Chapters

Chapter One : Introduction

Chapter Two : Preliminary Design

Chapter Three : 3 Dimensional Structural Analysis and Design

CHAPTER ONE :INTRODUCTION

Project title : Hirbawi Center

A building lies in the east side of Tulkarm, this building consists of five stories of (5372 m^2)

Under ground floor consists of Car Parking & water tank and it's height 3.8 m

Ground Floor (Entrance Level) : Retail – Commercial and Small Offices it's height 4.9 m

1st floor consists of commercial and Small Offices it's height 4.3 m

2nd & 3rd floor consists of apartments, Offices and Maintenance area for elevators, solar panels for water heating, it's height 3.6 m

Design Data

Yielding strength of steel, fy = 4200 kg/cm^2.

B300 → fc = 240 kg /cm^2 → Ec =

2.34×10ˆ5 Kg /cm^2

Unit weights of materials:

Reinforced concrete = 2.5 ton/m^3 .
Blocks = 1.2 ton/m^3 .
Stone =2.6 ton/m^3.
Sand =2 ton/m^3.

soil bearing capacity = 4 kg/cm^2 .

Design Data

code used in the design is ACI 2008 (American Concrete Institute .

Program used SAP 2000 V14 (structural analysis program).

Methods: Ultimate design method

Loads &Load combinations :

Load combinations

1.4D

1.2 D + 1.6 L + 0.5 S.

1.2 D + 1.6 S + 0.5 L

1.2 D + 1.6 W + 0.5 L + 0.5 S

1.2 D ± 1.0 E + 0.5 L + 0.2 S

0.9 D ± (1.6 W or 1.0 E)

Where :

D : Dead Load

L : Live Load

W : wind Load

S : snow load

E : Earthquake load

Design loads:

live load is 500 kg/m^2.

Super imposed dead load is 400 kg/m^2 .

The earthquake load is response spectrum in x and y directions, Ca = 0.18, Cv= 0.25

Chapter Two: Preliminary Design

Slab section:

For flat plate slab

Min t $= L_n/33$

t slab =28.2 cm ….use t= 30 cm.

Analysis and design frame using Sap

The flat plate can be divided to frames in each direction . Here , calculations are made for

frame 1 shown in figure (1-1)

Results from sap :

Frame bending moment as shown in figure (1-2)

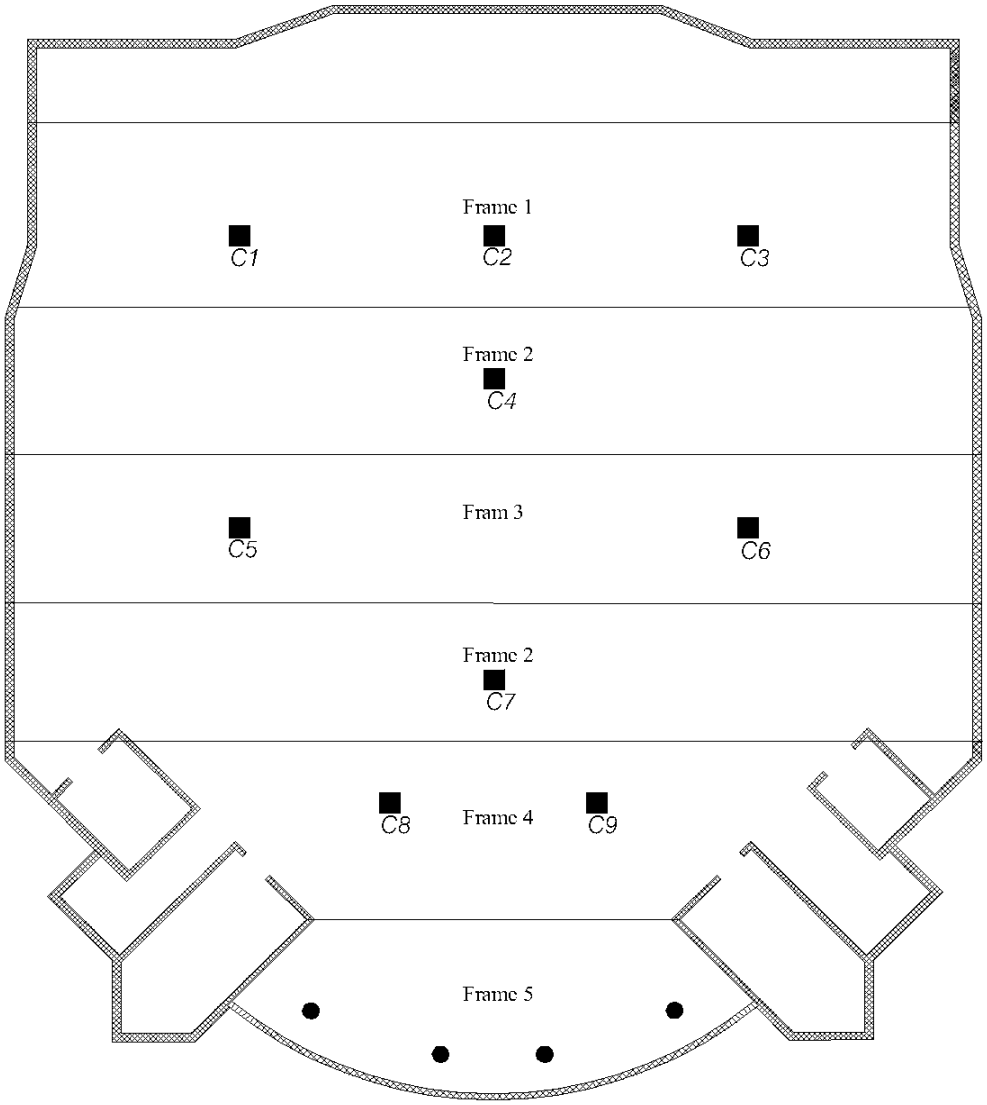

Frame 1
C1
C2
C3
Frame 2
C4
Fram 3
C5
C6
Frame 2
C7
C8
Frame 4
C9
Frame 5

Figure (1-1)

