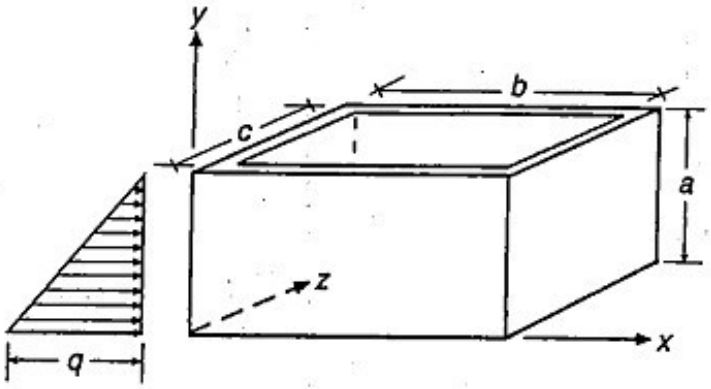
3 Tank Analysis Results

CASE 1



Hinged Top
Hinged Base

Deflections
on pages 3-5 & 3-6

Moments

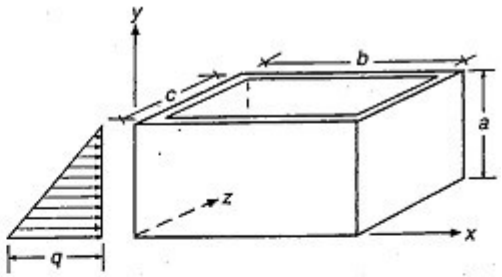
b/a	c/a	page
4.0	3.0	3-7
	2.0	3-7
	1.5	3-8
	1.0	3-8
	0.5	3-9
3.0	2.0	3-9
	1.5	3-10
	1.0	3-10
	0.5	3-11
2.0	1.5	3-11
	1.0	3-12
	0.5	3-12
1.5	1.0	3-13
	0.5	3-13
1.0	0.5	3-14

CASE 1

Hinged Top
Hinged Base

$$\text{Deflection} = \frac{C_d q a^4}{1000 D}$$

$$D = \frac{Et^3}{12(1-\mu^2)}$$



Deflection Coefficients, C_d

Long Side - Along Midheight ($y = a/2$)

b/a	x / c/a	END	0.1b / 0.9b	0.2b / 0.8b	0.3b / 0.7b	0.4b / 0.6b	0.5b
4.0	3.0	0	2.30	4.70	5.80	6.20	6.30
4.0	2.0	0	2.30	4.70	5.80	6.20	6.30
4.0	1.5	0	2.40	4.70	5.80	6.20	6.30
4.0	1.0	0	2.60	4.80	5.80	6.30	6.30
4.0	0.5	0	2.80	4.90	5.90	6.30	6.40
3.0	2.0	0	1.60	3.60	5.00	5.60	5.80
3.0	1.5	0	1.70	3.70	5.00	5.70	5.90
3.0	1.0	0	1.80	3.80	5.10	5.70	5.90
3.0	0.5	0	2.10	4.00	5.20	5.80	6.00
2.0	1.5	0	0.90	2.20	3.30	4.00	4.30
2.0	1.0	0	1.00	2.40	3.50	4.20	4.40
2.0	0.5	0	1.20	2.60	3.70	4.40	4.60
1.5	1.0	0	0.60	1.40	2.20	2.70	2.90
1.5	0.5	0	0.80	1.70	2.50	3.00	3.10
1.0	0.5	0	0.30	0.70	1.00	1.20	1.30

Short Side - Along Midheight ($y = a/2$)

b/a	z / c/a	END	0.1c	0.2c	0.3c	0.4c	0.5c
			0.9c	0.8c	0.7c	0.6c	
4.0	3.0	0	1.60	3.60	5.00	5.60	5.80
4.0	2.0	0	0.80	2.10	3.30	4.00	4.20
4.0	1.5	0	0.30	1.10	1.90	2.40	2.60
4.0	1.0	0	0.00	0.10	0.40	0.50	0.60
4.0	0.5	0	-0.20	-0.30	-0.40	-0.40	-0.40
3.0	2.0	0	0.80	2.10	3.30	4.00	4.20
3.0	1.5	0	0.30	1.10	1.90	2.40	2.60
3.0	1.0	0	0.00	0.10	0.40	0.50	0.60
3.0	0.5	0	-0.20	-0.30	-0.40	-0.40	-0.40
2.0	1.5	0	0.40	1.20	1.90	2.40	2.60
2.0	1.0	0	0.00	0.20	0.40	0.60	0.60
2.0	0.5	0	-0.20	-0.30	-0.30	-0.40	-0.40
1.5	1.0	0	0.00	0.20	0.50	0.70	0.70
1.5	0.5	0	-0.10	-0.20	-0.30	-0.30	-0.30
1.0	0.5	0	-0.10	-0.10	-0.20	-0.20	-0.20

