Ing. Yesid Munar Castañeda

Especialista en Estructuras
Escuela Colombiana de Ingeniería

MUNICIPIO: SALAZAR

DISEÑO ESTRUCTURAL -CASETA DE OPERACION

DAG INGENIERIA.

DISEÑO ESTRUCTURAL SISTEMA ACUEDUCTO

PATAP SALAZAR DE LAS PALMAS, NORTE DE SANTANDER.

DISEÑO ESTRUCTURAL -CASETA DE OPERACIÓN.

VERSIÓN No.	No. PAGINAS	FECHA DE EMISIÓN	DISEÑÓ	APROBÓ	DESCRIPCIÓN
1				Yesid Munar	Versión inicial

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1 INTRODUCCIÓN

El presente documento contiene la descripción y desarrollo del diseño estructural de las estructuras que conforman el sistema acueducto PTAP municipio de Salazar de las Palmas (Norte de Santander).

En el capítulo 2 se presenta la información básica empleada en el diseño estructural, mientras que en el capítulo 3 se presentan las normas de diseño.

En el capítulo 4 se encuentran las especificaciones generales de los materiales empleados en el diseño y en el capítulo 5 se presentan las consideraciones para el análisis y diseño estructural.

En los capítulos 6 y siguientes se presenta el análisis y diseño de las diferentes estructuras.

Por último, se presentan las referencias empleadas en la elaboración de estas memorias.

2 INFORMACIÓN BÁSICA

El diseño estructural se realizó a partir de la geometría determinada en los diseños hidráulicos.

Del estudio de suelos realizado por PERFOINGENIERIA SAS, se tomaron las recomendaciones concernientes a capacidad de carga del suelo de cimentación, módulos de reacción de la subrasante, nivel freático y demás parámetros requeridos para evaluar el efecto del suelo sobre la estructura.

Estructura de Caseta deoperación

Estructura en portico de columnas y vigas de sección de 0.30x0.35, cubierta metálica liviana.

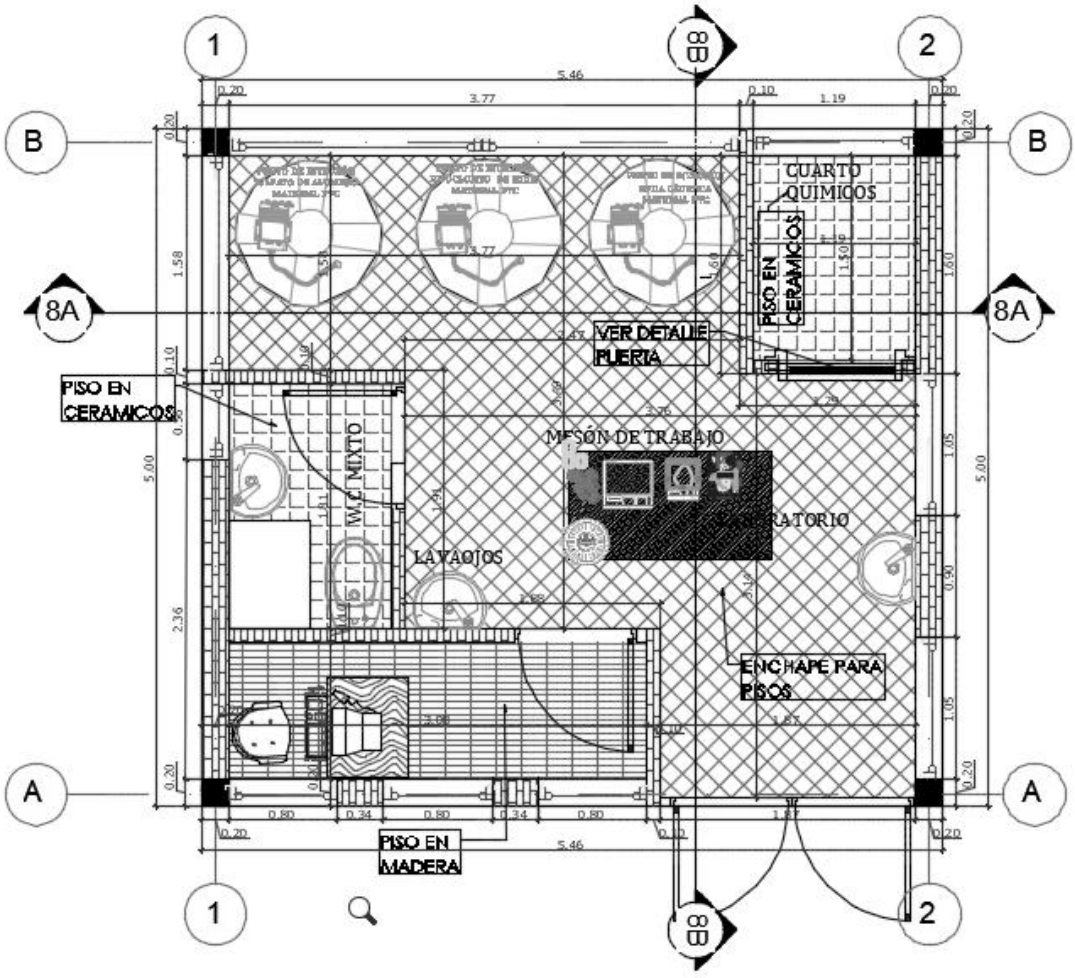


Figura 1. Planta estructura.

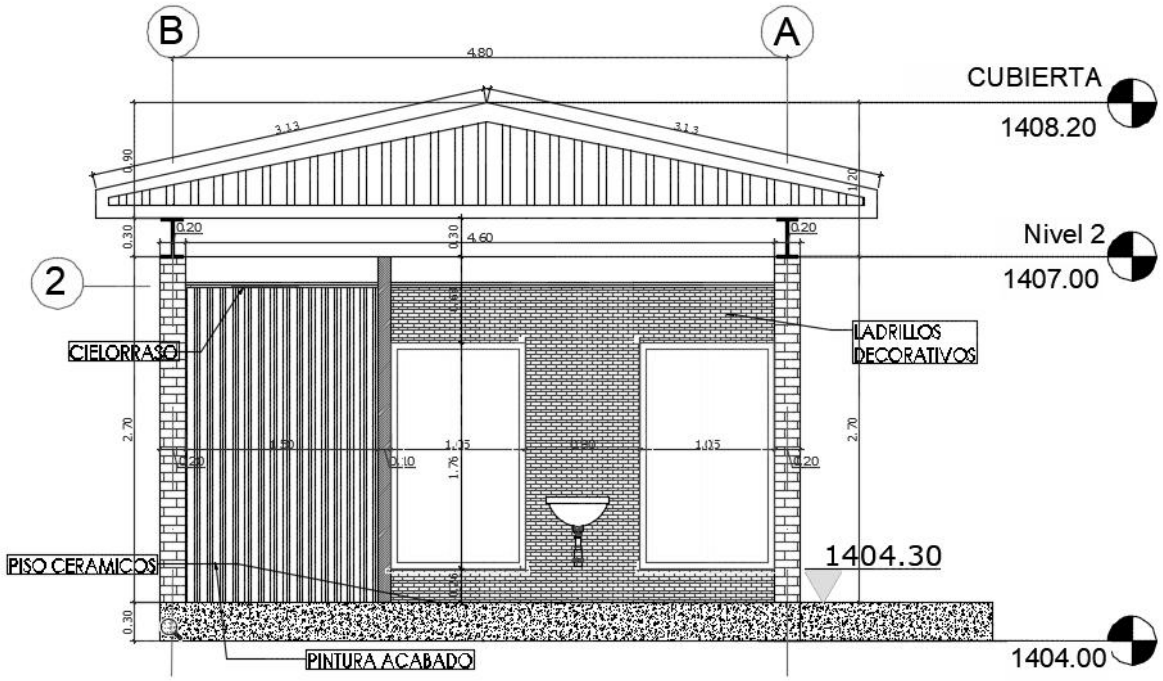


Figura 2. Corte estructural.

3. MATERIALES

En el análisis y diseño estructural se emplearán materiales acorde al tipo de construcción a ejecutar, que presenten gran resistencia a cargas verticales y horizontales, durabilidad, de fácil mantenimiento y brinden las condiciones de seguridad requeridas para este tipo de construcciones.

Las propiedades de estos materiales se toman como datos de entrada el programa de análisis estructural donde se requiere las constantes de los materiales de los miembros del modelo como son: Modulo de Elasticidad, Peso volumétrico, resistencia a la fluencia, resistencia a la compresión.

3.1 CONCRETO

El Concreto presenta propiedades mecánicas a ser tenidas en consideración en el diseño estructural y en el control de obra.

- Resistencia a la compresión.

  Esta se determina en muestras estandarizadas (cilindros) de 15 cm de diámetro por 30 cm de altura llevadas a la rotura mediante cargas repetitivas de corta duración.

  Esta resistencia se mide luego de 28 días de fraguado bajo condiciones controladas de humedad.

  La resistencia a la compresión de un concreto (f´c) utilizada en el diseño estructural se mide en términos probabilísticos tomando la resistencia media de un conjunto de muestras ensayadas en laboratorio.

  Los concretos a la compresión se consideran normales con resistencias entre (210 – 280 kg/cm2).

  A menor relación de agua cemento mayor resistencia, a mayor compactación mayor resistencia, y a mejores granulometrías se obtendrán mayores resistencias.

- Módulo de Elasticidad.

  Cuando se dibujan las curvas esfuerzo deformación (ε-δ) de la muestras cilíndricas de concreto bajo estándar ASTM, se obtienen gráficas que dependen de la rotura del material.

  Los concretos de menor resistencia muestran una mayor capacidad a la deformación que los concretos de mayor resistencia.

La pendiente de la curva en el rango de comportamiento lineal recibe el nombre de Módulo de Elasticidad o Módulo de Young y se simboliza "Ec".

El Módulo de Elasticidad es diferente para las diferentes resistencias a la compresión de los concretos e incrementa su valor cuando la resistencia es mayor.

El ACI (American Concrete Institute) y el Reglamento Colombiano de Construcción Sismo Resistente NSR-10, proponen una expresión obtenida experimentalmente del Módulo de Elasticidad en función de la resistencia.

El valor medio para toda la información experimental nacional, sin distinguir por tipo de agregado, es:

$$E_c = 3900\sqrt{f'_c} \text{ en MPa}$$

C.8.5 NSR-10

Ec = 3900V f´c donde:

Ec = Módulo de Elasticidad en Mpa.

F´c = Resistencia a la Compresión en Mpa.

Otras propiedades del concreto que se deben controlar son: Ductilidad, Resistencia a la Tracción, Resistencia al Corte y Flujo Plástico.

Para Muros, columnas, vigas aéreas.

- Concreto de f'c=28 MPa (280 kg/cm^2)
- Peso propio del concreto 23.5 kN/ m^3 (2,4 t/m^3)
- Modulo de Elasticidad 3900√28 =20636 Mpa =206368 kg/cm2

3.2 ACERO DE REFUERZO

El acero de refuerzo será varillas de sección circular con resaltes para asegurar una alta adherencia al concreto.

- Se utilizará acero de refuerzo con Norma ASTM, designación A-706 para varillas con resaltes , NTC 2289
- Esfuerzo de fluencia fy: 428,6MPa (4200 kg/cm^2)
- Peso propio del acero 77,0 kN/ m^3 (7,85 t/m^3)

- Módulo de Elasticidad = 2.100.000 kg/cm2
- Se utilizara mallas electrosoldadas bajo la Norma NTC 1925 ASTM A 185

3.3 PERFILES METALICOS

- Perfiles tubulares norma ASTM A500 GRADO C
- Perfil laminado de correas Grado 50 Norma ASTM A1011, NTC 6 fy = 340 Mpa (50ksi), Fu = 410 Mpa (60ksi) , E = 203.000 Mpa.
- Soldaduras AWS E6010
- Pernos ASTM A307, A325
- Platinas ASTM A36

4. NORMAS APLICADAS

- REGLAMENTO COLOMBIANO DE CONSTRUCCION SISMO RESISTENTE NSR-10.
- LRFD, AISC360-05

5. ASPECTOS SISMICOS CONSIDERADOS.

Para procesar el modelo matemático definido a partir de la geometría debemos tener en cuenta los parámetros establecido en la NSR-10.