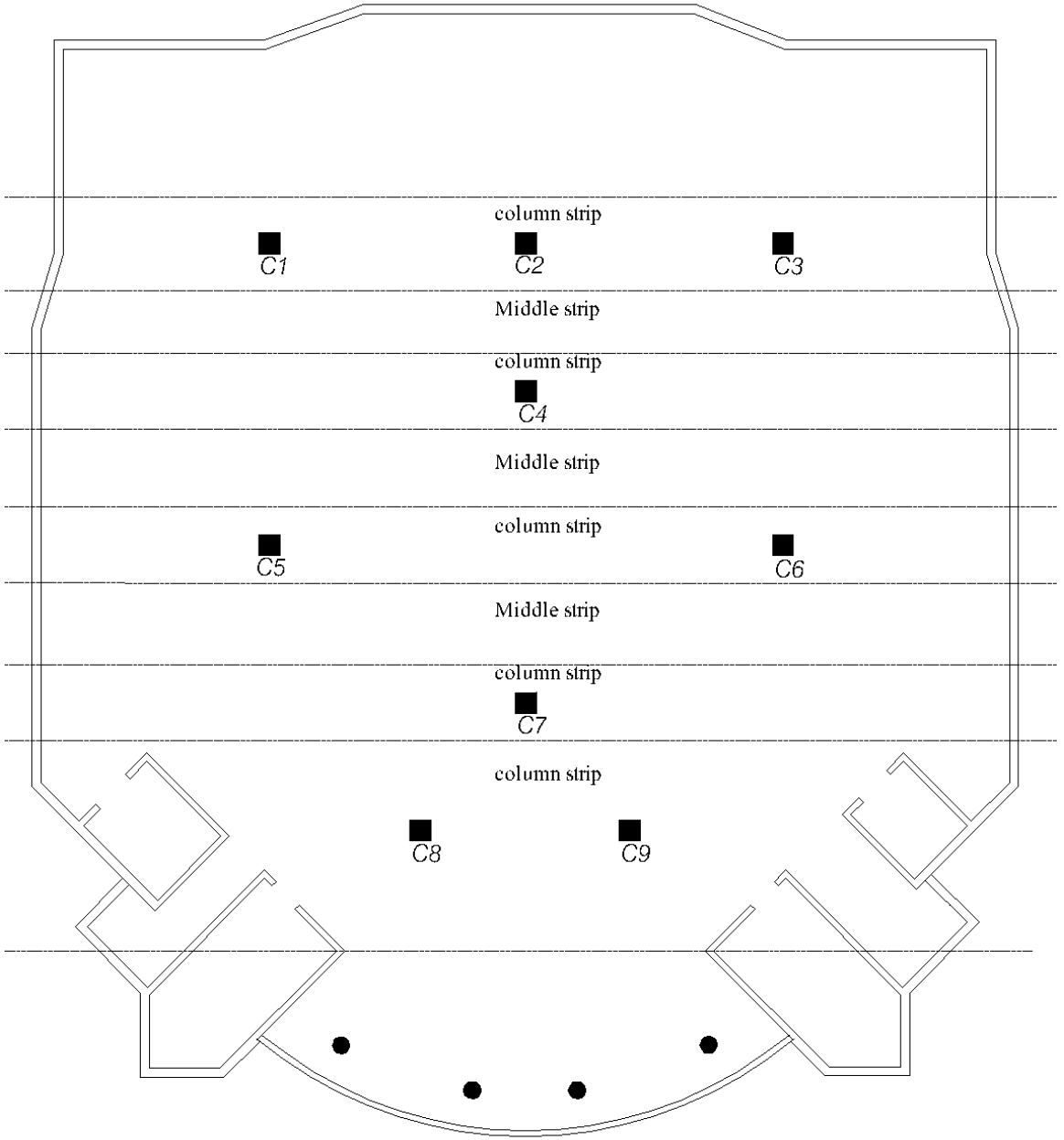

column strip
C1
C2
C3
Middle strip
column strip
C4
Middle strip
column strip
C5
C6
Middle strip
column strip
C7
column strip
C8
C9

Figure (1-2)

