ترتیب کوونکی:- انجینر عبدالحمید (رسولی)
مضمون:د تهداب دیزاین

اول فصل

Site Investigation

د ساحی ټیست کول(تحقیقات)

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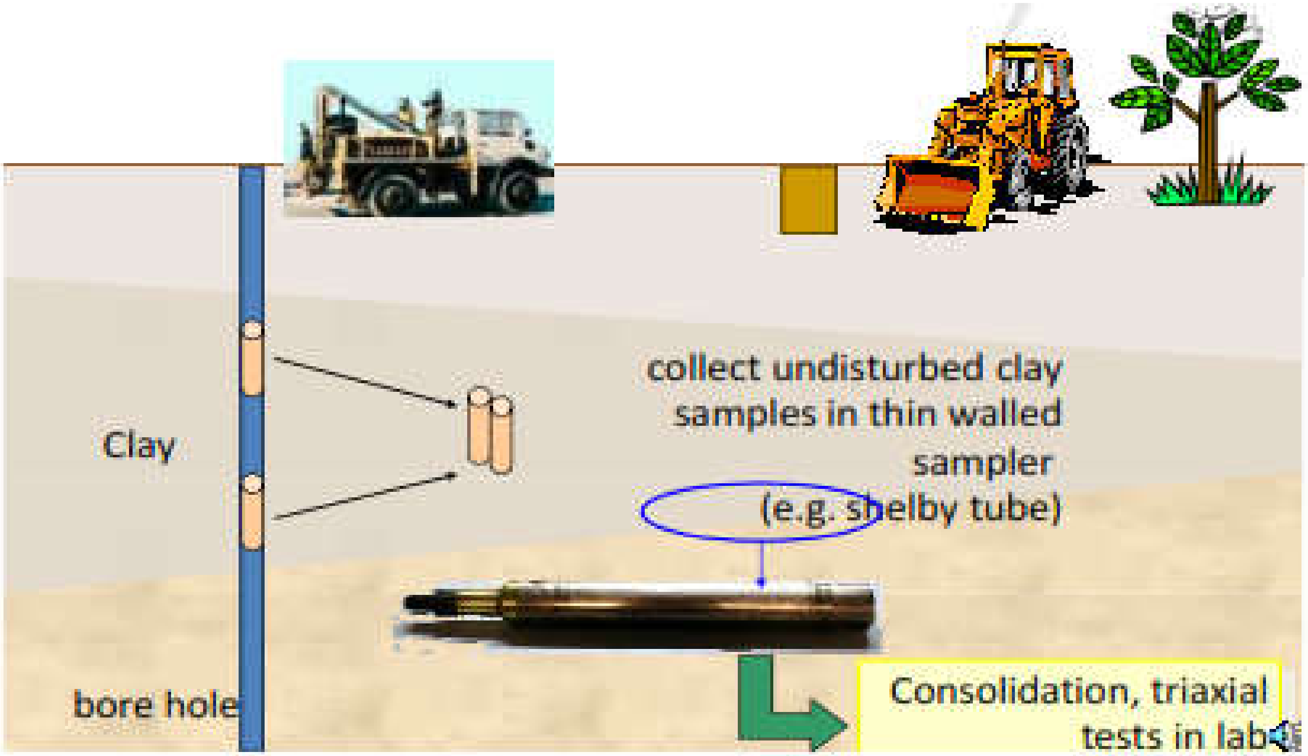
د ساحی ټیستول(تحقیقاتو) تکلاری



- مقدماتی(لمړنی) کتنه د ساحه نه
- د ساحی تحقیقات
- د ساحی په بارکی معلومات
- د موادو په لابراتوار کی تیست کول
- د جیوتکنیکل تحلیل او تفسیر

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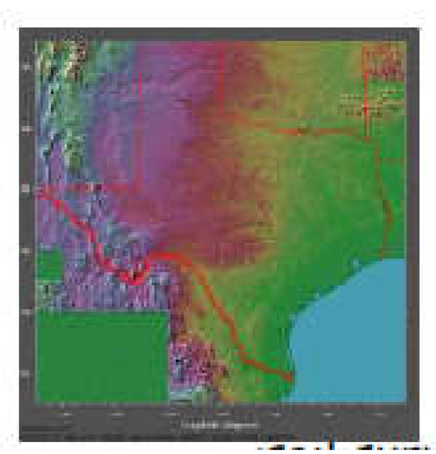
❖ د ساحی معلوماتو رپورټ جوړول

❖ مقدماتی(لمړنی) کتنه د ساحه نه

a. ساحی ته لاسرسیه
b. توپوګرافی
c. جیولوجیی معلومات
d. د همسایه ګانو سره توافق
e. د ترافیک کنترول
f. د ساحه آبرو
g. دغه ځمکې کوم بنه والی لری
h. د ساحه شیب(هموارى)
i. آوبه

❖ د ساحی تحقیقات



a. د ساحه توسعه پلان
b. د ساحه ماسترپلان
c. د محلی سایت نقشی
d. د توپوګرافی نقشی
e. د سټلایټ عکسونه(نقشه)
f. د جیولوجیکی نقشه
g. د ځمکې لاندی د ټیستونو(تحقیقاتو) رپورټ

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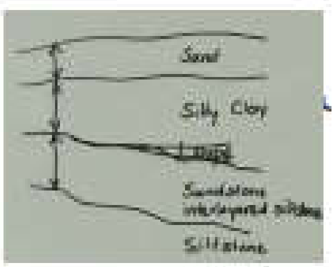
❖ د ځمکي لاندی تحقیقاتونه مطلب څه شي دی

a. د ځمکي قشرونه معلومول او مشخص کول دی
b. د هر قشر تشریح او مشخصات معلومول
c. د تراکم ، د هوآ خلاوی، کثافت او نور مقدارمعلومول
d. د ځمکي عوارض پیداکول لکه ،درزونه ، خلاوی ،ضیف قشرونه او نور
e. د ساده او عالی ازمایشتو(ټیستونه)
f. د هیدروژئولوژیکی شراطو ارزیابی



❖ د بورنو(Bores) تعداد او عمق

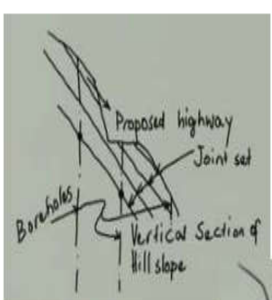
تر نن پوری کوم معین تعداد او معین عمق په کوم ستندرد که نشته ،

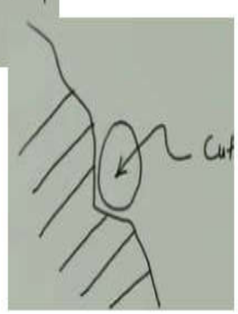
۱-معمولاً تعداد د بورنو په لاندی لاملونو پور تړلی دی

a. د خاوره تغیرات

b. د بار زیاتوالی

c. د ساختمان مهم والی او حیاتی





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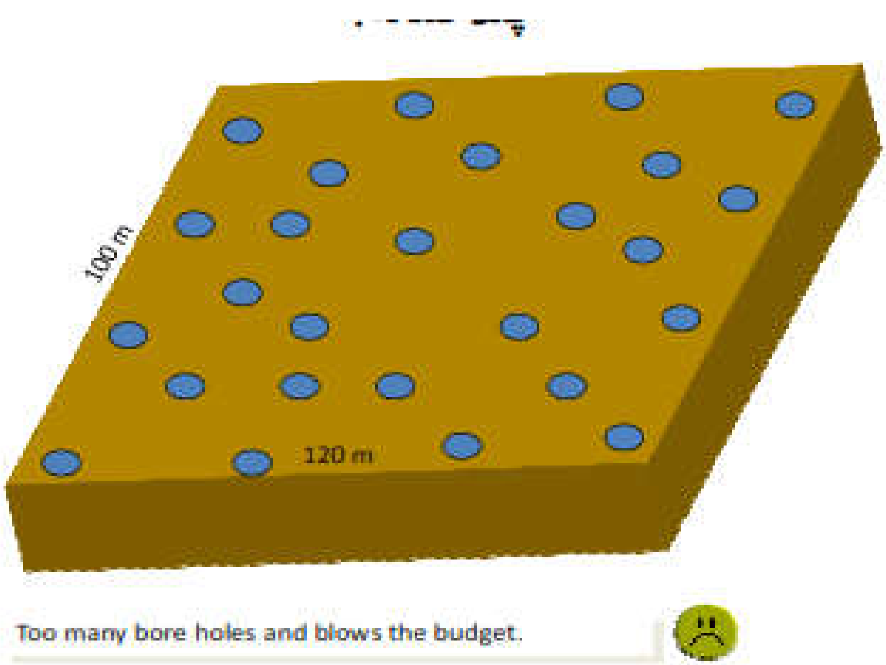
۲- د تیرو تجروبو پر بنیاد

a. نرمی خاورو لپاره ۳۰ نه تر ۶۰ مترو

b. په سختو خاورو که امکان لری تر ۱۵۰ مترو پوری ورسیږی



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په بعضی کتابونو که د لاندی جدولونو څخه استفادی کیږی

Subsurface Conditions	Structure Footprint Area for Each Exploratory Boring	
	(m^2)	(ft^2)
Poor quality and/or erratic	100–300	1,000–3,000
Average	200–400	2,000–4,000
High quality and uniform	300–1,000	3,000–10,000

Subsurface Conditions	Minimum Depth of Borings (S = number of stories; D = anticipated depth of foundation)	
	(m)	(ft)
Poor	$6\,S^{0.7}+D$	$20\,S^{0.7}+D$
Average	$5\,S^{0.7}+D$	$15\,S^{0.7}+D$
Good	$3\,S^{0.7}+D$	$10\,S^{0.7}+D$

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TABLE 2.7 Guidelines for Boring Layout

Areas of investigation	**Boring layout**
New site of wide extent	Space preliminary borings 60 to 150 m (200 to 500 ft) apart so that area between any four borings includes approximately 10 percent of total area. In detailed exploration, add borings to establish geological sections at the most useful orientations.
Development of site on soft compressible soil	Space borings 30 to 60 m (100 to 200 ft) at possible building locations. Add intermediate borings when building site is determined.
Large structure with separate closely spaced footings	Space borings approximately 15 m (50 ft) in both directions, including borings at possible exterior foundation walls, at machinery or elevator pits, and to establish geologic sections at the most useful orientations.
Low-load warehouse building of large area	Minimum of four borings at corners plus intermediate borings at interior foundations sufficient to define subsoil profile.
Isolated rigid foundation	For foundation 230 to 930 m2 (2500 to 10,000 ft2) in area, minimum of three borings around perimeter. Add interior borings, depending on initial results.
Isolated rigid foundation	For foundation less than 230 m2 (2500 ft2) in area, minimum of two borings at opposite corners. Add more for erratic conditions.
Major waterfront structures, such as dry docks	If definite site is established, space borings generally not farther than 15 m (50 ft), adding intermediate borings at critical locations, such as deep pump well, gate seat, tunnel, or culverts.
Long bulkhead or wharf wall	Preliminary borings on line of wall at 60-m (200-ft) spacing. Add intermediate borings to decrease spacing to 15 m (50 ft). Place certain intermediate borings inboard and outboard of wall line to determine materials in scour zone at toe and in active wedge behind wall.
Cut stability, deep cuts, and high embankments	Provide three to five borings on line in the critical direction to provide geological section for analysis. Number of geologic sections depends on extent of stability problem. For an active slide, place at least one boring upslope of sliding area.
Dams and water-retention structures	Space preliminary borings approximately 60 m (200 ft) over foundation area. Decrease spacing on centerline to 30 m (100 ft) by intermediate borings. Include borings at location of cutoff, critical spots in abutment, spillway, and outlet works.

Source: From NAVFAC DM-7.1, 1982.

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Areas of Investigation	Recommended Boring Depth
Bridge Foundations* Highway Bridges	
1. Spread Footings	For isolated footings of breadth L_f and width $\leq 2B_f$, where $L_f \leq 2B_f$, borings shall extend a minimum of two footing widths below the bearing level. For isolated footings where $L_f \geq 5B_f$, borings shall extend a minimum of four footing widths below the bearing level. For $2B_f \leq L_f \leq 5B_f$, minimum boring length shall be determined by linear interpolation between depths of $2B_f$ and $5B_f$ below the bearing level.
2. Deep Foundations	In soil, borings shall extend below the anticipated pile or shaft tip elevation a minimum of 6 m, or a minimum of two times the maximum pile group dimension, whichever is deeper. For piles bearing on rock, a minimum of 3 m of rock core shall be obtained at each boring location to verify that the boring has not terminated on a boulder. For shafts supported on or extending into rock, a minimum of 3 m of rock core, or a length of rock core equal to at least three times the shaft diameter for isolated shafts or two times the maximum shaft group dimension, whichever is greater, shall be extended below the anticipated shaft tip elevation to determine the physical characteristics of rock within the zone of foundation influence.
Retaining Walls	Extend borings to depth below final ground line between 0.75 and 1.5 times the height of the wall. Where stratification indicates possible deep stability or settlement problem, borings should extend to hard stratum. For deep foundations use criteria presented above for bridge foundations.
Roadways	Extend borings a minimum of 2 m below the proposed subgrade level.
Cuts	Borings should extend a minimum of 5 m below the anticipated depth of the cut at the ditch line. Borings depths should be increased in locations where base stability is a concern due to the presence of soft soils, or in locations where the base of the cut is below groundwater level to determine the depth of the underlying pervious strata.
Embankments	Extend borings a minimum depth equal to twice the embankment height unless a hard stratum is encountered above this depth. Where soft strata are encountered which may present stability or settlement concerns the borings should extend to hard material.
Culverts	Use criteria presented above for embankments.

*Note: Taken from AASHTO Standard Specifications for Design of Highway Bridges

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Geotechnical Features	***Boring Layout***
Bridge Foundations	For piers or abutments over 30 m wide, provide a minimum of two borings. For piers or abutments less than 30 m wide, provide a minimum of one boring. Additional borings should be provided in areas of erratic subsurface conditions.
Retaining Walls	A minimum of one boring should be performed for each retaining wall. For retaining walls more than 30 m in length, the spacing between borings should be no greater than 60 m. Additional borings inboard and outboard of the wall line to define conditions at the toe of the wall and in the zone behind the wall to estimate lateral loads and anchorage capacities should be considered.
Roadways	The spacing of borings along the roadway alignment generally should not exceed 60 m. The spacing and location of the borings should be selected considering the geologic complexity and soil/rock strata continuity within the project area, with the objective of defining the vertical and horizontal boundaries of distinct soil and rock units within the project limits.
Cuts	A minimum of one boring should be performed for each cut slope. For cuts more than 60 m in length, the spacing between borings along the length of the cut should generally be between 60 and 120 m. At critical locations and high cuts, provide a minimum of three borings in the transverse direction to define the existing geological conditions for stability analyses. For an active slide, place at least one boring upslope of the sliding area.
Embankments	Use criteria presented above for Cuts.
Culverts	A minimum of one boring at each major culvert. Additional borings should be provided for long culverts or in areas of erratic subsurface conditions.

*Also see *FHWA Geotechnical Checklist and Guidelines*; FHWA-ED-88-053

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Geotechnical Feature	Minimum Number of Borings	Minimum Depth of Borings
Structure foundation	One per substructure unit for width <=30 m Two per substructure unit for width >30 m	Advance borings: (1) through unsuitable foundation soils (e.g., peat, highly organic soils, soft fine-grained soils) into competent material of suitable bearing capacity; (2) to a depth where stress increases due to estimated footing load is less than 10% of the existing effective soil overburden stress; or (3) a minimum of 3 m into bedrock if bedrock is encountered at shallower depth
Retaining walls	Borings alternatively spaced every 30 to 60 m in front of and behind wall	Extend borings to depth of two times wall height or a minimum of 3 m into bedrock
Culverts	Two borings depending on length	See structure foundations
Bridge approach embankments over soft ground	For approach embankments placed over soft ground, one boring at each embankment to determine problems associated with stability and settlement of the embankment (note: borings for approach embankments are usually located at proposed abutment locations to serve a dual function)	See structure foundations Additional shallow explorations at approach embankment locations are an economical means to determine depth of unsuitable surface soils
Cuts and embankments	Borings typically spaced every 60 (erratic conditions) to 150 m (uniform conditions) with at least one boring taken in each separate landform For high cuts and fills, two borings along a straight line perpendicular to centerline or planned slope face to establish geologic cross section for analysis	Cut: (1) in stable materials, extend borings a minimum of 3 to 5 m below cut grade (2) in weak soils, extend borings below cut grade to firm materials, or to the depth of cut below grade whichever occurs first Embankment: extend borings to firm material or to depth of twice the embankment height

Source: Modified after FHWA, 1993, Soils and Foundations, Workshop Manual, 2nd ed., FHWA HI-88-009, National Highway Institute, NHI Course No. 13212, Revised, July.

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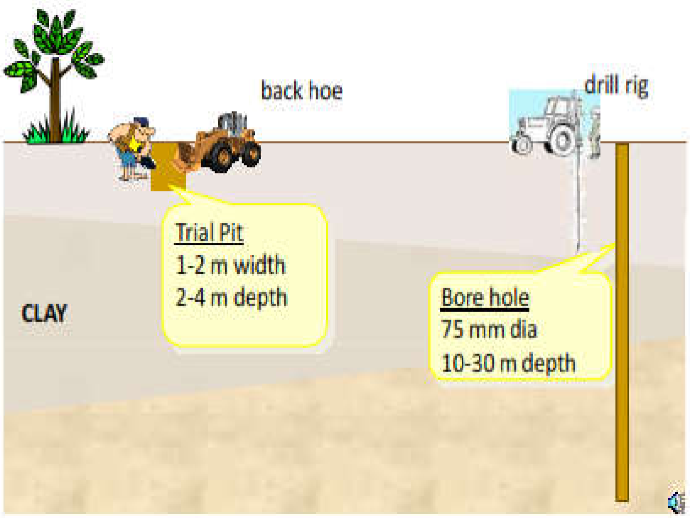
د نمونه راخستلو لاری

a. لاس خوړلی نمونه
b. لاس نه خوړلی نمونه



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اس پی ټی

Standard Penetration Test (SPT)

a. په دی ازمایشت کښ یو اله چه د غوچیونکی میله په سر وصل دی په ځمکې کښ داخلیږی اود هر قشر مقاومت او اندازګیری کوی
b. دغه مقاومت نظر د جیوتکنیکل پارمترو پوری تړل دی لکه د اصطکاک زاویه ، د خاوری سختی او نور
c. د ازمایشت ۸۰٪ د تعداب د دیزاین لپاره پکار کیږی

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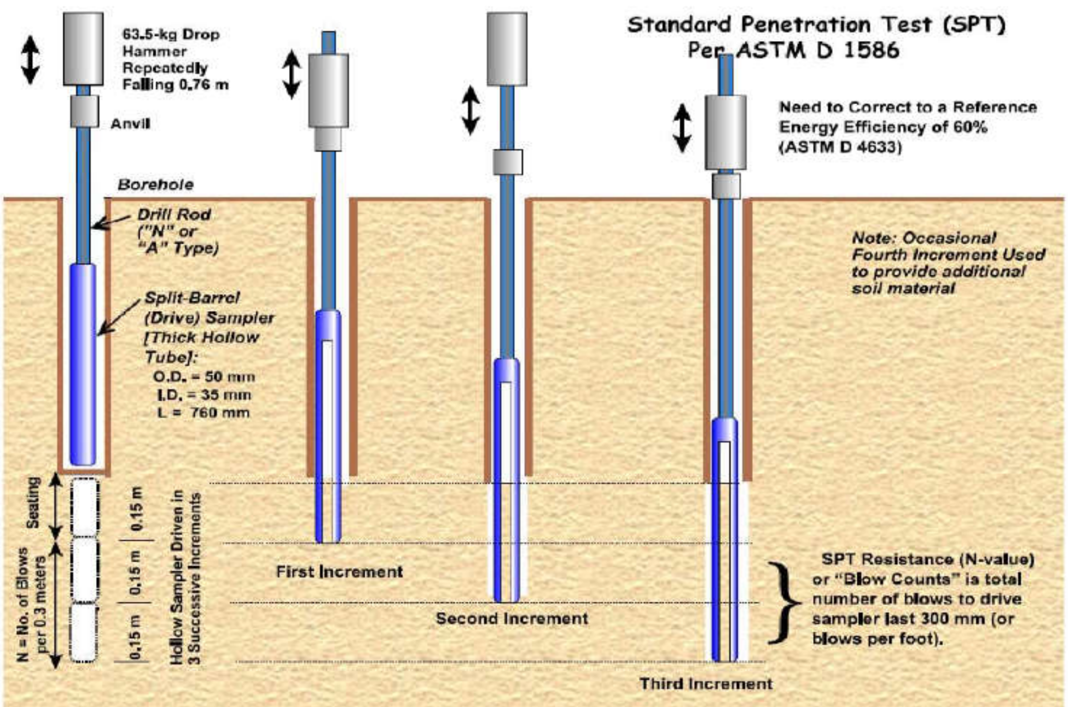
ترتیب کوونکی:- انجینر عبدالحمید (رسولی)

وسایل SPT

a. چکش ۶۳,۵ کیلوګرام
b. د چکش سقوط ارتفاع ۷۶ سانتی متر
c. د نمونه راخستلو اندازه ۴۵ سانتی متر
d. د ضرباتو تعداد د هر ۱۵ سانتی متر نفوذ(داخلیدلو) لپاره یاداشت شی

