DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Financial and Structural study of the advantages of using Autoclaved Aerated Concrete AAC

vs Clay bricks

Project

BO-SANDS

BUILDING TYPE: 3B

Owner

MAXIM

STRUCTURAL DESIGN:-

DELTA BUILDING SYSTEMS
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SANDS

- **Introduction:-**

DELTA BLOCK

DELTA Block are solid unreinforced Autoclaved aerated concrete AAC with a dry density of 550 kg/m³ . Blocks are available in a 200mm course height and are all 600mm long. Thicknesses of 100, 120 , 150, 200, 250, 300, 400 mm are available.

The blocks are glued together with DELTA MORTER Adhesive to form solid masonry walls OR can Glued together by ordinary MORTER (350 kg cement/m3 sand).

The normal finish for DELTA block walls is to render them with DELTA STUCCO A AND DELTA STUCCO B Render, which is trowelled on in two 5mm layer AND 2 mm layer, texture rendered and then coated with an acrylic paint. (refer to The DELTA BLOCK Coating Guide).

AUTOCLAVED AERATED CONCRETE TEN ADVANTAGES :-

Project description and statical system

This project is compound consist of different types of building

Type :-3 B

The building consist ground & 3 multi story

The statical system is (SOILD SLAB) beam & column system & shear wall , the building is totally designed to resist the vertical and horizontal loads acting on it and according to EGYPTIAN STANDARD.

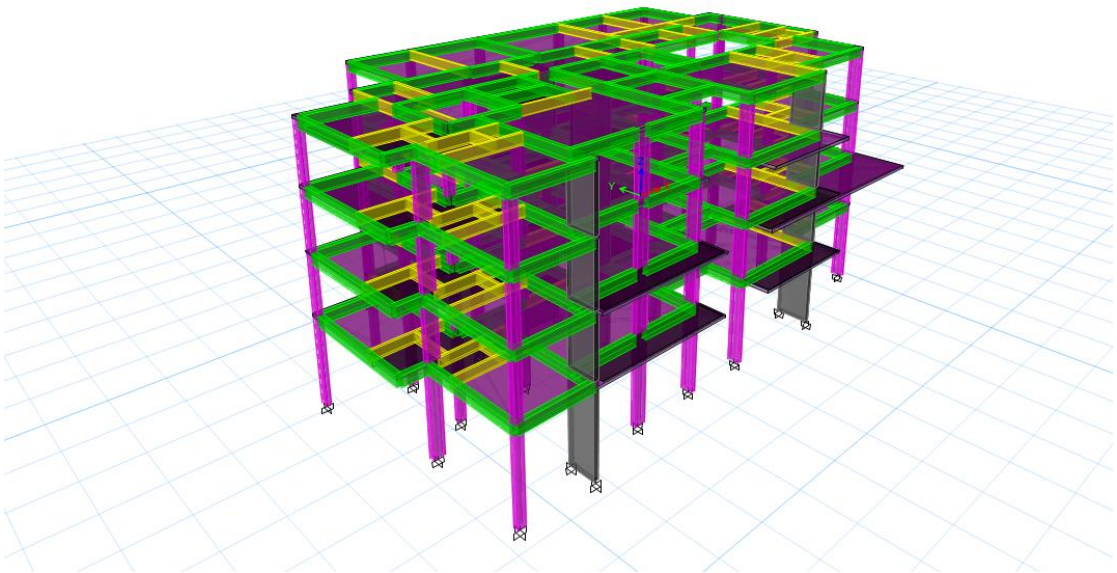
- **Structural loads**
    1. **Bearing capacity of soil 1.00 kg/cm2**
    2. **Common Live load 200 kg/m2**
    3. **Live load in balcony , bathroom and kitchen 300 kg/m2**
    4. **Common flooring cover 200 kg/m2**
    5. **Flooring cover at roof 300 kg/m2**
    6. **Density of walls 550 kg/m3**
    7. **Density of plastering mortar 1800 kg/m3**
    8. **Density of plain concrete 2200 kg/m3**
    9. **Density of reinforced concrete 2500 kg/m3**
- **Structural design consist the following**

1. **The design of reinforced concrete columns and reinforced walls**
2. **The design of reinforced concrete slabs and beams**

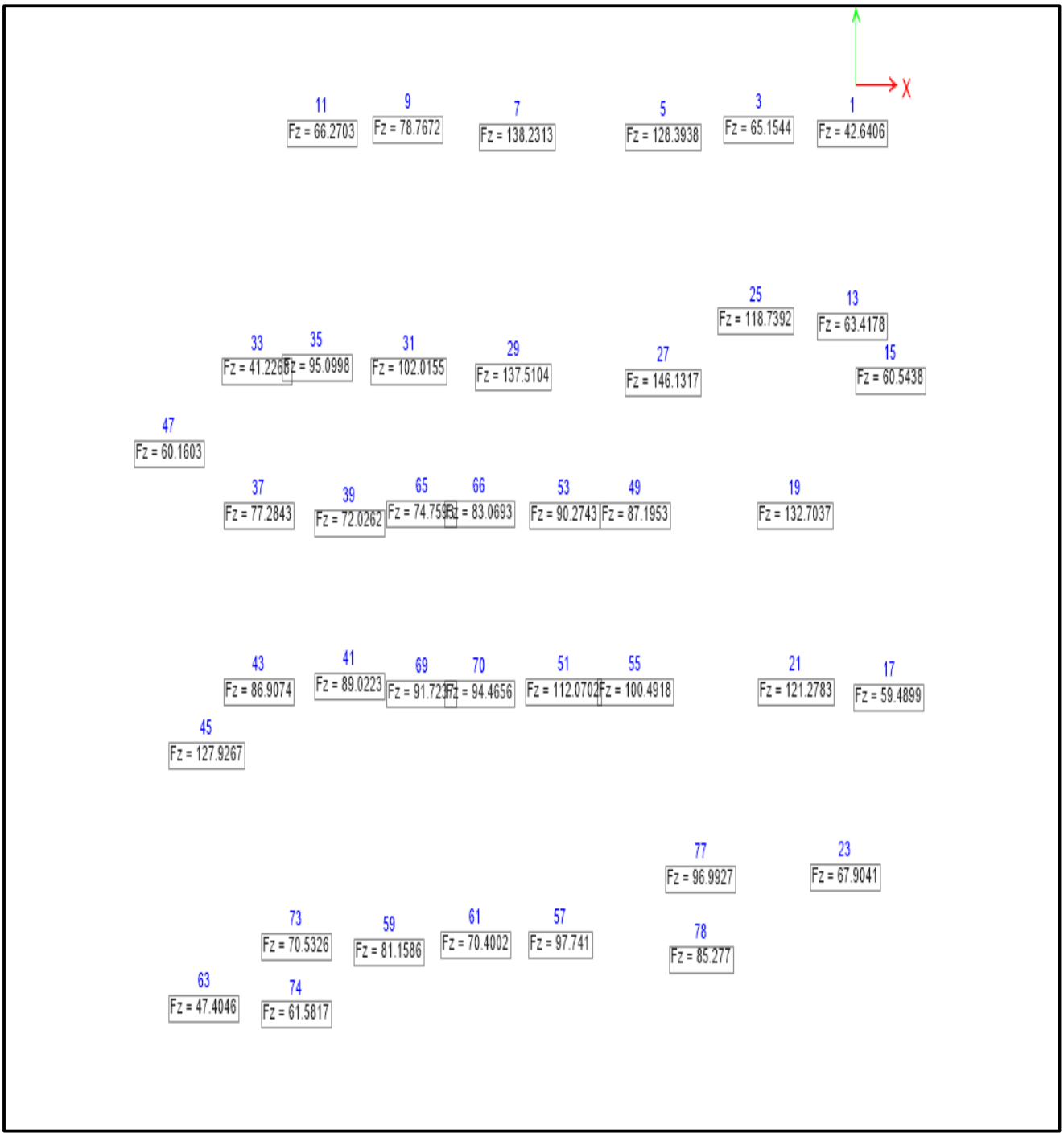
- **Design standard:-**
    1. **Egyptian code for Assessment of loads on building and structures- No.201/2012**
    2. **Egyptian code for Design and Construction for concrete structures No.203/2007**
    3. **Egyptian code for soil Mechanics, Design and construction foundation 202/2001**
- **Analysis software :**
    1. **ETABS 2016**
    2. **SAFE 2016**

TYPE 3 B

1-1 ETABS 3D MODEL



- **LOADS ON FOUNDATIONS**



- **1-2 ETABS ULTIMATE BASE REACTION**

- **Design of columns – main columns**

Project name	:	BO SAND
Location	:	NORTH COAST
Column no	:	C1

Given Data

Fcu = 300 kg/cm2 Fy = 3600 kg/cm2 PU = 100 ton b = 25 cm Ø bars = Ø 16 Ø stirrups = Ø 8 Column location Corner

Design Procedure

Pu = 0.35 Fcu Ac + 0.67 Fy As
b = 25 cm t = 40 cm
Ac actual = 1000.00 cm2
As = (Pu - 0.35 Fcu Ac) / 0.67 Fy
As = -2.07 cm2
As min = 0.006 Ac = 6.00 cm2
As max = 0.6% * 1000 = 60.00 cm2
Check As As min > As Take As = As min
As = 6.00 cm2 Ø = 16 mm ⇨ n = 4 ⇨ Bar spacing= 25.9 cm Safe
As actual = 8.05 cm2
S (stirrups spacing) = the biggest value of 15Ø and 20 cm = 20 cm
V (stirrups volume per meter height) = (100 / S) * 2(X + Y) * Asc = 276.6 cm3
V min = 0.0025 * 100 * b * t = 250.0 cm3
Check stirrups Safe Stirrups branches =

Project name	:	BO SAND
Location	:	NORTH COAST
Column no	:	C2

Given Data

Fcu = 300 kg/cm2 Fy = 3600 kg/cm2 PU = 150 ton b = 25 cm Ø bars = Ø 16 Ø stirrups = Ø 8 Column location Interior

Design Procedure

Pu = 0.35 Fcu Ac + 0.67 Fy As
b = 25 cm t = 60 cm
Ac actual = 1500.00 cm2
As = (Pu - 0.35 Fcu Ac) / 0.67 Fy
As = -3.11 cm2
As min = 0.006 Ac = 9.00 cm2
As max = 0.4% * 1500 = 60.00 cm2
Check As As min > As Take As = As min
As = 9.00 cm2 Ø = 16 mm ⇨ n = 6 ⇨ Bar spacing= 23.4 cm Safe
As actual = 12.07 cm2
S (stirrups spacing) = the biggest value of 15Ø and 20 cm = 20 cm
V (stirrups volume per meter height) = (100 / S) * 2(X + Y) * Asc = 377.1 cm3
V min = 0.0025 * 100 * b * t = 375.0 cm3
Check stirrups Safe Stirrups branches =

- **Design of Foundations :-**

Project name	:	bo sand
Location	:	north cost
Footing no	:	f1

Given Data

Fcu = 300 Kg/cm2 | Fy = 3600 Kg/cm2 | Pu = 90.0 t. | qna = 10 t/m2 | b = 0.40 m | a = 0.25 m | t P.C. = 0.40 m

Design Procedueres

Pw = Pu /1.5 = 64.3 t
A p.c. = Pw/qna = 6.4 m2
L' =2.65 m B' =2.50 m
Fn = Pu / L' *B' = 9.70 t/m2
C = t p.c. * (Ft /3 Fn)^0.5
C =0.47 m
L = L' - 2C B = B' - 2C
L =1.75 m B =1.60 m
q = Pu / L *B = 22.96 t/m2

Depth for moment
Mu 1-1 = q * B * (L - b)² /8 = 8.37 m.t.
Mu 2-2 = q * L * (B - a)² /8 = 9.15 m.t.
d_{1-1} = 5 * (Mu / Fcu * B) ^0.5 = 20.9 cm
d_{2-2} = 5 * (Mu / Fcu * L) ^0.5 = 20.9 cm
d B.M. = 20.9 cm

Depth for shear
Q 1-1 = q * B * (L - b - d)/2 = 24796 -1.84 d
Q 2-2 = q * L * (B - a - d)/2 = 27121 -2.01 d
qcu = 0.49 (Fcu / 1.5)^0.5 = 6.93 Kg/cm2
q 1-1 = Q 1-1 / (B * d_{1-1})
q 2-2 = Q 2-2 / (L * d_{2-2})
d 1-1 = q (L - b) / ((qcu + q/2) /2) = 19.2 cm
d 2-2 = q (B - a) / ((qcu + q/2) /2) = 19.2 cm
d shear = 19.2 cm