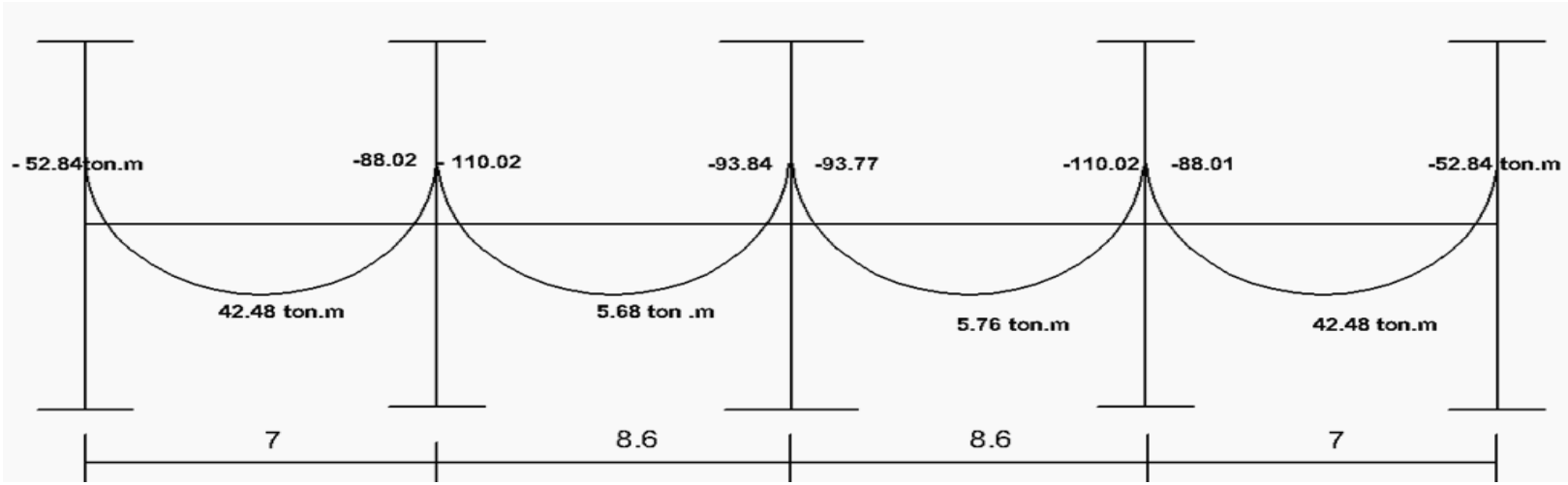


Figure (1-3) Frame bending moment

Negative moment at exterior support=0.75Mo

Positive moment =0.6Mo

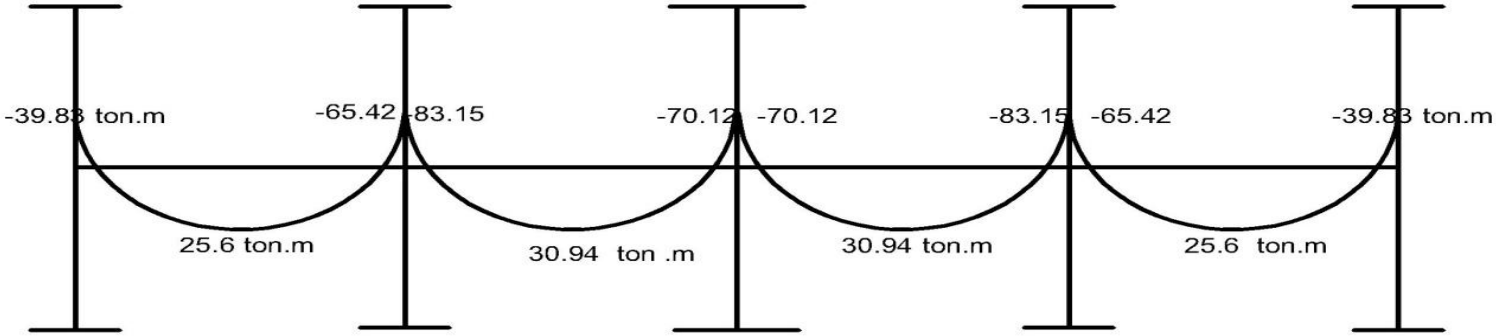


Figure (1-4) column strip moment