SPT Hammer



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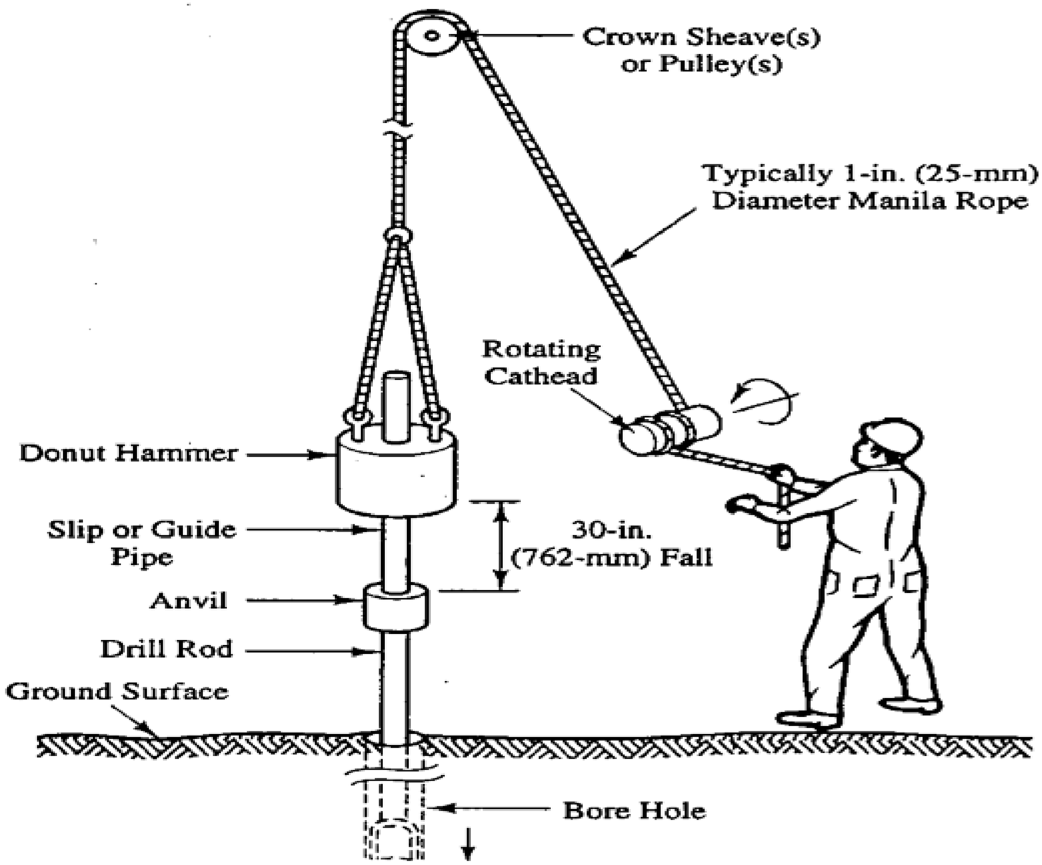
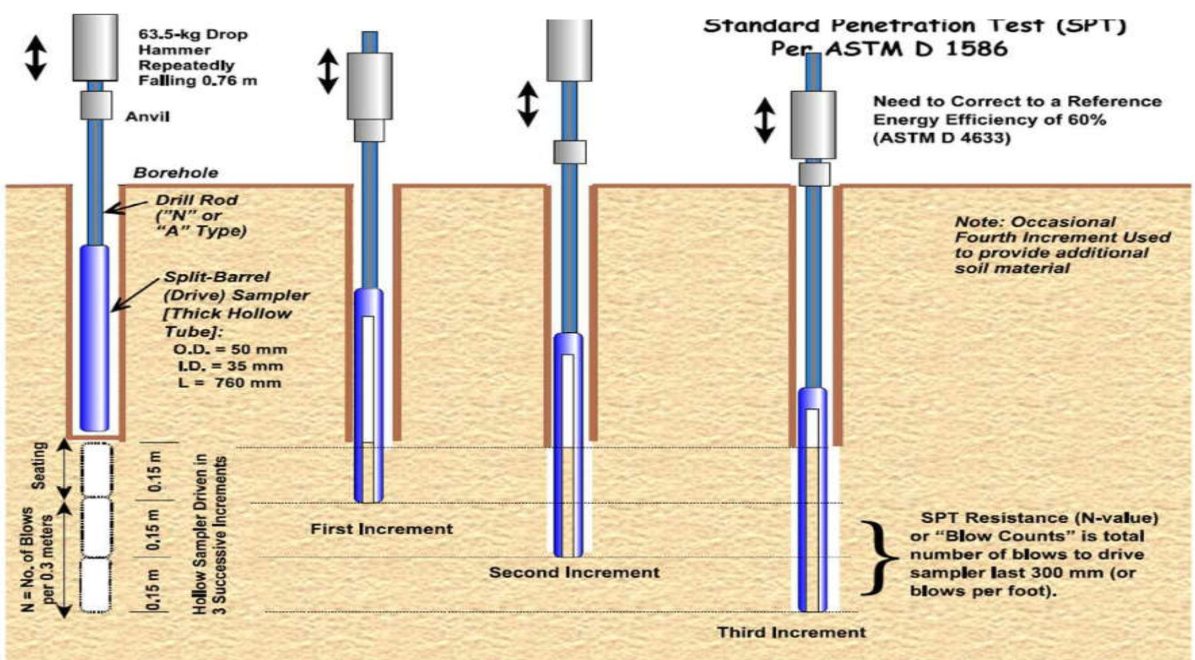


- Obtair
- Simpl
- Suitab
- Can p
- Availa

Standard Penetration Test (SPT)
Per ASTM D 1586



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Standard Split Spoon Sampler

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د SPT څخه کوم موارد(ارقام) لاسته راوړه شوی؟

a. د D_r (نسبتی تراکم) لاسته راوړو
b. د ϕ تعیین
c. د C تعیین
d. د خاورو نوعیت او خواص
e. د برشی امواجو سرعت

Soil Type	D_r	Ψ	K_0	OCR	S_t	s_u	ϕ	E,G	M	G_0	k	c_h
Sand	3-4	4		5			3-4	4-5		4-5		
Clay		5	5	4	5	3-4	5	4-5	5	4-5	5	5

1 = high; 2 = high to moderate; 3 = moderate; 4 = moderate to low; 5 = low;
Blank = no applicability

Where:

D_r	Relative density	ϕ	Friction angle
Ψ	State Parameter	K_0	In-situ stress ratio
E, G	Young's and Shear moduli	G_0	Small strain shear moduli
OCR	Over consolidation ratio	M (or m_v)	Compressibility
s_u	Undrained shear strength	S_t	Sensitivity
c_H	Coefficient of consolidation	k	Permeability

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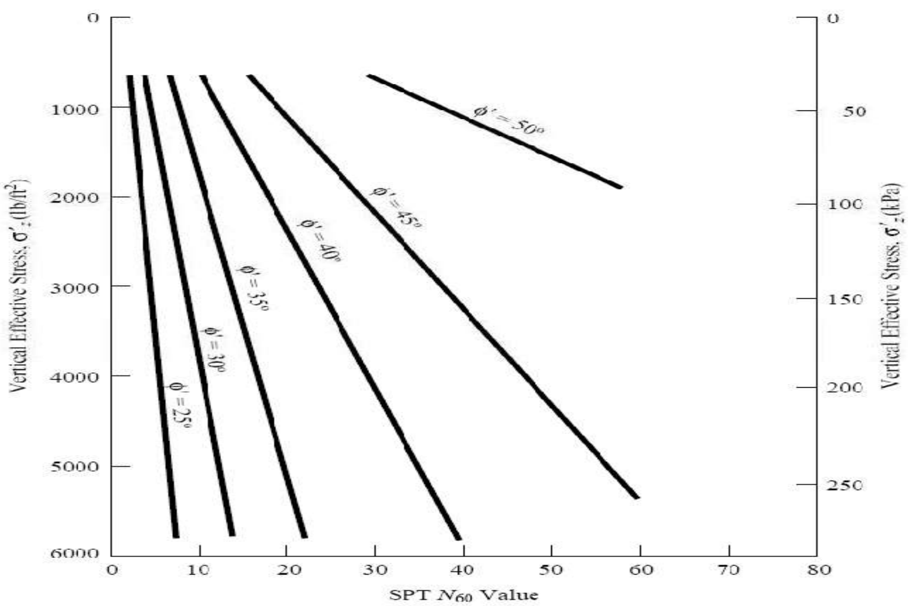
Type of Soil	Pile Design	Bearing Capacity	Settlement	Compaction Control	Liquefaction
Sand	2 – 3	1 – 2	2 – 3	2 – 3	1 – 2
Clay	3 – 4	3 – 4	4 – 5	4 – 5	1 – 2
Intermediate Soils	3 – 4	2 – 3	3 – 4	4 – 5	1 – 2

Reliability rating: 1 = High; 2 = High to moderate; 3 = Moderate; 4 = Moderate to low; 5 = low



Schmertman(1975) :

$$\phi' = \tan^{-1}\left[\frac{N_{60}}{12.2 + 20.3\left(\frac{\sigma'_0}{P_a}\right)}\right]^{0.34}$$

σ'_0 = effective overburden stress

P_a = atmospheric pressure in the same unit as σ'_0

($\approx 100\ kN/m^2$ or $2000\ lb/ft^2$)

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Peck, Hanson and Thornburn (1974):

$\phi'(\text{deg}) = 27.1 + 0.3(N_1)_{60} - 0.00054[(N_1)_{60}]^2$

Hatanaka and Uchida (1996):

$\phi' = \sqrt{20(N_1)_{60}} + 20$

Stroud (1974): $s_u = KN_{60}$

s_u = Undrained shear strength of clay

K=Constant=3.5-6.5 kN/m² (0.507 − 0.942 lb/in²) average 4.4 kN/m²

Hara et al. (1971): $c_u\left(kN/m^2\right) = 29N_{60}^{0.72}$

Mayne and Kemper (1988): $OCR = 0.193\left(\frac{N_{60}}{\sigma'_o}\right)^{0.689}$

σ'_o = effective vertical stress in MN/m

TABLE 7.4 Correlation of N, N_{60}, γ, D_r, and ϕ' for Coarse-Grained Soils

N	N_{60}	Compactness	γ (kN/m³)	D_r (%)	ϕ' (degrees)
0–4	0–3	Very loose	11–13	0–20	26–28
4–10	3–9	Loose	14–16	20–40	29–34
10–30	9–25	Medium	17–19	40–70	35–40*
30–50	25–45	Dense	20–21	70–85	38–45*
>50	>45	Very dense	>21	>85	>45*

*These values correspond to ϕ'_{cs}.

TABLE 7.5 Correlation of N_{60} and s_u for Saturated Fine-Grained Soils

N_{60}	Description	s_u (kPa)
0–2	Very soft	<10
3–5	Soft	10–25
6–9	Medium	25–50
10–15	Stiff	50–100
15–30	Very stiff	100–200
>30	Extremely stiff	>200

SPT Correlations in Granular Soils

not corrected for overburden

$(N)_{60}$	D_r (%)	consistency
0-4	0-15	very loose
4-10	15-35	loose
10-30	35-65	medium
30-50	65-85	dense
>50	85-100	very dense

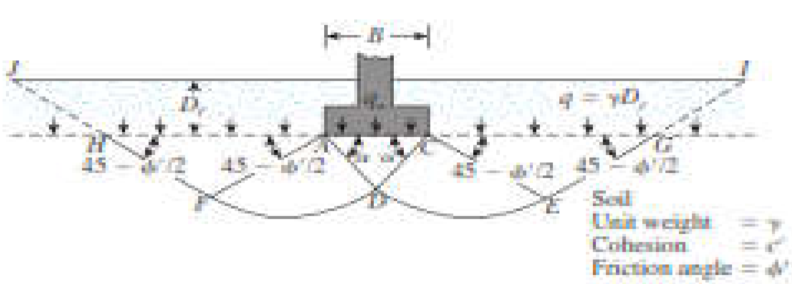

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Table 3.1 Terzaghi's Bearing Capacity Factors—Eqs. (3.4), (3.5), and (3.6) a From Kumbhojkar (1993)

ϕ'	N_c	N_q	N_γ[a]	ϕ'	N_c	N_q	N_γ[a]
0	5.70	1.00	0.00	26	27.09	14.21	9.84
1	6.00	1.10	0.01	27	29.24	15.90	11.60
2	6.30	1.22	0.04	28	31.61	17.81	13.70
3	6.62	1.35	0.06	29	34.24	19.98	16.18
4	6.97	1.49	0.10	30	37.16	22.46	19.13
5	7.34	1.64	0.14	31	40.41	25.28	22.65
6	7.73	1.81	0.20	32	44.04	28.52	26.87
7	8.15	2.00	0.27	33	48.09	32.23	31.94
8	8.60	2.21	0.35	34	52.64	36.50	38.04
9	9.09	2.44	0.44	35	57.75	41.44	45.41
10	9.61	2.69	0.56	36	63.53	47.16	54.36
11	10.16	2.98	0.69	37	70.01	53.80	65.27
12	10.76	3.29	0.85	38	77.50	61.55	78.61
13	11.41	3.63	1.04	39	85.97	70.61	95.03
14	12.11	4.02	1.26	40	95.66	81.27	115.31
15	12.86	4.45	1.52	41	106.81	93.85	140.51
16	13.68	4.92	1.82	42	119.67	108.75	171.99
17	14.60	5.45	2.18	43	134.58	126.50	211.56
18	15.12	6.04	2.59	44	151.95	147.74	261.60
19	16.56	6.70	3.07	45	172.28	173.28	325.34
20	17.69	7.44	3.64	46	196.22	204.19	407.11
21	18.92	8.26	4.31	47	224.55	241.80	512.84
22	20.27	9.19	5.09	48	258.28	287.85	650.67
23	21.75	10.23	6.00	49	298.71	344.63	831.99
24	23.36	11.40	7.08	50	347.50	415.14	1072.80
25	25.13	12.72	8.34				

[a] From Kumbhojkar (1993)

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Table 3.2 Terzaghi's Modified Bearing Capacity Factors N'_c, N'_q, and N'_γ

ϕ'	N'_c	N'_q	N'_γ	ϕ'	N'_c	N'_q	N'_γ
0	5.70	1.00	0.00	26	15.53	6.05	2.59
1	5.90	1.07	0.005	27	16.30	6.54	2.88
2	6.10	1.14	0.02	28	17.13	7.07	3.29
3	6.30	1.22	0.04	29	18.03	7.66	3.76
4	6.51	1.30	0.055	30	18.99	8.31	4.39
5	6.74	1.39	0.074	31	20.03	9.03	4.83
6	6.97	1.49	0.10	32	21.16	9.82	5.51
7	7.22	1.59	0.128	33	22.39	10.69	6.32
8	7.47	1.70	0.16	34	23.72	11.67	7.22
9	7.74	1.82	0.20	35	25.18	12.75	8.35
10	8.02	1.94	0.24	36	26.77	13.97	9.41
11	8.32	2.08	0.30	37	28.51	15.32	10.90
12	8.63	2.22	0.35	38	30.43	16.85	12.75
13	8.96	2.38	0.42	39	32.53	18.56	14.71
14	9.31	2.55	0.48	40	34.87	20.50	17.22
15	9.67	2.73	0.57	41	37.45	22.70	19.75
16	10.06	2.92	0.67	42	40.33	25.21	22.50
17	10.47	3.13	0.76	43	43.54	28.06	26.25
18	10.90	3.36	0.88	44	47.13	31.34	30.40
19	11.36	3.61	1.03	45	51.17	35.11	36.00
20	11.85	3.88	1.12	46	55.73	39.48	41.70
21	12.37	4.17	1.35	47	60.91	44.45	49.30
22	12.92	4.48	1.55	48	66.80	50.46	59.25
23	13.51	4.82	1.74	49	73.55	57.41	71.45
24	14.14	5.20	1.97	50	81.31	65.60	85.75
25	14.80	5.60	2.25				

که د دغه ساحه تحقیقات په وخت شوی وایی!!!!

نو نن به د پیزا مانی داسی نه وایی

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دوهم فصل

تهداب (Foundation)

تهداب د ساختمان هغه برخه ده چې پر ساختمان وارد شوی بار د خاورې هغه برخې ته لیږدوي چې تهداب پرې پروت دی ، په دې کې د ځمکې د لیول له سطحې څخه لاندې برخي(Sub structure) او هغه اضافي برخې چې د ساختمان په شمول وزنونه لاندې خاورې ته لیږدوی شاملې دي ،

او Sub Structure د تهداب هغه برخه ده چې د ځمکې د لیول له سطحې د ساختمان د پورته برخې (Supper structure) لپاره بنیاد یا قاعدې دنده تر سره کوي.

زیات د استفاده وړ اصطلاحات د تهداب ډیزین کی

1:- تهداب(Foundation) - تهداب د ساختمان هغه برخه ده چې پر ساختمان وارد شوی بار د خاورې هغه برخې ته لیږدوي او د اساس په نوم هم یادیږی.

2:- سپل (Footing)- سپل عبارت د تهداب له یو برخی څخه دی چه د ځمکې سر مستقیم په تماس کی دی

3:- د تهداب خاوره(Foundation Soil)- عبارت د ځمکي خارجې سطح څخه دی چه په تهداب وارد شوی بار احجار یا لاندی سطح ته انتقالوی.

4:-د خاوری برداشت قابلیت (د خاوره د زغم قوی)(Soil Bearing Capacity)- عبارت له هغه زغمونکی توان (توان تحمل پذیری) څخه دی چی خاوری یا احجار یی د قوی په مقابل کی لری

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6:- مجموعی شدت د فشار(Gross Pressure intensity)- عبارت له مجموعی فشار په تهداب یا سپل باندی په شمول د ټولو وزنونو لکه د سپل وزن ، د پرکاری خاوری وزن او داسی نور

7:- خالص شدت دفشار(Net Pressure intensity)- عبارت له مجموعی شدت د فشار بیدون دی اضافی خاورونه لکه

$$q_n=q-\gamma*D_f$$

q-مجموعی شدت دفشار

γ-د خاوری حجم ورن

D_f- د تهدات عمق(ژوروالی)

8:- نهایی د خاوری برداشت قابلیت (Ultimate Bearing Capacity)-نهایی براداشت قابلیت عبارت له هغه اصغری مجموعی فشار په تهداب باندی دی چی خاوری برش ونکړی دی ، او نشست هم د مجازی حد څخه زیات نشی .

9:-مصوون خالص د خاوری برداشت قابلیت(Net Safe Bearing Capacity)- عبارت د نهایی د خاوری برداشت قابلیت تقسیم پر یو د مصوونیت فکتور(Factor of Safety) باندی لکه :

$$q_{ns}=q_{ult/SF}$$

10:- مجازی فشار قابل د تحمل(زغم)(Allowable Bearing Pressure)-عبارت له خالص بار شدت چه نه د خاوری برش باعث شی او نه د مجازی نشست له حد زیات شی .

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Bearing Capacity Analyses for foundation

تحلیل برداشت قابلیت د تهداب لپاره

ویسیک(Vesic 1940-1973) د پنځلس نه زیاتی معادلی(تیوری) دخاوری برداشت قابلیت ته ترتیب کړی مکر یو معادلی (تیوری) هم نن سبا قابل د استفادی نه دی ، په همدی وختونو که (1943) پراندیل(Prandtl) په یو معادله(تیوری) کار شروع کړی مکر تکمیل وایی ونشو ، ترزاغی (Terzaghi) د پراندیل معادلی ته انکشاف ورکړ او یو معادلی د خاوری برداشت قابلیت لپاره ترتیب کړل چه تر نن پور قابل د استفادی ده ،او دغه معادله(تیور) د ترزاغی معادله په نوم یادیږی ، او د کم عمق تهدابونو لپاره کارول کیږی ، یعنی H≤B ، H-د تهداب ارتفاع او B- د تهداب عرض دی ، د ترزاغی معادله(تیوری) ته نور پوهانو لکه مایراوف ، هانسن او وزیک انکشاف او یا همدا شان معادله ترتیب کړی خو نن سبا د مایراوف معادله کوم چې د ترزاغی معادله ته یی د عمق ، شکل او د قوی زاویه په نظر که نیول دی ډیر زیات د استفادی وړ دی ، او دغه معادله د عمومی (ترزاغی-مایراوف) معادلی په نوم یادیږی.

