

EXERCISE 8

ANALYSIS OF TWO STOREY BUILDING FRAME

AIM

To analyze and design a two storied building frame of length 12m and width 7.5m

DATA:

Beam size	:	450x600mm
Column	:	450x450mm
Ceiling height	:	3000mm
Slab Thickness	:	150mm
Foundation	:	Isolated Footing
Concrete Grade	:	M20
Grade of steel	:	Fe 415
<u>Loads:</u>		
Live load on floor	:	1.5 kN/m ²
Live load on floor	:	3kN/m ²
Finishing load on floor	:	0.5 kN/m ²

PROCEDURE

1. The given model was created using graphical user interface method.
2. From the geometry, structure wizard option was selected.
3. Unit was set to meter and the model type was chosen as frame model. The bay frame was selected and its parameters (length, width and height) and number of bays along length, width and height were added. The length of each bay was also selected.
4. From file “merge model with staadpro model” was selected and the frame model was transferred to staadpro model.
5. From geometry add plate option was selected and slabs were added.
6. From the properties tab, the cross section of beam and column sections and thickness of slab were defined and it was assigned to respective members.
7. The hinge support was created from the support tab and it was assigned to all column ends.
8. From the load dialogue box, dead loads and live loads were defined.
9. Self-weight with a factor -1, self-weight of slab and finishing load on floors was added to the dead load and the given loads on floor, 1.5kN/m² and 3kN/m² were added to the live load. Self-weight with a factor -1 and self-weight of slab were assigned to members.
10. The load combinations were also created.
11. Perform analysis command was added from analysis tab.
12. From the design tab, concrete design was taken and Indian code IS 456 was selected.
13. Parameters like clear cover, FC, FYMAIN, FYSEC, MAXMAIN, MAXSEC, MINMAIN, MINSEC were defined and assigned to respective members.

14. From command, design beam, design column, and design slab/element was added and assigned to the respective members.
15. Analysis was run and the respective output file was obtained. The design results were obtained from output file.
16. The results -Bending Moment diagram, Shear force diagram, displacement diagram and axial force diagram were obtained from postprocessing mode.

RESULT

Analysis and design of frame is done. Shear force, Bending Moment, Deflection diagrams, axial force diagram and design details are obtained.

1. STAAD SPACE

INPUT FILE: C:\Users\user\Desktop\STAADPRO\GOWRILEKSHMI.STD

2. START JOB INFORMATION

3. ENGINEER DATE 16-APR-24

4. END JOB INFORMATION

5. INPUT WIDTH 79

6. UNIT METER KN

7. JOINT COORDINATES

8. 1 0 0 0; 2 6.00001 0 0; 3 12 0 0; 4 0 1.5 0; 5 6.00001 1.5 0; 6 12 1.5 0

9. 7 0 4.50001 0; 8 6.00001 4.50001 0; 9 12 4.50001 0; 10 0 7.50002 0

10. 11 6.00001 7.50002 0; 12 12 7.50002 0; 13 0 0 5.00001; 14 6.00001 0 5.00001

11. 15 12 0 5.00001; 16 0 1.5 5.00001; 17 6.00001 1.5 5.00001; 18 12 1.5 5.00001

12. 19 0 4.50001 5.00001; 20 6.00001 4.50001 5.00001; 21 12 4.50001 5.00001

13. 22 0 7.50002 5.00001; 23 6.00001 7.50002 5.00001; 24 12 7.50002 5.00001

14. 25 0 0 7.50002; 26 6.00001 0 7.50002; 27 12 0 7.50002; 28 0 1.5 7.50002

15. 29 6.00001 1.5 7.50002; 30 12 1.5 7.50002; 31 0 4.50001 7.50002

16. 32 6.00001 4.50001 7.50002; 33 12 4.50001 7.50002; 34 0 7.50002 7.50002

17. 35 6.00001 7.50002 7.50002; 36 12 7.50002 7.50002

18. MEMBER INCIDENCES

19. 1 4 5; 2 5 6; 3 7 8; 4 8 9; 5 10 11; 6 11 12; 7 1 4; 8 2 5; 9 3 6; 10 4 7

20. 11 5 8; 12 6 9; 13 7 10; 14 8 11; 15 9 12; 16 16 17; 17 17 18; 18 19 20

21. 19 20 21; 20 22 23; 21 23 24; 22 13 16; 23 14 17; 24 15 18; 25 16 19; 26 17 20

