Example 1 (Design of Rectangular Tank)

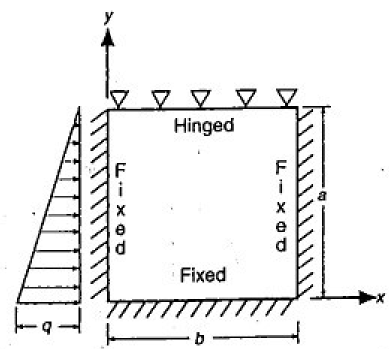
- **Note** when design of Wall for Loading Condition 3 (cover in place) (Top hinged and bottom fixed)
- Case 4 page 2-23 for the shear coefficient is smaller than previous case.

CASE 4

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

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

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



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	0.40	0.40	0.40	0.40	0.39	0.38	0.36	0.32	0.26	0.20
Side edge — maximum	0.26	0.26	0.26	0.27	0.26	0.26	0.25	0.24	0.22	0.17
Side edge — midpoint	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.23	0.19	0.13
Top edge — midpoint	0.10	0.11	0.11	0.11	0.11	0.11	0.09	0.07	0.05	0.03

Example 1 (Design of Rectangular Tank)

- Design of Wall for Loading Condition 1 (Leakage Test)
  - **Design for Vertical Reinforcement (Mx)**
  - Moments are in KN.m if coefficients are multiplied by $qa^2/1000 = 30*9/1000=0.27$
  - Moment coefficients taken from Table 5-1 for b/a = 3 and c/a = 2
  - For Sanitary Structures

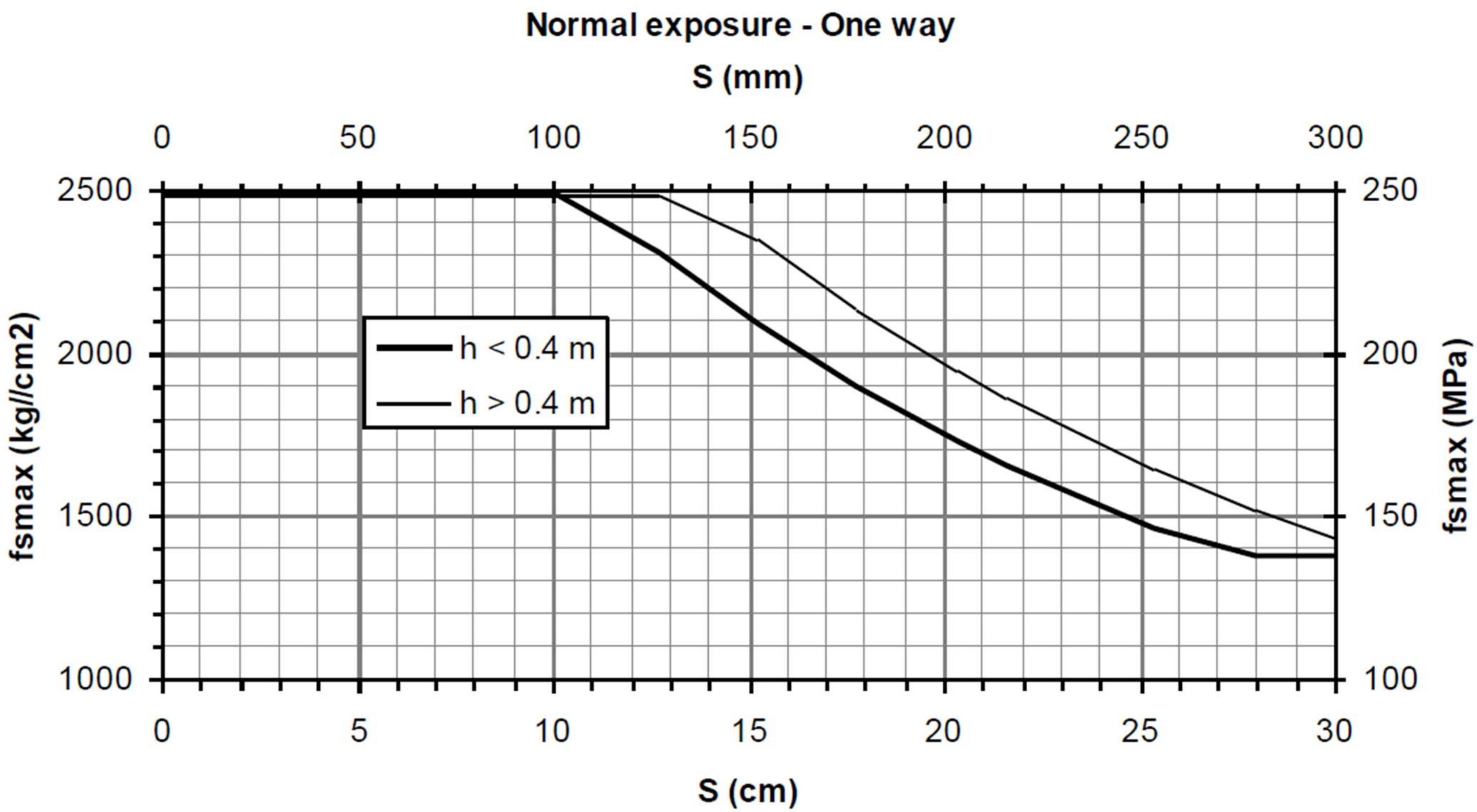
$$\text{Required Strength} = S_d \cdot \text{factored load} = S_d \cdot U$$