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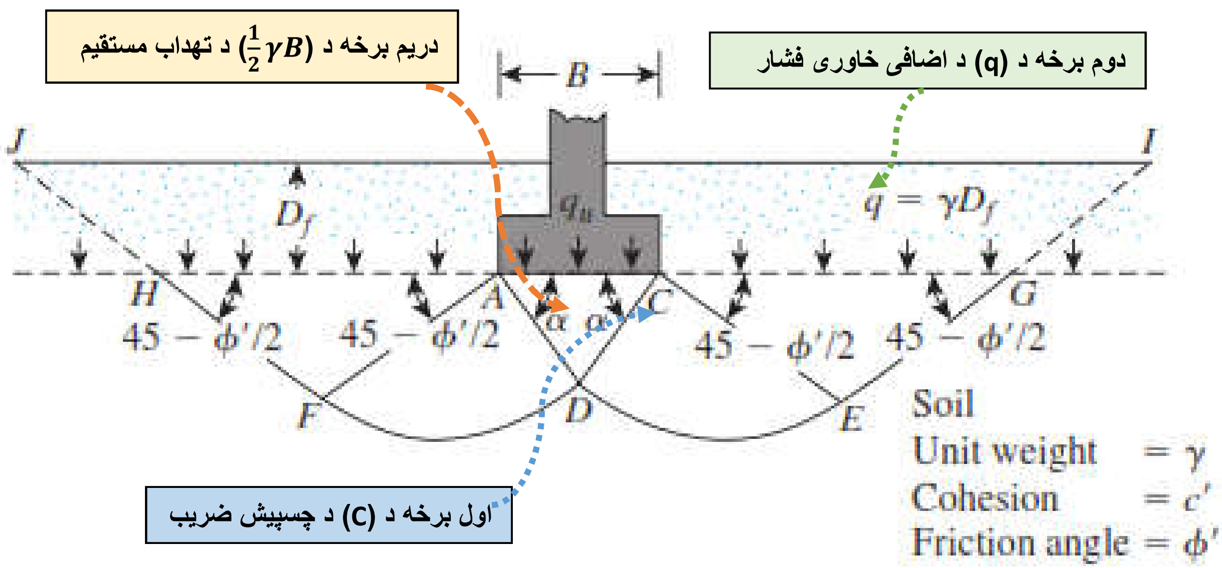
ترتیب کوونکی:- انجینر عبدالحمید (رسولی)
مضمون:د تهداب ډیزاین

1:- د ترزاغی (Terzaghi) معادلی(تیوری)

د ترزاغی تیوری د لاندی شکل نه تشکل شوی دی ، ترزاغی تهداب په دری برخو ویشل دی



او په نتیجه که لاندنی معادله تشکیل شوی

$$q = C + q + \frac{1}{2}\gamma \quad B$$

په دغه معادله کی بعض مشکلات ولیدل شول ، لکه د برداشت قابلیت کم خودل ، د مسطیل ، مربع او دایروی شکل په نظر نه نیول او داسی نور ، بنا ترزاغی پسی له ډیرو تحقیقاتو یو د (N) ضریب د دریو برخو لپاره په جدول کی ترتیب کړی چه نظر د اصطحکاک زاویه( ) ته دی او معادلی په لاندی شکل شوی

د مستطیل او مسلسل تهدابونو لپاره	$q_u = c'N_c + qN_q + \frac{1}{2}\gamma BN_\gamma$ (continuous or strip foundation)	(3.3)
د مربعی تهدابونو لپاره	$q_u = 1.3c'N_c + qN_q + 0.4\gamma BN_\gamma$ (square foundation)	(3.7)
د دایروی تهدابونو لپاره	$q_u = 1.3c'N_c + qN_q + 0.3\gamma BN_\gamma$ (circular foundation)	(3.8)

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نوټ: لاندنی جدول صرف د ترزاغی معادلو لپاره استعمالیږی او د یادونی وړ دی چه د اصطحکاک زاویه ( ) او د چسپش ضریب (C) په ساختمانی لابراتوارنو کې د یو خاص ماشین الاتو په واسطه پیدای کیږی او د جیوتکنیکل رپورت په واسطه د انجینرانو ته ورکول کیږی.

Table 3.1 Terzaghi's Bearing Capacity Factors—Eqs. (3.4), (3.5), and (3.6) a From Kumbhojkar (1993)

ϕ'	N_c	N_q	N_γ[a]	ϕ'	N_c	N_q	N_γ[a]
0	5.70	1.00	0.00	26	27.09	14.21	9.84
1	6.00	1.10	0.01	27	29.24	15.90	11.60
2	6.30	1.22	0.04	28	31.61	17.81	13.70
3	6.62	1.35	0.06	29	34.24	19.98	16.18
4	6.97	1.49	0.10	30	37.16	22.46	19.13
5	7.34	1.64	0.14	31	40.41	25.28	22.65
6	7.73	1.81	0.20	32	44.04	28.52	26.87
7	8.15	2.00	0.27	33	48.09	32.23	31.94
8	8.60	2.21	0.35	34	52.64	36.50	38.04
9	9.09	2.44	0.44	35	57.75	41.44	45.41
10	9.61	2.69	0.56	36	63.53	47.16	54.36
11	10.16	2.98	0.69	37	70.01	53.80	65.27
12	10.76	3.29	0.85	38	77.50	61.55	78.61
13	11.41	3.63	1.04	39	85.97	70.61	95.03
14	12.11	4.02	1.26	40	95.66	81.27	115.31
15	12.86	4.45	1.52	41	106.81	93.85	140.51
16	13.68	4.92	1.82	42	119.67	108.75	171.99
17	14.60	5.45	2.18	43	134.58	126.50	211.56
18	15.12	6.04	2.59	44	151.95	147.74	261.60
19	16.56	6.70	3.07	45	172.28	173.28	325.34
20	17.69	7.44	3.64	46	196.22	204.19	407.11
21	18.92	8.26	4.31	47	224.55	241.80	512.84
22	20.27	9.19	5.09	48	258.28	287.85	650.67
23	21.75	10.23	6.00	49	298.71	344.63	831.99
24	23.36	11.40	7.08	50	347.50	415.14	1072.80
25	25.13	12.72	8.34				

[a]From Kumbhojkar (1993)

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مثال : - یو مربع شکل تهداب چې $2m \times 2m$ ابعاد لری په پلان کې لرو او د ساحه جیوتکنیکل رپورټ له مخ لروی

د اصطحکاک زاویه ϕ =25 — د خاوری فی واحد حجم وزن $\gamma = 16.5 \frac{KN}{m^3}$

د خاوری چسپش ضریب $C = 20 \frac{KN}{m^2}$ — د مصوونیت ضریب SF=3

د تهداب عمق D_f=1.5m

په تهداب باندی دخاوری مجازی فشار (q_{all}) او په تهداب باندی د خاوری لخوا مجموعی قوی(Q) پیدا کړی .

حل:

$$q_u = 1.3c'N_c + qN_q + 0.4\gamma BN_\gamma$$

کله چی د اصطحکاک زاویه ϕ =25 وی د ترزاغی له جدول لروی

Table 3.1 Terzaghi's Bearing Capacity Factors—Eqs. (3.4), (3.5), and (3.6) a From Kumbhojkar (1993)

ϕ'	N_c	N_q	N_γ[a]	ϕ'	N_c	N_q	N_γ[a]
20	17.69	7.44	3.64	46	196.22	204.19	407.11
21	18.92	8.26	4.31	47	224.55	241.80	512.84
22	20.27	9.19	5.09	48	258.28	287.85	650.67
23	21.75	10.23	6.00	49	298.71	344.63	831.99
24	23.36	11.40	7.08	50	347.50	415.14	1072.80
25	25.13	12.72	8.34				

N_C=25.13 — $C' = 20 \frac{KN}{m^2}$ — $\gamma = 16.5 \frac{kg}{m^3}$

N_q=12.72 — SF=3

N_γ=8.34 — D_f=1.5m

$$q_u = 1.3c'N_c + qN_q + 0.4\gamma BN_\gamma$$

$$q_u = (1.3)(20)(25.13) + (1.5 \times 16.5)(12.72) + (0.4)(16.5)(2)(8.34)$$
$$= 653.38 + 314.82 + 110.09 = 1078.29 \text{ kN/m}^2$$

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د مجازی فشار د پیدا کولو لپاره لرو

$$q_{all}=\frac{q_u}{SF} \qquad \frac{1078.29}{3}\approx 359.5\frac{KN}{m^2}$$

د مجموعی قوی لپاره لرو

$$q_{all}=q_{all}\times B^2 \qquad 359.5\times 2^2\approx 1438KN$$

2:- د مایراوف - ترزاغی معادله (عمومی معادله) د خاوری برداشت قابلیت لپاره

د ترزاغی معادلی ته مایراوف انکشاف ورکړی ، مایراوف د تهداب د شکل ، عمق ضرایب په معادله کی اضاف کړل . چې تیوری او معادلی د ترزاغی په شان دی نو نوی معادله به په لاندی ډول وی

$$q_u = c'N_cF_{cs}F_{cd}F_{ci} + qN_qF_{qs}F_{qd}F_{qi} + \tfrac{1}{2}\gamma BN_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i} \qquad (3.19)$$

In this equation:

c' = cohesion
q = effective stress at the level of the bottom of the foundation
γ = unit weight of soil
B = width of foundation (= diameter for a circular foundation)
$F_{cs}, F_{qs}, F_{\gamma s}$ = shape factors — تهداب د شکل ضریب
$F_{cd}, F_{qd}, F_{\gamma d}$ = depth factors — تهداب د عمق ضریب
$F_{ci}, F_{qi}, F_{\gamma i}$ = load inclination factors — د قوی د عمل زاویه ضریب
N_c, N_q, N_γ = bearing capacity factors — د برداشت قابلیت ضریب

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د پورتنی معادلی د تهداب شکل ، د تهداب عمق او د قوی د عمل زاویه ضرایب د لاندنی روابطو په اساس سر لاسته راځی.

1: د شکل ضرایب

Shape

$$F_{cs} = 1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$$

$$F_{qs} = 1 + \left(\frac{B}{L}\right)\tan\phi'$$

$$F_{\gamma s} = 1 - 0.4\left(\frac{B}{L}\right)$$

2:- د عمق ضرایب څلور حالت لری چې په لاندی ډول دی

اول حالت : د تهداب عمق(D_f) پر د تهداب عرض (B) کوچنی یا مساوی د 1 سره وی او د اصطحکاک زاویه مساوی د صفر سره وی

$$\frac{D_f}{B} \le 1$$

For $\phi = 0$:

$$F_{cd} = 1 + 0.4\left(\frac{D_f}{B}\right)$$

$$F_{qd} = 1$$

$$F_{\gamma d} = 1$$

دوهم حالت : د تهداب عمق (D_f) پر د تهداب عرض (B) کوچنی یا مساوی د 1 سره وی او د اصطحکاک زاویه له صفر څخه زیات وی

$$\frac{D_f}{B} \le 1$$

For $\phi' > 0$:

$$F_{cd} = F_{qd} - \frac{1 - F_{qd}}{N_c \tan\phi'}$$

$$F_{qd} = 1 + 2\tan\phi'(1 - \sin\phi'_1)^2\left(\frac{D_f}{B}\right)$$

$$F_{\gamma d} = 1$$

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$$\frac{D_f}{B} > 1$$

For $\phi = 0$:

$$F_{cd} = 1 + 0.4 \underbrace{\tan^{-1}\left(\frac{D_f}{B}\right)}_{\text{radians}}$$

$$F_{qd} = 1$$

$$F_{\gamma d} = 1$$

دریم حالت : د تهداب عمق (D_f) پر د تهداب عرض (B) لوی د 1 وی او د اصطحکاک زاویه له صفر سره مساوی وی

For $\phi' > 0$:

$$\frac{D_f}{B} > 1$$

$$F_{cd} = F_{qd} - \frac{1 - F_{qd}}{N_c \tan \phi'}$$

$$F_{qd} = 1 + 2 \tan \phi' (1 - \sin \phi')^2 \underbrace{\tan^{-1}\left(\frac{D_f}{B}\right)}_{\text{radians}}$$

$$F_{\gamma d} = 1$$

دریم حالت : د تهداب عمق (D_f) پر د تهداب عرض (B) لوی د 1 وی او د اصطحکاک زاویه له صفر سره مساوی وی

3:- قوی په زاویه ضرایب

نوټ: که قوی په تهداب باندی عمود وی نو ضرایب به مساوی د 1 سره وی

Inclination

$$F_{ci} = F_{qi} = \left(1 - \frac{\beta^\circ}{90^\circ}\right)^2$$

$$F_{\gamma i} = \left(1 - \frac{\beta}{\phi'}\right)$$

β = inclination of the load on the foundation with respect to the vertical

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مثال : - یو مربع شکل تهداب چې 2m×2m ابعاد لری په پلان کې لرو او د ساحه جیوتکنیکل رپورټ له مخ لروی

د اصطحکاک زاویه ϕ =25 $\gamma = 16.5\frac{KN}{m^3}$ د خاوری فی واحد حجم وزن

د خاوری چسپش ضریب $C = 20\frac{KN}{m^2}$ د مصوونیت ضریب SF=3

د تهداب عمق D_f=1.5m

په تهداب باندی دخاوری مجازی فشار (q_{all}) او په تهداب باندی د خاوری لخوا مجموعی قوی(Q) پیدا کړی .

حل: $$q_u = c'N_cF_{cs}F_{cd}F_{ci} + qN_qF_{qs}F_{qd}F_{qi} + \frac{1}{2}\gamma BN_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$$

کله چی د اصطحکاک زاویه ϕ =25 وی د عمومی جدول نه لروی

Table 3.3 Bearing Capacity Factors

ϕ'	N_c	N_q	N_γ	ϕ'	N_c	N_q	N_γ
20	14.83	6.40	5.39	46	152.10	158.51	330.35
21	15.82	7.07	6.20	47	173.64	187.21	403.67
22	16.88	7.82	7.13	48	199.26	222.31	496.01
23	18.05	8.66	8.20	49	229.93	265.51	613.16
24	19.32	9.60	9.44	50	266.89	319.07	762.89
25	20.72	10.66	10.88				

N_c=20.72 , N_q=10.66 , N_γ=10.88

قوی عمودی دی نو د قوی زاویه ضرایب به مساوی د 1 سره وی

او د تهداب عمق او د تهداب شکل ضرایب با Since the load is vertical, $F_{ci} = F_{qi} = F_{\gamma i} = 1$

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1: اول باید $\frac{D_f}{B}$ چک کړو

$$\frac{D_f}{B} = \frac{1.5}{2} = 0.75 \; < 1$$

نوټ : تهداب شرایط د دوهم حالت لری نو لرو

1: د تهداب د شکل ضرایب

$$F_{cs} = 1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right) = 1 + \left(\frac{2}{2}\right)\left(\frac{10.66}{20.72}\right) = 1.514$$

$$F_{qs} = 1 + \left(\frac{B}{L}\right)\tan\phi' = 1 + \left(\frac{2}{2}\right)\tan 25 = 1.466$$

$$F_{\gamma s} = 1 - 0.4\left(\frac{B}{L}\right) = 1 - 0.4\left(\frac{2}{2}\right) = 0.6$$

1: د تهداب د عمق ضرایب

$$F_{qd} = 1 + 2\tan\phi'\,(1 - \sin\phi')^2\left(\frac{D_f}{B}\right) = 1 + (2)(\tan 25)(1 - \sin 25)^2\left(\frac{1.5}{2}\right) = 1.233$$

$$F_{cd} = F_{qd} - \frac{1 - F_{qd}}{N_c \tan\phi'} = 1.233 - \left[\frac{1 - 1.233}{(20.72)(\tan 25)}\right] = 1.257$$

$$F_{\gamma d} = 1$$

ضرایب پیدا شول اوس یی په لاندی عمومی معادله کی وضع کوی

$$q_u = c' N_c F_{cs} F_{cd} F_{ci} + q N_q F_{qs} F_{qd} F_{qi} + \frac{1}{2}\gamma B N_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i}$$

$$q_u = (20)(20.72)(1.514)(1.257)(1) + (1.5 \times 16.5)(10.66)(1.466)(1.233)(1)$$

$$+ \frac{1}{2}(16.5)(2)(10.88)(0.6)(1)(1) = 788.6 + 476.9 + 107.7 = 1373.2 \text{ kN/m}^2$$

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$$q_{\text{all}} = \frac{q_u}{\text{FS}} = \frac{1373.2}{3} = 457.7 \text{ kN/m}^2$$

$$Q = (457.7)(2 \times 2) = \mathbf{1830.8 \text{ kN}}$$

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دریم فصل

Design of footing

د تهداب ډیزاین

تهداب د ساختمان یو خاص او اساس برخه دی چه د لاندنی موخې لپاره استفاده کیږی

د تهداب موخې (مقاصد)

1:- د تهداب موخه داده چې د ساختمان بار په یو پراخه سیمه باندې وویشل شي تر څو بار په یوه نقطه باندی عمل ونکړی ، یعنی په خاوری د زیات بار له واریدو څخه وژغوري.

2:- د تهداب دویمه موخه داده چې د ساختمان بار په مساوي شکل وویشل شي او د غیر منظمې کیناستنی(نشست) مخنیوي وکړي.

3:-تهداب د ساختمان لپاره د لیول سطحه برابروي

4:-په ځمکه کې د تهداب په ننوتولو سره ساختمان ټیکاو(ثبات) اخلي او له تاویدو څخه یې مخنیوی کیږی.

د تهداب ډولونه

تهداب په عمومی ډول په دو برخه وویشل شوی دی.

1 :- ژور تهدابونه 2:- سطحي تهدابونه

1:- ژور تهدابونه

کله چې تهداب د ساختمان د Super Structure له ټولو څخه ښکتنی نقطې څخه لاندې واقع شي ژور تهداب بلل کیږي ، Pile , pier , well د ژور تهدابونو په ډله کې راځي

2:- سطحي تهدابونه

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کله چې تهداب د ځخه وروسته متصل واقع شي د سطحي تهدابونو په نوم یادیږي سطحي تهدابونه لاندې ډولونه لري.

1:- غزیدلی یا جداګانه تهدابونه(Spread/single Footing)

2:- مرکب یا مسلسل تهدابونه(Combined/Continuous Footing)

3:- فرشی تهدابونه(Raft/Mat Footing)

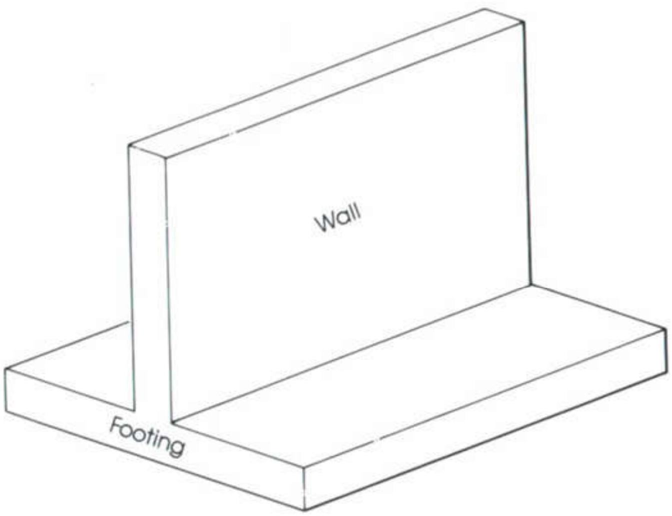
د شکل له مخې تهدابونه

1:- مسلسل یا دیوالی تهدابونه 2:- مربعوي تهدابونه 3:- مایل مربعوي تهدابونه
4 :- پته يي مربعوي تهدابونه 5:- مستطيل شکله تهدابونه 6:- مایل مستطیل شکله تهدابونه

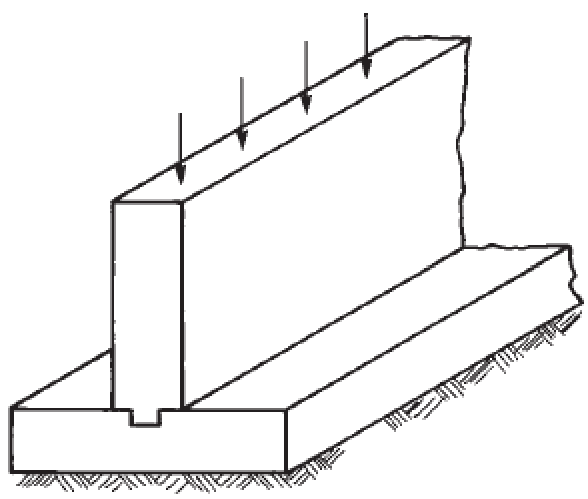
1:- دیوالي تهدابونه

دیوالي تهدابونه د ساختمان بار برداری یوالونو او غیر بار برداری دیوالونو لپاره استفادی کیږی. او همچنان د استنادی دیوالونو لپاره هم کارول کیږی.

Wall footings are used to support structural walls that carry loads for other floors or to support nonstructural walls.



Wall footing.



(a) Strip or wall footing.