22. 27 18 21; 28 19 22; 29 20 23; 30 21 24; 31 28 29; 32 29 30; 33 31 32; 34 32 33

23. 35 34 35; 36 35 36; 37 25 28; 38 26 29; 39 27 30; 40 28 31; 41 29 32; 42 30 33

24. 43 31 34; 44 32 35; 45 33 36; 46 4 16; 47 5 17; 48 6 18; 49 7 19; 50 8 20

25. 51 9 21; 52 10 22; 53 11 23; 54 12 24; 55 16 28; 56 17 29; 57 18 30; 58 19 31

26. 59 20 32; 60 21 33; 61 22 34; 62 23 35; 63 24 36

27. ELEMENT INCIDENCES SHELL

28. 64 10 11 23 22; 65 22 23 35 34; 66 23 24 36 35; 67 11 12 24 23; 68 7 8 20 19

29. 69 8 9 21 20; 70 20 21 33 32; 71 19 20 32 31

30. ELEMENT PROPERTY

31. 64 TO 71 THICKNESS 0.15

32. DEFINE MATERIAL START

33. ISOTROPIC CONCRETE

34. E 2.17184E+07

35. POISSON 0.17

36. DENSITY 23.5615

37. ALPHA 5.5E-06
38. DAMP 0.05
39. G 9.28137E+06
40. TYPE CONCRETE
41. STRENGTH FCU 27578.9
42. END DEFINE MATERIAL
43. MEMBER PROPERTY
44. 1 TO 6 16 TO 21 31 TO 36 46 TO 63 PRIS YD 0.6 ZD 0.45
45. 7 TO 15 22 TO 30 37 TO 45 PRIS YD 0.45 ZD 0.45
46. CONSTANTS
47. MATERIAL CONCRETE ALL
48. SUPPORTS
49. 1 TO 3 13 TO 15 25 TO 27 PINNED
50. LOAD 1 LOADTYPE DEAD TITLE DL
51. SELFWEIGHT Y -1 LIST 1 TO 63
52. MEMBER LOAD
53. 3 4 18 19 33 34 49 TO 51 58 TO 60 UNI GY -11.04
54. FLOOR LOAD
55. YRANGE 5 8 FLOAD -0.5 X RANGE 0 7 Z RANGE 0 6 GY
56. YRANGE 5 8 FLOAD -0.5 X RANGE 5 13 Z RANGE 0 6 GY
57. ONEWAY LOAD
58. YRANGE 5 8 ONE -0.5 X RANGE 0 7 Z RANGE 4 8 GY
59. YRANGE 5 8 ONE -0.5 X RANGE 5 13 Z RANGE 4 8 GY
60. FLOOR LOAD
61. YRANGE 2 5 FLOAD -0.5 X RANGE 0 7 Z RANGE 0 6 GY
62. YRANGE 2 5 FLOAD -0.5 X RANGE 5 13 Z RANGE 0 6 GY
63. ONEWAY LOAD
64. YRANGE 2 5 ONE -0.5 X RANGE 0 7 Z RANGE 4 8 GY
65. YRANGE 2 5 ONE -0.5 X RANGE 5 13 Z RANGE 4 8 GY
66. LOAD 2 LOADTYPE LIVE TITLE LL
67. FLOOR LOAD
68. YRANGE 5 8 FLOAD -1.5 X RANGE 0 7 Z RANGE 0 6 GY
69. YRANGE 5 8 FLOAD -1.5 X RANGE 5 13 Z RANGE 0 6 GY
70. ONEWAY LOAD
71. YRANGE 5 8 ONE -1.5 X RANGE 0 7 Z RANGE 4 8 GY
72. YRANGE 5 8 ONE -1.5 X RANGE 5 13 Z RANGE 4 8 GY
73. YRANGE 2 5 ONE -3 X RANGE 5 13 Z RANGE 4 8 GY
74. YRANGE 2 5 ONE -3 X RANGE 0 6 Z RANGE 4 8 GY
75. FLOOR LOAD
76. YRANGE 2 5 FLOAD -3 X RANGE 0 6 Z RANGE 0 7 GY
77. YRANGE 2 5 FLOAD -3 X RANGE 5 13 Z RANGE 0 7 GY
78. LOAD COMB 3 COMBINATION LOAD CASE 3
79. 1 1.0 2 1.0
80. LOAD COMB 4 COMBINATION LOAD CASE 4
81. 1 1.5 2 1.5
82. PERFORM ANALYSIS

