

**Universidad de San Carlos de Guatemala
Centro Universitario de Occidente
División de Ciencias de la Ingeniería
Curso: Diseño Estructural en Mampostería
Ing. Santos Danilo Xivir Huix**



**Análisis y Diseño Estructural de un Edificio de
Apartamentos mediante Software de diseño ETABS en el
departamento de San Marcos, Guatemala”**

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Datos de la Edificación

Lugar:

Departamento San Marcos
Municipio San Marcos

Uso :

Apartamentos

Niveles:

4 Niveles

Altura de cada Nivel

3m

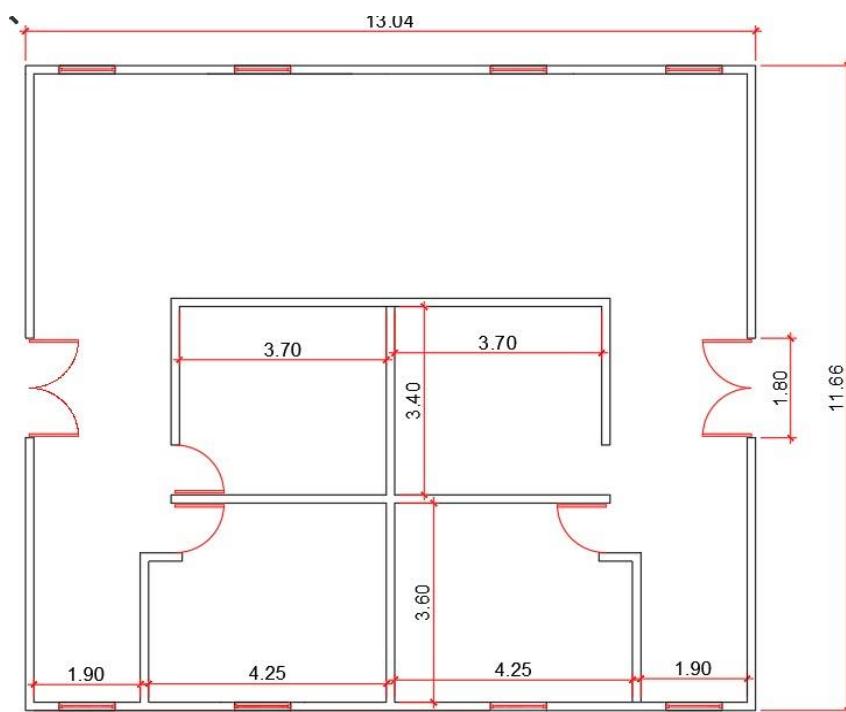
Valor Soporte Suelo

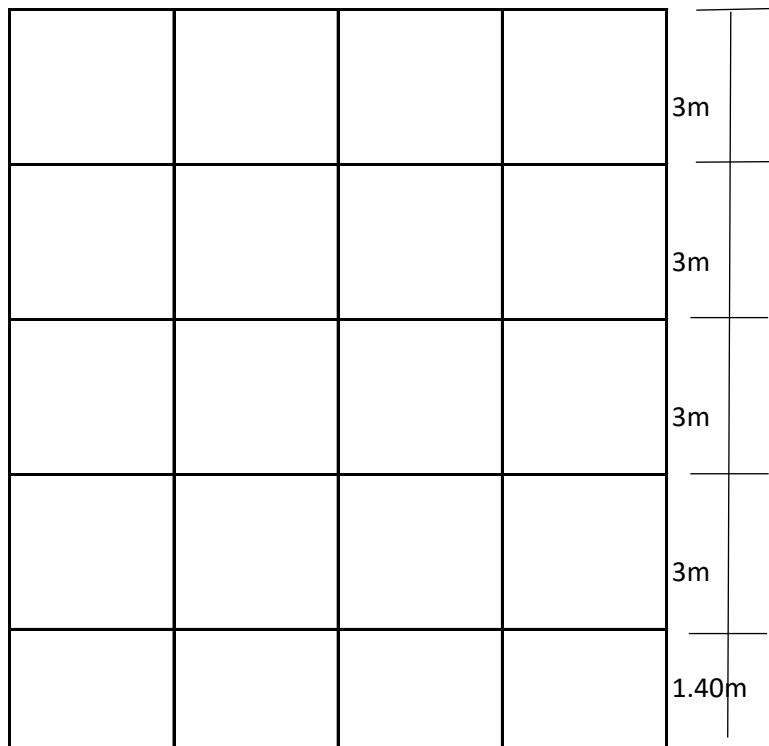
20T/m²

Desplante Minimo

1.20 m

Medidas Planta





Nombre del Proyecto: Apartamentos

Clasificacion de la obra NSE 1-18

Categoría ; II	Obras Ordinarias	Según AGIES NSE 1-18 Cap 3.1.4
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Vivienda y habitación

Hoteles y apartamentos

Ordinario

21

Demandas Estructural y Condiciones de Sitio

Carga Muerta

Por piso + relleno	150	kg/m ²
Peso propio de la losa	288	kg/m ²

Densidad de concreto	2400	kg/m ³
Espesor de losa	0.12	m
	288	kg/m ²

Carga Viva

Tablas 3.7.1-1 Cargas Vivas para Edificaciones AGIES NSE 2-18

Tipo de Ocupacion o uso	Wv (Kg/m²)
Apartamentos	
Habitaciones	200
Servicios De Areas Publicas	500

Aspectos Sismicos

Departamento San Marcos

Municipio San Marcos

Io: 4.1 Indice de Sismicidad

Según Figura 4.5-1 de AGIES NSE 2 - 18

NPS: D Nivel de Protección sismica

Tabla 4.2.2-1

No	Municipio	Departamento	Io
1	Acatenango	Chimaltenango	4.1
232	San Marcos	San Marcos	4.1

Tabla 4.2.2-1 — Nivel de protección sismica y probabilidad del sismo de diseño				
Índice de Sismicidad (b)	Esencial	Importante	Clase de obra (c)	Utilitaria
	E	D	D	C
Io = 4				
Io = 3				
Io = 2	C	B	B	A
Probabilidad de exceder el sismo de diseño (d)	5% en 50 años (d)	5% en 50 años (d)	10% en 50 años	Sismo mínimo (e)

Clasificación del Sitio

Clasificación del tipo de suelo

Tabla A-1 AGIES NSE 2-1

D Suelo Firme

Sismo para Diseño Estructural

Sismo Ordinario Según AGIES NSE 2-2018 Tabla 4.4.2

10% de probabilidad de ser excedido en 50 años

Tabla 4.5.5-1 — Factores K_d de acuerdo al nivel de sismo

Nivel de sismo	Factor K _d
Sismo ordinario — 10% probabilidad de ser excedido en 50 años	0.66
Sismo severo — 5% probabilidad de ser excedido en 50 años	0.80
Sismo extremo — 2% probabilidad de ser excedido en 50 años	1.00
Sismo mínimo — condición de excepción	0.55

Parámetros para Diseño

Amenaza sismica para San Marcos

Tabla A-1 NSE2-18

Scr:	1.61
S1r:	0.85

TI:	3.45
Fa:	1
Fv:	1

Coeficiente de Sitio	Tabla 4.5-1	NSE 2-18
Coeficiente de Sitio	Tabla 4.5-2	NSE 2-18

No	Municipio	Departamento	Scr	S1r	TL
			D		
1	Acatenango	Chimaltenango	1.61	0.84	3.27
232	San Marcos	San Marcos	1.61	0.85	3.45

Ajuste por clase de Sitio

Scs: 1.61 Ecuacion 4.5.2-1

S1s: 0.85 Ecuacion 4.5.2-2

Ajuste por Intensidad Sismica Especial

Na: 1

Nv: 1

Scs: 1.61

S1s: 0.85

Periodo de Vibracion de Transicion

Ts: 0.527950311 Ecuacion 4.5.4-1

To: 0.105590062 Ecuacion 4.5.4-2
Inicio de la meseta de periodo corto del espectro

Probabilidad Nominal de Ocurrencia del sismo de diseño

kd: 0.66 Tabla 4.5.5-1 NSE 2-18

Scd: 1.0626

S1d: 0.561

Periodo Fundamental

Según AGIES NSE 3-18 Secc 2.1.6

Ta: 0.343182141

Kt: 0.049
 hn: 13.4 m 1.4+12
 x: 0.75 Cimiento + nivel SE AUMENTA EN BASE A LOS NIVELES QUE SE

- (1) $K_T = 0.049, x = 0.75$ para sistemas estructurales E2, E3, E4 o E5;
 (2) $K_T = 0.047, x = 0.90$ solamente para sistemas estructurales E1, de concreto reforzado que sean abiertos o con fachadas de vidrio o paneles livianos y pocas particiones rígidas;

Espectros Genericos Probables

4.5.6 NSE 2-18

Sa(T):	2.49719718 No cumple	T<To	0.34318214 <	0.10559006	
Sa(T):	1.0626 Si Cumple	To<T<Ts	0.10559006 <	0.34318214 <	0.52795031
Sa(T)	1.63470045 No cumple	Ts<T<Tl	0.52795031 <	0.34318214 <	3.45
Sa(T)	16.4335957 No Cumple	T≥Tl	0.34318214 ≥		3.45

4.5.6 Espectros genéricos probables — Cuando se puedan utilizar los espectros de diseño genéricos, las ordenadas espetrales $S_a(T)$ para cualquier período de vibración T , se definen con las siguientes expresiones

$$S_a(T) = S_{cd} \quad \text{cuando } T_0 \leq T \leq T_s \quad (4.5.6-1)$$

$$S_a(T) = \frac{S_{1d}}{T} \leq S_{cd} \quad \text{cuando } T > T_s \quad (4.5.6-2)$$

$$S_a(T) = S_{cd} \left[0.4 + 0.6 \frac{T}{T_0} \right] \quad \text{cuando } T < T_0 \quad (4.5.6-3)$$

Aceleracion Maxima del Suelo AMS

AMSD: 0.42504

Tipologia Estructural

AGIES NSE 3-18 Secc 1.6

Sistema Estructural E2 MAMPOSTERIA

R 4
 QR 2.5
 Cd 3.5

Cs: 0.30 o 0.35 2 o 3 niveles

Mamposteria reforzada ductilidad alta

Cs 0.26565
 Coeficiente Sismico

Para 4 nivel.

Para mas niveles cambiar hn

V=Cs*W

SISTEMA ESTRUCTURAL Sección 1.6 [a]		Norma	R	Ω_R	Cd	Límite de altura en metros				notas
						Nivel de protección				
		B	C	D	E					
E2	SISTEMA DE MUROS	Sección 1.6.3								
	De concreto reforzado DA	NSE 7.1	6	2.5	5	SL	SL	SL	SL	[b]
	De concreto reforzado DB	NSE 7.9	4	2.5	4	[d]	[d]	[d]	[d]	[c]
	De mampostería reforzada DA	NSE 7.4	4	2.5	3.5	[f]	[f]	[f]	[f]	[e]
	De mampostería reforzada DB	N/A	3	2.5	2	[h]	[h]	[h]	[h]	[h]

No	Municipio	Departamento
1	Acatenango	Chimaltenango
232	San Marcos	San Marcos

Tabla 4.5-1 — Coeficientes de sitio F_a

Clase de sitio	Índice de sismicidad				4.1	4.2	4.3
	2.1	2.2	3.1	3.2			
AB	1.0	1.0	1.0	1.0		1.0	
C [1]	1.3	1.2	1.2	1.2		1.2	
D	1.4	1.2	1.1	1.0		1.0	
E	1.7	1.3	1.1	1.0		0.9	
F	Se requiere evaluación específica - ver Sección 4.4						

[1] En los casos en que la investigación de suelos abreviada no especifique si un suelo firme clasifica como C o como D, el factor F_a se tomará del suelo C.

	0.527950311
:	3.45

mento	Io	Scr	S1r	TL	Scr	S1r	TL	Scr	S1
		A			B			C	
go	4.1	1.48	0.47	2.57	1.48	0.52	2.57	1.61	0.61
	4.1	1.48	0.47	2.57	1.48	0.52	2.57	1.61	0.61

7.1 1.70 0.77 2.57 1.70 0.52 2.57 1.01 0.1

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■

■

■

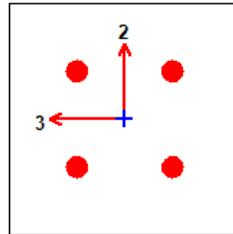
1r	TL	Scr	S1r	TL	Scr	S1r	TL	V viento
C		D			E			
68	2.67	1.61	0.84	3.27	1.40	1.39	3.88	100
68	2.67	1.61	0.85	3.45	1.44	1.39	3.88	100

2.07 1.04 0.89 0.79 1.11 1.05 0.88 100

**DATOS
GENERADOS
POR
SOFTWARE
ETABS**

ETABS Concrete Frame Design

ACI 318-19 Column Section Design (Summary)



Column Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (cm)	LLRF	Type
Story3	C41	143	Mocheta	DConS7	0	300	1	Sway Special

Section Properties

b (cm)	h (cm)	dc (cm)	Cover (Torsion) (cm)
14	14	4.091	1.23

Material Properties

E _c (kgf/cm ²)	f' _c (kgf/cm ²)	Lt.Wt Factor (Unitless)	f _y (kgf/cm ²)	f _{ys} (kgf/cm ²)
253456.35	281.23	1	2812.28	2812.28

Design Code Parameters

φ _T	φ _{CTied}	φ _{cspiral}	φ _{Vns}	φ _{Vs}	φ _{Vjoint}	Ω ₀
0.9	0.65	0.75	0.75	0.6	0.85	2

Axial Force and Biaxial Moment Design for P_u, M_{u2}, M_{u3}

Design P _u kgf	Design M _{u2} kgf-cm	Design M _{u3} kgf-cm	Minimum M2 kgf-cm	Minimum M3 kgf-cm	Rebar Area cm ²	Rebar % %
890.38	557.8	62546.7	1730.89	1730.89	5.22	2.66

Axial Force and Biaxial Moment Factors

	C _m Factor Unitless	δ _{ns} Factor Unitless	δ _s Factor Unitless	K Factor Unitless	Length cm
Major Bend(M3)	1	1.01696	1	1	150
Minor Bend(M2)	1	1.061697	1	1	280

Shear Design for V_{u2}, V_{u3} (Part 1 of 2)

	Shear V _u kgf	Modified Shear V _u kgf	Shear φV _c kgf	Shear φV _s kgf	Shear φV _p kgf	Rebar A _v /s cm ² /cm
Major, V _{u2}	483.28	644.37	0	644.37	477.67	0.0273
Minor, V _{u3}	249.16	332.22	0	413.4	238.83	0.0175

Shear Design for V_{u2}, V_{u3} (Part 2 of 2)

$V_u / \varphi V_n$
Unitless

$V_u / \phi V_n$
Unitless
0.75
0.602714

Joint Shear Check/Design

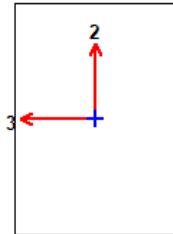
	Joint Shear Force kgf	Shear $V_{u,\text{Top}}$ kgf	Shear $V_{u,\text{Tot}}$ kgf	Shear ϕV_c kgf	Joint Area cm ²	Shear Ratio Unitless
Major Shear, V_{u2}	0	475.29	8137.31	11112.06	196	0.732
Minor Shear, V_{u3}	0	238.83	4067.47	11112.06	196	0.366

(6/5) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
0.975	0.487

ETABS Concrete Frame Design

ACI 318-19 Beam Section Design (Summary)



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (cm)	LLRF	Type
Story1	B90	725	SoleraCorona	DConS10	414	421	1	Sway Special

Section Properties

b (cm)	h (cm)	b _f (cm)	d _s (cm)	d _{ct} (cm)	d _{cb} (cm)
14	20	14	0	2.5	2.5

Material Properties

E _c (kgf/cm ²)	f' (kgf/cm ²)	Lt.Wt Factor (Unitless)	f _y (kgf/cm ²)	f _{ys} (kgf/cm ²)
218819.79	210	1	2812.28	2812.28

Design Code Parameters

φ _T	φ _C Tied	φ _C Spiral	φ _V ns	φ _V s	φ _V joint
0.9	0.65	0.75	0.75	0.6	0.85

Design Moment and Flexural Reinforcement for Moment, M_{u3}

	Design Moment kgf-cm	Design P _u kgf	-Moment Rebar cm ²	+Moment Rebar cm ²	Minimum Rebar cm ²	Required Rebar cm ²
Top (+2 Axis)	-2923.19	0	0.07	0	1.23	1.23
Bottom (-2 Axis)	1461.6	0	0	0.03	1.23	1.23

Shear Force and Reinforcement for Shear, V_{u2}

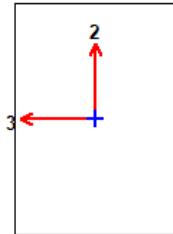
Shear V _{u2} kgf	Shear φV _c kgf	Shear φV _s kgf	Shear V _p kgf	Rebar A _v /s cm ² /cm
459.97	0	459.97	352.09	0.0125

Torsion Force and Torsion Reinforcement for Torsion, T_u

T _u kgf-cm	T _{u,Design} kgf-cm	φT _{th} kgf-cm	φT _{cr} kgf-cm	Rebar A _t /s cm ² /cm	Rebar A _I cm ²
28.17	28.17	3345.12	13380.49	0	0

ETABS Concrete Frame Design

ACI 318-19 Beam Section Design (Summary)



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (cm)	LLRF	Type
Story5	B129	871	SoleralIntermedia	DConS10	100	100	1	Sway Special

Section Properties

b (cm)	h (cm)	b _f (cm)	d _s (cm)	d _{ct} (cm)	d _{cb} (cm)
14	20	14	0	2.5	2.5

Material Properties

E _c (kgf/cm ²)	f' (kgf/cm ²)	Lt.Wt Factor (Unitless)	f _y (kgf/cm ²)	f _{ys} (kgf/cm ²)
218819.79	210	1	2812.28	2812.28

Design Code Parameters

φ _T	φ _C Tied	φ _C Spiral	φ _V ns	φ _V s	φ _V joint
0.9	0.65	0.75	0.75	0.6	0.85

Design Moment and Flexural Reinforcement for Moment, M_{u3}

	Design Moment kgf-cm	Design P _u kgf	-Moment Rebar cm ²	+Moment Rebar cm ²	Minimum Rebar cm ²	Required Rebar cm ²
Top (+2 Axis)	0	893.62	0	0	0	0
Bottom (-2 Axis)	5755.35	0	0	0.13	1.23	1.23

Shear Force and Reinforcement for Shear, V_{u2}

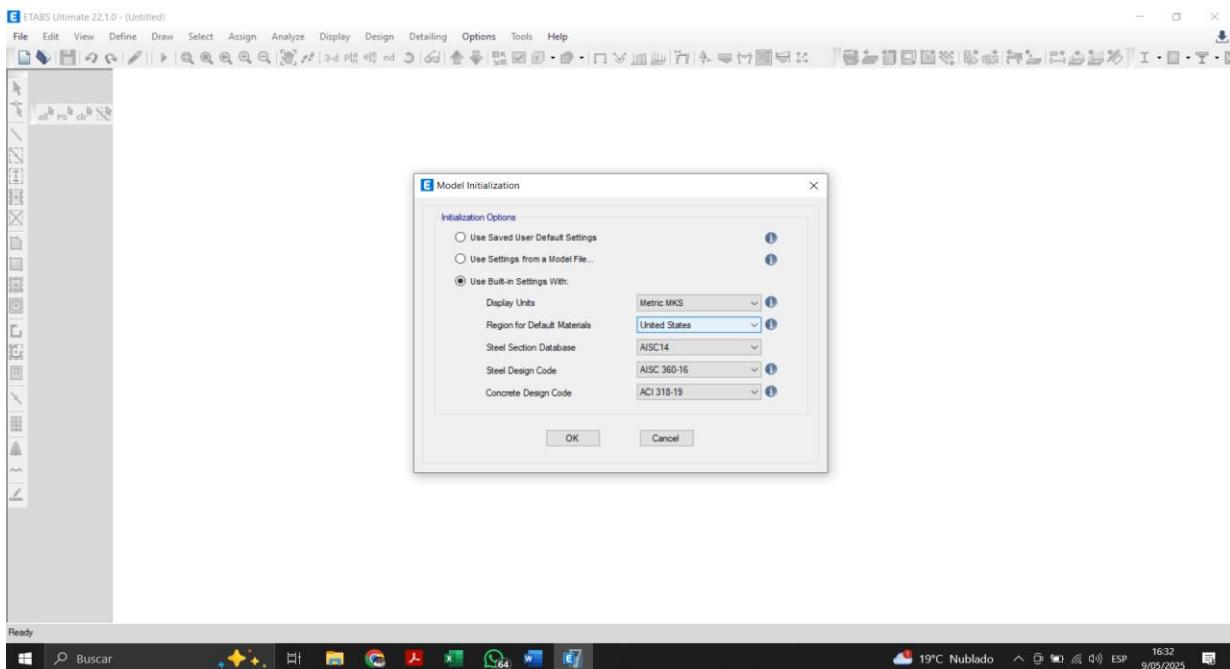
Shear V _{u2} kgf	Shear φV _c kgf	Shear φV _s kgf	Shear V _p kgf	Rebar A _v /s cm ² /cm
1438.05	0	1438.05	1433	0.039

Torsion Force and Torsion Reinforcement for Torsion, T_u

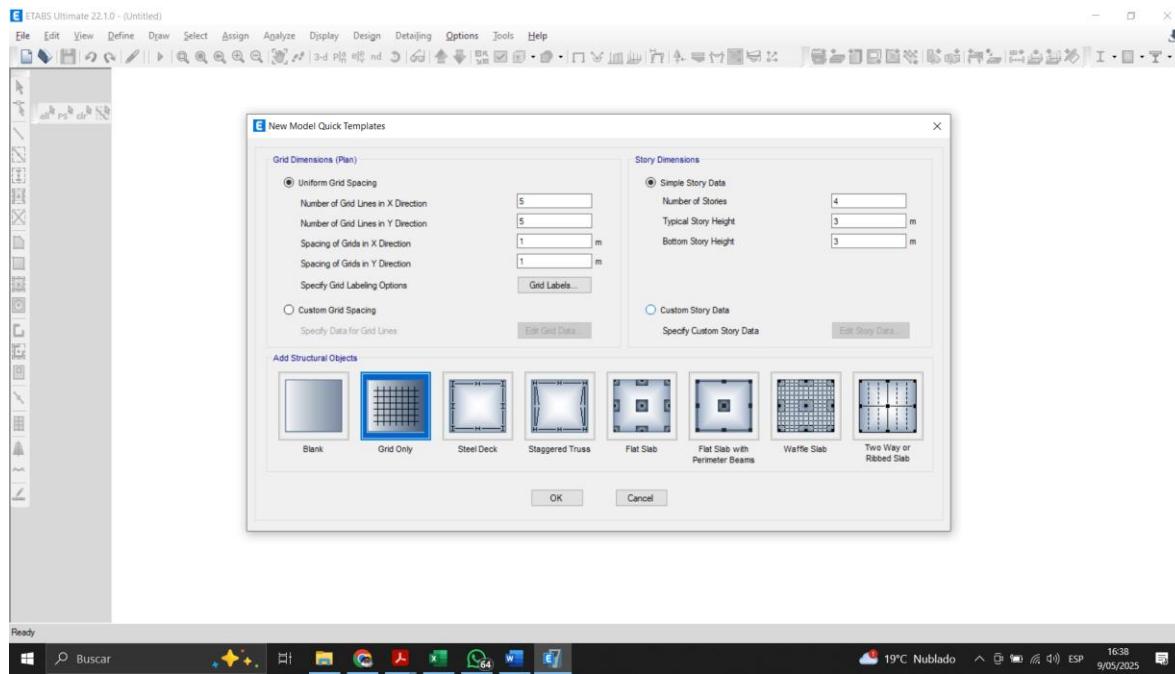
T _u kgf-cm	T _{u,Design} kgf-cm	φT _{th} kgf-cm	φT _{cr} kgf-cm	Rebar A _t /s cm ² /cm	Rebar A _I cm ²
190.78	190.78	3651.3	14605.19	0	0

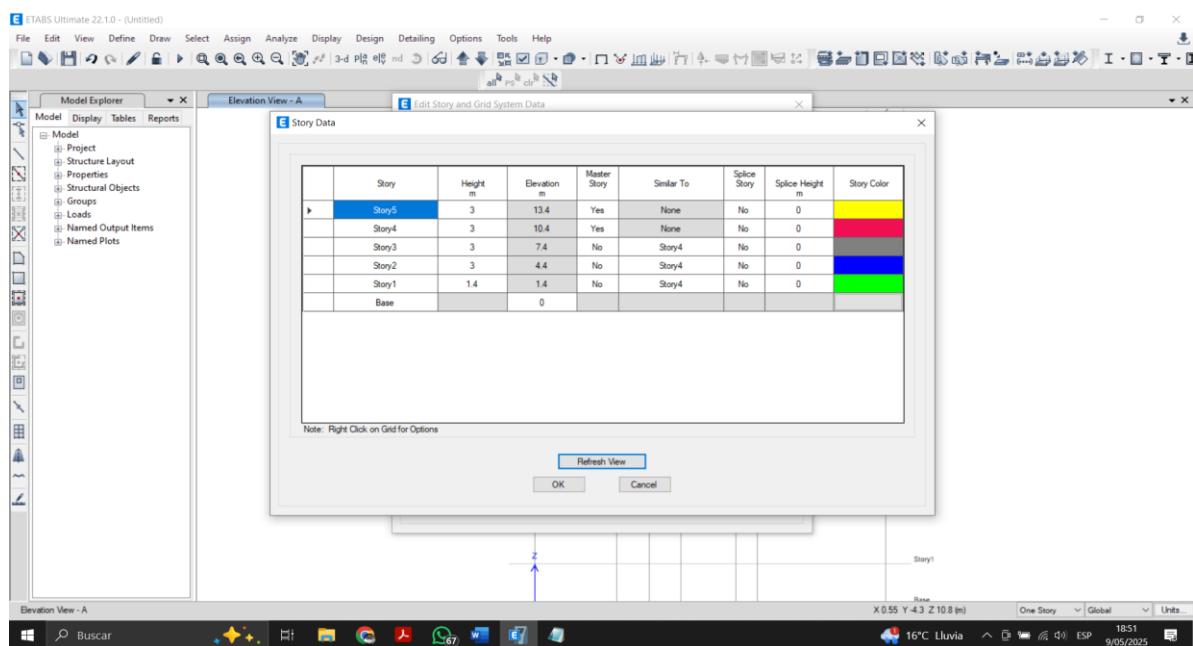
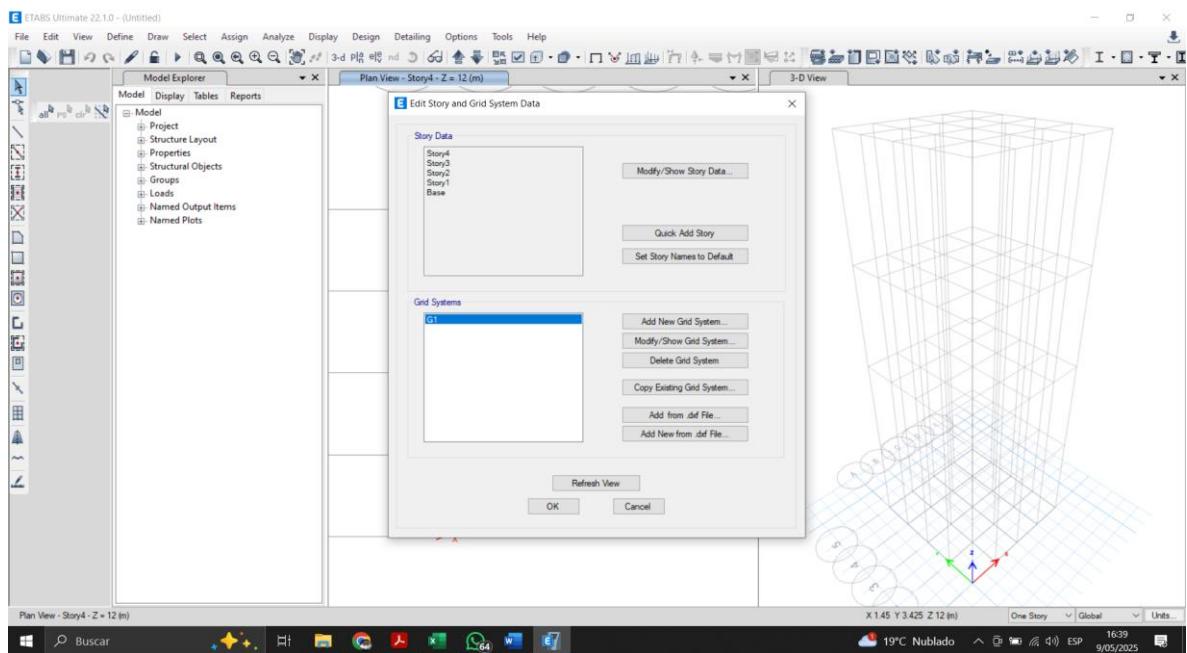
CAPTURAS DE PANTALLA DEL PROCESO