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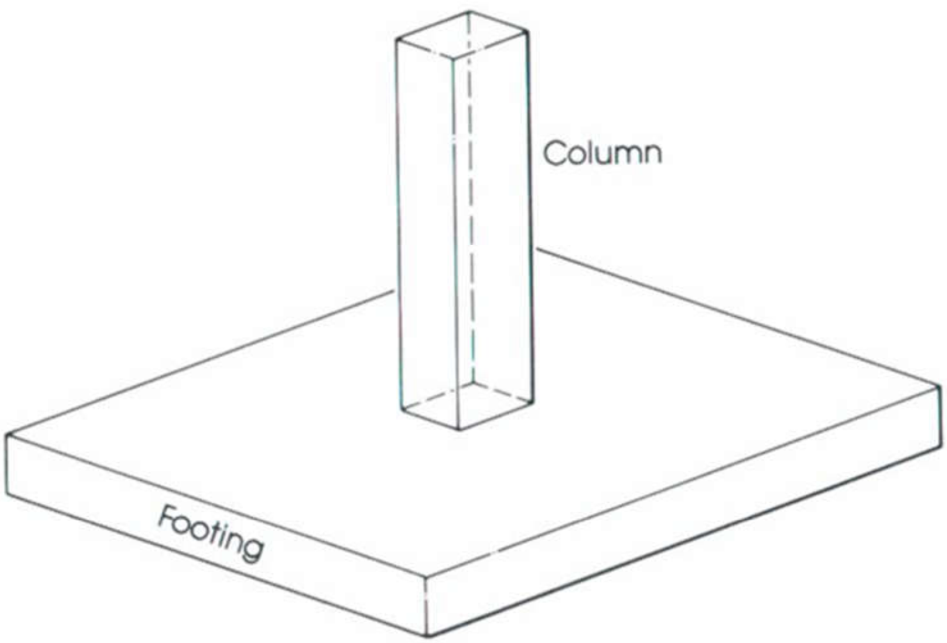
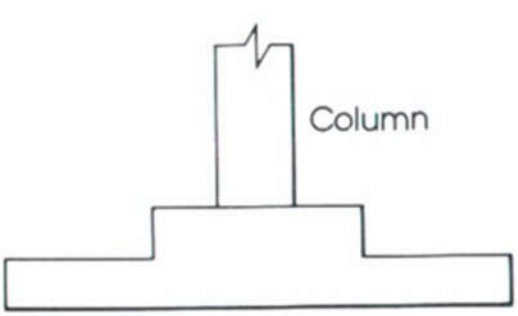
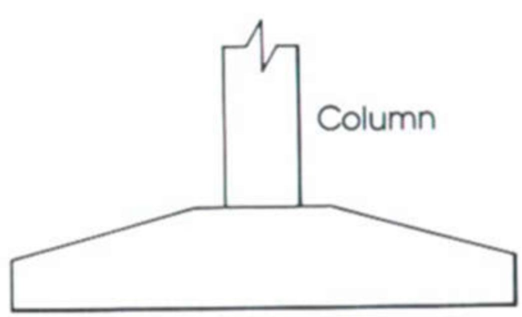
2:- جداگانی تهدابونه

جداگانه تهدابونه د هر کالم(پایه) لپاره یو تهداب استعمالیږی ،او یا د پایو تر منځی فاصله چې زیاتی وی استفادی کیږی او تر ټول اقتصادی ترین تهدابونه دی چه نن سبا ډیر زیات کاروال کیږی.

Isolated or single footings are used to support single columns. This is one of the most economical types of footings and is used when columns are spaced at relatively long distances







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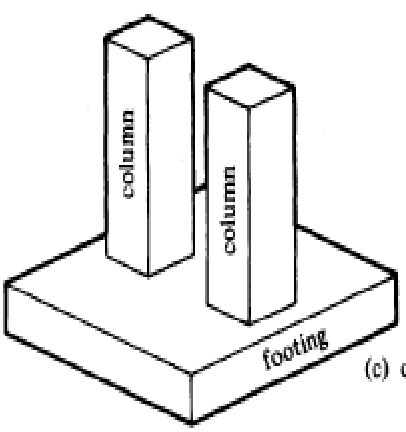
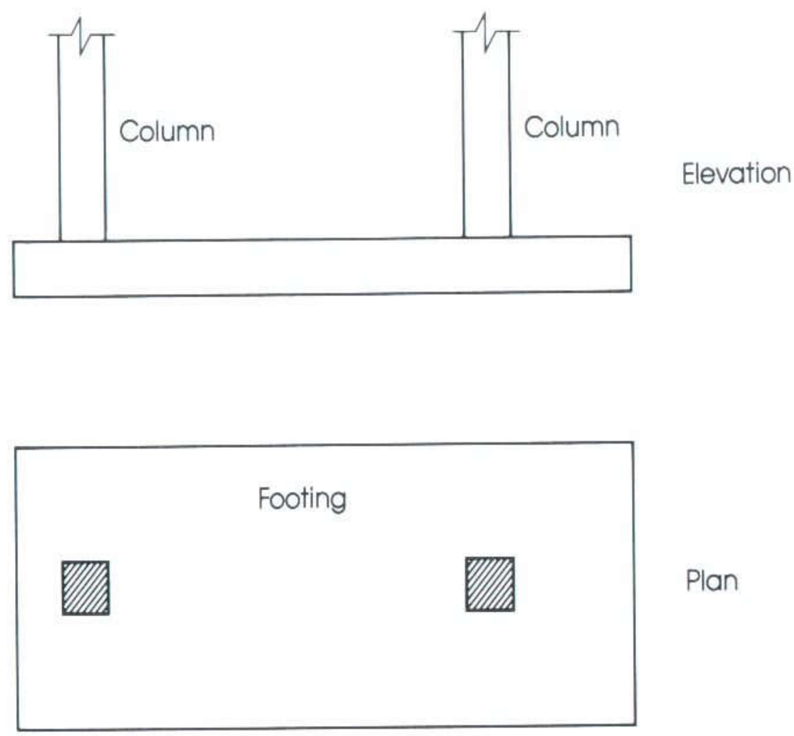
3:- مرکب تهدابونه

مرکب تهدابونه معمولا د دوه کالمونه، یا درې ستنې چې په یو قطار کې وي. او همچنان مرکب تهدابونه هغه وخت کارول کیږي کله چې دوه تهدابونه ډیر نږدې وي یا کله چې یو کالم د ملکیت په اخیرکرښې ته نږدې وي

Combined footings usually support two columns, or three columns in a row. Combined footings are used when two columns are so close that single footings cannot be used or when one column is located at or near a property line.



(c) combined footing



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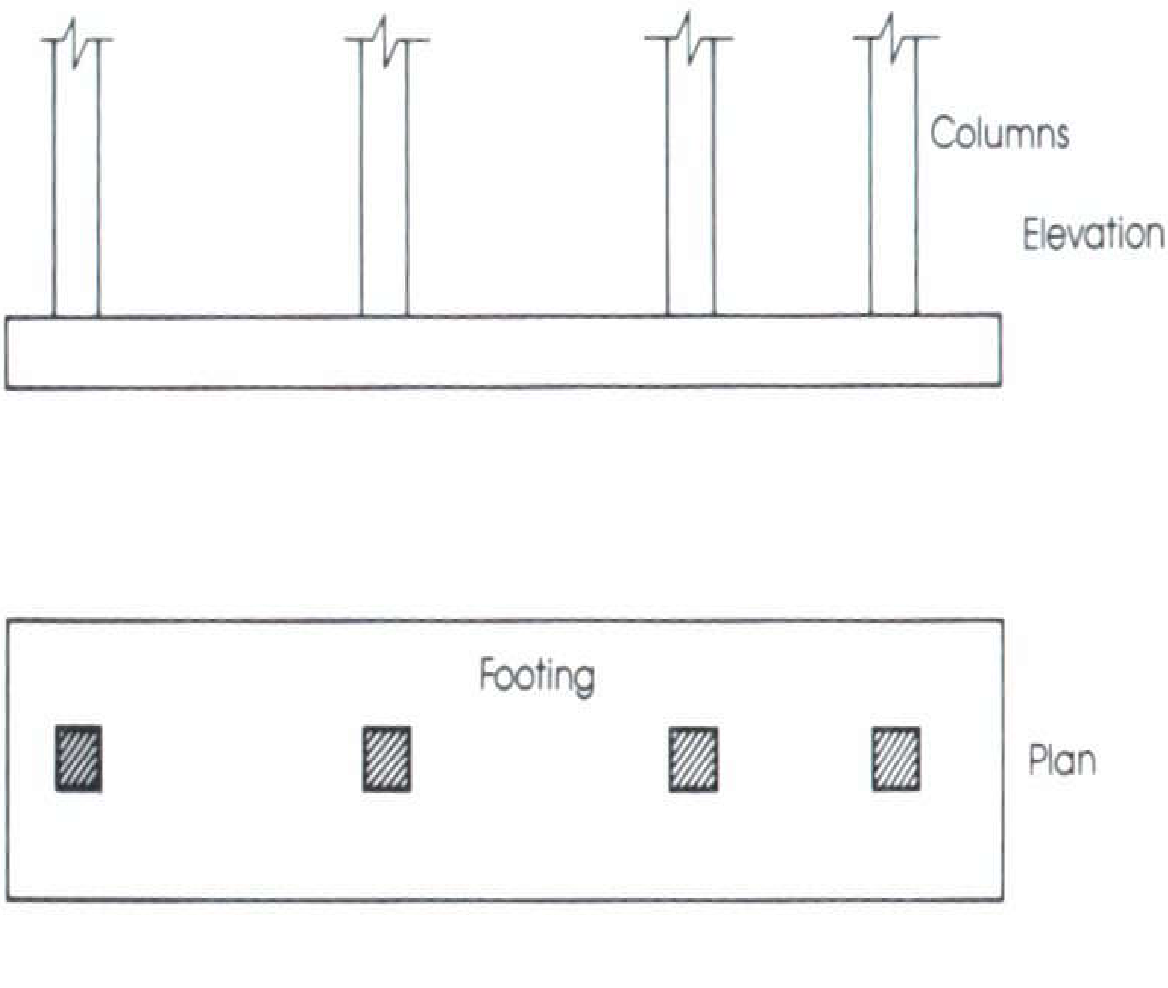
4:- مسلسل تهدابونه

مسلسل تهدابونه د دریو یا زیات تر دریو پایو لپاره استفادی کیږی ، مسلسل تهدابونه د یو وایه ټولو پایو لاندی په معین عرض سره استمعالیږی

Continuous footings support a row of three or more columns. They have limited width and continue under all columns.



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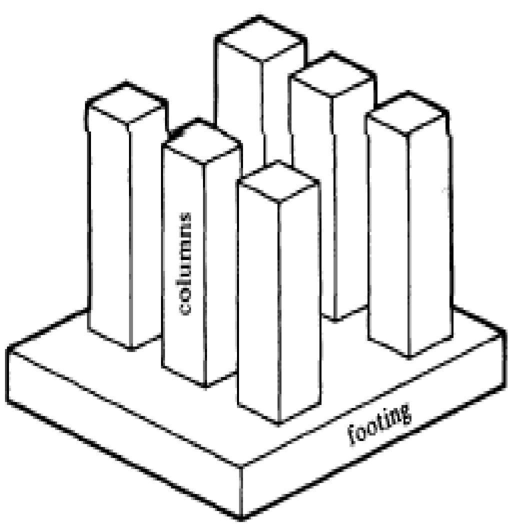
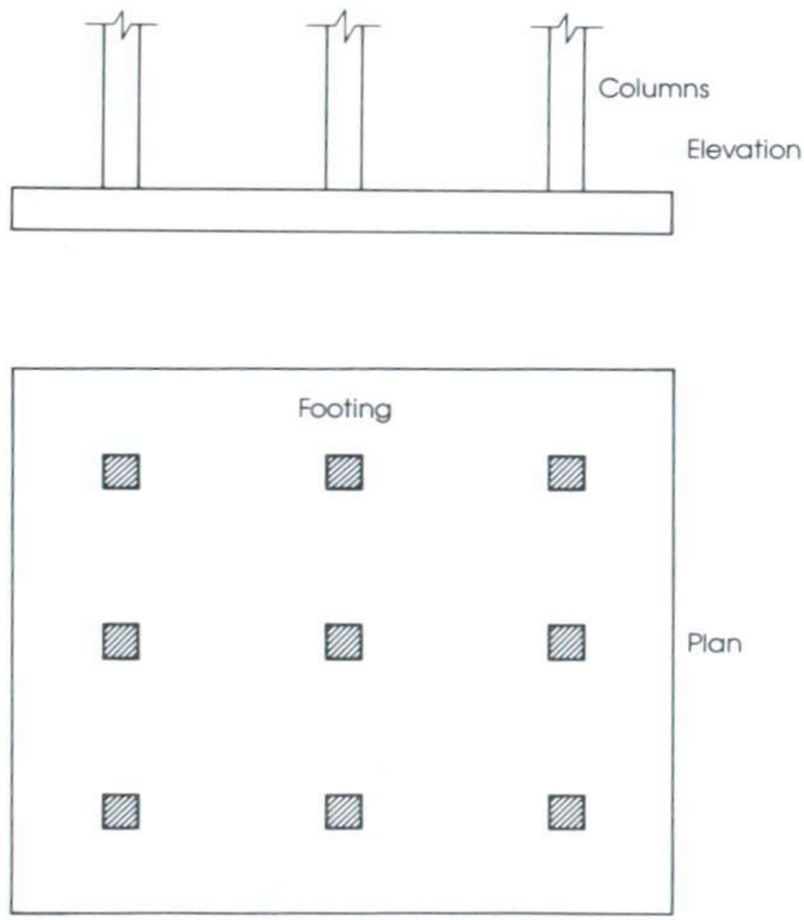
5:- فرشی تهدابونه

فرشی تهداب د ساختمان ټولو پایو لاندی په شکل د فرش استمعالیږی ، دغه تهداب په هغه وخت کی استفادی کیږی چه د خاوری برداشت قابلیت ډیر کمزوری وی یعنی جداګانی تهدابونو مساحت یو د بل سر ټکر کوی

Rafted or mat foundation consists of one footing usually placed under the entire building area. They are used, when soil bearing capacity is low, column loads are heavy single footings cannot be used



(d) mat or raft or floating foundation



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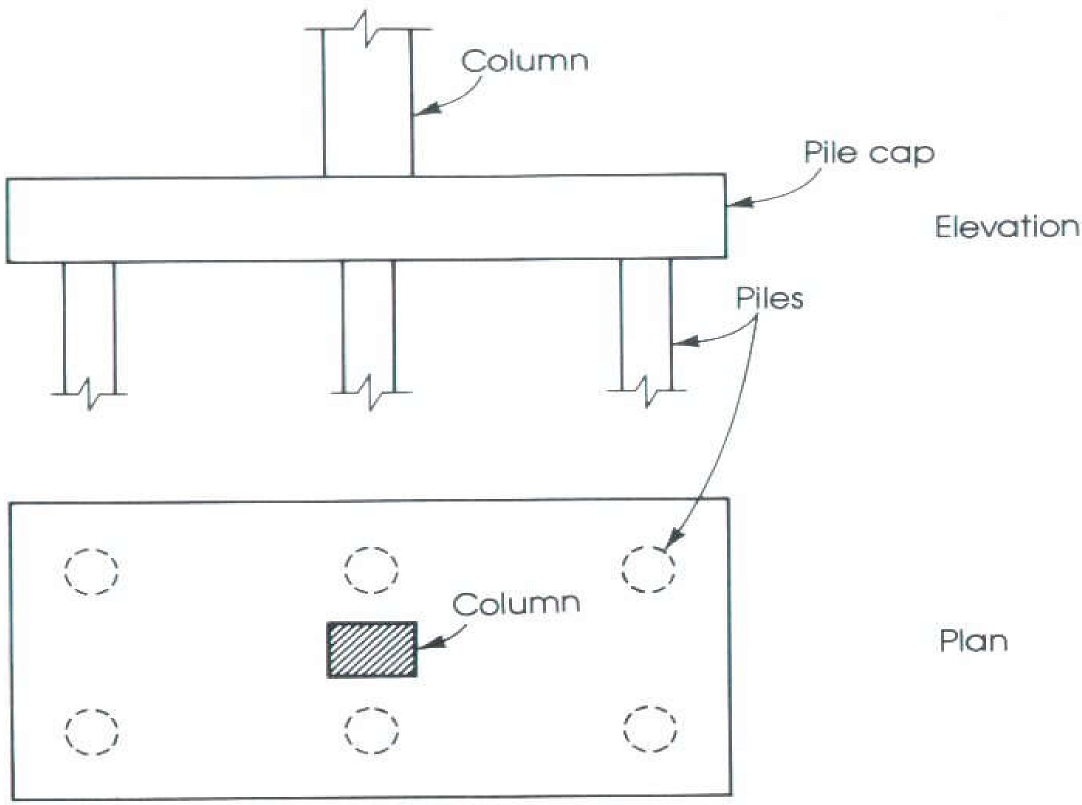
Pile caps are thick slabs used to tie a group of piles together to support and transmit column loads to the piles.



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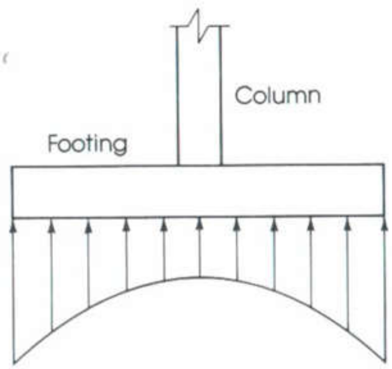
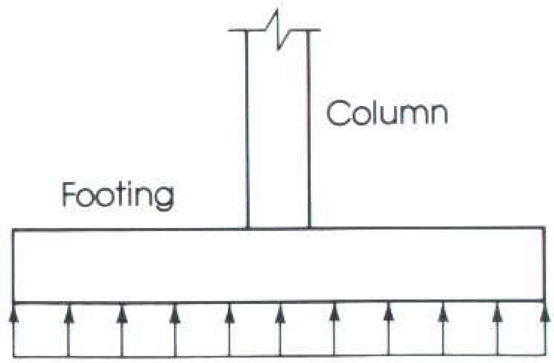
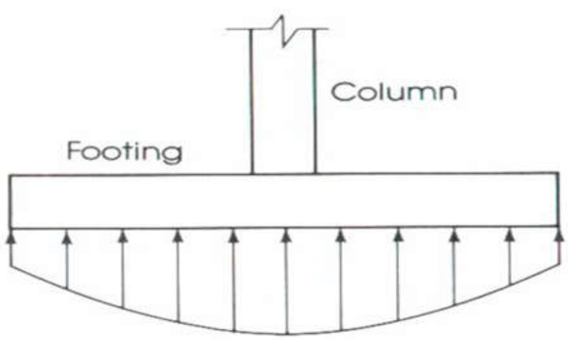
د تهداب لاندی د خاوری عکس العمل نظر د خاوری خواص ته



Soil pressure distribution in cohesive soil.





Soil pressure distribution in cohesionless soil.

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مثال:- دپايي لاندی تهداب ډیزاین کړی چه د پایی ابعاد 18*18in دی او د پایی لخوا نهای بار P_u=300.54Kip ، خالص بار P=235.64 kip عمل کړی وی ، او همچنان د خاوری برداشت قابلیت q_a=2.204kip/ft^2 وی ،او د ډکوونکو خاورو حجمی وزن =0.1Klb/ft^3 او د کانکریټو حجمی وزن γ_c =0.15kip/ft^3 وی ، نظر جیوتکنیکل راپورته د تهداب ارتفاع 18in وی ، نوموړی تهداب د ځمکی له سطحه څخه په 5ft کی لاندی قرار لری ، دا چې د کانکریټو فشاری مقاومت f_c =3ksi وی او د فولادی سخانو کشش مقاومت f_y =40ksi وی

حل:-

راکړ شوی ارقام (Given Data)

P_u=300.54Kip f_c =3ksi

P=235.64 Kip f_y=40ksi

q_a=2.204kip/ft^2 D_f=5ft

γ_{fill} =0.1kip/ft^3 h=18in

γ_c =0.15kip/ft^3 Column size=18*18in

Step-1

د خاوری خالص فشار

$q_e=q_a-w_s$

$w_s=\gamma_{fill}(D_f-h)+\gamma_c*h = 0.1(5-1.5)+0.15*0.15$

$w_s=0.575$

$q_e=q_a-w_s = 2.204-0.575=1.629kip/ft^2$

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$$A = \frac{p}{q_e} = \frac{235.64}{1.624} = 144.63ft^2 \approx 144ft^2$$

که چیری مربع شکل تهداب وی نو لروی

$$B = L \;\; and \;\; B \times B \quad so \;\; B^2 = 144ft^2 \qquad \Rightarrow \sqrt{B} = \sqrt{144}$$

B=12ft

Step-2

(Two way shear or punching shear)په دوهم مرحله کی دو طرفه برش په لاس راوړی

$V_u = P_u - q_a(l_c + d_{avrage}) * (b_c + d_{avrage})$

$$q_a = \frac{P_u}{A} = \frac{300.54}{144} = 2.087\frac{kip}{ft^2}$$

$d_{average}$=h-3-one bar-dia

if we use #8 so $d_{average}$=14in

$$Vu = 300.54 \quad 2.087\left(1.5 + \frac{14}{12}\right) \quad \left(1.5 + \frac{14}{12}\right) = 285.69kip$$

اوس مقاومه عرضانی قوه په لاس راوړو چې عبارت دی له

$$\phi V_c = 0.75 \quad 4 \quad \sqrt{f_c} \quad b_0 \quad d_{average}$$

$$b_0 = 2(l_c + b_c + 2d) or\ 4(b_c + d_{average}) = 4\left(1.5 + \frac{14}{12}\right) = 10.67ft = 128in$$

$$\phi V_c = 0.75 \quad 4 \quad \sqrt{3}000 \quad 128 \quad 14 = \frac{294455.64}{1000} = 294.45kip$$

څرنګه چی زمونږ $Vu < \phi V_c$ زیات دی نو d درست انتخاب شوی یا د تهداب ارتفاع (h) صیحح دی

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اوس یو طرفه(یو لوریزه) اعظمی عرضانی قوه په لاس راوړو

1:- د لوری سره اعظمی عرضانی قوه په لاس راوړو

$$V_{u-B} = q_a\left(\frac{l \quad d}{2} \quad d_{average}\right)B = 2.087\left(\frac{5 \quad 1.5}{2} \quad \frac{14}{12}\right) \quad 12 = 14.609kip$$

اوس د لوری سره موازه مقاومه عرضانی قوه په لاس راوړو

$$\phi V_c = 0.75 \quad 2 \quad \sqrt{f_c} \quad B \quad d_{average}$$

$$\phi V_c = 0.75 \quad 4 \quad \sqrt{3}000 \quad 144 \quad 14 = \frac{331262.6}{1000} = 331.263kip$$

څرنګه چې L او B لوری سره مساوی دی یعنی تهداب مربع شکل دی نو د بل لوری محاسبه نه صرف نظر کیږی.

