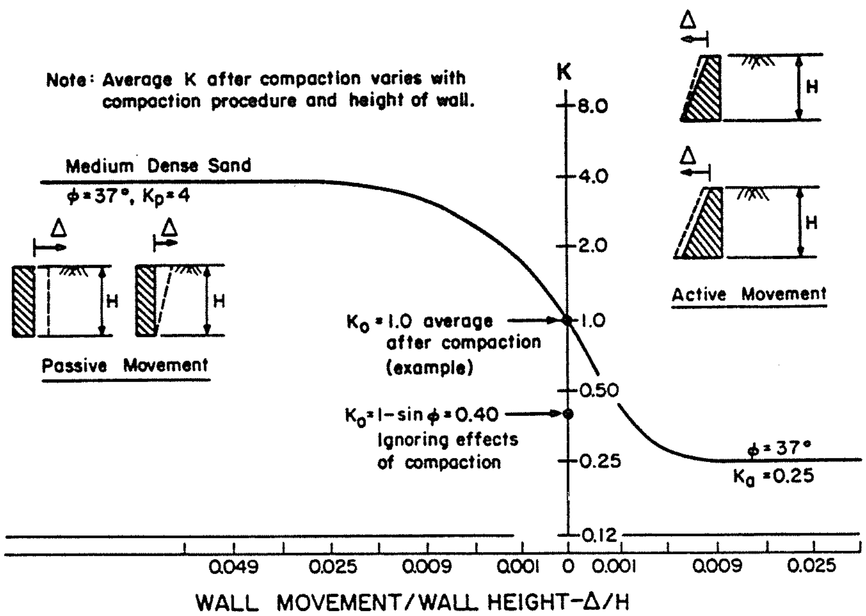


Fig. 6.21 Relationship between wall movement and earth pressure for a wall with compacted backfill.

6.7 EARTH PRESSURES FOR DESIGN

Although the earth pressures exerted on structures and walls by the adjacent backfill depend on soil–structure interaction, and are thus influenced by a number of different factors, it is nevertheless possible to estimate earth pressures with sufficient accuracy for most practical purposes without resorting to elaborate or complex analyses. To estimate earth pressures for design, the questions that must be answered are the following.

(1) Will the backfill be drained? If not, the major design consideration will be water pressure. If water can pond behind a wall, the wall must be designed to resist the hydrostatic water pressure plus the earth pressure exerted by the buoyant backfill. Usually in this condition the water pressures exceed the earth pressures, often by a considerable margin. If the backfill will be drained throughout its life, the wall need only be designed for earth pressures.

(2) What kind of backfill will be used? Free-draining cohesionless backfills are easy to compact, and exert relatively low pressures on walls. Walls backfilled with cohesionless backfills can be designed for minimum active earth pressures provided they can yield as much as 1 inch in 20 feet. Cohesive backfills are harder to compact and have higher at-rest pressures. Walls backfilled with cohesive soils cannot be designed for active earth pressures even if movements as large as 1 inch in 20 feet are acceptable, because cohesive soils creep. Walls with cohesive backfills that are designed for active earth pressures will continue to move gradually throughout their lives, usually with another episode of movement each time the backfill is thoroughly soaked by rainfall infiltration or rising groundwater levels. Even if wall movements as large as 1 inch in 20 feet are tolerable, walls backfilled with cohesive soils must be designed for pressures between active and at-rest.

(3) How much movement of the wall can be tolerated? Walls that can tolerate very little or no movement should be designed for at-rest pressures, including the effects of compaction-induced pressures. Earth pressures due to compaction can be estimated using Figures 6.17, 6.18, and 6.19, and Tables 6.4 and 6.5. Walls that can tolerate movements as large as 1 inch in 20 feet can be designed for minimum active earth pressures if the backfill is free-draining and cohesionless. If the backfill is cohesive, pressures intermediate between active and at-rest must be used for design. Wall movements after compaction relieve compaction-induced earth pressures. Therefore, when movements as large as 1 inch in 20 feet after compaction are tolerable, earth pressures due to compaction need not be considered for design. Excessive compaction of the backfill, however, can induce large movements of walls. Especially during later stages of backfilling, heavy equipment should be kept away from the wall.

