Salahaddin University

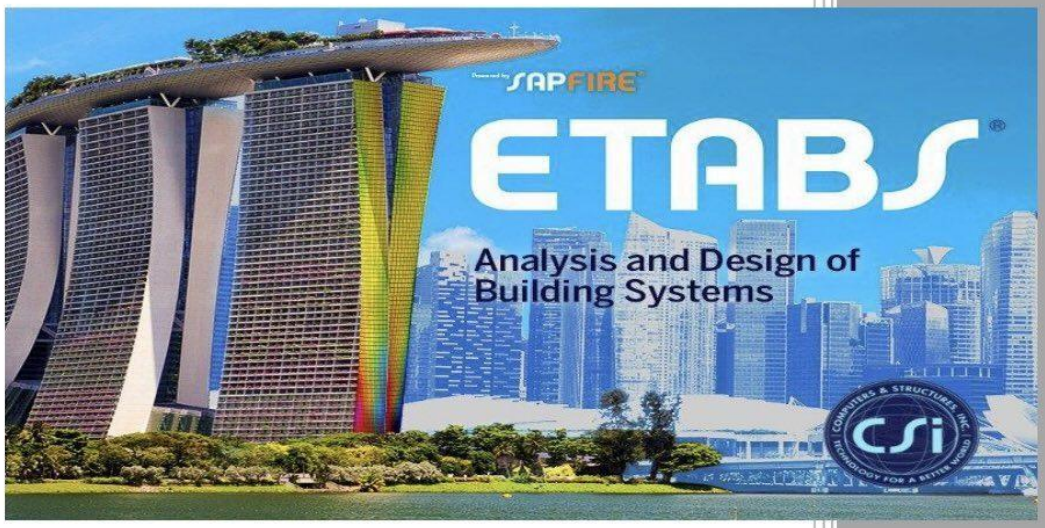
College of Engineering

Civil Engineering Department

2023 - 2024

Part I

CAD Software



Dr. Ali Ramadhan Yousif

Prof. of Structural Engineering

Dr. Muhammad Ismaiel Omer

Ph.D in Structural Engineering

Salahaddin University-Erbil

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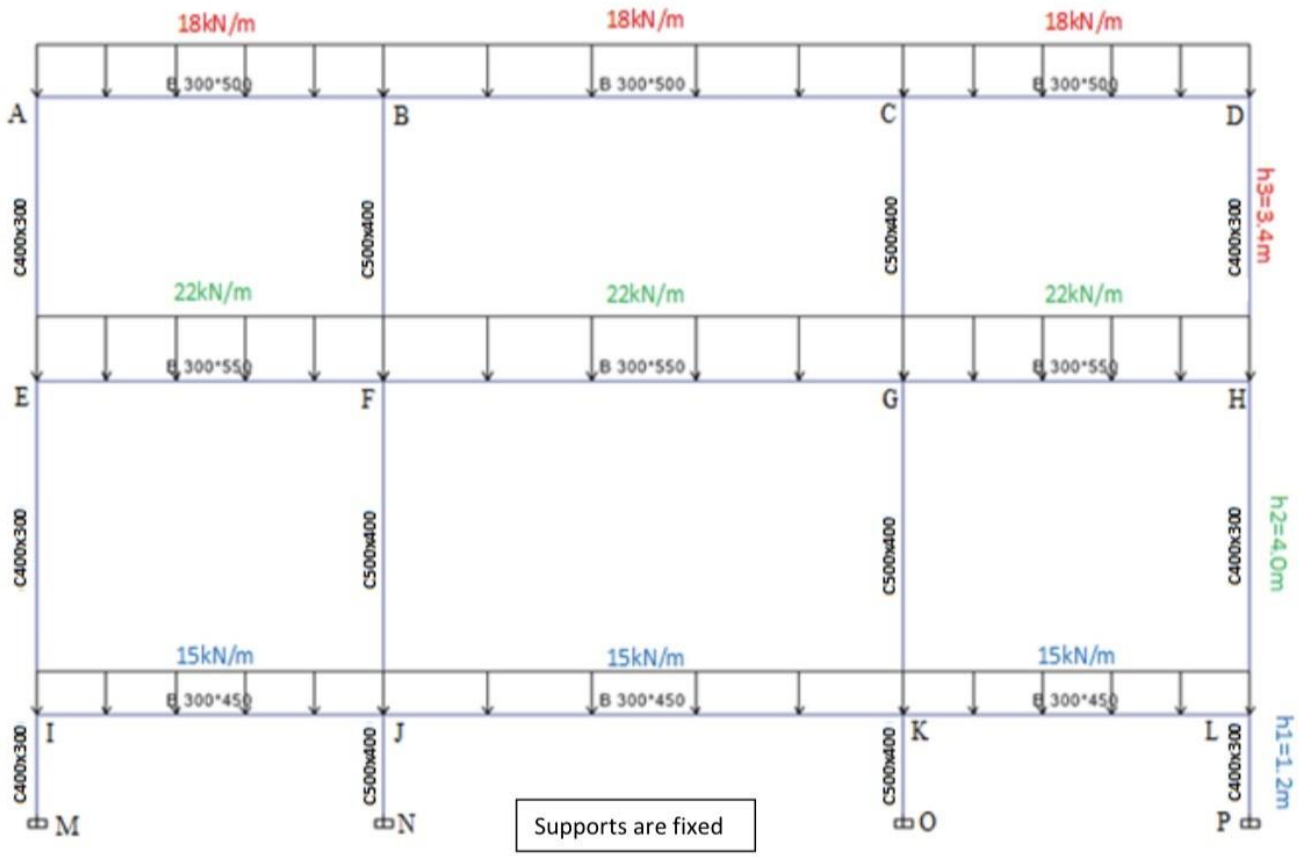
Ex.1

Analysis and Design of Multi-story Frame by **(ETABS V19.1.0 Program)** and **(Hand calculation [Moment Distribution Method]);** Comparison of results.

f`c=28 MPa (for all structure) & fy=420 MPa (for steel bars).

The multi-story frame plan and elevation are as in following:

Plan of the multi-story frame

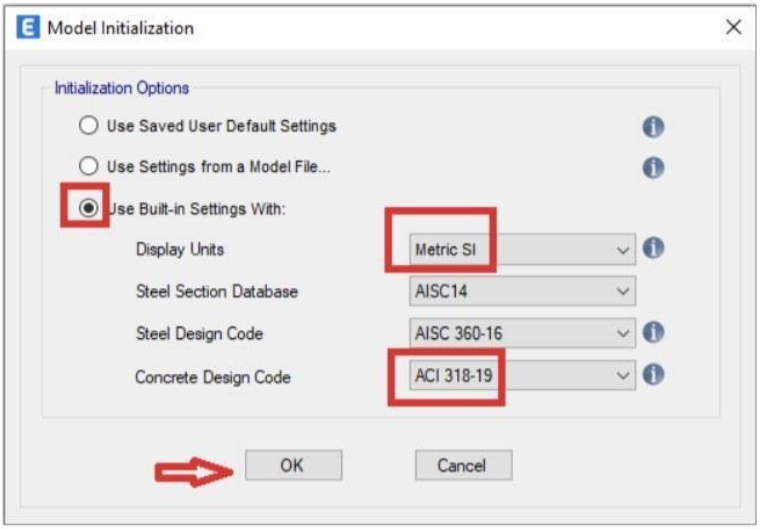


Elevation view of the multi-story frame along (**Gride 1**).