Step-3

اوس مومنټ په لاس راوړو

$$M_{u-B} = q_a\left(\frac{(L \quad l_c)}{8}\right) \quad B = 2.087\left(\frac{(5 \quad 1.5)}{8}\right) \quad 12 = 38.34kip \quad ft$$

$$\mathrm{M_{u-B}} = 480.18\mathrm{kip} \quad \mathrm{in}$$

$$\mathrm{M_{u-h}} = \frac{M_{u-B}}{\phi} = \frac{480.18\mathrm{kip} \quad \mathrm{in}}{0.9} = 511.315kip \quad in$$

$$\mathrm{R_{h-B}} = \frac{M_{h-B}}{B \quad {d_{average}}^2} = \frac{511.315\mathrm{kip} \quad \mathrm{in}}{12 \quad 12 \quad 14^2} = 18.11PSI$$

$$\rho_B = 0.85\frac{f_c}{f_y}\left[1 \quad \sqrt{(1 \quad \frac{2\mathrm{R}_h}{0.85f_c})}\right] = 0.85\frac{3}{40}\left[1 \quad \sqrt{(1 \quad \frac{2 \quad 18.11}{0.85 \quad 3000})}\right]$$

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$$\rho_B = 0.000454$$

چون رو $\rho_B < \rho_{min}$ لوی دی بنا ρ_{min} استفادی کوی

$$As_{min} = \rho_{min} \quad B \quad d_{average} = 0.002 \quad 12 \quad 12 \quad 14 = 4.032in^2$$

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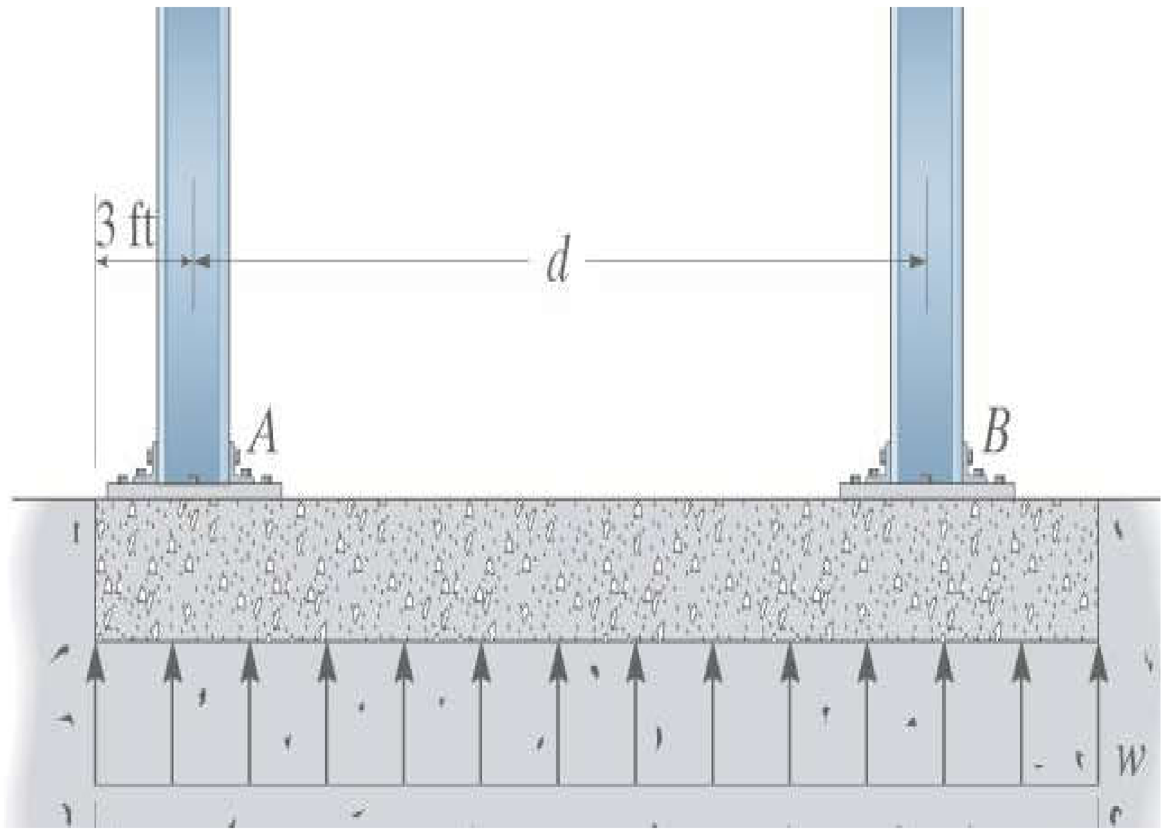
Footing Design
Part II
Combined footing



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مرکب تهدابونه

مرکب تهدابونه د لاندي اړتیاو له مخې ټاکل کیږی

1. کله چې دو پایی دومره نژدی وی چې د دو تهدابونو مساحت یو د بل سره ټکری وکړی
2. کله چې د یوی دوانی باندنی پایی داسی وی چی د بل چاه تعمیر ته ډیر نژدی وی
3. کله چې د تهداب د خاوری برداشت قوه کمزوری وی

د مرکب تهدابونو ډولونه

- مستطیلی تهدابونه
- ذوذنقه یی تهدابونه
- کنسولی تهدابونه
- پته یی تهدابونه

د مسطتیلی مرکب تهداب د ډیزاین لپاره لاندی ټکي په پام کي ونیول شي

- ❖ په پایه باندی وارد شوی مجموعی بار معلومول
- ❖ د تهداب تقریبی مساحت ټاکل
- ❖ د تهداب د ابعادو ټاکل او د هغې له مخې د خاوری فشار پیدا کول
- ❖ په مختلفو مقطعو کی د عرضی قوي پیدا کول
- ❖ مومنټ پیدا کول

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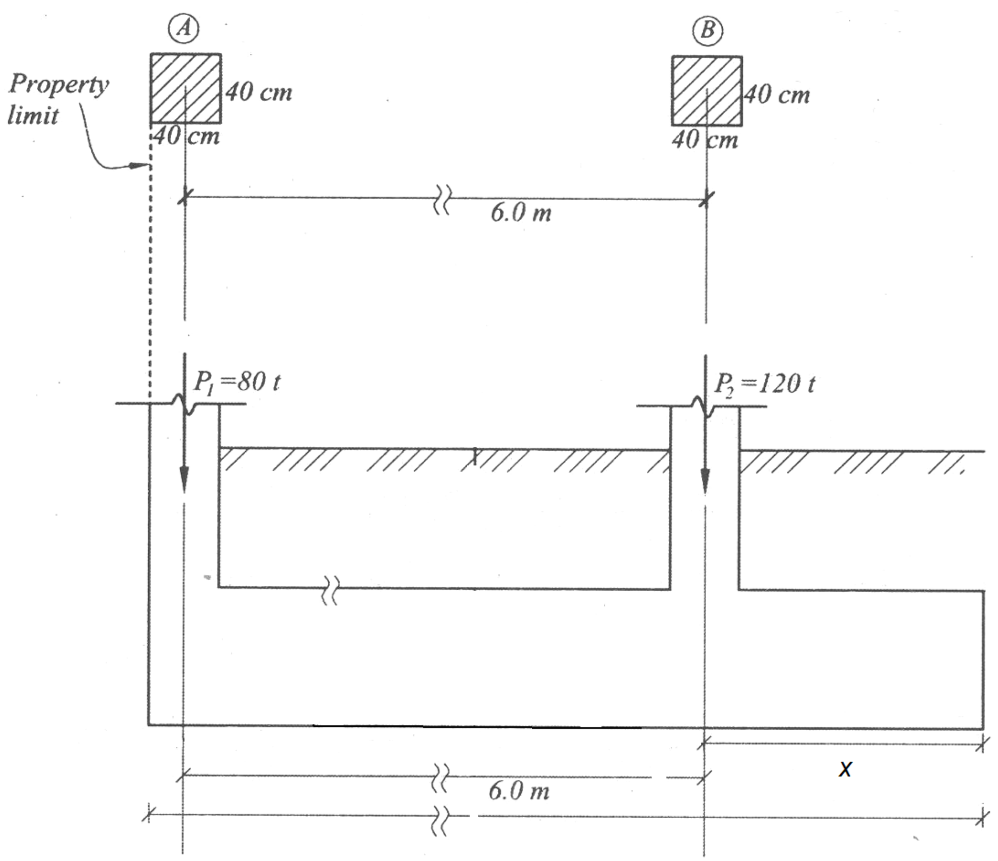
مثال: د C_A اوC_B پایو لپاره مرکب تهداب ډیزین کړی چې د پایو د مرکز نه تر مرکز فاصله 6mاو ، 40*40cm ابعاد لری چې په ترتیب سره 800KN په C_A باند او 120KN په C_B باندی او د خاوری د برداشت قابلیت q_a=200Kpa، او د کانکریټو فشار مقاومت =200 f_c N/mm², او د سیخانو کشش مقاومت f_y=420 N/mm² چی په لاندی شکل که خودل شوی

Design a combined footing As shown

$$q_{all(net)} = 20t/m^2 = 200kPa \qquad f'_c = 25\,N/mm^2 \qquad f_y = 420\,N/mm^2$$



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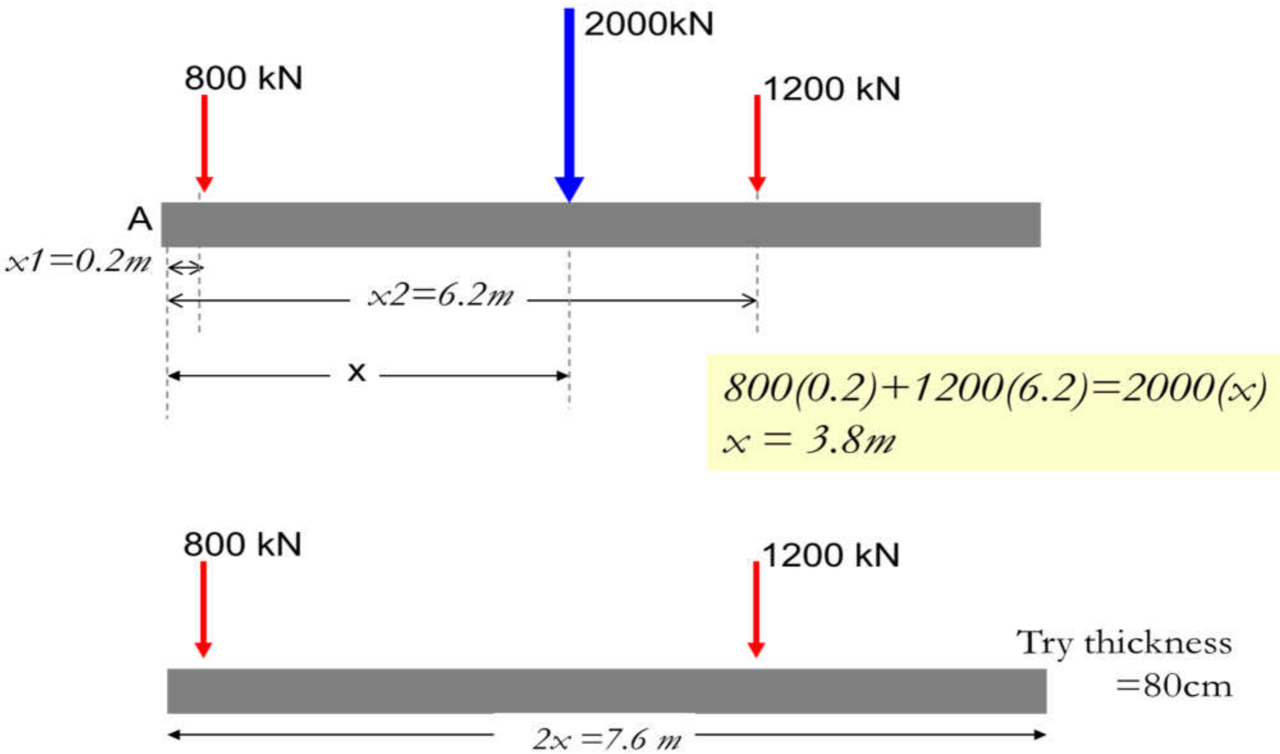
Dimension calculation د مجموعی قوه فاصله پیدا کوی

The base dimension to get uniform distributed load



Area required

$$q_{all\,(net)} = 20\,t/m^2 = 200\,kPa\,,$$

$$P_u = 1.3(P_s) = 1.3(2000) = 2600\,kN$$

$$A_g = \frac{P_s}{q_{all\,(net)}} = \frac{2000\times10^3}{200\times10^3} = 10\,m^2 \approx 7.6*1.8$$

$$q_u = \frac{P_u}{A} = \frac{(2600)\times10^3}{7.6*1.8} = 190\times10^3\,Pa = 190\,kPa$$

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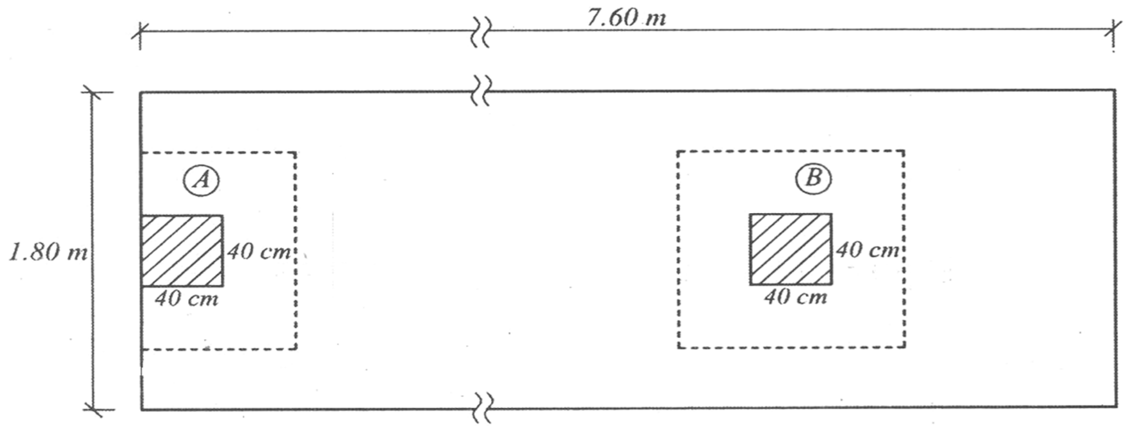
Check for punching Shear د دو طرفه برش پيدا کول

نوټ: فرض کوی چي d = 730 mm



Column A

$$b_o = 2(765) + 1130 = 2260mm$$

$$\phi V_C = \phi \frac{\sqrt{f_c'}}{3} b_o d = 0.75 \times \frac{\sqrt{25}}{3} \times 730 \times 2260 / 1000 = 2062.3kN$$

$$\phi V_C = \phi \left(2 + \frac{\alpha_s d}{b} \right) \frac{\sqrt{f_c'}}{12} b_o d = 0.75 \left(2 + \frac{30 \times 730}{2260} \right) \times \frac{\sqrt{25}}{12} \times 730 \times 2260 / 1000 = 6027kN$$

$$V_U = 800(1.3) - 1.13 * 0.765 * 190 = 875.8kN < \phi V_c \quad \text{oK}$$

Column B

$$b_o = 4[(730 + 400)] = 4520mm$$

$$\phi V_C = \phi \frac{\sqrt{f_c'}}{3} b_o d = 0.75 \times \frac{\sqrt{25}}{3} \times 730 \times 4520 / 1000 = 4124.4kN$$

$$\phi V_C = \phi \left(2 + \frac{\alpha_s d}{b} \right) \frac{\sqrt{f_c'}}{12} b_o d = 0.75 \left(2 + \frac{40 \times 730}{4520} \right) \times \frac{\sqrt{25}}{12} \times 730 \times 4520 / 1000 = 13322.5kN$$

$$V_U = 1200(1.3) - 1.13 * 1.13 * 190 = 1317.4kN < \phi V_c \quad \text{oK}$$

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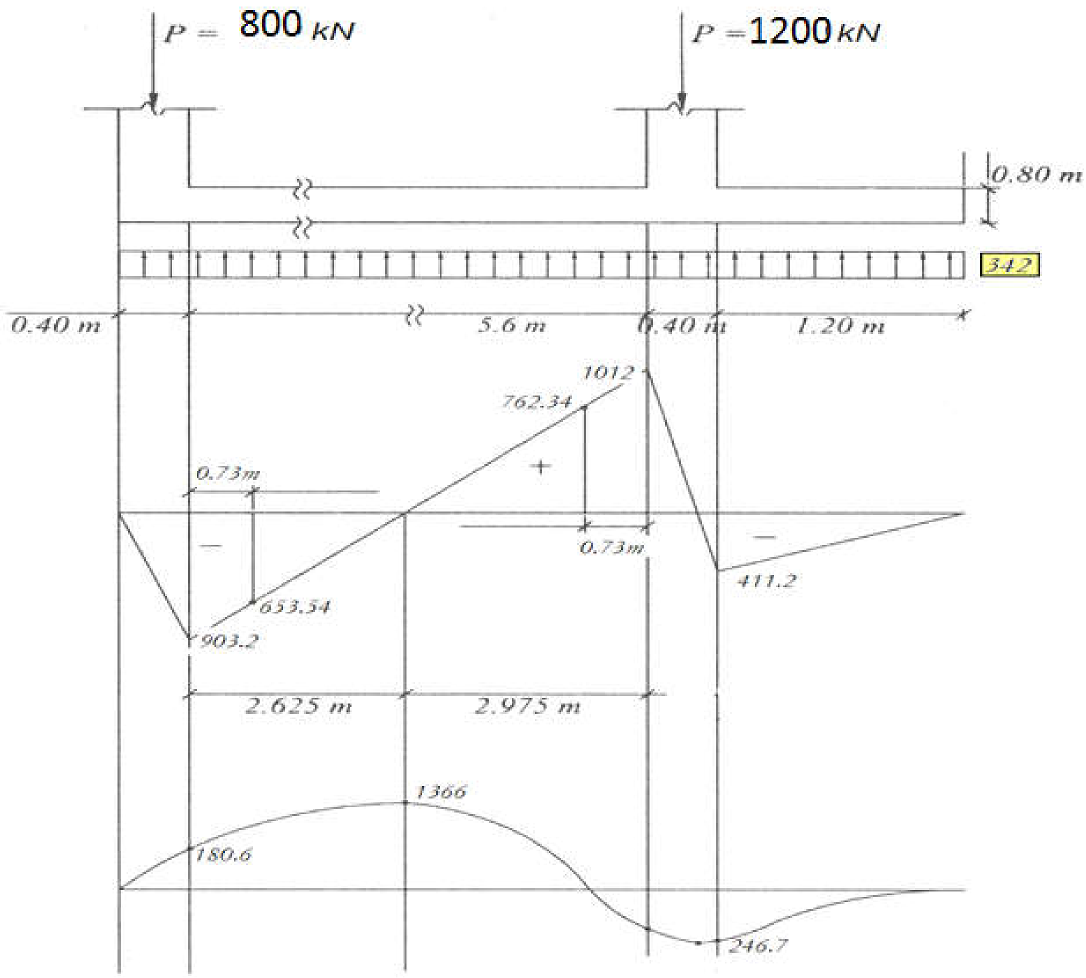
Draw S.F.D & B.M.D

Stress under footing د خاوری فشار
$= 190 * 1.8 = 342\ kN/m$



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Check for beam shear

b = 1800mm, d = 730mm

$$\phi V_C = 0.75 \times \frac{\sqrt{25}}{6} \times 730 \times 1800 / 1000 = 821.25 kN$$

$$Max. \rightarrow V_U \text{ at } \underline{\underline{d}} \text{ from column face} = 762.34 kN$$

$$V_U < \phi V_C$$

Bending moment Long direction مومنټ په طولی سیکشن کی

$$-ve\ M = 1366 kN.m$$

$$\text{b} = 1800 mm, \text{d} = 730 mm$$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2 \times 10^6 * 1366}{0.9(0.85)25 * 730^2 * 1800}}\right] = 0.0039$$

$$A_S = 0.0039 \times 730 \times 1000 = 2847 mm^2 = 28.5 cm^2 \quad use\ 9\phi 20 / m \quad \text{Top}$$

$$+ve\ M = 246.7 kN.m$$

$$\text{b} = 1800 mm, \text{d} = 730 mm$$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2 \times 10^6 * 246.7}{0.9(0.85)25 * 730^2 * 1800}}\right] = 0.0007 < \rho_{\min}$$

$$A_{S\min} = 0.0018 \times 800 \times 1000 = 1440 mm^2 = 14.4 cm^2 \quad use\ 7\phi 16 / m \quad \text{Bottom}$$