PARAMETROS SISMICOS

Zona de Amenaza Sísmica. Alta (A.2.3-2 NSR-10)

Localización: Salzar Norte de Santader.. Codigo 54660

Aa = 0.30

Av = 0.25

Ae = 0.09

Ad = 0.04

Fa = 1.50

I=1.50

Suelo tipo D

Coeficiente de Importancia

Grupo de uso IV (A.2.5.1.1 NSR-10) I=1.50

Edificaciones Indispensables.

Espectro Elástico Aceleraciones de Diseño.

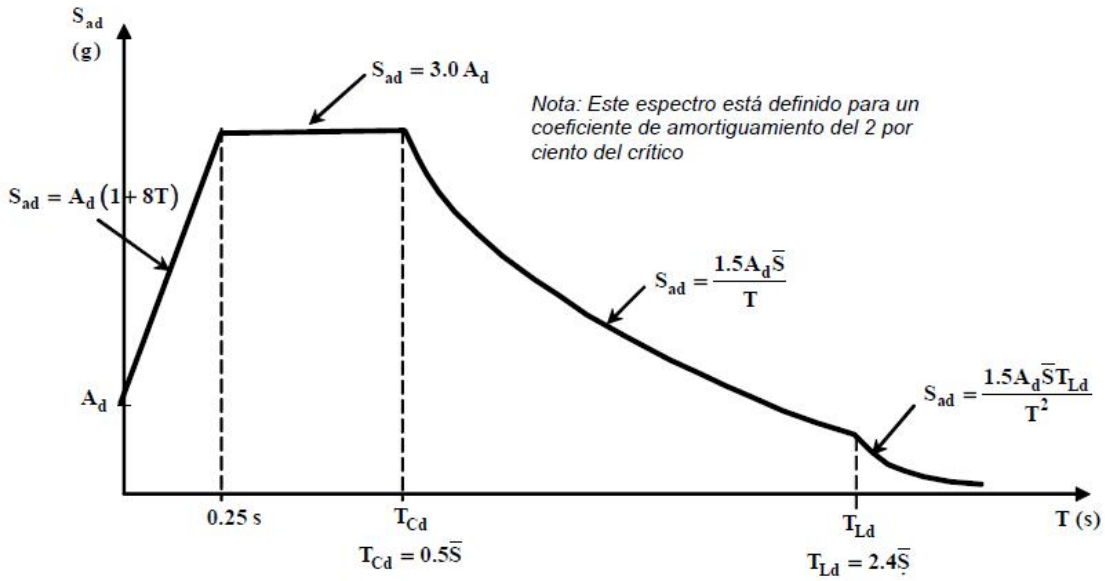


Figura A.12.3-1 — Espectro de aceleraciones horizontales elástico del umbral de daño

El Espectro de diseño está definido para un coeficiente de amortiguamiento del 2% del crítico.

Efectos Ortogonales.

Se supone la concurrencia simultánea del 100% de las fuerzas sísmicas en una dirección y el 30% de las fuerzas sísmicas en la dirección Perpendicular (A.3.6.3. NSR10).

Torsión Accidental.

Se toma el 5% (0.05) de la dimensión de la edificación en cada sentido ortogonal, tomando el valor perpendicular de la dirección en estudio (A.3.6.7.1 NSR-10)

Separación sísmica de Estructuras

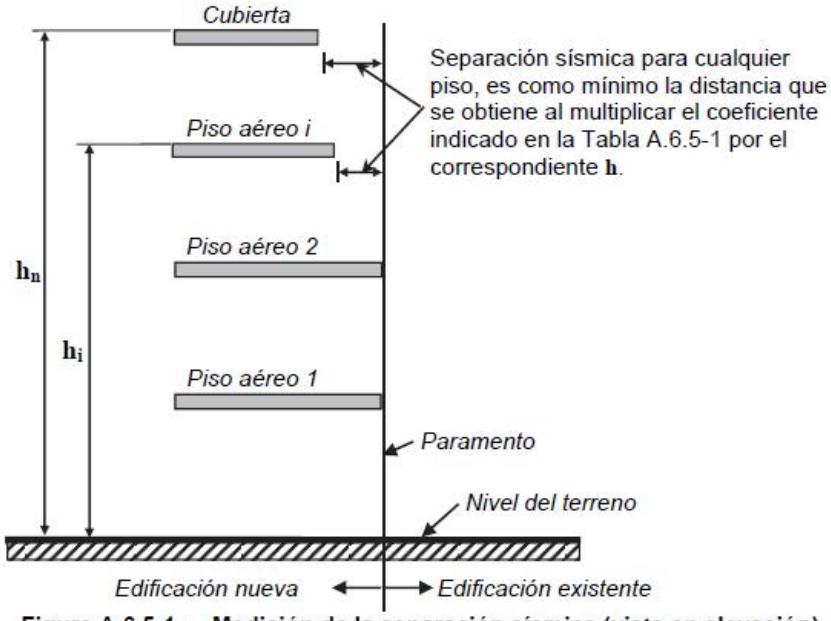


Figura A.6.5-1 — Medición de la separación sísmica (vista en elevación)

Tabla A.6.5-1
Separación sísmica mínima en la cubierta entre edificaciones colindantes que no hagan parte de la misma construcción

Altura de la edificación nueva	Tipo de Colindancia		
	Existe edificación vecina que no ha dejado la separación sísmica requerida		No existe edificación vecina o la que existe ha dejado la separación sísmica requerida
	Coinciden las losas de entrepiso	No coinciden las losas de entrepiso	
1 y 2 pisos	no requiere separación	no requiere separación	no requiere separación
3 pisos	no requiere separación	0.01 veces la altura de la edificación nueva (1% de h_n)	no requiere separación
Más de 3 pisos	0.02 veces la altura de la edificación nueva (2% de h_n)	0.03 veces la altura de la edificación nueva (3% de h_n)	0.01 veces la altura de la edificación nueva (1% de h_n)

Notas:
1. Para obtener la separación sísmica en pisos diferentes a la cubierta se aplicará el coeficiente indicado en la Tabla multiplicado por la altura sobre el terreno del piso en particular.
2. Cuando el terreno en la colindancia sea inclinado en el sentido del paramento, o haya diferentes alturas de piso o diferentes números de pisos aéreos en la colindancia, se tomará en la edificación nueva la altura de piso, o el número de pisos aéreos que conduzca a la mayor separación sísmica.

Edificaciones de 1 Piso.

PARAMETROS DE DISEÑO.

Sistema Estructural.

.Sistema Estructural de muros en concreto (Tabla A.3-1 NSR-10)

Disipación Especial de Energía (DES)

Coeficiente De Disipación de Energía (Ro)

Pórticos con capacidad especial de disipación Energía (DES).

Ro = 5.0 (Tabla A.3-1 NSR-10)

Ωo = 2.50

6. EVALUACION DE CARGAS VERTICALES Y HORIZONTALES

6.2 EVALUACION DE CARGAS VERTICALES

Para determinar las cargas verticales se emplea lo sugerido en el Reglamento Colombiano de Construcción Sismo Resistente (CAPITULO B.3 NSR-10), (CAPITULO B.4 NSR-10).

AVALUO DE CARGAS VERTICALES			
CUBIERTA			
CUBIERTA			
Teja ondulada en asbesto cemento.		15.00Kg/m2	
Estructura metalica		25.00Kg/m2	
Iluminación y cableado		40.00Kg/m2	
		CM	**80.00Kg/m2**
Pendiente < 15^{o}		**CV**	**50.00Kg/m2**
CARGA VIVA			

Carga por granizo. Cubiertas con pendiente mayor a 15º =50 kg/m2.

2.1.1 Relleno (RELLENO)

Las estructuras son enterradas o semienterradas y no cuenta con relleno sobre la placa superior.

2.1.2 Empuje (EMPUJE)

La estructura es superficial, no se avlua presión del terreno en los muros laterales.

2.1.3 Presión hidrostática (AGUA)

Corresponde a la presión lateral sobre los muros y la placa de fondo debida al agua contenida en los tanques para la condición de nivel máximo de operación.

Tabla 1. Presión Hidrostática.

Altura máxima de agua (m)	1.00
Peso unitario (t/m3)	1.0
Presión hidrostática en la base (t/m2)	1.00

2.1.4 Nivel freático (FREATICO)

Según el estudio de suelos el nivel freático no se reporta Nivel freático.

6.3 EVALUACION DE CARGAS HORIZONTALES (SISMO)

Para el avaluó de las cargas horizontales seguimos lo establecido en el Reglamento Colombiano de Construcción Sismo Resistente (NSR-10).

Para lo cual tomamos las masas debidas al peso propio del edificio y las generadas por las cargas muertas adicionales, según evaluación de cargas verticales descrita en el anterior numeral.

Con estas masas por la aceleración de la gravedad obtenemos el peso que multiplicado por el valor (Sa) valor del espectro de aceleraciones de diseño, se obtiene el valor del Cortante basal V (Cortante sísmico en la base, para las fuerzas sísmicas del espectro elástico de aceleraciones).

6.3.1 Método de la fuerza Horizontal Equivalente. (A.4 NSR-10)

EQUIVALENCIAS PARA LA EVALUACIÓN DEL ESPECTRO PARA EL UMBRAL DE DAÑO										NSR - 10
Del Apéndice A-4										
Para el Municipio de Salazar				**Para suelo tipo D**					**Grupo de uso: IV**	
Aa =	0.30			**Fa =**	1.48		Tabla A.2.4-3		**I =**	1.5
Av =	0.25			**Fv =**	1.9	prom.	Tabla A.2.4-4		Tabla A.2.5-1	
Ad =	0.04									
1)	PARTE PLANA (MESETA)									
	2.5*Aa*Fa*I =	3*Ad	=====	(Aa)equiv. =		3*Ad/ (2.5*Fa*I) =		CA		
			=====	(Aa)equiv. =	0.0216					
2)	PARTE DESCENDENTE:									
	1.2*Av*Fv*I / T =	1.5*Ad*(1.25*Fv) / T	======	(Av) equiv. =		1.5625*Ad / I =				
			======	(Av) equiv. =	0.0417					

5.2.1.1 EVALUACION DE SISMO PARA VERIFICACION DE DERIVAS POR UMBRAL DE DAÑO

```
  S E I S M I C    D E S I G N    C O D E :   COL NSR-10

============================================================
 S E I S M I C   B A S E   L E V E L :  1
============================================================


S E I S M I C   F O R C E   R E S I S T I N G   S Y S T E M

System X-Direction:   C: Moment Res.Frame
System Y-Direction:   C: Moment Res.Frame
------------------------------------------------------------
Energy dissip capacity: 3: Special-DES
------------------------------------------------------------


EQUIVALENT STATIC EARTHQUAKE FORCES COL NSR-10

Base Shear
                V = Sa W
                Sa = 1.2 Av Fv I/ T,  Sa = 1.2 Av Fv Tl/T² for T >Tl
                Sa = 2.5 Aa Fa I for T<Tc, where Tc = 0.48 AvFv/AaFa
```

S E I S M I C P A R A M E T E R S

Eff. peak acceleration & veloc., Aa = 0.0216 Av = 0.417

Region:	10	9	8	7	6	5	4	3	2	1
Aa or Av	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05

LOCATION	Aa	Av	Menace
Barranquilla, Cartagena, San Andres, Valledupar	0.10	0.10	Low
Bogota, Medellin	0.15	0.20	Interm
Armenia, Bucaramanga, Cali, Manizalez, Pereira	0.25	0.25	High
Cucuta, Villavicencio	0.35	0.30	High
Quibdo	0.35	0.35	High

Importance coefficient, I ..... = 1.15

GROUP	COEFFICIENT
IV - Essential facilities	1.50
III- Public assistance facilities	1.25
II - Especial occupancy buildings	1.10
I - Normal occupancy buildings	1.00

Site profile type, S ..... = D

TYPE	SOIL PROFILE TYPE	Shear Wave Velocity
A	Hard Rock	> 1500 m/s
B	Rock	1500 - 760 m/s
C	Very Dense Soil & Soft Rock	760 - 360 m/s
D	Stiff Soil Profile	360 - 180 m/s
E	Soft Soil Profile	< 180 m/s
F	Soils requiring site-specific evaluations	