PROBLEM STATISTICS

NUMBER OF JOINTS 36 NUMBER OF MEMBERS 63
NUMBER OF PLATES 8 NUMBER OF SOLIDS 0
NUMBER OF SURFACES 0 NUMBER OF SUPPORTS 9

Using 64-bit analysis engine.

SOLVER USED IS THE IN-CORE ADVANCED MATH SOLVER

TOTAL PRIMARY LOAD CASES = 2, TOTAL DEGREES OF FREEDOM =
189

TOTAL LOAD COMBINATION CASES = 2 SO FAR.

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STRUCTURAL ELEMENTS IN LOAD CASE 1 ALONG Y.

THIS COULD BE DUE TO SELFWEIGHT APPLIED TO SPECIFIC

LIST OF MEMBERS/PLATES/SOLIDS/SURFACES.

TOTAL UNFACTORED WEIGHT OF THE STRUCTURE = 2074.682 KN

TOTAL UNFACTORED WEIGHT OF THE STRUCTURE APPLIED = 1438.520
KN

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83. START CONCRETE DESIGN

 CONCRETE DESIGN_

84. CODE INDIAN

85. CLEAR 0.03 MEMB 1 TO 63

86. FC 20000 MEMB 1 TO 63

87. FYMAIN 415000 MEMB 1 TO 63

88. FYSEC 415 ALL

89. MAXMAIN 20 ALL

90. MAXSEC 16 ALL

91. MINMAIN 12 ALL

92. MINSEC 10 ALL

93. DESIGN BEAM 1 TO 6 16 TO 21 31 TO 36 46 TO 63

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IS 456 - 2000 BEAM DESIGN RESULTS

IS-456 LIMIT STATE DESIGN

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BEAM NO. 18 DESIGN RESULTS

M20 Fe415 (Main) Fe 0 (Sec.)

LENGTH: 6000.0 mm SIZE: 450.0 mm X 600.0 mm COVER: 30.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	1500.0 mm	3000.0 mm	4500.0 mm	6000.0 mm
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TOP	519.83	0.00	0.00	0.00	737.54
REINF.	(Sq. mm)	(Sq. mm)	(Sq. mm)	(Sq. mm)	(Sq. mm)
BOTTOM	0.00	519.83	519.83	519.83	0.00
REINF.	(Sq. mm)	(Sq. mm)	(Sq. mm)	(Sq. mm)	(Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	1500.0 mm	3000.0 mm	4500.0 mm	6000.0 mm
TOP	5-12d	5-12d	5-12d	5-12d	7-12d
REINF.	1 layer(s)	1 layer(s)	1 layer(s)	1 layer(s)	1 layer(s)
BOTTOM	5-12d	5-12d	5-12d	5-12d	5-12d
REINF.	1 layer(s)	1 layer(s)	1 layer(s)	1 layer(s)	1 layer(s)
SHEAR	2 legged 10d	2 legged 10d	2 legged 10d	2 legged 10d	2 legged 10d
REINF.	@ 0 mm c/c	@ 0 mm c/c	@ 0 mm c/c	@ 0 mm c/c	@ 0 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 789.0 mm AWAY FROM START SUPPORT
VY = 86.61 MX = 0.60 LD= 4
Provide 2 Legged 10d @ 0 mm c/c

SHEAR DESIGN RESULTS AT 789.0 mm AWAY FROM END SUPPORT
VY = -101.88 MX = 0.60 LD= 4
Provide 2 Legged 10d @ 0 mm c/c

IS-456 LIMIT STATE DESIGN BEAM NO. 19 DESIGN RESULTS

M20 Fe415 (Main) Fe 0 (Sec.)