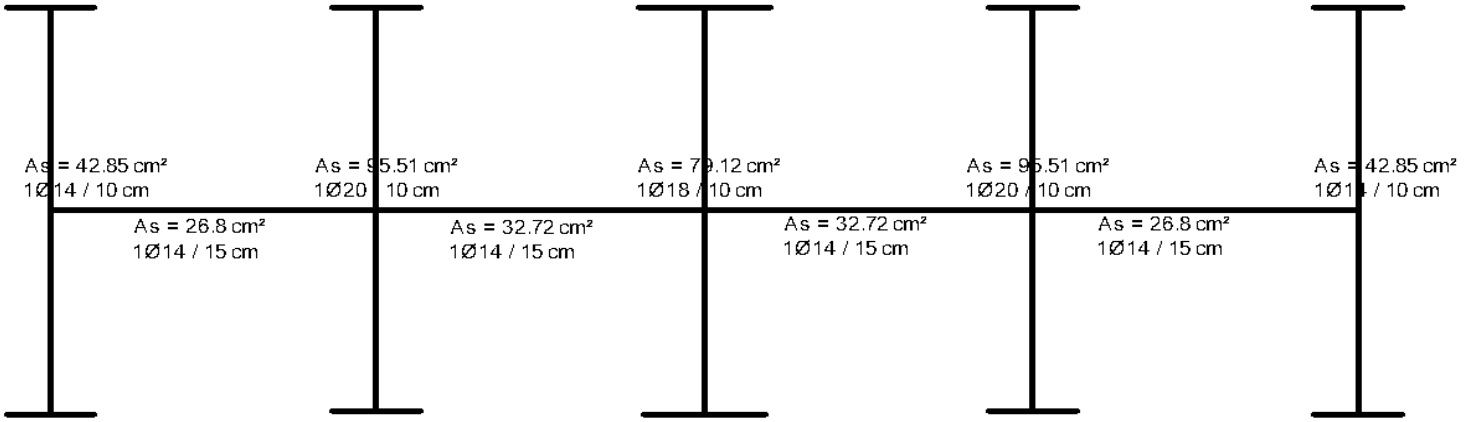


Figure (1-5) column strip steel reinforcement

For middle strip

Negative moment at exterior support = 0.25 Mo
Positive moment = 0.4 Mo

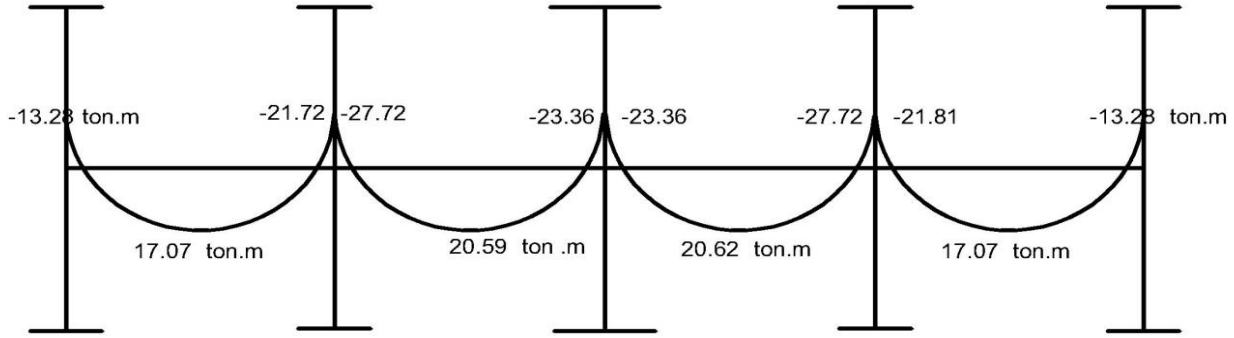


Figure (1-6) middle strip moment