$$S_d = \frac{\phi f_y}{\gamma f_s} \geq 1.0 \qquad where: \ \gamma = \frac{\text{factored load}}{\text{unfactored load}}$$

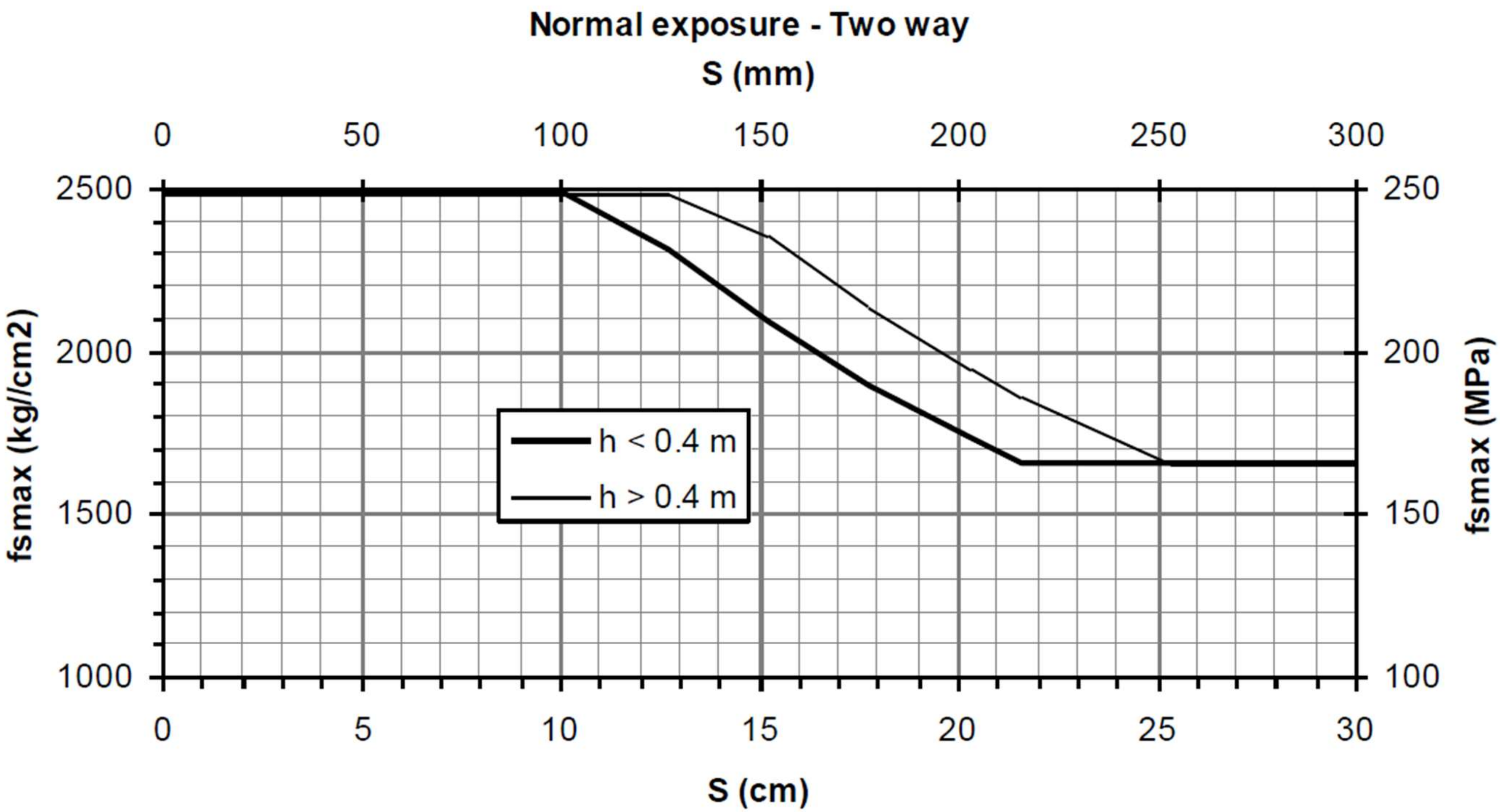
$$f_s = 165 \quad \text{from diagram} \qquad S_d = \frac{0.9 \times 420}{1.4 \times 165} = 1.6$$