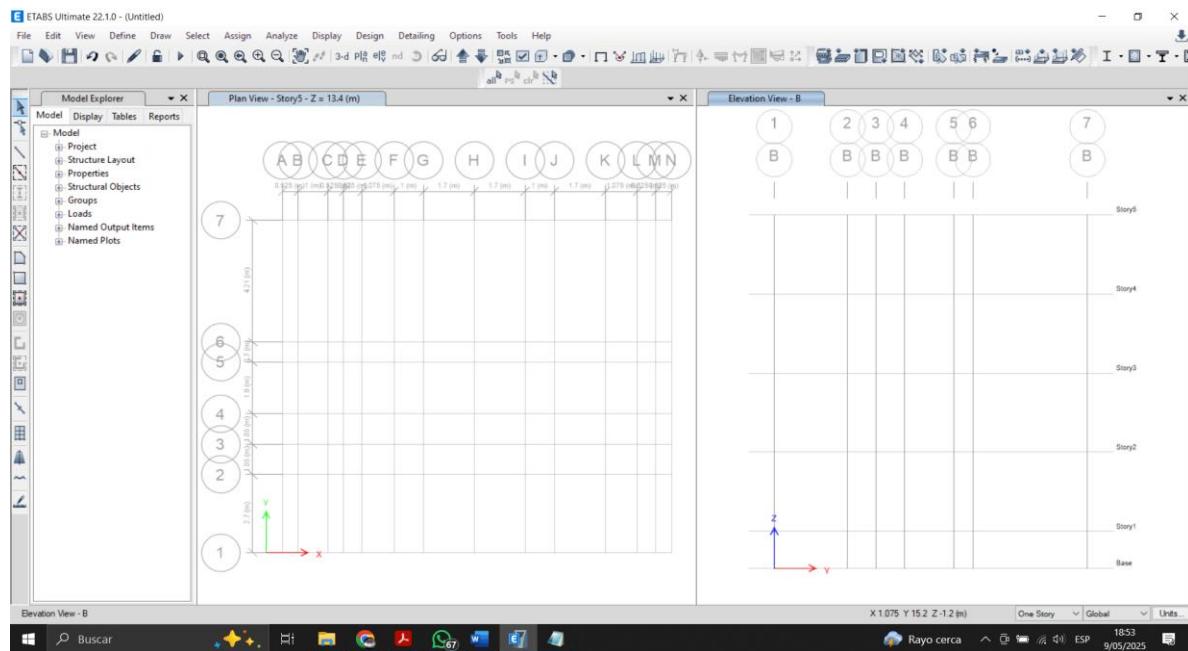
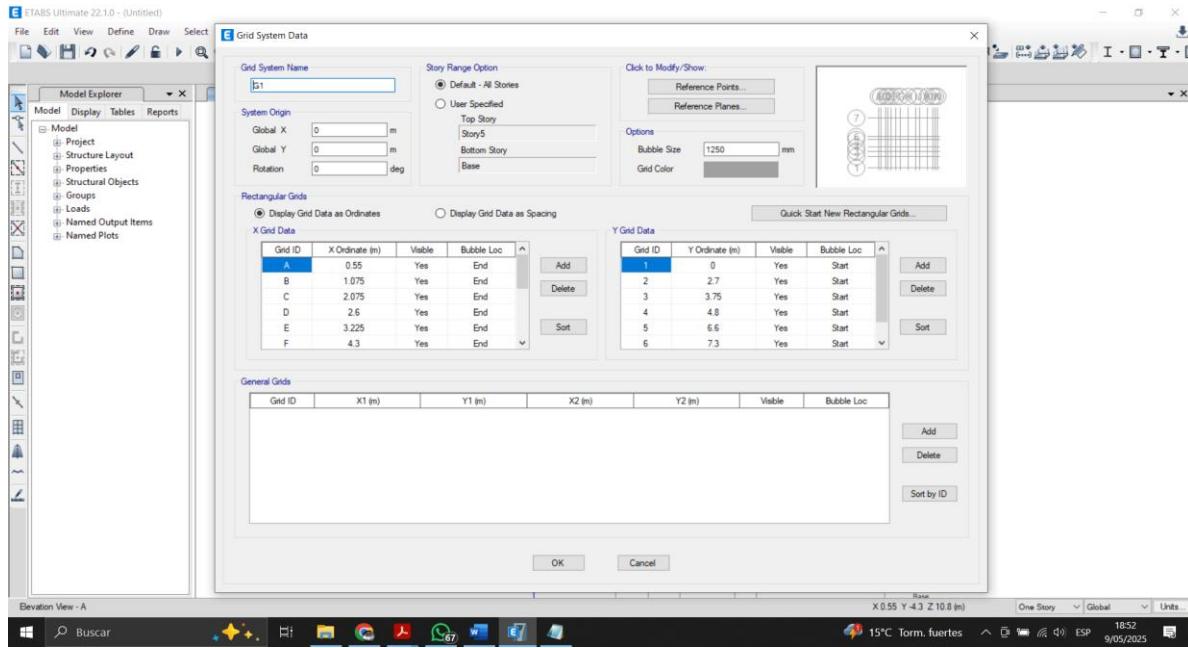
Creando las unidades de medida y datos que contendrá las especificaciones que el software ETABS predeterminara para la creación de la estructura

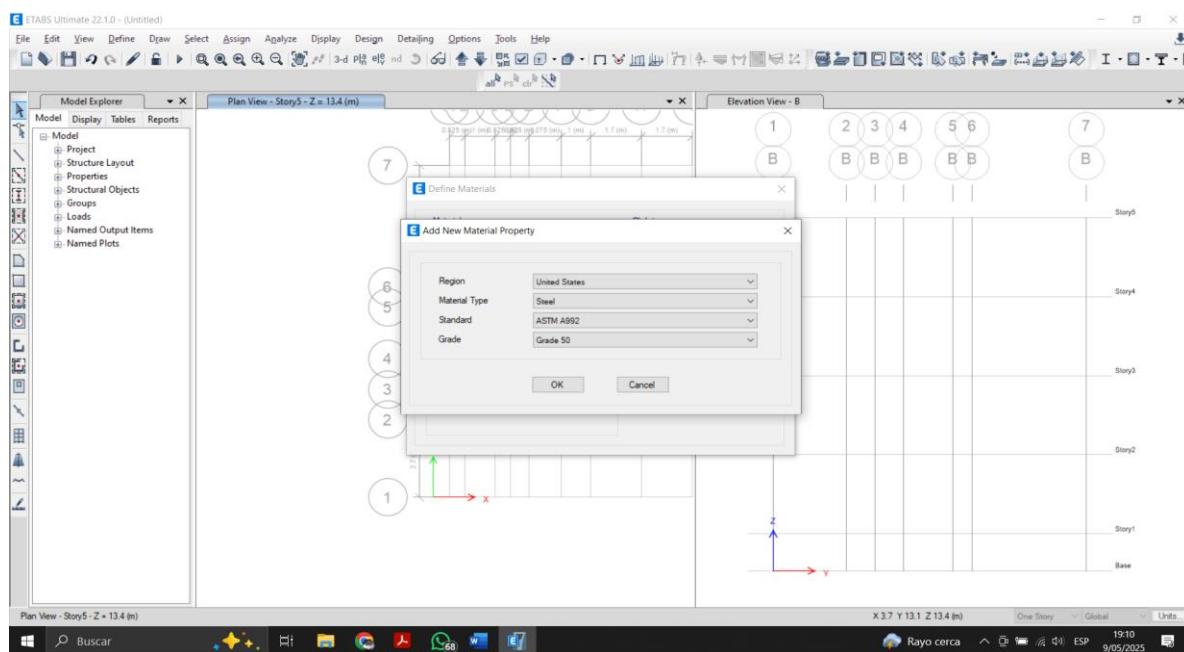
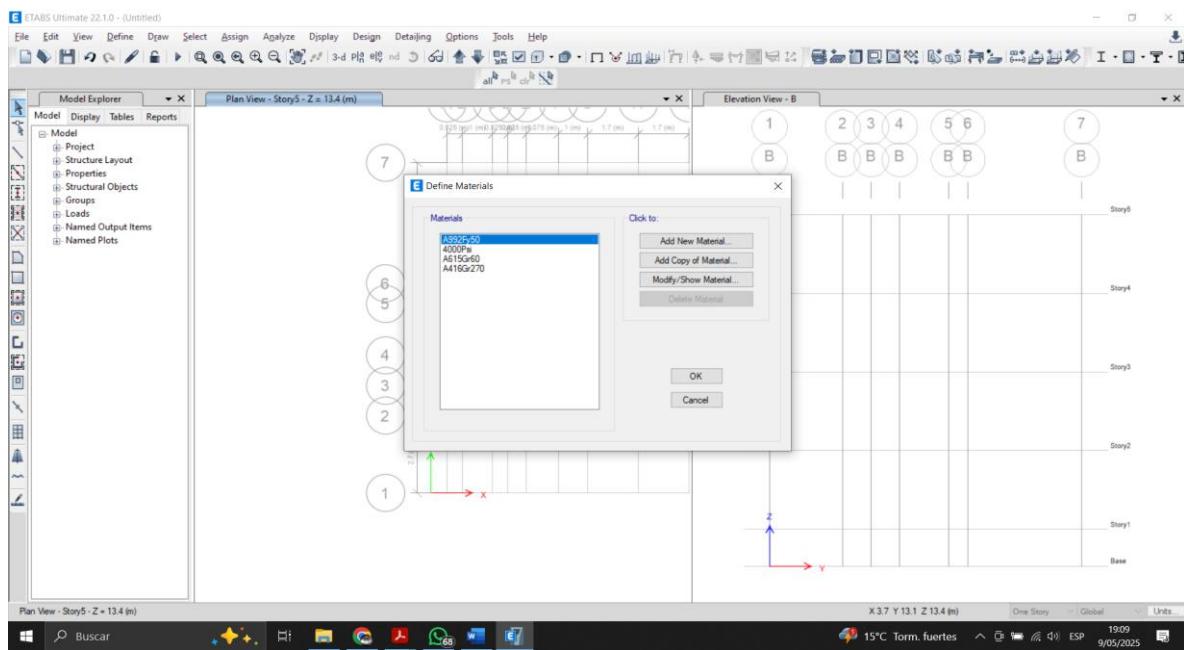


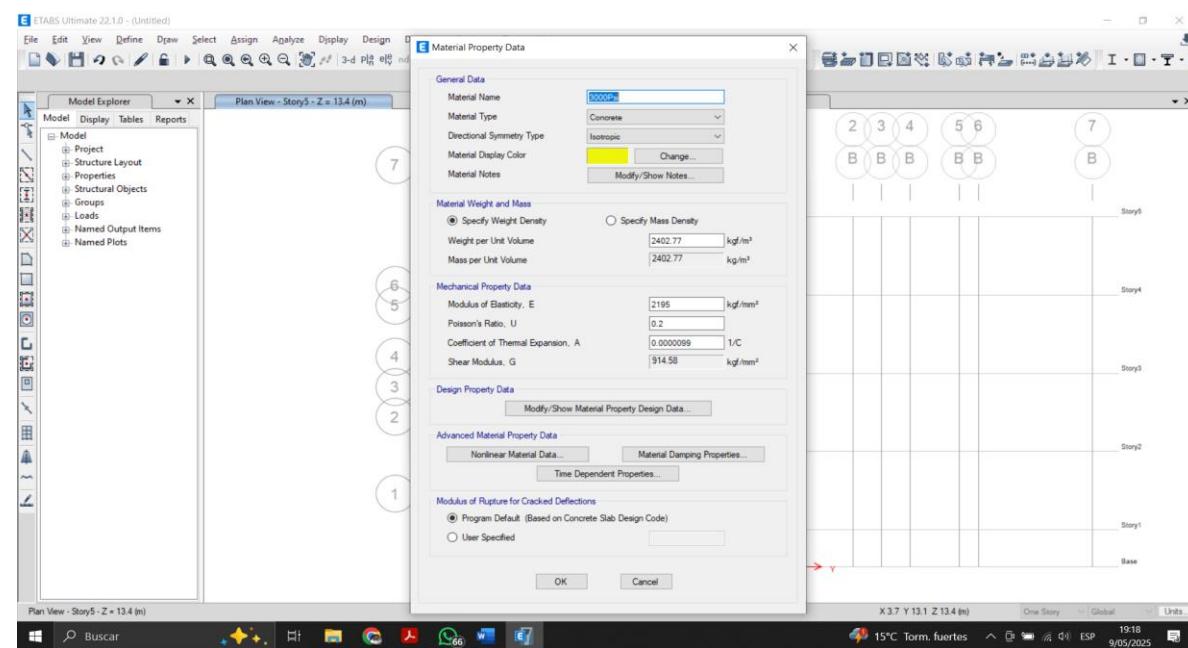
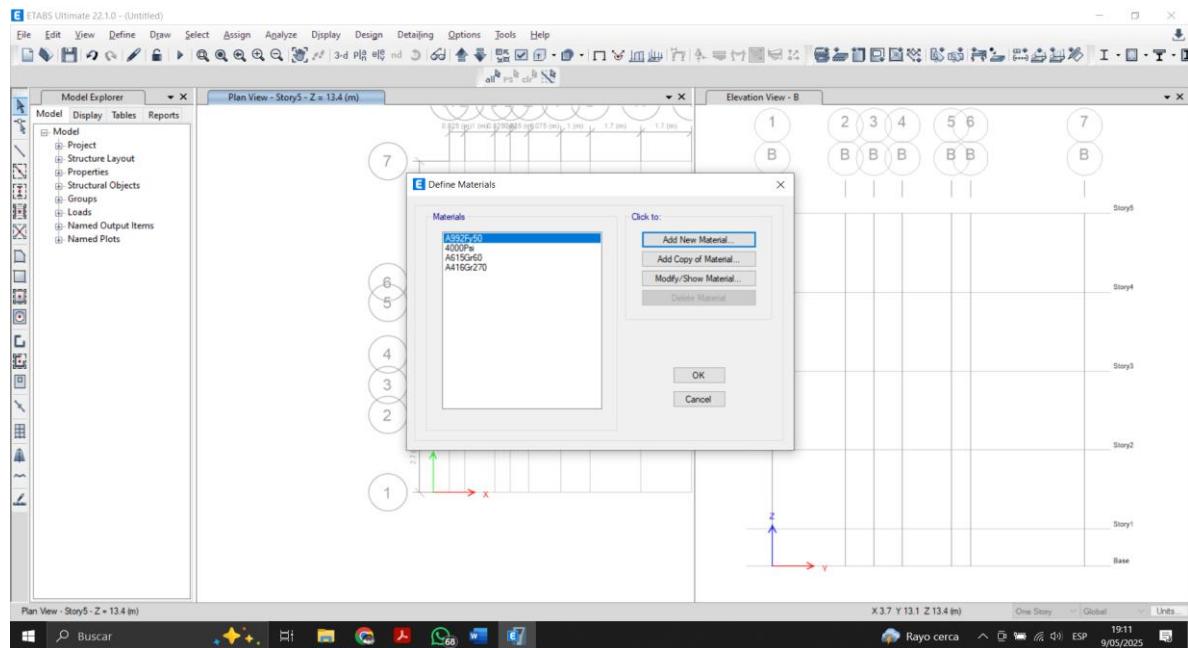
Estableciendo las cantidad de grillas necesarias

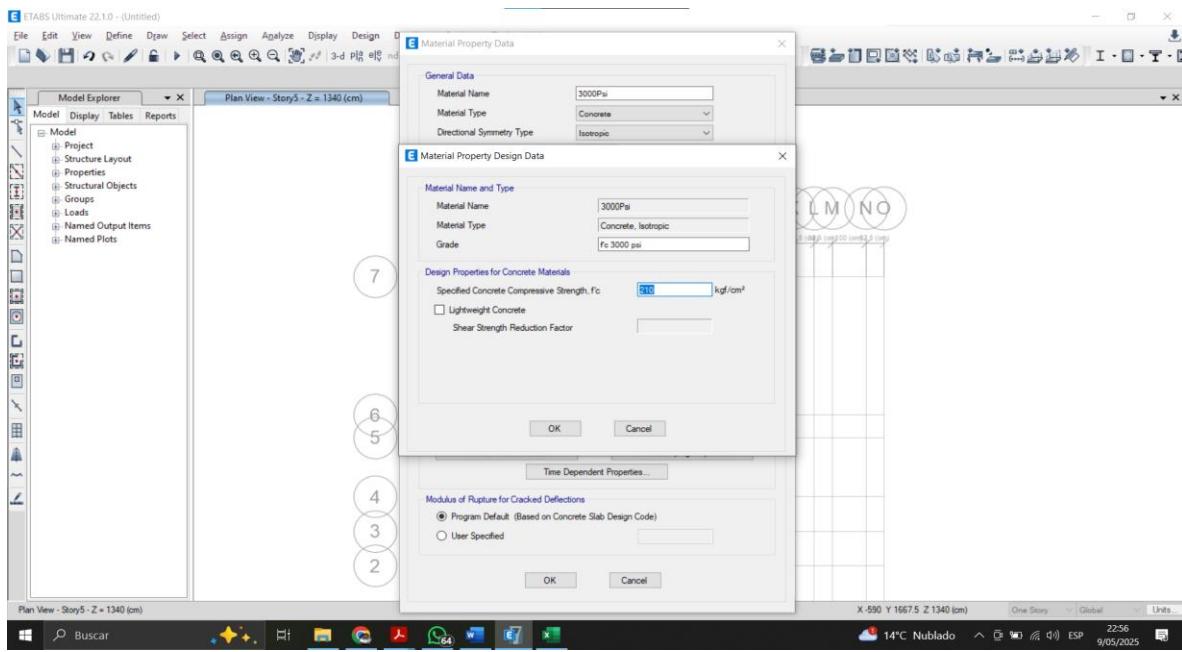




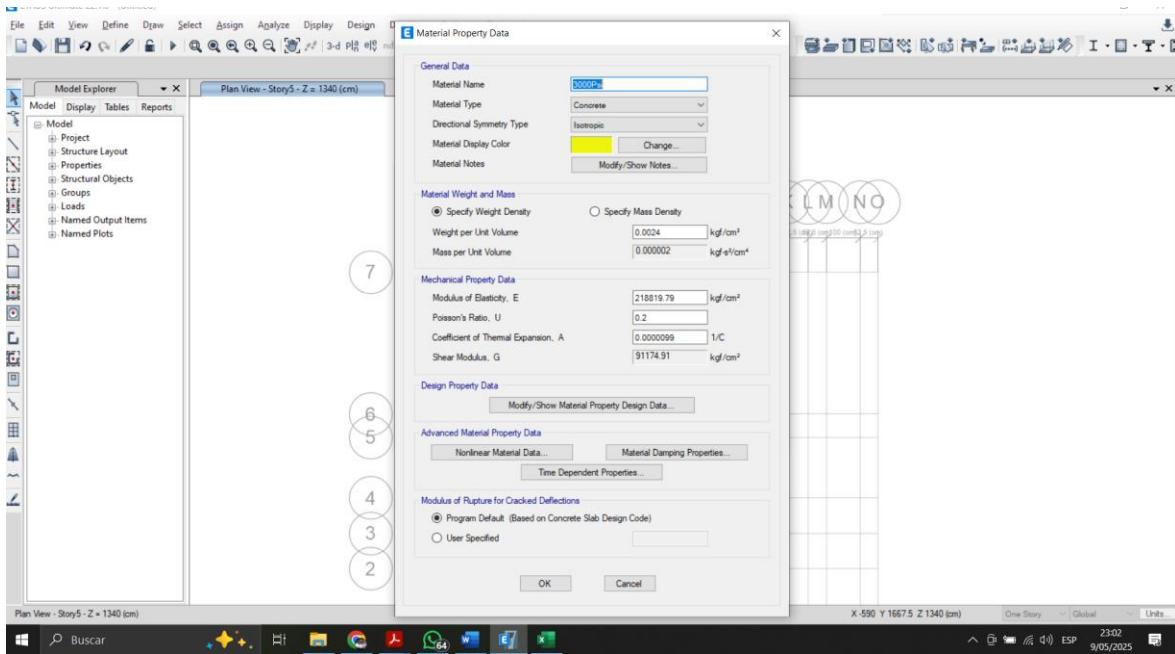




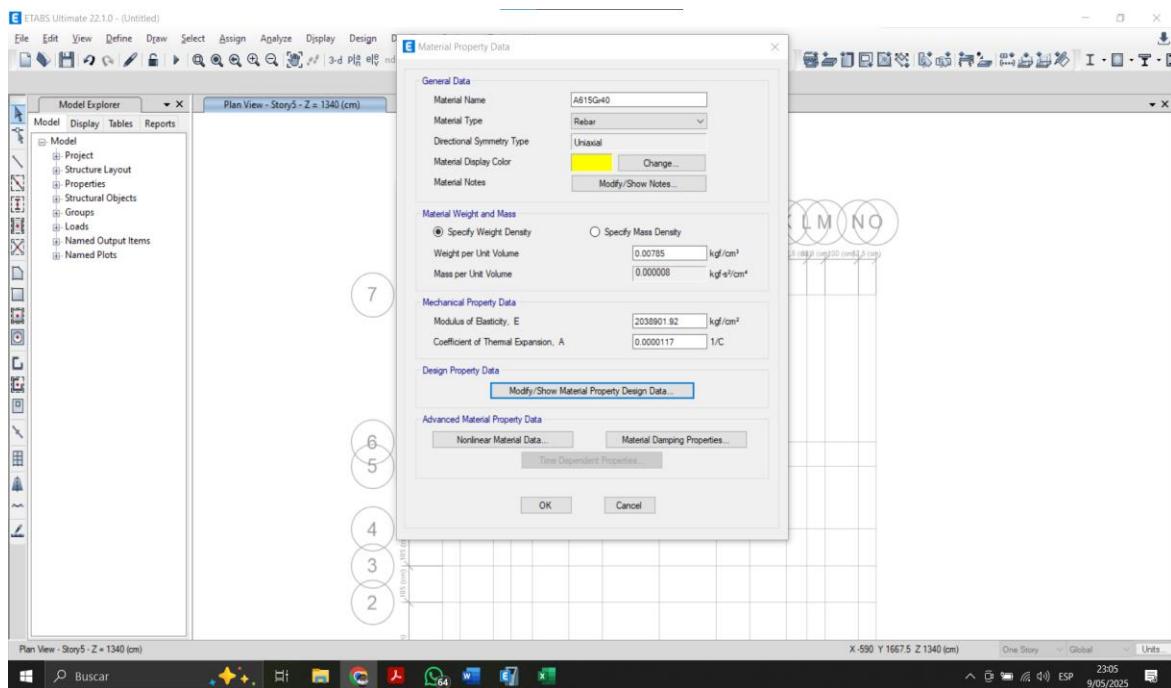
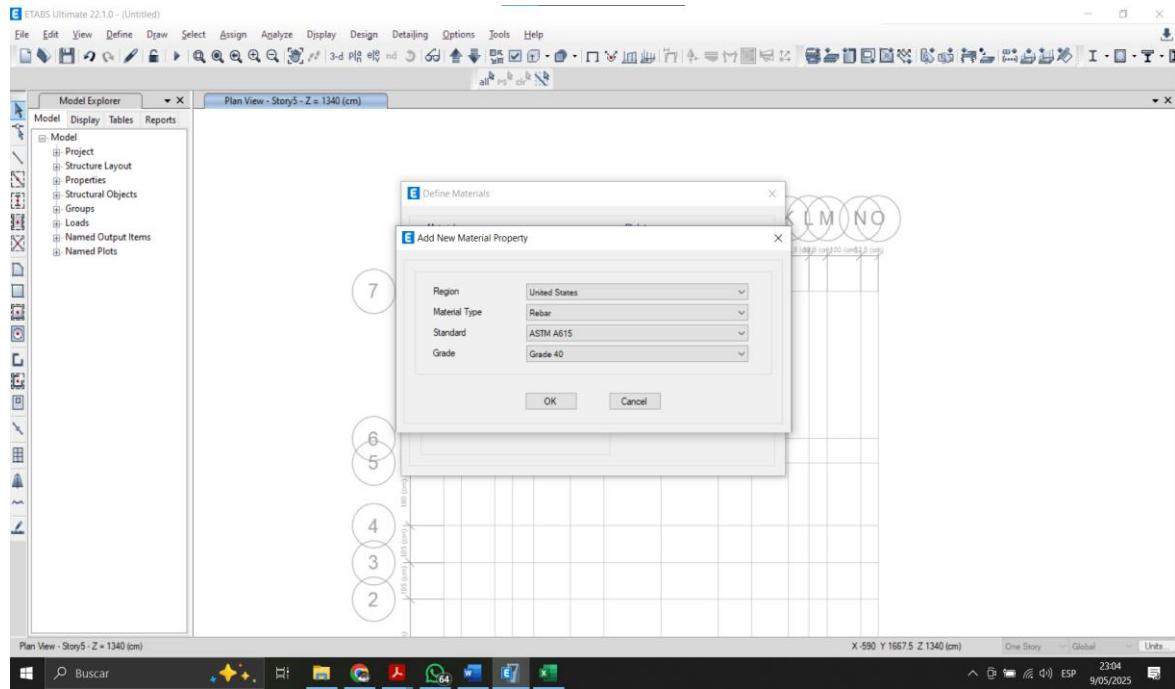