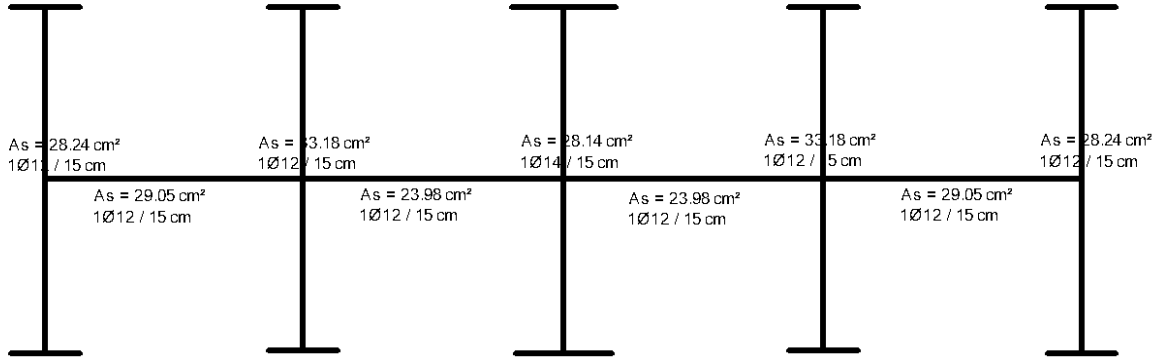


Figure (1-7) middle strip steel reinforcement

Chapter Three: Three Dimensional Structural Analysis and Design

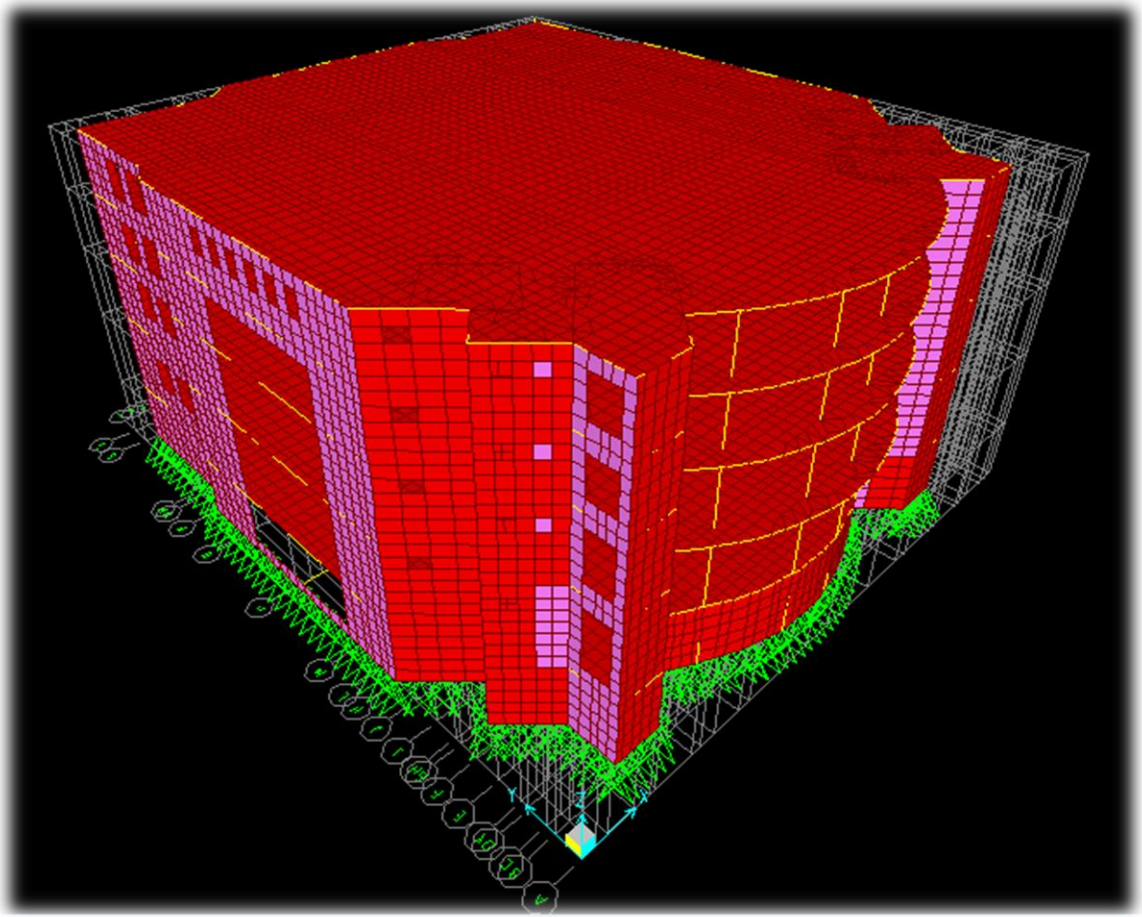
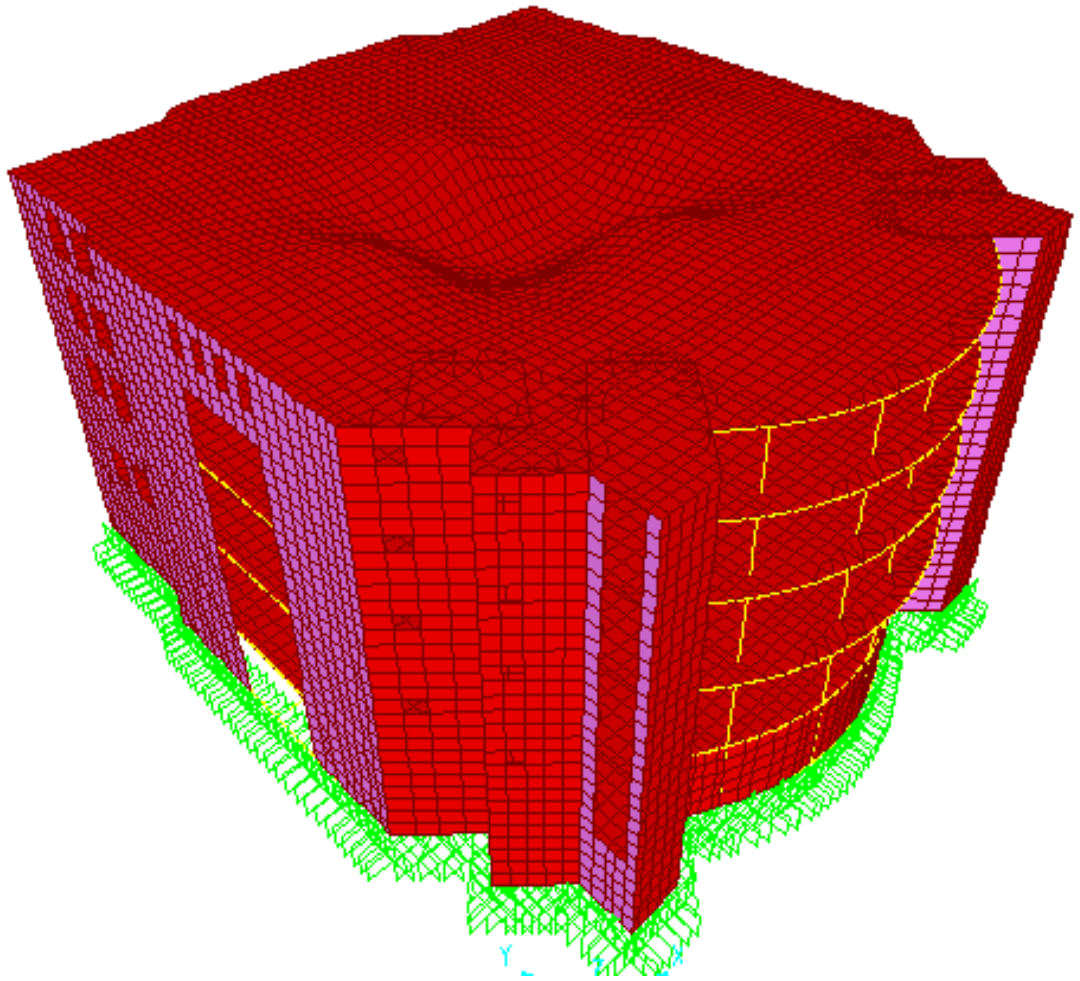