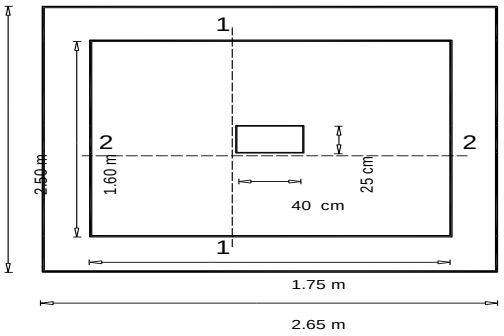
Depth for punching
Qp = q (L*B - (a+d)*(b+d)) = 61990 -149 d -2.30d²
qpu = (0.5 + a/b) (Fcu / 1.5) ^0.5 = 14.14 Kg/cm2 ≤ (Fcu/1.5)^0.5
qp*2(a+b+2d)*d= 1838.5 d + 57 d²
qp * 2(a+b+2d) = Qp
61990 -149.2 d -2.30d² = 1838.5 d + 57 d²
58.9 d² + 1988 d -61989.8 = 0
d punch = 19.7 cm
Take d = 20.9 cm

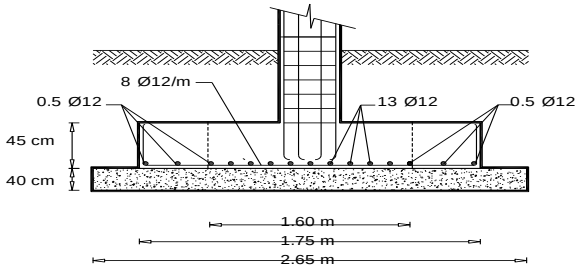
Reinforcement steel
Long direction
As req = Mu1-1 / Fy * J * d = 13.48 cm2
As min = μ min * B * d = 10.21 cm2
As = 13.48 cm2
Use 12 Ø12 8 Ø12 /m Safe
As act. = 13.58 cm2
Short direction
As req = Mu2-2 / Fy * J * d = 14.74 cm2
As min = μ min * L * d = 11.16 cm2
As = 14.74 cm2
As (central zone of width B) = 14.08 cm2
Use 13 Ø12 8 Ø12 /m Safe
As (end zones) = 0.66 cm2
Use 1 Ø12 7 Ø12 /m Safe
As act. = 15.84 cm2

Check of Bond stress
qbu = 0.95 * (Fcu / 1.5)^0.5 = 13.435
Qb1-1 = q * B * (B - b) /2 = 24.80 t.
db1-1 = Qb1-1 / qbu * ∑o = 40.8 cm
Qb2-2 = q * L * (L - b) /2 = 27.12 t.
db2-2 = Qb2-2 / qbu * ∑o = 38.3 cm
d bond = 40.8 cm

Check for anchorage length
dd avilable = (L - b)/2+d-cover = (B - a)/2+d-cover : 107.5 Cm
dd long = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe
dd short = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe

d final = 40 cm **t** final = 45 cm





DELTA BUILDING SYSTEMS
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Project name	:	bo sand
Location	:	north cost
Footing no	:	f2

Given Data

Fcu = 300 Kg/cm2 Fy = 3600 Kg/cm2 Pu = 100.0 t. qna = 10 t/m2 b = 0.60 m a = 0.25 m t P.C. = 0.40 m

Design Procedueres

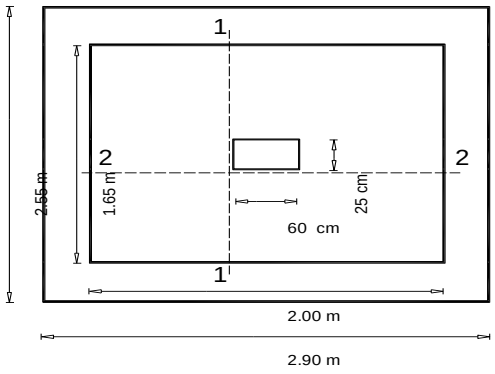
Pw = Pu /1.5 = 71.4 t
A p.c. = Pw/qna = 7.1 m2
L' =2.90 m B' =2.55 m
Fn = Pu / L' *B' = 9.66 t/m2
C = t p.c. * (Ft /3 Fn)^0.5
C =0.47 m
L = L' - 2C B = B' - 2C
L =2.00 m B =1.65 m
q = Pu / L *B = 21.65 t/m2

Depth for moment

Mu 1-1 = q * B * (L - b)² /8 = 8.75 m.t.
Mu 2-2 = q * L * (B - a)² /8 = 10.61 m.t.
d1-1 = 5 * (Mu / Fcu * B) ^0.5 = 21.0 cm
d2-2 = 5 * (Mu / Fcu * L) ^0.5 = 21.0 cm
d B.M. = 21.0 cm

Depth for shear

Q 1-1 = q * B * (L - b - d)/2 = 25000 -1.79 d
Q 2-2 = q * L * (B - a - d)/2 = 30303 -2.16 d
qcu = 0.49 (Fcu / 1.5)^0.5 = 6.93 Kg/cm2
q 1-1 = Q 1-1 / (B * d1-1)
q 2-2 = Q 2-2 / (L * d2-2)
d 1-1 = q (L - b) / ((qcu + q/2) /2) = 18.9 cm
d 2-2 = q (B - a) / ((qcu + q/2) /2) = 18.9 cm
d shear = 18.9 cm



Depth for punching

Qp = q (L*B - (a+d)*(b+d)) = 68182 -184 d -2.16d²
qpu = (0.5 + a/b) (Fcu / 1.5) ^0.5 = 12.96 Kg/cm2 ≤ (Fcu/1.5)^0.5
qp*2(a+b+2d)*d= 2203.8 d + 52 d²
qp * 2(a+b+2d) = Qp
68182 -184.0 d -2.16d² = 2203.8 d + 52 d²
54.0 d² + 2388 d -68181.8 = 0
d punch = 19.7 cm
Take d = 21.0 cm

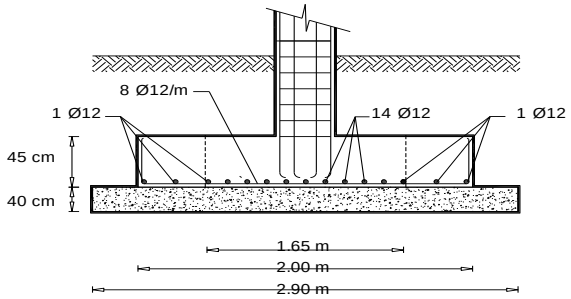
Reinforcement steel

Long direction

As req = Mu1-1 / Fy * J * d = 14.00 cm2
As min = μ min * B * d = 10.60 cm2
As = 14.00 cm2
Use 13 Ø12 8 Ø12 /m Safe
As act. = 14.71 cm2

Short direction

As req = Mu2-2 / Fy * J * d = 16.97 cm2
As min = μ min * L * d = 12.85 cm2
As = 16.97 cm2
As (central zone of width B) = 15.34 cm2
Use 14 Ø12 8 Ø12 /m Safe
As (end zones) = 1.63 cm2
Use 2 Ø12 6 Ø12 /m Safe
As act. = 18.10 cm2



Check of Bond stress

qbu = 0.95 * (Fcu / 1.5)^0.5 = 13.435
Qb1-1 = q * B * (B - b) /2 = 25.00 t.
db1-1 = Qb1-1 / qbu * ∑o = 38.0 cm
Qb2-2 = q * L * (L - b) /2 = 30.30 t.
db2-2 = Qb2-2 / qbu * ∑o = 37.4 cm
d bond = 38.0 cm

Check for anchorage length

dd avilable = (L - b)/2+d-cover = (B - a)/2+d-cover : 105.0 Cm
dd long = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe
dd short = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe

d final = 40 cm **t** final = 45 cm

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DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Project name	:	bo sand
Location	:	north cost
Footing no	:	f3

Given Data

Fcu = 300 Kg/cm2 Fy = 3600 Kg/cm2 Pu = 140.0 t. qna = 10 t/m2 b = 0.60 m a = 0.25 m t P.C. = 0.40 m

Design Procedueres

Pw = Pu /1.5 = 100.0 t
A p.c. = Pw/qna = 10.0 m2
L' =3.35 m B' =3.00 m
Fn = Pu / L' *B' = 9.95 t/m2
C = t p.c. * (Ft /3 Fn)^0.5
C =0.46 m
L = L' - 2C B = B' - 2C
L =2.45 m B =2.10 m
q = Pu / L *B = 19.44 t/m2

Depth for moment

Mu 1-1 = q * B * (L - b)² /8 = 17.46 m.t.
Mu 2-2 = q * L * (B - a)² /8 = 20.37 m.t.
d_{1-1} = 5 * (Mu / Fcu * B) ^0.5 = 26.3 cm
d_{2-2} = 5 * (Mu / Fcu * L) ^0.5 = 26.3 cm
d B.M. = 26.3 cm

Depth for shear

Q 1-1 = q * B * (L - b - d)/2 = 37755 -2.04 d
Q 2-2 = q * L * (B - a - d)/2 = 44048 -2.38 d
qcu = 0.49 (Fcu / 1.5)^0.5 = 6.93 Kg/cm2
q 1-1 = Q 1-1 / (B * d_{1-1})
q 2-2 = Q 2-2 / (L * d_{2-2})
d 1-1 = q (L - b) / ((qcu + q/2) /2) = 22.8 cm
d 2-2 = q (B - a) / ((qcu + q/2) /2) = 22.8 cm
d shear = 22.8 cm

Depth for punching

Qp = q (L*B - (a+d)*(b+d)) = 97085 -165 d -1.94d²
qpu = (0.5 + a/b) (Fcu / 1.5) ^0.5 = 12.96 Kg/cm2 ≤ (Fcu/1.5)^0.5
qp*2(a+b+2d)*d= 2203.8 d + 52 d²
qp * 2(a+b+2d) = Qp
97085 -165.2 d -1.94d² = 2203.8 d + 52 d²
53.8 d² + 2369 d -97084.5 = 0
d punch = 25.8 cm
Take d = 26.3 cm

Reinforcement steel

Long direction

As req = Mu1-1 / Fy * J * d = 22.31 cm2
As min = μ min * B * d = 16.89 cm2
As = 22.31 cm2
Use 20 Ø12 10 Ø12 /m Safe
As act. = 22.63 cm2

Short direction

As req = Mu2-2 / Fy * J * d = 26.03 cm2
As min = μ min * L * d = 19.71 cm2
As = 26.03 cm2
As (central zone of width B) = 24.02 cm2
Use 22 Ø12 10 Ø12 /m Use Bigger Ø
As (end zones) = 2.00 cm2
Use 2 Ø12 6 Ø12 /m Safe
As act. = 27.15 cm2

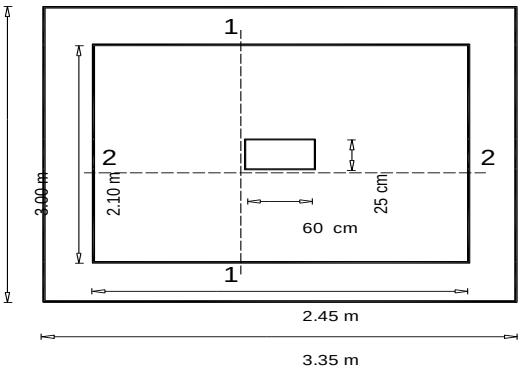
Check of Bond stress

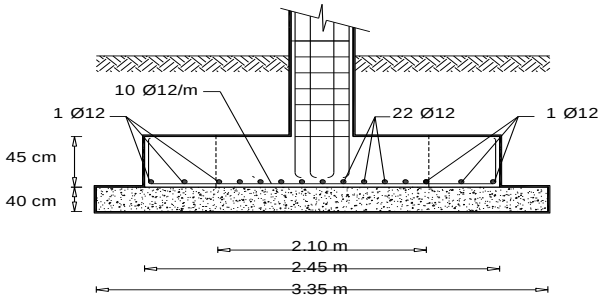
qbu = 0.95 * (Fcu / 1.5)^0.5 = 13.435
Qb1-1 = q * B * (B - b) /2 = 37.76 t.
db1-1 = Qb1-1 / qbu * ∑o = 37.3 cm
Qb2-2 = q * L * (L - b) /2 = 44.05 t.
db2-2 = Qb2-2 / qbu * ∑o = 36.3 cm
d bond = 37.3 cm

Check for anchorage length

dd avilable = (L - b)/2+d-cover = (B - a)/2+d-cover : 127.5 Cm
dd long = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe
dd short = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe

d final = 40 cm **t** final = 45 cm





DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Project name	:	bo sand
Location	:	north cost
Footing no	:	f4

Given Data

Fcu = 300 Kg/cm2 | Fy = 3600 Kg/cm2 | Pu = 150.0 t. | qna = 10 t/m2 | b = 1.45 m | a = 0.25 m | t P.C. = 0.40 m

Design Procedueres

Pw = Pu /1.5 = 107.1 t
A p.c. = Pw/qna = 10.7 m2
L' =3.95 m B' =2.75 m
Fn = Pu / L' *B' = 9.86 t/m2
C = t p.c. * (Ft /3 Fn)^0.5
C =0.47 m
L = L' - 2C B = B' - 2C
L =3.05 m B =1.85 m
q = Pu / L *B = 18.99 t/m2

Depth for moment
Mu 1-1 = q * B * (L - b)² /8 = 11.24 m.t.
Mu 2-2 = q * L * (B - a)² /8 = 18.53 m.t.
d_{1-1} = 5 * (Mu / Fcu * B) ^0.5 = 22.5 cm
d_{2-2} = 5 * (Mu / Fcu * L) ^0.5 = 22.5 cm
d B.M. = 22.5 cm