$$M_{ux} = 1.6 \times 1.4 \times 0.27 \times M_x Coef. = 0.605 \times M_x Coef.$$

Example 1 (Design of Rectangular Tank)



Example 1 (Design of Rectangular Tank)

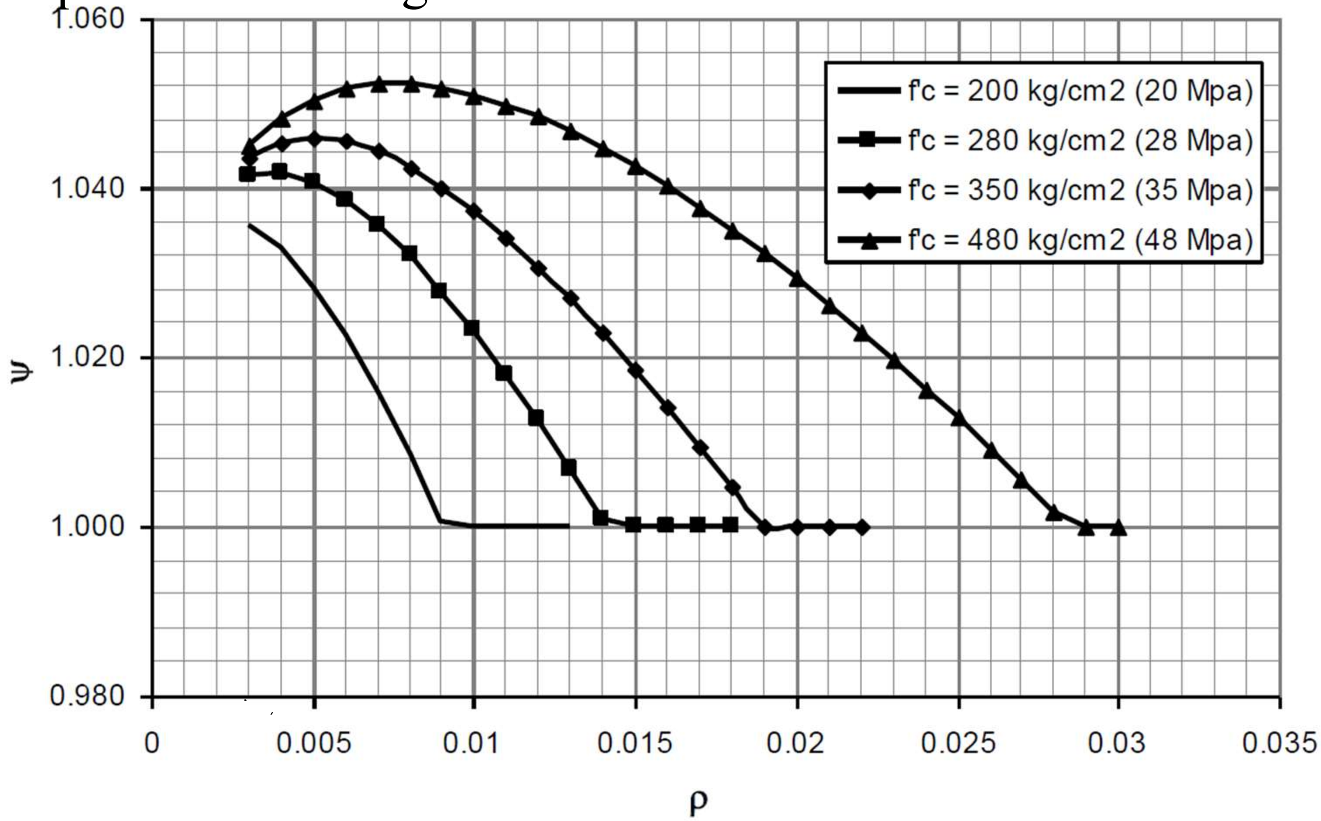


Example 1 (Design of Rectangular Tank)

- **After finding the reinforcement check the table below where Mu** $_{design}$ = ψ x Sd x Mu where Mu = 1.4 M$_{\text{from tables}}$

Or use ψ = 1.044 at design stage for concrete f'c≤ 35 Mpa

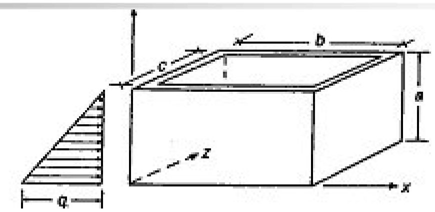
- The required reinforcing of the interior face of the wall is



Example 1 (Design of Rectangular Tank)

Free Top
Fixed Base

Moment = Coef. × $qa^2/1000$



$\frac{b}{a} = 3.0, \frac{c}{a} = 2.0$

Long Side

	M_x Coefficient						M_y Coefficient						M_{xy} Coefficient					