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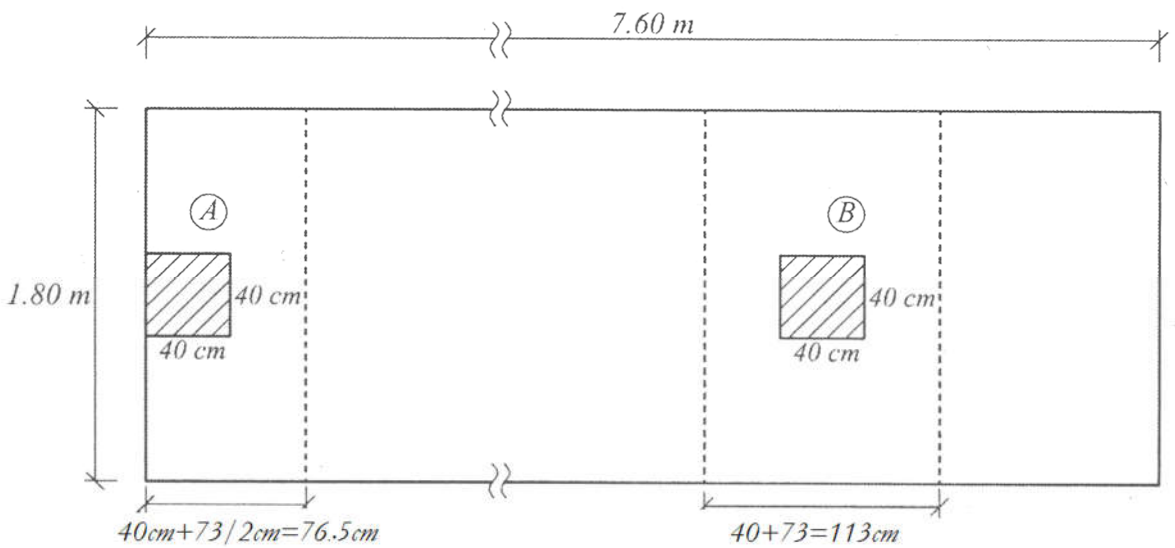
Bending moment Short direction مومنټ په عرضی سیکشن کی



Under Column A

$$M = \frac{1040}{(1.8*0.765)} \times \frac{0.765}{2}\left(\frac{1.8-0.4}{2}\right)^2 = 141.6$$

$b = 765mm, d = 730mm$

$$\rho = 0.85*\frac{25}{420}\left[1 - \sqrt{1 - \frac{2\times10^6 *141.6}{0.9(0.85)25*730^2*765}}\right] < \rho_{min}$$

$$A_{S\,min} = 0.0018\times800\times765 = 1101.6mm^2 = 11cm^2 \quad use\ 7\phi14/m$$

Under Column B

$$M = \frac{1560}{(1.8*1.13)} \times \frac{1.13}{2}\left(\frac{1.8-0.4}{2}\right)^2 = 212.33$$

$b = 1130\,mm, d = 730\,mm$

$$\rho = 0.85*\frac{25}{420}\left[1 - \sqrt{1 - \frac{2\times10^6 *212.33}{0.9(0.85)25*730^2*1130}}\right] < \rho_{min}$$

$$A_{S\,min} = 0.0018\times800\times765 = 1101.6mm^2 = 11cm^2 \quad use\ 7\phi14/m$$

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Shrinkage Reinforcement in short direction

$$A_{S\min} = 0.0018 \times 800 \times 765 = 1101.6mm^2 = 11cm^2 \quad use\ 7\phi 14/m$$

Under Column B

$$M = \frac{1560}{(1.8 * 1.13)} \times \frac{1.13}{2}\left(\frac{1.8-0.4}{2}\right)^2 = 212.33$$

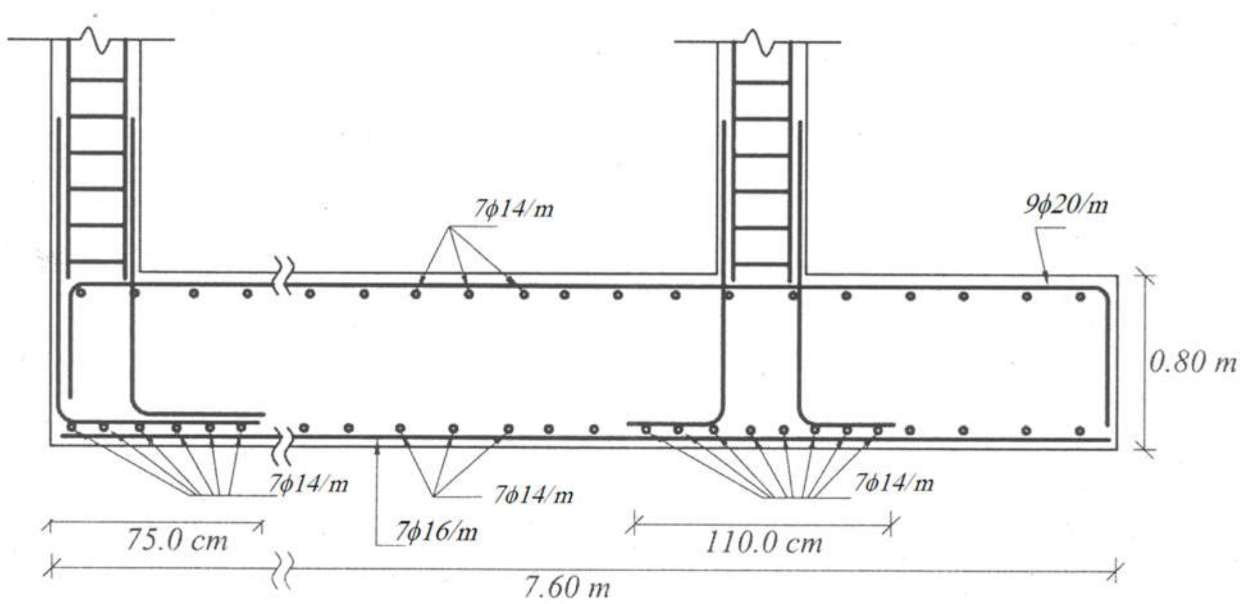
$$\text{b} = 1130mm, \text{d} = 730mm$$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2 \times 10^6 * 212.33}{0.9(0.85)25 * 730^2 * 1130}}\right] < \rho_{\min}$$

$$A_{S\min} = 0.0018 \times 800 \times 765 = 1101.6mm^2 = 11cm^2 \quad use\ 7\phi 14/m$$

Shrinkage Reinforcement in short direction

$$A_{S\min} = 0.0018 \times 800 \times 765 = 1101.6mm^2 = 11cm^2 \quad use\ 7\phi 14/m$$



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Footing Design
Part III

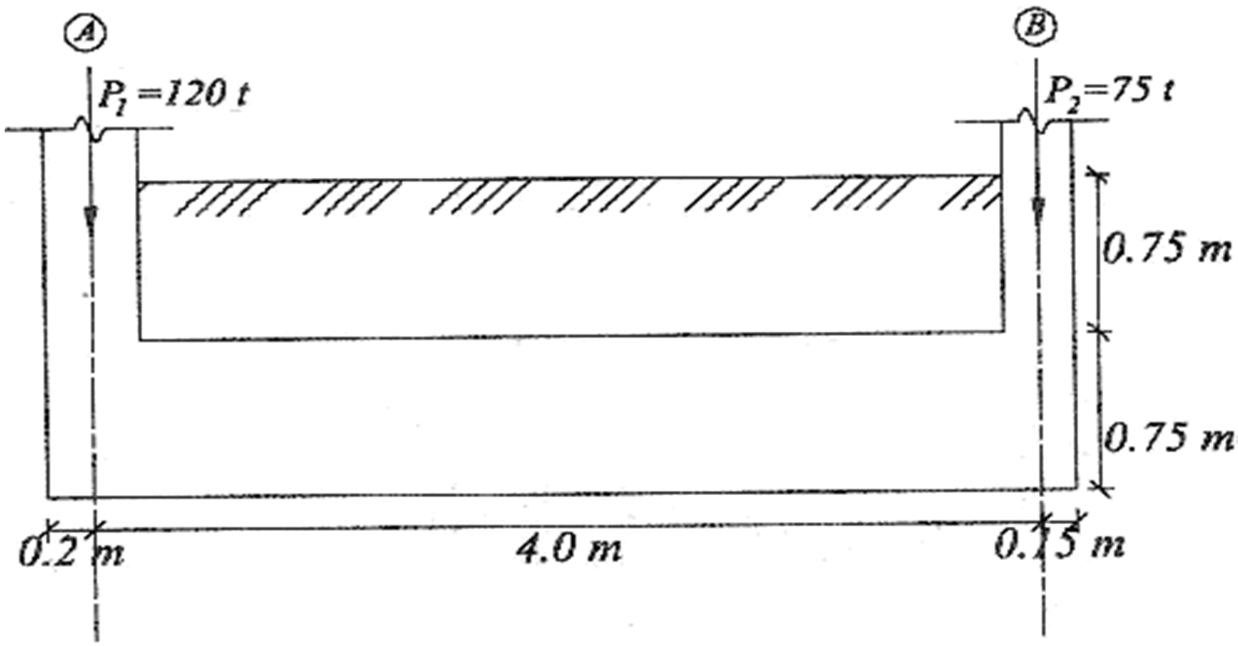
نوټ : په لاندنیو ټولو مثالونو که پورتنی تکلار استفادی کیږی

Combined footing, strip footing, & Mat foundation

Example 2

Design a combined footing As shown

$$q_{all(net)} = 18\ t/m^2 = 180 kPa \qquad f'_c = 25\ N/mm^2 \qquad f_y = 420\ N/mm^2$$



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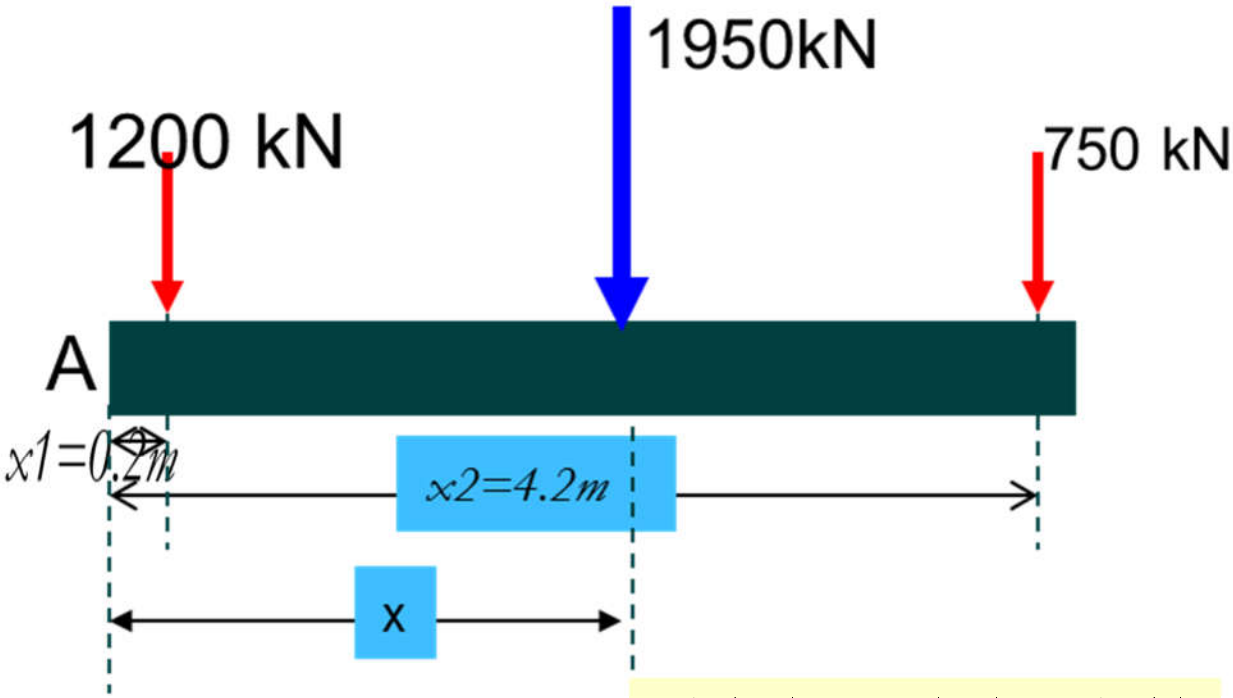
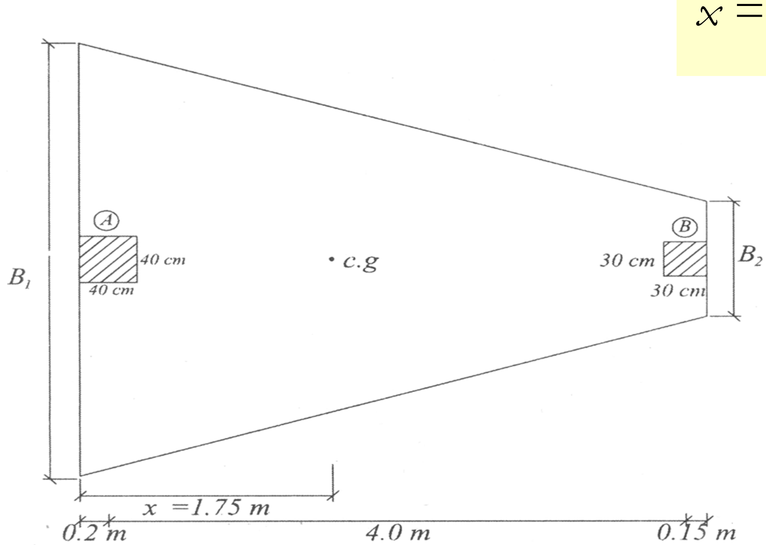
Dimension calculation

The base dimension to get uniform distributed load



$750(4.2)+1200(0.2)=1950\ (x)$
$x = 1.75m$



$$x = \left(\frac{B_1 + 2B_2}{B_1 + B_2}\right)\frac{L}{3}$$

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Area required

$$q_{all\,(net)} = 20\ t/m^2 = 200\ kPa\ ,$$

$$A_g = \frac{P_s}{q_{all\,(net)}} = \frac{1950 \times 10^3}{180 \times 10^3} = 10.8\,m^2$$

$$\left(\frac{B_1 + B_2}{2}\right)L = 10.8$$

$$\left(\frac{B_1 + B_2}{2}\right)4.35 = 10.8$$

$$\left(\frac{B_1 + B_2}{2}\right) = 2.5$$

$$B_1 + B_2 = 5$$

$$x = \left(\frac{B_1 + 2B_2}{B_1 + B_2}\right)\frac{L}{3} = \left(\frac{5 + B_2}{5}\right)\frac{4.35}{3}$$

$$1.75 = 1.45 + 0.29\,B_2$$

$$B_2 = 1m$$

$$B_1 = 4m$$

$$q_u = \frac{P_u}{A} = \frac{1.3(1950)\times 10^3}{10.8} = 235\times 10^3\,Pa = 235kPa$$

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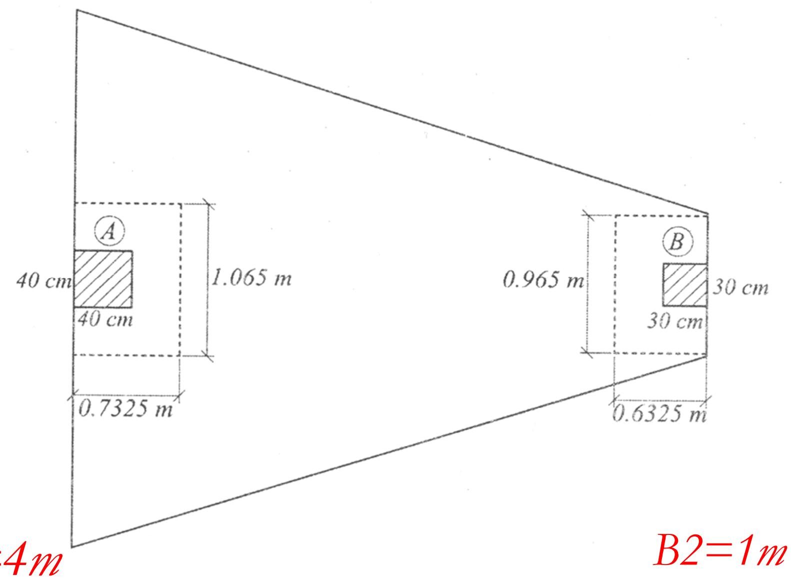
Check for punching Shear

h= 750mm

d = 732 mm



Column - A

$$b_o = 2(732) + 1065 = 2590mm$$

$$\phi V_C = \phi \frac{\sqrt{f_c'}}{3} b_o d = 0.75 \times \frac{\sqrt{25}}{3} \times 665 \times 2590 / 1000 = 2160.4kN$$

$$\phi V_C = \phi \left(2 + \frac{\alpha_s d}{b} \right) \frac{\sqrt{f_c'}}{12} b_o d = 0.75 \left(2 + \frac{30 \times 665}{2590} \right) \times \frac{\sqrt{25}}{12} \times 665 \times 2590 / 1000 = 5222kN$$

$$V_U = 1200(1.3) - 1.065 * 0.733 * 235 = 1376.6kN < \phi V_c \quad \text{oK}$$

Column - B

$$b_o = 2(633) + 965 = 2231 \ mm$$

$$\phi V_C = \phi \frac{\sqrt{f_c'}}{3} b_o d = 0.75 \times \frac{\sqrt{25}}{3} \times 665 \times 2231 / 1000 = 1854.5kN$$

$$\phi V_C = \phi \left(2 + \frac{\alpha_s d}{b} \right) \frac{\sqrt{f_c'}}{12} b_o d = 0.75 \left(2 + \frac{30 \times 665}{2231} \right) \times \frac{\sqrt{25}}{12} \times 665 \times 2231 / 1000 = 5273kN$$

$$V_U = 800(1.3) - 0.965 * 0.633 * 235 = 896.5kN < \phi V_c \quad \text{oK}$$

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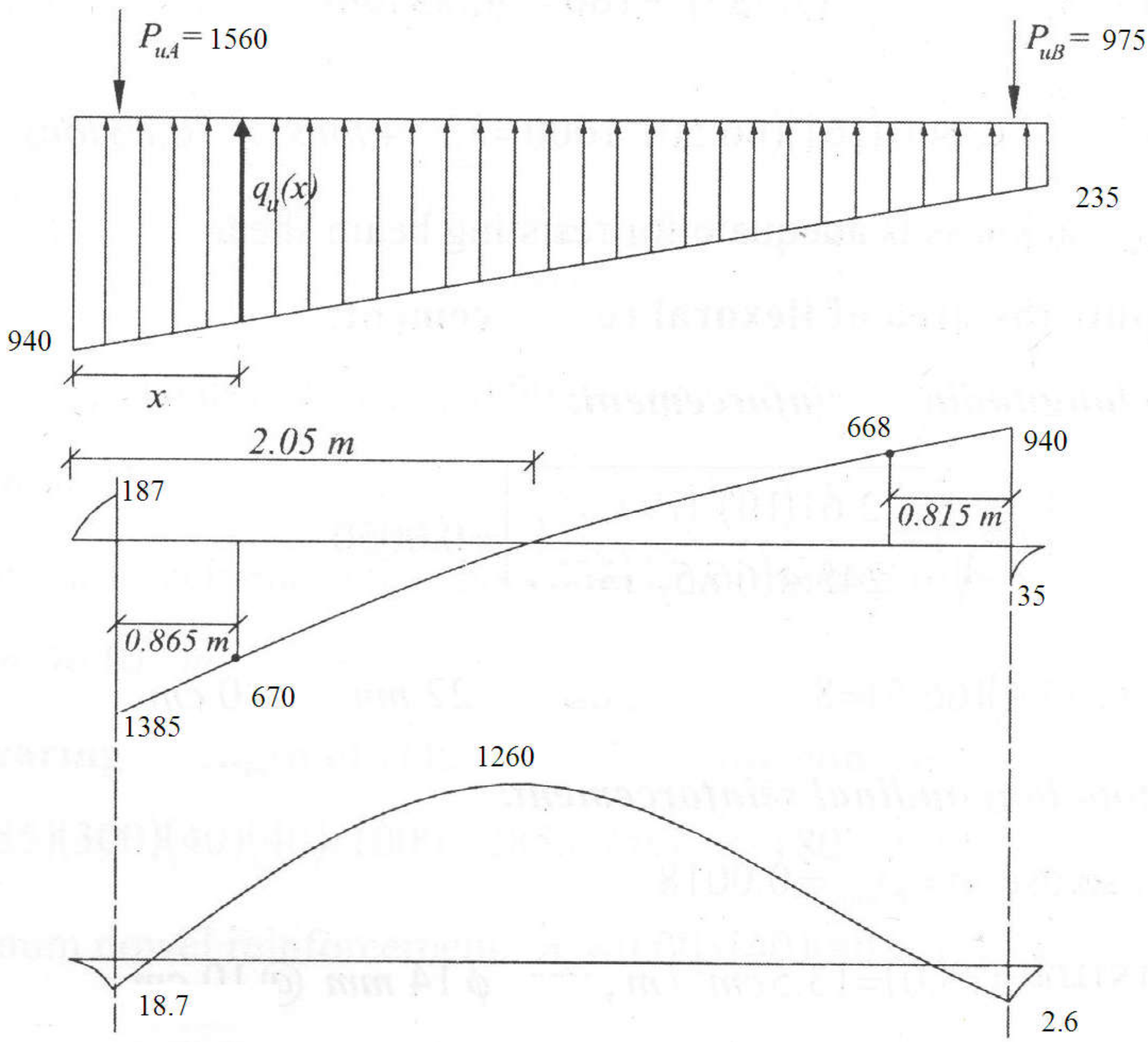
Draw S.F.D & B.M.D