Depth for shear
Q 1-1 = q * B * (L - b - d)/2 = 28103 -1.76 d
Q 2-2 = q * L * (B - a - d)/2 = 46332 -2.90 d
qcu = 0.49 (Fcu / 1.5)^0.5 = 6.93 Kg/cm2
q 1-1 = Q 1-1 / (B * d_{1-1})
q 2-2 = Q 2-2 / (L * d_{2-2})
d 1-1 = q (L - b) / ((qcu + q/2) /2) = 19.3 cm
d 2-2 = q (B - a) / ((qcu + q/2) /2) = 19.3 cm
d shear = 19.3 cm

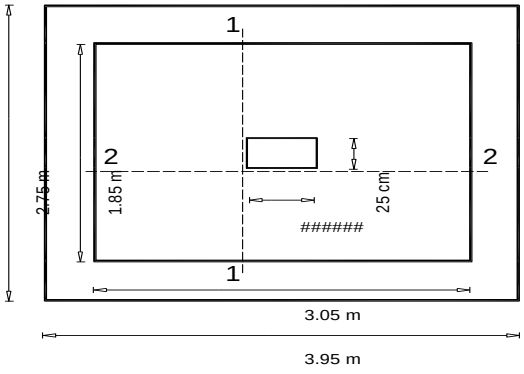
Depth for punching
Qp = q (L*B - (a+d)*(b+d)) = 100260 -323 d -1.90d²
qpu = (0.5 + a/b) (Fcu / 1.5) ^0.5 = 9.51 Kg/cm2 ≤ (Fcu/1.5)^0.5
qp*2(a+b+2d)*d= 3233.2 d + 38 d²
qp * 2(a+b+2d) = Qp
100260 -322.8 d -1.90d² = 3233.2 d + 38 d²
39.9 d² + 3556 d -100259.5 = 0
d punch = 22.5 cm
Take d = 22.5 cm

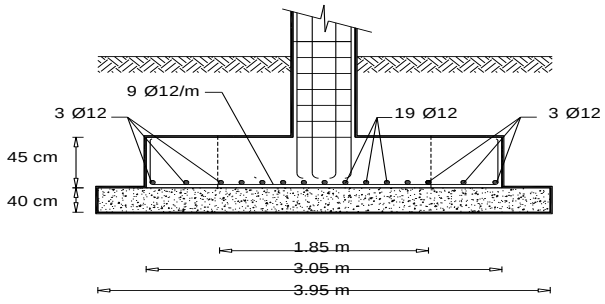
Reinforcement steel
Long direction
As req = Mu1-1 / Fy * J * d = 16.80 cm2
As min = μ min * B * d = 12.72 cm2
As = 16.80 cm2
Use 15 Ø12 9 Ø12 /m Safe
As act. = 16.97 cm2
Short direction
As req = Mu2-2 / Fy * J * d = 27.70 cm2
As min = μ min * L * d = 20.97 cm2
As = 27.70 cm2
As (central zone of width B) = 20.91 cm2
Use 19 Ø12 10 Ø12 /m Use Bigger Ø
As (end zones) = 6.78 cm2
Use 6 Ø12 5 Ø12 /m Safe
As act. = 28.29 cm2

Check of Bond stress
qbu = 0.95 * (Fcu / 1.5)^0.5 = 13.435
Qb1-1 = q * B * (B - b) /2 = 28.10 t.
db1-1 = Qb1-1 / qbu * ∑o = 37.0 cm
Qb2-2 = q * L * (L - b) /2 = 46.33 t.
db2-2 = Qb2-2 / qbu * ∑o = 36.6 cm
d bond = 37.0 cm

Check for anchorage length
dd avilable = (L - b)/2+d-cover = (B - a)/2+d-cover : 115.0 Cm
dd long = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe
dd short = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe

d final = 40 cm **t** final = 45 cm





DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Project name	:	bo sand
Location	:	north cost
Footing no	:	f5

Given Data

Fcu = 300 Kg/cm2 Fy = 3600 Kg/cm2 Pu = 190.0 t. qna = 10 t/m2 b = 1.70 m a = 0.25 m t P.C. = 0.40 m

Design Procedueres

Pw = Pu /1.5 = 135.7 t
A p.c. = Pw/qna = 13.6 m2
L' =4.50 m B' =3.05 m
Fn = Pu / L' *B' = 9.89 t/m2
C = t p.c. * (Ft /3 Fn)^0.5
C =0.46 m
L = L' - 2C B = B' - 2C
L =3.60 m B =2.15 m
q = Pu / L *B = 17.53 t/m2

Depth for moment

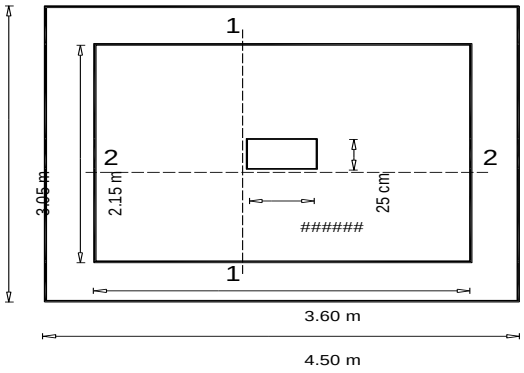
$Mu_{1-1} = q * B * (L - b)^2 /8 =$ 17.01 m.t.
$Mu_{2-2} = q * L * (B - a)^2 /8 =$ 28.48 m.t.
$d_{1-1} = 5 * (Mu / Fcu * B) ^0.5 =$ 25.7 cm
$d_{2-2} = 5 * (Mu / Fcu * L) ^0.5 =$ 25.7 cm
d B.M. = 25.7 cm

Depth for shear

$Q_{1-1} = q * B * (L - b - d)/2 =$ 35813 -1.88 d
$Q_{2-2} = q * L * (B - a - d)/2 =$ 59967 -3.16 d
qcu = 0.49 (Fcu / 1.5)^0.5 = 6.93 Kg/cm2
$q_{1-1} = Q_{1-1} / (B * d_{1-1})$
$q_{2-2} = Q_{2-2} / (L * d_{2-2})$
$d_{1-1} = q (L - b) / ((qcu + q/2) /2) =$ 21.3 cm
$d_{2-2} = q (B - a) / ((qcu + q/2) /2) =$ 21.3 cm
d shear = 21.3 cm

Depth for punching

Qp = q (L*B - (a+d)*(b+d)) = 128262 -342 d -1.75d²
qpu = (0.5 + a/b) (Fcu / 1.5) ^0.5 = 9.15 Kg/cm2 ≤ (Fcu/1.5)^0.5
qp*2(a+b+2d)*d= 3568.8 d + 37 d²
qp * 2(a+b+2d) = Qp
128262 -341.9 d -1.75d² = 3568.8 d + 37 d²
38.4 d² + 3911 d -128262.3 = 0
d punch = 26.1 cm
Take d = 25.7 cm



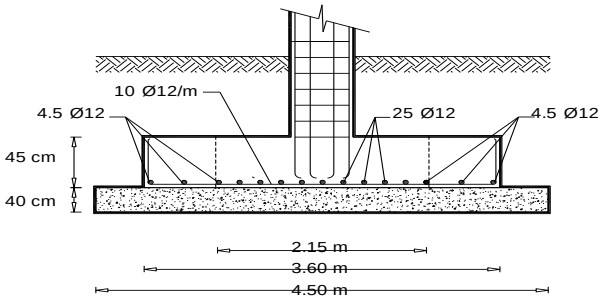
Reinforcement steel

Long direction

$As_{req} = Mu_{1-1} / Fy * J * d =$ 22.28 cm2
$As_{min} = \mu_{min} * B * d =$ 16.87 cm2
As = 22.28 cm2
Use 20 Ø12 10 Ø12 /m Safe
As act. = 22.63 cm2

Short direction

$As_{req} = Mu_{2-2} / Fy * J * d =$ 37.30 cm2
$As_{min} = \mu_{min} * L * d =$ 28.25 cm2
As = 37.30 cm2
As (central zone of width B) = 27.90 cm2
Use 25 Ø12 12 Ø12 /m Use Bigger Ø
As (end zones) = 9.41 cm2
Use 9 Ø12 6 Ø12 /m Safe
As act. = 38.47 cm2



Check of Bond stress

qbu = 0.95 * (Fcu / 1.5)^0.5 = 13.435
$Qb_{1-1} = q * B * (B - b) /2 =$ 35.81 t.
$db_{1-1} = Qb_{1-1} / qbu * \sum o =$ 35.4 cm
$Qb_{2-2} = q * L * (L - b) /2 =$ 59.97 t.
$db_{2-2} = Qb_{2-2} / qbu * \sum o =$ 34.8 cm
d bond = 35.4 cm

Check for anchorage length

dd avilable = (L - b)/2+d-cover = (B - a)/2+d-cover : 130.0 Cm
dd long = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe
dd short = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe

d final = 40 cm **t** final = 45 cm

Delta Sand Bricks Co. 35B Saray El-Maadi, Corniche El-Nil, Maadi, Cairo, Egypt (+20) 2-2527779 0/1/2/3/4 info@plenaegypt.com www.plenaegypt.com

DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Project name	:	bo sand
Location	:	north cost
Footing no	:	f6

Given Data

Fcu = 300 Kg/cm2 Fy = 3600 Kg/cm2 Pu = 190.0 t. qna = 10 t/m2 b = 2.35 m a = 0.25 m t P.C. = 0.40 m

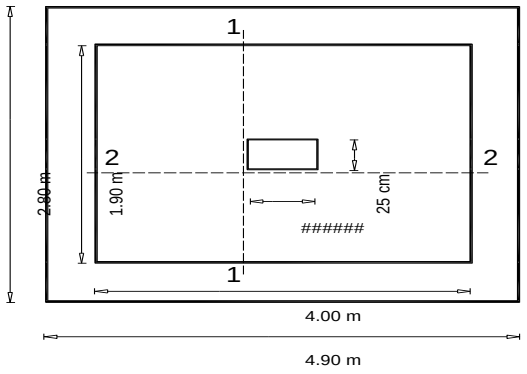
Design Procedueres

Pw = Pu /1.5 = 135.7 t
A p.c. = Pw/qna = 13.6 m2
L' =4.90 m B' =2.80 m
Fn = Pu / L' *B' = 9.89 t/m2
C = t p.c. * (Ft /3 Fn)^0.5
C =0.46 m
L = L' - 2C B = B' - 2C
L =4.00 m B =1.90 m
q = Pu / L *B = 17.86 t/m2

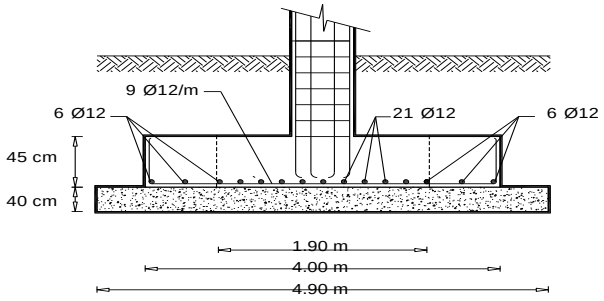
Depth for moment
Mu 1-1 = q * B * (L - b)² /8 = 11.55 m.t.
Mu 2-2 = q * L * (B - a)² /8 = 24.31 m.t.
d_{1-1} = 5 * (Mu / Fcu * B) ^0.5 = 22.5 cm
d_{2-2} = 5 * (Mu / Fcu * L) ^0.5 = 22.5 cm
d B.M. = 22.5 cm

Depth for shear
Q 1-1 = q * B * (L - b - d)/2 = 27991 -1.70 d
Q 2-2 = q * L * (B - a - d)/2 = 58929 -3.57 d
qcu = 0.49 (Fcu / 1.5)^0.5 = 6.93 Kg/cm2
q 1-1 = Q 1-1 / (B * d_{1-1})
q 2-2 = Q 2-2 / (L * d_{2-2})
d 1-1 = q (L - b) / ((qcu + q/2) /2) = 18.8 cm
d 2-2 = q (B - a) / ((qcu + q/2) /2) = 18.8 cm
d shear = 18.8 cm

Depth for punching
Qp = q (L*B - (a+d)*(b+d)) = 125223 -464 d -1.79d²
qpu = (0.5 + a/b) (Fcu / 1.5) ^0.5 = 8.58 Kg/cm2 ≤ (Fcu/1.5)^0.5
qp*2(a+b+2d)*d= 4459.3 d + 34 d²
qp * 2(a+b+2d) = Qp
125223 -464.3 d -1.79d² = 4459.3 d + 34 d²
36.1 d² + 4924 d -125223.2 = 0
d punch = 21.9 cm
Take d = 22.5 cm