LENGTH: 6000.0 mm SIZE: 450.0 mm X 600.0 mm COVER: 30.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	1500.0 mm	3000.0 mm	4500.0 mm	6000.0 mm
TOP	737.53	0.00	0.00	0.00	519.83
REINF.	(Sq. mm)	(Sq. mm)	(Sq. mm)	(Sq. mm)	(Sq. mm)

BOTTOM	0.00	519.83	519.83	519.83	0.00
REINF.	(Sq. mm)	(Sq. mm)	(Sq. mm)	(Sq. mm)	(Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	1500.0 mm	3000.0 mm	4500.0 mm	6000.0 mm
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TOP	7-12d	5-12d	5-12d	5-12d	5-12d
REINF.	1 layer(s)	1 layer(s)	1 layer(s)	1 layer(s)	1 layer(s)

BOTTOM	5-12d	5-12d	5-12d	5-12d	5-12d
REINF.	1 layer(s)	1 layer(s)	1 layer(s)	1 layer(s)	1 layer(s)

SHEAR	2 legged 10d	2 legged 10d	2 legged 10d	2 legged 10d	2 legged 10d
REINF.	@ 0 mm c/c	@ 0 mm c/c	@ 0 mm c/c	@ 0 mm c/c	@ 0 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 789.0 mm AWAY FROM START SUPPORT

VY = 102.95 MX = -0.60 LD= 4

Provide 2 Legged 10d @ 0 mm c/c

SHEAR DESIGN RESULTS AT 789.0 mm AWAY FROM END SUPPORT

VY = -85.54 MX = -0.60 LD= 4

Provide 2 Legged 10d @ 0 mm c/c

IS-456 LIMIT STATE DESIGN
COLUMN NO. 23 DESIGN RESULTS

M20	Fe415 (Main)	Fe 0 (Sec.)
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LENGTH: 1500.0 mm CROSS SECTION: 450.0 mm X 450.0 mm COVER: 40.0 mm

** GUIDING LOAD CASE: 4 END JOINT: 14 SHORT COLUMN

REQD. STEEL AREA : 638.14 Sq.mm.

REQD. CONCRETE AREA: 201861.86 Sq.mm.

MAIN REINFORCEMENT : Provide 8 - 12 dia. (0.45%, 904.78 Sq.mm.)
(Equally distributed)

TIE REINFORCEMENT : Provide 10 mm dia. rectangular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS)

