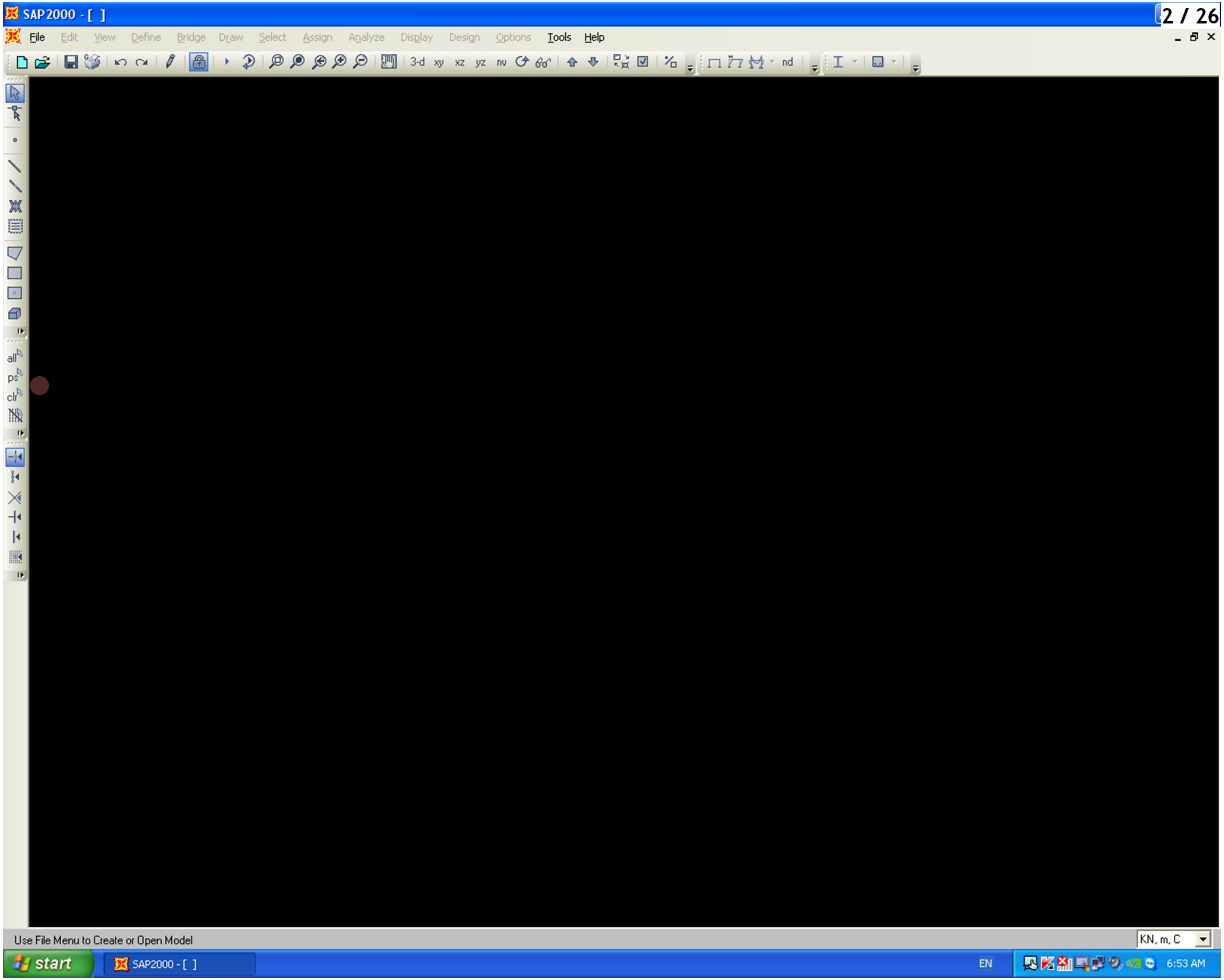

SAP2000 - [ ]
File Edit View Define Bridge Draw Select Assign Analyze Display Design Options Tools Help
3-d xy xz yz nv nd
all ps clr
Use File Menu to Create or Open Model
KN, m, C
start
SAP2000 - [ ]
EN
6:53 AM