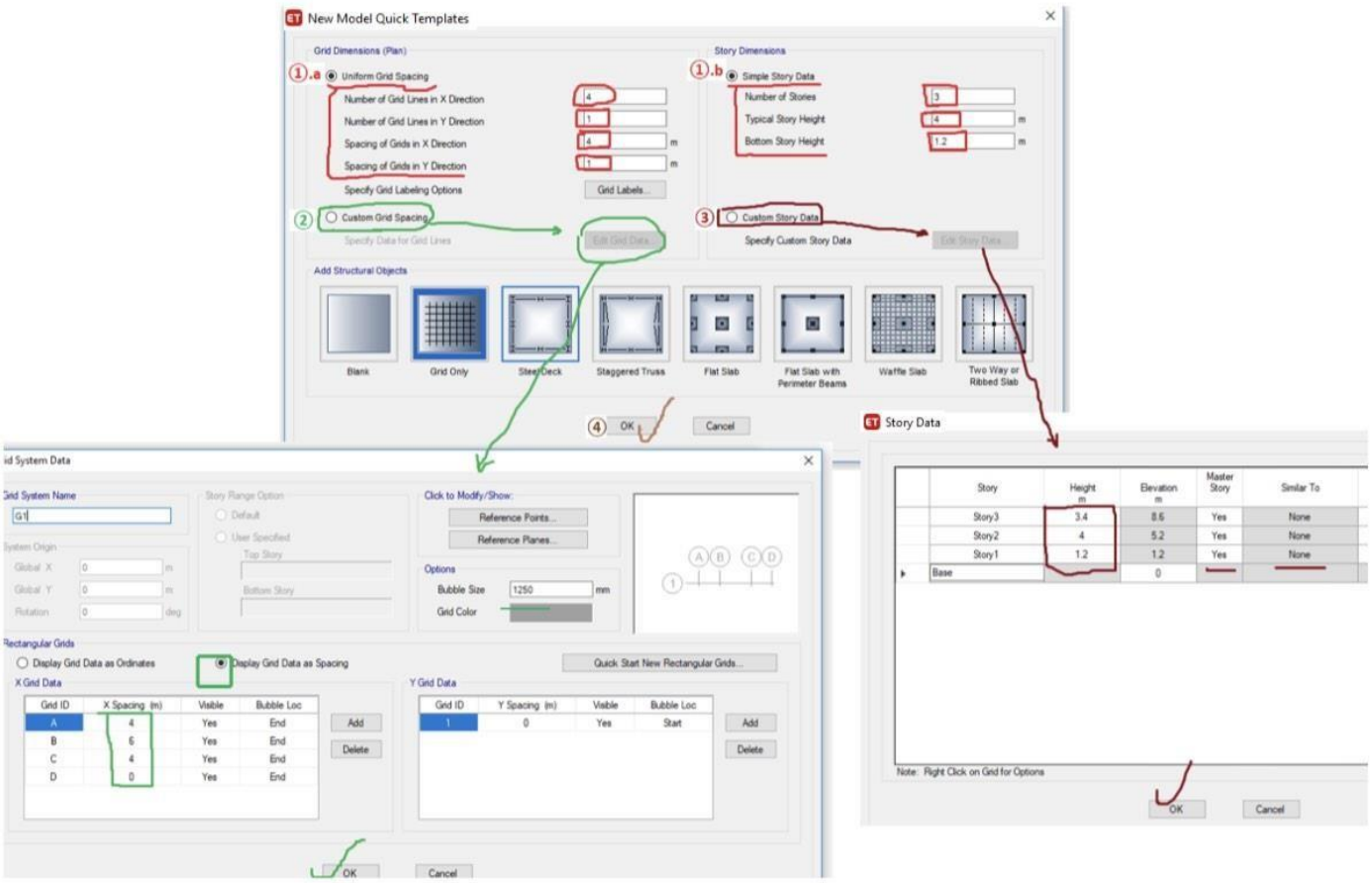
a. Create the Structural multi-story frames

Step 1: To define unit and design codes & Grid dimensions and height of stories.

File menu → New model → Select (**Built-in setting with:**) → **Display units (Metric SI)**, **(Concrete design code) ACI 318-19**→ Ok

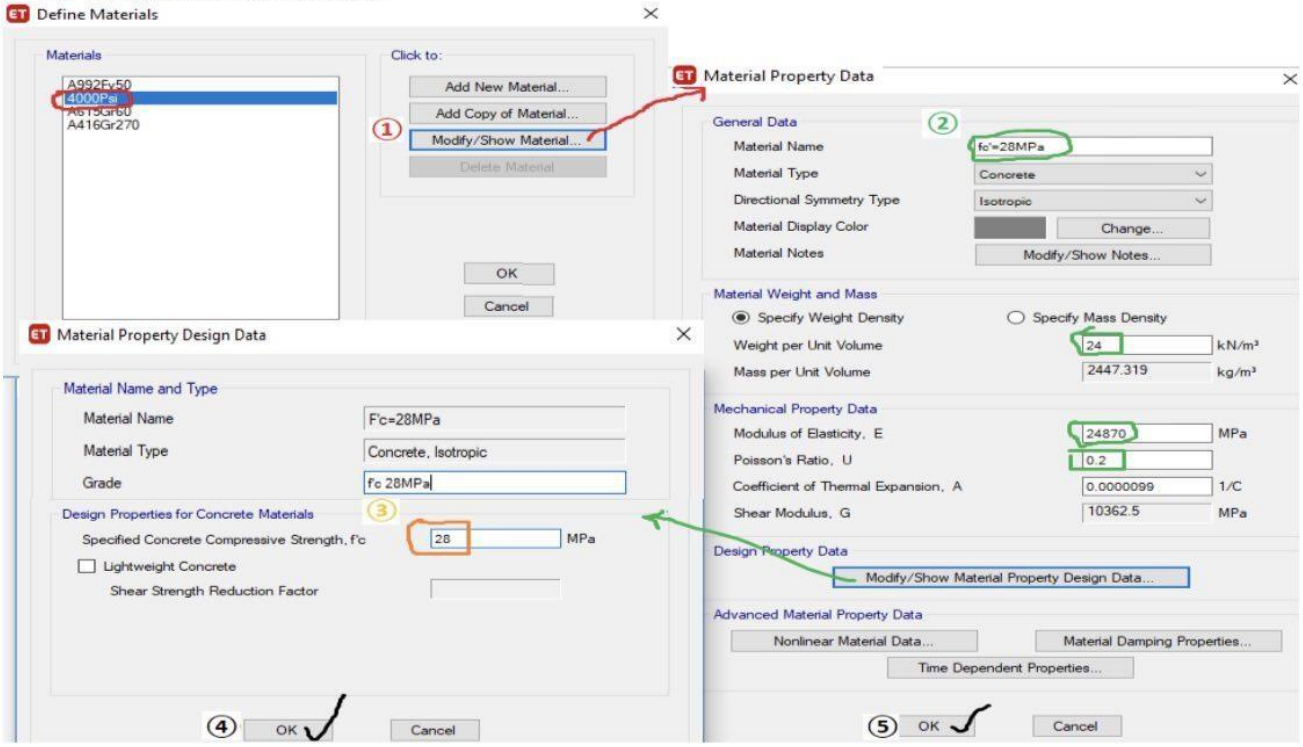


Following window is display → **1.**The grids in x- and y-directions, **2.** Spacing between x and y grids, **3.** Number of stories.