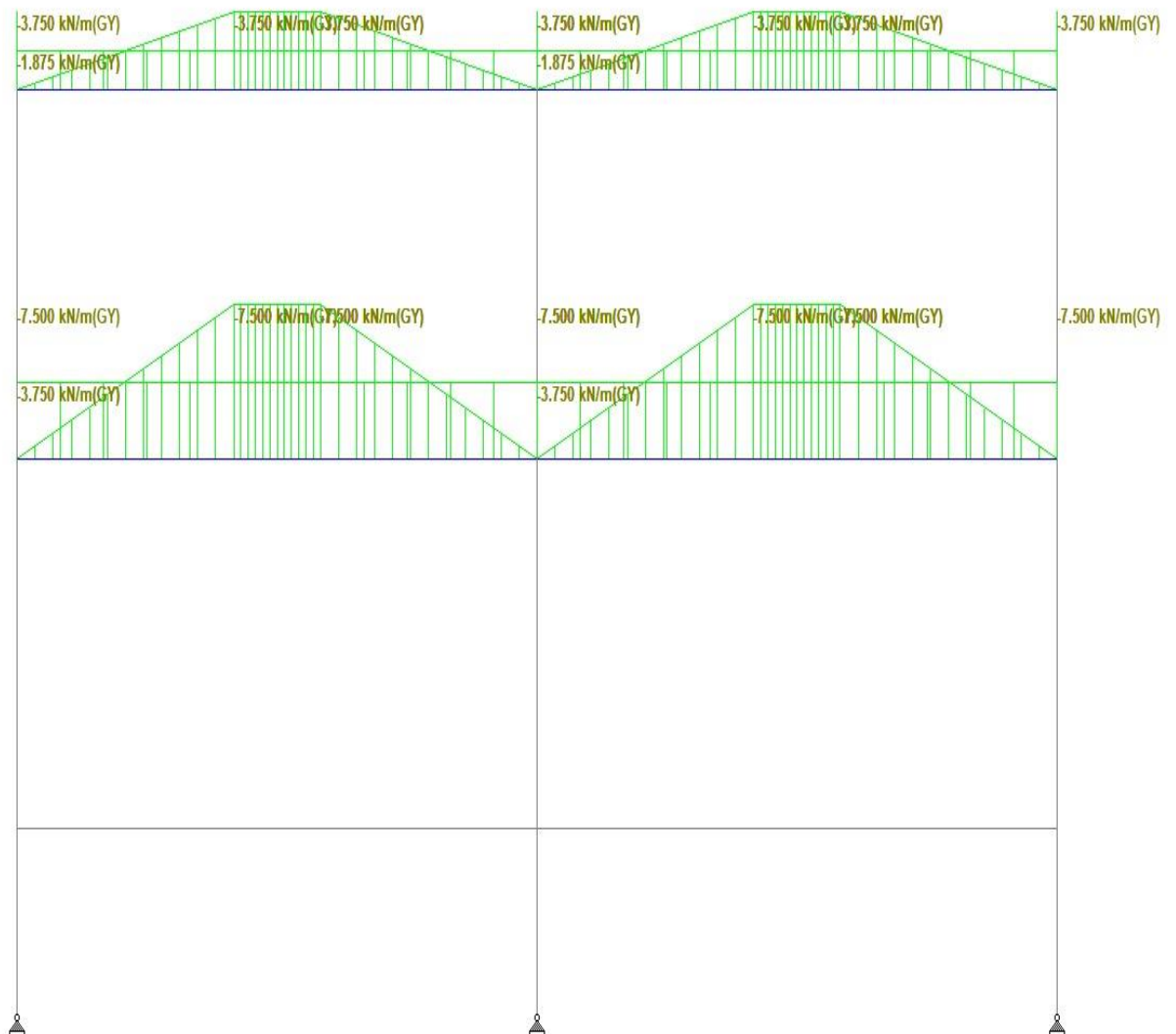
Puz : 1792.33 KNS

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS)