Reinforcement steel
Long direction
As req = Mu1-1 / Fy * J * d = 17.25 cm2
As min = μ min * B * d = 13.06 cm2
As = 17.25 cm2
Use 16 Ø12 9 Ø12 /m Safe
As act. = 18.10 cm2
Short direction
As req = Mu2-2 / Fy * J * d = 36.33 cm2
As min = μ min * L * d = 27.50 cm2
As = 36.33 cm2
As (central zone of width B) = 23.40 cm2
Use 21 Ø12 11 Ø12 /m Use Bigger Ø
As (end zones) = ########
Use 12 Ø12 6 Ø12 /m Safe
As act. = 37.34 cm2



Check of Bond stress
qbu = 0.95 * (Fcu / 1.5)^0.5 = 13.435
Qb1-1 = q * B * (B - b) /2 = 27.99 t.
db1-1 = Qb1-1 / qbu * ∑o = 34.6 cm
Qb2-2 = q * L * (L - b) /2 = 58.93 t.
db2-2 = Qb2-2 / qbu * ∑o = 35.3 cm
d bond = 35.3 cm

Check for anchorage length
dd avilable = (L - b)/2+d-cover = (B - a)/2+d-cover : 117.5 Cm
dd long = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe
dd short = As (Fy / 1.15) / (π * Ø * qbc) = 70.0 Cm Safe

d final = 40 cm **t** final = 45 cm

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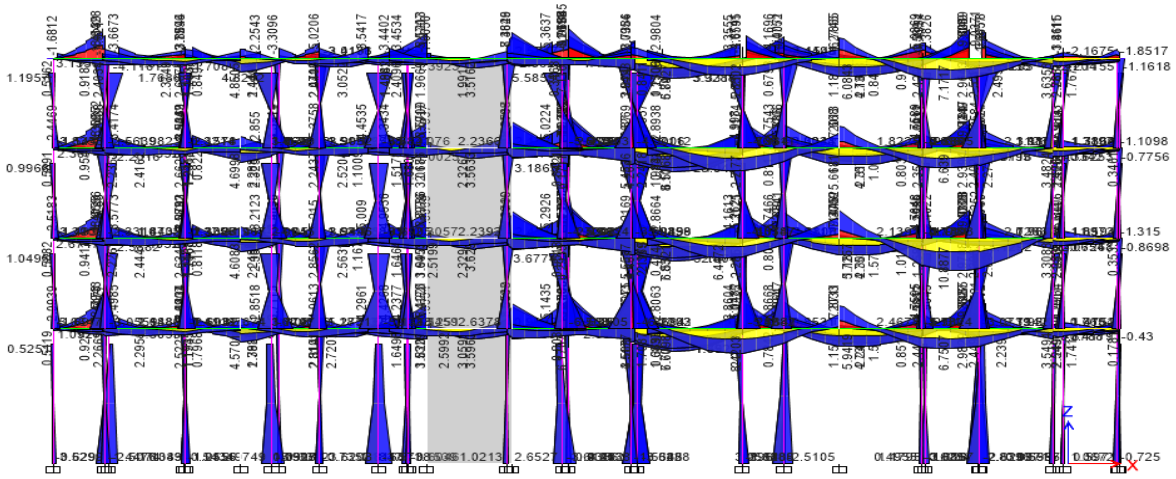
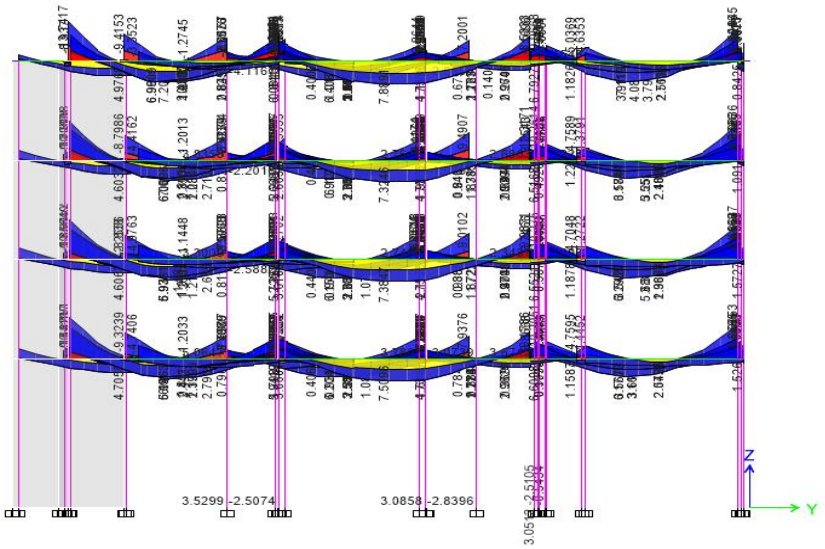
THE moment in maximum state due to lateral loads , as the shown the moments values can be neglected



MOMENT IN X DIR



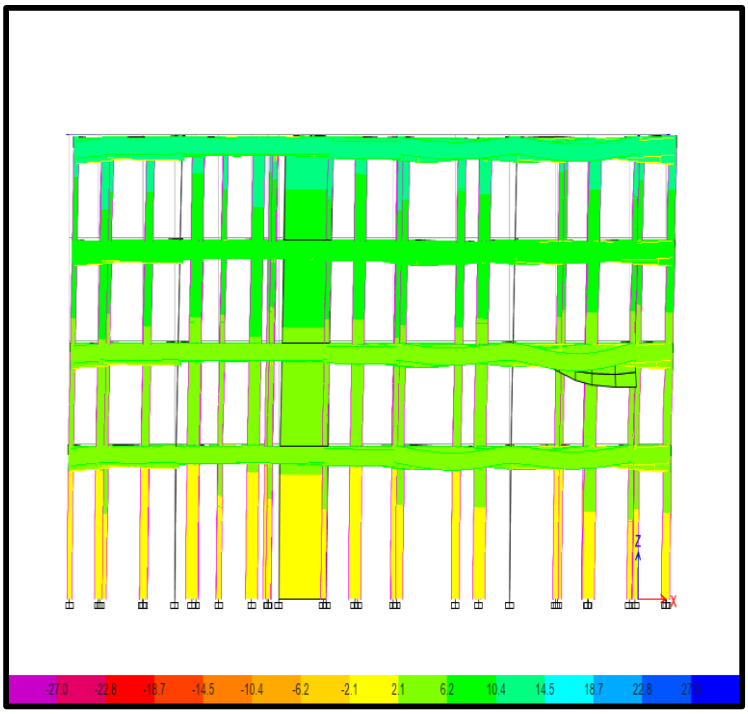
MOMENT IN Y DIR

Maximum moment acting on columns due to Lateral loads = 4 mt . can be neglected

- **Displacement of building due to Lateral loads:**

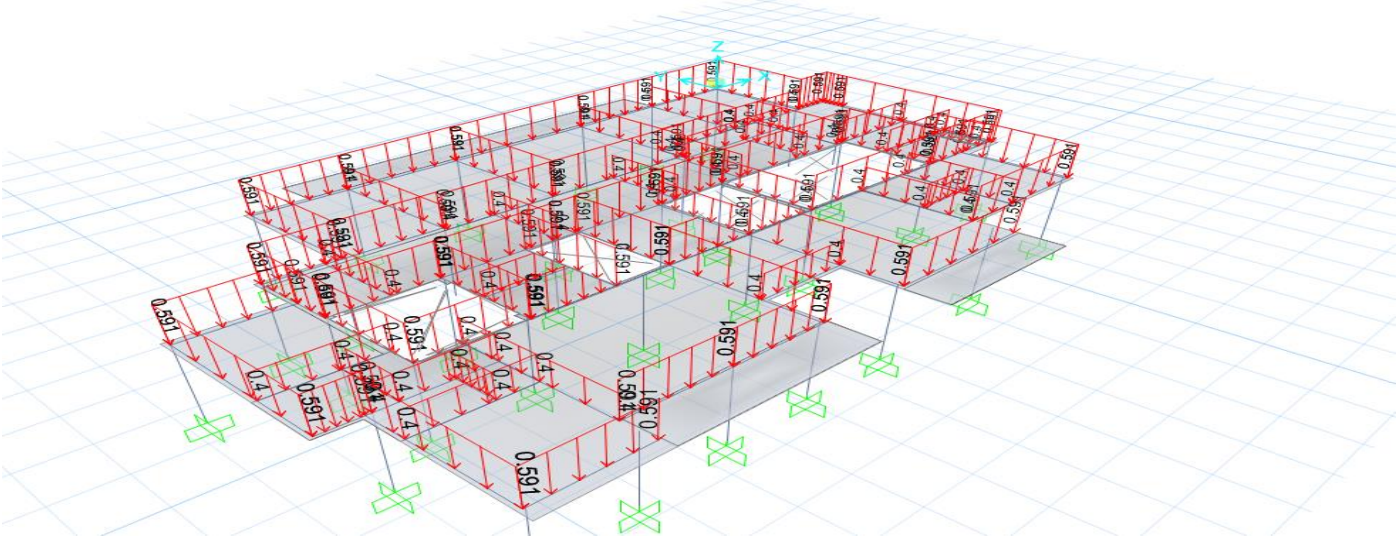
y direction

x direction



the maximum deformation and horizontal displacement due to lateral loads = 1.1 cm maximum , and the allowable is =H/480=13.5/480=2.82 cm , satisfied code conditions.

- **Design of slabs :- ground floor**
  1. **Loads Assign (WALL LOADS)**



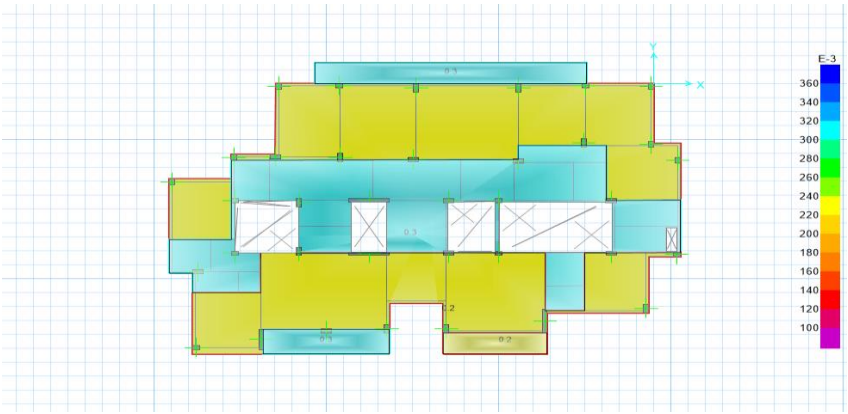
Outer walls\m'

Walls height= 2.5 m , walls density =550 kg/m3 , walls thickness=0.25m
loads of walls without plastering \m'=2.5×0.55×0.25=0.344 t\m'
weight of plastering=0.04×1.8×3=0.21 t\m'
total wall loads\m'=0.56 t\m'

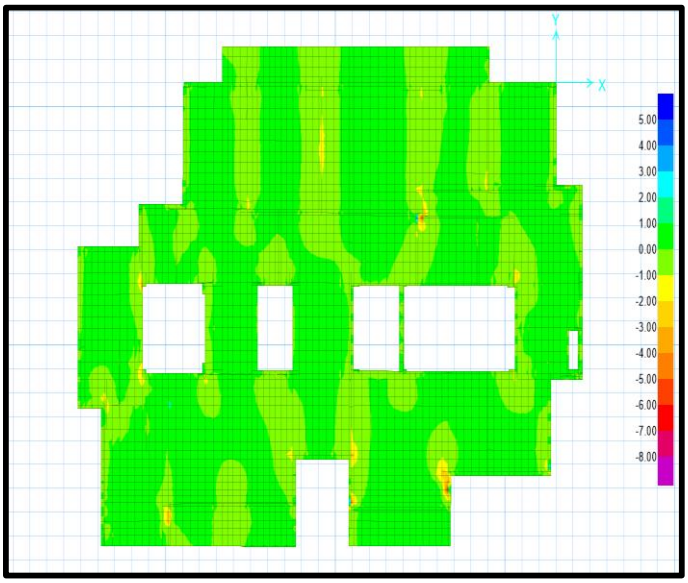
Inner wall\m'

Walls height= 2.5 m , walls density =550 kg/m3 , walls thickness=0.12m
loads of walls without plastering \m'=3.00×0.55×0.12=0.198 t\m'
weight of plastering=0.04×1.8×3=0.21 t\m'
total wall loads\m'=0.40 t\m'