Deflection Coefficients, C_d

Long Side - Along Midspan ($x = b/2$)

b/a	y / c/a	BOT.	0.1a	0.2a	0.3a	0.4a	0.5a	0.6a	0.7a	0.8a	0.9a	TOP
4.0	3.0	0	2.10	4.00	5.30	6.10	6.30	5.90	5.00	3.60	1.90	0
4.0	2.0	0	2.10	4.00	5.30	6.10	6.30	5.90	5.00	3.60	1.90	0
4.0	1.5	0	2.10	4.00	5.30	6.10	6.30	5.90	5.00	3.60	1.90	0
4.0	1.0	0	2.10	4.00	5.40	6.20	6.30	5.90	5.00	3.60	1.90	0
4.0	0.5	0	2.10	4.00	5.40	6.20	6.40	5.90	5.00	3.60	1.90	0
3.0	2.0	0	2.00	3.70	4.90	5.70	5.80	5.50	4.60	3.30	1.70	0
3.0	1.5	0	2.00	3.70	5.00	5.70	5.90	5.50	4.60	3.30	1.70	0
3.0	1.0	0	2.00	3.70	5.00	5.70	5.90	5.50	4.60	3.30	1.70	0
3.0	0.5	0	2.00	3.70	5.00	5.80	6.00	5.60	4.70	3.30	1.70	0
2.0	1.5	0	1.50	2.70	3.70	4.20	4.30	4.00	3.30	2.40	1.20	0
2.0	1.0	0	1.50	2.80	3.80	4.30	4.40	4.10	3.40	2.40	1.30	0
2.0	0.5	0	1.60	2.90	3.90	4.50	4.60	4.20	3.50	2.50	1.30	0
1.5	1.0	0	1.00	1.90	2.50	2.80	2.90	2.60	2.20	1.50	0.80	0
1.5	0.5	0	1.10	2.10	2.70	3.10	3.10	2.90	2.40	1.70	0.90	0
1.0	0.5	0	0.50	0.90	1.20	1.30	1.30	1.20	1.00	0.70	0.30	0

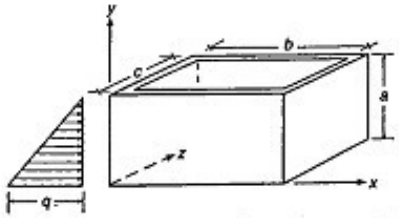
Short Side - Along Midspan ($z = c/2$)

b/a	y / c/a	BOT.	0.1a	0.2a	0.3a	0.4a	0.5a	0.6a	0.7a	0.8a	0.9a	TOP
4.0	3.0	0	2.00	3.70	4.90	5.70	5.80	5.50	4.60	3.30	1.70	0
4.0	2.0	0	1.50	2.70	3.60	4.10	4.20	3.90	3.20	2.30	1.20	0
4.0	1.5	0	0.90	1.70	2.30	2.50	2.60	2.30	1.90	1.40	0.70	0
4.0	1.0	0	0.30	0.50	0.60	0.60	0.60	0.50	0.40	0.30	0.10	0
4.0	0.5	0	-0.10	-0.20	-0.30	-0.40	-0.40	-0.40	-0.30	-0.20	-0.10	0
3.0	2.0	0	1.50	2.70	3.60	4.10	4.20	3.90	3.20	2.30	1.20	0
3.0	1.5	0	0.90	1.70	2.30	2.50	2.60	2.30	1.90	1.40	0.70	0
3.0	1.0	0	0.30	0.50	0.60	0.60	0.60	0.50	0.40	0.30	0.10	0
3.0	0.5	0	-0.10	-0.20	-0.30	-0.40	-0.40	-0.40	-0.30	-0.20	-0.10	0
2.0	1.5	0	0.90	1.70	2.30	2.60	2.60	2.40	1.90	1.40	0.70	0
2.0	1.0	0	0.30	0.50	0.70	0.70	0.60	0.50	0.40	0.30	0.10	0
2.0	0.5	0	-0.10	-0.20	-0.30	-0.40	-0.40	-0.40	-0.30	-0.20	-0.10	0
1.5	1.0	0	0.30	0.60	0.70	0.80	0.70	0.60	0.50	0.30	0.20	0
1.5	0.5	0	-0.10	-0.20	-0.20	-0.30	-0.30	-0.30	-0.30	-0.20	-0.10	0
1.0	0.5	0	0.00	-0.10	-0.10	-0.10	-0.20	-0.20	-0.10	-0.10	-0.10	0