5.1. Regular systems

5.2. Ribbed slab systems

5.3. Two way slab systems

If time permits

5.4. Systems without vertical continuity

5.5. General shape building systems

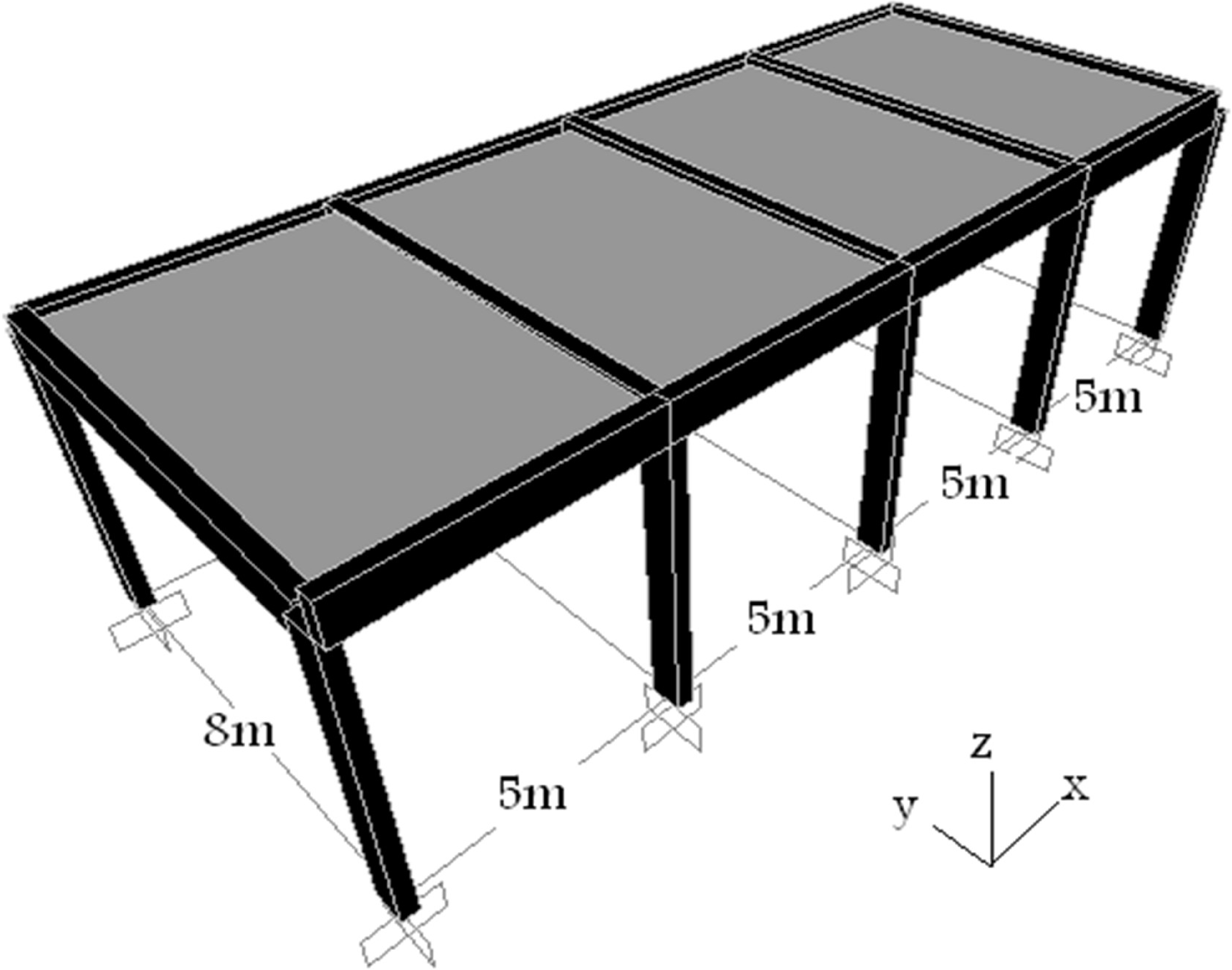
5.1 Regular systems

Regular systems are those which have one way solid slab and vertical continuity; i.e. load of slab is transferred to beams, from beams to columns and then to footings.

Analysis of all systems are done using either 1D, 2D or 3D modeling.

Regular systems: example

- 1-storey RC slab-beam factory structure shown next slide
- Fixed foundations, 4 spans 5m bays in x and a single 8m span in y, 6m elevation
- E=24GPa, μ=0.2, ρ=2.5t/m^3
- Cylinder concrete strength=25MPa, steel yield=420MPa
- superimposed loads=5kN/m^2, live load=9kN/m^2


6m
5m
5m
5m
8m
5m
z
y
x

Regular systems: example

- Due to cracking of elements, use the following modifiers for gross inertia for 3D analysis (ACI R10.11.1):
  - Beam 0.35
  - Column 0.7
  - One way slab (0.35, 0.035)

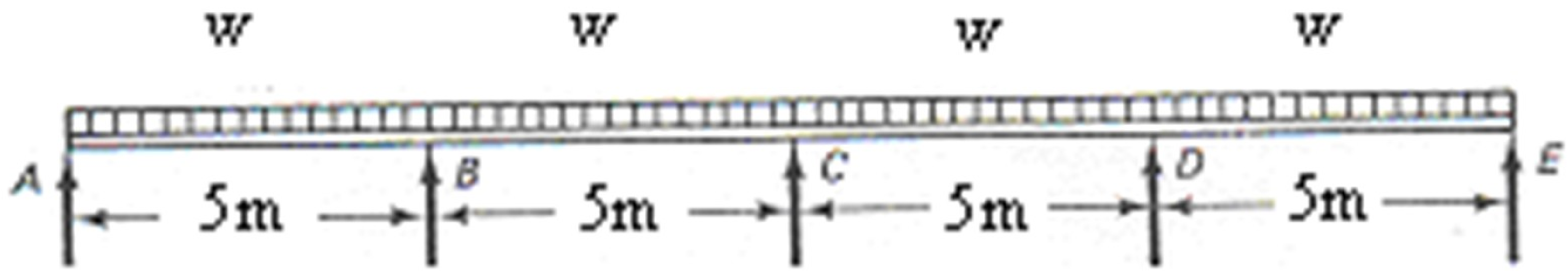
Preliminary dimensioning

- Slab: According to ACI 9.5.2 thickness of slab=500/24=20.83cm, but considering that concentrated loads might be placed at middle of slab, use 25cm thickness
- Beam: 800/16=50cm, however beams fail by strength and not deflection, and because it is a factory use: drop beams 30cmX80cm (6cm cover)
- Columns: use 30X60cm reinforced on two faces (cover 4cm).