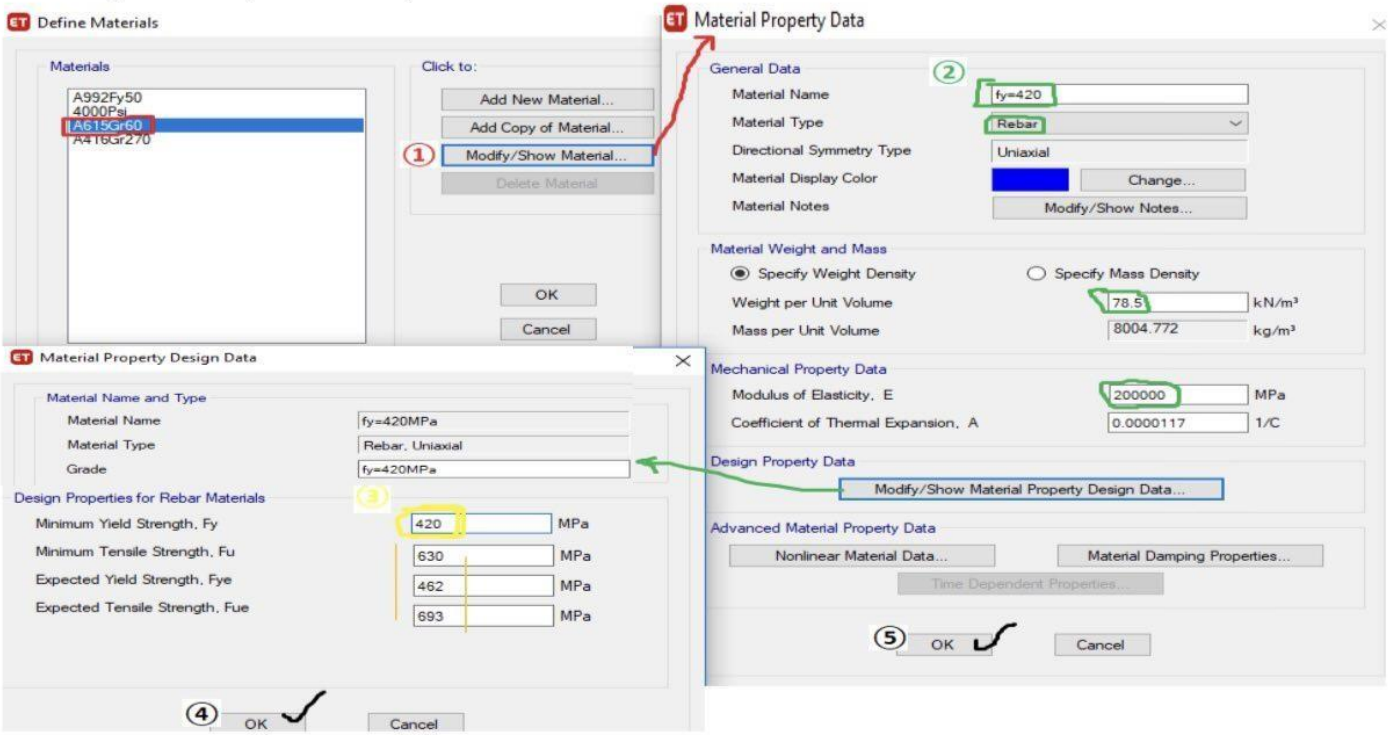


Step 2: Define Materials: **Define menu → Material properties** Material Properties...

- f'c =28 MPa (for all structure):



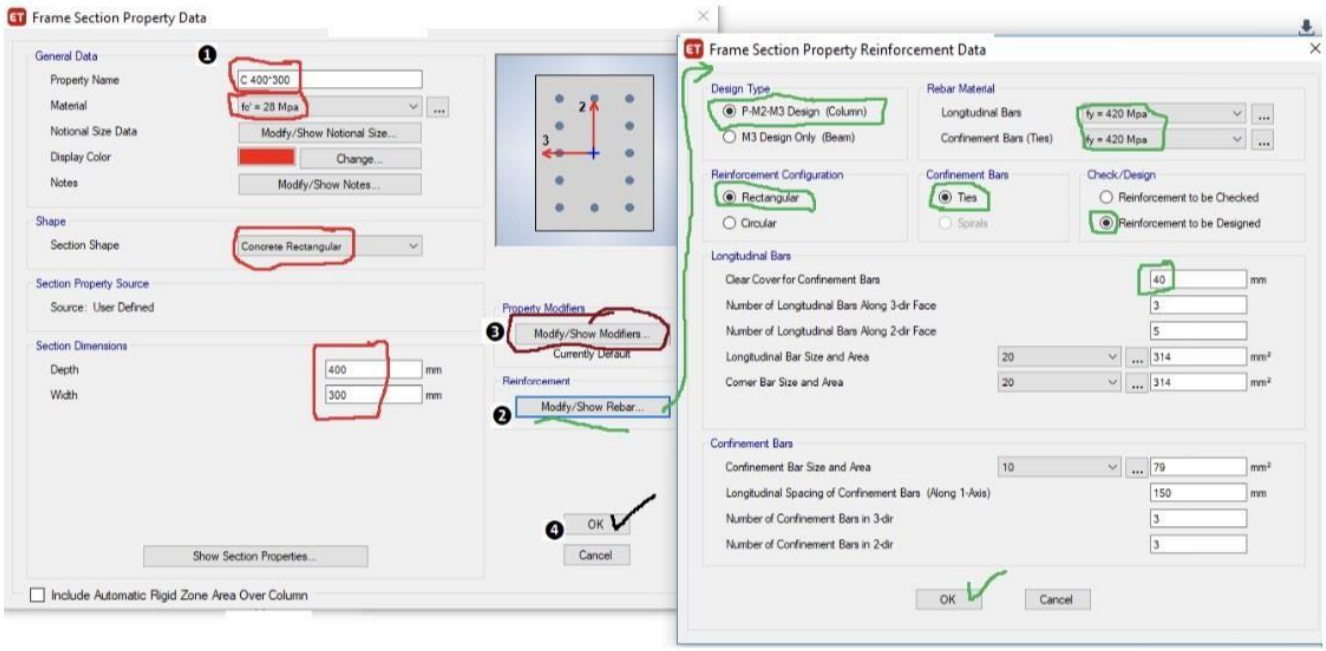
- fy=420 MPa (for steel bars):