(4) Will the surface of the backfill support surcharge loads? Earth pressures due to uniform surcharge loads can be estimated using Equation 6.12. The value of k used in the equation should be equal to k_a, K_0, or an intermediate value, as appropriate for the type of backfill and the amount of wall movement that can be tolerated. Earth pressures due to point loads, live loads, or strip loads can be estimated by means of the theory of elasticity, using Equations 6.14 through 6.18. Although these equations were developed for nonyielding walls, it is appropriate to use them for all walls. To use lower pressures might lead to a condition where the wall would move an additional amount each time a load was applied to the backfill.

In many cases earth pressures for design can be based on answers to these questions, combined with judgment and experience, without laboratory tests on the soils or extensive theoretical analyses of the earth pressures. Table 6.7 gives values of earth pressure coefficients and equivalent fluid unit weights that can be used for design of walls of moderate height, up to about 20 feet.

For higher walls, consideration should be given to use of detailed design procedures, and determination of backfill properties through laboratory tests on samples of the backfill soil compacted to the expected field conditions. If cohesive backfills are used behind high walls, however, an appropriate empirical adjustment should be made to account for the effects of creep. Earth pressures for cohesive backfills estimated using methods that do not allow for creep effects should be increased, using judgment, to allow for long-term increases in earth pressures as a consequence of the tendency for these soils to creep.

TABLE 6.7 EARTH PRESSURES FOR DESIGN.

	Equivalent Fluid Unit Weights and Pressure Coefficients							
	Level Backfill				Backfill 2(H) on 1(V)			
	At-Rest		$\Delta/H = 1/240$		At-Rest		$\Delta/H = 1/240$	
Type of Soil	γ_{eq} (lb/ft^3)	k	γ_{eq} (lb/ft^3)	k	γ_{eq} (lb/ft^3)	k	γ_{eq} (lb/ft^3)	k
Loose sand or gravel	55	0.45	40	0.35	65	0.55	50	0.45
Medium-dense sand or gravel	50	0.40	35	0.25	60	0.50	45	0.35
Dense sand or gravel	45	0.35	30	0.20	55	0.45	40	0.30
Compacted silt (ML)	60	0.50	40	0.35	70	0.60	50	0.45
Compacted lean clay (CL)	70	0.60	45	0.40	80	0.70	55	0.50
Compacted fat clay (CH)	80	0.65	55	0.50	90	0.75	65	0.60

Note: $p_h = \gamma_{eq}z + kq_s$.
c_{eq} = equivalent fluid unit weight, z = depth below ground surface, k = horizontal earth pressure coefficient, q_s = uniform surcharge pressure.

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6.4 EARTH PRESSURES DUE TO SURFACE LOADS

Vertical loads on the surface of the ground increase both the vertical and lateral pressures in the ground. Loads on the backfill surface near an earth-retaining structure cause increased earth pressures on the structure.

6.4.1 Uniform Surcharge Loads

A uniform surcharge pressure applied to the ground surface over a large area causes a uniform increase in vertical pressure of the same amount,

$$\Delta p_v = q_s \tag{6.11}$$

in which Δp_v = increase in vertical pressure due to surcharge, and q_s = surcharge pressure. The surcharge pressure also causes an increase in lateral pressure,

$$\Delta p_h = kq_s \tag{6.12}$$

in which Δp_h = increase in horizontal pressure due to surcharge, and k is an earth pressure coefficient. For active earth pressure conditions, $k = k_a$; for at-rest conditions, $k = k_0$; and for passive earth pressure conditions, $k = k_p$.

Owing to the fact that the surcharge loading is applied over a large area (theoretically, an infinitely large area) both the vertical pressure due to the surcharge (Eq. 6.11) and the horizontal pressure due to the surcharge (Eq. 6.12) are constant at all depths.

6.4.2 Point Loads, Line Loads, and Strip Loads

When the surface loading is not uniform, or does not act over a large area, more complex calculations are needed to estimate the magnitude of the induced lateral stresses. As shown in Figure 6.13, the horizontal pressure induced by a vertical point load varies with depth and distance along the wall.

Although exact solutions to the problem shown in Figure 6.13 have not been developed, a simple approximation has been found that is accurate enough for practical purposes. Boussinesq developed expressions for the stresses induced within an elastic mass by a point load acting on the surface. According to this solution, the horizontal stress can be expressed as (radial stress)

$$\Delta p_r = \frac{Q}{2\pi R^2}\left[\frac{3zr^2}{R^3} - \frac{R(1-2\nu)}{R+z}\right] \tag{6.13}$$

in which Q = the magnitude of the point load, expressed in units of force; $R^2 = x^2 + y^2 + z^2$; $r^2 = x^2 + y^2$; x and y are horizontal distances from the load to the stress point; z = depth of stress point below surface; and ν = Poisson's ratio.