	X-direction	Y-direction
Seismic Force-resisting system	C: Moment	C: Moment
Energy Dissipation Coefficient, Ro =	7	7
T = 0.1 N ..... =	.2	.2
Ta = Ct (Hn)^x ..... =	0.047 H^0.9	0.047 H^0.9
=	.18	.18
*Tmax: 1.7 Ta ..... =	.31	.31

*Tmax = Cu Ta
Cu = 1.75 - 1.2 Av Fv >= 1.2

Fundamental period, T ..... = .18 .18

DESIGN SPECTRAL RESPONSE ACCELERATION PARAMETERS

	Short Periods	Long Periods
Effect. peak acceleration & velc.,	Aa =0.022	Av = 0.42
Site coefficients (Tables below),	Fa = 1.60	Fv = 1.58

Design response parameters, Aa Fa = 0.035 Av Fv= 0.66

Long-period transition period, Tl sec = 3.80 (2.4 Fv)

Site Coefficient Fa

Site Class	Aa<=0.1	Aa=0.2	Aa=0.3	Aa=0.4	Ss>=0.5
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	a	a	a	a	a

Site Coefficient Fv

Site Class	Av<=0.1	Av=0.2	Av=0.3	Av=0.4	Av>=0.5
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5

E	3.5	3.2	2.8	2.4	2.4
F	a	a	a	a	a

a: Site-specific geotechnical investigation required

Reduction in R for Irregularity and Lack of Redundancy:

PLAN IRREGULARITIES			ELEVATION IRREGULARITIES		
Type	Description	Øp	Type	Description	Øa
1aP	Torsional	0.9	1aA	Flexible	0.9
1bP	Torsional Extrme	0.8	1bA	Flexible Extrme	0.8
2P	Reentrant corners	0.9	2A	Mass	0.9
3P	Diaph. discontin.	0.9	3A	Geometrical	0.9
4P	Plane shifting	0.8	4A	Plane shifting	0.8
5P	Unparallel grid	0.9	5aA	Weak Story	0.9
			5bA	Weak Story Extr	0.8

NOTE: EngSolutions RCB assumes irregular but redundant building.
For regular buildings make (Øp . Øa)= 1.0

	X - D I R E C T I O N	Y - D I R E C T I O N
Reduct. factor, (Øp.Øa) =	0.81	0.81
Redundancy factor, Ør =	1	1

R = (Øp Øa) Ør Ro

T O T A L B A S E S H E A R

Building Weight, W, (ton) = 15.31

Peak Acceleration Coeffi., Fa Aa = .035
Peak Velocity coefficient, Fv Av = .66
Transition period, Tc . . . . . = 9.05
Importance factor, I . . . . . = 1.15
Site class, S . . . . . = D

	X-direction	Y-direction
Energ-disspat coeff, R =	5.67	5.67
Period, T, (sec) . . . =	.18	.18
1.2 Av Fv I / T =	5.06	5.06
2.5 Aa Fa I =	.101	.101
Sa =	.101	.101
Total Base Shear, V, (ton) =	1.54	1.54

A C C I D E N T A L T O R S I O N

	X-direction	Y-direction
Accidental eccentricity as a percentage of building dimension, (%)=	5	5

A C C I D E N T A L E C C E N T R I C I T Y:

X - D I R E C T I O N (EQY)	Y - D I R E C T I O N (EQX)

Level	dexo (m)	Ax -	dex (m)	deyo (m)	Ax -	dey (m)
3	0.23	1.00	0.23	0.00	1.00	0.00
2	0.23	1.00	0.23	0.27	1.00	0.27

Ax: Amplification factor for accidental eccentricity

EQY: Envelope (1) Ex = ex
(2) Ex = ex + dex
(3) Ex = ex - dex

EQX: Envelope (1) Ey = ey
(2) Ey = ey + dey
(3) Ey = ey - dey

D E S I G N E C C E N T R I C I T Y : E = e + de

	X - D I R E C T I O N (EQY)				Y - D I R E C T I O N (EQX)			
Level	Center Mass CMx	Inherent Eccent. ex*	Accident Eccent. dex	Design Eccent. Ex	Center Mass CMy	Inherent Eccent. ey*	Accident Eccent. dey	Design Eccent. Ey
3	2.35	0.00	0.23	0.2323	2.73	2.73	0.00	2.7373
2	2.35	0.00	0.23	0.2323	2.73	0.00	0.27	0.2727

Note: * Inherent eccentricity: ex = CMx - CRx and ey = CMy - CRy
All values are in meters

D E S I G N E C C E N T R I C I T Y : E = e - de

	X - D I R E C T I O N (EQY)				Y - D I R E C T I O N (EQX)			
Level	Center Mass CMx	Inherent Eccent. ex*	Accident Eccent. dex	Design Eccent. Ex	Center Mass CMy	Inherent Eccent. ey*	Accident Eccent. dey	Design Eccent. Ey
3	2.35	0.00	0.23	-0.233	2.73	2.73	0.00	2.7373
2	2.35	0.00	0.23	-0.233	2.73	0.00	0.27	-0.277

Note: * Inherent eccentricity: ex = CMx - CRx and ey = CMy - CRy
All values are in meters

Equivalent Forces

Fi = (Wi Hi^n /SWj Hj^n) V
V =SFi
V = Sa W

E Q U I V A L E N T F O R C E S: X - D I R E C T I O N (EQUAKE X)

Floor i -	Height Hi (m)	Weigth Wi (ton)	Wi Hi^n ------ SWj Hj^n	Force Fi (ton)	Shear Vi (ton)	Torsion Ti=Fi(Ey-ey) (ton-m)
3	4.50	4.65	0.373	0.57	0.574	0.0
2	3.29	10.67	0.628	0.967	1.541	0.261
S		15.31		1.541		

n = 1

E Q U I V A L E N T F O R C E S: Y - D I R E C T I O N (EQUAKE Y)

Floor i -	Height Hi (m)	Weigth Wi (ton)	Wi Hi^n ------ SWj Hj^n	Force Fi (ton)	Shear Vi (ton)	Torsion Ti=Fi(Ex-ex) (ton-m)
3	4.50	4.65	0.373	0.57	0.574	0.132
2	3.29	10.67	0.627	0.966	1.539	0.222
S		15.31		1.539		

n = 1

1

729

1

5.2.1.2 EVALUACION DE SISMO PARA DISEÑO DE ELEMENTOS.

```
1          S E I S M I C    D E S I G N    C O D E :   COL NSR-10

============================================================
 S E I S M I C   B A S E   L E V E L :  1
============================================================


S E I S M I C   F O R C E   R E S I S T I N G   S Y S T E M

System X-Direction:   C: Moment Res.Frame
System Y-Direction:   C: Moment Res.Frame
------------------------------------------------------------
Energy dissip capacity: 2: Moderate-DMO
------------------------------------------------------------


EQUIVALENT STATIC EARTHQUAKE FORCES COL NSR-10

Base Shear
                V = Sa W
                Sa = 1.2 Av Fv I/ T,  Sa = 1.2 Av Fv Tl/T² for T >Tl
                Sa = 2.5 Aa Fa I for T<Tc, where Tc = 0.48 AvFv/AaFa



S E I S M I C   P A R A M E T E R S

Eff. peak acceleration & veloc., Aa =   0.30     Av =   0.25

   Region:      10    9     8     7     6     5     4     3     2     1
   Aa or Av    0.50  0.45  0.40  0.35  0.30  0.25  0.20  0.15  0.10  0.05

   LOCATION                                              Aa     Av     Menace
   Barranquilla, Cartagena, San Andres, Valledupar     0.10   0.10    Low
   Bogota, Medellin                                    0.15   0.20    Interm
   Armenia, Bucaramanga, Cali, Manizalez, Pereira      0.25   0.25    High
   Cucuta, Villavicencio                               0.35   0.30    High
   Quibdo                                              0.35   0.35    High

Importance coefficient, I ........ =    1.50

   GROUP                                             COEFFICIENT
   IV - Essential facilities                             1.50
   III- Public assistance facilities                     1.25
   II - Especial occupancy buildings                     1.10
   I  - Normal occupancy buildings                       1.00

Site profile type, S ............ =      D

   TYPE   SOIL PROFILE TYPE          Shear Wave Velocity
    A     Hard Rock                        > 1500 m/s
    B     Rock                          1500 - 760 m/s
    C     Very Dense Soil & Soft Rock    760 - 360 m/s
    D     Stiff Soil Profile             360 - 180 m/s
    E     Soft Soil Profile                 < 180 m/s
    F     Soils requiring site-specific evaluations

                                    X-direction   Y-direction
                                    -----------   -----------
Seismic Force-resisting system     = C: Moment      C: Moment
Energy Dissipation Coefficient, Ro =    5              5

          T = 0.1 N ............. =     .2            .2
         Ta = Ct (Hn)^x ......... =  0.047 H^0.9   0.047 H^0.9
                                 =    .18            .18
        *Tmax: 1.7 Ta  .......... =    .31            .31
        *Tmax = Cu Ta
               Cu = 1.75 - 1.2 Av Fv  >= 1.2

Fundamental period, T ............ =     .18           .18
```

DESIGN SPECTRAL RESPONSE ACCELERATION PARAMETERS

	Short Periods	Long Periods
Effect. peak acceleration & velc.,	Aa = 0.30	Av = 0.25
Site coefficients (Tables below),	Fa = 1.20	Fv = 1.90

Design response parameters, Aa Fa = 0.36 Av Fv= 0.48

Long-period transition period, Tl sec = 4.56 (2.4 Fv)

Site Coefficient Fa

Site Class	Aa<=0.1	Aa=0.2	Aa=0.3	Aa=0.4	Ss>=0.5
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	a	a	a	a	a

Site Coefficient Fv

Site Class	Av<=0.1	Av=0.2	Av=0.3	Av=0.4	Av>=0.5
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	a	a	a	a	a

a: Site-specific geotechnical investigation required

Reduction in R for Irregularity and Lack of Redundancy:

PLAN IRREGULARITIES			ELEVATION IRREGULARITIES		
Type	Description	Øp	Type	Description	Øa
1aP	Torsional	0.9	1aA	Flexible	0.9
1bP	Torsional Extrme	0.8	1bA	Flexible Extrme	0.8
2P	Reentrant corners	0.9	2A	Mass	0.9
3P	Diaph. discontin.	0.9	3A	Geometrical	0.9
4P	Plane shifting	0.8	4A	Plane shifting	0.8
5P	Unparallel grid	0.9	5aA	Weak Story	0.9
			5bA	Weak Story Extr	0.8

NOTE: EngSolutions RCB assumes irregular but redundant building.
For regular buildings make (Øp . Øa)= 1.0

	X - D I R E C T I O N	Y - D I R E C T I O N
Reduct. factor, (Øp.Øa) =	0.81	0.81
Redundancy factor, Ør =	1	1

R = (Øp Øa) Ør Ro

T O T A L B A S E S H E A R

Building Weight, W, (ton) = 15.31

Peak Acceleration Coeffi., Fa Aa = .36
Peak Velocity coefficient, Fv Av = .48
Transition period, Tc . . . . . = .64
Importance factor, I . . . . . = 1.5
Site class, S . . . . . = D

	X-direction	Y-direction

Energ-disspat coeff, R =	4.05	4.05
Period, T, (sec) . . . =	.18	.18
1.2 Av Fv I / T =	4.8	4.8
2.5 Aa Fa I =	1.35	1.35
Sa =	1.35	1.35
Total Base Shear, V, (ton) =	20.67	20.67

A C C I D E N T A L T O R S I O N

	X-direction	Y-direction
Accidental eccentricity as a percentage of building dimension, (%)=	5	5

A C C I D E N T A L E C C E N T R I C I T Y:

	X - D I R E C T I O N (EQY)			Y - D I R E C T I O N (EQX)		
Level	dexo (m)	Ax -	dex (m)	deyo (m)	Ax -	dey (m)
3	0.23	1.00	0.23	0.00	1.00	0.00
2	0.23	1.00	0.23	0.27	1.00	0.27