Step 3: Defines: Columns, beams

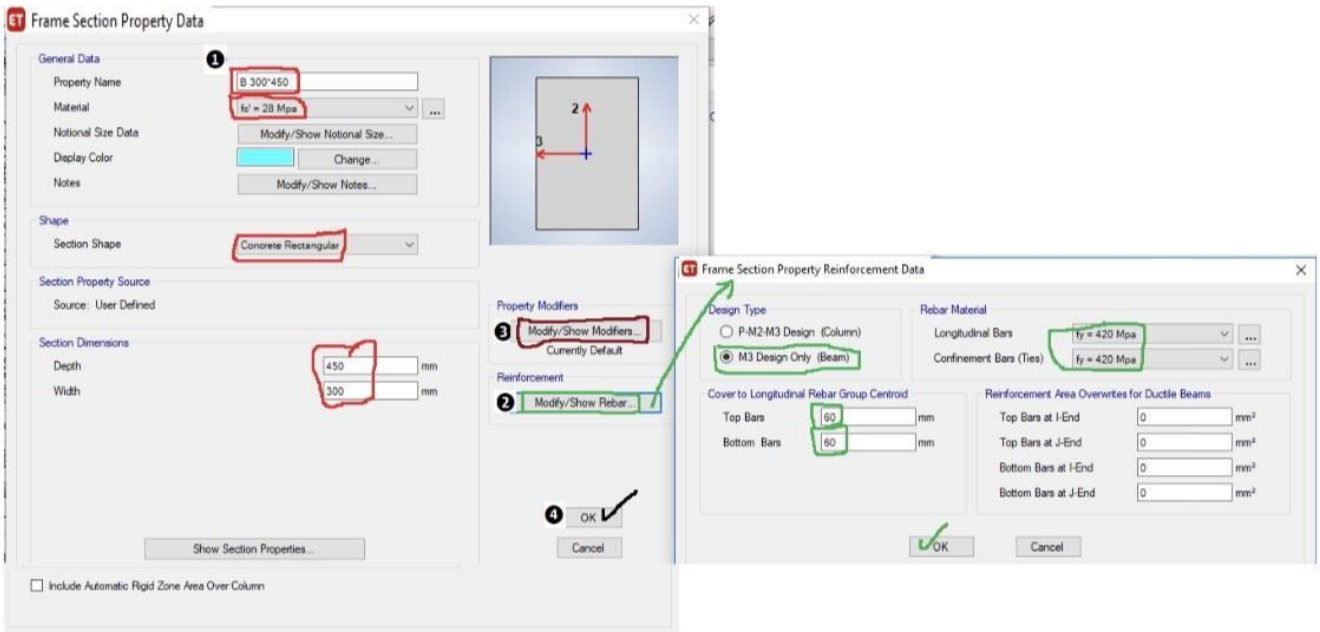
▪ Columns

Define menu → section properties → frame sections → ConcCol → add copy of property… (Modify the property of the columns) & (Modify/Show Rebar…) → … Ok



▪ Beams:

Define menu → section properties → frame sections → ConcBm → add copy of property… (Modify the property of the beams) & (Modify/Show Rebar…) → … Ok



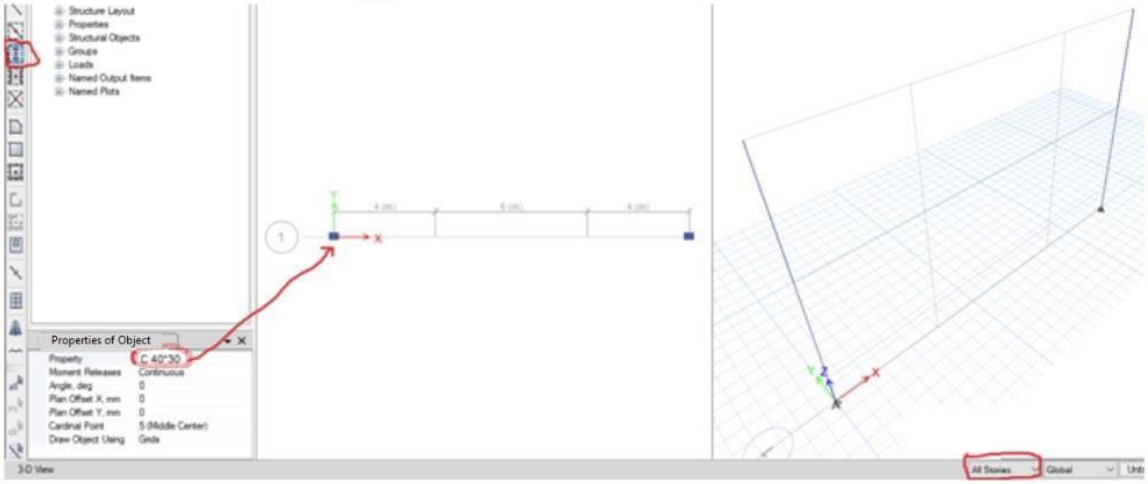
Step 4: Draw Columns and Beams:


Draw Beam/Column (Plan, Elev. , 3D).

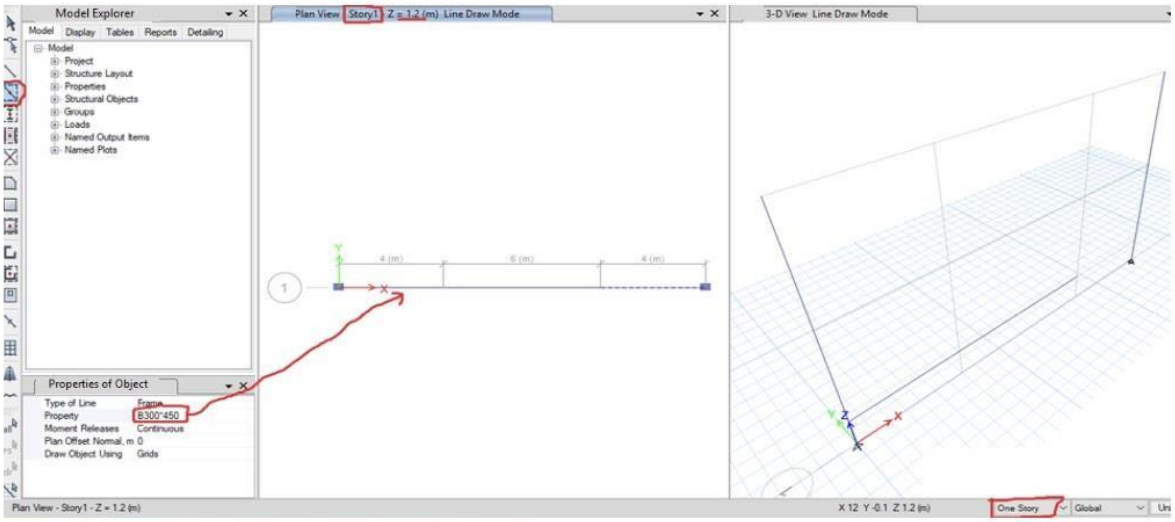

Quick Draw Beams/Columns (Plan, Elev., 3D).