Especificando modulo de elasticidad



AGREGANDO VARILLAS DE ACERO



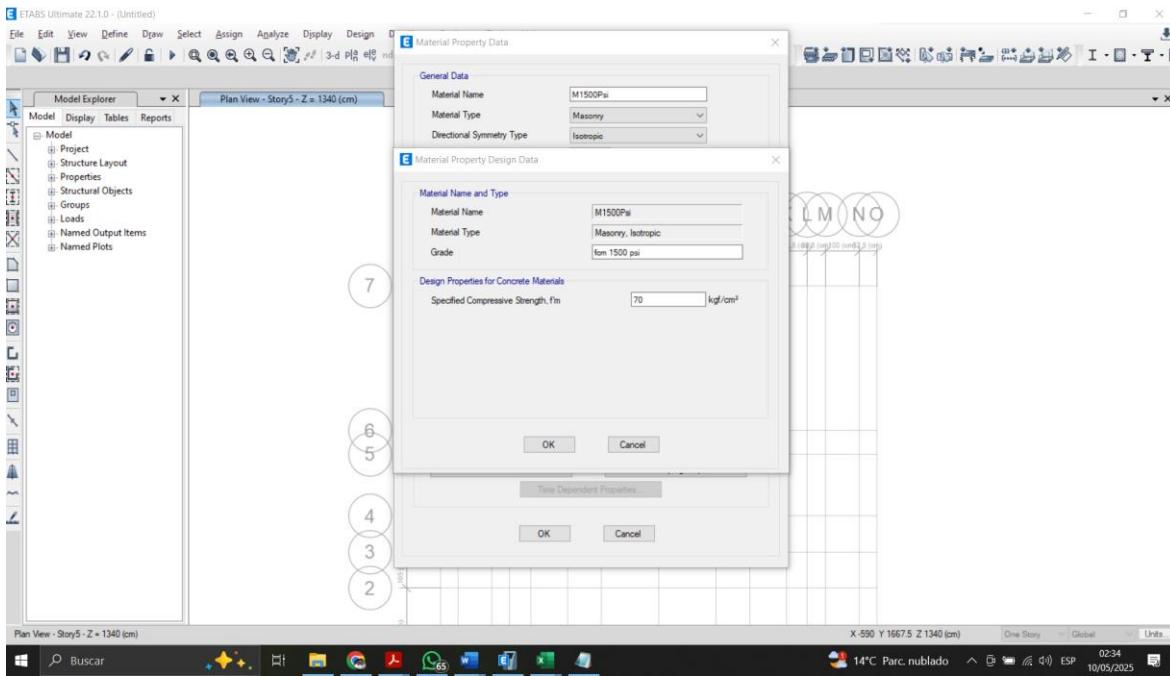
Agregando Mamposteria

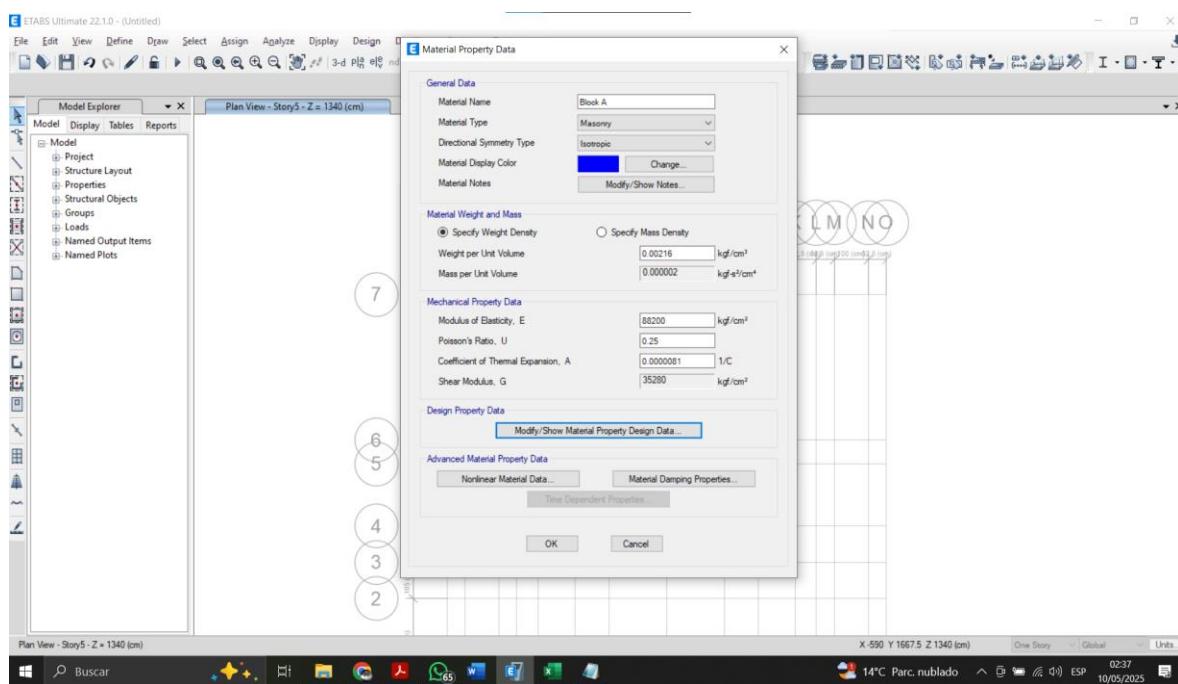
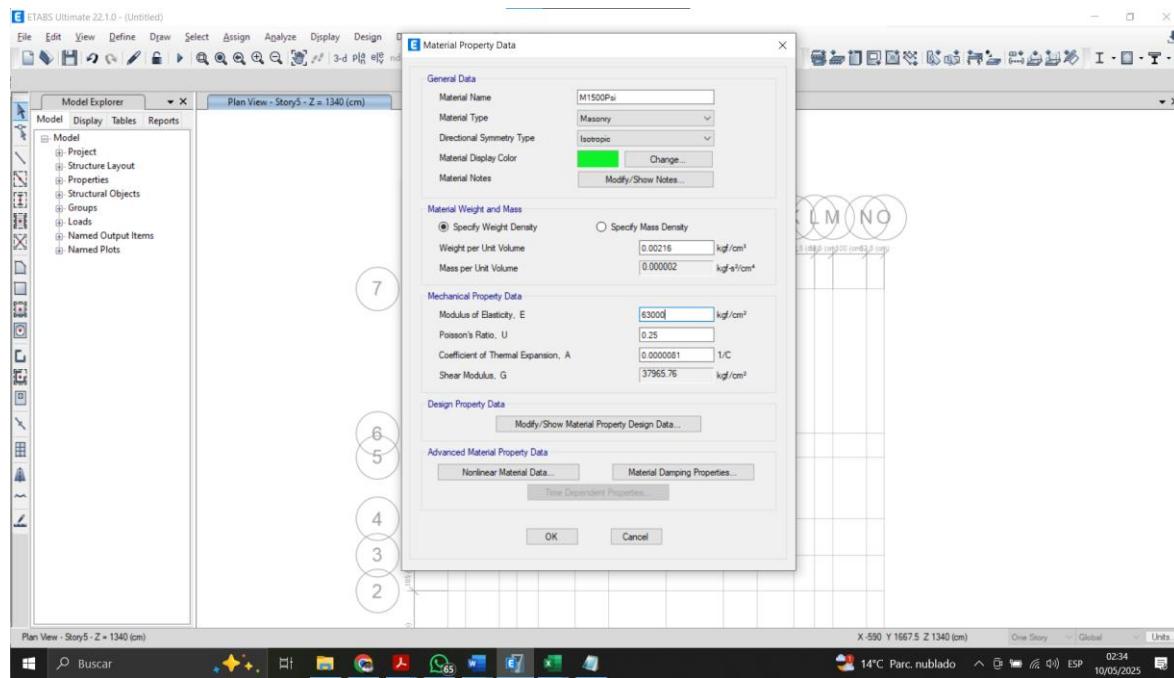
Agregando Resistencia de Cada block

The screenshot shows an Excel spreadsheet titled "Libro2 - Excel". The data is organized into several sections:

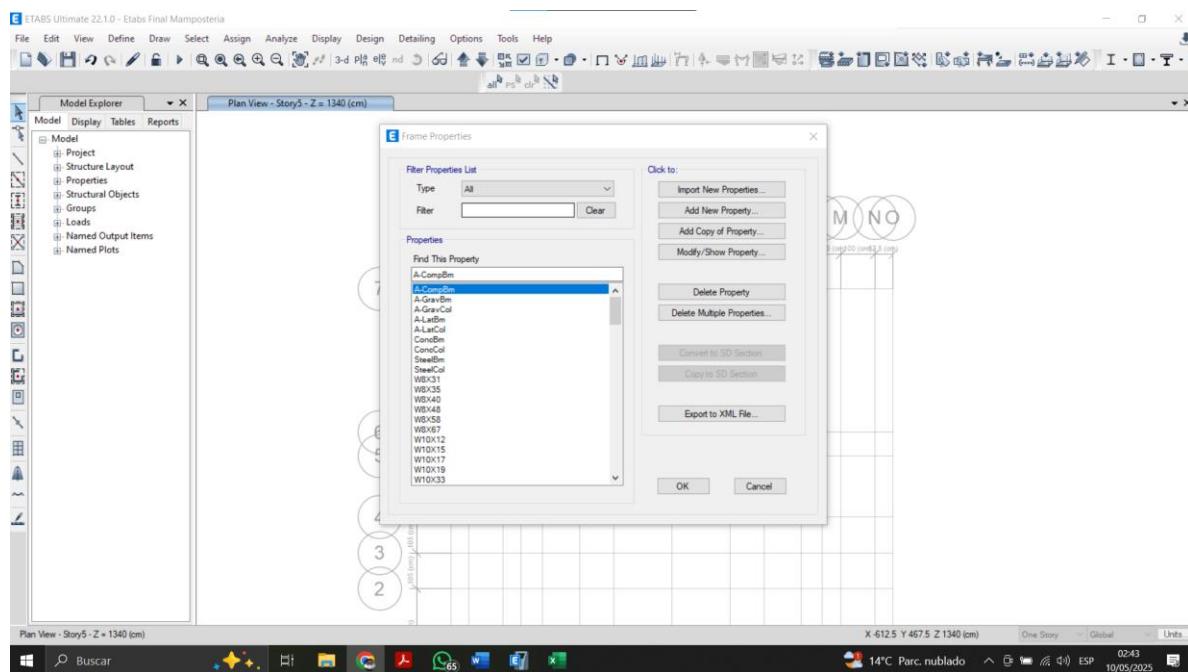
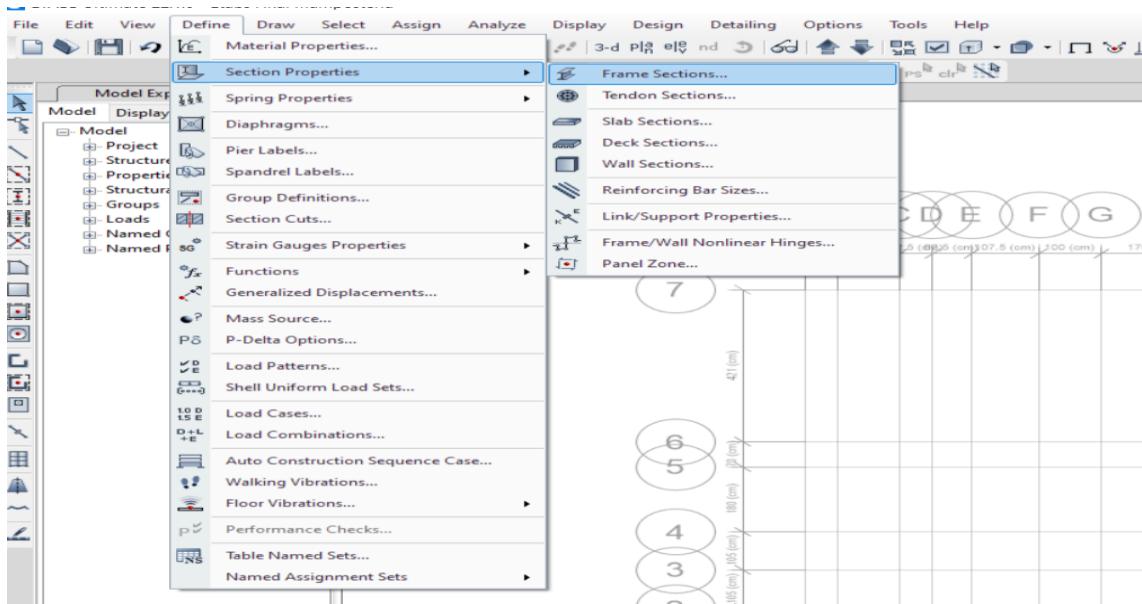
- MODULO DE ELASTICIDAD CONCRETO**:
 - E $f'c$ = 15100/ $f'c$ = 210 kg/cm²
 - E = 218819.789
- MODULO DE ELASTICIDAD MAMPOSTERIA**:
 - $E_m = 900 * f'm$ and $f'm = 0.7 f'ud$
- CLASE BLOCK RESISTENCIA**:

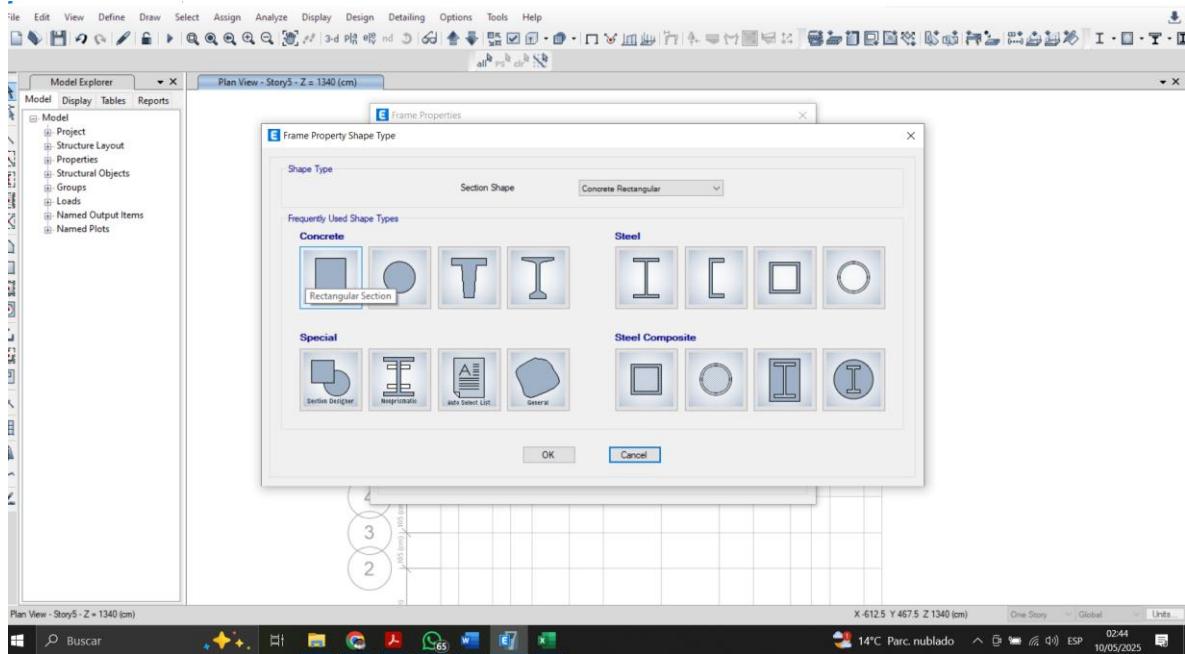
	KG/CM ²	$f'm$ (kg/cm ²)	E_m
A	140	98	88200
B	100	70	63000
C	66	46.2	41580



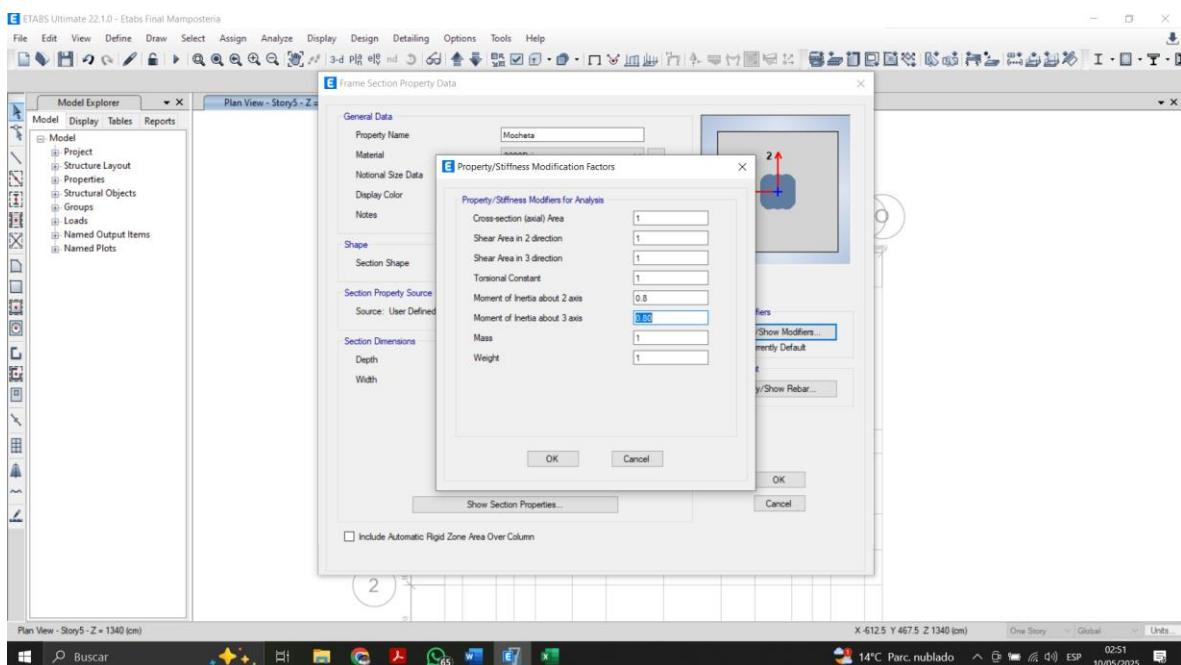


DEFINIR SECCIONES





DEFINIENDO MOMENTO DE INCERICA



Libro2 - Excel

Marlon Ivan Carreto Rivera

C23

CLASE BLOCK RESSTENIA

	fud(kg/cm ²)	f'm(kg/cm ²)	Em(kg/cm ²)
A	140	98	88200
B	100	70	63000
C	66	46.2	41580

REDUCCION

MOMENTO DE INERCIA

VIGAS COLUMNAS

ACI	0.35	0.7
AGIES	0.5	0.8

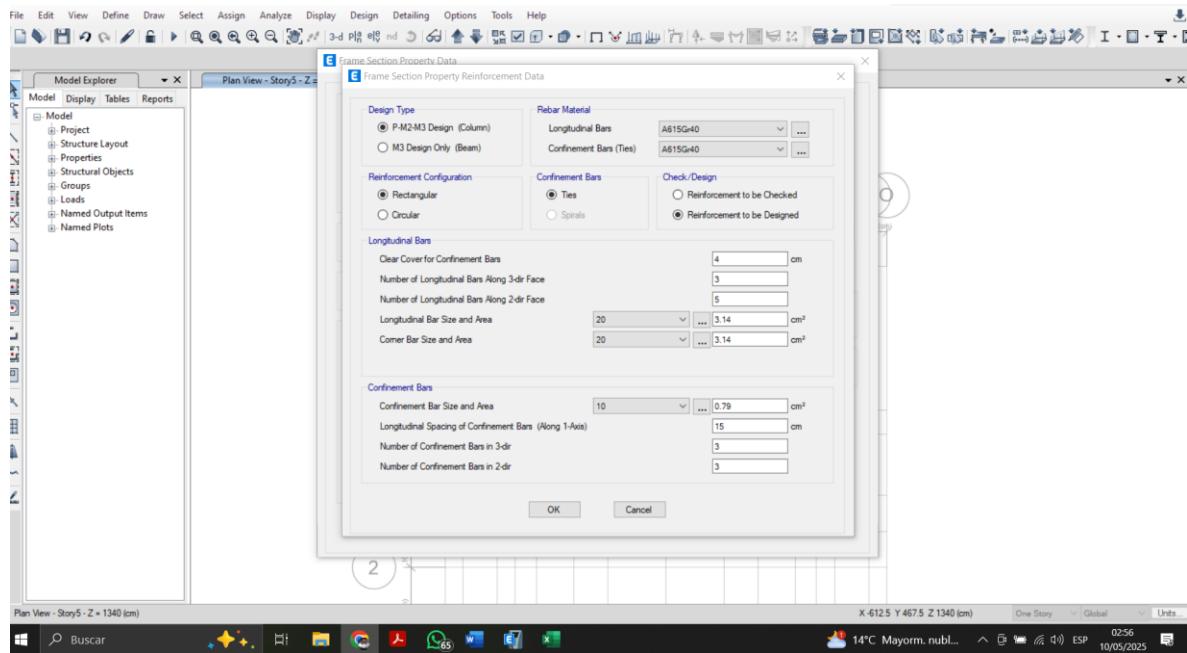
Hoja1

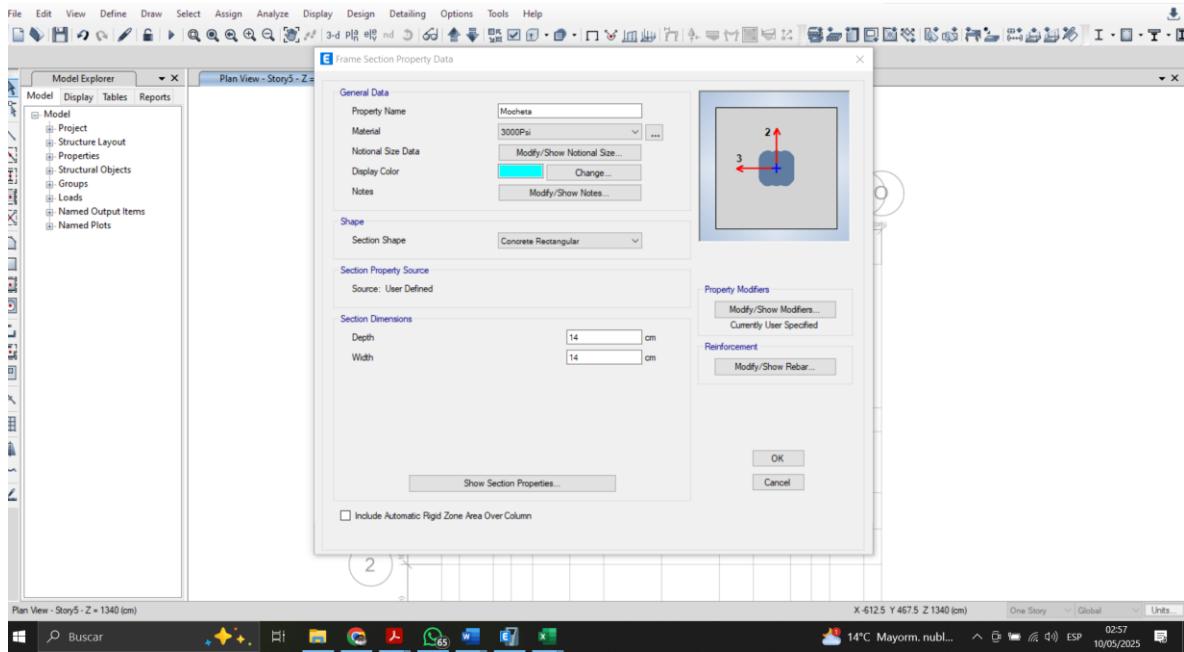
Accesibilidad todo correcto

Configuración de visualización

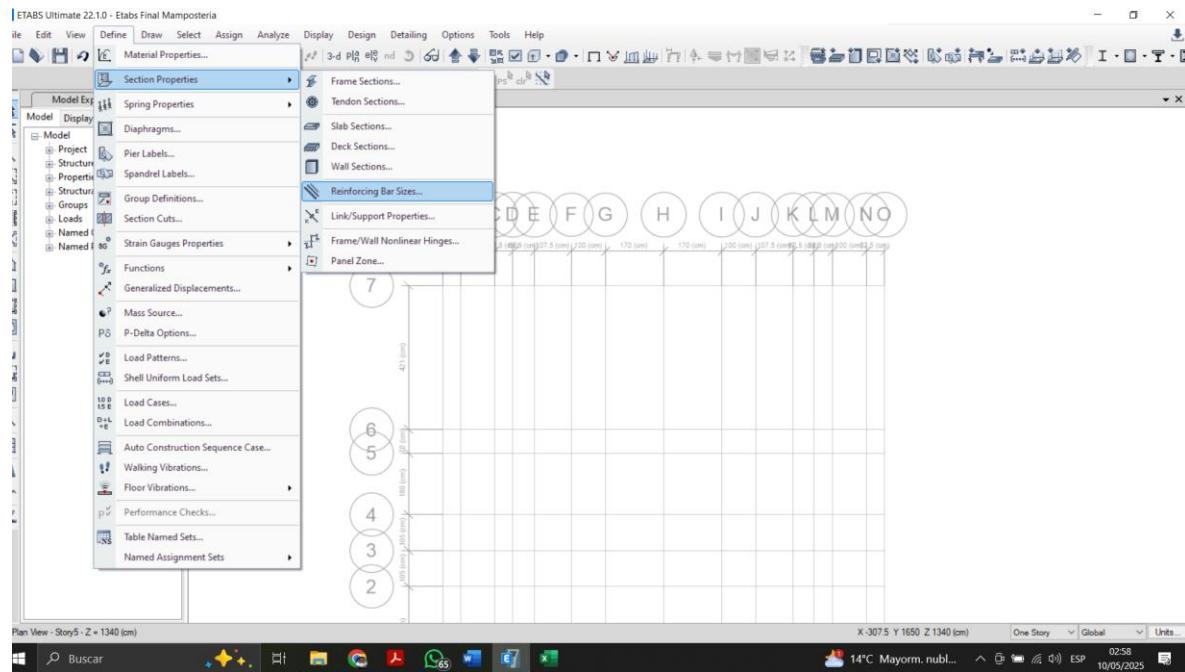
14°C Mayorm. nubl... 02:52 10/05/2025

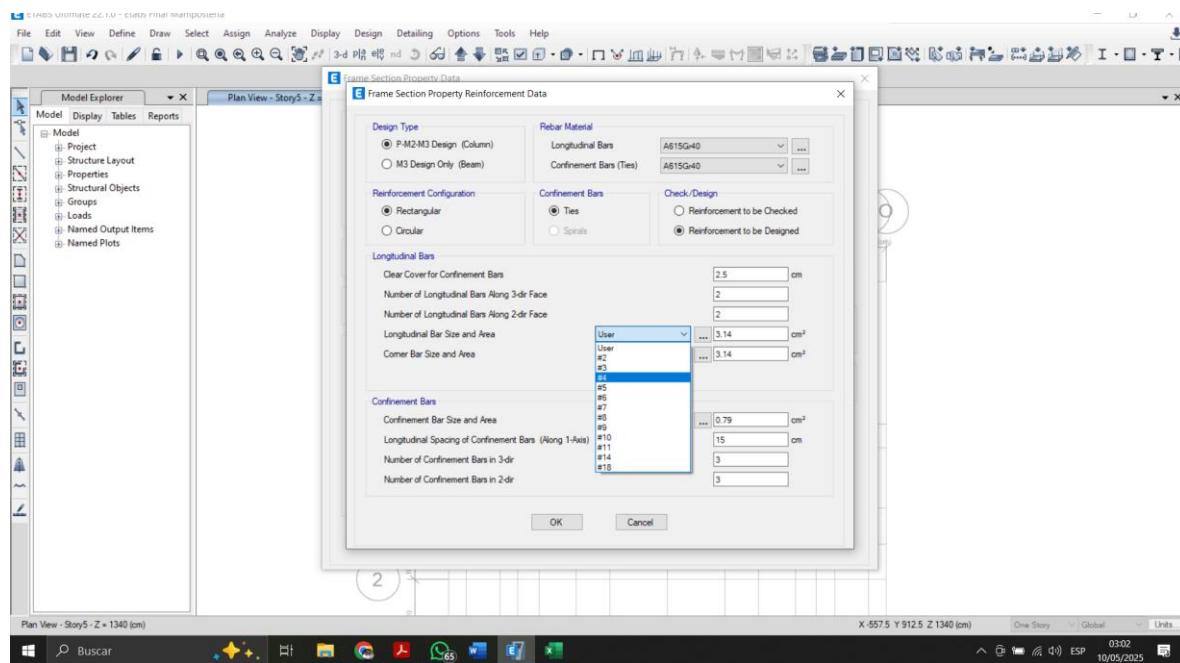
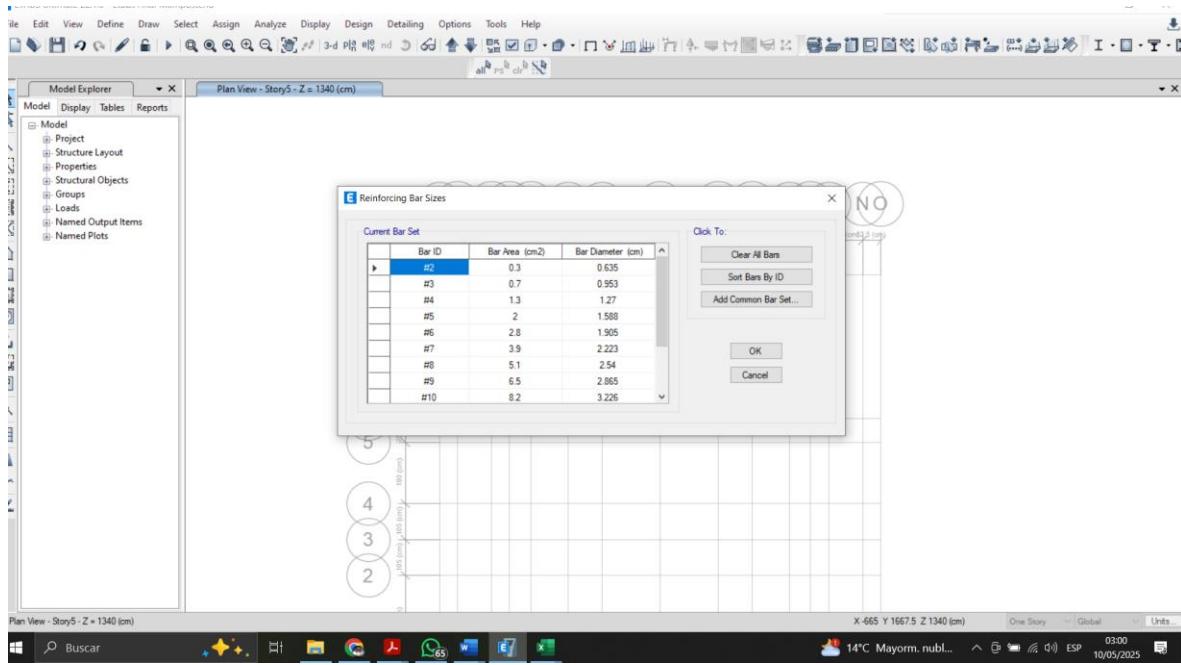
MODIFICANDO REFUERZO