Ax: Amplification factor for accidental eccentricity

EQY: Envelope (1) Ex = ex
(2) Ex = ex + dex
(3) Ex = ex - dex

EQX: Envelope (1) Ey = ey
(2) Ey = ey + dey
(3) Ey = ey - dey

D E S I G N E C C E N T R I C I T Y : E = e + de

	X - D I R E C T I O N (EQY)				Y - D I R E C T I O N (EQX)			
Level	Center Mass CMx	Inherent Eccent. ex*	Accident Eccent. dex	Design Eccent. Ex	Center Mass CMy	Inherent Eccent. ey*	Accident Eccent. dey	Design Eccent. Ey
3	2.35	0.00	0.23	0.2323	2.73	2.73	0.00	2.7373
2	2.35	0.00	0.23	0.2323	2.73	0.00	0.27	0.2727

Note: * Inherent eccentricity: ex = CMx - CRx and ey = CMy - CRy
All values are in meters

D E S I G N E C C E N T R I C I T Y : E = e - de

	X - D I R E C T I O N (EQY)				Y - D I R E C T I O N (EQX)			
Level	Center Mass CMx	Inherent Eccent. ex*	Accident Eccent. dex	Design Eccent. Ex	Center Mass CMy	Inherent Eccent. ey*	Accident Eccent. dey	Design Eccent. Ey

3	2.35	0.00	0.23	-0.233	2.73	2.73	0.00	2.7373
2	2.35	0.00	0.23	-0.233	2.73	0.00	0.27	-0.277

Note: * Inherent eccentricity: ex = CMx - CRx and ey = CMy - CRy
All values are in meters

Equivalent Forces

Fi = (Wi Hi^n /SWj Hj^n) V
V =SFi
V = Sa W

E Q U I V A L E N T F O R C E S: X - D I R E C T I O N (EQUAKE X)

Floor i -	Height Hi (m)	Weigth Wi (ton)	Wi Hi^n / SWj Hj^n	Force Fi (ton)	Shear Vi (ton)	Torsion Ti=Fi(Ey-ey) (ton-m)
3	4.50	4.65	0.373	7.71	7.710	0.0
2	3.29	10.67	0.628	12.980	20.691	3.505
S		15.31		20.691		

n = 1

E Q U I V A L E N T F O R C E S: Y - D I R E C T I O N (EQUAKE Y)

Floor i -	Height Hi (m)	Weigth Wi (ton)	Wi Hi^n / SWj Hj^n	Force Fi (ton)	Shear Vi (ton)	Torsion Ti=Fi(Ex-ex) (ton-m)
3	4.50	4.65	0.373	7.71	7.710	1.773
2	3.29	10.67	0.627	12.960	20.670	2.980
S		15.31		20.670		

n = 1

A C C E L E R A T I O N S O N N O N - S T R U C T U R A L E L E M E N T S - N S R - 1 0

F L O O R A C C E L E R A T I O N S

Level	hx	hx/heq	ax
3	4.50	1.33	1.799
2	3.29	0.98	1.332

Seismic base level . . . . . = 1
Height above seismic base, hn . . . . . = 4.50 m
Equivalent height, heq = 0.75 hn . . . . . = 3.38 m
Ground acceleration, As = Aa Fa I . . . . . = 0.540
Spectral acceleration, Sa . . . . . = 1.350

ax = Sa hx/heq for hx > heq
ax = As + (Sa -As) hx/heq for hx < heq

Force on structural non-seismic element : Fp = ax Wp / Ro

```
Force on nonstructural element :          Fp = ax ap Wp / Rp
                                             > 0.5 Aa I Wp
  ap : component amplification factor
```

5.2.1.3 EVALUACION DE CARGAS DE VIENTO

```
R
WIND LOADS NSR-10

Wind pressure
                p  = q G  Cp  rigid buildings
                   = q Gf Cp  flexible buildings
                qz = 0.00483 Kz Kzt Kd V² I (Kg/m²); V in Km/h



W I N D   L O A D I N G   P A R A M E T E R S

Basic wind speed (Km/h), V ....... =     200

   V: 3-second gust speed at 10 m, with annual probability of 0.002

Importance factor, I ............. =    1.15

  OCCUPANCY CATEGORY              IMPORTANCE   F A C T O R
                                     (1)       (2)
   I    Normal occupancy buildings     0.87      0.77
   II   Especial occupancy buildings   1.00      1.00
   III  Public assistance facilities   1.15      1.15
   IV   Essential facilities           1.15      1.15
   (1): Non-hurricane prone regions with V=140-160 km/h
   (2): Hurricane prone regions with V >160 Km/h

Exposure category ................. =    C

   ROUGHNESS  DESCRIPTION
     B       Urban and suburban areas, wooded areas, obstructions >30ft
     C       Open terrain with scattered obstructions less than 30 ft
     D       Flat, unobstructed areas, wind over large bodies of water

Directionality factor, Kd ......... =    0.85

Topographic factor, Kzt ........... =    1.0

     Kzt = (1 + K1 K2 K3)²

Wall pressure coefficients, Cp

     Windward wall ............... =      0.8
     Leeward wall (Wind X) ...... =      -0.5
     Leeward wall (Wind Y) ...... =      -0.468
     Side walls .................. =      -0.7
     Roof ........................ =      0.0

_____________________________________________________________________


G U S T    E F F E C T S    F A C T O R S

Basic wind velocity, (Km/h) =  200
Exposure category ......... =  C
```

Exposed height, (m) ..... = 4.5

	X-direction	Y-direction	
Computed natural frequency, f (Hz) =	7.634	5.291	
Height / Length ratio, H/L ..... =	.957	.824	
Structure clasification ..... =	RIGID	RIGID	
Background response index, Q ..... =	.935	.937	(Eq. B.6.5-4)
Resonant response factor, R1 *.... =	.133	.223	(Eq. B.6.5-8)
Gh: Rigid - Simplified analysis .. =	.85	.85	(Sec B.6.5.8.1)
Gh: Rigid - Complete analysis .... =	.888	.889	(Eq. B.6.5-2)
Gf: Flexible -Analytical(2% dampng)=	1.173	1.166	(Eq. B.6.5-2)
Gf: Flexible -Analytical(1% dampng)=	1.176	1.172	(Eq. B.6.5-2)
Gust effects factor, G ..... =	.888	.889	

* 1% damping ratio. For damping ratio ß, R = R1 * (0.01/ß)^½

V E L O C I T Y P R E S S U R E

Floor -	Height z, m	Pressure qz, K/m2
3	4.50	162.03
2	3.29	162.03
1	0.0	162.03

A C C I D E N T A L T O R S I O N F O R W I N D L O A DS

	X-direction	Y-direction
Accidental eccentricity as a percentage of building dimension, (%)=	15	15

WY is Envelope of:
Case 1: Pwy + Ply
Case 2: 0.75 (Pwy + Ply) + Mt
Mt=0.75(Pwy+Ply)Bx ex

WX is Envelope of:
Case 1: Pwx + Plx
Case 2: 0.75 (Pwx + Plx) + Mt
Mt=0.75(Pwx+Plx)By ey

NOTE: Load cases 3 and 4 are handled through load combinations

---

A C C I D E N T A L E C C E N T R I C I T Y W I N D L O A D S

Level -	X-DIRECTION (WY) ex (m)	Y-DIRECTION (WX) ey (m)
3	0.70	0.00
2	0.70	0.82

WY is Envelope of:
Case 1: Pwy + Ply
Case 2: 0.75 (Pwy + Ply) + Mt
Mt=0.75(Pwy+Ply)Bx ex

WX is Envelope of:
Case 1: Pwx + Plx
Case 2: 0.75 (Pwx + Plx) + Mt
Mt=0.75(Pwx+Plx)By ey

NOTE: Load cases 3 and 4 are handled through load combinations

---

```
Wind nodal forces:
                  Pw = S pz Ai        Pl = S ph Ai
                  Ps = S ph Ai        Pr = S ph Ai
                  Ai = Nodal tributary area
```

W I N D F O R C E S: X - D I R E C T I O N

Floor No	Height z, m	Windward Pw, Ton	Leeward Pl, Ton	Side Ps, Ton	Roof Pr, Ton
3	4.50	0.0	0.0	0.28	0.0
2	3.29	1.40	0.88	1.07	0.0
1	0.0	0.0	0.0	0.78	0.0

```
Base shear, V:S(Pw+Pl) .. = 2.29 ton
Building Weight, W ..... = 15.31 ton   (V/W = 0.150)
Overturning moment
  From horizontal forces . = 7.57 ton-m
  From roof forces ..... = 0.0 ton-m
  Total moment, Mo ..... = 7.57 ton-m
Stabilizing moment, Ms.... = 35.97 ton-m   (Mo/Ms = 0.211)
```

```
Wind nodal forces:
                  Pw = S pz Ai        Pl = S ph Ai
                  Ps = S ph Ai        Pr = S ph Ai
                  Ai = Nodal tributary area
```

W I N D F O R C E S: Y - D I R E C T I O N

Floor No	Height z, m	Windward Pw, Ton	Leeward Pl, Ton	Side Ps, Ton	Roof Pr, Ton
3	4.50	0.32	0.19	0.0	0.0
2	3.29	1.22	0.71	1.24	0.0
1	0.0	0.89	0.52	0.0	0.0

```
Base shear, V:S(Pw+Pl) .. = 3.85 ton
Building Weight, W ..... = 15.31 ton   (V/W = 0.252)
Overturning moment
  From horizontal forces . = 8.68 ton-m
  From roof forces ..... = 0.0 ton-m
  Total moment, Mo ..... = 8.68 ton-m
Stabilizing moment, Ms.... = 41.79 ton-m   (Mo/Ms = 0.208)
```

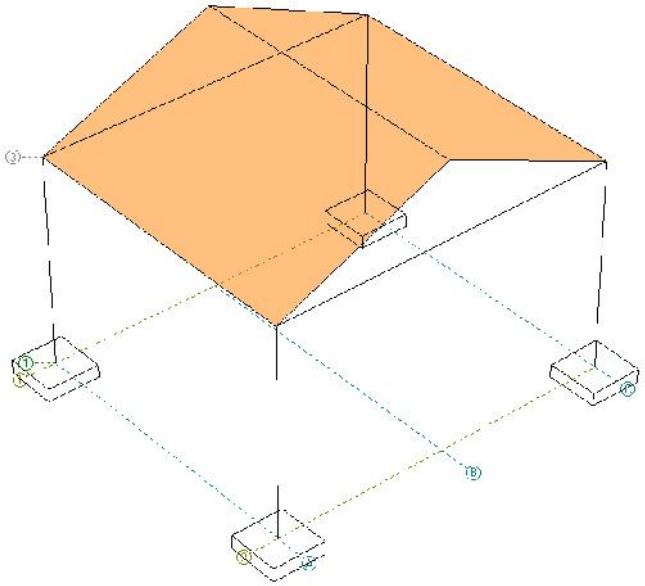
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7. MODELO ESTRUCTURAL.

El modelo matemático de la estructura incluye todos los elementos que conforman el sistema estructural resistente, así como también la distribución espacial de las masas y rigideces en la estructura, con una aproximación de tal manera que es capaz de capturar las características más significativas del comportamiento dinámico.

Para el análisis dinámico de la estructura se utiliza un modelo tridimensional con software especializado de análisis y diseño estructural (RCBE), en el cual como datos de entrada se le especifica la geometría, las cargas verticales, espectro de diseño sísmico para la generación de cargas horizontales, generando los resultados de esfuerzos en los elementos, vigas y columnas.