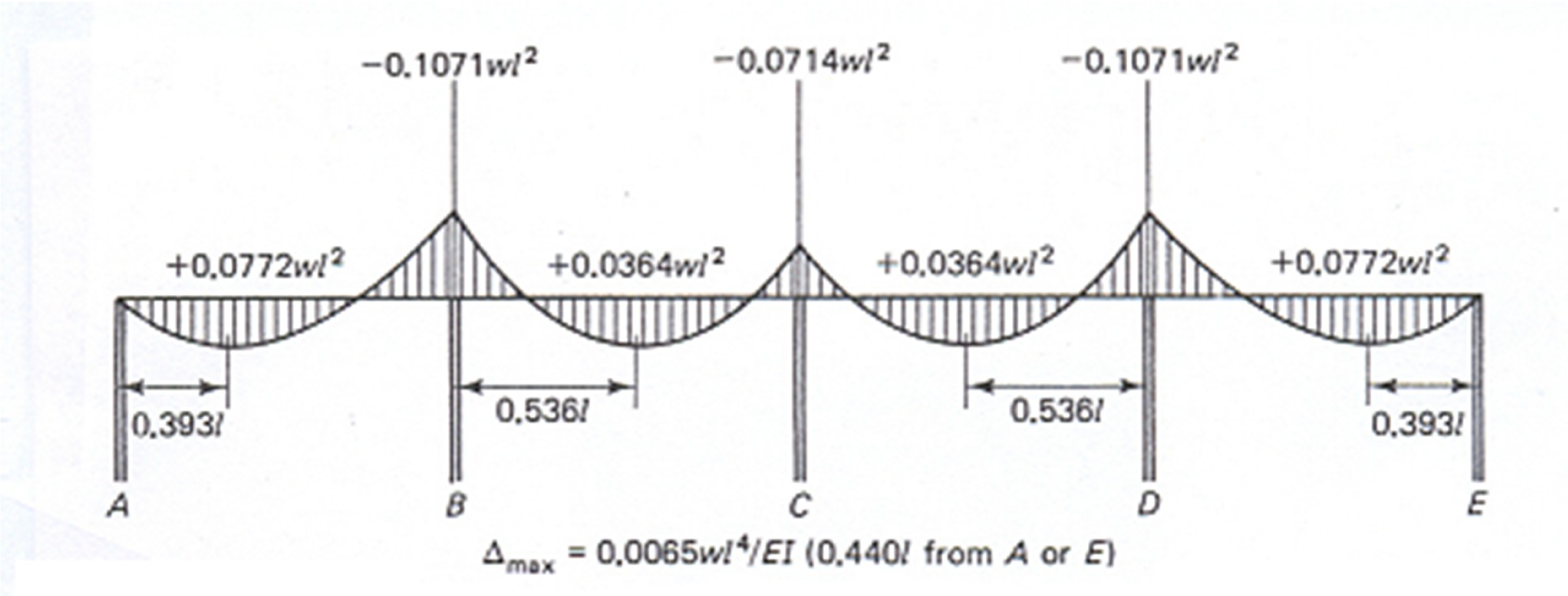
1D analysis and design: slab model

- Slab $M_{11} = 1.0$ $M_{12} = M_{22} = 0.01$

  beam $M_{33} = 100$ torsional $= 0.01$



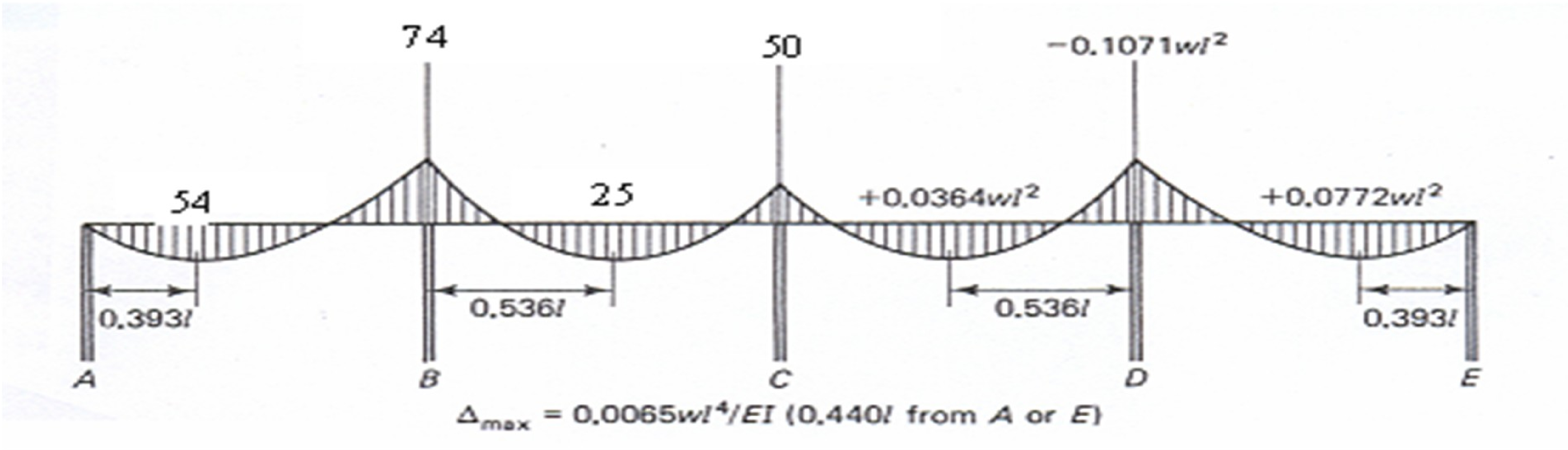
1D analysis and design: slab analysis

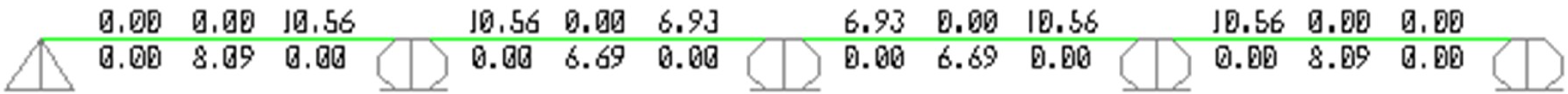


1D analysis and design: slab analysis

- w_d=(.25*24.5+5)=11.125kN/m
- w_l=9kN/m
- w_u=1.2*11.125+1.6*9=27.75kN/m

1D analysis and design: slab analysis, BM in KN.m, As in square cm

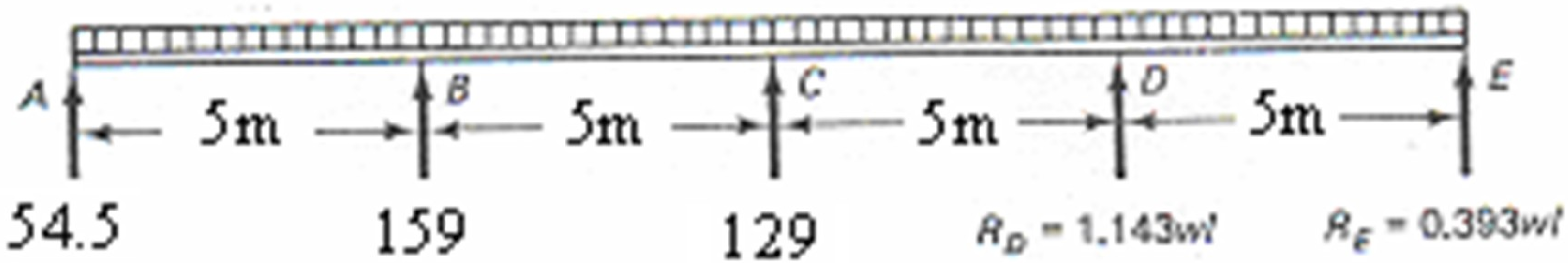




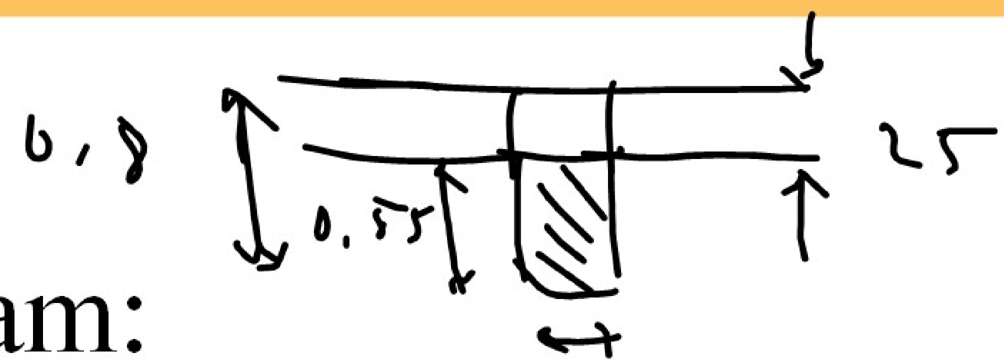
$$A_s \approx \frac{3M_u}{20} = 0.15M_u \geq \frac{1.4}{420}(100*20) = 6.67$$

1D analysis and design: slab analysis, values of reactions in KN

- Note: for slabs and footings of uniform thickness the minimum steel is that for temperature and shrinkage but with maximum spacing three times the thickness or 450mm. (ACI10.5.4)



1D analysis and design: beam analysis,



- Assume simply supported beam:

-Beam C, M_u=(129+1.2*0.3*.55*24.5)*8^2 /8=1070kN.m, As=43.4cm^2

-Beam B, M_u=(159+1.2*0.3*.55*24.5)*8^2 /8=1311kN.m, As=53.1cm^2

-Beam A, M_u=(54.5+1.2*0.3*.55*24.5)*8^2 /8=475kN.m, As=19.3cm^2

3D SAP

If same assumptions are used in 3D model, results should be the same

- Do not put secondary beams
- Set modifiers for slab $m_{12}=m_{22}=0.01$
- Set modifiers for beam torsion=0.01, flexure 3=100, weight=0.55/0.8
- Set modifiers for column: axial=100, flexure=torsion=0.01

3D SAP: Gravity equilibrium checks

D:

Slab=20X8X (0.25X24.5+5) =1780kN

Beams= (5X8) X.55X.3X24.5=161.7kN

Columns=10X6X.3X.6X24.5=264.6KN

Sum=2206.3kN

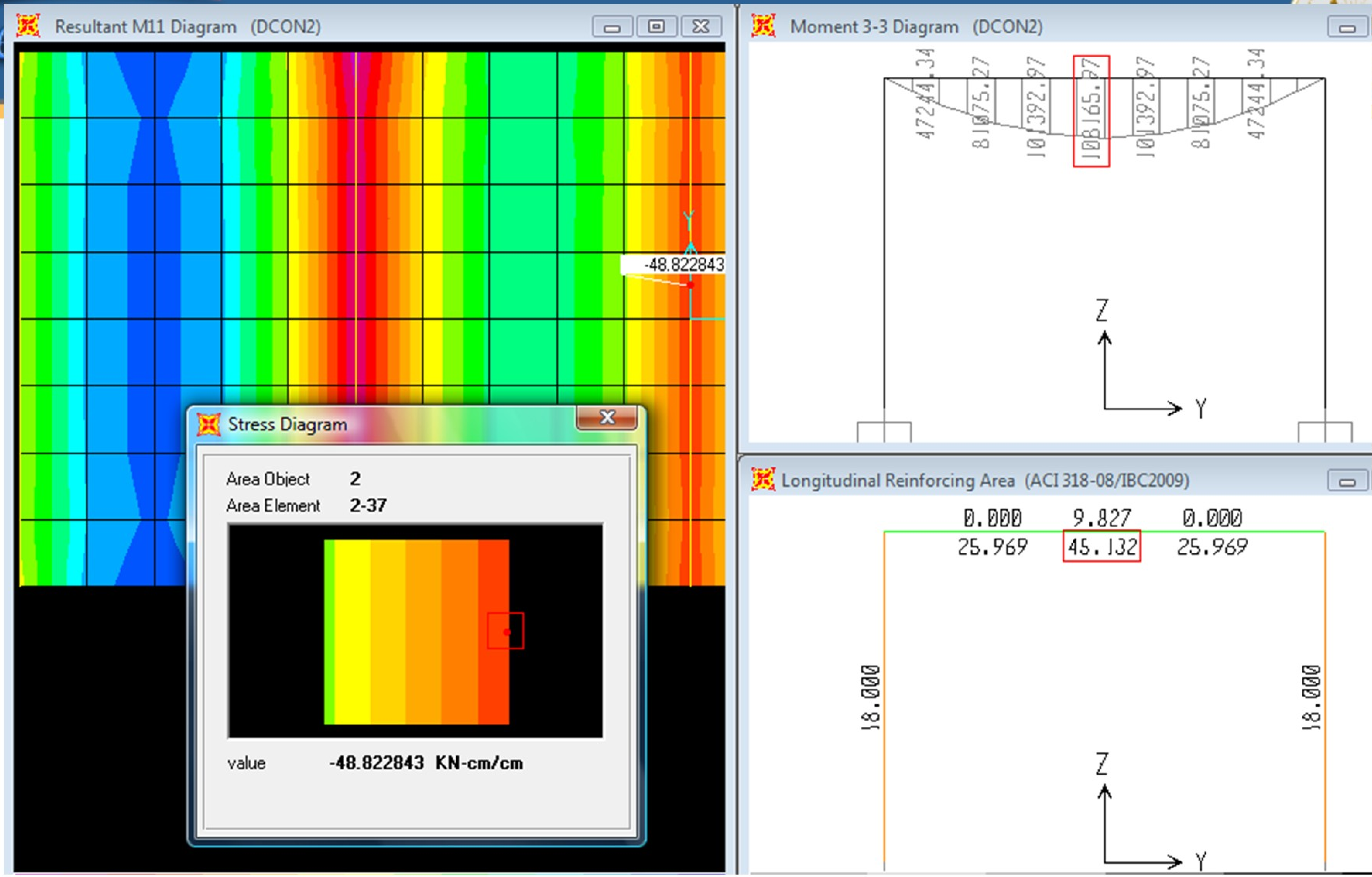
- L:

R =20X8X9=1440KN

Gravity equilibrium checks

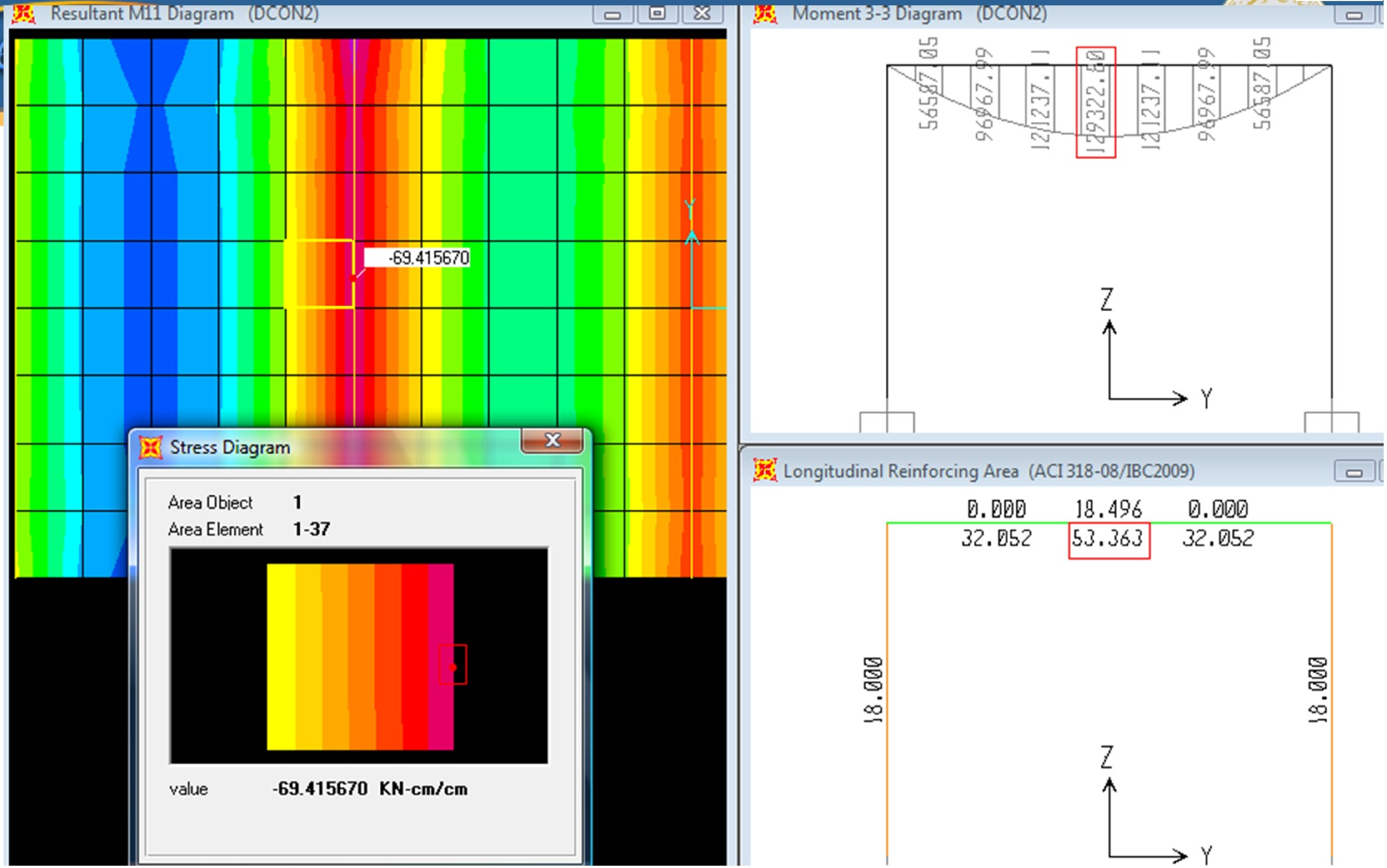
- SAP results:

	OutputCase Text	CaseType Text	GlobalFX KN	GlobalFY KN	GlobalFZ KN	GlobalMX KN-cm	GlobalMY KN-cm	GlobalMZ KN-cm	GlobalX cm
▶	DEAD	LinStatic	-8.327E-17	-5.117E-17	2206.3	000000001478	000000001137	-2.22E-14	0
	live	LinStatic	-4.163E-17	-3.686E-17	1440	000000004547	000000001478	2.776E-15	0