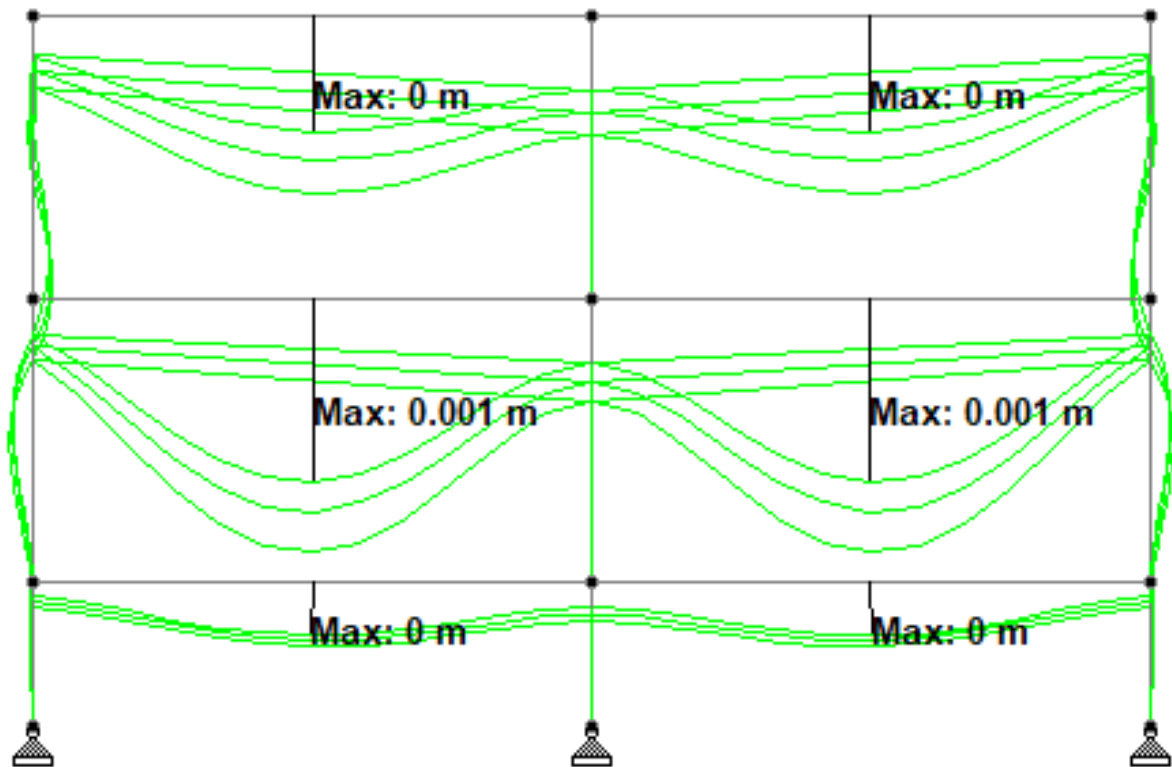
END JOINT: 14 Puz : 1864.34 KNS IR:0.38

END JOINT: 17 Puz : 2095.97 KNS IR:0.00

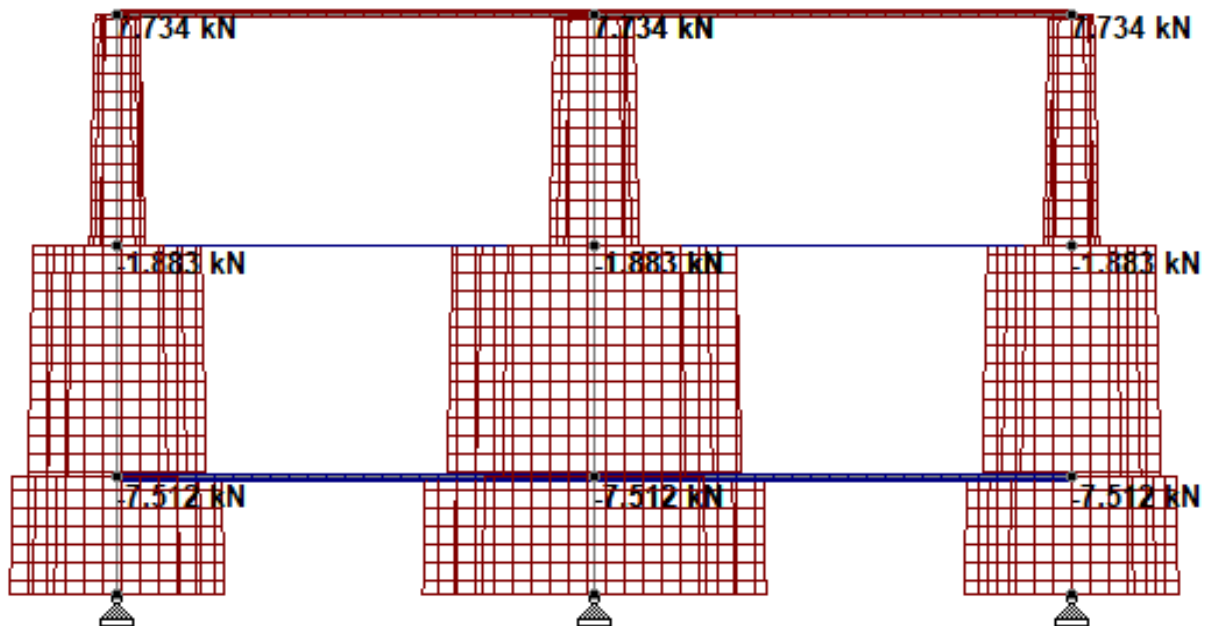
LOADING DIAGRAM



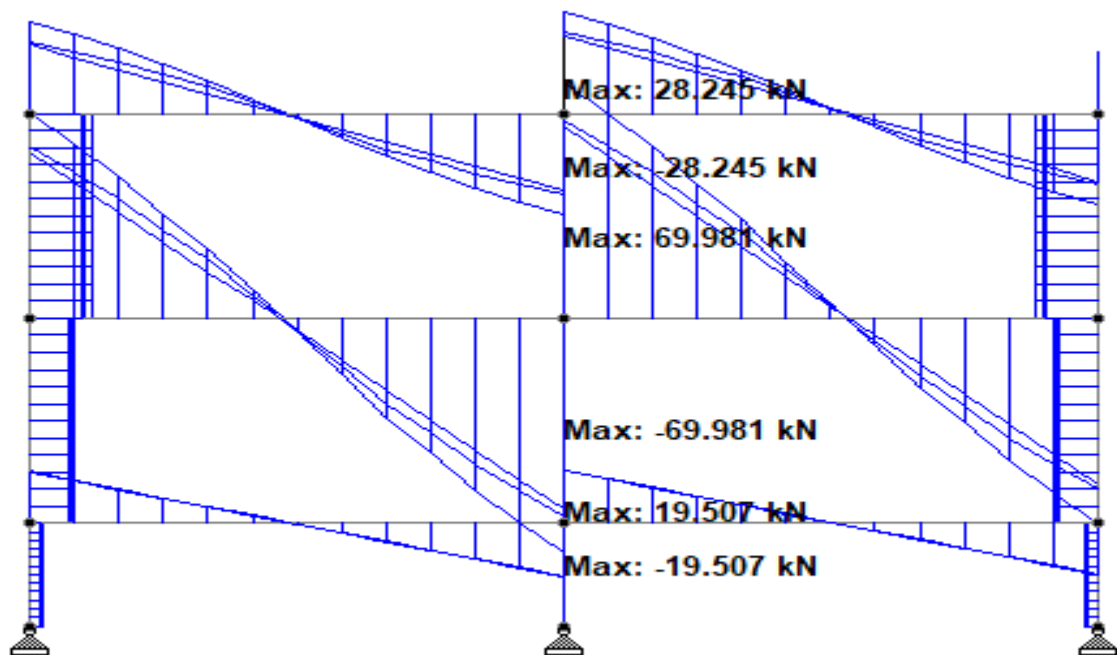
DISPLACEMENT DIAGRAM



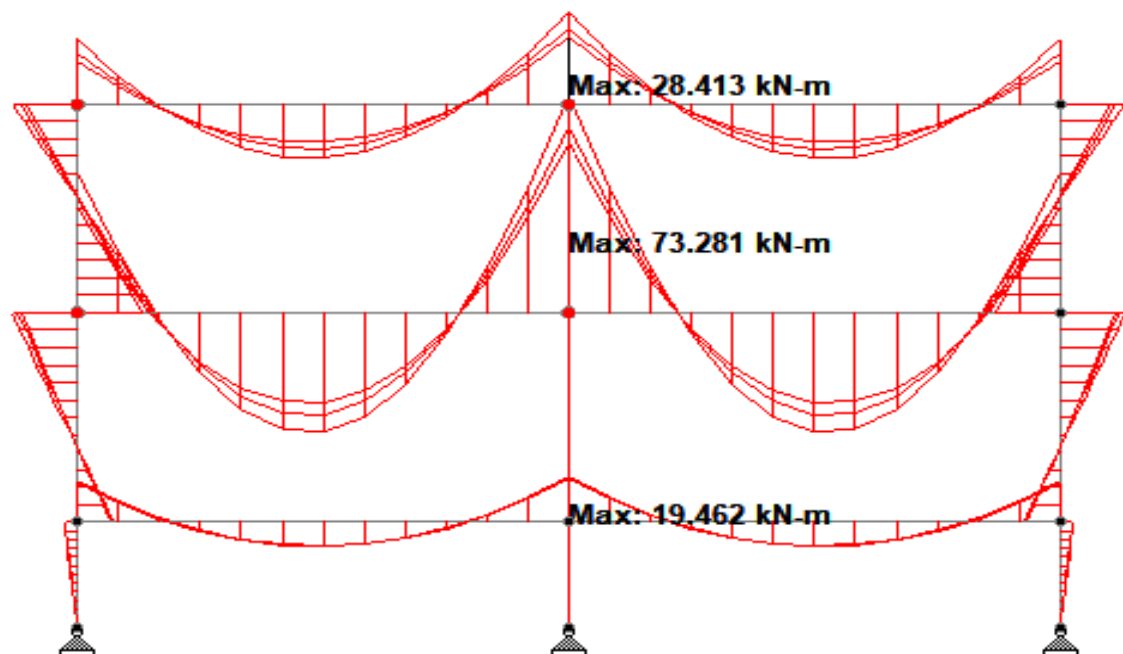
AXIAL FORCE DIAGRAM



SHEAR FORCE DIAGRAM



BENDING MOMENT DIAGRAM

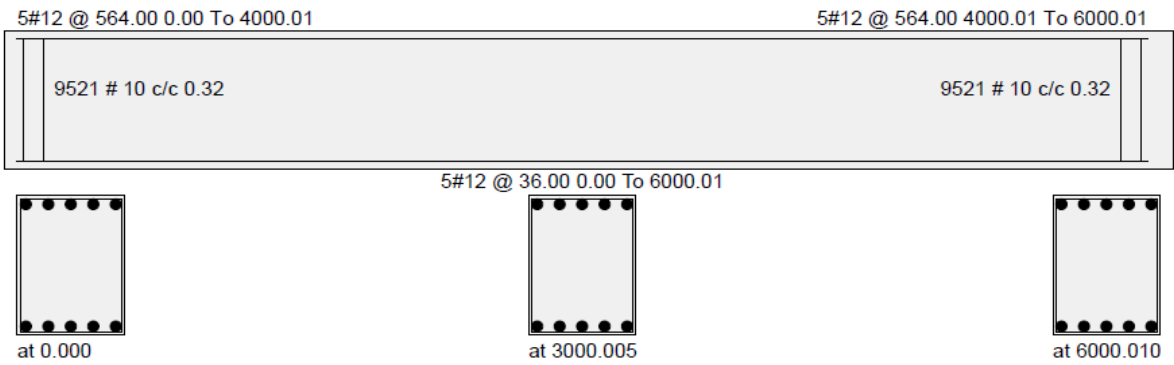


BEAM DESIGN-1

STAAD.Pro Query Concrete Design

Beam no. 18

Design Code: IS-456



Design Load

Mz(Kn Met)	Dist.et	Load