7.2 ISOMETRICO DEL MODELO



8. DATOS DE ENTRADA PARA ANALISIS Y DISEÑO.

0.0

GENERAL INPUT DATA

Structure type: Three-Dimensional Frame Structure
Number of Floor Grids . . . . = 1
Building total length . . . . = 4.7 m
Building total width . . . . . = 5.46 m

STORY INFORMATION

Number of Stories . . . . = 2
Total Frame Height . . . . = 4.5 m

Floor	Story Height	Grid No
1	3.30	1
2	1.20	1
3	-	1

* Story Height in (m)

STRUCTURAL GRID INFORMATION

GRID No 1

Grid Point	X	Y
A-1	0.00	0.00
B-1	0.00	2.73
C-1	0.00	5.46
A-2	4.70	0.00
B-2	4.70	2.73
C-2	4.70	5.46

* Coordinates X & Y are in (m)

M A T E R I A L S

Number of materials = 2

STRUCTURAL STEEL

Mat	Name	Fy Kg/cm2	Fbmaj Kg/cm2	Fbmin Kg/cm2	E Kg/cm2	G Kg/cm2	w Kg/m3
2	ASTM A500	3500	2310	2310	2030000	805000	7840.0

REINFORCED CONCRETE

Mat	Name	f'c Kg/cm2	fy Kg/cm2	fys1 Kg/cm2	fys2 Kg/cm2	E Kg/cm2	G Kg/cm2	w Kg/m3
1	fc28	280	4200	4200	4200	206368	87430	2400.0

f'c: Compressive strength of concrete
fy: Yield strength of longitudinal reinforcement
fys1: Yiel strength of shear reinforcement, bar sizes <= 3/8"
fys2: Yiel strength of shear reinforcement, bar sizes > 3/8"

M E M B E R D A T A

Total number of members..... = 15
Number of columns..... = 4
Number of beams ..... = 7
Number of braces ..... = 4

C O L U M N S E C T I O N S

Number of prismatic sections = 1

Sec	Name	Shape	b (cm)	h (cm)	tw (cm)	tf (cm)	P1 (cm)	P2 (cm)	A (cm2)	I2 (cm4)	I3 (cm4)	J (cm4)
1	C30x35	Rectang	30.00	35.00	-	-	-	-	1050.0	107187	78750	144900

COLUMNS

Column	Story	L (m)	Lu (m)	a (m)	c (m)	Theta (o)	Sec -	Mat -	System -
C-2	1	3.30	3.03	0.00	0.28	90.0	1	1	G&L
A-2	1	3.30	3.03	0.00	0.28	90.0	1	1	G&L
C-1	1	3.30	3.03	0.00	0.28	90.0	1	1	G&L
A-1	1	3.30	3.03	0.00	0.28	90.0	1	1	G&L

B E A M S E C T I O N S

Number of prismatic sections = 2

Sec	Name	Shape	b (cm)	h (cm)	tw (cm)	tf (cm)	P1 (cm)	P2 (cm)	A (cm2)	I2 (cm4)	I3 (cm4)	J (cm4)
1	V30x35	Rectang	30.00	35.00	-	-	-	-	1050.0	107187	78750	144900
2	PTE100X200X7	Box/Tub	10.00	20.00	0.70	0.70	-	-	40.0	2055	681	1867

BEAMS

Beam	Floor	L (m)	Lu (m)	a (m)	c (m)	Sec -	Mat -	System -
A(1-2)	2	4.70	4.35	0.18	0.18	1	1	G&L
C(1-2)	2	4.70	4.35	0.18	0.18	1	1	G&L
B(1-2)	3	4.70	4.70	0.00	0.00	2	2	G&L

1(A-B)	2	2.73	2.58	0.15	0.00	1	1	G&L
1(B-C)	2	2.73	2.58	0.00	0.15	1	1	G&L
2(A-B)	2	2.73	2.58	0.15	0.00	1	1	G&L
2(B-C)	2	2.73	2.58	0.00	0.15	1	1	G&L

B R A C E S E C T I O N S

Number of prismatic sections = 1

Sec	Name	Shape	b (cm)	h (cm)	tw (cm)	tf (cm)	P1 (cm)	P2 (cm)	A (cm2)	I2 (cm4)	I3 (cm4)	J (cm4)
1	PTE100X200X7	Box/Tub	10.00	20.00	0.70	0.70	-	-	40.0	2055	681	1867

BRACES

Brace	Floors	L (m)	Lu (m)	a (m)	c (m)	Sec -	Mat -	System -
1(A-B)	2-3	2.98	2.98	0.00	0.00	1	2	G&L
1(B-C)	3-2	2.98	2.98	0.00	0.00	1	2	G&L
2(A-B)	2-3	2.98	2.98	0.00	0.00	1	2	G&L
2(B-C)	3-2	2.98	2.98	0.00	0.00	1	2	G&L

G R O U N D S U P P O R T D A T A

Total number of ground supports = 4

K = Spring constant(ton/cm)

Characteristics for All Degrees of Freedom
Value = K Dash = free C = constrained

Support	Floor	Type	Ux	Uy	Uz	TetX	TetY	TetZ
A-1	1	Fixed	C	C	C	C	C	C
C-1	1	Fixed	C	C	C	C	C	C
A-2	1	Fixed	C	C	C	C	C	C
C-2	1	Fixed	C	C	C	C	C	C

S U M M A R Y O F T O T A L F L O O R L O A D S

LOAD CASE 1 : SELFW (D0)

	Force (ton)			Moment (ton-m)		
Floor	Px	Py	Pz	Mx	My	Mz
3	0.00	0.00	0.33	0.0	0.0	0.0
2	0.00	0.00	8.63	0.0	0.0	0.0
1	0.00	0.00	0.00	0.0	0.0	0.0
Total	0.00	0.00	8.97	0.0	0.0	0.0

LOAD CASE 2 : DEAD (DL)

	Force (ton)			Moment (ton-m)		
Floor	Px	Py	Pz	Mx	My	Mz
3	0.00	0.00	4.31	0.0	0.0	0.0
2	0.00	0.00	0.00	0.0	0.0	0.0
1	0.00	0.00	0.00	0.0	0.0	0.0
Total	0.00	0.00	4.31	0.0	0.0	0.0

LOAD CASE 3 : LIVE (LL)

	Force (ton)			Moment (ton-m)		
Floor	Px	Py	Pz	Mx	My	Mz
3	0.00	0.00	2.57	0.0	0.0	0.0
2	0.00	0.00	0.00	0.0	0.0	0.0
1	0.00	0.00	0.00	0.0	0.0	0.0
Total	0.00	0.00	2.57	0.0	0.0	0.0

LOAD CASE 4 : EQUAKE X (EQX) - TYPE : EQUIVALENT STATIC

	Force (ton)			Acc. Tors. Mom. (ton-m)		
Floor	Px	Py	Pz	Mx	My	Mz
3	7.71	0.00	0.00	0.0	0.0	0.0
2	12.98	0.00	0.00	0.0	0.0	3.5
1	0.00	0.00	0.00	0.0	0.0	0.0
Total	20.69	0.00	0.00	0.0	0.0	3.5

LOAD CASE 5 : EQUAKE Y (EQY) - TYPE : EQUIVALENT STATIC

	Force (ton)			Acc. Tors. Mom. (ton-m)		
Floor	Px	Py	Pz	Mx	My	Mz
3	0.00	7.71	0.00	0.0	0.0	1.8
2	0.00	12.96	0.00	0.0	0.0	3.0
1	0.00	0.00	0.00	0.0	0.0	0.0
Total	0.00	20.67	0.00	0.0	0.0	4.8

LOAD CASE 6 : WIND X (WLX)

	Force (ton)			Moment (ton-m)		
Floor	Px	Py	Pz	Mx	My	Mz
3	0.00	0.00	0.00	0.0	0.0	0.0
2	2.30	0.00	0.00	0.0	0.0	0.7
1	0.00	0.00	0.00	0.0	0.0	0.0
Total	2.30	0.00	0.00	0.0	0.0	0.7

LOAD CASE 7 : WIND Y (WLY)

Floor	Force (ton)			Moment (ton-m)		
	Px	Py	Pz	Mx	My	Mz
3	0.00	0.52	0.00	0.0	0.0	0.1
2	0.00	1.93	0.00	0.0	0.0	0.5
1	0.00	1.42	0.00	0.0	0.0	0.0
Total	0.00	3.86	0.00	0.0	0.0	0.6

SUMMARY QUANTITY OF MATERIALS

C O L U M N S

Item	Section	Material	Length	Weight/Len	Total Weight
-	-	-	m	ton/m	ton
1	C30x35	fc28	12.10	0.252	3.05
				TOTAL =	3.05

B E A M S

Item	Section	Material	Length	Weight/Len	Total Weight
-	-	-	m	ton/m	ton
1	V30x35	fc28	19.67	0.252	4.96
2	PTE100X200X7	ASTM A500	4.70	0.031	0.15
				TOTAL =	5.10

B R A C E S

Item	Section	Material	Length	Weight/Len	Total Weight
-	-	-	m	ton/m	ton
1	PTE100X200X7	ASTM A500	11.93	0.031	0.37
				TOTAL =	0.37

S L A B S

Item	Section	Material	Area	Weight/Area	Total Weight
-	-	-	m^2	ton/m^2	ton
1	Slab type 1	w =2.4	25.66	0.048	1.23
				TOTAL =	1.23

4

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9. RESULTADOS DE ANALISIS.

Del modelo se toman los datos de análisis (acciones internas de fuerzas, momentos, esfuerzos y deflexiones) para el diseño de cada uno de los elementos, columnas vigas y pantallas.

9.2 MOMENTOS DE FLEXION, FUERZA CORTANTE.

Los resultados de momentos y cortantes se muestran en los resultados de diseño de cada uno de los elementos, VER resultados de diseño de elementos estructurales.

9.3 VERIFICACION DE DERIVAS

Siguiendo el Reglamento Colombiano de Construcción Sismo Resistente NSR-10, en (A.12.5.3)

Tabla A.12.5-1
Derivas máximas para el umbral de daño como porcentaje de h_{pi}

Estructuras de:	Deriva máxima
concreto reforzado, metálicas, de madera, y de mampostería que cumplen los requisitos de A.12.5.3.1	$0.40\% \left(\Delta^{i}_{max} \le 0.0040\, h_{pi}\right)$
de mampostería que cumplen los requisitos de A.12.5.3.2	$0.20\% \left(\Delta^{i}_{max} \le 0.0020\, h_{pi}\right)$

DERIVAS - UMBRAL DE DAÑO

-DELTA ANALYSIS - SUMMARY MAXIMUM STORY DRIFT RATIO, D/h

	Drift-Ratio at CENTER OF MASS			MAXIMUM Corner Story-Drift-Ratio			
Story	DriftX	DriftY	DriftR	DriftX	DriftY	DriftR	Axis
1	0.0006	0.0007	0.0007	0.0006	0.0007	0.0007	A-2
Maxima	0.0006	0.0007	0.0007	0.0006	0.0007	0.0007	

DriftX = (Dx/h)max
DriftY = (Dy/h)max
DriftR = ([(Dx/h)² + (Dy/h)²]½)max

AL 1%
v
P
P-DELTA ANALYSIS - SUMMARY MAXIMUM STORY DRIFT RATIO, D/h

	Drift-Ratio at CENTER OF MASS			MAXIMUM Corner Story-Drift-Ratio			
Story	DriftX	DriftY	DriftR	DriftX	DriftY	DriftR	Axis
1	0.0046	0.0047	0.0047	0.0046	0.0047	0.0047	C-2
Maxima	0.0046	0.0047	0.0047	0.0046	0.0047	0.0047	

DriftX = (Dx/h)max
DriftY = (Dy/h)max
DriftR = ([(Dx/h)² + (Dy/h)²]½)max

9.4 VERIFICACION DE IRREGULARIDAD TORSIONAL

y =

P L A N T O R S I O N A L I R R E G U L A R I T Y C H E C K - N S R - 10

	E A R T H Q U A K E - X				E A R T H Q U A K E - Y			
Level	D/h max	D/h avg	max/avg D/h	Irregular	D/h max	D/h avg	max/avg D/h	Irregular
3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	0.0000	0.0000	1.0000	NO	0.0000	0.0000	1.0000	NO

Torsional irregularity is considered to exist if D/h max > 1.2 D/h ave
EXTreme torsional irregularity is considered to exist if D/h max > 1.4 D/h ave
N/A: Non applicable to levels at or below seismic base nor levels without rigid floors

Torsional irregularities do NOT exist.

Accidental torsion does not have to be amplified

Notes:
The determination of torsional irregularities (plan structural irregularity type 1) and computation of amplification factors for accidental torsion Ax, is conducted according to FEMA's NEHRP Recommended Provitions for Seismic Regulations for New Buildings and other Structures, Provisions and Commentary ed. 1994, 1997, 2000, 2003, 2009, which is applicable to the following building codes derived from the above
documents: (USA) IBC-03/06, ASCE 7-05/10, CBC-01/07, UBC-97, (COLOMBIA) NSR-10, and (PAN) REP-2004,(Dom) R-001, (GUA) NSE10.