	CORNER	0.1b / 0.9b	0.2b / 0.8b	0.3b / 0.7b	0.4b / 0.6b	0.5b	CORNER	0.1b / 0.9b	0.2b / 0.8b	0.3b / 0.7b	0.4b / 0.6b	0.5b	CORNER	0.1b / 0.9b	0.2b / 0.8b	0.3b / 0.7b	0.4b / 0.6b	0.5b
TOP	-11	0	0	0	0	0	-55	-20	9	20	23	24	1	16	17	13	7	0
0.9a	-16	-2	2	4	4	5	-78	-18	9	19	21	22	5	14	17	13	7	0
0.8a	-14	-3	4	7	8	8	-71	-15	9	18	19	19	5	14	17	13	7	0
0.7a	-13	-1	6	9	10	10	-65	-12	9	16	17	17	4	15	17	14	7	0
0.6a	-12	0	7	9	9	9	-59	-9	9	14	14	14	4	16	18	14	7	0
0.5a	-10	1	6	6	5	4	-52	-6	8	10	10	10	4	17	18	14	7	0
0.4a	-9	1	2	-2	-5	-7	-43	-4	6	6	5	5	4	18	18	13	6	0
0.3a	-6	-2	-7	-16	-22	-24	-32	-2	2	1	0	-1	3	18	17	11	6	0
0.2a	-4	-8	-23	-37	-46	-49	-18	-2	-2	-5	-7	-8	2	15	14	9	4	0
0.1a	-1	-19	-46	-67	-80	-84	-6	-4	-9	-13	-15	-16	1	10	8	5	2	0
BOT.	0	-38	-80	-109	-124	-129	0	-8	-16	-22	-25	-26	0	0	0	0	0	0