Figure (1-8) 3-D model

Structural modal verification

- Check of compatibility
- Compatibility is achieved as the structure behaves as a one unit as in reality through the meshing of all areas and dividing of all frames such as beams and columns in a way that the point of divisions meet. achieved as shown on Compatibility was figure (1-9)



shape Figure (1-8) deformed

Check of equilibrium

Live load manually= 2685.69 ton

Total dead load manually= 9100.39 ton

Results of live and dead loads from SAP

Base Reactions

File View Format-Filter-Sort Select Options

Units: As Noted | Base Reactions

	OutputCase Text	CaseType Text	GlobalFX Tonf	GlobalFY Tonf	GlobalFZ Tonf	GlobalMX Tonf-m	GlobalMY Tonf-m	GlobalMZ Tonf-m	GlobalX m
▶	DEAD	LinStatic	000000001002	000000001697	9055.9306	173176.87	-149592.332	000000008838	0
	live	LinStatic	6.983E-13	000000001641	2701.4172	52561.59259	-44613.483	000000005025	0

- % of error for dead load = 0.49 % < 5 %
- % of error for live load= 0.58 % < 5 %

Stress strain relationships:

verify the magnitude of moment which extracted from SAP

& manually:

Result manually

Mu = 88.02

- Result from S
- Mu = 81.7

% of error = 7.7 %

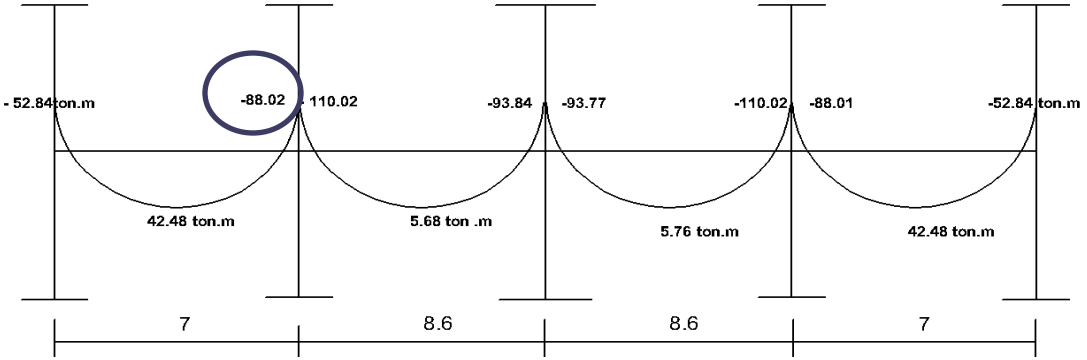


Figure (1-9) frame bending moment manually

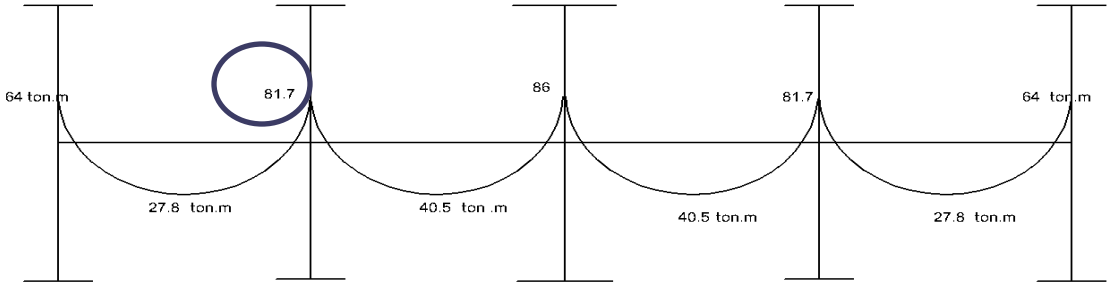


Figure (1-10) frame bending moment from sap

Check Building Natural Period

From sap analysis result **(0.4707)**

Ta = **0.1 * N**

= 0.1 * 5 = 0.5 so **(0.4707)** from sap analysis result Ok

(approximate compassion

Column design

Columns classification:

Short columns
Long columns

If it is short if the following achieved:

For braced columns :

$KL/r \leq 34-12(M_{1b}/M_{2b})$.

For unbraced columns :

$KL/r \leq 12$

Column design

The design load can be calculated using the following equation:

$Pd = \phi Pn = \phi * \lambda \{0.85 * f'c(Ag-As) + As*fy\}$

ϕ = 0.65 for tied columns

ϕ = 0.75 for spiral columns

λ = 0.8 for tied columns

λ = 0.85 for spiral columns

column	# of bars from sap
C1,C2,C3,C4,C7,C8,C9	24Φ20
C4, C5	24Φ25

Slab design

Design requirements:

Bending moment resistance:

$$\rho = \frac{0.85\, fc}{fy}\left[1 - \sqrt{1 - \frac{2.61 * 10^6 Mu}{fc\ b\ d^2}}\right]$$

As_{min} =ρ shrinkage*b*d

Slab design

- For frame 1 refer to figure (1-1) .