Quick Draw Columns (Plan).

- **To Draw Columns:**
  On Plan View → go to story 3 → select (**All Stories**),
  Click on quick draw column icon  → choose (Property: C .....)→ & draw columns.



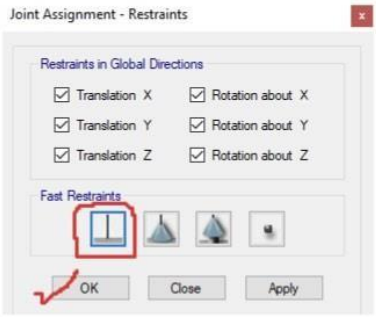
- **To Draw Beams** On Plan View → go to story ..... → select (**One Story**),
  Click on quick draw beam icon  → choose (Property: B .....)→ and draw beams.



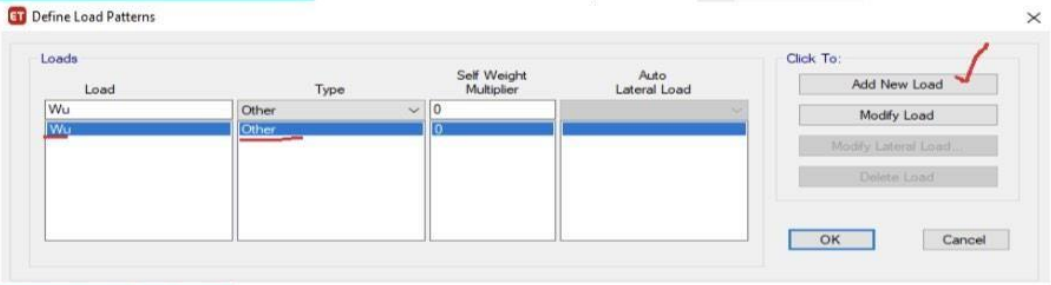
Step 5: Fixing the Ground Floor Joints(Columns):

Select (**One Story**) → Select ground floor (Base) joints,

And click on assign → Joints  Joint → restrains  Restraints... → Ok



Step 6: Define Static Load Patterns: Define menu → Load patterns Load Patterns...

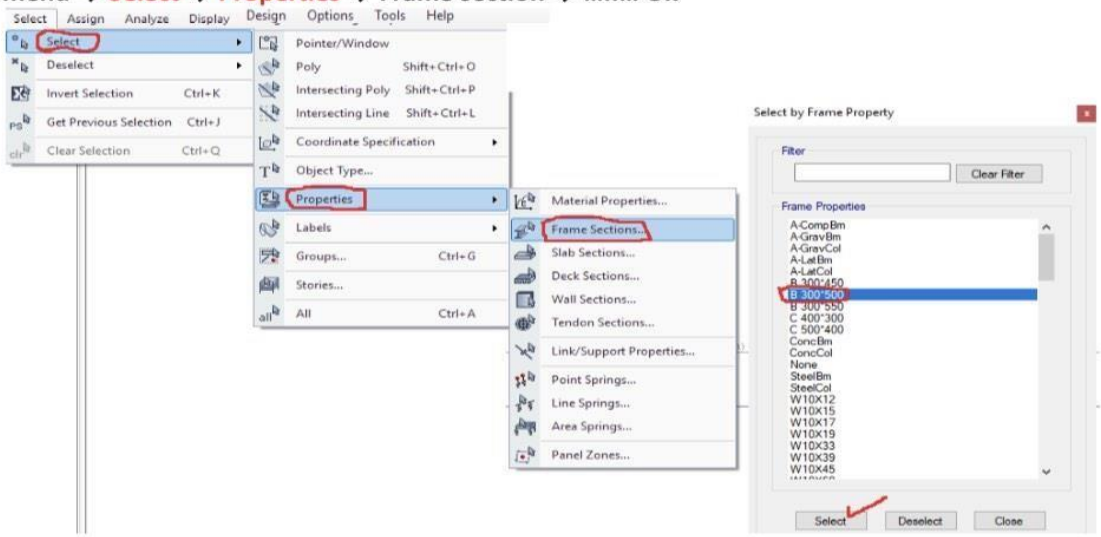


Step 7: Assign Gravity Loads:

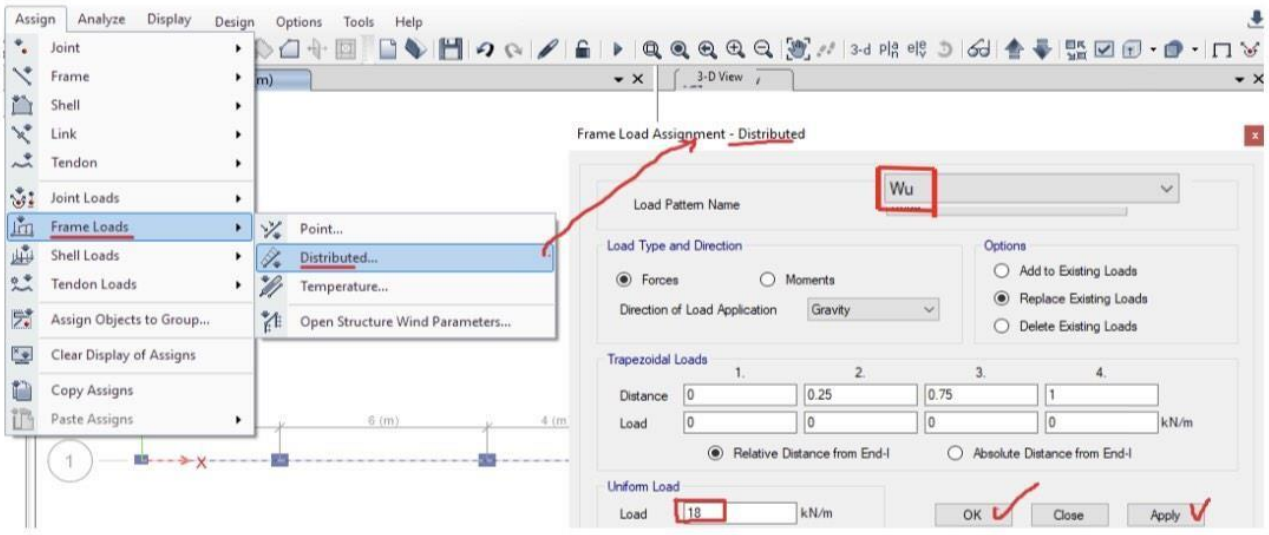
In this Step, the Line loads will be applied to the model. Make sure that the (**One story**) feature is enabled and that the plan View is active.