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Empirical S.F.D & B.M.D

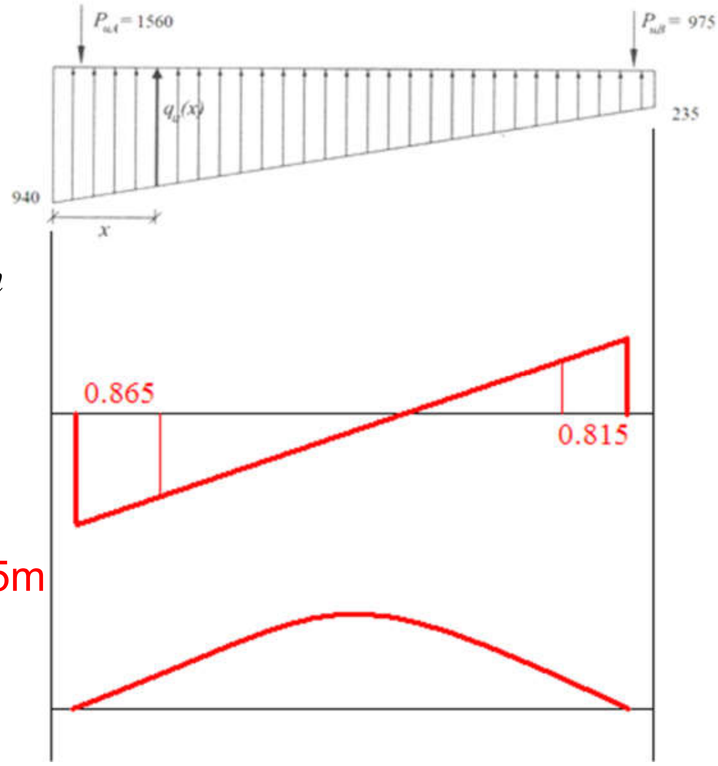
Convert trapezoidal load to rectangle

$$w_{ave} = 235 + \tfrac{2}{3}(940 - 235) = 705$$

$$-M_{\max} = \frac{wl^2}{8} = \frac{705(3.65)^2}{8} = 1174\,kN.m$$

Clear distance between column

B in moment design = ave. width = 2.5m



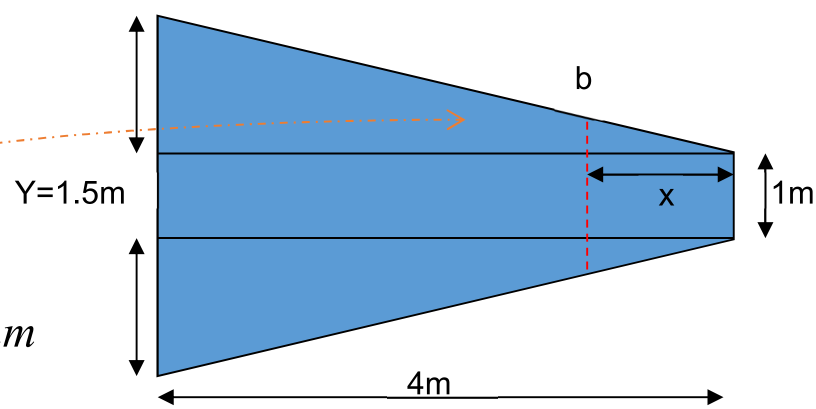
Check for beam shear

d = 665mm

$$b = 1 + 2(\tfrac{x}{L}) \times y$$

at $x = 0.815 + 0.15$

$$1 + 2(\tfrac{0.965}{4.35}) \times 1.5 = 1.7m = 1700mm$$



$$\phi V_C = 0.75 \times \frac{\sqrt{25}}{6} \times 665 \times 1700/1000 = 696kN$$

$$Max. \rightarrow V_U \text{ at } \underline{\underline{d}} \text{ from column B face (the most critical)} = 668kN$$

$$V_U < \phi V_C$$

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Bending moment Long direction

$b = 1 + 2(\frac{2.25}{4.35}) \times 1.5 = 2.60m = 2600$ *Top*

$-ve\ M = 1260kN.m$

$d = 730mm$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2 \times 10^6 * 1260}{0.9(0.85)25 * 665^2 * 2600}}\right] = 0.003$$

$A_S = 0.003 \times 665 \times 1000 = 1995mm^2 = 20cm^2 \quad use\,10\phi16/m$ Top

Bottom

$A_{S\min} = 0.0018 \times 750 \times 1000 = 1350mm^2 = 13.5cm^2 \quad use\,9\phi14/m$ Bottom

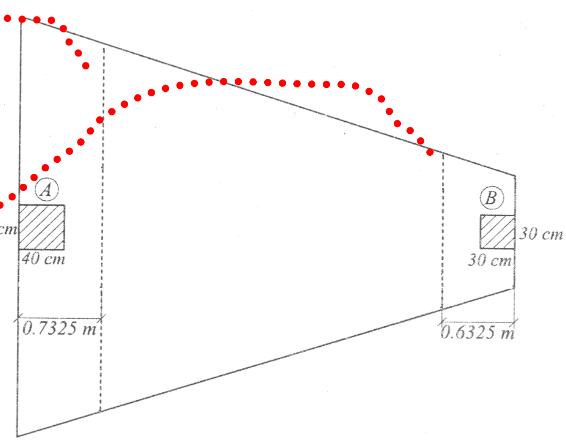
Bending moment Short direction

Under Column A

$b' = 1 + 2(\frac{3.62}{4.35}) \times 1.5 = 3.5m = 3500mm$

$b = \frac{3.5 + 4}{2} m = 3.75\,m = 3750\,mm$

$b' = 1 + 2(\frac{0.633}{4.35}) \times 1.5 = 1.44m = 1440mm$



$$M = \frac{1560}{(3.75 * 0.733)} \times \frac{0.733}{2}\left(\frac{3.75 - 0.4}{2}\right)^2 = 583.6$$

$d = 665mm$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2 \times 10^6 * 583.57}{0.9(0.85)25 * 665^2 * 733}}\right] = 0.005$$

$A_S = 0.005 \times 665 \times 733 = 3325mm^2 = 33cm^2 \quad use\,10\phi20$

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Under Column B

$$b=\frac{1.44+1}{2}m=1.22m=1220mm \qquad \rho=0.85\times\frac{f_c}{f_y}\left[1-\sqrt{1-\frac{M}{0.9\times0.86\times b\times d}}\right]$$

$$M=\frac{975}{(1.22*0.633)}\times\frac{0.633}{2}\left(\frac{1.22-0.3}{2}\right)^2=84.6$$

$$\mathrm{b}=633mm,\ \mathrm{d}=665mm$$

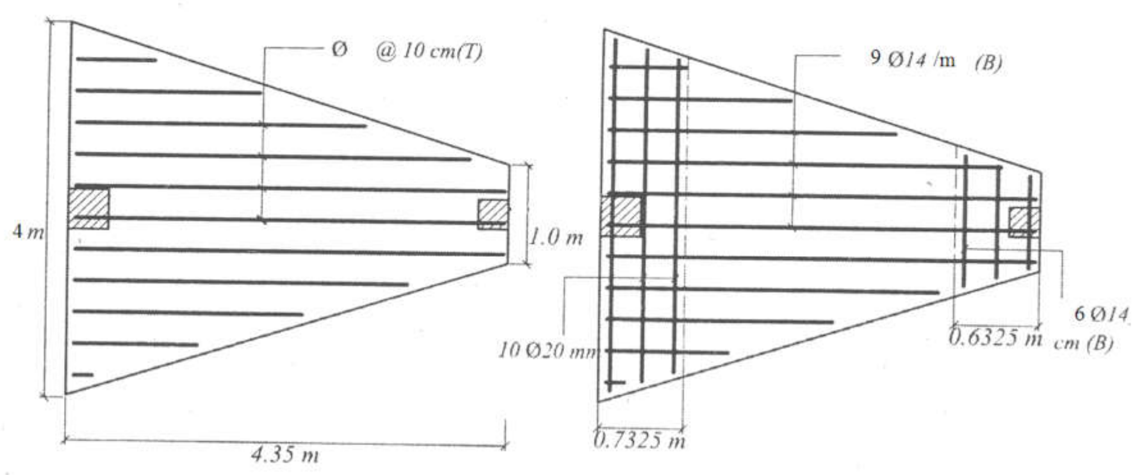
$$\rho=0.85*\frac{25}{420}\left[1-\sqrt{1-\frac{2\times10^6*84.6}{0.9(0.85)25*665^2*633}}\right]<\rho_{\min}$$

$$A_{S\min}=0.0018\times750\times633=854.6mm^2=8.6cm^2 \quad use\,6\phi14$$

Shrinkage Reinforcement in short direction

$$A_{S\min}=0.0018\times1000\times750=1350mm^2=13.5cm^2 \quad use\,9\phi14/m$$

Reinforcement details



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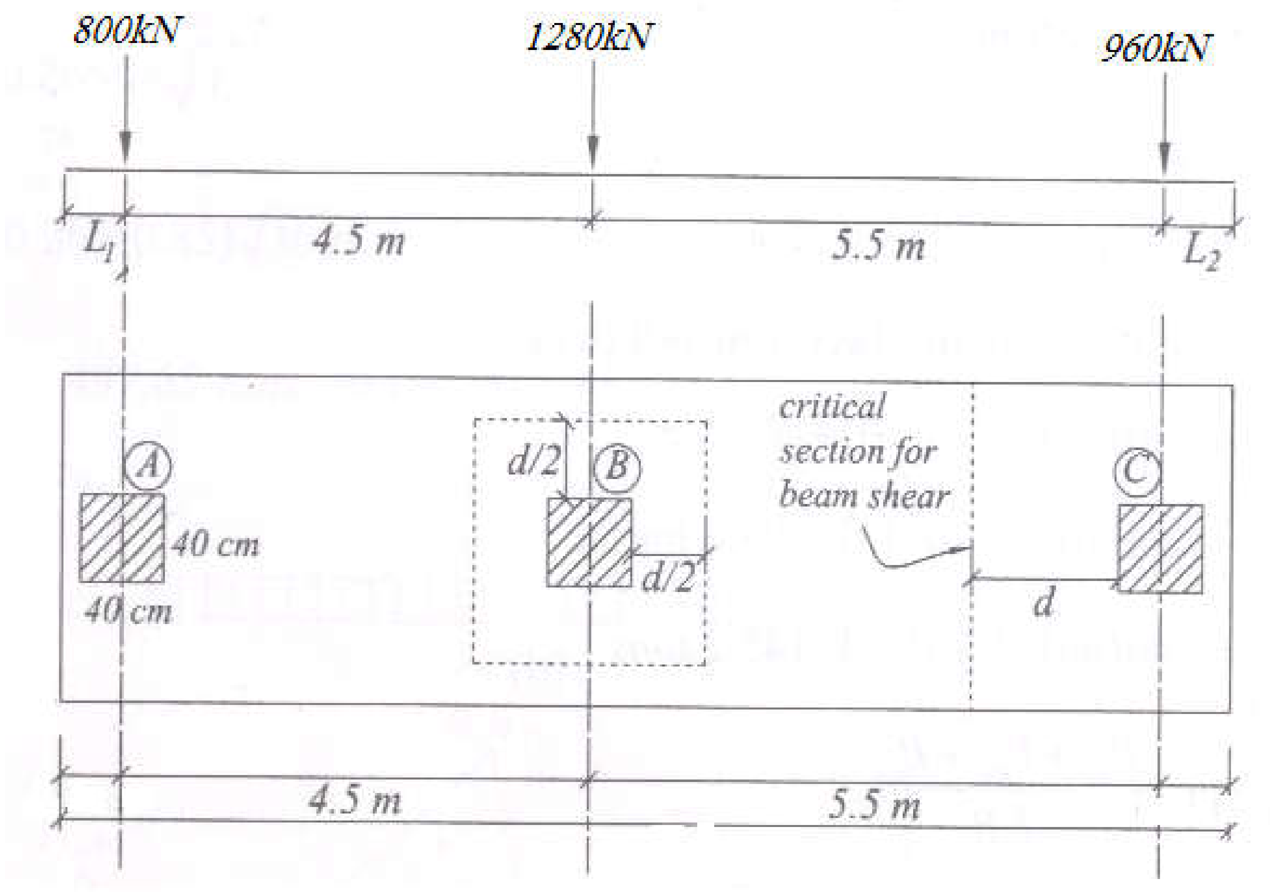
Example 3 (Strip footing)

Design a combined or continue footing as shown

$q_{all(net)} = 20t/m^2 = 200kPa \qquad f'_c = 25\,N/mm^2 \qquad f_y = 420\,N/mm^2$



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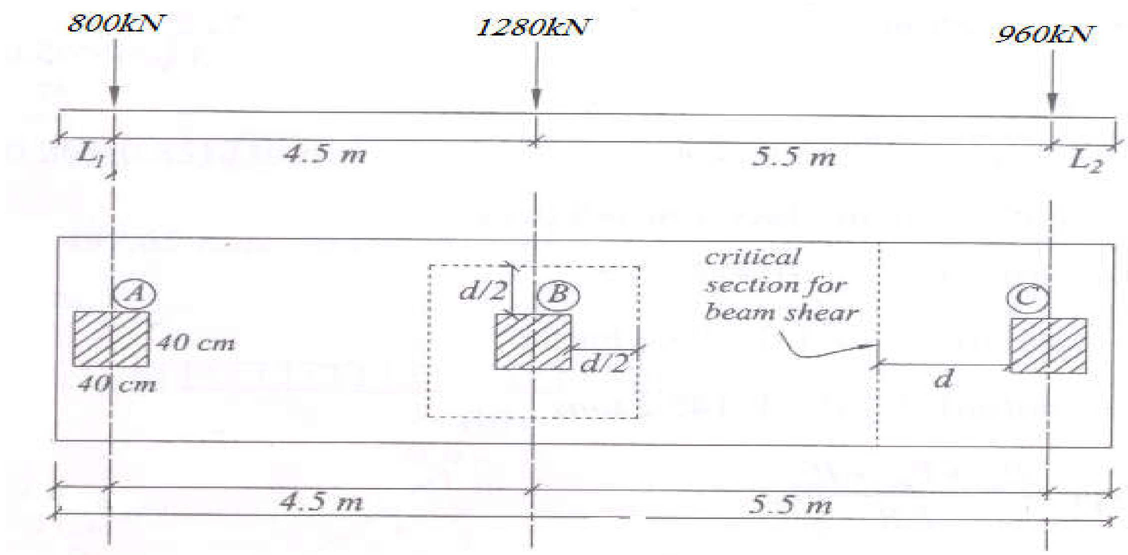
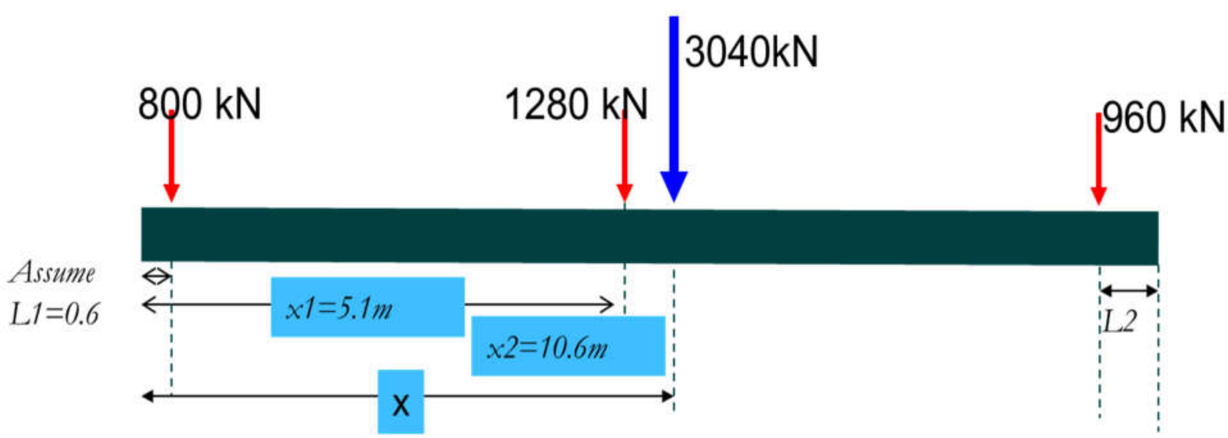
Dimension calculation

The base dimension to get uniform distributed load





$800(0.6)+1280(5.1)+960(10.6)=3040\ (x)$

$x = 5.65m,$

$2(x)=11.3m$

$L2=11.3 - (10.6)=0.7$

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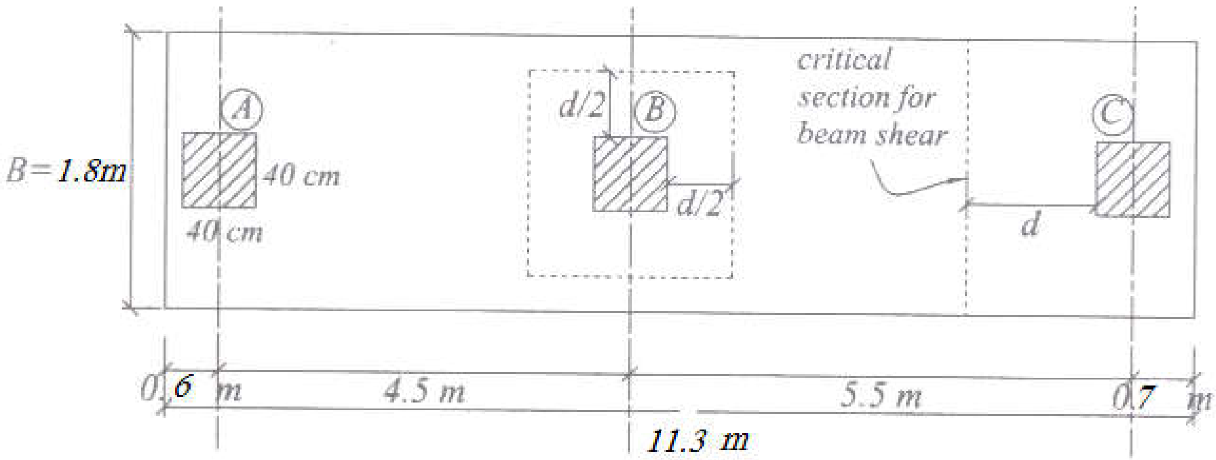
$$q_{all(net)} = 18t/m^2 = 180\,kPa,$$

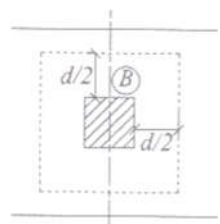
$$A_g = \frac{P_s}{q_{all(net)}} = \frac{3040\times10^3}{180\times10^3} = 16.9m^2 \approx 11.3m\times1.8m$$

$$q_u = \frac{P_u}{A} = \frac{1.3(3040)\times10^3}{11.3\times1.8} = 195\times10^3\,Pa = 195kPa$$



Check for punching Shear

h = 700 mm
d=630mm



Column B

$$b_o = 4(630+400)) = 4120mm$$

$$\phi V_C = \phi\frac{\sqrt{f_c'}}{3}b_o d = 0.75\times\frac{\sqrt{25}}{3}\times630\times4120/1000 = 3244.5kN$$

$$\phi V_C = \phi\left(2+\frac{\alpha_s d}{b}\right)\frac{\sqrt{f_c'}}{12}b_o d = 0.75\left(2+\frac{40\times630}{4120}\right)\times\frac{\sqrt{25}}{12}\times630\times4120/1000 = 6584kN$$

$$V_U = 1280(1.3) - 1.03^2 * 195 = 1457.1kN < \phi V_c \qquad \text{oK}$$

You can check other columns

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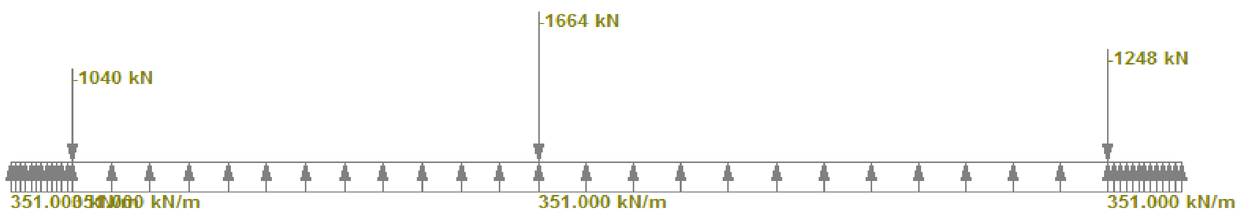
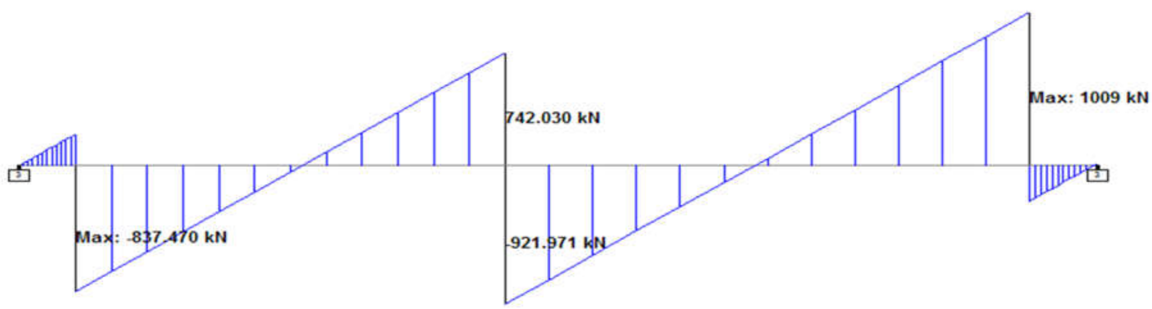
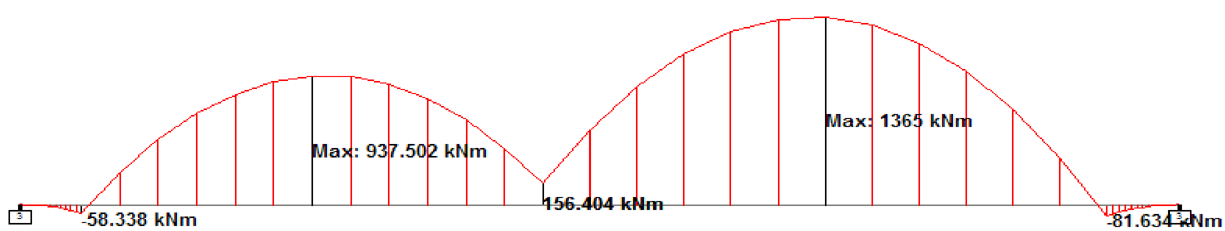
Draw S.F.D & B.M.D