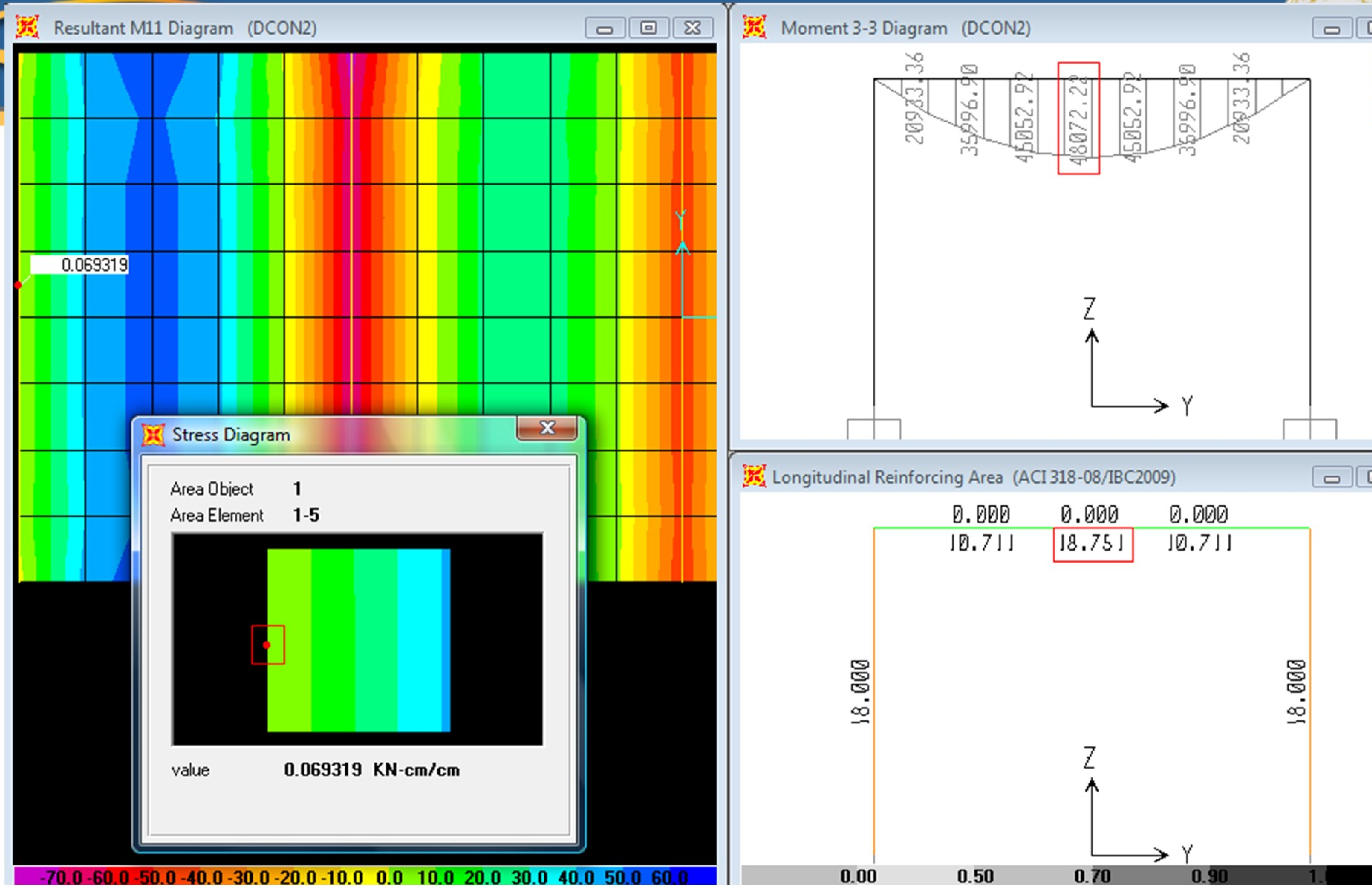


Left: bending moment in slab at point c 48.8kN.m/m

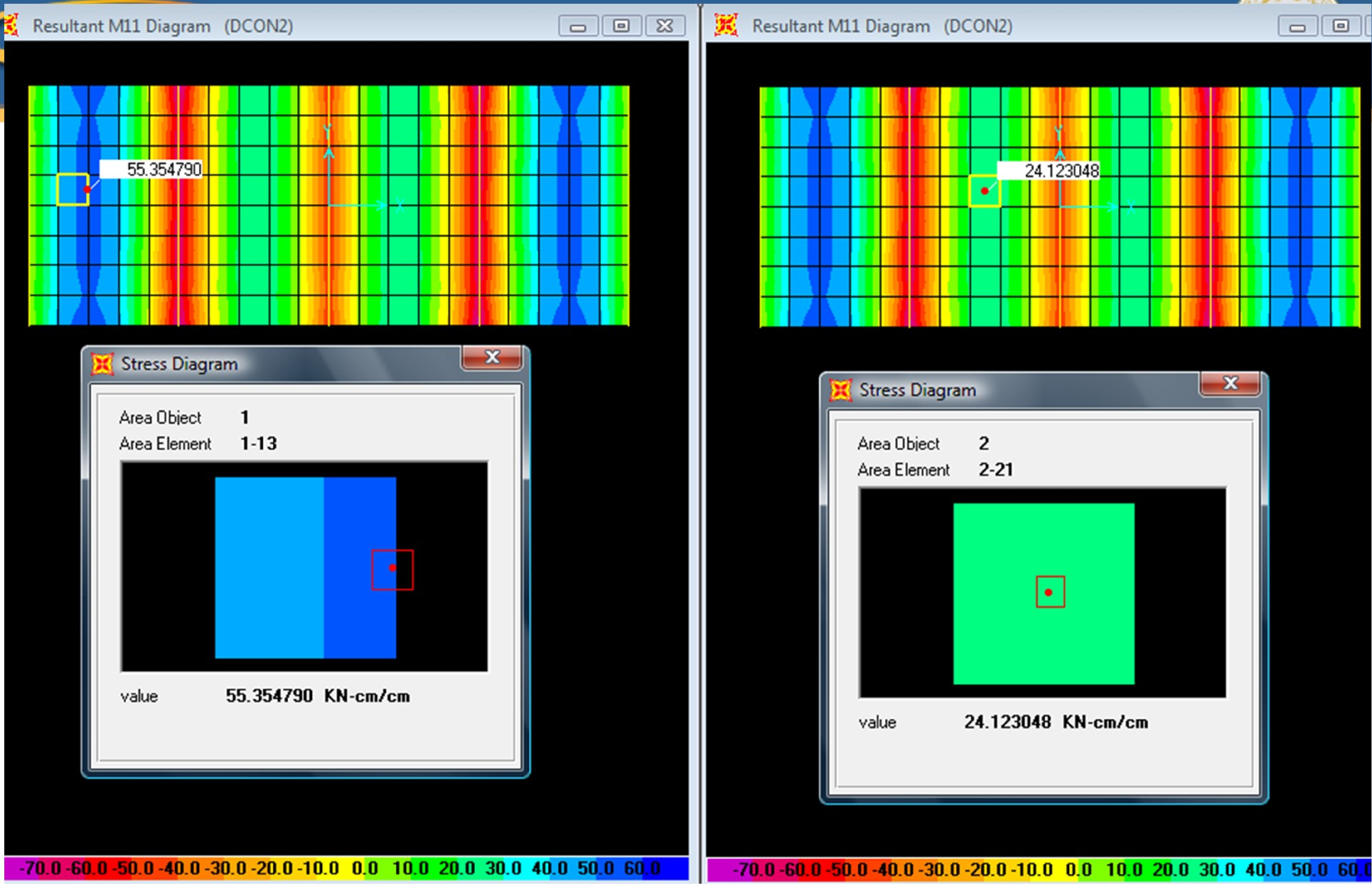
Right: top bending in beam C 1081kN.m, bottom area of steel 45cm^2.