33.590000	3.000000	1
-40.580002	0.000000	1
-63.119999	6.000000	1

Design Parameter

Fy(Mpa)	415.000000
Fc(Mpa)	20.000000
Depth(m)	0.599999
Width(m)	0.449999
Length(m)	5.999998

BEAM DESIGN-2

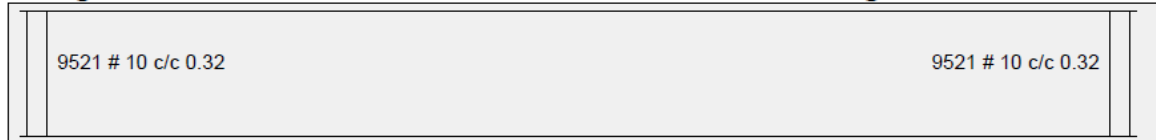
STAAD.Pro Query Concrete Design

Beam no. 19

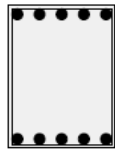
Design Code: IS-456

5#12 @ 564.00 0.00 To 3999.99

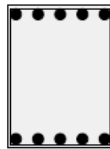
5#12 @ 564.00 3999.99 To 5999.99



5#12 @ 36.00 0.00 To 5999.99



at 0.000



at 2999.995



at 5999.990

Design Load