Stress under footing
$= 195 * 1.8 = 351\ kN/m$







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Check for beam shear

b = 1800mm, d = 630mm

$$\phi V_C = 0.75 \times \frac{\sqrt{25}}{6} \times 630 \times 1800 / 1000 = 708.75 kN$$

$$Max. \rightarrow V_U \text{ at } \underline{\underline{d}} \text{ from column face} \approx 0.7(1009) = 706.3 kN$$

$$V_U < \phi V_C$$

Bending moment Long direction

$$\rho = 0.85 \times \frac{f_c}{f_y}\left[1 - \sqrt{1 - \frac{M}{0.9 \times 0.86 \times b \times d}}\right]$$

$$-ve\ M = 1366\ kN.m$$

$$\text{b} = 1800\,mm,\ \text{d} = 730\,mm$$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2 \times 10^6 * 1365}{0.9(0.85)25 * 630^2 * 1800}}\right] = 0.0053$$

$$A_S = 0.0053 \times 630 \times 1000 = 3362\,mm^2 = 33.6\,cm^2 \quad use\ 9\phi 22 / m \quad \text{Top}$$

$$+ve\ M = 246.7\,kN.m$$

$$\text{b} = 1800\,mm,\ \text{d} = 730\,mm$$

$$\rho = 0.85 * \frac{25}{420}\left[1 - \sqrt{1 - \frac{2 \times 10^6 * 81}{0.9(0.85)25 * 730^2 * 1800}}\right] < \rho_{\min}$$

$$A_{S\min} = 0.0018 \times 700 \times 1000 = 1260\,mm^2 = 12.6\,cm^2 \quad use\ 8\phi 14 / m \quad \text{Bottom}$$

Design Short direction as example 1 *(lecture 11)*

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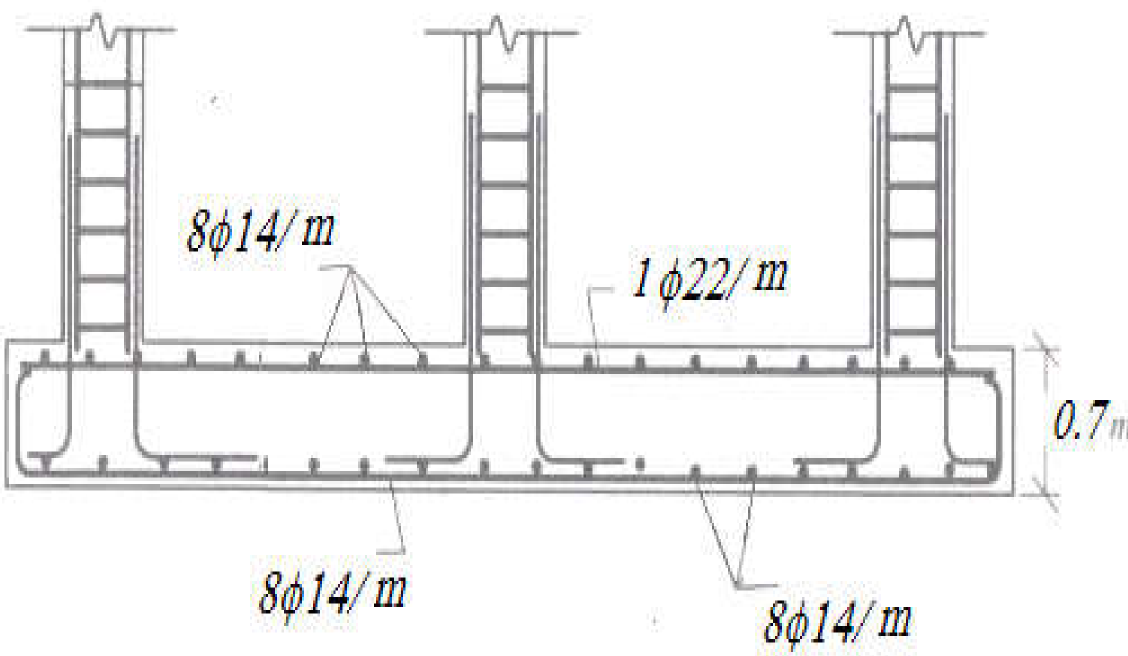
Reinforcement details



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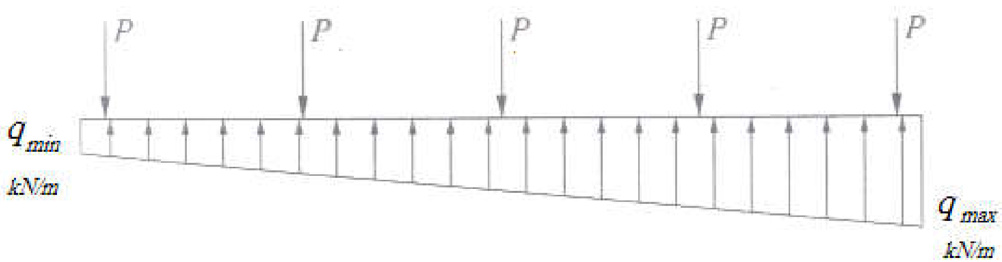
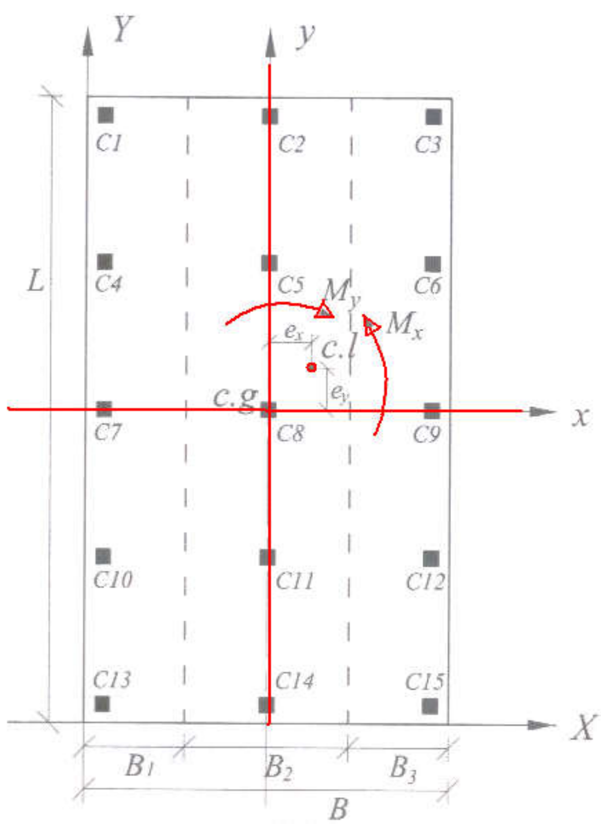
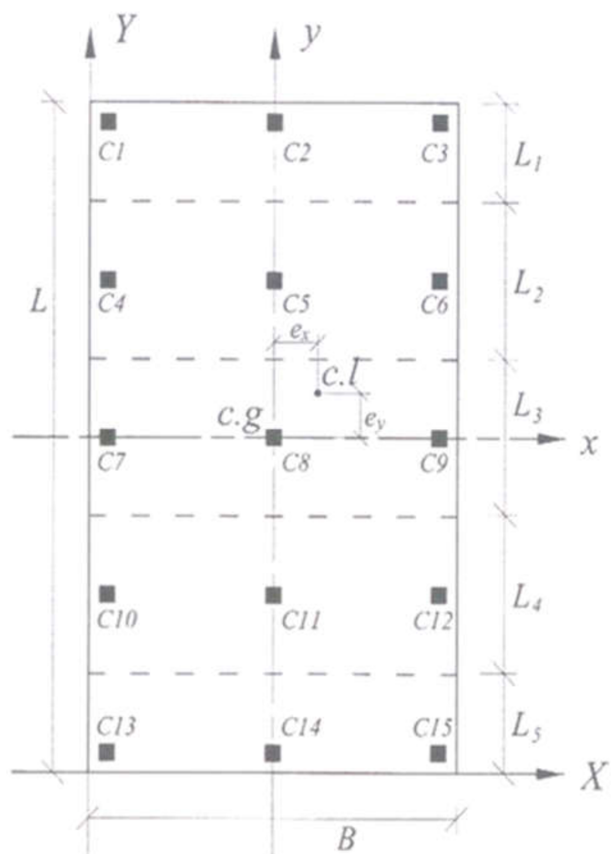
Mat Foundation

$$q = \frac{\sum P}{A} \pm \frac{M_x y}{I_x} \pm \frac{M_y x}{I_y}$$







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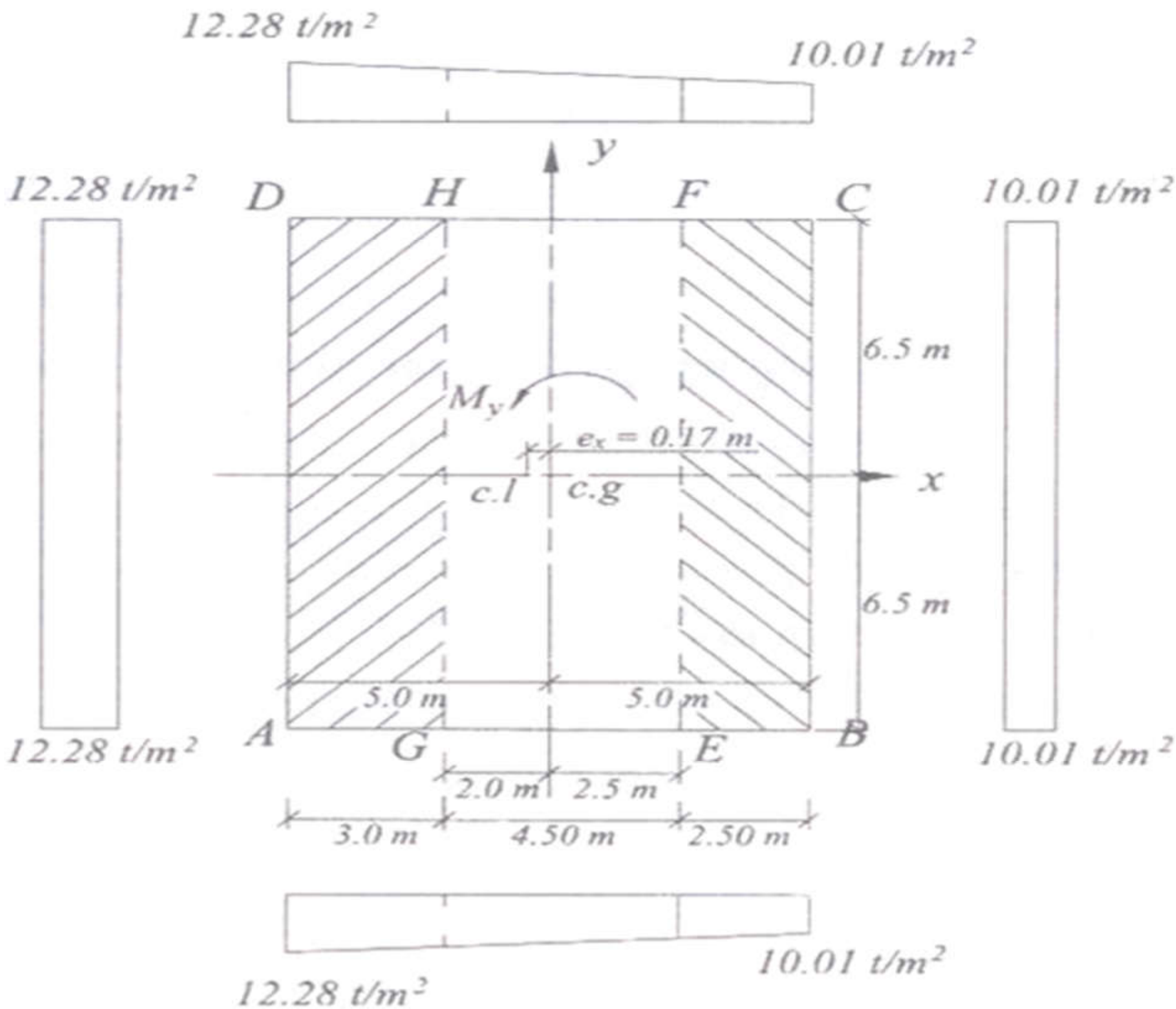
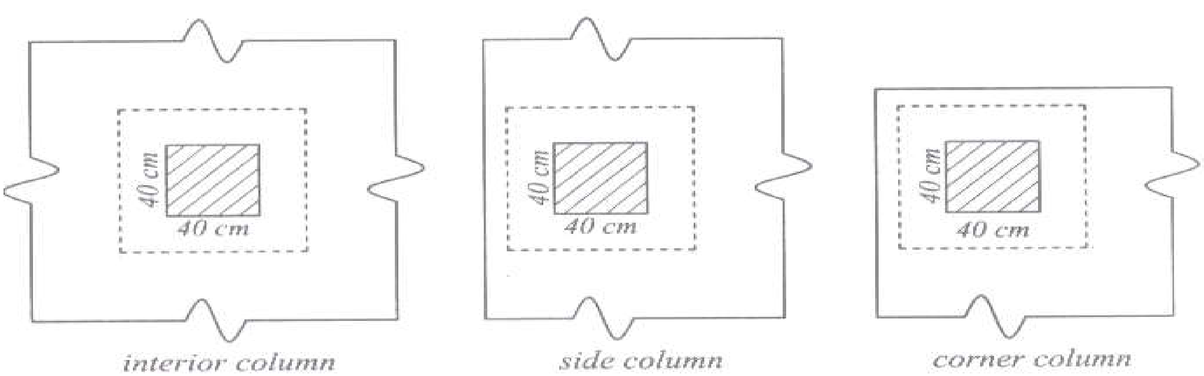


Check for punching Shear



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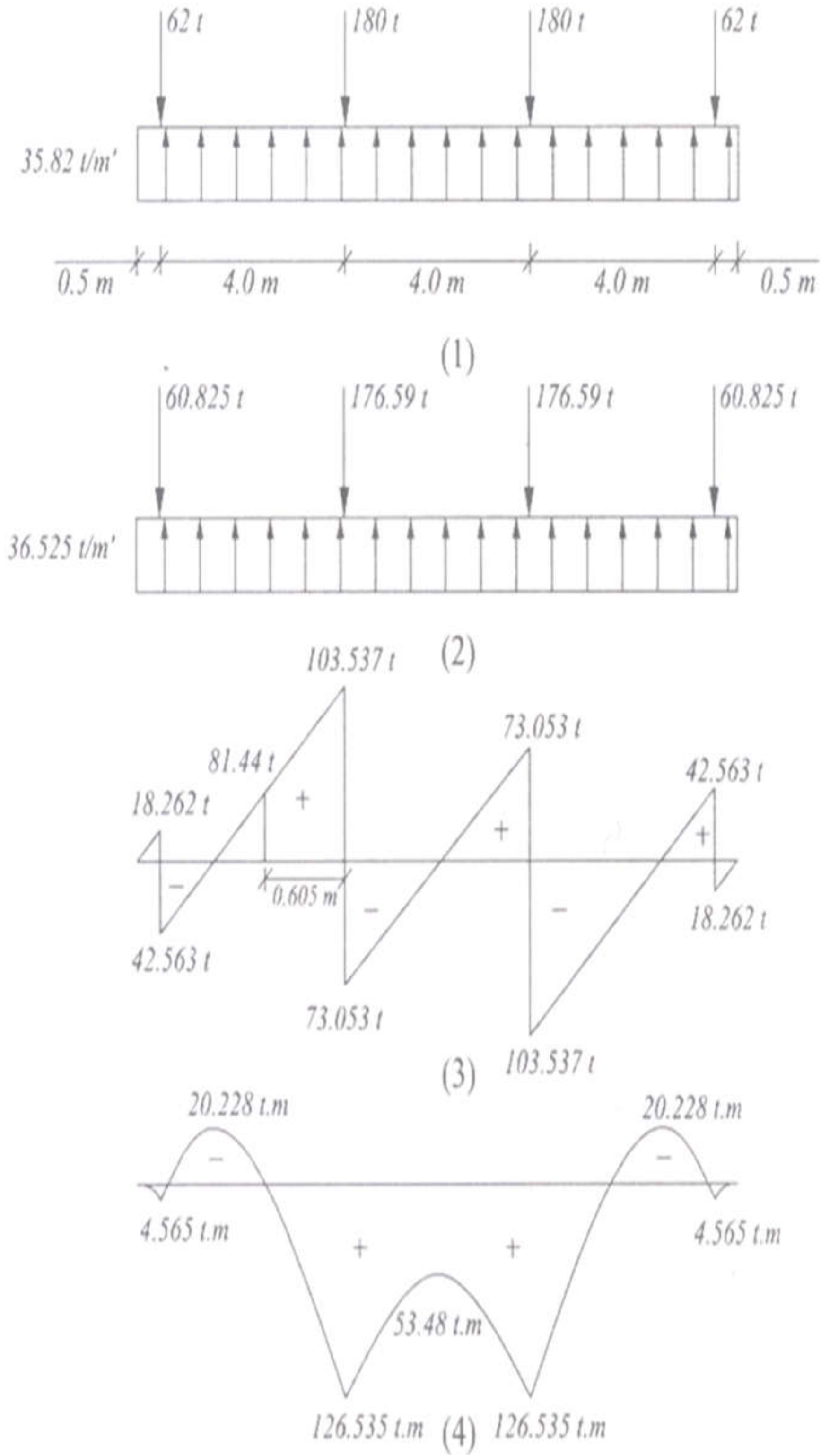
General Example, Ref. 3

Modified load



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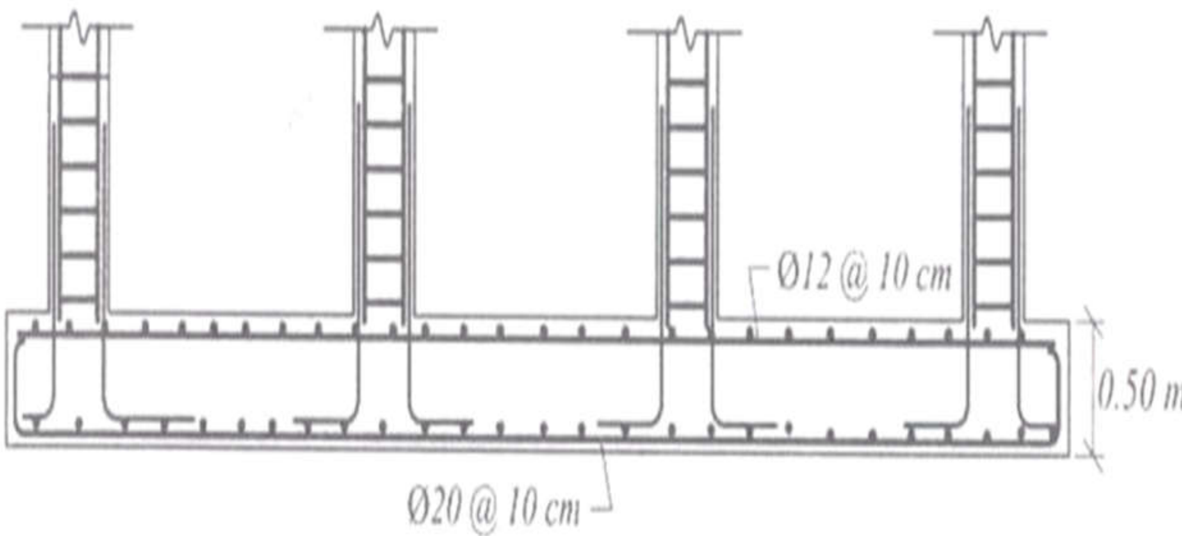

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