- Left: bending moment in slab at point B 69.4kN.m/m
- Right: top bending in beam B 1293kN.m, bottom area of steel 53cm^2



- Left: bending moment in slab at point A 0.0kN.m/m
- Right: top bending in beam A 480kN.m, bottom area of steel 18.8cm^2



Left: maximum bending moment in slab between A and B 55.4kN.m/m

- Right: maximum bending moment in slab between B and C 24.1kN.m/m eolearning

Item	1D	3D	%diff.	As eq.	As concp.	%diff.
Slab MA	0	0	0			
Exter M+	54	55.4	2.5			
Slab MB	74	69.4	6.6			
Inter M+	25	24.1	3.7			
Slab MC	50	48.8	2.5			
Beam Ma	1070	1081	1.0	44.4	45	1.3
Beam Mb	1311	1293	-1.4	53.9	53	1.7
Beam Mc	475	480	.1.0	18.5	18.8	1.6

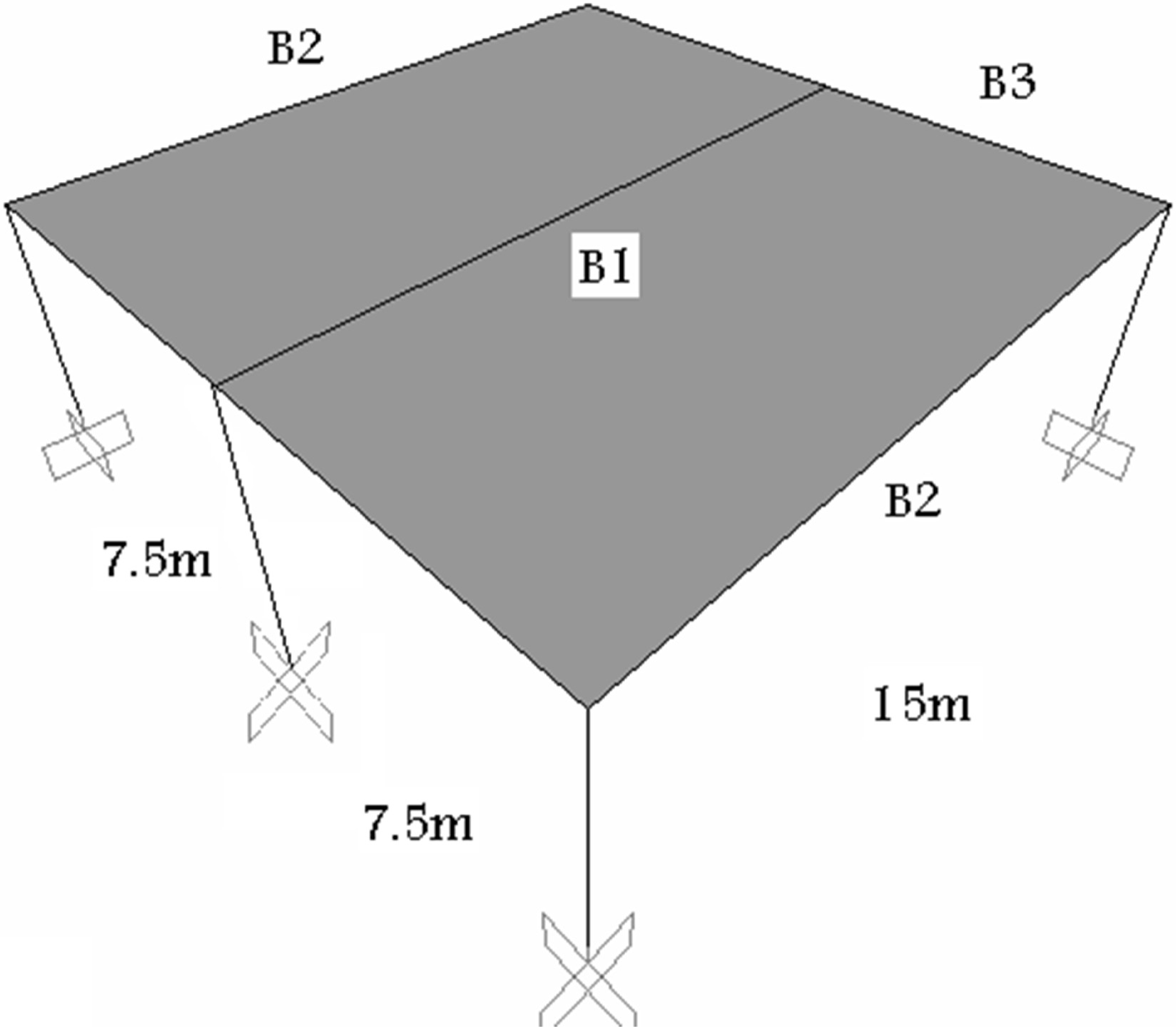
Comparison between results of 1D and 3D under similar assumptions.

Conclusion:

- Regular systems are conservatively designed as seen in attached file chapter6comp.doc

Problem set #6

- Analyze and design a one story reinforced concrete structure (entertainment hall) made of one way solid slab sitting on drop beams supported on six square columns 50cm dimensions. The superimposed and live loads are $3KN/m^2$ and $4KN/m^2$ respectively.


B2
B3
B1
B2
7.5m
15m
7.5m

End of section 5.1

Let Learning Continue