Mz(Kn Met)	Dist.et	Load
33.590000	3.000000	1
-63.119999	0.000000	1
-40.580002	6.000000	1

Design Parameter

Fy(Mpa)	415.000000
Fc(Mpa)	20.000000
Depth(m)	0.599999
Width(m)	0.449999
Length(m)	5.999978

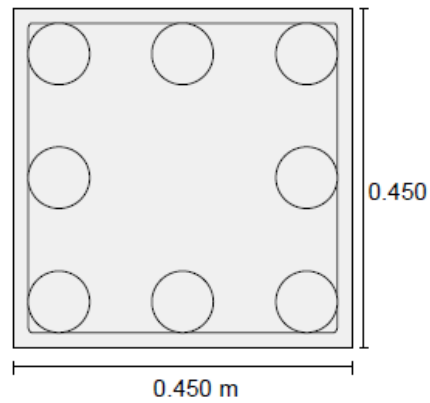


COLUMN DESIGN

STAAD.Pro Query Concrete Design

Beam no. 23

Design Code: IS-456



Design Load

Load	1
Location	End 1
Pu(Kns)	371.619995
Mz(Kns-Mt)	0.000000
My(Kns-Mt)	0.000000

Design Results

Fy(Mpa)	415
Fc(Mpa)	20
As Reqd(mm2)	333.000000
As (%)	0.447000
Bar Size	12
Bar No	8