CASE 1

Hinged Top
Hinged Base

Moment = Coef. × $qa^2/1000$



$\frac{b}{a} = 4.0, \frac{c}{a} = 3.0$

Long Side

	M_x Coefficient						M_y Coefficient						M_{xy} Coefficient					
	CORNER	0.1b	0.2b	0.3b	0.4b	0.5b	CORNER	0.1b	0.2b	0.3b	0.4b	0.5b	CORNER	0.1b	0.2b	0.3b	0.4b	0.5b
		0.9b	0.8b	0.7b	0.6b			0.9b	0.8b	0.7b	0.6b			0.9b	0.8b	0.7b	0.6b	
TOP	0	0	0	0	0	0	0	0	0	0	0	0	1	17	10	4	1	0
0.9a	-3	5	11	15	16	16	-16	2	5	4	4	4	1	17	10	4	1	0
0.8a	-6	10	22	28	31	31	-32	4	9	8	7	7	1	14	8	4	1	0
0.7a	-9	15	32	40	44	44	-45	6	12	11	10	10	1	11	6	3	1	0
0.6a	-11	19	40	50	54	55	-56	8	15	14	12	12	1	7	3	1	0	0
0.5a	-12	22	46	56	60	61	-62	9	17	15	14	13	0	1	0	0	0	0
0.4a	-13	24	48	58	62	63	-64	10	17	15	14	14	0	4	3	1	0	0
0.3a	-12	25	46	54	58	58	-59	10	15	14	13	13	1	10	6	2	1	0
0.2a	-10	22	38	44	47	47	-48	8	12	11	10	10	1	15	8	3	1	0
0.1a	-6	15	23	27	28	28	-28	5	7	7	6	6	2	18	10	4	1	0
BOT.	0	0	0	0	0	0	0	0	0	0	0	0	2	20	10	4	1	0

Short Side

	M_z Coefficient						M_y Coefficient						M_{yz} Coefficient					
	CORNER	0.1c	0.2c	0.3c	0.4c	0.5c	CORNER	0.1c	0.2c	0.3c	0.4c	0.5c	CORNER	0.1c	0.2c	0.3c	0.4c	0.5c
		0.9c	0.8c	0.7c	0.6c			0.9c	0.8c	0.7c	0.6c			0.9c	0.8c	0.7c	0.6c	
TOP	0	0	0	0	0	0	0	0	0	0	0	0	1	17	14	8	4	0
0.9a	-3	3	9	12	14	15	-16	0	4	5	4	4	1	17	14	8	3	0
0.8a	-6	6	17	24	28	29	-32	0	8	9	8	8	1	15	12	7	3	0
0.7a	-9	9	25	35	39	41	-45	0	11	13	12	11	1	12	9	5	2	0
0.6a	-11	11	31	43	49	51	-56	0	14	15	14	14	1	7	5	3	1	0
0.5a	-12	14	36	49	55	57	-62	1	16	17	16	15	0	2	1	0	0	0
0.4a	-13	16	38	51	57	59	-64	2	16	17	16	16	0	4	4	2	1	0
0.3a	-12	17	37	48	53	55	-59	3	15	16	15	14	1	10	8	5	2	0
0.2a	-10	15	32	40	44	45	-48	4	12	12	12	11	1	15	12	7	3	0
0.1a	-6	11	20	24	26	27	-28	3	7	7	7	7	2	20	14	8	3	0
BOT.	0	0	0	0	0	0	0	0	0	0	0	0	2	21	15	8	4	0