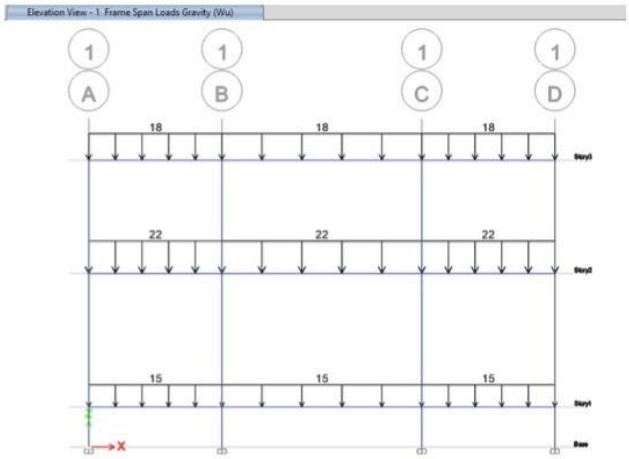
Now we will assign the line loads to the beams.

Select menu → Select → Properties → Frame section → ..... Ok



After that; **Assign menu → frame loads** Frame Loads **→ distributed** Distributed... **..... → Ok.**

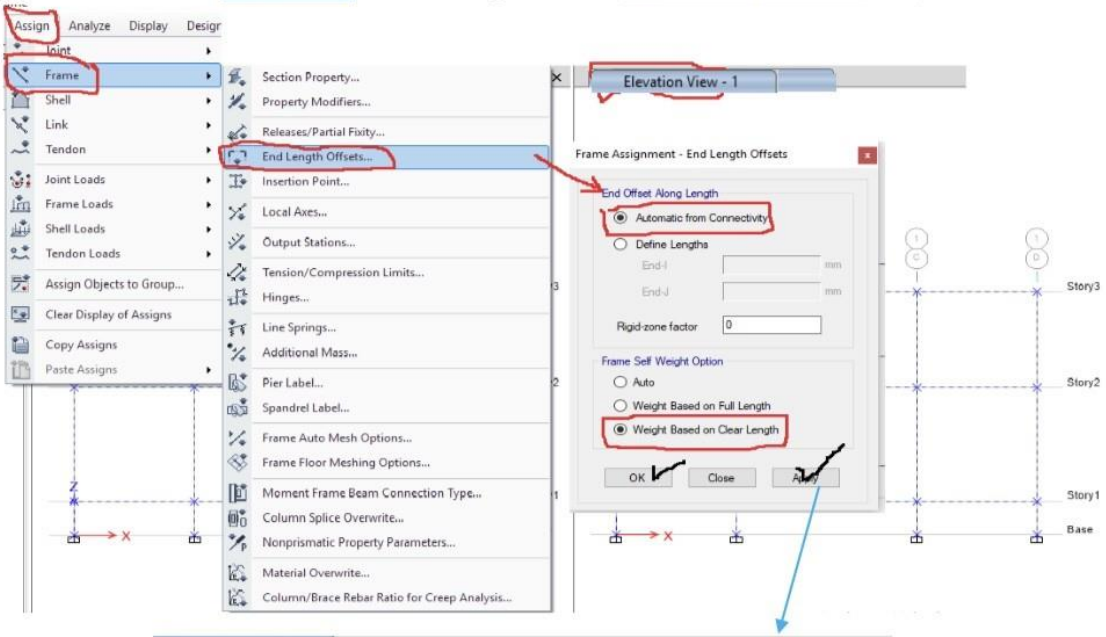


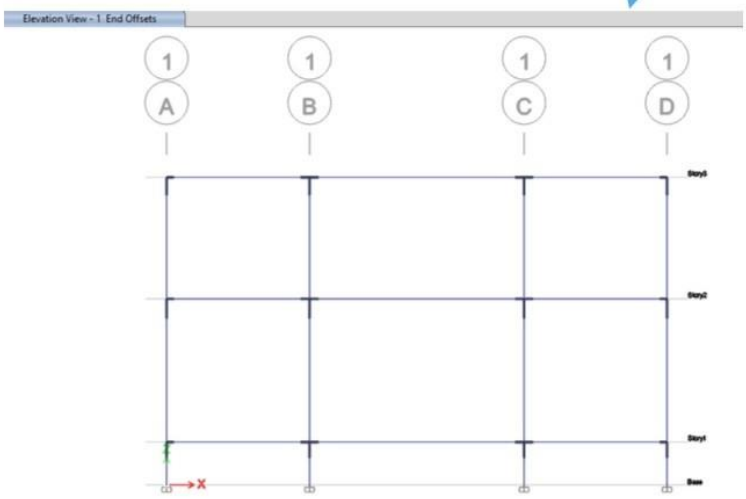


Step 8: Moments @ the face of supports (Columns):

Elevation view (**Gride 1**) or **3D** → select multi-story frame,

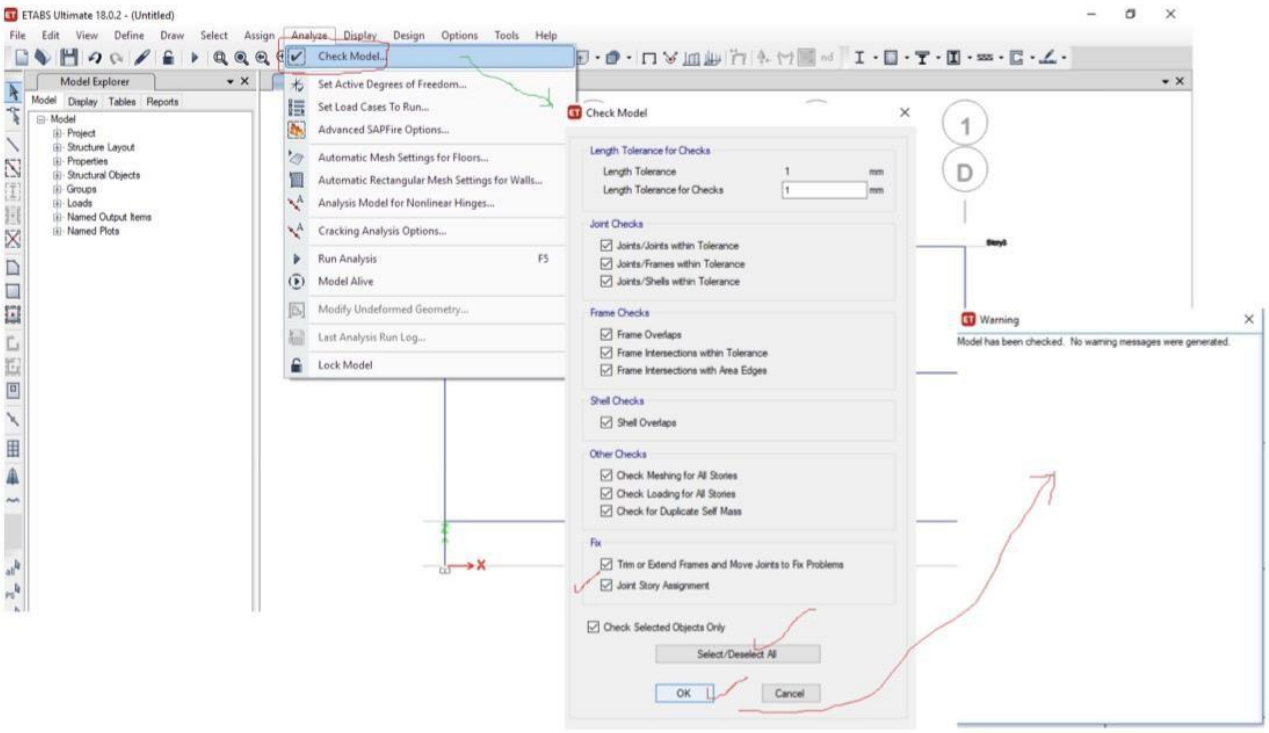
Assign menu → Frame Frame → **End length offsets** End Length Offsets... ↓





Step 9: Check the Model:

To check the Model: Analyze menu → check model Check Model... → select all items … → Ok.