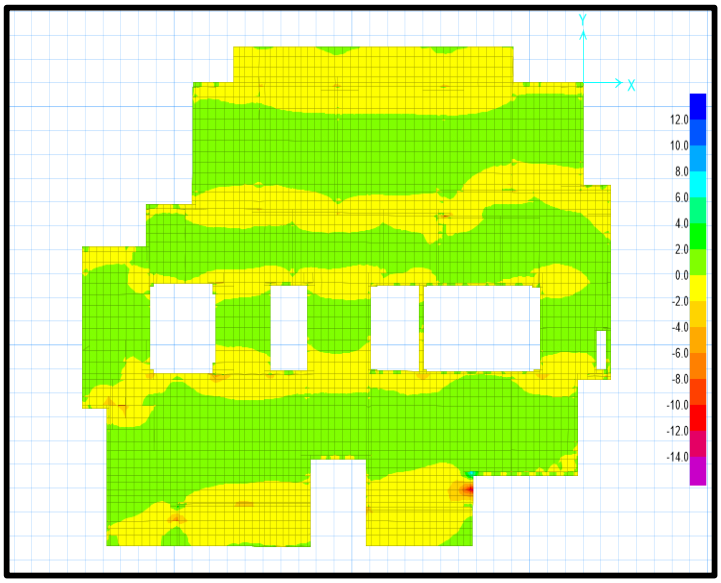
live loads



M1-1

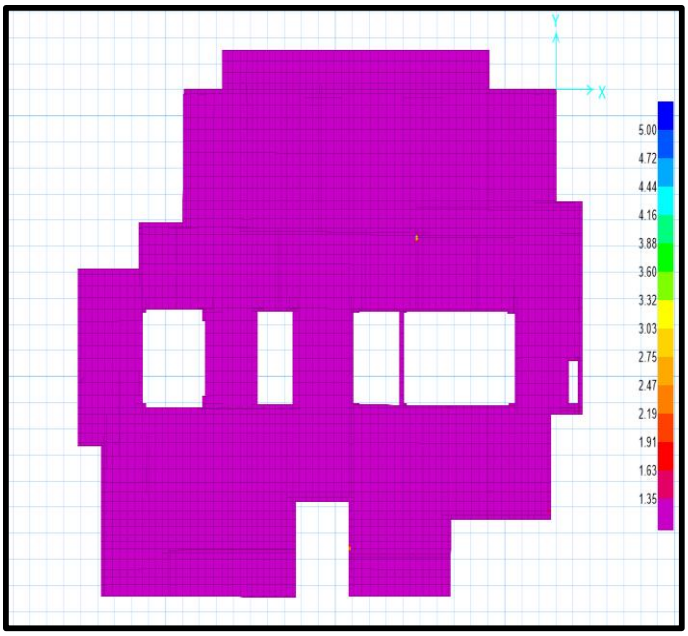


M2-2

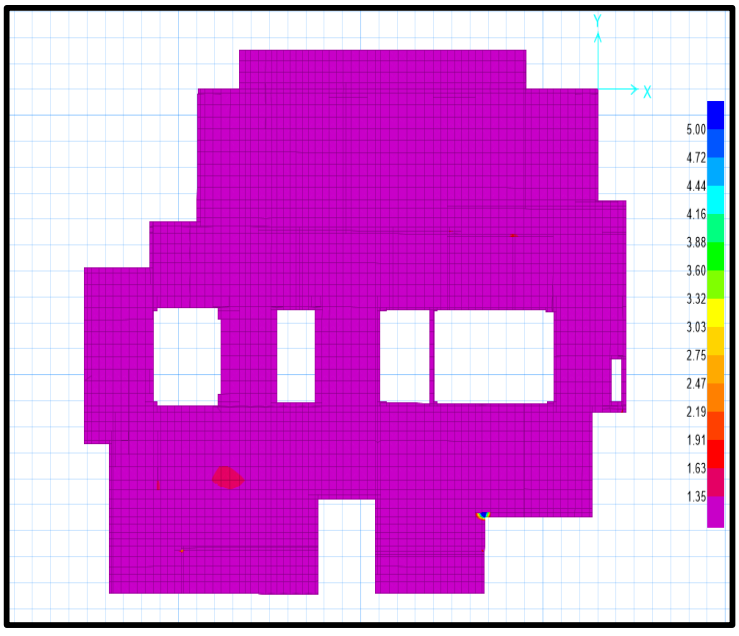


REINFORCMENT WITH BOTTOM MESH T10@165 mm

+ve M1-1

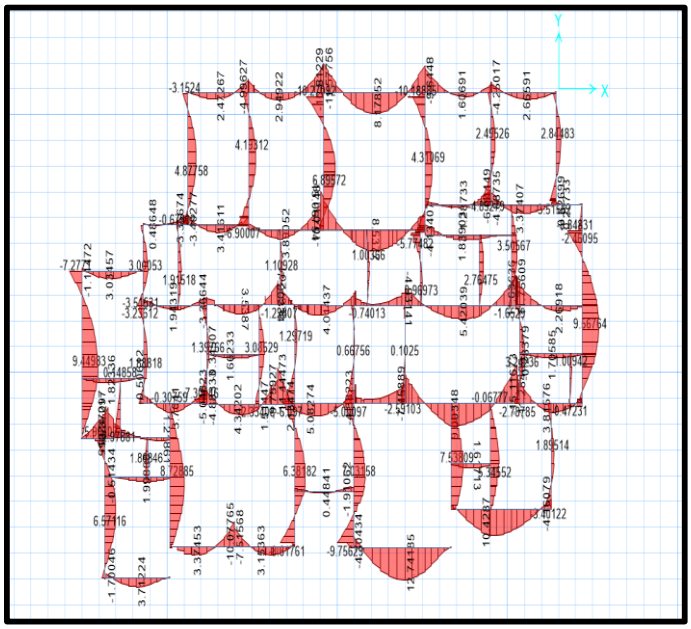


+ve m2-2

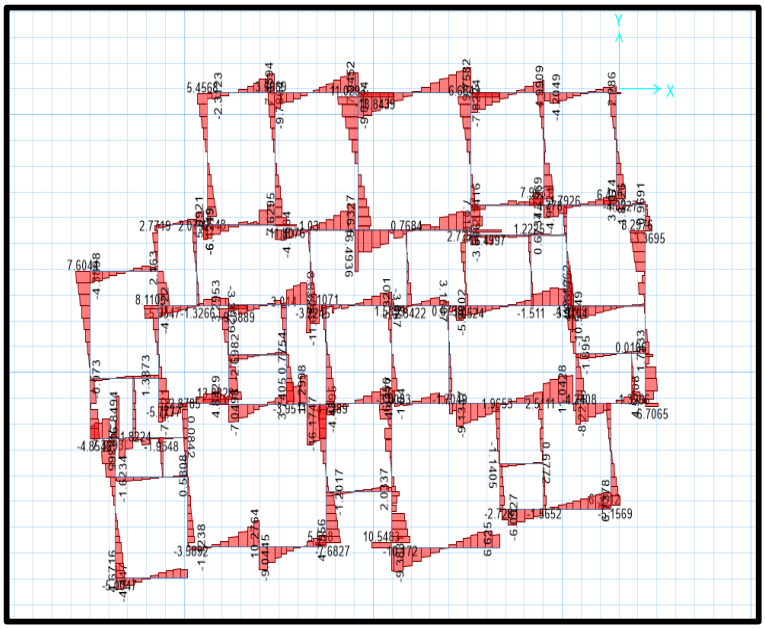


- **Beams stresses**

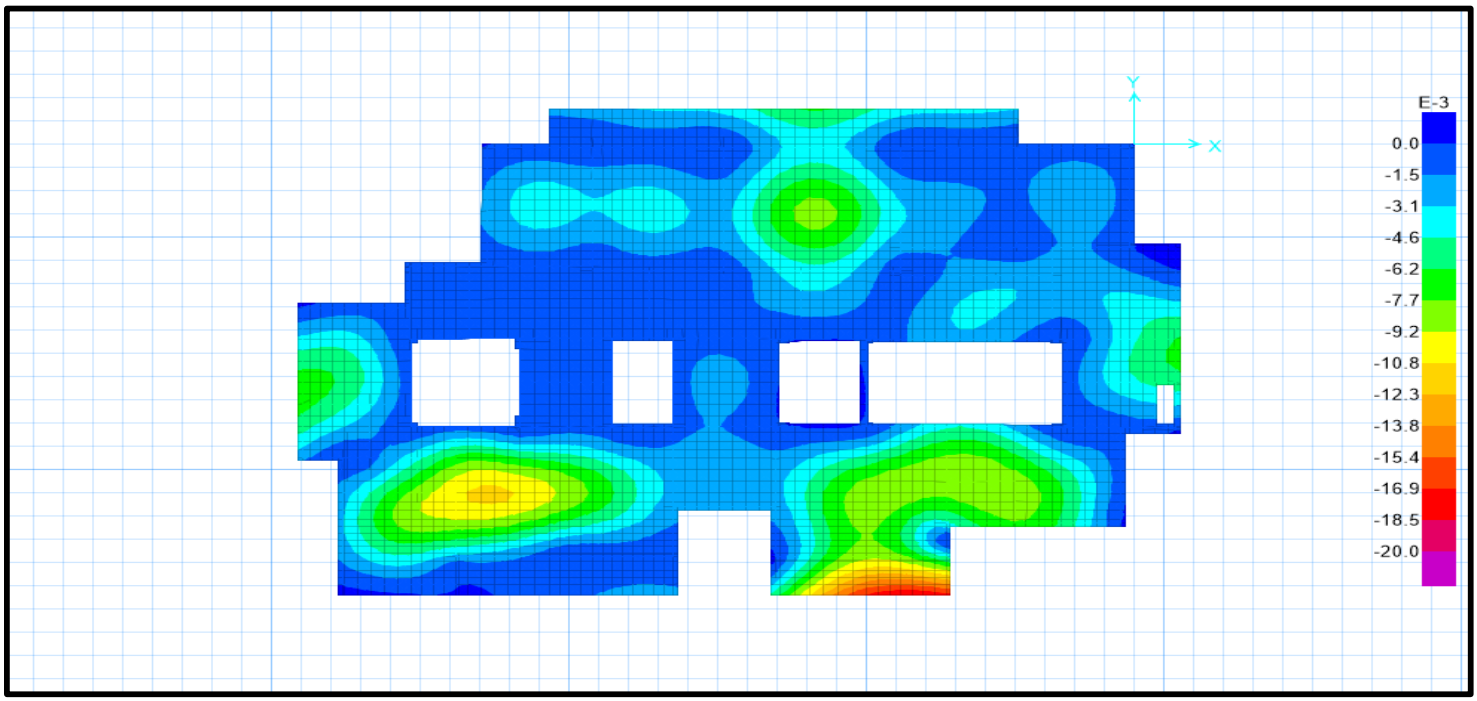
Moment



shear

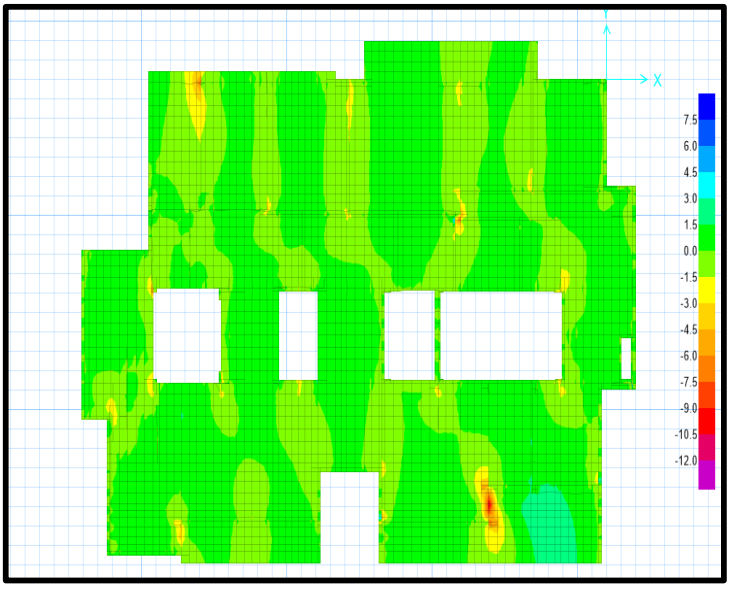


- **Deformations**

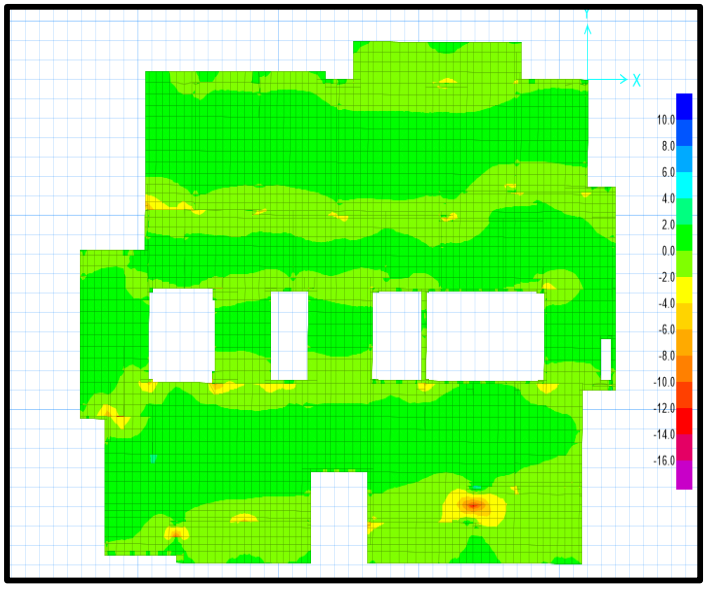


First floor:-

M1-1

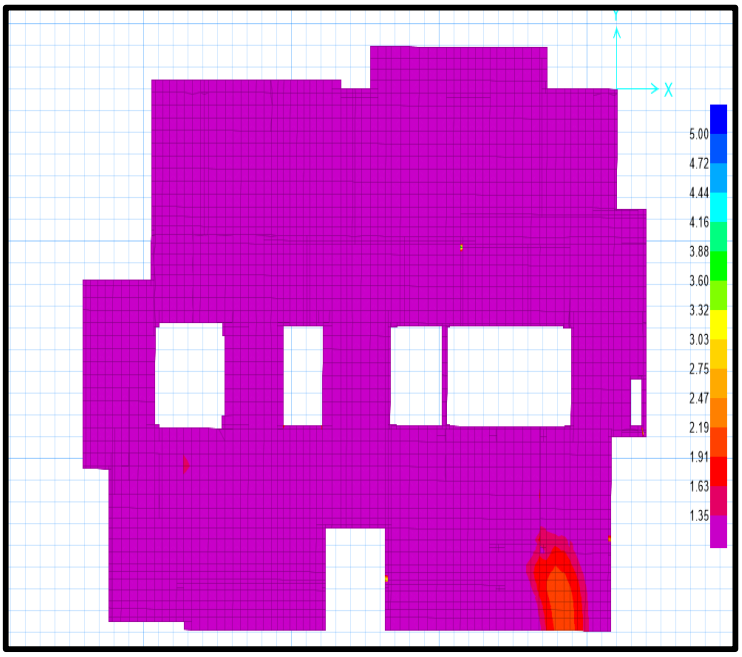


M2-2



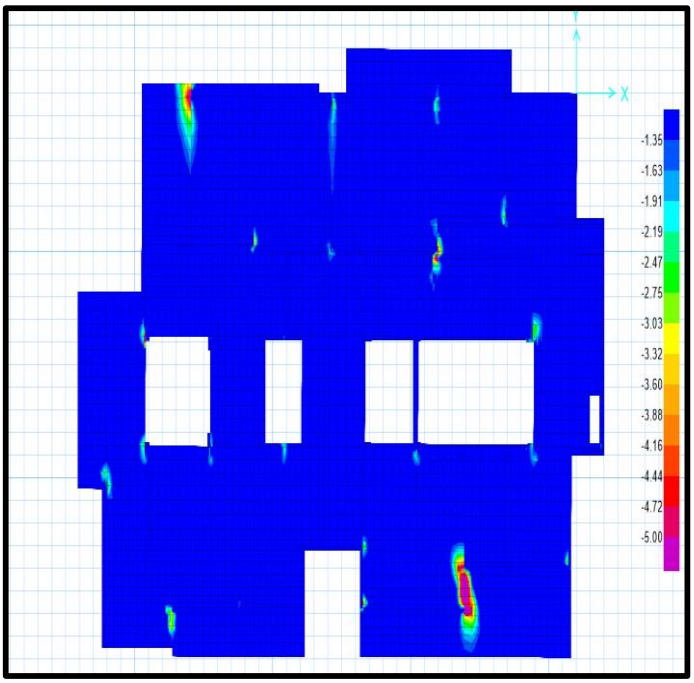
REINFORCMENT WITH TOP&BOTTOM MESH T10@165 mm

+ve M1-1

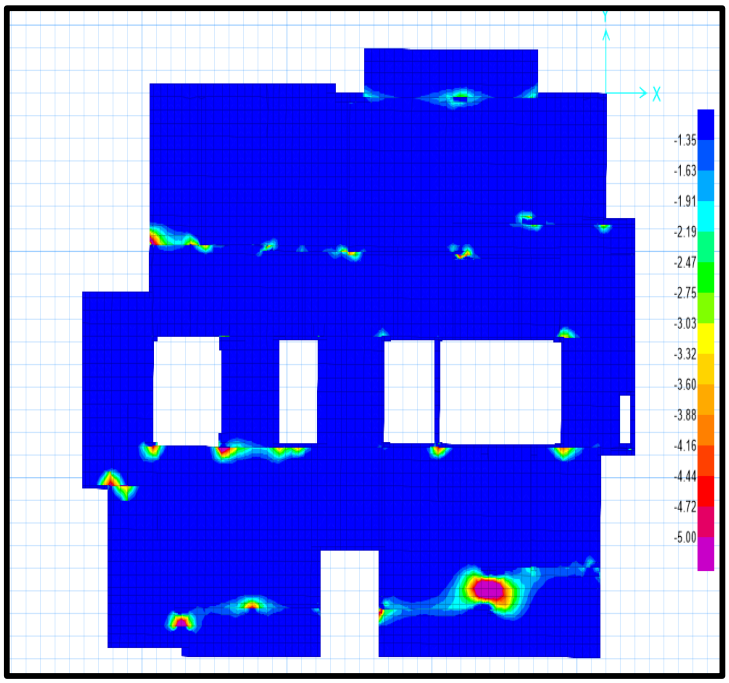


+ve M2-2

-ve M1-1

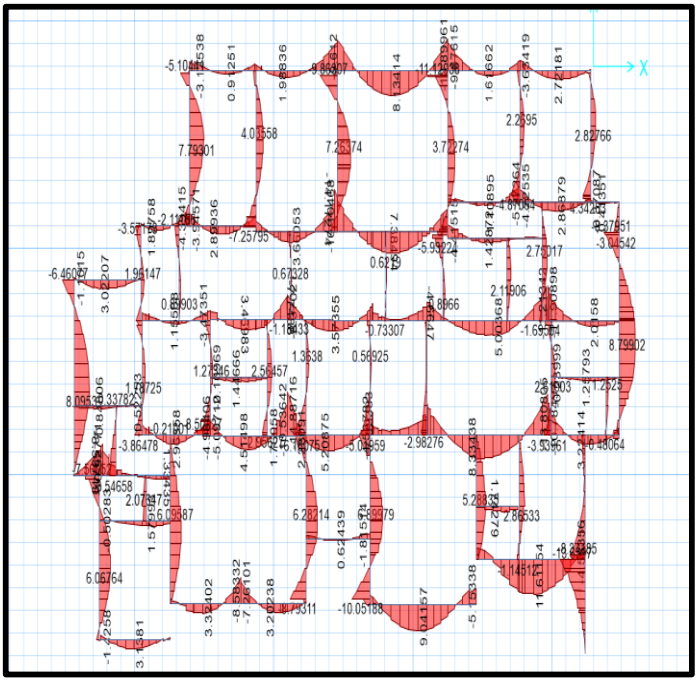


-ve M2-2

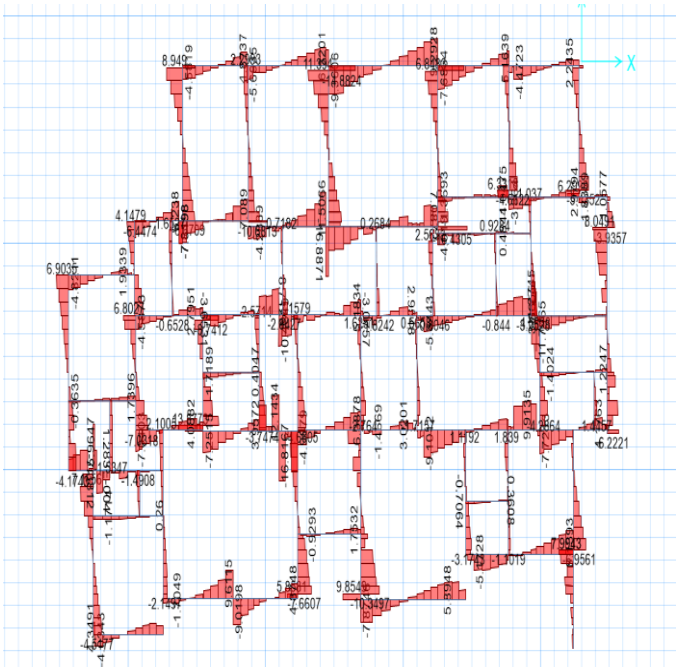


- **Beams stresses**

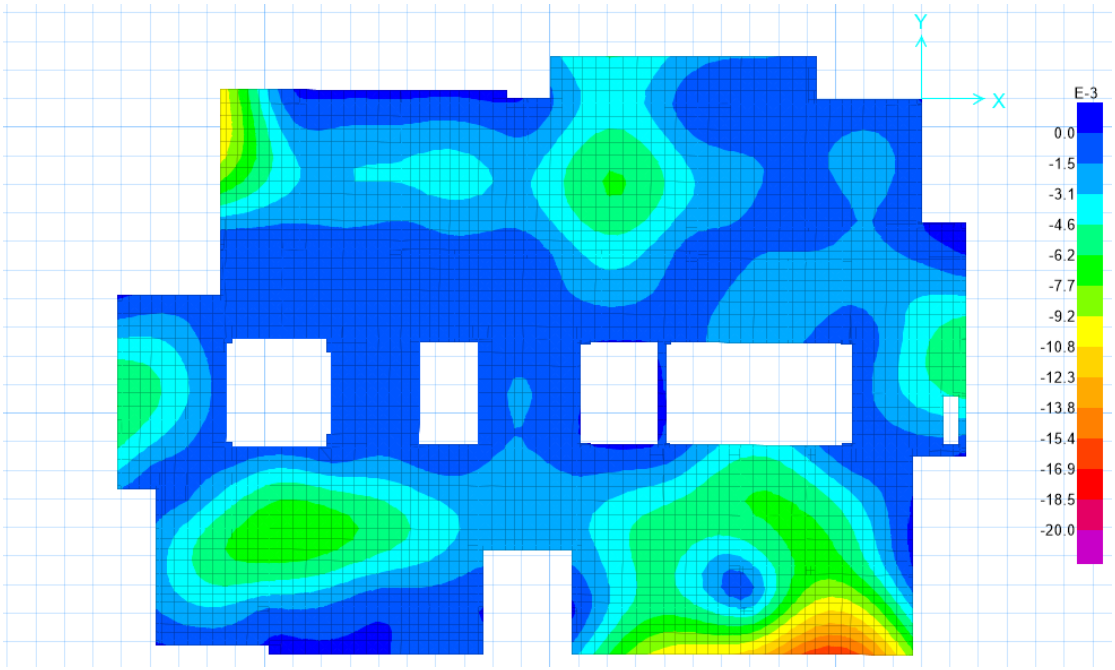
Moment



shear



- **DEFORMATIONS**



- **ANALYSIS and Design OF SLABS , Beams**

For The Shown figure (slab & beam stresses and deformations)

Allowable deformations for all slabs as the following

Maximum span =5.5 m

Two way solid slab continuous from one end , Thickness = Ls/40