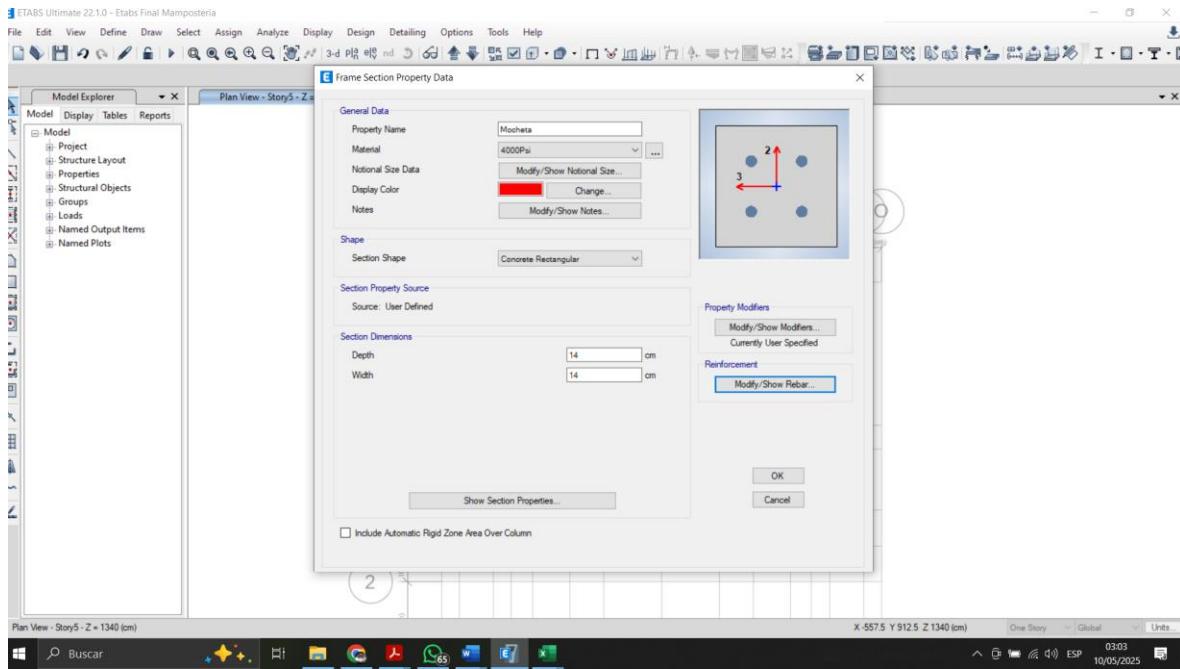




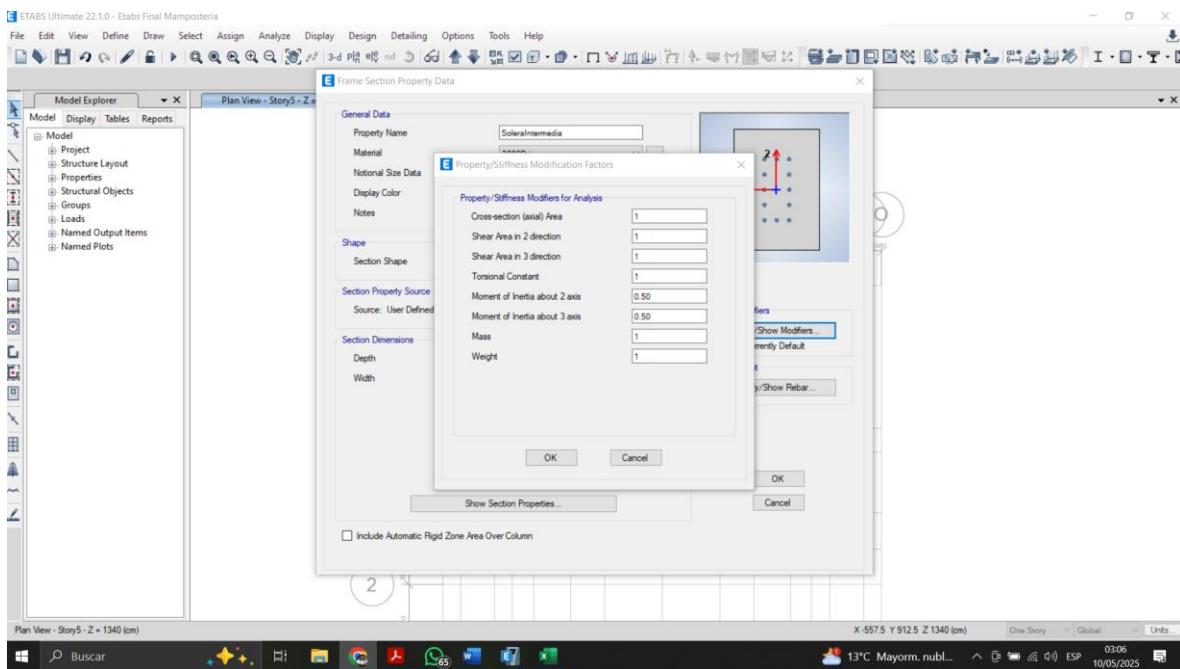
MODIFICANDO ACEROS

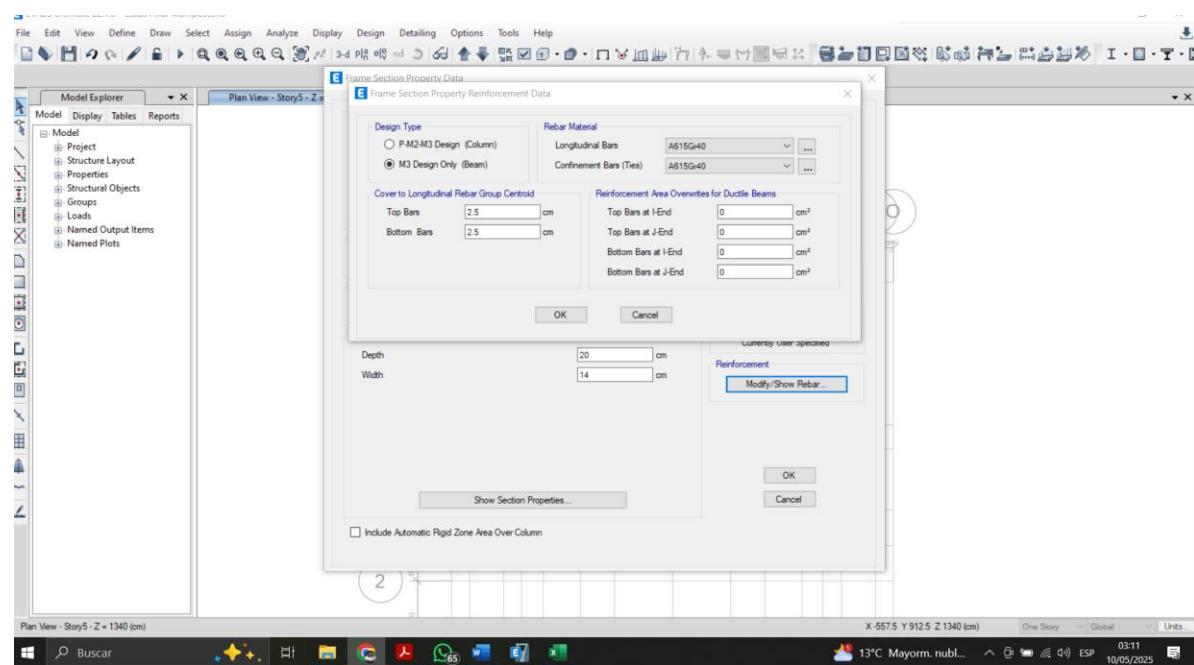
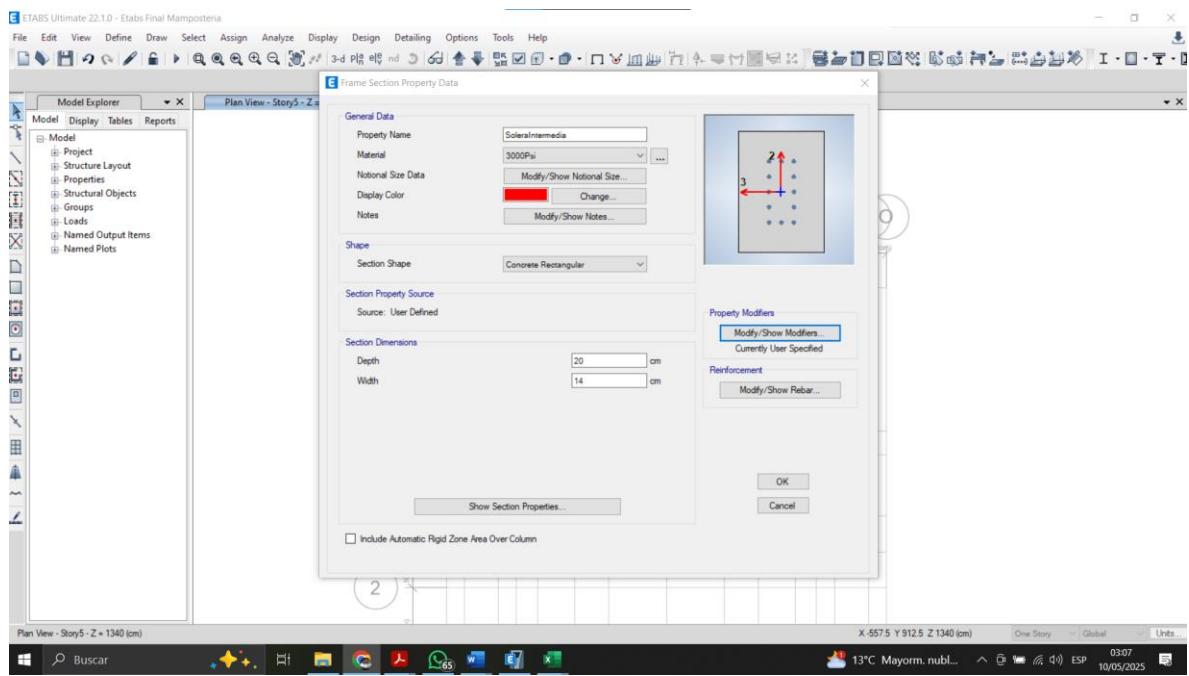




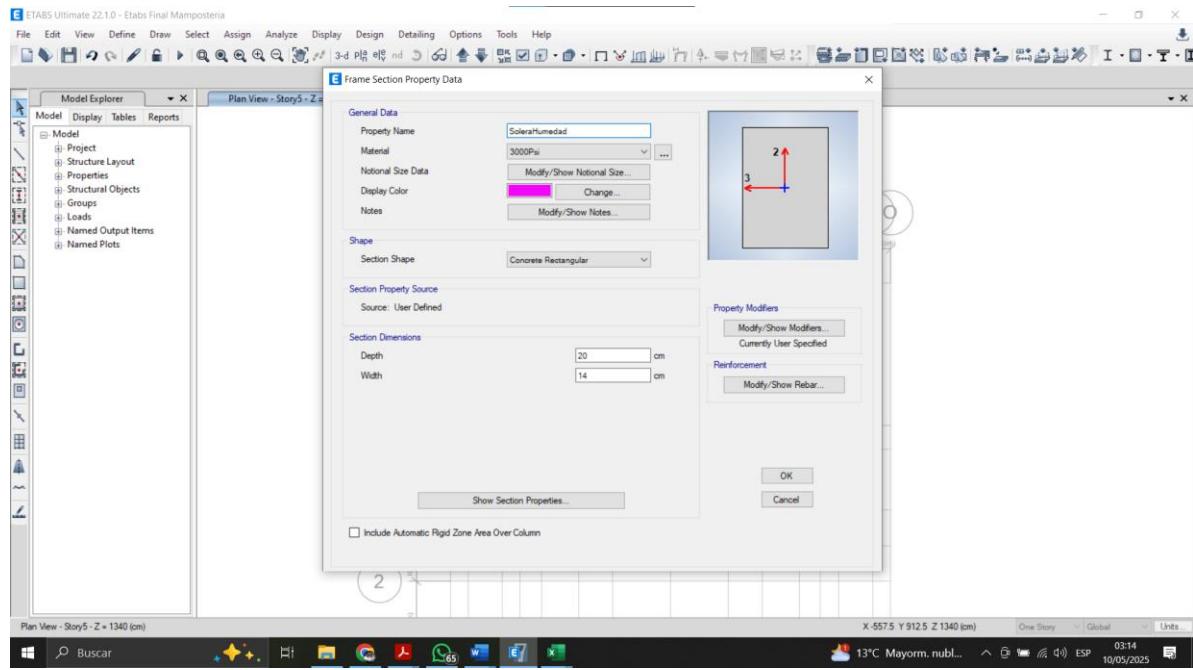


DEFINIENDO SOLERA INTERMEDIA

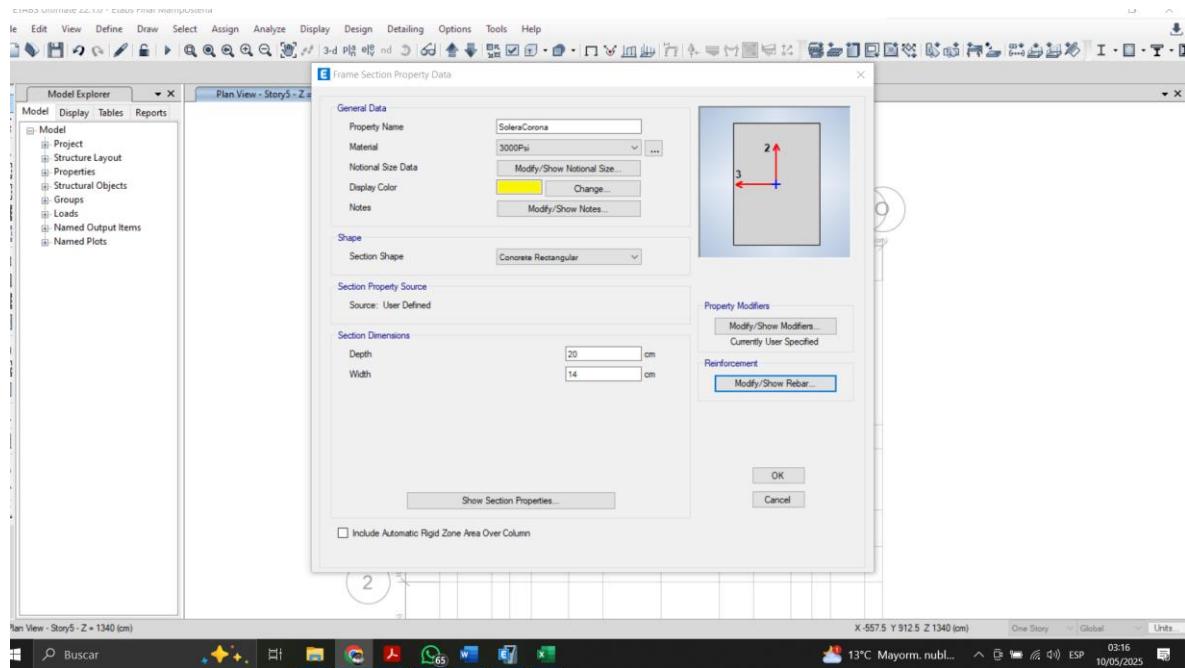




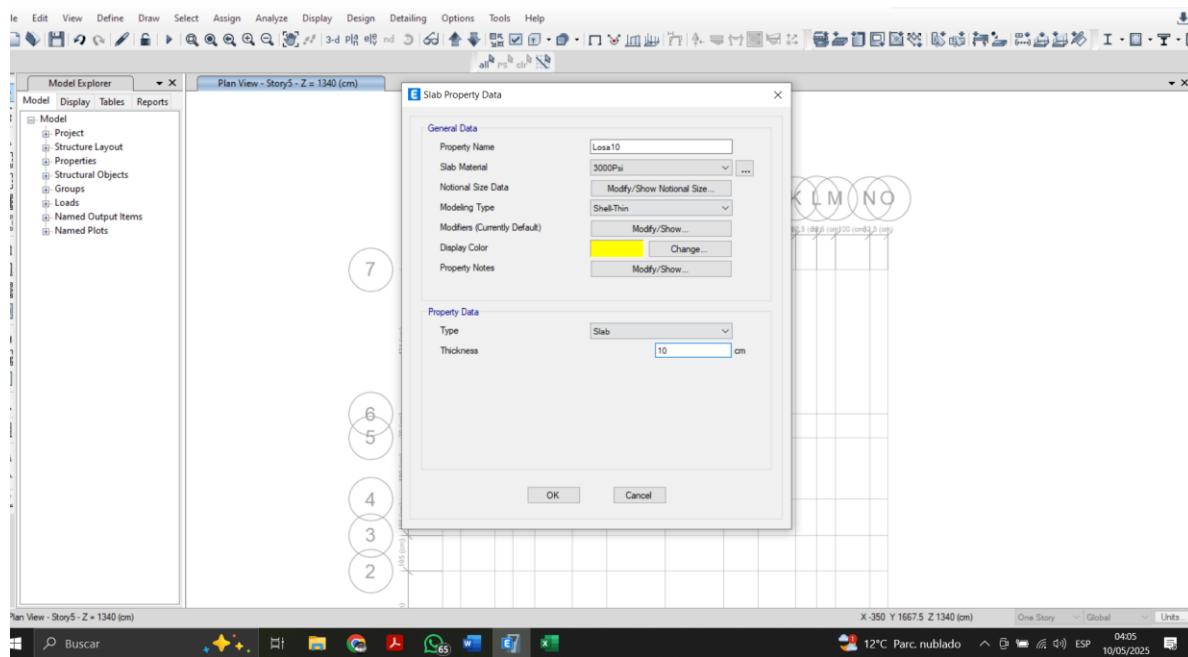
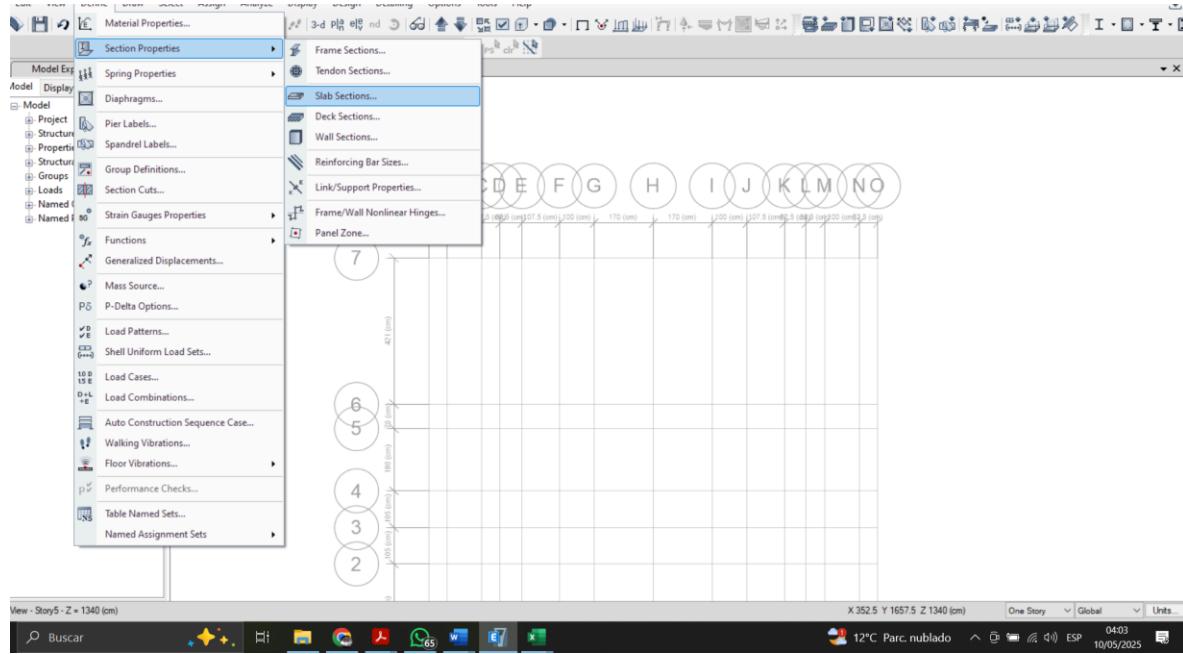
DEFINIENDO SOLERA DE HUMEAD



DEFINIENDO SOLERA DE CORONA

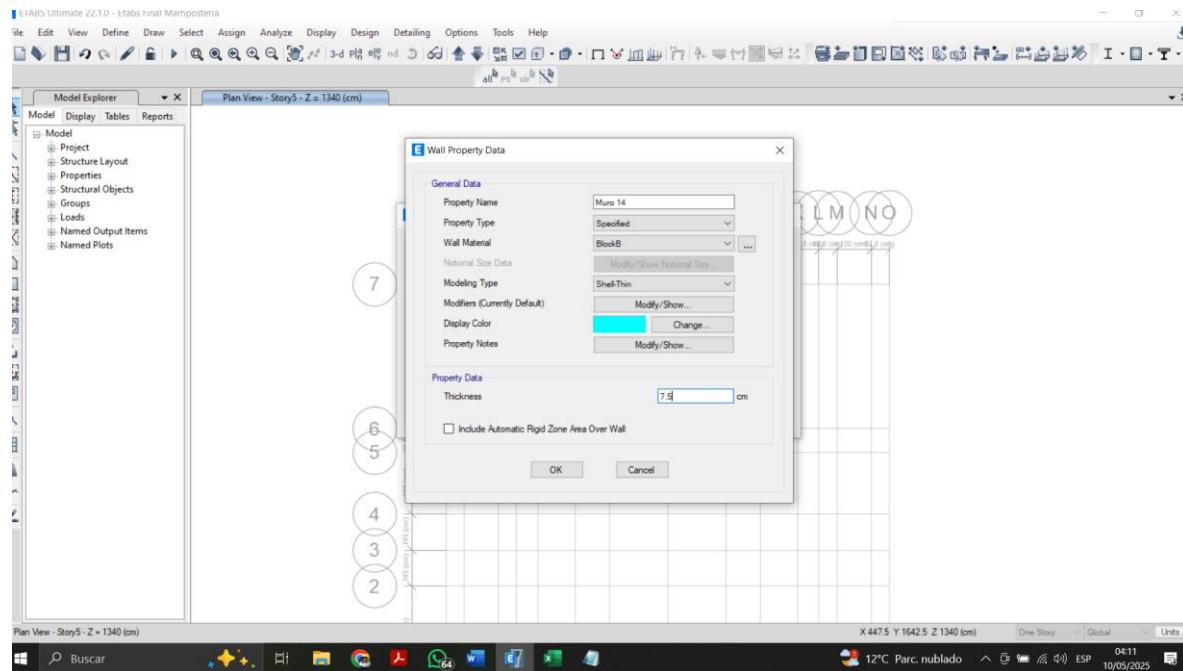


DEFINIENDO LOSAS

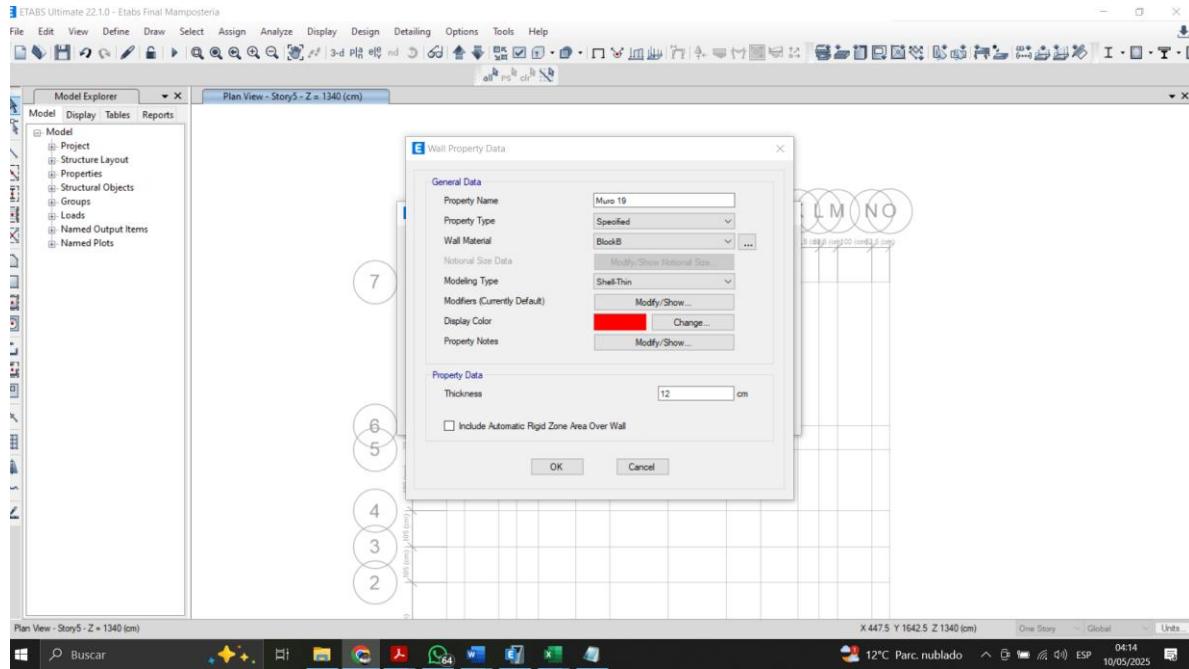


DEFINIENDO MUROS

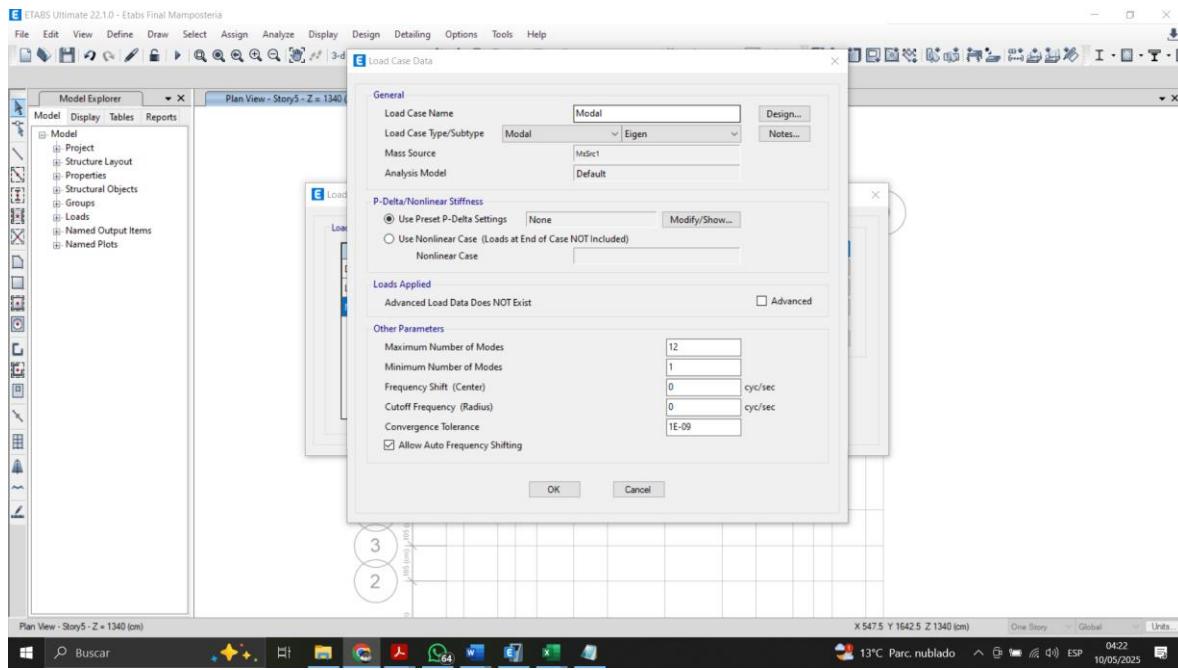
TABLA 2.4 ESPESOR EQUIVALENTE (t_e) PARA BLOQUES DE HORMIGÓN		
ESPACIAMIENTO DE CÁMARA LLENAS DE CONCRETO	ESPESORES EQUIVALENTES	
	Bloques de Hormigón 8" = 20 cm	Bloques de Hormigón 6" = 15 cm
@ 0.20 m	7.60" = 19.30 cm	5.60" = 14.22 cm
@ 0.40 m	5.80" = 14.73 cm	4.50" = 11.43 cm
@ 0.60 m	5.20" = 13.21 cm	4.10" = 10.42 cm
@ 0.80 m	4.90" = 12.45 cm	4.00" = 7.87 cm