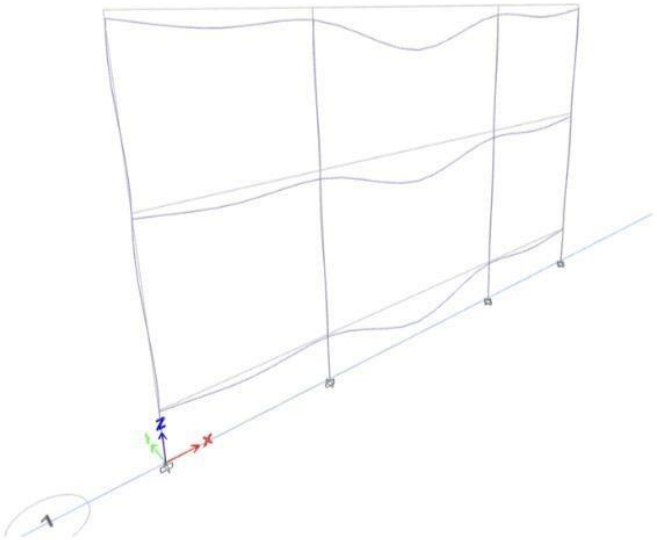
Step 10: Run the Analysis:

In this step, the analysis will be Run.

Click the Analyze menu → Run Analysis command or The Run Analysis button, .

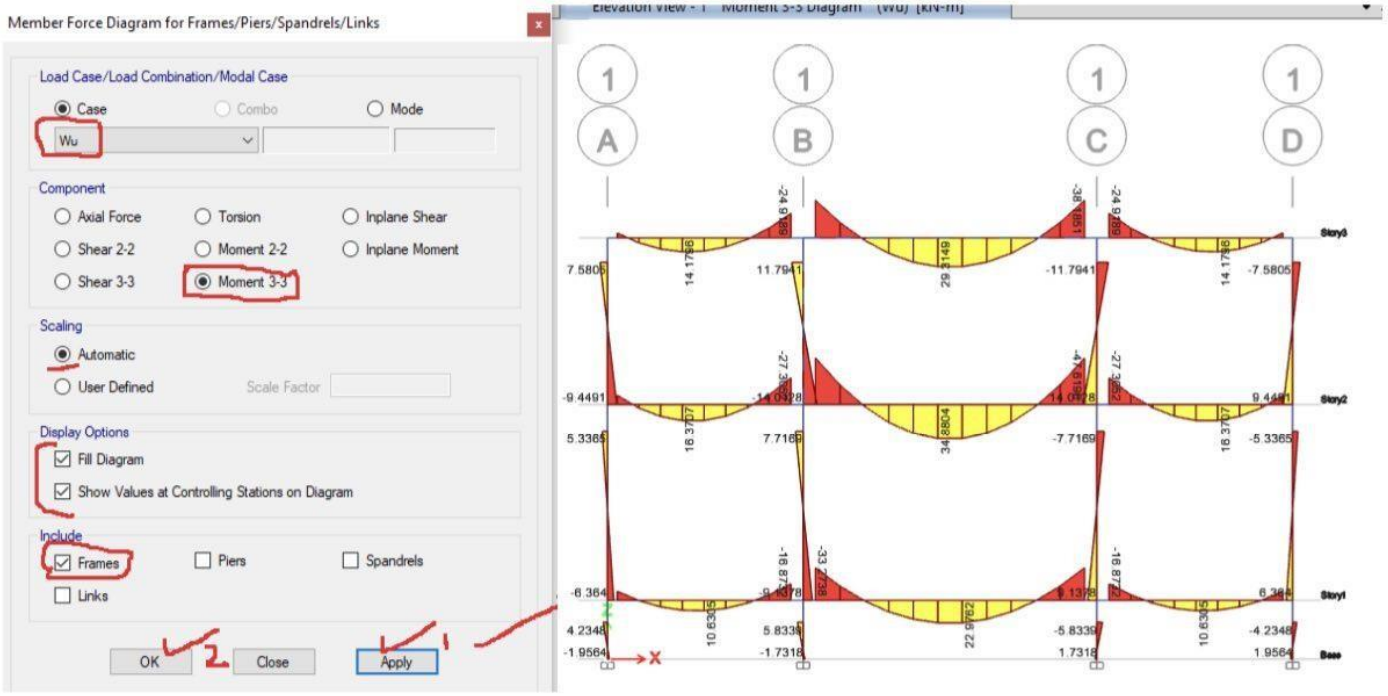
When the **entire analysis process has been completed**, the model automatically **displays a deformed shape view of the model**, and the model is locked. The model is locked when the **Lock/Unlock Model button**, , Appears locked.

Locking the model **prevents any changes to the model** that would invalidate the analysis results.