Ts=5.2/40= 12.5 cm. 14 cm is satisfied for this spans

Slabs of thickness 12 cm is very satisfied for spans up to 4.8 m

Deformations under loading must to be less than =L/250=2.2 cm .satisfied

- **Reinforcement of slabs**

BOTTOM mesh 6 Ø10\m'with thickness 12 cm will cover moment 1.35 m.t

BOTTOM mesh 6 Ø10\m'with thickness 14 cm will cover moment 1.63 m.t

DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Project name :Bo- Sand
Location :NORTH CO/
Beam no :B1

Given Data

Fcu = 300 kg/cm2 Fy = 3600 kg/cm2 Mu = 3.00 m.t. Qu = 8 ton Mt = 0.0 m.t. b = 12 cm d = 45 cm

Design Procedueres

Fy = 3600 kg/cm2 From table get ⟹ Cmax/d = 0.44 and Rmax = 0.1943 Cmin/d = 0.125

μ_{max} = 0.0151 and μmin = 11/ Fy = 0.0031

$d_{min} = \sqrt{\frac{Mu}{Rmax * Fcu/\gamma c * b}}$ = 25.4 cm

d = 45 cm Check d'/d ≤ 0.15 ⟹ Fs' = Fy/γs

From d get c/d = 0.125 Check $c_{min}/d < c/d < c_{max}/d$ ⟹ Safe

Mumax1 (moment Capacity for single reinforced section) = Rmax * Fcu/γc * b * d^2 = 9.44 m.t.

Mumax2 (moment Capacity for double reinforced section) = Rmax * Fcu/γc * b * d^2 + 0.004 * b * d * Fy /γs * (d - d') = 12.15 m.t.