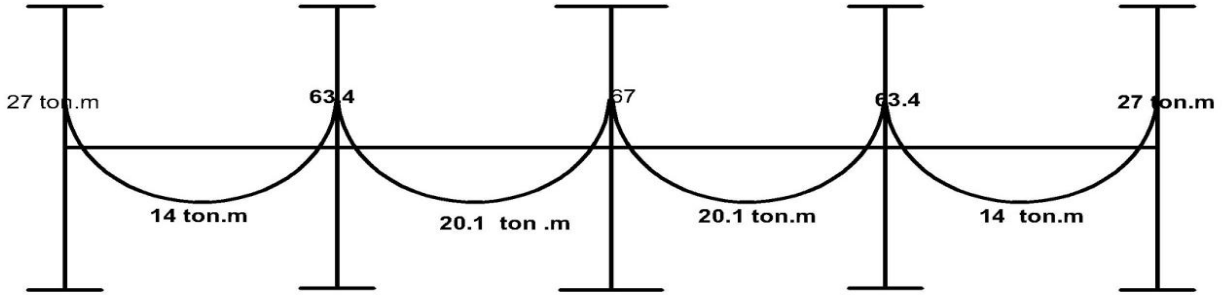


Figure (1-11) Bending moment for column strip for frame 1 in slab1 X-dir

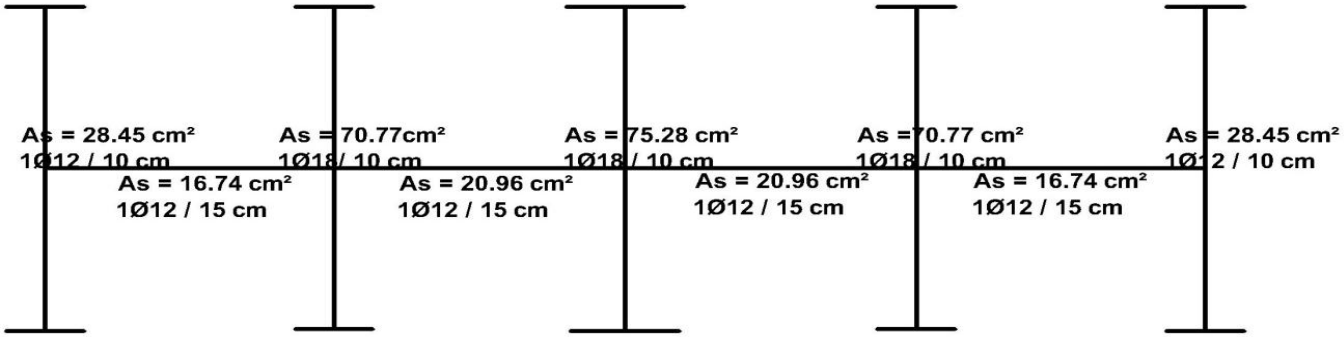


Figure (1-12) column strip reinforcement for frame 1 in slab1 X-dir

For middle strip :

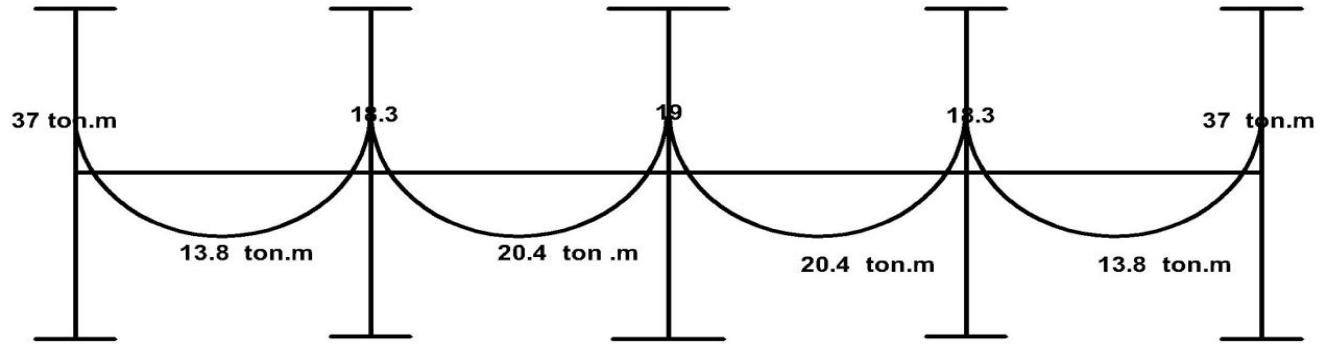


Figure (1-13) Bending moment for middle strip for frame 1 in slab1 X-dir

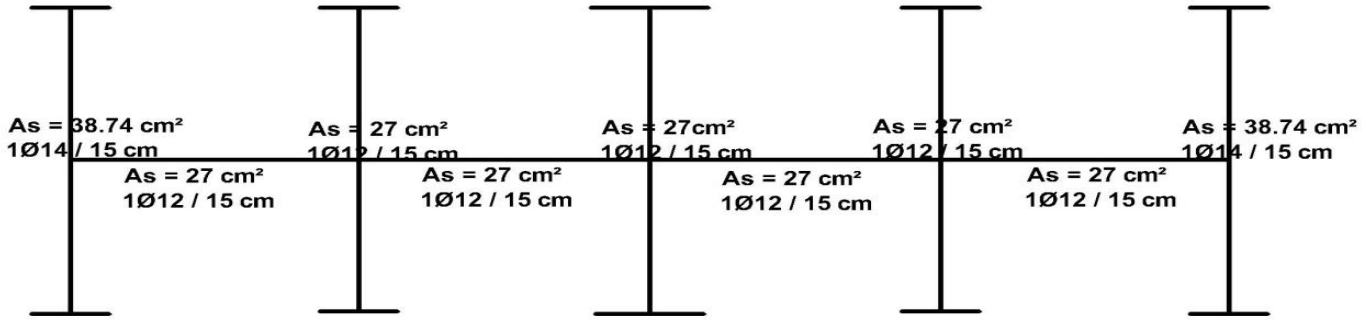


Figure (1-14) Middle strip reinforcement for frame 1 in slab1 X-dir

Footing Design

The function of foundation is transmitting load of structure to soil layers.