Short Side

	M_z Coefficient						M_y Coefficient						M_{yz} Coefficient					
	CORNER	0.1c / 0.9c	0.2c / 0.8c	0.3c / 0.7c	0.4c / 0.6c	0.5c	CORNER	0.1c / 0.9c	0.2c / 0.8c	0.3c / 0.7c	0.4c / 0.6c	0.5c	CORNER	0.1c / 0.9c	0.2c / 0.8c	0.3c / 0.7c	0.4c / 0.6c	0.5c
TOP	-11	0	0	0	0	0	-55	-34	-3	15	24	27	1	4	8	7	4	0
0.9a	-16	-5	0	3	4	5	-78	-31	-2	15	23	26	5	3	7	7	4	0
0.8a	-14	-5	2	6	9	10	-71	-28	-1	15	22	24	5	3	7	7	4	0
0.7a	-13	-4	4	10	13	14	-65	-24	1	14	20	22	4	4	8	8	5	0
0.6a	-12	-1	7	12	15	16	-59	-20	2	13	18	20	4	5	9	9	5	0
0.5a	-10	0	8	13	15	16	-52	-15	3	12	16	17	4	7	11	10	6	0
0.4a	-9	2	8	11	12	12	-43	-10	4	9	12	12	4	8	12	10	6	0
0.3a	-6	1	4	3	2	2	-32	-6	3	6	7	7	3	10	13	10	6	0
0.2a	-4	-1	-4	-10	-15	-16	-18	-3	1	1	0	0	2	10	12	9	5	0
0.1a	-1	-6	-20	-32	-41	-43	-6	-2	-3	-6	-7	-8	1	8	8	6	3	0
BOT.	0	-17	-44	-65	-78	-82	0	-3	-9	-13	-16	-16	0	0	0	0	0	0

Example 1 (Design of Rectangular Tank)

- **Vertical Bending Reinforcement:**
  - ✓ **Inside Reinforcement (Mu=-78 kn.m)**

- The required reinforcing of the interior face of the wall is

$$M_{ux} = 0.605 \times (-129) = -78\ KN.m \times \psi \rightarrow 1.044$$

$$\rho = \frac{0.85(30)}{420}\left[1 - \sqrt{1 - \frac{2.61(10)^6(78)}{1000(243)^2(30)}}\right] = 0.0036 > \rho_{min}$$

$$A_s = 0.0036 \times 1000 \times 243 = 875\ mm^2/m \times 1.044$$

Use 8ϕ12 mm/m on the inside of the wall.

✓ **Outside Reinforcement**

$$M_{ux} = 0.605 \times (10) = 6.05\ kn.m$$

This maximum positive moment is very small and will controlled by minimum reinforcement.

Example 1 (Design of Rectangular Tank)

Design for Horizontal Reinforcement (My)

- **Horizontal Bending Reinforcement:**
  - **Inside Reinforcement**

$$M_{ux} = 0.605\times(-78) = -47\ kn.m$$

$$\rho = \frac{0.85(30)}{420}\left[1-\sqrt{1-\frac{2.61(10)^6(47)}{1000(243)^2(30)}}\right] = 0.0021 < \rho_{min}$$

$$A_s = 0.0033\times1000\times243 = 800\ mm^2/m$$

So from table ψ = 1.044 , $M_{ux\ design}$ =1.044x-47 =49 so ρ=0.0022< ρ_{min}

Use 8ϕ12 mm/m on the inside of the wall.

  - **Outside Reinforcement**

$$M_{ux} = 0.605\times(24) = 14.5 kn.m$$

This maximum positive moment is very small and will controlled by minimum reinforcement.