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10. DISEÑO DE LOS ELEMENTOS

10.2 DISEÑO DE COLUMNAS, VIGAS Y MUROS.

LOAD COMBINATIONS

01

LOAD COMBINATIONS

No	Load combination
1	1.4D0 + 1.4DL
2	1.2D0 + 1.2DL + 1.6LL
3	1.2D0 + 1.2DL + .5LL + WLX
4	1.2D0 + 1.2DL + .5LL - WLX
5	1.2D0 + 1.2DL + .5LL + WLY
6	1.2D0 + 1.2DL + .5LL - WLY
7	1.2D0 + 1.2DL + .5LL + .75WLX + .75WLY
8	1.2D0 + 1.2DL + .5LL - .75WLX - .75WLY
9	1.2D0 + 1.2DL + .5WLX
10	1.2D0 + 1.2DL - .5WLX
11	1.2D0 + 1.2DL + .5WLY
12	1.2D0 + 1.2DL - .5WLY
13	1.2D0 + 1.2DL + .375WLX + .375WLY
14	1.2D0 + 1.2DL - .375WLX - .375WLY
15	.9D0 + .9DL + WLX
16	.9D0 + .9DL - WLX
17	.9D0 + .9DL + WLY
18	.9D0 + .9DL - WLY
19	1.2D0 + 1.2DL + .5LL + EQX + .3EQY
20	1.2D0 + 1.2DL + .5LL - EQX - .3EQY
21	1.2D0 + 1.2DL + .5LL + EQX - .3EQY
22	1.2D0 + 1.2DL + .5LL - EQX + .3EQY
23	1.2D0 + 1.2DL + .5LL + .3EQX + EQY
24	1.2D0 + 1.2DL + .5LL - .3EQX - EQY
25	1.2D0 + 1.2DL + .5LL - .3EQX + EQY
26	1.2D0 + 1.2DL + .5LL + .3EQX - EQY
27	.9D0 + .9DL + EQX + .3EQY
28	.9D0 + .9DL - EQX - .3EQY
29	.9D0 + .9DL + EQX - .3EQY
30	.9D0 + .9DL - EQX + .3EQY
31	.9D0 + .9DL + .3EQX + EQY
32	.9D0 + .9DL - .3EQX - EQY
33	.9D0 + .9DL - .3EQX + EQY
34	.9D0 + .9DL + .3EQX - EQY

M A T E R I A L S

Number of materials = 2

REINFORCED CONCRETE

Mat	Name	f'c Kg/cm2	fy Kg/cm2	fys1 Kg/cm2	fys2 Kg/cm2	E Kg/cm2	G Kg/cm2	w Kg/m3
1	fc28	280	4200	4200	4200	206368	87430	2400.0

f'c: Compressive strength of concrete
fy: Yield strength of longitudinal reinforcement
fys1: Yiel strength of shear reinforcement, bar sizes <= 3/8"
fys2: Yiel strength of shear reinforcement, bar sizes > 3/8"

C O L U M N S E C T I O N S

Number of prismatic sections = 1

Sec	Name	Shape	b (cm)	h (cm)	tw (cm)	tf (cm)	P1 (cm)	P2 (cm)	A (cm2)	I2 (cm4)	I3 (cm4)	J (cm4)
1	C30x35	Rectang	30.00	35.00	-	-	-	-	1050.0	107187	78750	144900

Design Results - Columns (DES)

Column	Story	L (m)	Lu (m)	Sec Mat	bxh (cm)	TRANSVERSE REINFORCEMENT TIES	TRANSVERSE REINFORCEMENT XTIES	LONGITUDINAL REINFORCEMENT Sec	LdCmb critc	Pu (ton)	Mu2 (ton-m)	Mu3 (ton-m)	RHO -	As (cm2)
C-2	1	3.30	3.03	1	30x35	8 #4 @ 7 cm (end)	2 (b)	Top	24	6.43	1.33	3.08	0.0100	10.50
				1		14 #4 @ 14 cm (ctr)	1 (h)	Bot	24	6.43	1.14	2.87	0.0100	10.50
A-2	1	3.30	3.03	1	30x35	8 #4 @ 7 cm (end)	2 (b)	Top	25	6.55	1.27	3.08	0.0100	10.50
				1		14 #4 @ 14 cm (ctr)	1 (h)	Bot	25	6.55	1.00	2.87	0.0100	10.50
C-1	1	3.30	3.03	1	30x35	8 #4 @ 7 cm (end)	2 (b)	Top	26	6.43	1.19	3.08	0.0100	10.50
				1		14 #4 @ 14 cm (ctr)	1 (h)	Bot	26	6.43	0.96	2.87	0.0100	10.50
A-1	1	3.30	3.03	1	30x35	8 #4 @ 7 cm (end)	2 (b)	Top	23	6.55	1.41	3.08	0.0100	10.50
				1		14 #4 @ 14 cm (ctr)	1 (h)	Bot	23	6.55	1.18	2.87	0.0100	10.50

B E A M S E C T I O N S

Number of prismatic sections = 2

Sec	Name	Shape	b (cm)	h (cm)	tw (cm)	tf (cm)	P1 (cm)	P2 (cm)	A (cm2)	I2 (cm4)	I3 (cm4)	J (cm4)
1	V30x35	Rectang	30.00	35.00	-	-	-	-	1050.0	107187	78750	144900
2	PTE100X200X7	Box/Tub	10.00	20.00	0.70	0.70	-	-	40.0	2055	681	1867

Design Results - Beams (DES)

BEAM: A(1-2) FLOOR: 2

Length: L = 4.70 m a = 0.18 m Section: b = 30.0 cm Sec: V30x35
Lu = 4.35 m c = 0.18 m h = 35.0 cm Mat: fc28

X, m:	0.18	0.61	1.05	1.48	1.92	2.35	2.79	3.22	3.66	4.09	4.53
Mu(-), ton-m:	-2.69	-1.85	-1.14	-0.67	-0.67	-0.67	-0.67	-0.67	-1.14	-1.85	-2.69
Mu(+), ton-m:	1.66	1.53	1.38	1.22	0.99	0.87	0.99	1.22	1.38	1.53	1.66
As(-), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
As(+), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Vu, ton:	2.47	2.39	2.14	1.89	1.64	1.39	1.64	1.89	2.14	2.39	2.47
Tu, ton-m:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stirrup:	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing, cm:	7.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	7.50	7.50

DESIGN

A-1 10 #3 @ 7.5 19 #3 @ 15 10 #3 @ 7.5 A-2

BEAM: C(1-2) FLOOR: 2

Length: L = 4.70 m a = 0.18 m Section: b = 30.0 cm Sec: V30x35
Lu = 4.35 m c = 0.18 m h = 35.0 cm Mat: fc28

X, m:	0.18	0.61	1.05	1.48	1.92	2.35	2.79	3.22	3.66	4.09	4.53
Mu(-), ton-m:	-2.63	-1.83	-1.14	-0.66	-0.66	-0.66	-0.66	-0.66	-1.14	-1.83	-2.63
Mu(+), ton-m:	1.66	1.53	1.36	1.18	0.92	0.68	0.92	1.18	1.36	1.53	1.66
As(-), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
As(+), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Vu, ton:	2.27	2.21	2.00	1.79	1.58	1.37	1.58	1.79	2.00	2.21	2.27
Tu, ton-m:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stirrup:	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing, cm:	7.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	7.50	7.50

DESIGN

C-1	10 #3 @ 7.5 19 #3 @ 15 10 #3 @ 7.5	C-2

BEAM: 1(A-C) FLOOR: 2

Length: L = 5.46 m, Lu = 5.16 m; a = 0.15 m, c = 0.15 m; Section: b = 30.0 cm, h = 35.0 cm; Sec: V30x35; Mat: fc28

X, m:	0.15	0.67	1.18	1.70	2.21	2.73	3.25	3.76	4.28	4.79	5.31
Mu(-), ton-m:	-2.50	-1.61	-0.88	-0.63	-0.63	-0.63	-0.63	-0.63	-0.88	-1.61	-2.50
Mu(+), ton-m:	1.25	1.24	1.25	1.23	1.09	0.99	1.09	1.23	1.25	1.24	1.25
As(-), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
As(+), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Vu, ton:	2.13	2.03	1.77	1.52	1.26	1.01	1.27	1.52	1.77	2.03	2.13
Tu, ton-m:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stirrup:	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing, cm:	7.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	7.50	7.50

DESIGN

A-1	11 #3 @ 7.5 23 #3 @ 15 11 #3 @ 7.5	C-1

BEAM: 2(A-C) FLOOR: 2

Length: L = 5.46 m, Lu = 5.16 m; a = 0.15 m, c = 0.15 m; Section: b = 30.0 cm, h = 35.0 cm; Sec: V30x35; Mat: fc28

X, m:	0.15	0.67	1.18	1.70	2.21	2.73	3.25	3.76	4.28	4.79	5.31
Mu(-), ton-m:	-2.50	-1.61	-0.88	-0.63	-0.63	-0.63	-0.63	-0.63	-0.88	-1.61	-2.50
Mu(+), ton-m:	1.25	1.24	1.25	1.23	1.09	0.99	1.09	1.23	1.25	1.24	1.25
As(-), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
As(+), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Vu, ton:	2.13	2.03	1.77	1.52	1.26	1.01	1.27	1.52	1.77	2.03	2.13
Tu, ton-m:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stirrup:	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing, cm:	7.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	7.50	7.50

DESIGN

A-2	11 #3 @ 7.5 23 #3 @ 15 11 #3 @ 7.5	C-2

LONG-TERM BEAM DEFLECTIONS

PERMISSIBLE DEFLECTIONS
Immediate deflection due to Live Load . . . . . = L/360
Long-term deflection due to Sustained loads . . = L/480

TYPE OF DEFLECTION	LOAD COMBINATION
Immediate due to Dead load (DLs)	D0 + DL
Immediate due to Live load (LLs)*	LL
Immediate due to Sus. load (SLds)	D0 + DL + .25LL
Long-term due to Sus. load (SLds)	D0 + DL + .25LL

* Computed as Defl(DLS + LLs) - Defl(DLs)

Units: Defl: Max. deflection (cm), L: Beam length (m), h: Beam depth (cm)

Beam	Floor	h	L	L/h	Beam Type	IMMEDIATE DEFLECTIONS DLs Deflc	Live Deflc	Sut.Lds Deflc	ADDITIONAL LONG-TERM DEFLEC. Sus.Lds 6 months Deflc	1-year Deflc	5-years Deflc
A(1-2)	2	35	4.70	13	SimpSupprt	0.029	0.017	0.033	0.034	0.040	0.057
C(1-2)	2	35	4.70	13	SimpSupprt	0.029	0.008	0.031	0.032	0.038	0.054
1(A-C)	2	35	5.46	16	SimpSupprt	0.062	0.018	0.066	0.068	0.080	0.114
2(A-C)	2	35	5.46	16	SimpSupprt	0.062	0.018	0.066	0.068	0.080	0.114

NOTE: All beam deflections are smaller than maximum permissible deflection
Depth, H, of all beams is larger than that recomemenden in Table 9.5(a)

Immediate deflections are computed according to 9.5.2.3 with:
Effective stiffness: E I = Ec . Ie

$$Ie = (Mcr/Ma)^3\ Ig + [1 - (Mcr/Ma)^3]\ Icr$$

$$Mcr = fr\ Ig/Yt$$

$$Icr = b(kd)^3/3 + n\ As(d-kd)^1 + (n-1)A's(kd-d')^2$$

$$n = Es/Ec$$

Long-term deflections are computed according to 9.5.2.5

B R A C E S E C T I O N S

Number of prismatic sections = 1

Sec	Name	Shape	b (cm)	h (cm)	tw (cm)	tf (cm)	P1 (cm)	P2 (cm)	A (cm2)	I2 (cm4)	I3 (cm4)	J (cm4)
1	PTE100X200X7	Box/Tub	10.00	20.00	0.70	0.70	-	-	40.0	2055	681	1867

Design Results - Brace (DES)