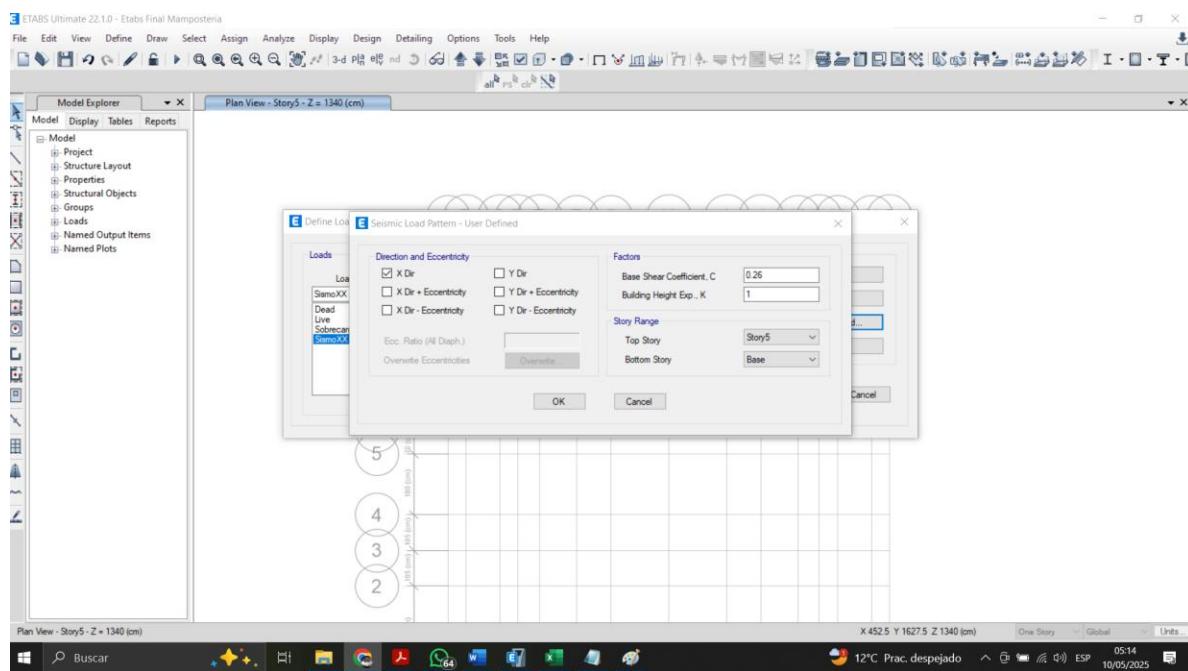
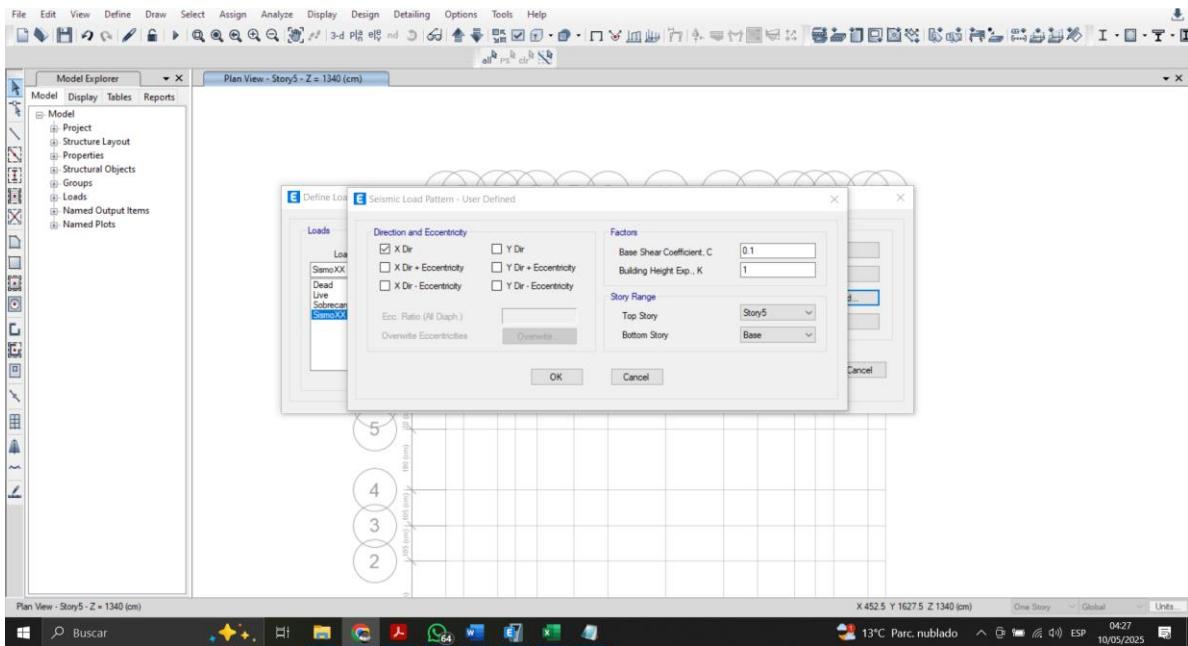
MURO DE 19

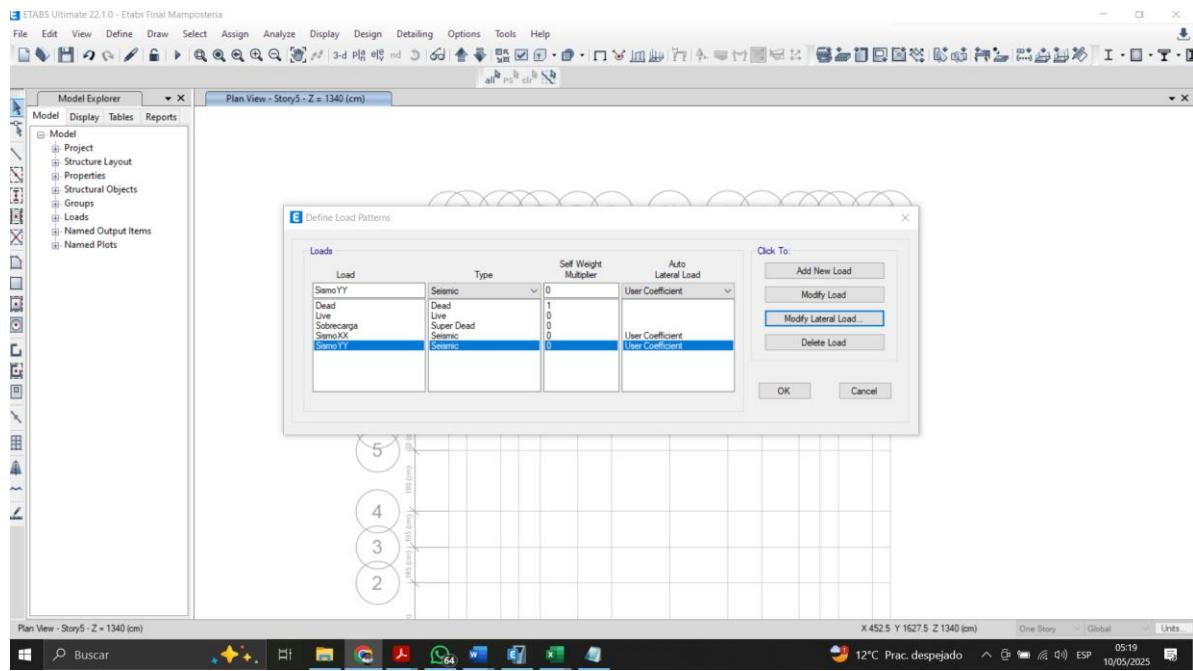


DEFINIENDO CASO MODAL

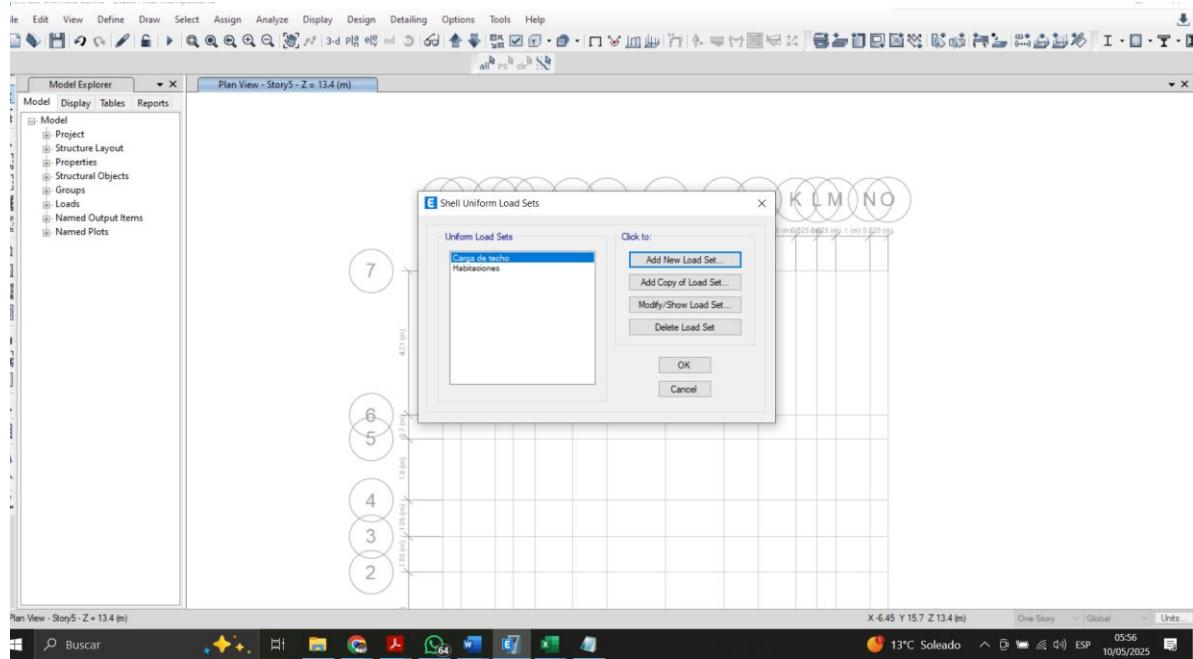


DEFINIENDO CASOS DE CARGA

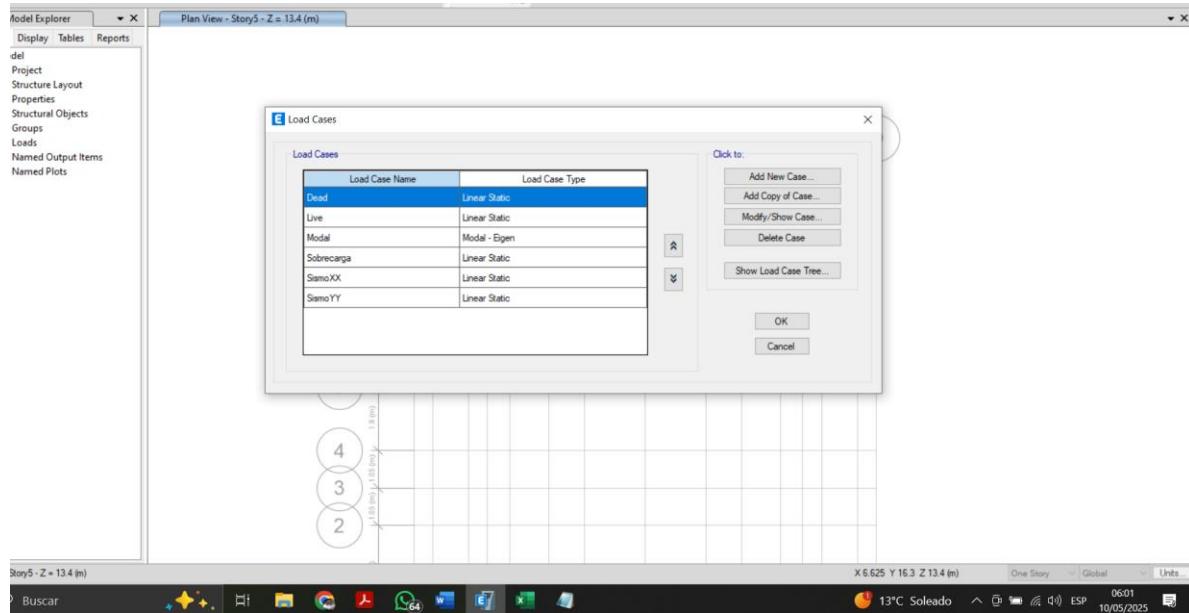




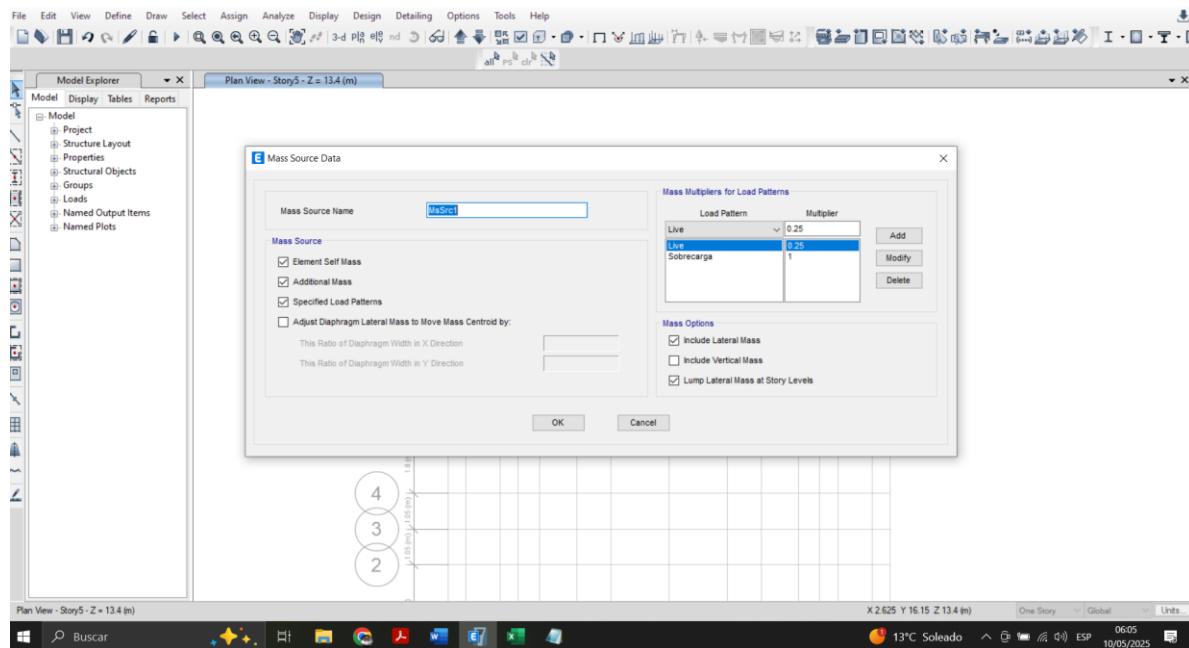
DEFINIENDO CARGAS



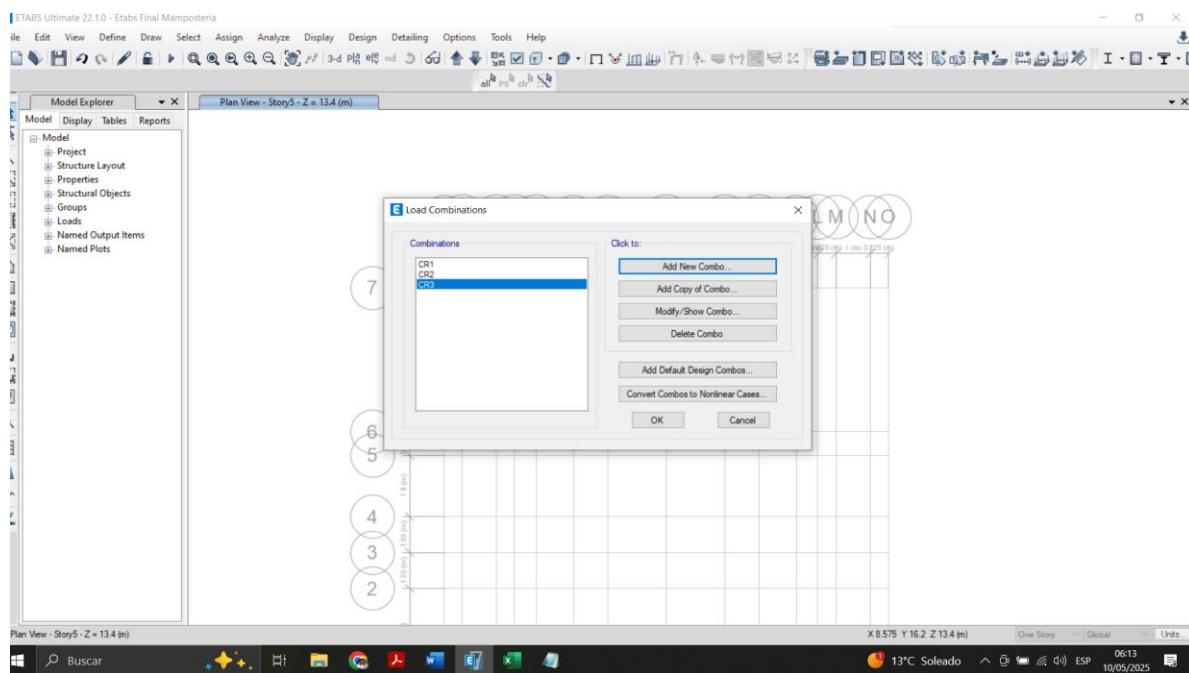
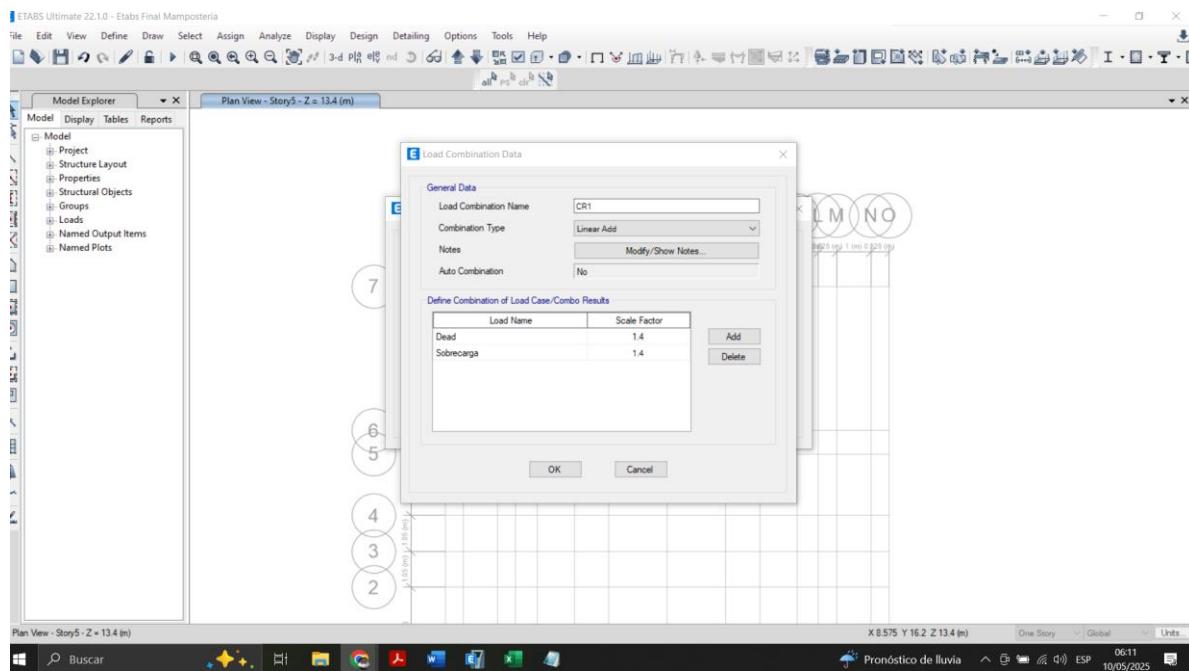
CASOS DE CARGA

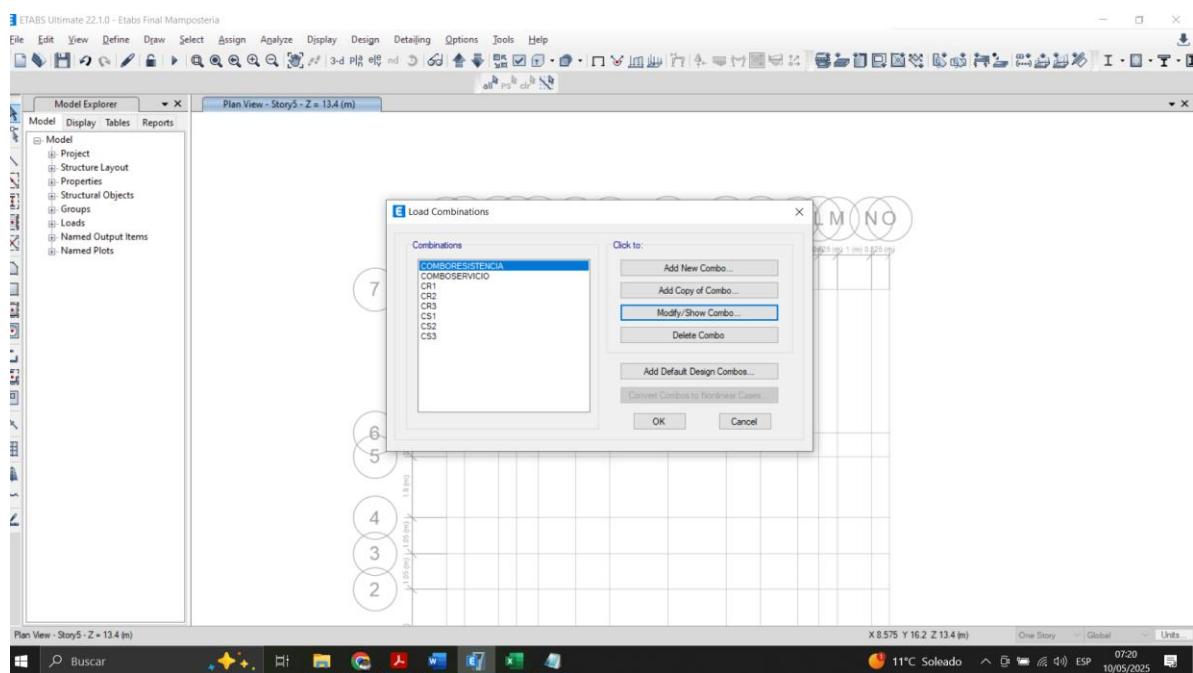
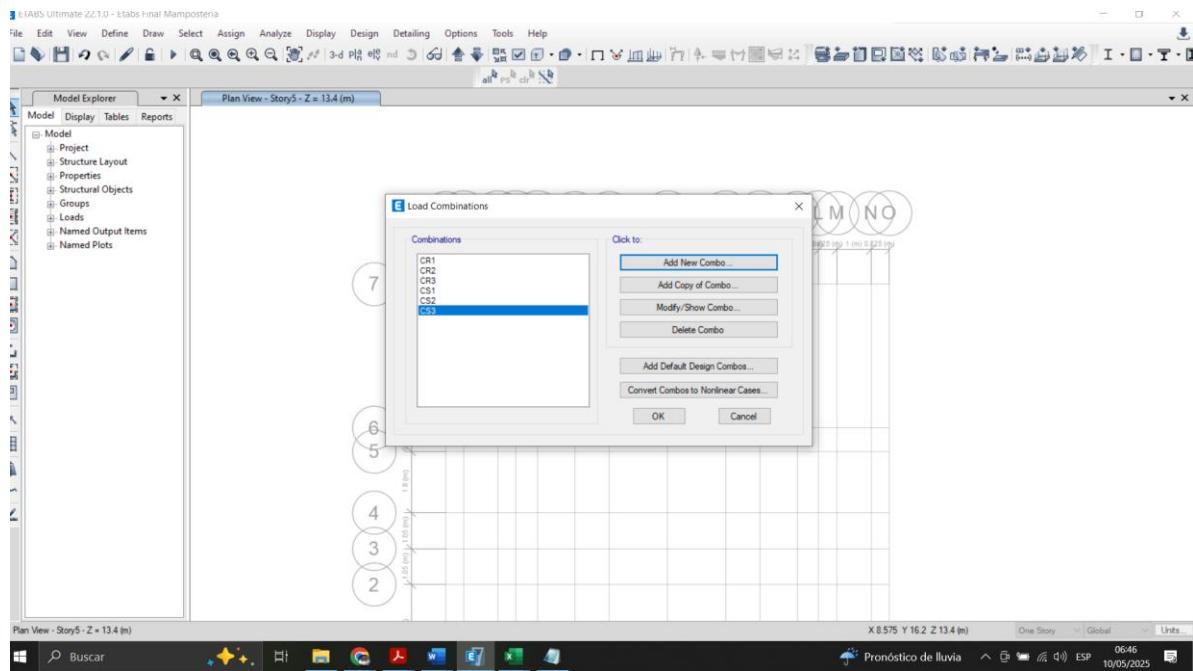