Boussinesq's solution can be used to develop an expression for the horizontal stress on a wall due to point load on the surface if two simplifying assumptions are made: (1) the wall does not move, and (2) the wall is perfectly smooth (there is no shear stress between the wall and the soil). Under these conditions the stress induced on the wall would be the same as the stress induced in an elastic half-space by two loads of equal magnitude situated as shown in Figure 6.14. The second load (called the image or imaginary load) would cause equal and opposite normal displacements on a plane midway between it and the real load, thus enforcing the zero-horizontal-displacement boundary condition at the wall. Thus, the horizontal pressures on the wall are twice as large as the horizontal stress induced in an elastic half-space, and can be calculated from the expression

$$\Delta p_h = \frac{Q}{\pi R^2}\left[\frac{3zx^2}{R^3} - \frac{R(1-2\nu)}{R+z}\right] \tag{6.14}$$

in which x = horizontal distance from load to wall, $y = 0$, and the other terms are as defined for Equation 6.13.

Spangler (1938) and Terzaghi (1954) performed experiments to compare measured and calculated pressures on walls due to point loads. These experiments confirmed the fact that doubling the free-field stress (i.e., using the stress calculated from Equation 6.14), provides a good approximation to measured values of earth pressures on walls.

The same procedure has been used to develop expressions for stresses due to line loads and strip loads. For an infinitely

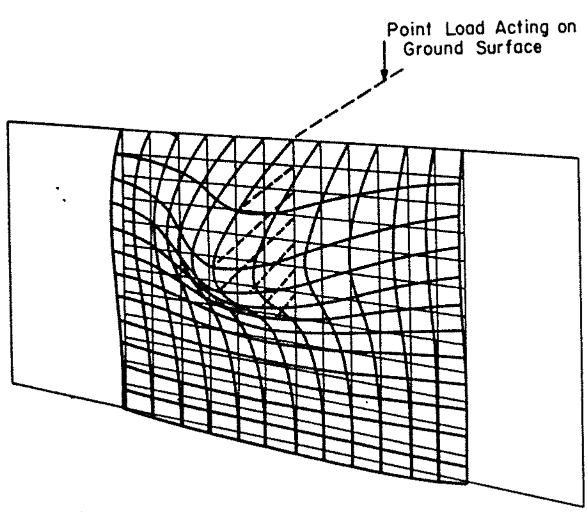

Fig. 6.13 Earth pressure data due to a point load. (*After Spangler, 1938.*)

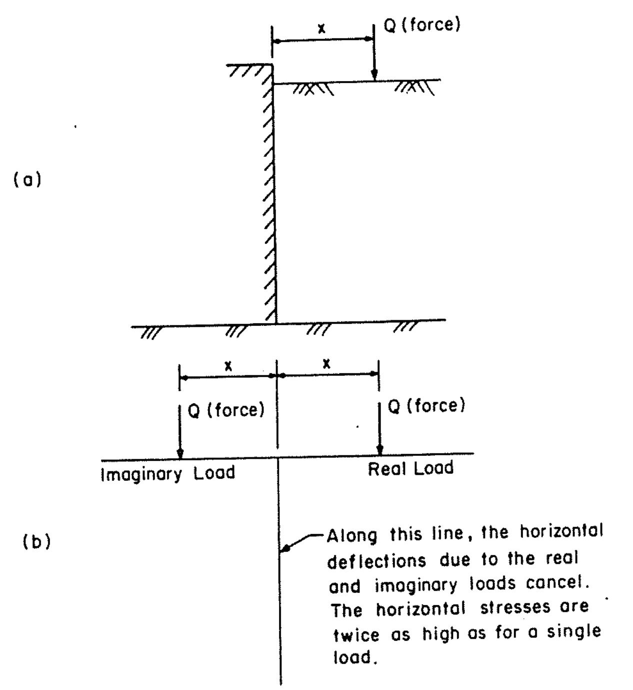

Fig. 6.14 Use of an imaginary load to enforce a zero-displacement condition at a wall. (a) A point load near a wall. (b) Two point loads on an elastic half-space.