Brace	Story	L (m)	Lu (m)	Sec Mat	bxh (cm)	TRANSVERSE REINFORCEMENT TIES	TRANSVERSE REINFORCEMENT XTIES	LONGITUDINAL REINFORCEMENT Sec	LdCmb critc	Pu (ton)	Mu2 (ton-m)	Mu3 (ton-m)	RHO -	As (cm2)

S T E E L D E S I G N C H E C K

C O L U M N C A P A C I T Y R A T I O S

Column	Story	Sec	Lb2	Lb3	rBA	rV3	rV2

B E A M C A P A C I T Y R A T I O S

Beam	Floor	Sec	LbTop	LbBot	rMn	rMp	rV3
B(1-2)	3	PTE100X200X7	470	470	0.159	0.563	0.089

B R A C E C A P A C I T Y R A T I O S

Brace	Story	Sec	Lb2	Lb3	rBA	rV3	rV2
1(A-B)	2-3	PTE100X200X7	298	298	0.335	0.002	0.033
1(B-C)	3-2	PTE100X200X7	298	298	0.336	0.002	0.033
2(A-B)	2-3	PTE100X200X7	298	298	0.336	0.002	0.033
2(B-C)	3-2	PTE100X200X7	298	298	0.335	0.002	0.033

-m

11. DISEÑO DE LA CIMENTACION.

11.2 COMBINACIONES DE CARGA.

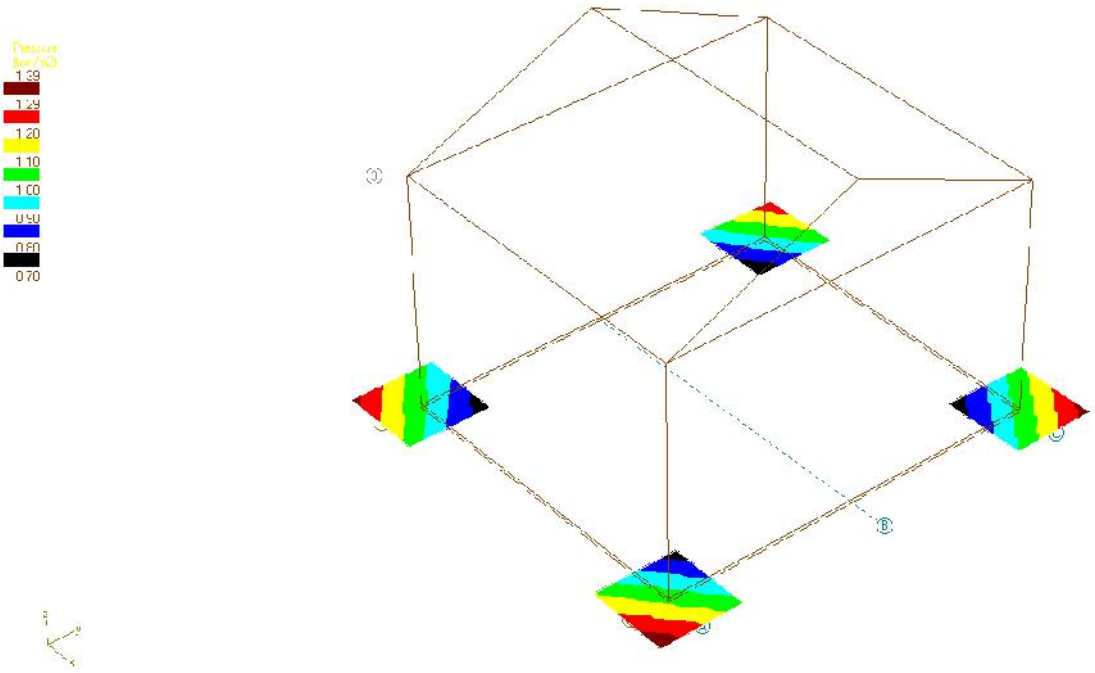
Combinaciones Básicas. Limites de Servicio (B.2.3 NSR-10), ***para dimensionamiento de elementos.***

1	D
2	D+L
3	D+L +0.53 Sx
4	D+L -0.53 Sx
5	D+L +0.53Sy
6	D+L-0.53Sy

11.3 DISEÑO DE LA CIMENTACION.

El concreto para la cimentación se especifica resistencia de 4000 psi.

11.4 PRESION DE CONTACTO AL TERRENO.



01

P-
P-Delta Analysis- Footing Contact Pressures

Footing group		Load	Force (ton)			Moment (ton-m)			Pressure (ton/m2)	
Group	Floor	LdComb	Rx	Ry	Rz	Mx	My	Mz	PcMax	PcMin
C-2	1	1	0.12	0.05	1.16	0.04	-0.03	-0.01	1.06	0.56
		2	0.16	0.08	1.50	0.05	-0.04	-0.01	1.37	0.72
		3	0.48	-0.25	0.97	0.04	-0.01	0.00	0.84	0.51
		4	-0.24	0.36	1.36	0.04	-0.05	-0.01	1.28	0.60
		5	0.05	0.65	0.98	0.02	-0.03	-0.02	0.84	0.52
		6	0.19	-0.54	1.35	0.06	-0.03	0.00	1.28	0.60
		7	0.42	-0.16	1.27	0.05	-0.02	-0.01	1.12	0.65
		8	-0.12	0.30	1.56	0.05	-0.05	-0.01	1.45	0.72
		9	0.10	0.52	1.28	0.03	-0.04	-0.02	1.13	0.65
		10	0.20	-0.38	1.56	0.07	-0.04	0.00	1.45	0.71
		11	0.43	-0.27	0.50	0.02	0.00	0.00	0.43	0.27
		12	-0.29	0.34	0.89	0.03	-0.04	-0.01	0.86	0.38
		13	0.00	0.63	0.51	0.00	-0.02	-0.01	0.42	0.29
		14	0.14	-0.56	0.88	0.05	-0.02	0.00	0.85	0.37
		15	1.04	-0.12	0.60	0.03	0.03	0.00	0.60	0.23
		16	-0.80	0.23	1.73	0.05	-0.09	-0.02	1.70	0.70
		17	-0.04	0.98	0.69	-0.02	-0.02	0.00	0.61	0.34
		18	0.28	-0.88	1.64	0.10	-0.04	-0.01	1.61	0.66
		19	0.85	-0.06	0.99	0.04	0.01	0.00	0.84	0.54
		20	-0.54	0.21	1.85	0.06	-0.08	-0.02	1.78	0.79
		21	0.03	0.77	1.06	0.01	-0.03	-0.01	0.87	0.60
		22	0.27	-0.63	1.78	0.09	-0.05	-0.01	1.71	0.76
		23	0.99	-0.15	0.13	0.01	0.04	0.01	0.27	-0.08

		24	-0.84	0.21	1.26	0.04	-0.08	-0.01	1.28	0.48
		25	-0.09	0.96	0.22	-0.03	-0.01	0.00	0.30	0.01
		26	0.23	-0.90	1.17	0.08	-0.03	-0.01	1.19	0.44
A-2	1	1	0.11	-0.05	1.12	-0.04	-0.03	0.01	1.02	0.54
		2	0.12	-0.08	1.54	-0.05	-0.04	0.01	1.40	0.73
		3	0.47	0.25	0.93	-0.03	-0.01	0.00	0.80	0.50
		4	-0.25	-0.36	1.31	-0.04	-0.05	0.01	1.24	0.58
		5	0.17	0.54	1.30	-0.06	-0.03	0.02	1.23	0.57
		6	0.05	-0.65	0.94	-0.02	-0.03	0.00	0.81	0.50
		7	0.39	0.16	1.29	-0.05	-0.02	0.01	1.14	0.65
		8	-0.16	-0.30	1.57	-0.05	-0.06	0.01	1.47	0.71
		9	0.16	0.38	1.57	-0.07	-0.04	0.02	1.47	0.71
		10	0.07	-0.52	1.30	-0.03	-0.04	0.00	1.15	0.66
		11	0.43	0.27	0.49	-0.02	0.00	0.00	0.42	0.26
		12	-0.30	-0.33	0.86	-0.03	-0.04	0.01	0.83	0.36
		13	0.13	0.56	0.85	-0.05	-0.02	0.01	0.82	0.36
		14	0.01	-0.63	0.49	0.00	-0.02	0.00	0.40	0.29
		15	1.03	0.12	0.57	-0.03	0.03	0.00	0.58	0.21
		16	-0.81	-0.22	1.67	-0.05	-0.09	0.02	1.65	0.67
		17	0.27	0.88	1.58	-0.09	-0.04	0.00	1.56	0.64
		18	-0.05	-0.99	0.66	0.02	-0.02	0.01	0.59	0.32
		19	0.81	0.06	1.02	-0.04	0.00	0.00	0.86	0.55
		20	-0.58	-0.20	1.85	-0.06	-0.08	0.02	1.78	0.78
		21	0.23	0.64	1.78	-0.09	-0.05	0.01	1.72	0.76
		22	0.00	-0.78	1.08	-0.01	-0.03	0.01	0.89	0.61
		23	0.99	0.14	0.13	-0.01	0.04	-0.01	0.26	-0.09
		24	-0.86	-0.20	1.22	-0.04	-0.08	0.01	1.24	0.45
		25	0.22	0.90	1.13	-0.08	-0.03	0.00	1.15	0.42
		26	-0.09	-0.96	0.21	0.03	-0.01	0.01	0.29	0.00
C-1	1	1	-0.12	0.04	1.11	0.04	0.03	0.01	1.01	0.54
		2	-0.16	0.06	1.44	0.05	0.04	0.01	1.30	0.70
		3	0.24	-0.13	1.30	0.04	0.05	0.01	1.22	0.58
		4	-0.48	0.21	0.93	0.04	0.01	0.00	0.79	0.49
		5	-0.05	0.64	0.93	0.02	0.03	0.02	0.79	0.50
		6	-0.19	-0.56	1.29	0.06	0.03	0.00	1.22	0.57
		7	0.12	-0.07	1.50	0.05	0.05	0.01	1.39	0.69
		8	-0.42	0.18	1.22	0.04	0.02	0.01	1.07	0.62
		9	-0.10	0.50	1.22	0.03	0.03	0.02	1.07	0.63
		10	-0.20	-0.39	1.49	0.06	0.04	0.00	1.39	0.68
		11	0.29	-0.14	0.85	0.03	0.04	0.01	0.82	0.36
		12	-0.44	0.19	0.48	0.02	0.00	0.00	0.41	0.25
		13	-0.01	0.62	0.49	0.00	0.01	0.01	0.39	0.29
		14	-0.14	-0.57	0.85	0.05	0.02	0.00	0.82	0.35
		15	0.80	0.21	1.66	0.05	0.09	0.02	1.63	0.67
		16	-1.04	-0.13	0.57	0.03	-0.03	0.00	0.58	0.20
		17	0.03	0.98	0.65	-0.02	0.02	0.00	0.59	0.31
		18	-0.27	-0.90	1.57	0.10	0.04	0.01	1.56	0.62
		19	0.55	0.18	1.77	0.06	0.08	0.02	1.70	0.76
		20	-0.85	-0.08	0.94	0.04	-0.01	0.00	0.81	0.50
		21	-0.04	0.76	1.01	0.00	0.03	0.01	0.81	0.59
		22	-0.27	-0.66	1.70	0.09	0.04	0.01	1.64	0.72
		23	0.85	0.20	1.21	0.04	0.08	0.01	1.23	0.45
		24	-0.99	-0.15	0.12	0.01	-0.04	-0.01	0.26	-0.09
		25	0.08	0.96	0.21	-0.03	0.01	0.00	0.30	-0.01
		26	-0.23	-0.91	1.13	0.08	0.03	0.01	1.16	0.41
A-1	1	1	-0.11	-0.04	1.07	-0.04	0.03	-0.01	0.97	0.52
		2	-0.12	-0.06	1.47	-0.05	0.04	-0.01	1.34	0.71
		3	0.25	0.13	1.25	-0.04	0.05	-0.01	1.19	0.56
		4	-0.48	-0.21	0.89	-0.03	0.01	0.00	0.76	0.48
		5	-0.17	0.56	1.25	-0.06	0.03	-0.02	1.18	0.55
		6	-0.05	-0.64	0.90	-0.01	0.03	0.00	0.76	0.49
		7	0.16	0.07	1.51	-0.05	0.05	-0.01	1.41	0.69
		8	-0.39	-0.18	1.24	-0.05	0.02	-0.01	1.08	0.63
		9	-0.16	0.39	1.50	-0.07	0.04	-0.02	1.40	0.68
		10	-0.07	-0.50	1.24	-0.03	0.03	0.00	1.09	0.64
		11	0.30	0.15	0.82	-0.03	0.04	-0.01	0.80	0.35
		12	-0.43	-0.19	0.46	-0.02	0.00	0.00	0.40	0.24
		13	-0.12	0.58	0.82	-0.05	0.02	-0.01	0.79	0.34
		14	-0.01	-0.62	0.47	0.00	0.01	0.00	0.38	0.28
		15	0.82	-0.20	1.60	-0.05	0.09	-0.02	1.59	0.64
		16	-1.04	0.12	0.54	-0.02	-0.03	0.00	0.57	0.19
		17	-0.26	0.90	1.52	-0.09	0.04	-0.01	1.51	0.60
		18	0.04	-0.98	0.63	0.02	0.02	0.00	0.58	0.29
		19	0.59	-0.18	1.77	-0.06	0.08	-0.02	1.71	0.75
		20	-0.82	0.07	0.97	-0.04	-0.01	0.00	0.83	0.51
		21	-0.23	0.66	1.71	-0.09	0.04	-0.01	1.65	0.72
		22	0.00	-0.77	1.03	0.00	0.03	-0.01	0.84	0.60
		23	0.86	-0.19	1.17	-0.04	0.08	-0.01	1.20	0.43
		24	-1.00	0.14	0.11	-0.01	-0.04	0.01	0.26	-0.10
		25	-0.22	0.92	1.09	-0.08	0.02	-0.01	1.12	0.39
		26	0.08	-0.96	0.20	0.04	0.01	0.00	0.29	-0.02