FUENTE DE MASA

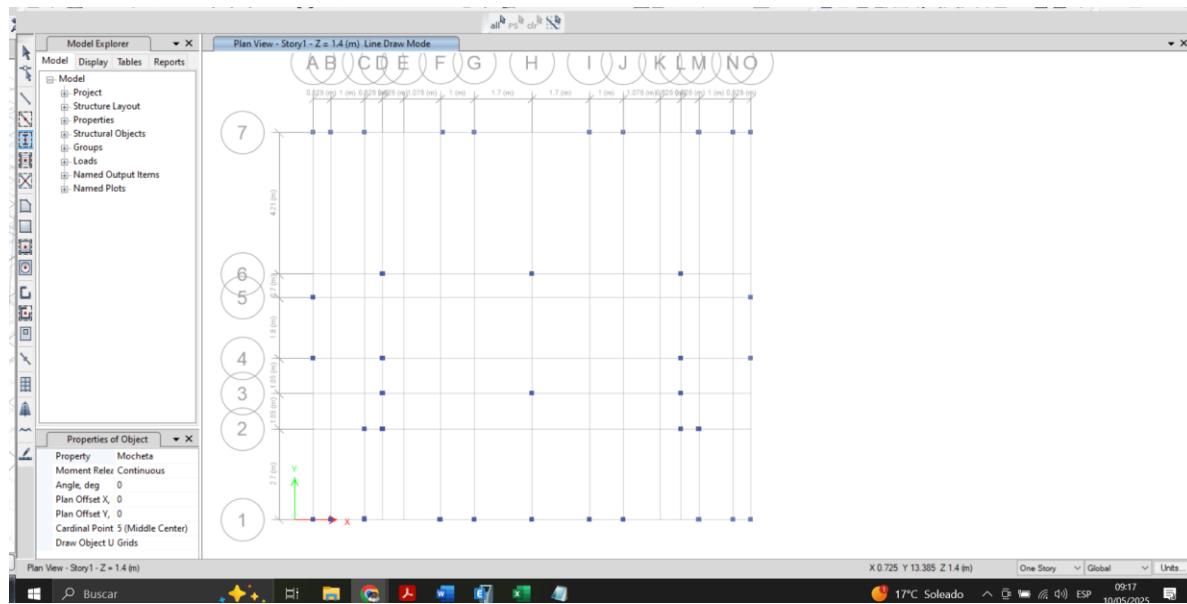


DEFINIR COMBINACIONES DE CARGA

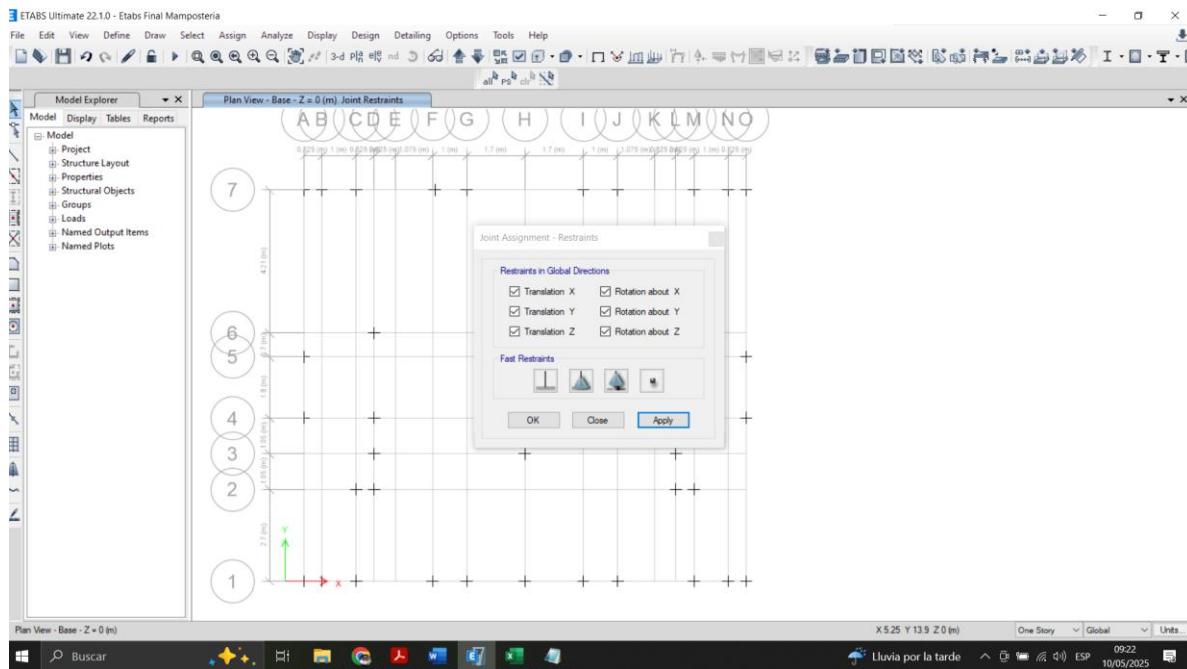




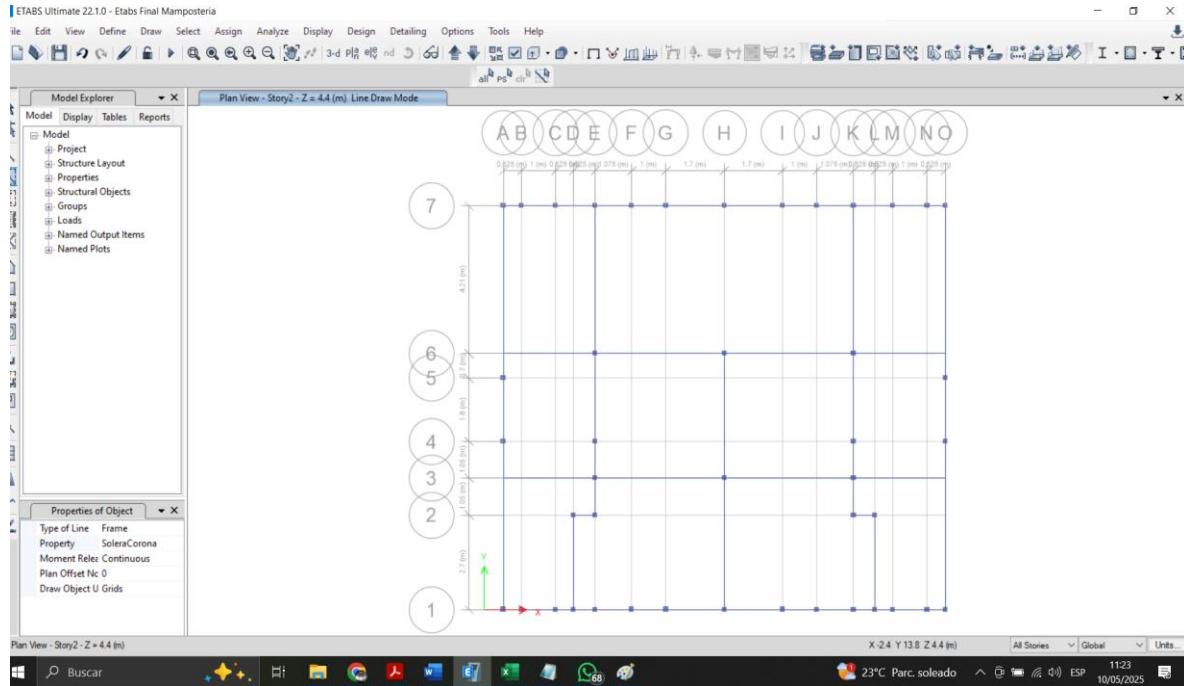
ASIGNANDO MOCHETAS



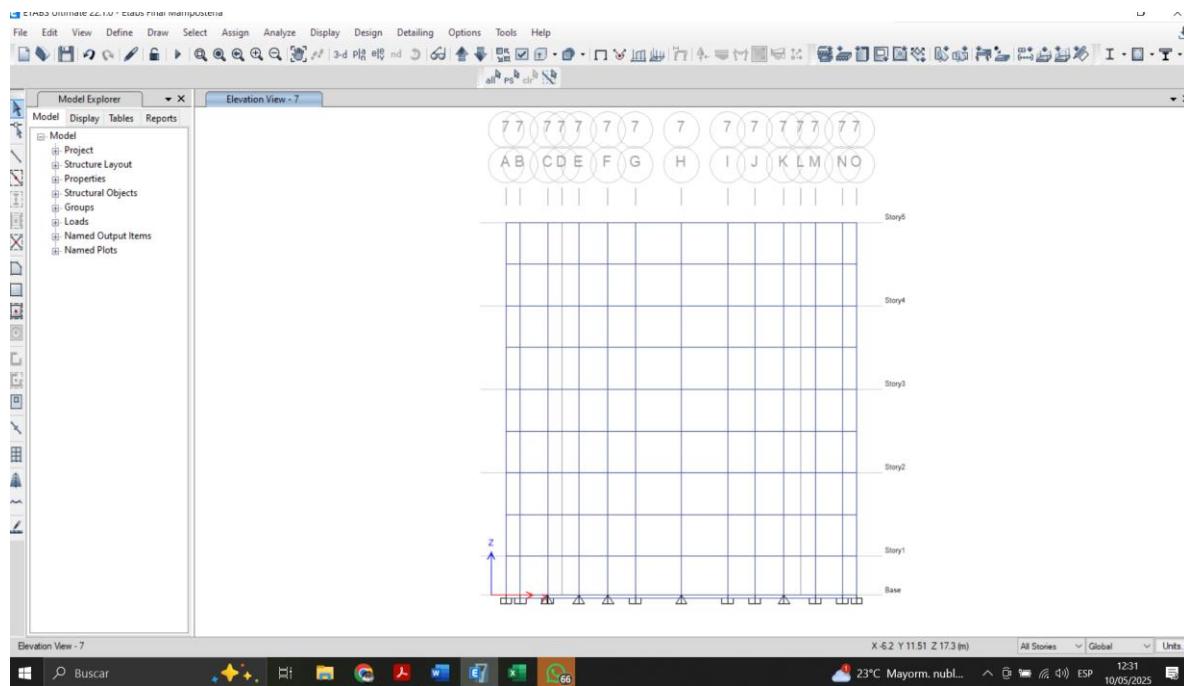
Asignando Empotramiento

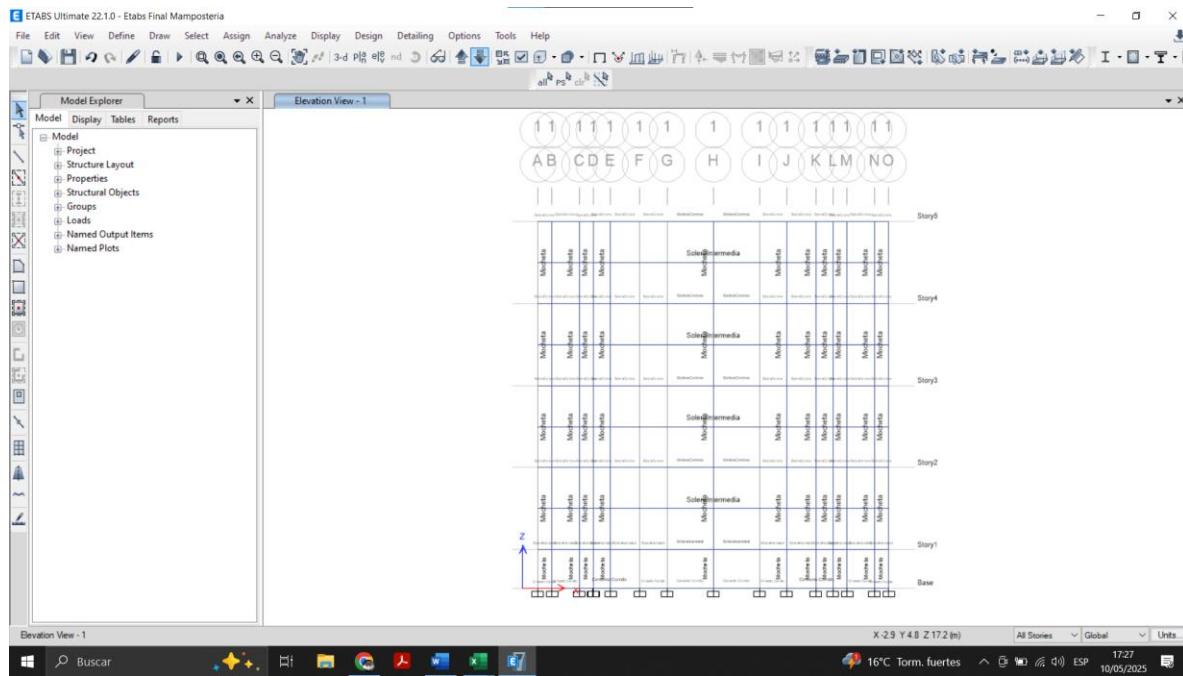


COLOCANDO SOLERAS DE CORONA

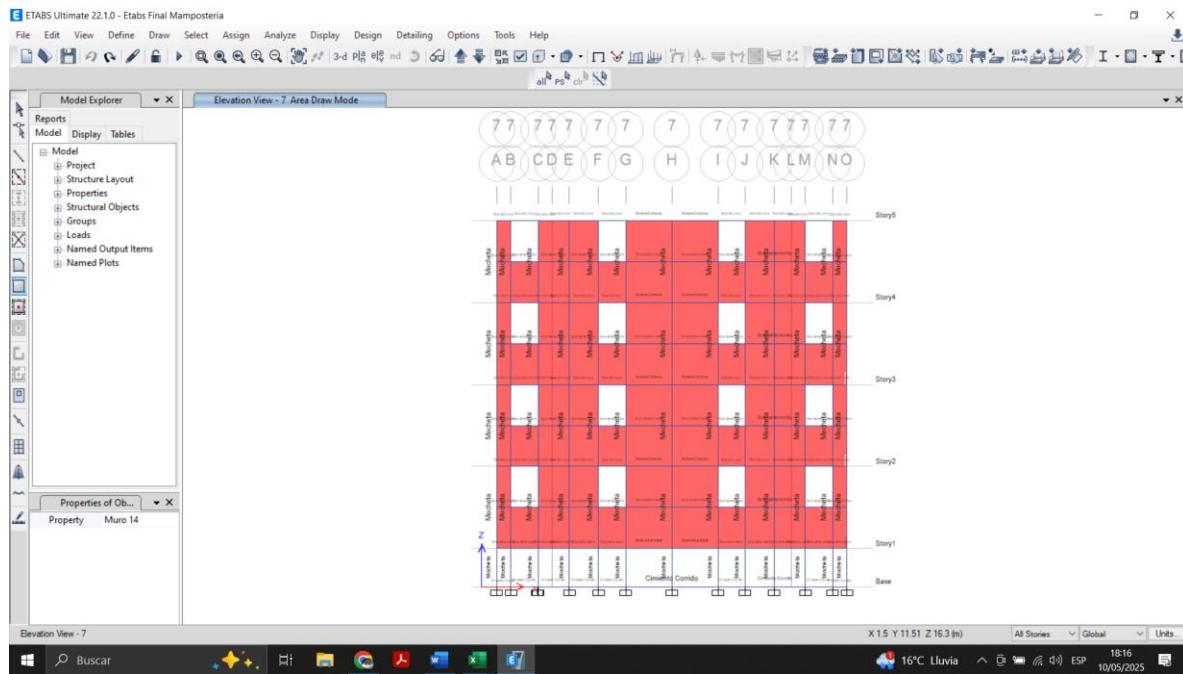


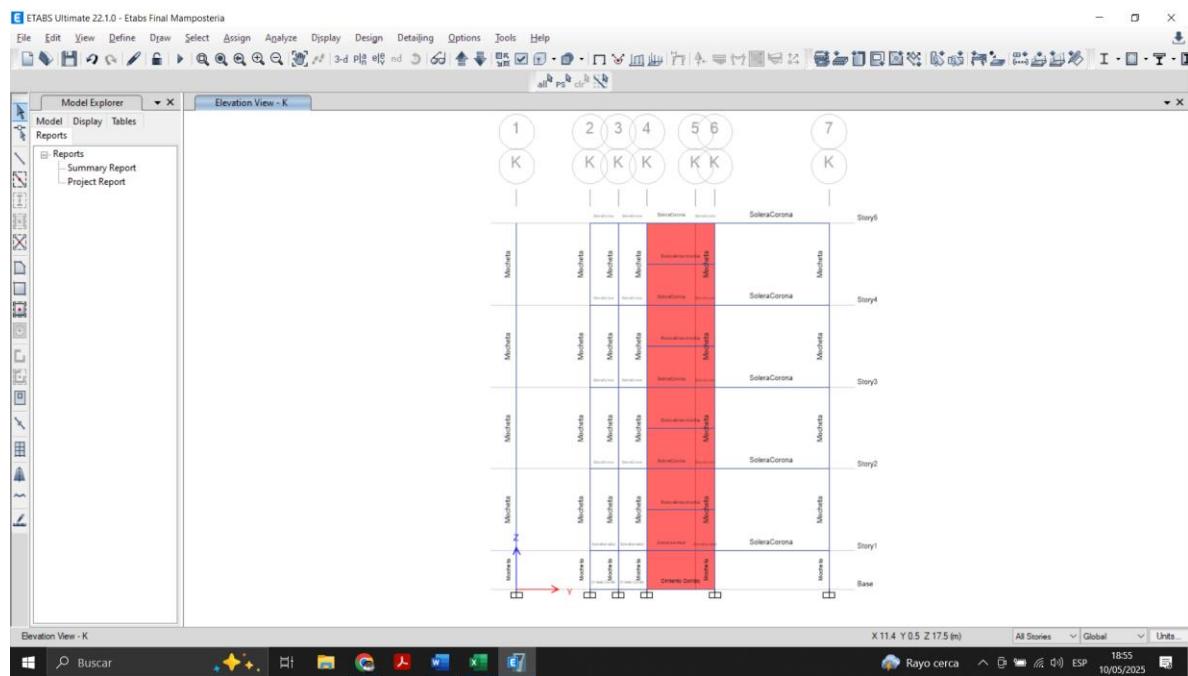
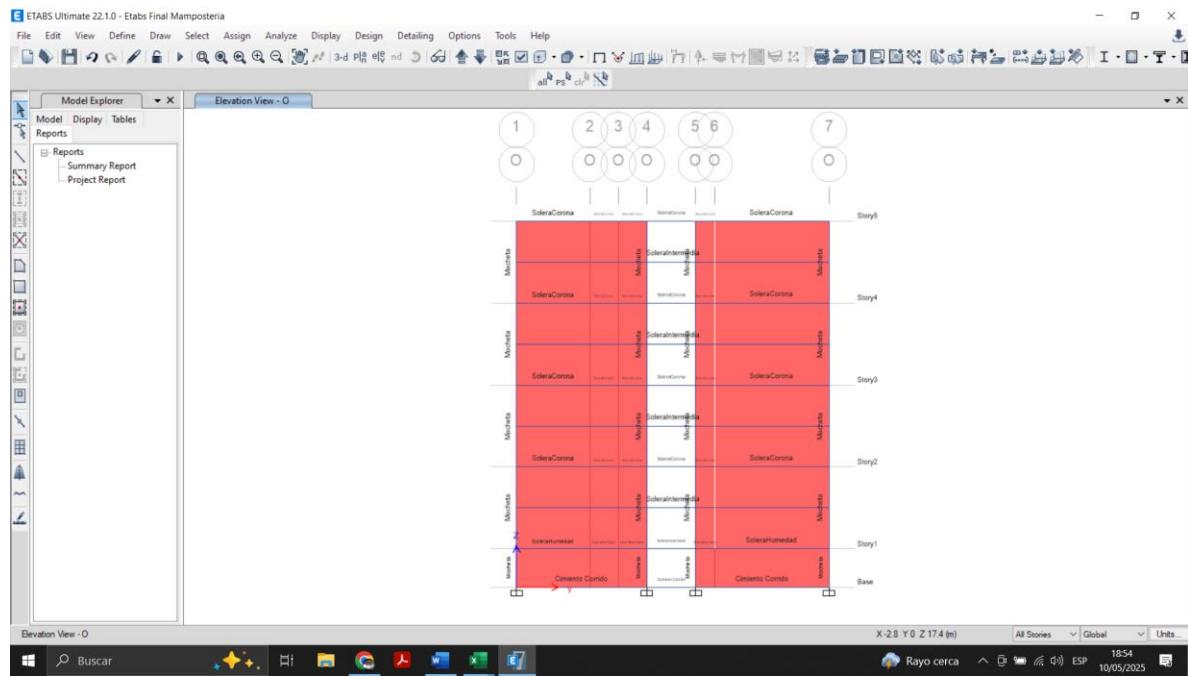
SOLERA INTERMEDIA