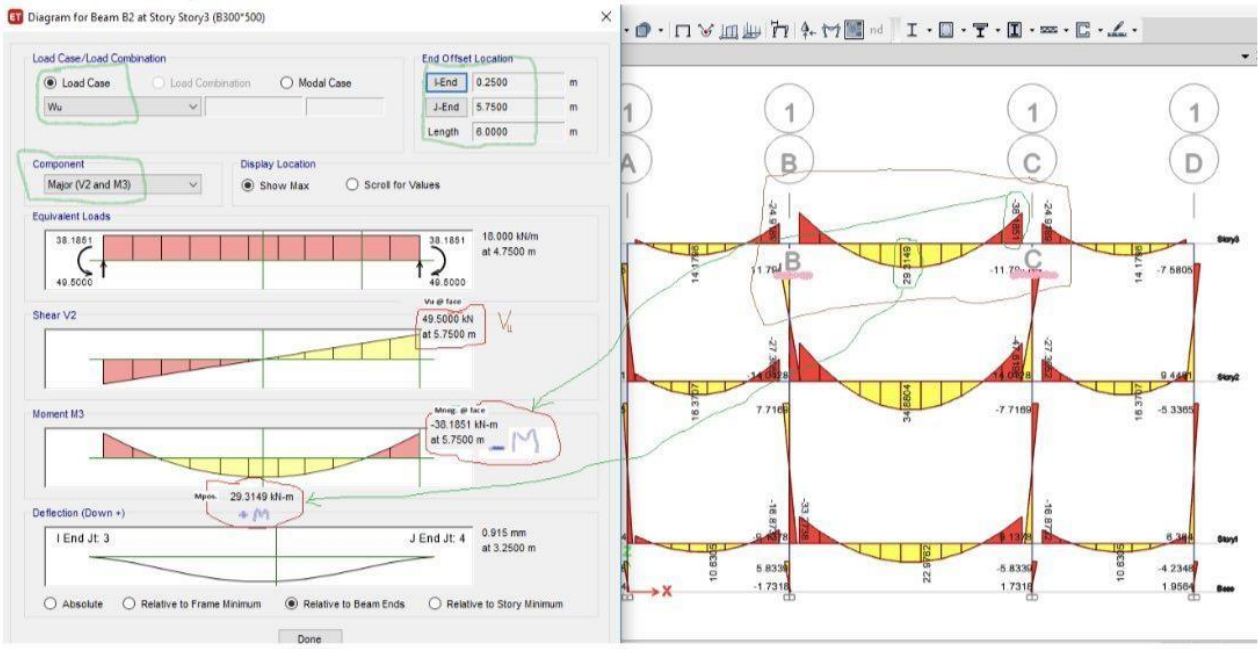


Step 11: Display the Results:

- Make sure that the elevation view (**Grid 1**) is active.
  Display menu → Force/stress diagrams → Frame/pier/Spandrel/Link force | ..... **→Ok**



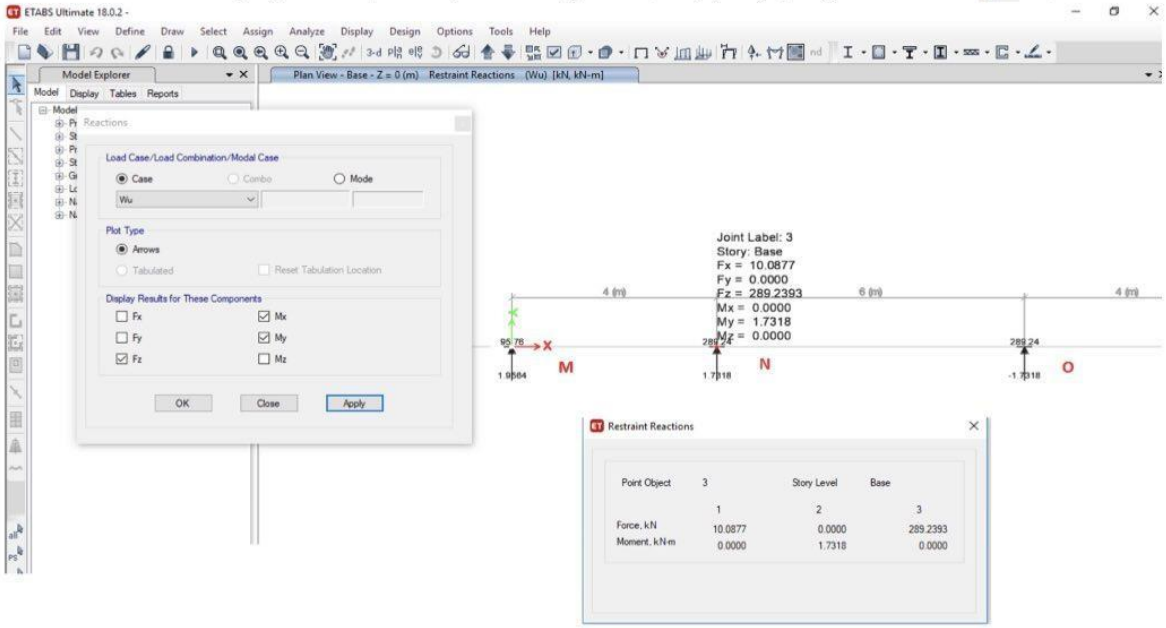
- Right click on the beam or column between any grid lines to access the diagram for beams and columns from shown in figure below.



- **Find reactions:**

Elevation view (**Plan/Base**) or **3D** or **Grid 1** active,

To find reactions: Display menu → Force/stress diagrams → Support/spring reactions… → Ok



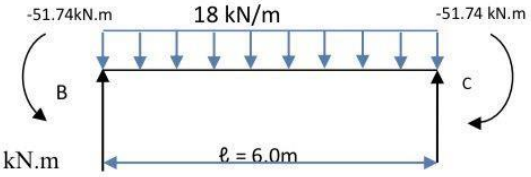
b. Moment Distribution Method for multi-story frame by (**hand calculation**)

Joint	A		B			F				E		
member	AE	AB	BA	BC	BF	FB	FG	FJ	FE	EF	EA	EI
D.F	0.376	0.624	0.345	0.115	0.54	0.335	0.095	0.285	0.285	0.545	0.24	0.209
F.E.M		-24	24	-54			-66		29	-29		
D.M	9.024	14.976	10.35	3.45	16.2	12.40	3.52	10.55	10.55	15.81	6.96	6.06
C.O.F	3.48	5.18	7.49		6.20	8.1		2.48	7.90	5.27	4.51	1.74
D.M	-3.25	-5.40	-4.72	-1.57	-7.39	-6.19	-1.76	-5.27	-5.27	-6.28	-2.77	-2.41
C.O.F	-1.38	-2.36	-2.70		-3.09	-3.70		-0.77	-3.14	-2.63	-1.63	-0.38
D.M	1.41	2.34	2.00	0.67	3.13	2.55	0.72	2.17	2.17	1.09	0.48	0.42
C.O.F	0.24	1.00	1.17		1.27	1.56		0.31	0.55	1.08	0.70	0.14
D.M	-0.47	-0.77	-0.84	-0.28	-1.32	-0.81	-0.23	-0.69	-0.69	-1.05	-0.46	-0.40
	9.05	-9.05	36.74	-51.74	15.00	13.91	-63.75	8.78	41.06	-15.71	7.80	5.17

Calculate positive moments for interior spans as follows: for interior panel, $M_{pos} = 18 \times 6^2 / 8 - 51.74 = 29.26$ kN.m

*To find reactions, take moments about point B (@center of column);

$6\,R_C - 18 \times 6 \times 3 = 0 \rightarrow R_B = R_C = 54$ kN



M_{neg} **at face of support B, C** $= 51.74 - 54 \times 0.25 + (18 \times 0.25^2 / 2) \approx 38.80$ kN.m

Check $M_{pos} + (M_{neg})_{average\ at\ face} \le Mo = 18 \times (6-0.5)^2 / 8 = 68.06$ kN.m → $29.26 + 38.8 = 68.06 = Mo = 68.06$ kN.m **OK**

*To find reactions, take moments about point B` (@face of column);

$5.5\,R_C` - 18 \times 5.5 \times 2.75 = 0 \rightarrow R_B` = R_C` = 49.5$ kN (@face of column)