P-Delta Analysis- Footing Envelopes

Load combinations : Service
Type of contact pressure: Linear, PmaxPmin = Rz/A (1 ± eb/S3 ± el/S2)
Self weight of footing: 0.10 Rz (D0 + DL + LL)

Group	Floor	Rz max ton	Rz min ton	Pc max ton/m2	Pc min ton/m2	Pc/Pa max	Pc/Pa min
C-2	1	2.00	0.28	1.88	0.02	0.10	0.00
A-2	1	2.00	0.28	1.89	0.02	0.10	0.00
C-1	1	1.91	0.27	1.80	0.01	0.10	0.00
A-1	1	1.92	0.26	1.81	0.00	0.10	0.00

LOAD COMBINATIONS

No	Load combination
1	D0 + DL
2	D0 + DL + LL
3	D0 + DL + .6WLX
4	D0 + DL - .6WLX
5	D0 + DL + .6WLY
6	D0 + DL - .6WLY
7	D0 + DL + .75LL + .45WLX
8	D0 + DL + .75LL - .45WLX
9	D0 + DL + .75LL + .45WLY
10	D0 + DL + .75LL - .45WLY
11	.6D0 + .6DL + .6WLX
12	.6D0 + .6DL - .6WLX
13	.6D0 + .6DL + .6WLY
14	.6D0 + .6DL - .6WLY
15	D0 + DL + .7EQX
16	D0 + DL - .7EQX
17	D0 + DL + .7EQY
18	D0 + DL - .7EQY
19	D0 + DL + .75LL + .53EQX
20	D0 + DL + .75LL - .53EQX
21	D0 + DL + .75LL + .53EQY
22	D0 + DL + .75LL - .53EQY
23	.6D0 + .6DL + .7EQX
24	.6D0 + .6DL - .7EQX
25	.6D0 + .6DL + .7EQY
26	.6D0 + .6DL - .7EQY

11.4.1 DISEÑO DE LA CIMNETACION.

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LOAD COMBINATIONS

No	Load combination
1	1.4D0 + 1.4DL
2	1.2D0 + 1.2DL + 1.6LL
3	1.2D0 + 1.2DL + .5LL + WLX
4	1.2D0 + 1.2DL + .5LL - WLX
5	1.2D0 + 1.2DL + .5LL + WLY
6	1.2D0 + 1.2DL + .5LL - WLY
7	1.2D0 + 1.2DL + .5LL + .75WLX + .75WLY
8	1.2D0 + 1.2DL + .5LL - .75WLX - .75WLY
9	1.2D0 + 1.2DL + .5WLX
10	1.2D0 + 1.2DL - .5WLX
11	1.2D0 + 1.2DL + .5WLY
12	1.2D0 + 1.2DL - .5WLY
13	1.2D0 + 1.2DL + .375WLX + .375WLY
14	1.2D0 + 1.2DL - .375WLX - .375WLY
15	.9D0 + .9DL + WLX
16	.9D0 + .9DL - WLX
17	.9D0 + .9DL + WLY
18	.9D0 + .9DL - WLY
19	1.2D0 + 1.2DL + .5LL + EQX + .3EQY
20	1.2D0 + 1.2DL + .5LL - EQX - .3EQY
21	1.2D0 + 1.2DL + .5LL + EQX - .3EQY
22	1.2D0 + 1.2DL + .5LL - EQX + .3EQY
23	1.2D0 + 1.2DL + .5LL + .3EQX + EQY
24	1.2D0 + 1.2DL + .5LL - .3EQX - EQY
25	1.2D0 + 1.2DL + .5LL - .3EQX + EQY
26	1.2D0 + 1.2DL + .5LL + .3EQX - EQY
27	.9D0 + .9DL + EQX + .3EQY
28	.9D0 + .9DL - EQX - .3EQY
29	.9D0 + .9DL + EQX - .3EQY
30	.9D0 + .9DL - EQX + .3EQY

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31       .9D0 + .9DL + .3EQX + EQY
32       .9D0 + .9DL - .3EQX - EQY
33       .9D0 + .9DL - .3EQX + EQY
34       .9D0 + .9DL + .3EQX - EQY
```

M A T E R I A L S

Number of materials = 2

REINFORCED CONCRETE

Mat	Name	f'c Kg/cm2	fy Kg/cm2	fys1 Kg/cm2	fys2 Kg/cm2	E Kg/cm2	G Kg/cm2	w Kg/m3
1	fc28	280	4200	4200	4200	206368	87430	2400.0

f'c: Compressive strength of concrete
fy: Yield strength of longitudinal reinforcement
fys1: Yiel strength of shear reinforcement, bar sizes <= 3/8"
fys2: Yiel strength of shear reinforcement, bar sizes > 3/8"

B E A M S E C T I O N S

Number of prismatic sections = 2

Sec	Name	Shape	b (cm)	h (cm)	tw (cm)	tf (cm)	P1 (cm)	P2 (cm)	A (cm2)	I2 (cm4)	I3 (cm4)	J (cm4)
1	V30x35	Rectang	30.00	35.00	-	-	-	-	1050.0	107187	78750	144900
2	PTE100X200X7	Box/Tub	10.00	20.00	0.70	0.70	-	-	40.0	2055	681	1867

Design Results - Beams (DES)

BEAM: A(1-2) FLOOR: 1

Length: L = 4.70 m a = 0.18 m Section: b = 30.0 cm Sec: V30x35
Lu = 4.35 m c = 0.18 m h = 35.0 cm Mat: fc28

X, m:	0.18	0.61	1.05	1.48	1.92	2.35	2.79	3.22	3.66	4.09	4.53
Mu(-), ton-m:	-1.71	-2.07	-2.33	-2.38	-2.27	-2.24	-2.19	-2.21	-2.15	-1.93	-1.65
Mu(+), ton-m:	2.62	1.46	0.81	0.26	0.00	0.00	0.00	0.21	0.77	1.46	2.62
As(-), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
As(+), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Vu, ton:	2.43	2.36	2.07	1.75	1.37	1.02	1.37	1.73	2.07	2.35	2.40
Tu, ton-m:	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Stirrup:	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing, cm:	7.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	7.50	7.50

DESIGN

A-1 11 #3 @ 7.5 18 #3 @ 15 11 #3 @ 7.5 A-2

BEAM: C(1-2) FLOOR: 1

Length: L = 4.70 m a = 0.18 m Section: b = 30.0 cm Sec: V30x35
Lu = 4.35 m c = 0.18 m h = 35.0 cm Mat: fc28

X, m:	0.18	0.61	1.05	1.48	1.92	2.35	2.79	3.22	3.66	4.09	4.53
Mu(-), ton-m:	-1.68	-2.06	-2.33	-2.39	-2.30	-2.27	-2.21	-2.22	-2.14	-1.92	-1.62
Mu(+), ton-m:	2.63	1.45	0.79	0.24	0.00	0.00	0.00	0.19	0.76	1.45	2.63
As(-), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
As(+), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Vu, ton:	2.44	2.37	2.08	1.75	1.38	1.02	1.38	1.73	2.08	2.36	2.41
Tu, ton-m:	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Stirrup:	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing, cm:	7.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	7.50	7.50

DESIGN

C-1 11 #3 @ 7.5 18 #3 @ 15 11 #3 @ 7.5 C-2

BEAM: 1(A-C) FLOOR: 1

Length: L = 5.46 m a = 0.15 m Section: b = 30.0 cm Sec: V30x35
Lu = 5.16 m c = 0.15 m h = 35.0 cm Mat: fc28

X, m:	0.15	0.67	1.18	1.70	2.21	2.73	3.25	3.76	4.28	4.79	5.31
Mu(-), ton-m:	-1.67	-1.90	-2.07	-2.02	-1.86	-1.78	-1.85	-1.96	-1.97	-1.81	-1.64
Mu(+), ton-m:	2.63	1.48	0.85	0.32	0.00	0.00	0.00	0.32	0.85	1.50	2.63
As(-), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
As(+), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Vu, ton:	2.42	2.18	1.77	1.44	1.12	0.84	1.10	1.40	1.72	2.11	2.34
Tu, ton-m:	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Stirrup:	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing, cm:	7.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	7.50	7.50

DESIGN

A-1	11 #3 @ 7.5 23 #3 @ 15 11 #3 @ 7.5	C-1

BEAM: 2(A-C) FLOOR: 1

Length: L = 5.46 m a = 0.15 m Section: b = 30.0 cm Sec: V30x35
Lu = 5.16 m c = 0.15 m h = 35.0 cm Mat: fc28

X, m:	0.15	0.67	1.18	1.70	2.21	2.73	3.25	3.76	4.28	4.79	5.31
Mu(-), ton-m:	-1.64	-1.90	-2.10	-2.07	-1.93	-1.85	-1.92	-2.01	-1.99	-1.80	-1.60
Mu(+), ton-m:	2.65	1.47	0.83	0.30	0.00	0.00	0.00	0.31	0.83	1.49	2.65
As(-), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
As(+), cm2:	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Vu, ton:	2.51	2.26	1.81	1.47	1.14	0.84	1.12	1.42	1.76	2.19	2.43
Tu, ton-m:	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Stirrup:	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3	#3
Spacing, cm:	7.50	7.50	15.00	15.00	15.00	15.00	15.00	15.00	15.00	7.50	7.50

DESIGN

A-2	11 #3 @ 7.5 23 #3 @ 15 11 #3 @ 7.5	C-2

Design results - Footings

Footing	Floor	Mat	B m	L m	h cm	Vu1/ØVc1 Vu2/ØVc2	Dir -	Reinforcem	As cm2	Mu ton-m
C-2	1	1	1.20	1.20	35	0.03	B	6#4@20 cm	7.560	0.25
						0.03	L	6#4@20 cm	7.560	0.23
A-2	1	1	1.20	1.20	35	0.03	B	6#4@20 cm	7.560	0.25
						0.03	L	6#4@21 cm	7.560	0.23
C-1	1	1	1.20	1.20	35	0.02	B	6#4@21 cm	7.560	0.25
						0.03	L	6#4@20 cm	7.560	0.22
A-1	1	1	1.20	1.20	35	0.02	B	6#4@21 cm	7.560	0.24
						0.03	L	6#4@21 cm	7.560	0.22

YESID ALEXANDER MUNAR CASTAÑEDA
C.C 79.317.188
MP 25202-47246 CND