The soil in this project is rock .

The ultimate bearing capacity of a soil supporting the footing is 4 kg/cm^2 .

Types of footing in this project

Wall footing: to support bearing wall

Single footing (continues): to support columns

.

Wall footing design

- After calculations :
- width of wall = 1.7 m
- Depth = 0.4 m

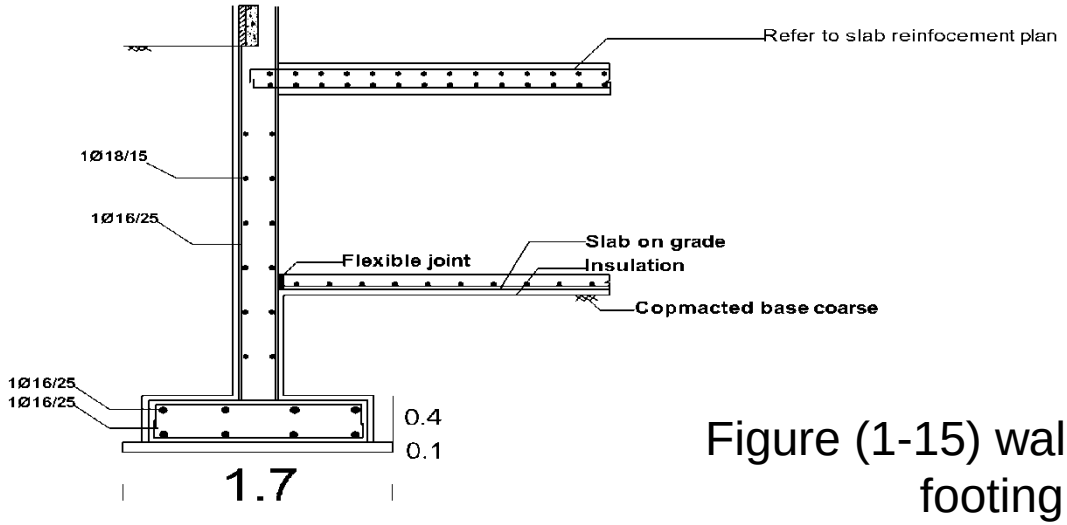


Figure (1-15) wall footing

Maximum area of steel from sap (footing) = 11.33 cm^2

Use 1 Ø 16 / 15 cm .

Maximum area of steel from sap (Wall) = 7.86 cm^2

Use 1 Ø 16 / 25 cm

Design of stairs :

Concrete compressive strength, f'c= 240kg/cm^2.

Yield Strength of steel, fy=4200kg/cm^2.

The thickness of stairs slab is = 0.15m

Loads

For landing part, S.I.D=0.3 ton/m^2

For flight part, S.I.D = 0.3 ton/m^2

Live load=0.5 ton/m^2 .

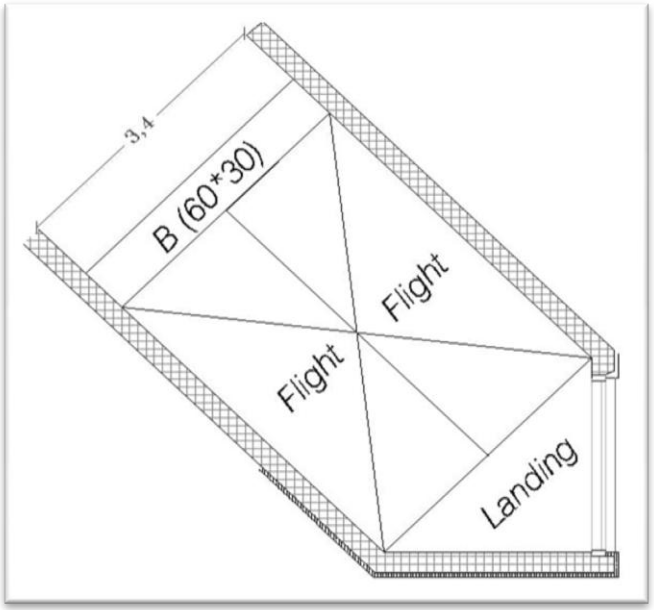


Figure (1-16)stairs plan

Steel of beam

use 5 ϕ 16 bottom bars and 5 ϕ 12 top bars

Steel of the flight

use (1 ϕ 14 / 15cm) main steel

Use (1 ϕ 12 / 30 cm) secondary steel

Steel for landing :

Use (1 ϕ 18 / 10 cm) main steel

Design of water tank

Steel for Base of tank

Use (1ф20/25 cm) as bottom steel.

Use (1ф20/10 cm) as top steel.

Steel for (curve)

Use (1ф14/20 cm) as bottom steel.

Use(1ф14/20 cm) as top steel.