Check Mu < Mumax1 =======> Single reinforced section

$As = \frac{Mu}{Fy/\gamma s * d * (1- 0.4*c/d)}$ = 2.24 cm2

As' = 0.15*As = 0.34 cm2

Tension reinforcement

Choosen Φ_{main} = 12 mm ⟹ no. of Bars = 2

As actual = 2.26 cm2

μ = As/(b*d) = 0.004

Compression reinforcement

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 2

As' actual = 2.26 cm2

μ' = As'/(b*d) = 0.0042

Check μmin < μ < μmax ⟹ Safe

Check 0.1μ < μ' < 0.004 ⟹ Increase d

Check of Shear

qu = Qu / (b*d) = 14.81 kg/cm2

qt = 3*$M_{torsion}$ / (b² * t) = 0.00 kg/cm2

δsi = ((1+ (qt / qu)²)^0.5)^-1 = 1.000

δti = ((1+ (qt / qu)²)^0.5)^-1 = 1.000

q_{cu} = 0.75 * δsi *(Fcu/γc)^.5 = 10.61 kg/cm2

q_{umax} = 2.2* δsi *(Fcu/γc)^.5 = 30.00 kg/cm2 ≤ 30 kg/cm2

q_{tu} = 0.75 * δti *(Fcu/γc)^.5 = 10.61 kg/cm2

q_{tumax} = 2.2 * δti *(Fcu/γc)^.5 = 31.11 kg/cm2

If qcu < qu < qumax and qtu < qtcu ⟹ Reinforce to resist qu

Closed stirrups for Shear & Torsion

Shear		Torsion	
qsteel = qu - 0.5*qcu =	9.51 kg/cm2	qsteel = tu - 0.5*qtcu =	0.00 kg/cm2
μ = n*Ast_1 / (b * s) = qsteel / (Fystr/γs)		x_1 , y_1 are stirrup dimensions	Y1= 40 X1 = 7
b < 40 cm take n = 2	2 Branches	α = 0.66 + 0.33* (y_1 / x_1) =	1.5
Ast/Ss =	0.027 cm	$Ast/St = \frac{(qsteel * (b^2*t)/3)}{\alpha_t*x_1*y_1*(Fystr/\gamma_s)}$ =	0.000 cm

Choose $\Phi_{stirrups}$ Ø8

No. of stirrups = 100/St + 100/Ss = 5.4380

Use Stirrups 6 Ø8 2 Branches

Longitudinal bars for torsion

$As.l. = \frac{2 * Astr * (x1 + y1) * Fystr.}{S * Fy}$ = 0.00 cm2

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 0

Shrinkage bar

t < 70 no need to shrinkage bar

DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Project name :Bo- Sand
Location :NORTH CO/
Beam no :B2

Given Data

Fcu = 300 kg/cm2 Fy = 3600 kg/cm2 Mu = 4.90 m.t. Qu = 8 ton Mt = 0.0 m.t. b = 12 cm d = 45 cm

Design Procedueres

Fy = 3600 kg/cm2 From table get ⟹ Cmax/d = 0.44 and Rmax = 0.1943 Cmin/d = 0.125

μ_{max} = 0.0151 and μmin = 11/ Fy = 0.0031

$$d_{min} = \sqrt{\frac{Mu}{Rmax * Fcu/\gamma c * b}} = 32.4 \text{ cm}$$

d = 45 cm Check d'/d ≤ 0.15 ⟹ Fs' = Fy/γs

From d get c/d = 0.205 Check $c_{min}/d < c/d < c_{max}/d$ ⟹ Safe

Mumax1 (moment Capacity for single reinforced section) = Rmax * Fcu/γc * b * d^2 = 9.44 m.t.

Mumax2 (moment Capacity for double reinforced section) = Rmax * Fcu/γc * b * d^2 + 0.004 * b * d * Fy /γ_s * (d - d') = 12.15 m.t.

Check Mu < Mumax1 ========> Single reinforced section

$$As = \frac{Mu}{Fy/\gamma s * d * (1 - 0.4*c/d)} = 3.79 \text{ cm2}$$

$$As' = \frac{0.15*As}{} = 0.57 \text{ cm2}$$

Tension reinforcement

Choosen Φ_{main} = 12 mm ⟹ no. of Bars = 4

As actual = 4.53 cm2

μ = As/(b*d) = 0.008

Compression reinforcement

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 2

As' actual = 2.26 cm2

μ' = As'/(b*d) = 0.0042

Check μmin < μ < μmax ⟹ Safe

Check 0.1μ < μ' < 0.004 ⟹ Increase d

Check of Shear

qu = Qu / (b*d) = 14.81 kg/cm2

qt = 3*$M_{torsion}$ / (b^2 * t) = 0.00 kg/cm2

δsi = ((1+ (qt / qu)²)^0.5)^-1 = 1.000

δti = ((1+ (qt / qu)²)^0.5)^-1 = 1.000

q_{cu} = 0.75 * δsi *(Fcu/γ_c)^.5 = 10.61 kg/cm2

q_{umax} = 2.2* δsi *(Fcu/γ_c)^.5 = 30.00 kg/cm2 ≤ 30 kg/cm2

q_{tu} = 0.75 * δti *(Fcu/γ_c)^.5 = 10.61 kg/cm2

q_{tumax} = 2.2 * δti *(Fcu/γ_c)^.5 = 31.11 kg/cm2

If qcu < qu < qumax and qtu < qtcu ⟹ Reinforce to resist qu

Closed stirrups for Shear & Torsion

Shear		Torsion	
qsteel = qu - 0.5*qcu =	9.51 kg/cm2	qsteel = tu - 0.5*qtcu =	0.00 kg/cm2
μ = n*Ast_1 / (b * s) = qsteel / (Fystr/γ_s)		x_1 , y_1 are stirrup dimensions	Y1= 40 X1 = 7
b < 40 cm take n = 2	2 Branches	α = 0.66 + 0.33* (y_1 / x_1) =	1.5
Ast/Ss =	0.027 cm	$Ast/St = \frac{(qsteel * (b^2*t)/3)}{\alpha_t * x_1 * y_1 * (Fystr/\gamma_s)}$ =	0.000 cm

Choose $\Phi_{stirrups}$ Ø8

No. of stirrups = 100/St + 100/Ss = 5.4380

Use Stirrups 6 Ø8 2 Branches

Longitudinal bars for torsion

$$As.l. = \frac{2 * Astr * (x1 + y1) * Fystr.}{S * Fy} = 0.00 \text{ cm2}$$

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 0

Shrinkage bar

t < 70 no need to shrinkage bar

DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Project name :Bo- Sand
Location :NORTH COAST
Beam no :B3

Given Data

Fcu = 300 kg/cm2 Fy = 3600 kg/cm2 Mu = 5.15 m.t. Qu = 8 ton Mt = 0.0 m.t. b = 12 cm d = 45 cm

Design Procedueres

Fy = 3600 kg/cm2 From table get ⟹ Cmax/d = 0.44 and Rmax = 0.1943 Cmin/d = 0.125

μ_{max} = 0.0151 and μmin = 11/ Fy = 0.0031

$$d_{min} = \sqrt{\frac{Mu}{Rmax * Fcu/\gamma c * b}} = 33.2 \text{ cm}$$

d = 45 cm Check d'/d ≤ 0.15 ⟹ Fs' = Fy/γs

From d get c/d = 0.216 Check $c_{min}/d < c/d < c_{max}/d$ ⟹ Safe

Mumax1 (moment Capacity for single reinforced section) = Rmax * Fcu/γc * b * d^2 = 9.44 m.t.

Mumax2 (moment Capacity for double reinforced section) = Rmax * Fcu/γc * b * d^2 + 0.004 * b * d * Fy /γs * (d - d') = 12.15 m.t.

Check Mu < Mumax1 ========> Single reinforced section

$$As = \frac{Mu}{Fy/\gamma s * d * (1 - 0.4*c/d)} = 4.00 \text{ cm2}$$

As' = 0.15*As = 0.60 cm2

Tension reinforcement

Choosen Φ_{main} = 16 mm ⟹ no. of Bars = 2

As actual = 4.02 cm2

μ = As/(b*d) = 0.007

Compression reinforcement

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 2

As' actual = 2.26 cm2

μ' = As'/(b*d) = 0.0042

Check μmin < μ < μmax ⟹ Safe

Check 0.1μ < μ' < 0.004 ⟹ Increase d

Check of Shear

qu = Qu / (b*d) = 14.81 kg/cm2

qt = 3*$M_{torsion}$ / (b² * t) = 0.00 kg/cm2

δsi = ((1+ (qt / qu)²)^0.5)^-1 = 1.000

δti = ((1+ (qt / qu)²)^0.5)^-1 = 1.000

q_{cu} = 0.75 * δsi *(Fcu/γc)^.5 = 10.61 kg/cm2

q_{umax} = 2.2* δsi *(Fcu/γc)^.5 = 30.00 kg/cm2 ≤ 30 kg/cm2

q_{tu} = 0.75 * δti *(Fcu/γc)^.5 = 10.61 kg/cm2

q_{tumax} = 2.2 * δti *(Fcu/γc)^.5 = 31.11 kg/cm2

If qcu < qu < qumax and qtu < qtcu ⟹ Reinforce to resist qu

Closed stirrups for Shear & Torsion

Shear

qsteel = qu - 0.5*qcu = 9.51 kg/cm2

μ = n*Ast_1 / (b * s) = qsteel / (Fystr/γs)

b < 40 cm take n = 2 2 Branches

Ast/Ss = 0.027 cm

Torsion

qsteel = tu - 0.5*qtcu = 0.00 kg/cm2

x_1 , y_1 are stirrup dimensions Y1= 40 X1 = 7

α = 0.66 + 0.33* (y_1 / x_1) = 1.5

$$Ast/St = \frac{(qsteel * (b^2*t)/3)}{\alpha_t * x_1 * y_1 * (Fystr/\gamma s)} = 0.000 \text{ cm}$$

Choose $\Phi_{stirrups}$ Ø8

No. of stirrups = 100/St + 100/Ss = 5.4380

Use Stirrups 6 Ø8 2 Branches

Longitudinal bars for torsion

$$As.l. = \frac{2 * Astr * (x1 + y1) * Fystr.}{S * Fy} = 0.00 \text{ cm2}$$

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 0

Shrinkage bar

t < 70 no need to shrinkage bar

DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Project name :**Bo- Sand**
Location :**NORTH COAST**
Beam no :**B4**

Given Data

Fcu = 300 kg/cm2 Fy = 3600 kg/cm2 Mu = 8.00 m.t. Qu = 8 ton Mt = 0.0 m.t. b = 12 cm d = 45 cm

Design Procedueres

Fy = 3600 kg/cm2 From table get ⟹ Cmax/d = 0.44 and Rmax = 0.1943 Cmin/d = 0.125

μ_{max} = 0.0151 and μmin = 11/ Fy = 0.0031

$$d_{min} = \sqrt{\frac{Mu}{Rmax * Fcu/\gamma c * b}} = 41.4 \text{ cm}$$

d = 45 cm Check d'/d ≤ 0.15 ⟹ Fs' = Fy/γs

From d get c/d = 0.359 Check $c_{min}/d < c/d < c_{max}/d$ ⟹ Safe

Mumax1 (moment Capacity for single reinforced section) = Rmax * Fcu/γc * b * d^2 = 9.44 m.t.

Mumax2 (moment Capacity for double reinforced section) = Rmax * Fcu/γc * b * d^2 + 0.004 * b * d * Fy /γ_s * (d - d') = 12.15 m.t.

Check Mu < Mumax1 =======> Single reinforced section

$$As = \frac{Mu}{Fy/\gamma s * d * (1- 0.4*c/d)} = 6.63 \text{ cm2}$$

As' = 0.15*As = 0.99 cm2

Tension reinforcement

Choosen Φ_{main} = 16 mm ⟹ no. of Bars = 4

As actual = 8.05 cm2

μ = As/(b*d) = 0.015

Compression reinforcement

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 2

As' actual = 2.26 cm2

μ' = As'/(b*d) = 0.0042

Check μmin < μ < μmax ⟹ Safe

Check 0.1μ < μ' < 0.004 ⟹ Increase d

Check of Shear

qu = Qu / (b*d) =	14.81 kg/cm2	
qt = 3*$M_{torsion}$ / (b^2 * t) =	0.00 kg/cm2	
δsi = ((1+ (qt / qu)²)^0.5)^-1 =	1.000	
δti = ((1+ (qt / qu)²)^0.5)^-1 =	1.000	
q_{cu} = 0.75 * δsi *(Fcu/γ_c)^.5 =	10.61 kg/cm2	
q_{umax} = 2.2* δsi *(Fcu/γ_c)^.5 =	30.00 kg/cm2	≤ 30 kg/cm2
q_{tu} = 0.75 * δti *(Fcu/γ_c)^.5 =	10.61 kg/cm2	
q_{tumax} = 2.2 * δti *(Fcu/γ_c)^.5 =	31.11 kg/cm2	

If qcu < qu < qumax and qtu < qtcu ⟹ Reinforce to resist qu

Closed stirrups for Shear & Torsion

Shear	Torsion
qsteel = qu - 0.5*qcu = 9.51 kg/cm2	qsteel = tu - 0.5*qtcu = 0.00 kg/cm2
μ = n*Ast_1 / (b * s) = qsteel / (Fystr/γ_s)	x_1 , y_1 are stirrup dimensions Y1= 40 X1 = 7
b < 40 cm take n = 2 2 Branches	α = 0.66 + 0.33* (y_1 / x_1) = 1.5
Ast/Ss = 0.027 cm	$$Ast/St = \frac{(qsteel * (b^2*t)/3)}{\alpha_t*x_1*y_1* (Fystr/\gamma_s)} = 0.000 \text{ cm}$$

Choose $\Phi_{stirrups}$ Ø8

No. of stirrups = 100/St + 100/Ss = 5.4380

Use Stirrups 6 Ø8 2 Branches

Longitudinal bars for torsion

$$As.l. = \frac{2 * Astr * (x1 + y1) * Fystr.}{S * Fy} = 0.00 \text{ cm2}$$

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 0

Shrinkage bar

t < 70 no need to shrinkage bar

DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Project name :Bo- Sand
Location :NORTH COAST
Beam no B5

Given Data

Fcu = 300 kg/cm2 Fy = 3600 kg/cm2 Mu = 11.68 m.t. Qu = 11 ton Mt = 0.0 m.t. b = 25 cm d = 45 cm

Design Procedueres

Fy = 3600 kg/cm2 From table get ⟹ Cmax/d = 0.44 and Rmax = 0.1943 Cmin/d = 0.125

μ_{max} = 0.0151 and μmin = 11/ Fy = 0.0031

$$d_{min} = \sqrt{\frac{Mu}{Rmax * Fcu/\gamma c * b}} = 34.7 \text{ cm}$$

d = 45 cm Check d'/d ≤ 0.15 ⟹ Fs' = Fy/γs

From d get c/d = 0.238 Check $c_{min}/d < c/d < c_{max}/d$ ⟹ Safe

Mumax1 (moment Capacity for single reinforced section) = Rmax * Fcu/γc * b * d^2 = 19.68 m.t.