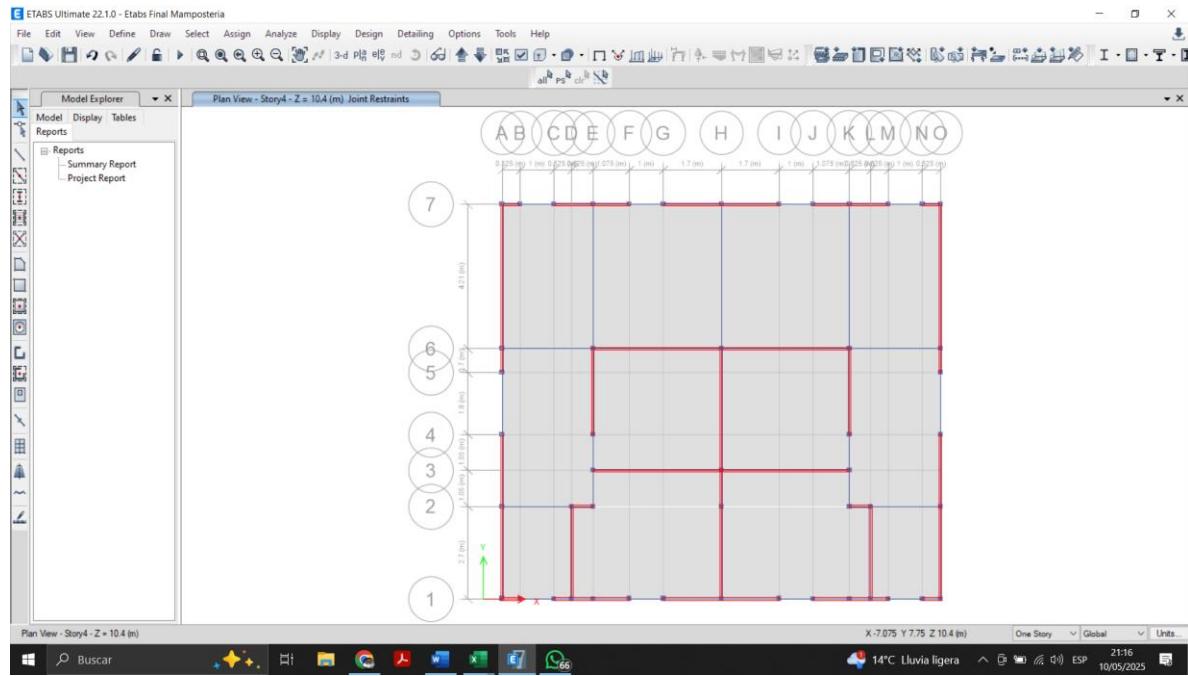
ASIGNANDO MUROS



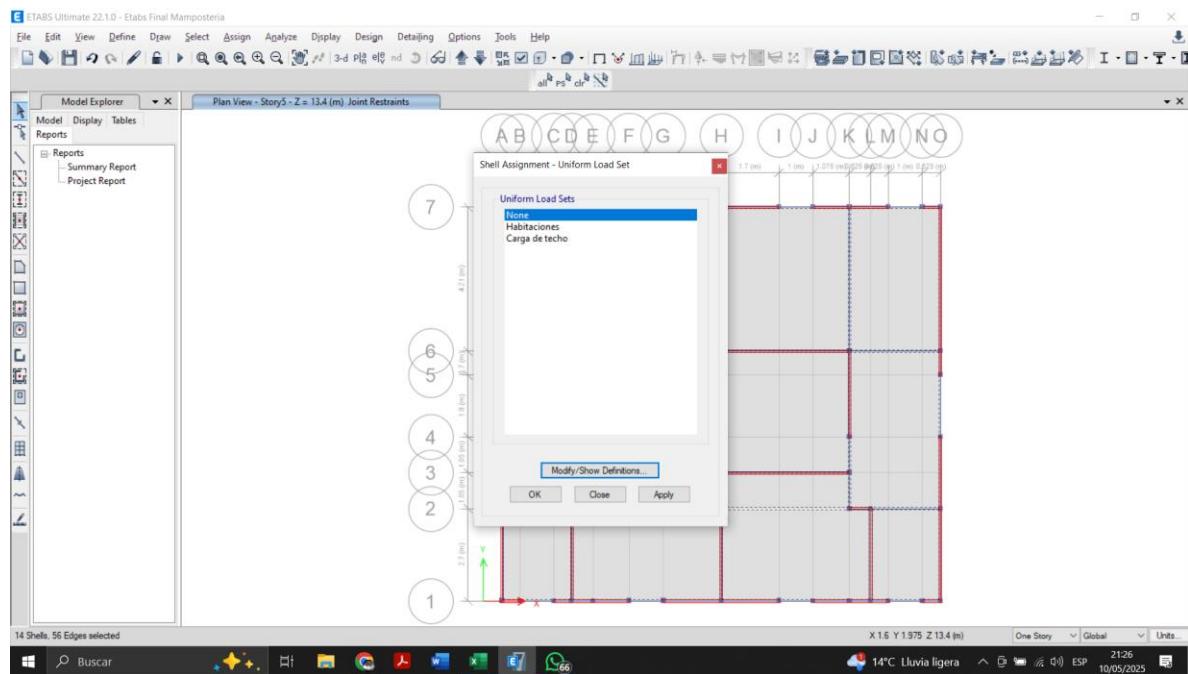


COLOCANDO LOSAS

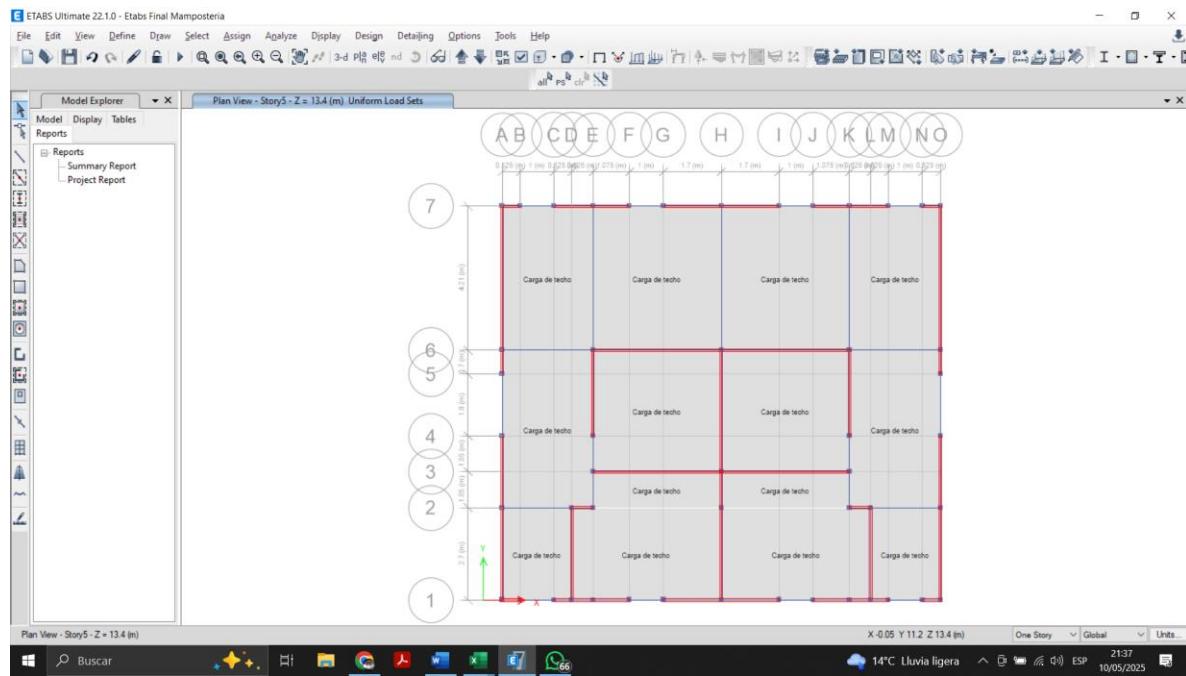
TODOS LOS NIVELES



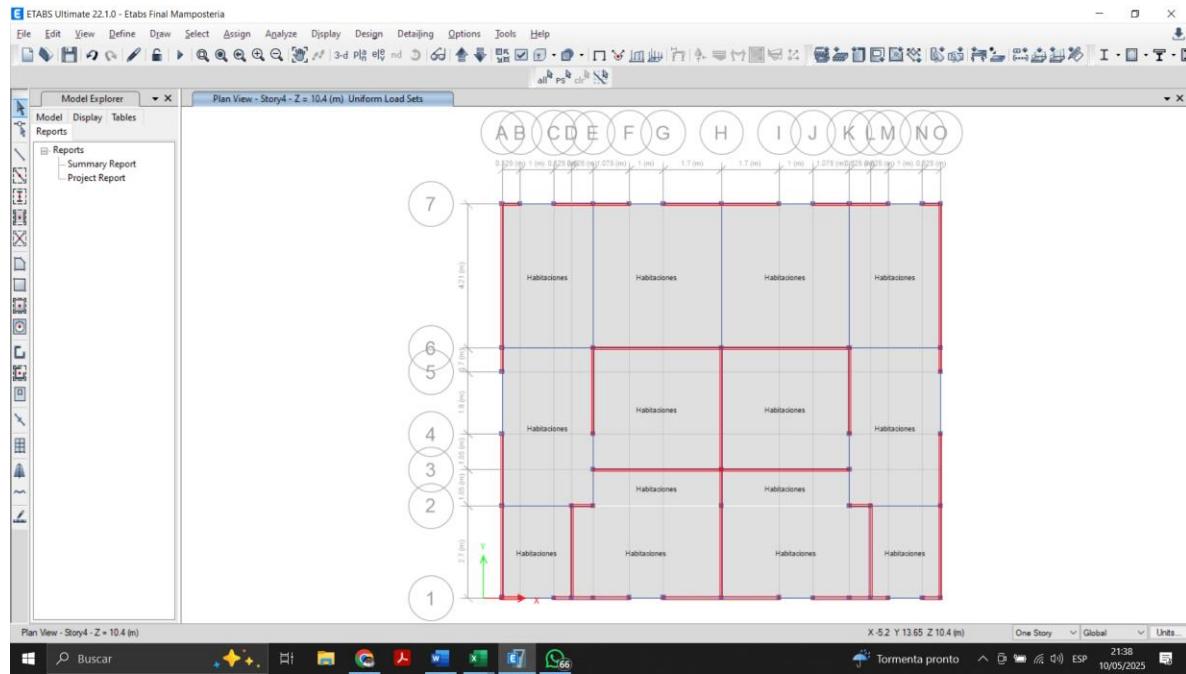
ASIGNAR CARGAS SOBRE LOSA



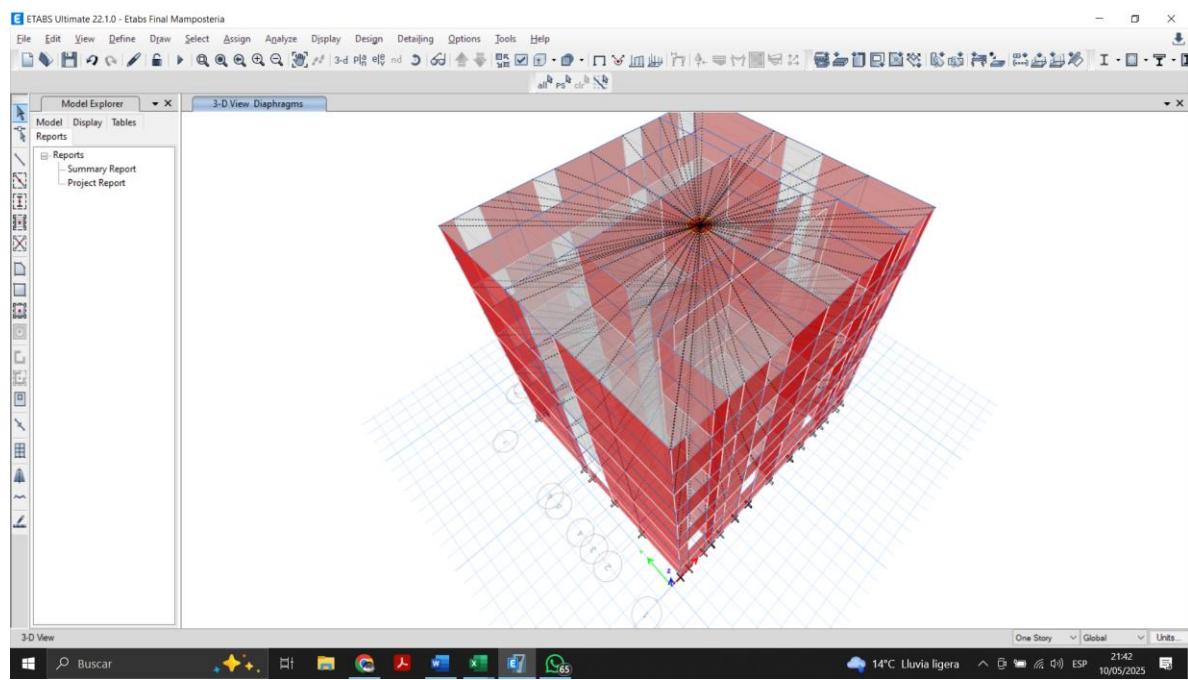
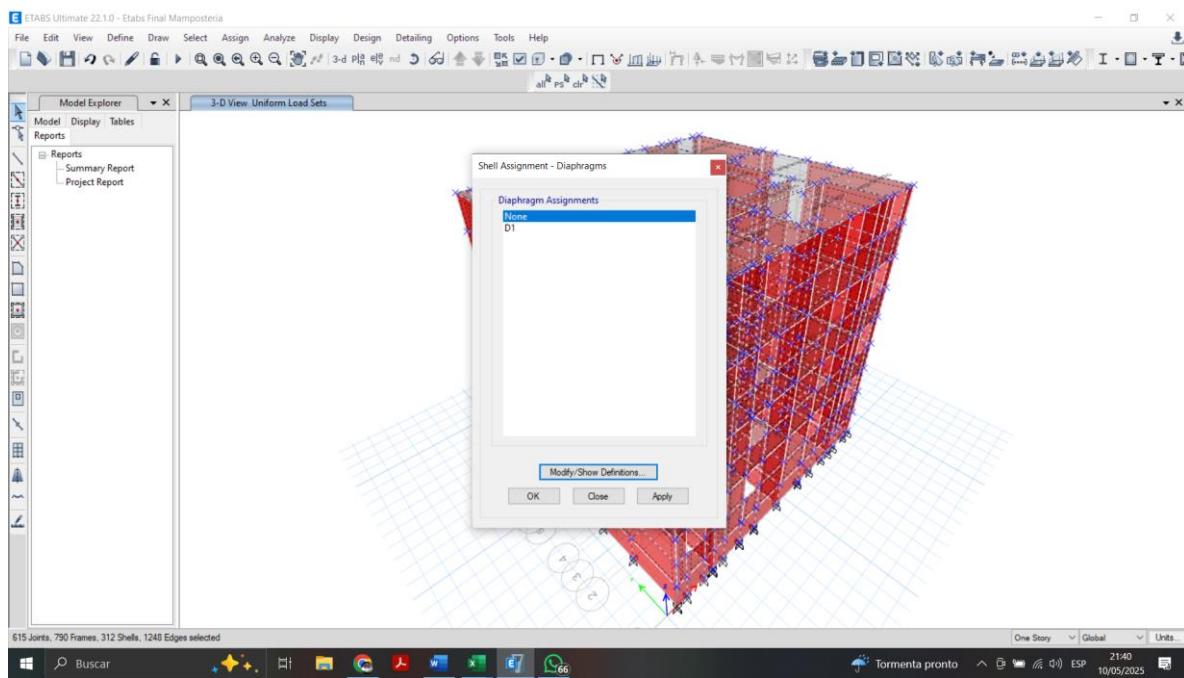
CARGA VIVA DE TECHO



CARGA VIVA DE HABITACIONES

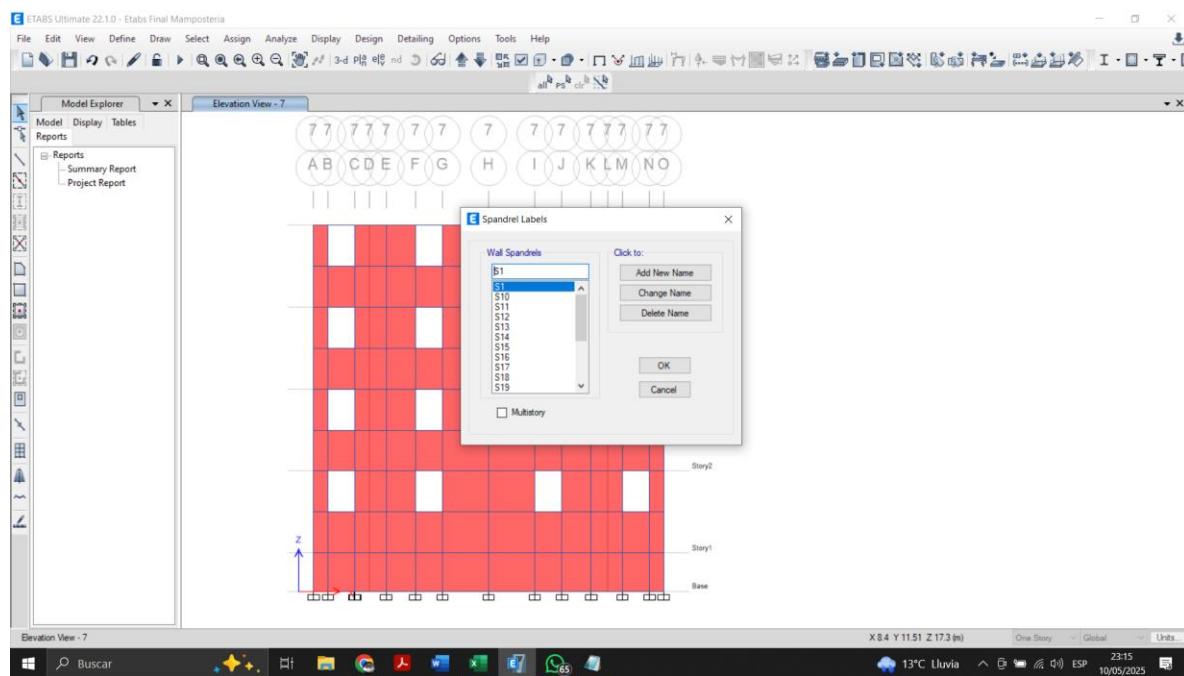
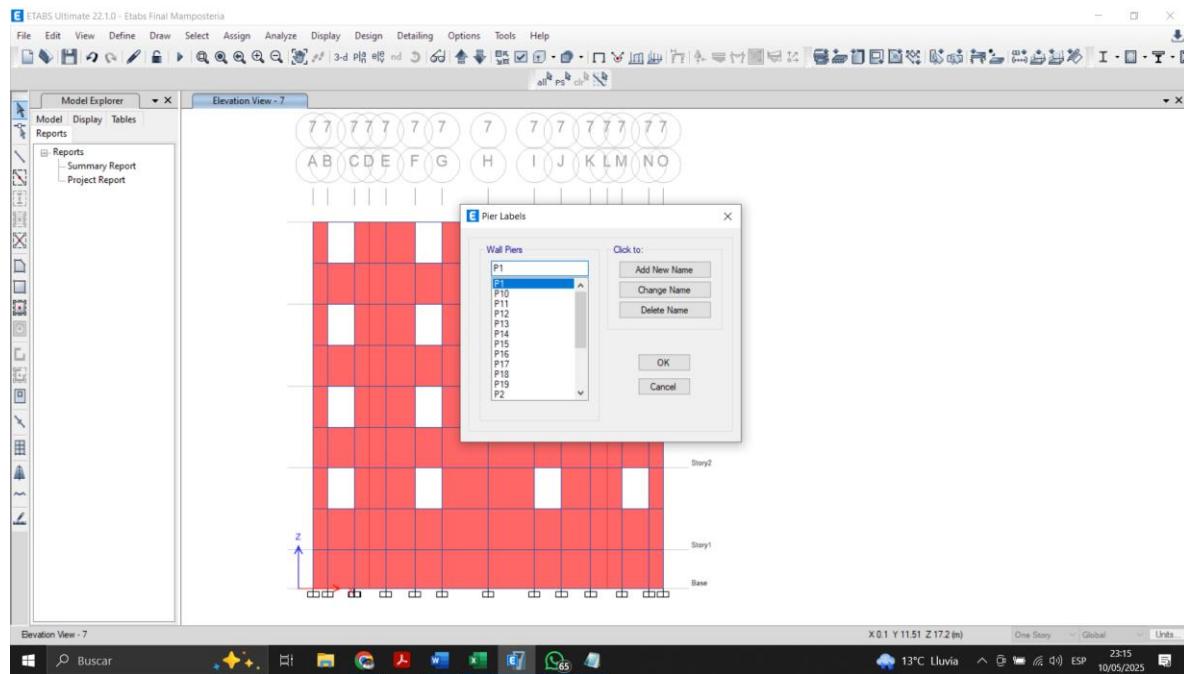


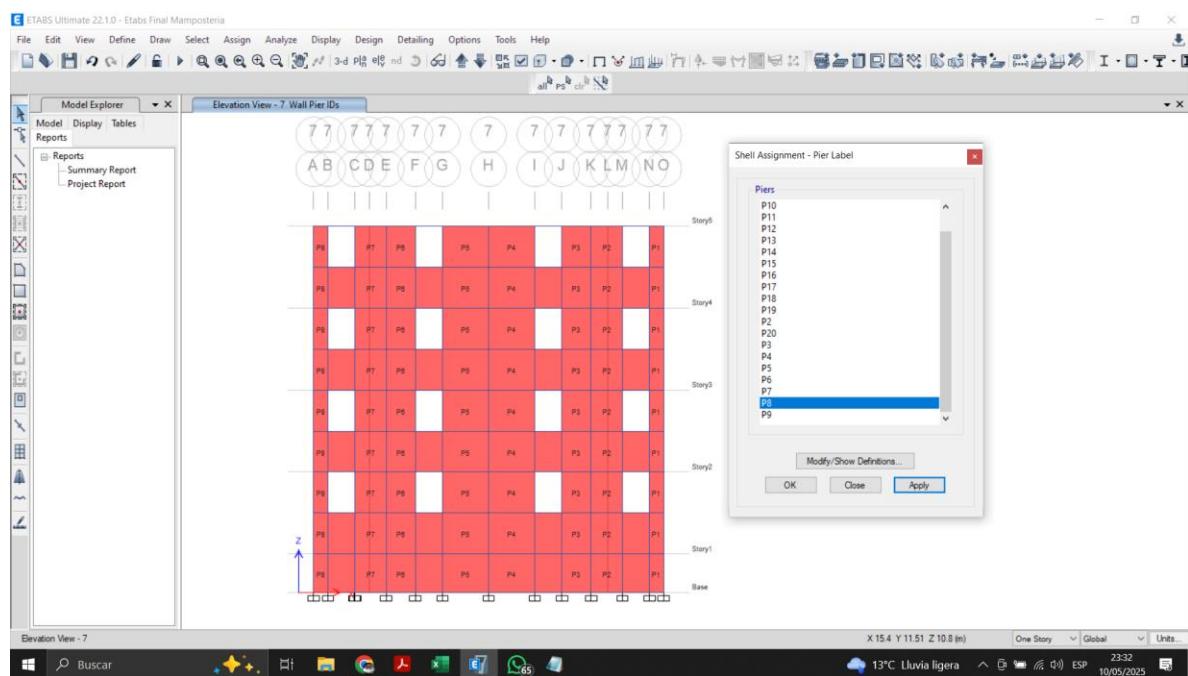
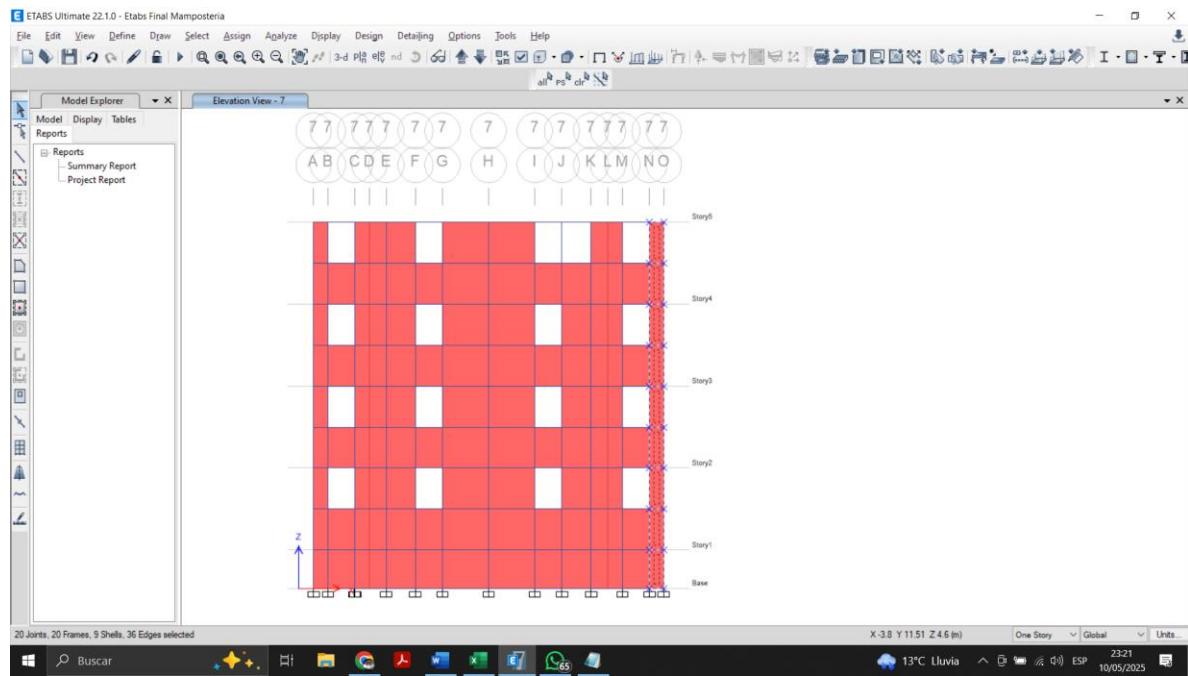
ASINGANDO DIAFRAGMA

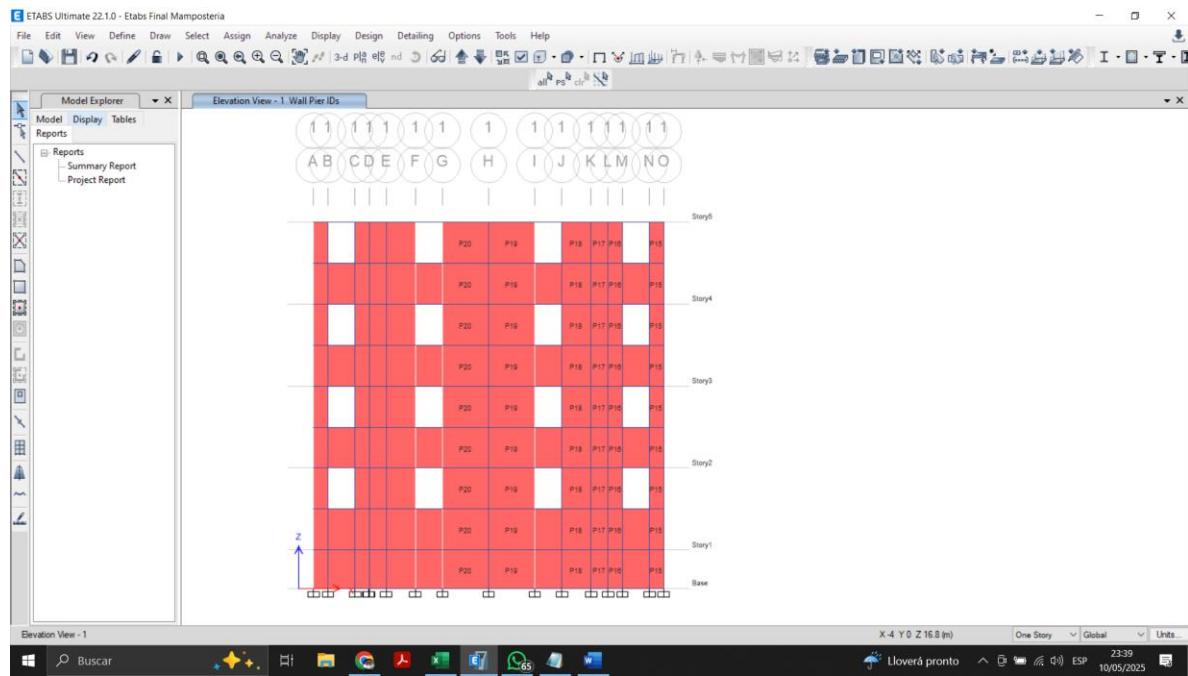


ASIGNAR PIER LABELS

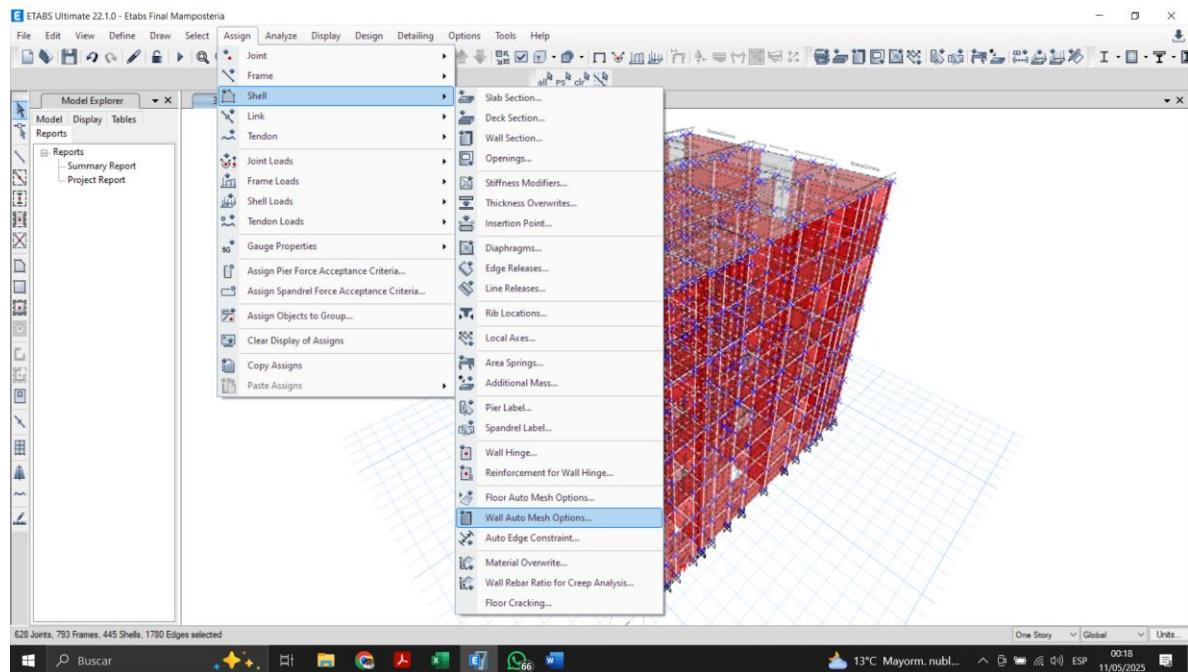
PIER COLUMNAS SPRANDEL VIGA

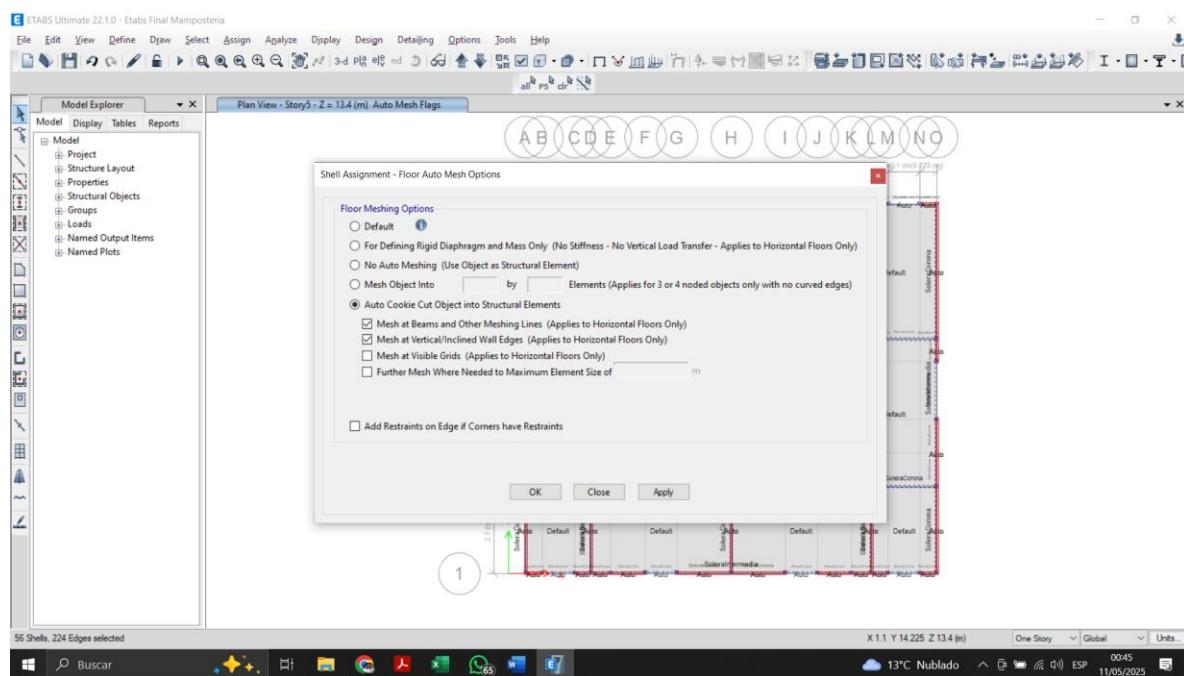
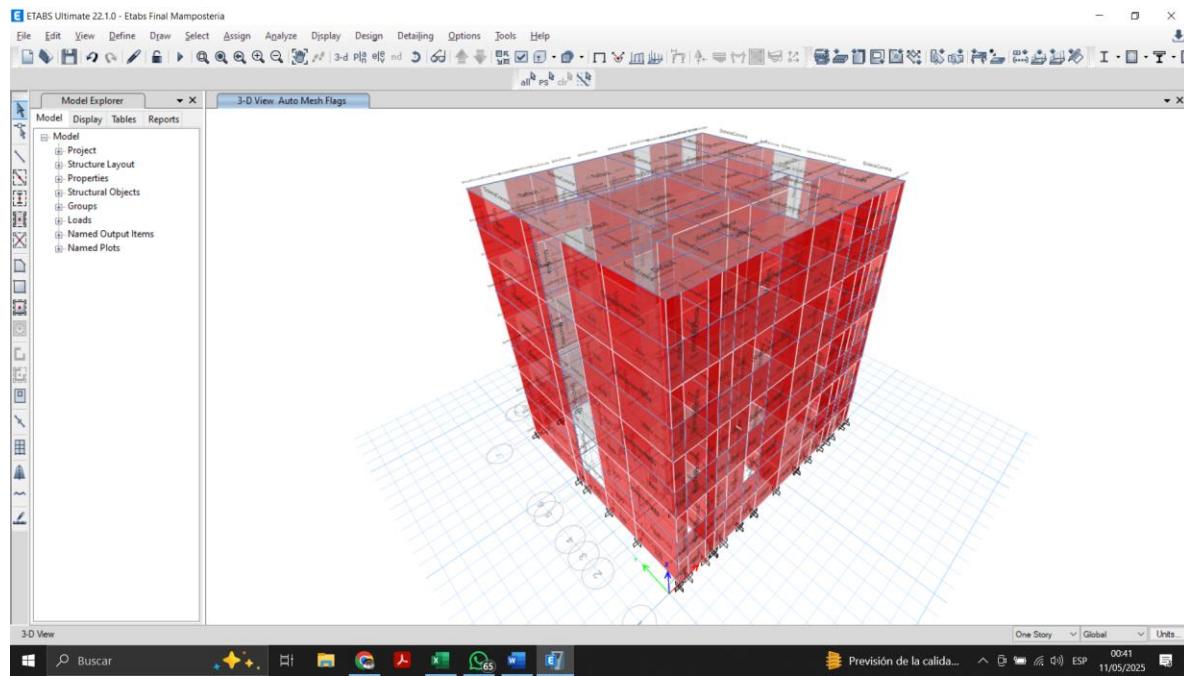