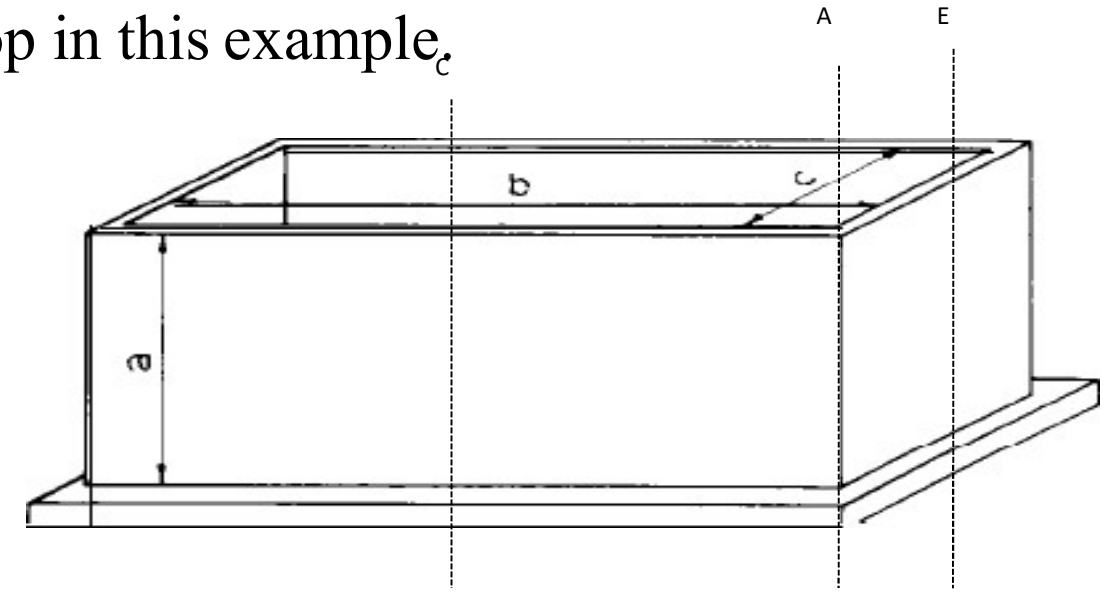
Example 1

Design of Single-Cell Rectangular Tank

- The tank shown has a clear height of a = 3m. horizontal inside dimensions are b = 9.0 m and c = 6.0 m.
- Height of the soil against wall is 1.3m.

Assume f_c = 30 Mpa and f_y =420 MPa

- The tank will consider fixed at the base and free at the top in this example.



Example 1 (Design of Rectangular Tank)

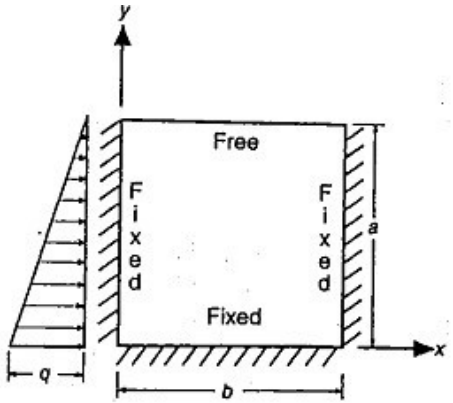
- Design of Wall for Loading Condition 1 (Leakage Test)
  - Design for Shear Forces (Top Free anbd bottom Fixed)
    - According to Case 3 for : b/a = 3.0 and c/a = 2.0 (Page 2-17)

CASE 3

$$\text{Shear} = C_s \times q \times a$$

$$\text{Deflection} = \frac{C_d q a^4}{1000\, D}$$

$$D = \frac{Et^3}{12(1-\mu^2)}$$



Shear Coefficients, C_s

LOCATION \ b/a	4.0	3.0	2.5	2.0	1.75	1.5	1.25	1.0	0.75	0.5
Bottom edge — midpoint	0.50	0.50	0.48	0.45	0.43	0.40	0.36	0.32	0.26	0.19
Side edge — maximum	0.38	0.37	0.33	0.27	0.26	0.26	0.25	0.24	0.22	0.17
Side edge — midpoint	0.23	0.24	0.25	0.26	0.26	0.26	0.25	0.23	0.19	0.13

Example 1 (Design of Rectangular Tank)

- Assume the wall thickness is 30 cm
- Check for shear at bottom of the wall

$$V = C_s \times q \times a$$
$$= 0.5 \times (10 \times 3) \times 3 = 45\text{KN}$$
$$V_u = 1.4 \times V$$
$$= 1.4 \times 45 = 63KN$$

$$\phi V_c = \phi(0.17) \sqrt{f_c'}(b)(d)$$
$$= 0.75(0.17)\sqrt{30}(1000)(243)/1000$$
$$= 167KN > V_u$$

$$d = 300 - 50 - 14/2 = 243mm$$

For $b/a = 3$ (long wall),

Bottom edge - midpoint = 0.50
Side edge - maximum = 0.37
Side edge - midpoint = 0.24

For $b/a = 2$ (short wall),

Bottom edge - midpoint = 0.45
Side edge - maximum = 0.27
Side edge - midpoint = 0.26

Example 1 (Design of Rectangular Tank)

- Check for shear at side edge of the long wall

$$V = C_s \times q \times a = 0.37 \times (10 \times 3) \times 3 = 33.3KN$$

$$V_u = 1.4 \times V = 1.4 \times 33.3 = 46.7KN$$

- This wall is subjected to tensile forces due to shear in the short wall
- Shear in the short wall

$$V = C_s \times q \times a = 0.27 \times (10 \times 3) \times 3 = 24.3ton$$

$$V_u = 1.4 \times V = 1.4 \times 24.3 = 34KN$$

$$\phi V_c = \phi \left| 1 + \frac{N}{3.5A_g} \right| \sqrt{f_c^{`}}(b)(d)$$ Shear capacity when shear combined with tension forces

$$= 0.75 \times 0.16 \times \left| 1 - \frac{34 \times 1000}{3.5 \times (300 \times 1000)} \right| \sqrt{30}(1000)(243)/1000$$

$$= 163KN > V_u$$