Mumax2 (moment Capacity for double reinforced section) = Rmax * Fcu/γc * b * d^2 + 0.004 * b * d * Fy /γs * (d - d') = 25.31 m.t.

Check Mu < Mumax1 ========> Single reinforced section

$$As = \frac{Mu}{Fy/\gamma s * d * (1- 0.4*c/d)} = 9.16 \text{ cm2}$$

As' = 0.15*As = 1.37 cm2

Tension reinforcement

Choosen Φ_{main} = 18 mm ⟹ no. of Bars = 4

As actual = 10.18 cm2

μ = As/(b*d) = 0.009

Compression reinforcement

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 2

As' actual = 2.26 cm2

μ' = As'/(b*d) = 0.0020

Check μmin < μ < μmax ⟹ Safe

Check 0.1μ < μ' < 0.004 ⟹ Safe

Check of Shear

qu = Qu / (b*d) =	9.78 kg/cm2	
qt = 3*Mtorsion / (b² * t) =	0.00 kg/cm2	
δsi = ((1+ (qt / qu)²)^0.5)^-1 =	1.000	
δti = ((1+ (qt / qu)²)^0.5)^-1 =	1.000	
q_{cu} = 0.75 * δsi *(Fcu/γc)^.5 =	10.61 kg/cm2	
q_{umax} = 2.2* δsi *(Fcu/γc)^.5 =	30.00 kg/cm2	≤ 30 kg/cm2
q_{tu} = 0.75 * δti *(Fcu/γc)^.5 =	10.61 kg/cm2	
q_{tumax} = 2.2 * δti *(Fcu/γc)^.5 =	31.11 kg/cm2	

If qu < qcu and qtu < qtcu ⟹ Use min stirrups 5Φ8 / m'

Closed stirrups for Shear & Torsion

Shear

qsteel = qu - 0.5*qcu = 0.00 kg/cm2

μ = n*Ast1 / (b * s) = qsteel / (Fystr/γs)

b < 40 cm take n = 2 2 Branches

Ast/Ss = 0.000 cm

Torsion

qsteel = tu - 0.5*qtcu = 0.00 kg/cm2

x1 , y1 are stirrup dimensions Y1= 40 X1 = 20

α = 0.66 + 0.33* (y1 / x1) = 1.32

$$Ast/St = \frac{(qsteel * (b^2*t)/3)}{\alpha_t*x_1*y_1* (Fystr/\gamma_s)} = 0.000 \text{ cm}$$

Choose $\Phi_{stirrups}$ #DIV/0!

No. of stirrups = 100/St + 100/Ss = #DIV/0!

Use Stirrups #DIV/0! #DIV/0! 2 Branches

Longitudinal bars for torsion

$$As.l. = \frac{2 * Astr * (x1 + y1) * Fystr.}{S * Fy} = 0.00 \text{ cm2}$$

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 0

Shrinkage bar

t < 70 no need to shrinkage bar

DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Project name :Bo- Sand
Location :NORTH COAST
Beam no **B6**

Given Data

Fcu = 300 kg/cm2 Fy = 3600 kg/cm2 Mu = 15.90 m.t. Qu = 11 ton Mt = 0.0 m.t. b = 25 cm d = 45 cm

Design Procedueres

Fy = 3600 kg/cm2 From table get ⟹ Cmax/d = 0.44 and Rmax = 0.1943 Cmin/d = 0.125

μ_{max} = 0.0151 and μmin = 11/ Fy = 0.0031

$$d_{min} = \sqrt{\frac{Mu}{Rmax * Fcu/\gamma c * b}} = 40.5 \text{ cm}$$

d = 45 cm Check d'/d ≤ 0.15 ⟹ Fs' = Fy/γs

From d get c/d = 0.339 Check $c_{min}/d < c/d < c_{max}/d$ ⟹ Safe

Mumax1 (moment Capacity for single reinforced section) = Rmax * Fcu/γc * b * d^2 = 19.68 m.t.

Mumax2 (moment Capacity for double reinforced section) = Rmax * Fcu/γc * b * d^2 + 0.004 * b * d * Fy /γs * (d - d') = 25.31 m.t.

Check Mu < Mumax1 =======> Single reinforced section

$$As = \frac{Mu}{Fy/\gamma s * d * (1 - 0.4*c/d)} = 13.05 \text{ cm2}$$

As' = 0.15*As = 1.96 cm2

Tension reinforcement

Choosen Φ_{main} = 18 mm ⟹ no. of Bars = 6

As actual = 15.27 cm2

μ = As/(b*d) = 0.014

Compression reinforcement

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 2

As' actual = 2.26 cm2

μ' = As'/(b*d) = 0.0020

Check μmin < μ < μmax ⟹ Safe

Check 0.1μ < μ' < 0.004 ⟹ Safe

Check of Shear

qu = Qu / (b*d) = 9.78 kg/cm2

qt = 3*$M_{torsion}$ / (b² * t) = 0.00 kg/cm2

δsi = ((1+ (qt / qu)²)^0.5)^-1 = 1.000

δti = ((1+ (qt / qu)²)^0.5)^-1 = 1.000

q_{cu} = 0.75 * δsi *(Fcu/γc)^.5 = 10.61 kg/cm2

q_{umax} = 2.2* δsi *(Fcu/γc)^.5 = 30.00 kg/cm2 ≤ 30 kg/cm2

q_{tu} = 0.75 * δti *(Fcu/γc)^.5 = 10.61 kg/cm2

q_{tumax} = 2.2 * δti *(Fcu/γc)^.5 = 31.11 kg/cm2

If qu < qcu and qtu < qtcu ⟹ Use min stirrups 5Φ8 / m'

Closed stirrups for Shear & Torsion

Shear		Torsion	
qsteel = qu - 0.5*qcu =	0.00 kg/cm2	qsteel = tu - 0.5*qtcu =	0.00 kg/cm2
μ = n*Ast_1 / (b * s) = qsteel / (Fystr/γ_s)		x_1 , y_1 are stirrup dimensions	Y1= 40 X1 = 20
b < 40 cm take n = 2	2 Branches	α = 0.66 + 0.33* (y_1 / x_1) =	1.32
Ast/Ss =	0.000 cm	$Ast/St = \frac{(qsteel * (b^2*t)/3)}{\alpha_t * x_1 * y_1 * (Fystr/\gamma_s)}$ =	0.000 cm

Choose $\Phi_{stirrups}$ #DIV/0!

No. of stirrups = 100/St + 100/Ss = #DIV/0!

Use Stirrups #DIV/0! #DIV/0! 2 Branches

Longitudinal bars for torsion

$$As.l. = \frac{2 * Astr * (x1 + y1) * Fystr.}{S * Fy} = 0.00 \text{ cm2}$$

Choosen $\Phi_{secondary}$ = 12 mm ⟹ no. of Bars = 0

Shrinkage bar

t < 70 no need to shrinkage bar

DELTA BUILDING SYSTEMS
MEMBER OF PLENA

Tables of quantities & CONSLOSION

ONE BUILDING (B3, GROUND +3 MUILTI STORIES)

1. FOUNDATIONS

1. Plain concrete

	DELTA BLOCK	CLAY
TOTAL QUANTITY OF PC	156	356
QUANTITY OF SAVING	200	
% OF SAVING	56.2%	

2. Reinforced concrete

	DELTA BLOCK	CLAY
TOTAL QUANTITY OF PC	124.2	678.6
QUANTITY OF SAVING	554.4	
% OF SAVING	81.7%	

2. COLUMNS AND WALLS

	DELTA BLOCK	CLAY
TOTAL QUANTITY OF RC IN M3/FLOOR	161.86	169.3
QUANTITY OF SAVING	7.44	
% OF SAVING	4.4%	

3. FLOORS AND BEAMS

	DELTA BLOCK	CLAY
Total quantity of concrete/GROUND	162.38	183.7
Total saving	21.32	
% of saving	11.6%	
Total quantity of concrete/FIRST	179.4	204.12
Total saving	24.72	
% of saving	12.11%	
Total quantity of concrete/SECOND	161.5	186.2
Total saving	24.7	
% of saving	13.2%	
Total quantity of concrete/THIRD	144.22	168.56
Total saving	24.34	
% of saving	14.4%	
Total quantity of saving/floors	95.08	
TOTAL % OF SAVING IN FLOORS	12.8%	

4. REINFORCEMENT

	DELTA BLOCK	CLAY
TOTAL QUANTITY OF STEEL IN FOUNDATIONS	11.8	47.1
% OF REINFORCEMENT IN FOUNDATIONS KG/M3	95.1	69.9
QUANTITY OF SAVING	35.3	
% OF SAVING	50.5%	
TOTAL QUANTITY OF STEEL IN WALLS & COL TON	7.1	7.1
% OF REINFORCEMENT IN COLUMNS &WALLS	175.5 KG/M3	167.7 KG/M3
QUANTITY OF SAVING	0%	
% OF SAVING	0%	
TOTAL QUANTITY OF STEEL IN GROUND FLOOR TON	15.2	16.7
% OF REINFORCEMENT IN GROUND FLOOR TON	93.5KG/M3	90.9KG/M3
QUANTITY OF SAVING	1.5	
% OF SAVING	8.98%	
TOTAL QUANTITY OF STEEL IN FIRST FLOOR TON	17.3	19.2
% OF REINFORCEMENT IN FIRST FLOOR	96.4KG/M3	94.1KG/M3
QUANTITY OF SAVING	1.9	
% OF SAVING	9.9%	
TOTAL QUANTITY OF STEEL IN SECOND FLOOR TON	14.98	17.1
% OF REINFORCEMENT IN SECOND FLOOR	116.7KG/M3	91.8KG/M3
QUANTITY OF SAVING	2.12	
% OF SAVING	12.4%	
TOTAL QUANTITY OF STEEL IN third FLOOR TON	13.34	15.2
% OF REINFORCEMENT IN third FLOOR	123.3KG/M3	131.12KG/M3
QUANTITY OF SAVING	1.86	
% OF SAVING	12.1	
TOTAL QUANTITY OF SAVING	42.68	
TOTAL % OF SAVING	28.3%	

DELTA BUILDING SYSTEMS
MEMBER OF PLENA

5. walls

	DELTA BLOCK	CLAY
TOTAL OF QUANTITY 25 CM M3	**620**	620
TOTAL OF QUANTITY 12 CM M3	180	**180**
TOTAL OF QUANTITY M3	800	**800**
PRICE/M3 AFTER SALE TAX INCLUDED	820	**446**
TOTAL PRICE	656000	**356800**
TOTAL QUANTITY OF DELTA MORTER	800 BAG	**90 ton**
TOTAL PRICE OF DELTA MORTER	36000	**108000**
TOTAL SAVING in	**72000**	
%OF TOTAL SAVING	**66.67 %**	

TOTAL COST OF ONE BUILDING TYPE B3

	DELTA BLOCK	CLAY
TOTAL QUANTITY OF PC \M3	**156**	**356**
COST OF M3 INCLUDED CON. &FORMERS	750	
TOTAL COST OF PC	**117000**	**267000**
TOTAL QUANTITY OF RC FOUNDATIONS \M3	**124.2**	**678.6**
COST OF M3 INCLUDED CON. &FORMERS WITHOUT REIN.	1000	
TOTAL COST OF RC foundations	**124200**	**678600**
TOTAL QUANTITY OF FLOORS AND COLUMNS IN M3	**809.36**	**911.88**
COST OF M3 INCLUDED CON. &FORMERS WITHOUT REIN.	**1050**	
TOTAL COST OF RC OF SLABS AND COLUMNS	**849828**	**957474**
TOTAL COST OF MASONARY /BLOCKS	**656000**	**356800**
TOTAL QUANTITY OF STEEL	**101.02**	**143.7**
TOTAL COST OF STEEL	**1313260**	**1868100**
TOTAL COST OF DELTA MORTER	**36000**	**108000**
TOTAL COST OF BUILDING	**3096288**	**4235974**
TOTAL SAVING	**1139686**	
% OF SAVING IN BUILDING	**26.9%**	

Technical Department

Eng.Essam Samy