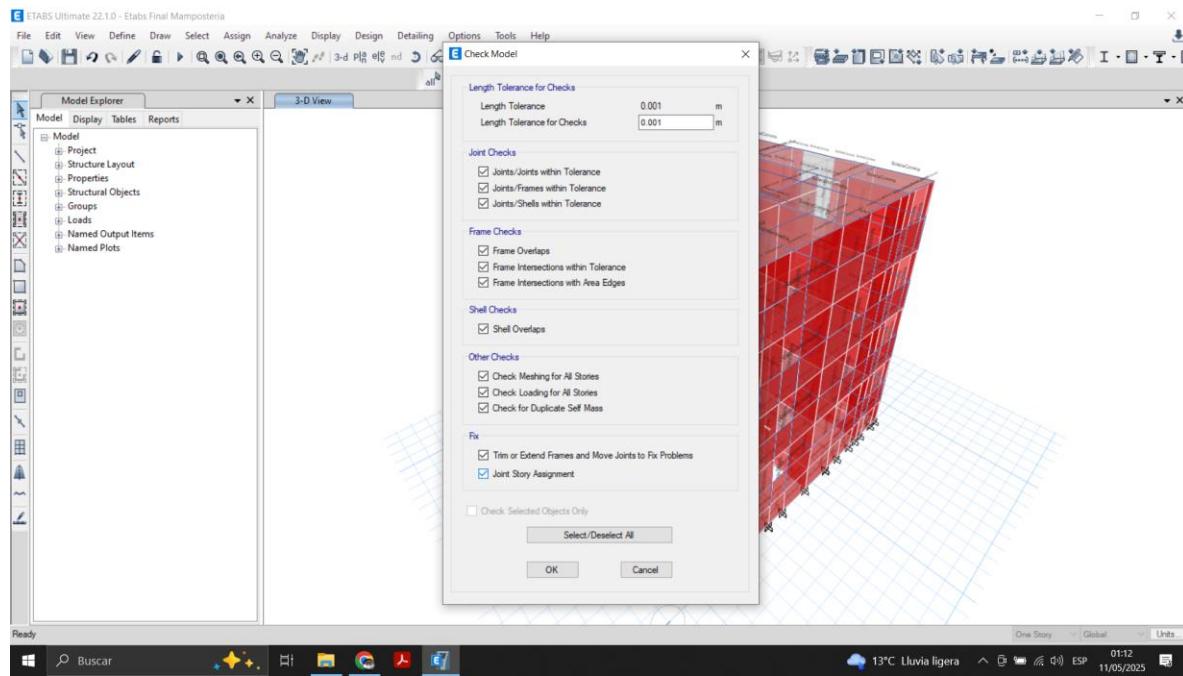


AGREGANDO AUTOMESH

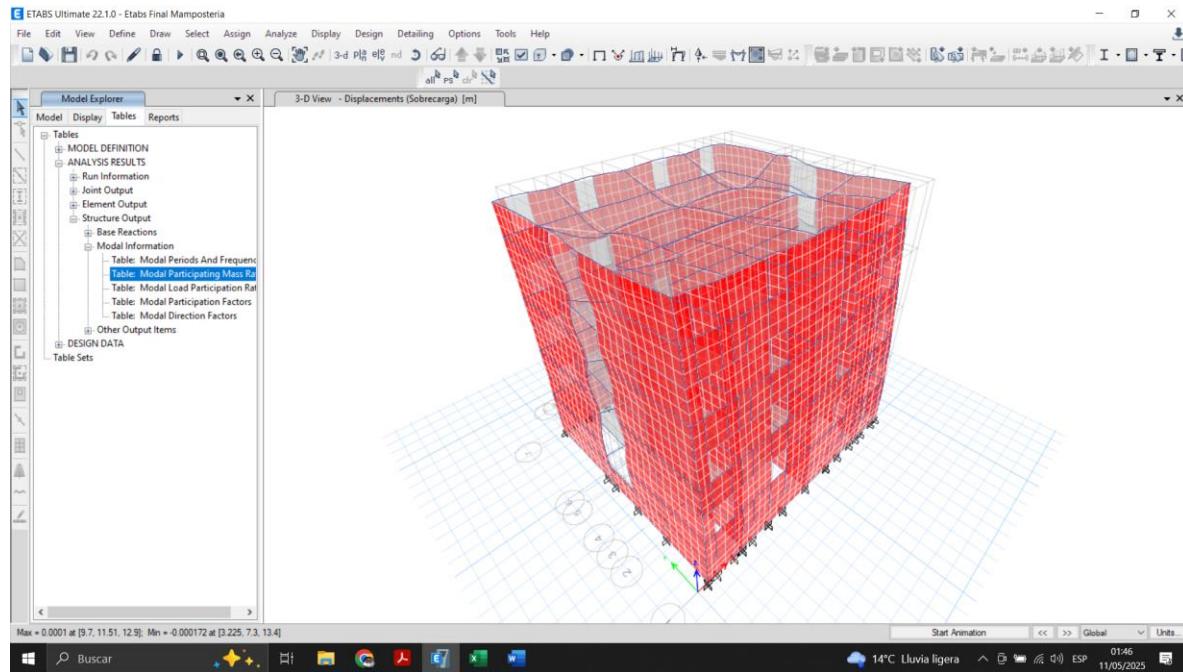




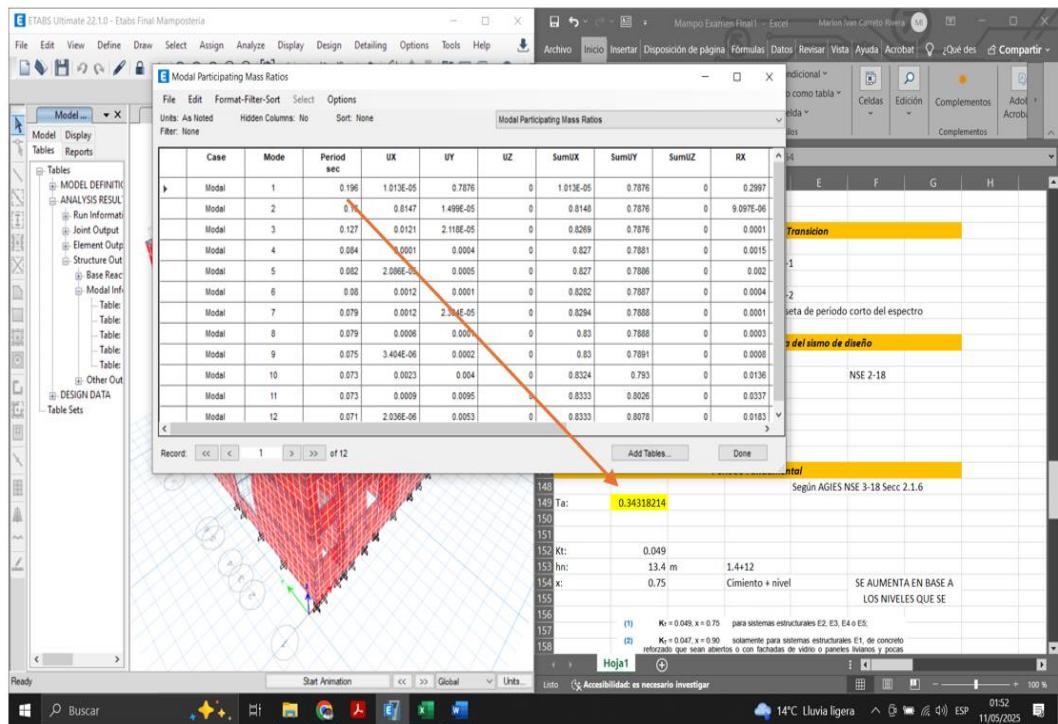
ANALIZANDOLO



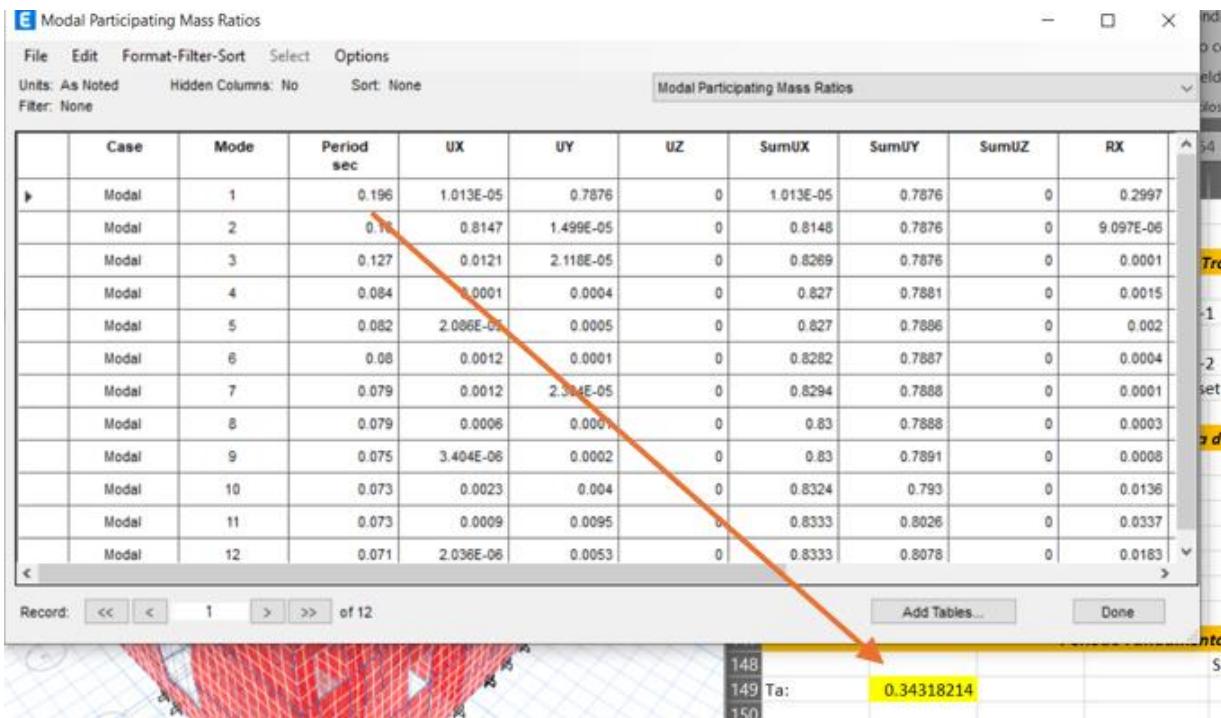
CORRIENDO EL PROGRAMA



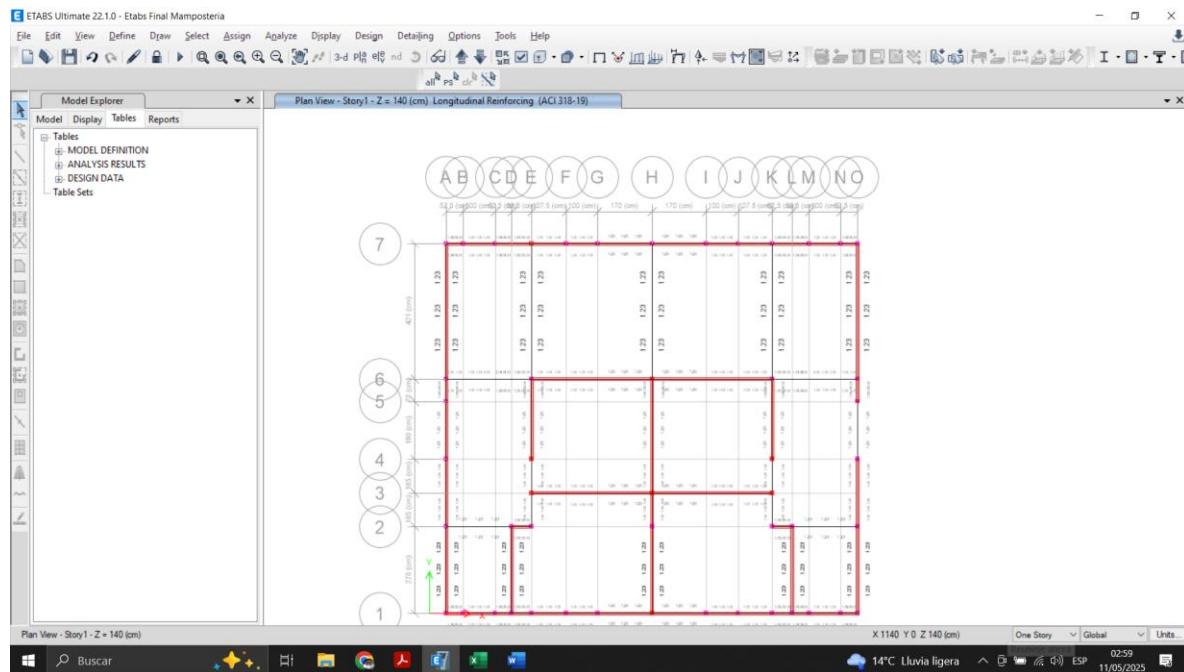
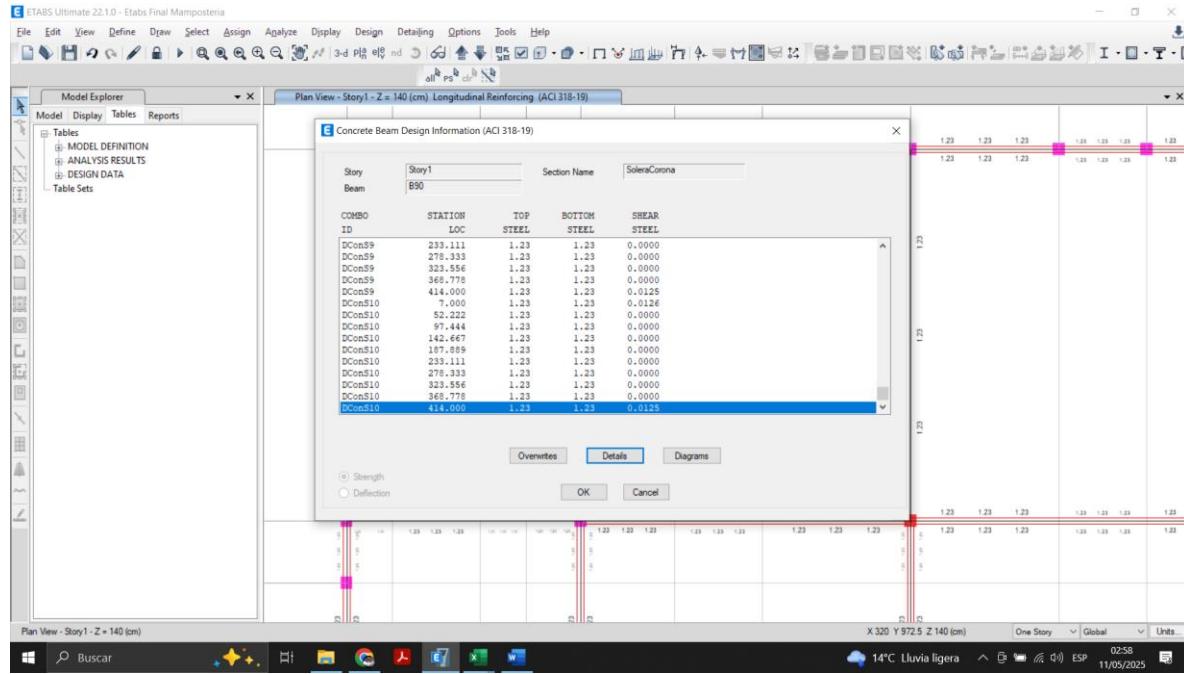
Chequeando el Periodo

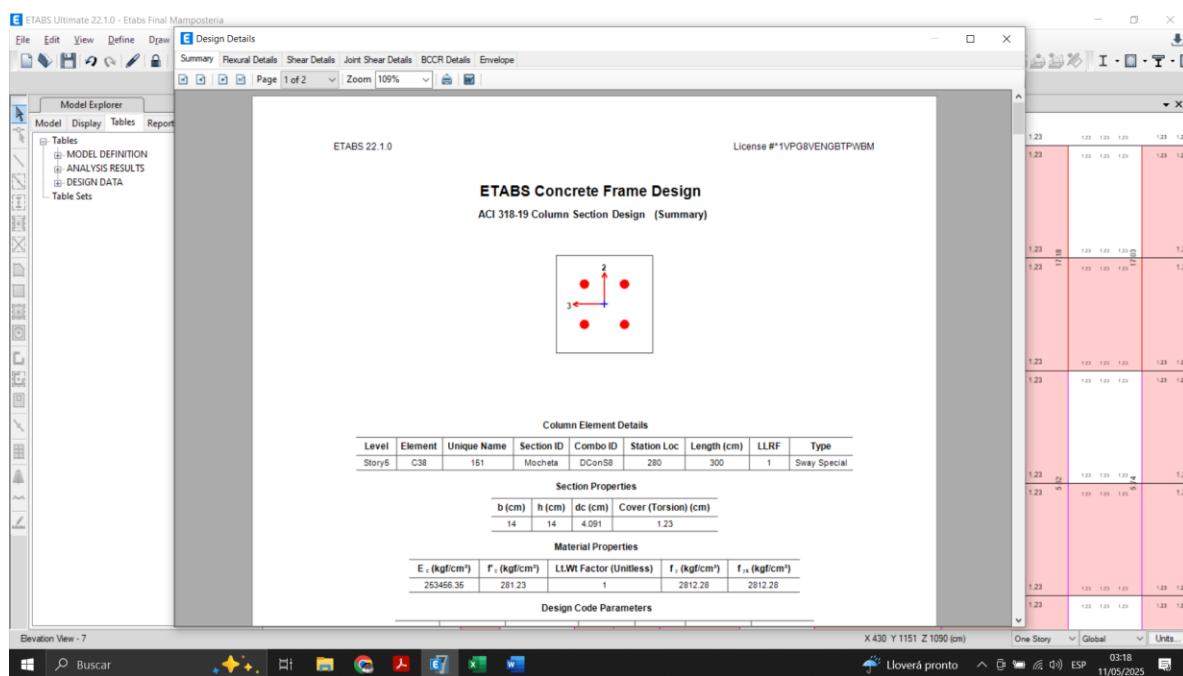
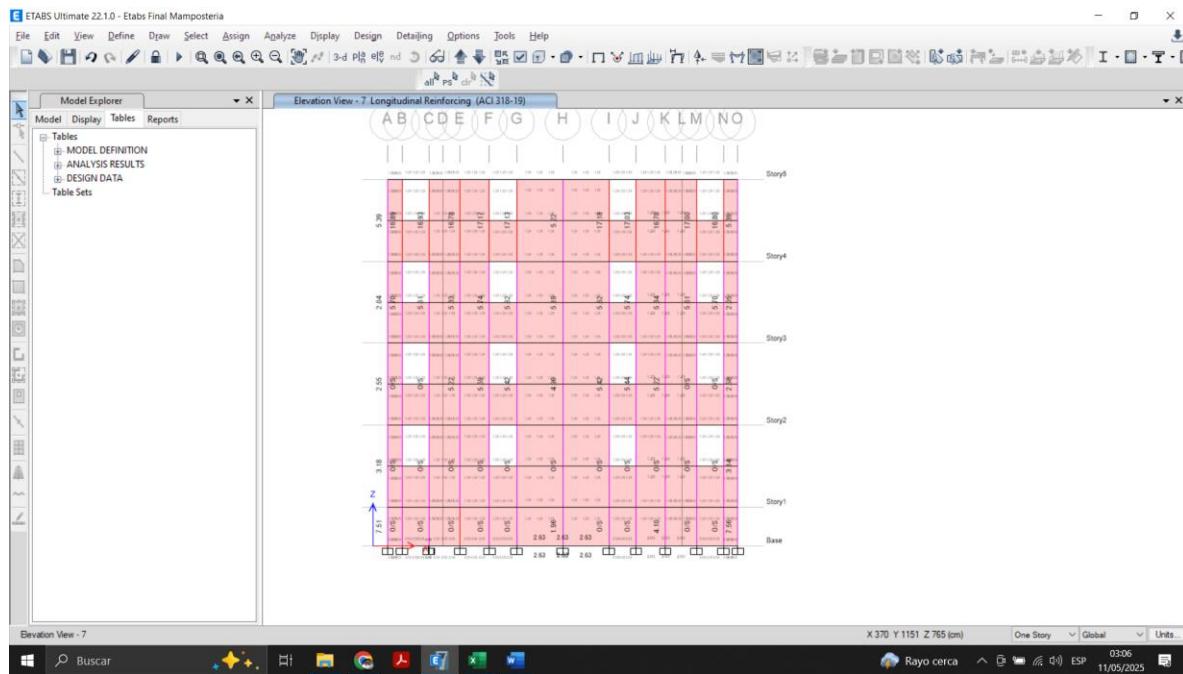


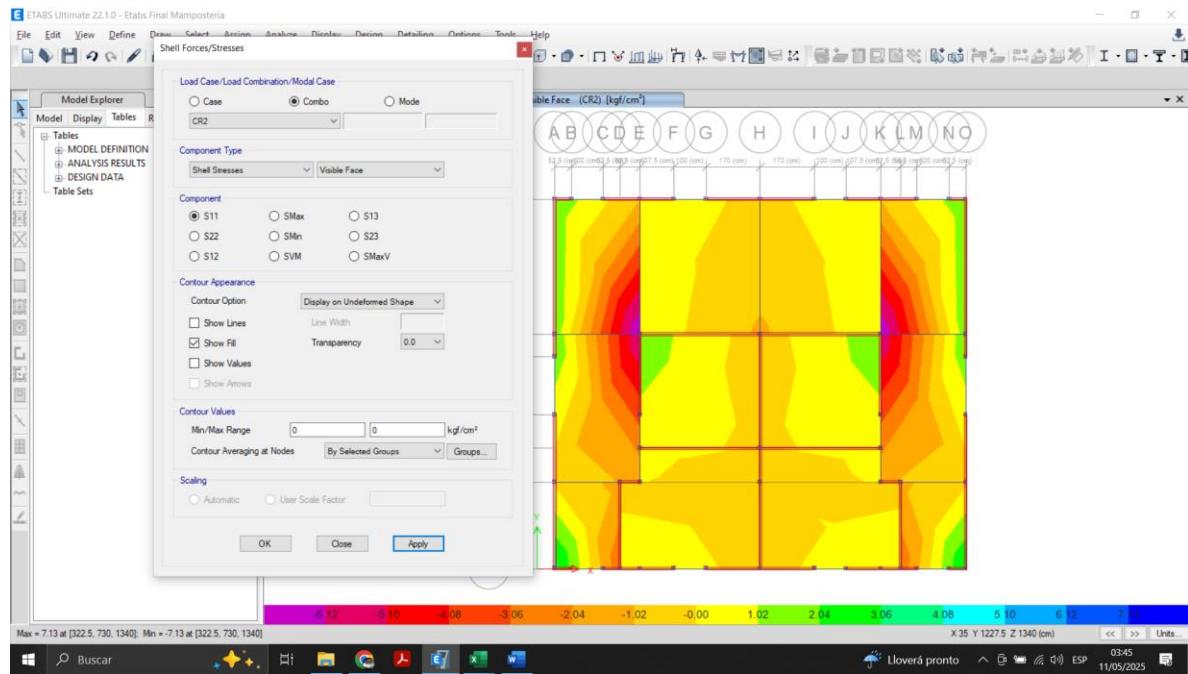
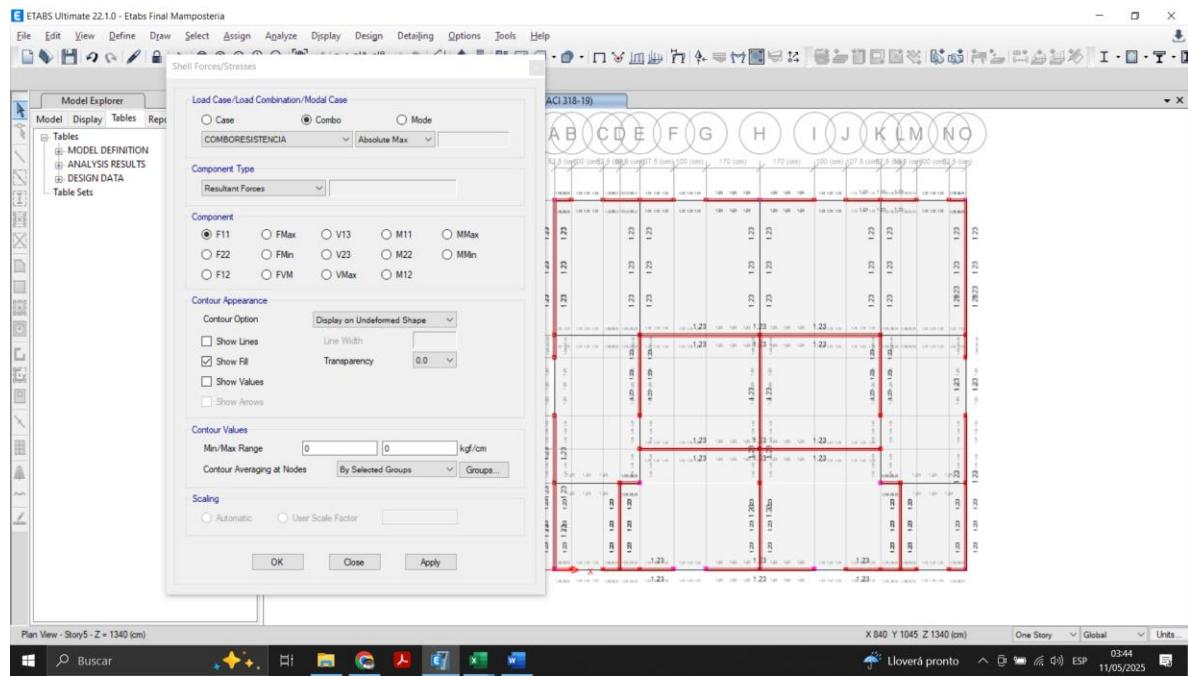
El periodo obtenido del programa es menor al calculado

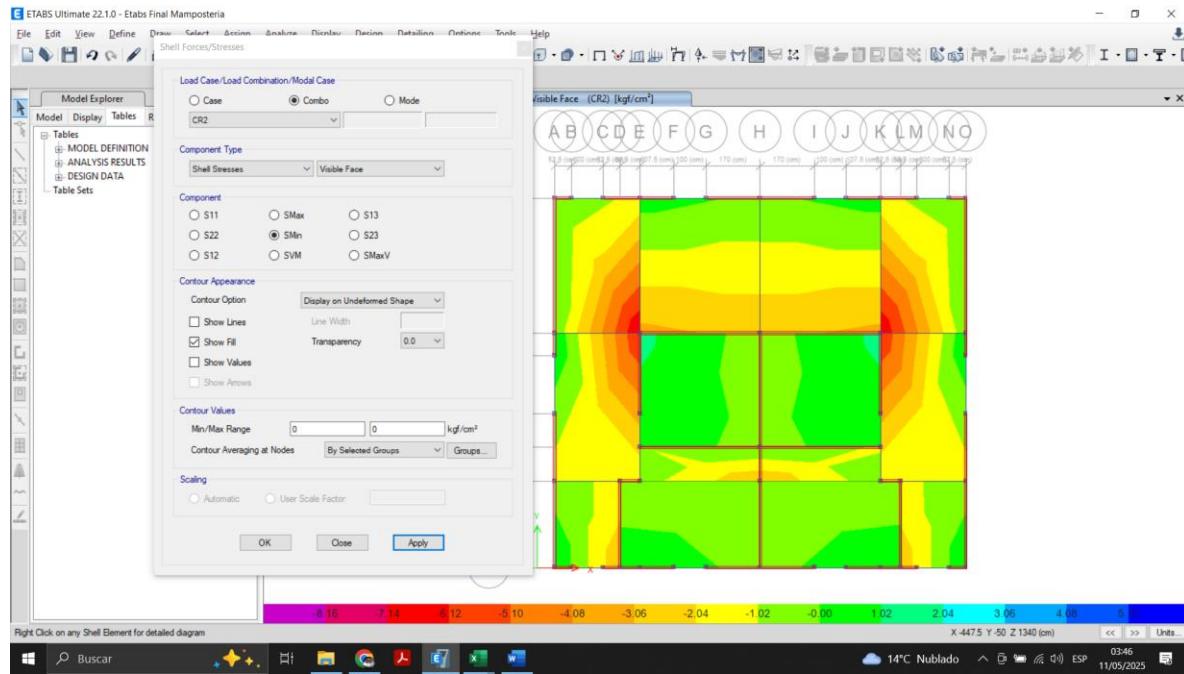


Datos Generados

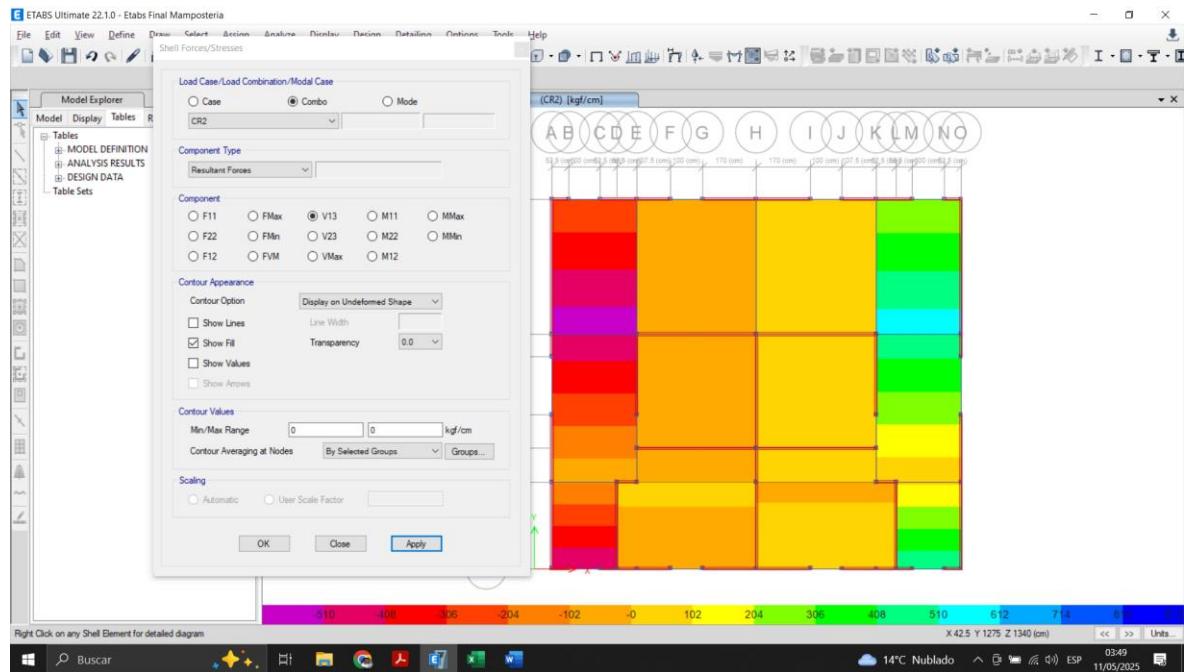








Chequeo con COMBORESISTENCIA



Momentos para Diseño

