ANALYSIS AND DESIGN OF RESIDENTIAL BUILDING OF 2BHK UNDER GHMC

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ABSTRACT: The project comprises the development of plans, elevations, and sectional view of a Residential Reinforced Concrete building of ground floor, using Auto-cad 2008. Structural loads (Gravitational loads only), Dead and Live loads are only considered for the design of structure, and the loads considered are as per IS: 875 – Part-I & II. The analysis and design of the building skeletal fame is performed by using STAAD Pro V8i package for factored (Limit state of strength) combination(s). The structural displacements in vertical and horizontal directions of the building are permitted to the limitations as per IS: 456 – 2000, for un-factored (Limit state of serviceability) combination(s). Structural elements like Slab(s) are designed manually and foundation design is done using STAAD foundation. The reinforcement details are furnished according to the codal provisions and presented in this report.

ABOUT STAAD PRO

STAAD Pro is a Structural Analysis and design computer program originally developed by Research Engineers International in Yorba Linda, CA. In late 2005, Research Engineer International was bought by Bentley Systems.

STAAD Pro allows structural engineers to analyse and design virtually any type of structure through its flexible modelling environment, advanced features and fluent data collaboration.

STAAD Pro is one of the leading structural analysis and design software which supports more than 100 steel, concrete and timber design codes and has the largest worldwide user base.

It can make use of various forms of analysis from the traditional 1st order static analysis, 2nd order p-delta analysis, geometric nonlinear analysis or a buckling analysis. It can also make use of various forms of dynamic analysis from modal extraction to time history and response spectrum analysis.

In recent years it has become part of integrated structural analysis and design solutions mainly using an exposed API called Open STAAD to access and drive the program using an VB macro system included in the application or other by including Open STAAD functionality in applications that themselves include suitable programmable macro systems. Additionally STAAD Pro is added direct links to applications such as RAM Connection and STAAD Foundation to provide engineers working with those applications which handle design post processing not handled by STAAD Pro itself. Another form of integration supported by STAAD Pro is the analysis schema of the CIM steel Integration Standard, version 2 commonly known as CIS/2 and used by a number modelling and analysis applications.

Statement of the project:

Utility of building : RESIDENTIAL BUILDING OF 2BHK UNDER GHMC

No of stories : C+G+7

Shape of the building : Rectangle shape

No of Story : 7 Story

No of staircases : 2

Type of construction : R.C.C framed structure

Types of walls : brick wall

Geometric details:

Ground floor : 3m

Floor to floor height : 3m.

Materials:

Concrete grade : M20

All steel grades : Fe415 grade

Bearing capacity of soil : 250KN/M2

Design of multi storied residential building:

General:

A structure can be defined as a body which can resist the applied loads without appreciable deformations. Structural engineering is concerned with the planning, designing and the construction of structures. Structure analysis involves the determination of the forces and displacements of the structures or components of a structure. Design process involves the selection and detailing of the components that make up the structural system. The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.

The objective of the design is

- Foundation design
- Column design
- Beam design

- Slab design

These all are designed under limit state method

Limit state method:

The object of design based on the limit state concept is to achieve an acceptability that a structure will not become unserviceable in its life time for the use for which it is intended. I.e. it will not reach a limit state. In this limit state method, all relevant states must be considered in design to ensure a degree of safety and serviceability.

Limit state:

The acceptable limit for the safety and serviceability requirements before failure occurs is called a limit state.

Limit state of collapse:

This is corresponding to the maximum load carrying capacity. Violation of collapse limit state implies failures in the source that a clearly defined limit state of structural usefulness has been exceeded. However, it does not mean complete collapse.

This limit state corresponds to:

- Flexural
- Compression
- Shear
- Torsion

Limit state of survivability:

This state corresponds to development of excessive deformation and is used for checking member in which magnitude of deformations may limit the rise of the structure of its components.

- Deflection
- Cracking
- Vibration

2.1CALCULATION OF LOADS

Dead and live loads at plinth level (0.00)

Dead load of brick wall (230 mm thick) = 0.23*3*20

=12.0 KN/m

Dead load of brick wall (115 mm thick) = 0.115*3.0*20 =6.0kN/m

Dead and live loads at Floor level:

Dead load of slab (125 mm assuming) = 0.125*25

= 3.0 KN/m2

Floor finishes = 1KN/m2

Total floor load = 3.0 + 1.0

= 4.0 kN/m2

Live load (On floor, accessible) = 2.0 kN/m2

Dead and live loads at Roof level:

Dead load of brick wall (230 mm thick) = 0.23*0.45*20

(Parapet wall) = 2.07 N/m

Dead load of slab (125 mm assuming) = 0.125*25

= 3.0 kN/m2

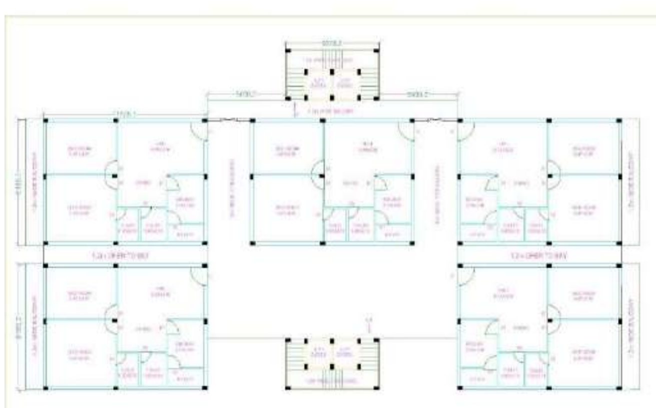
Water proofing = 3.0 kN/sq.m

Total floor load = 3.125+3.0

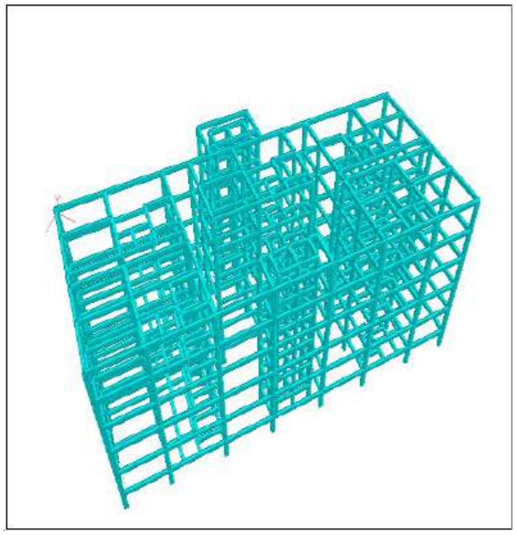
= 6.125 kN/ m2

Live load (On floor, accessible) = 1.5 kN/ m2

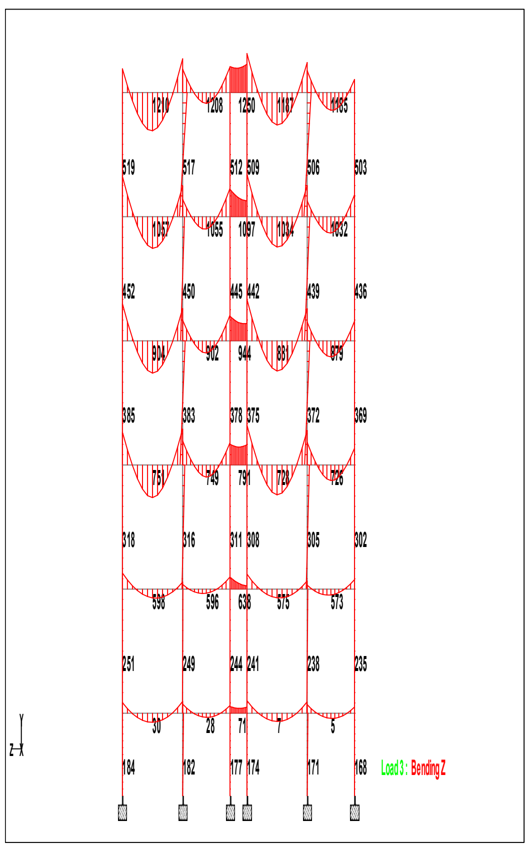
PLAN OF THE STRUCTURE



3D RENDERING



BENDING MOMENT DIAGRAM OF FRAMES



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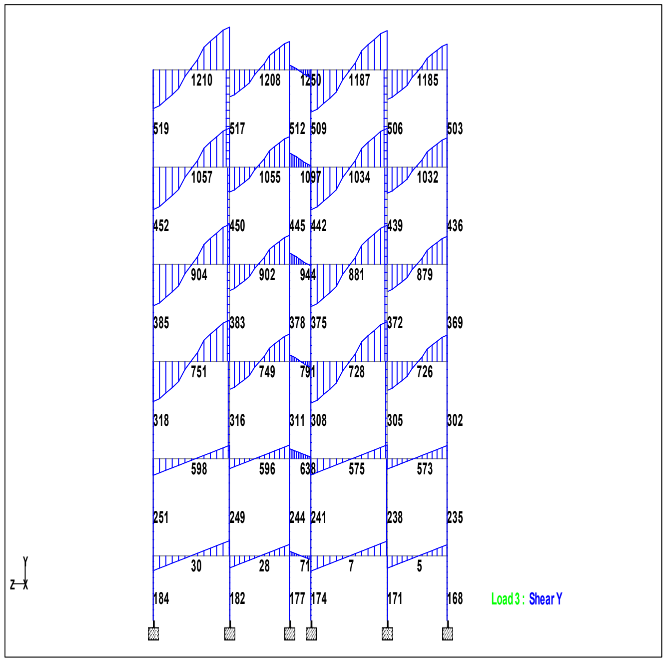
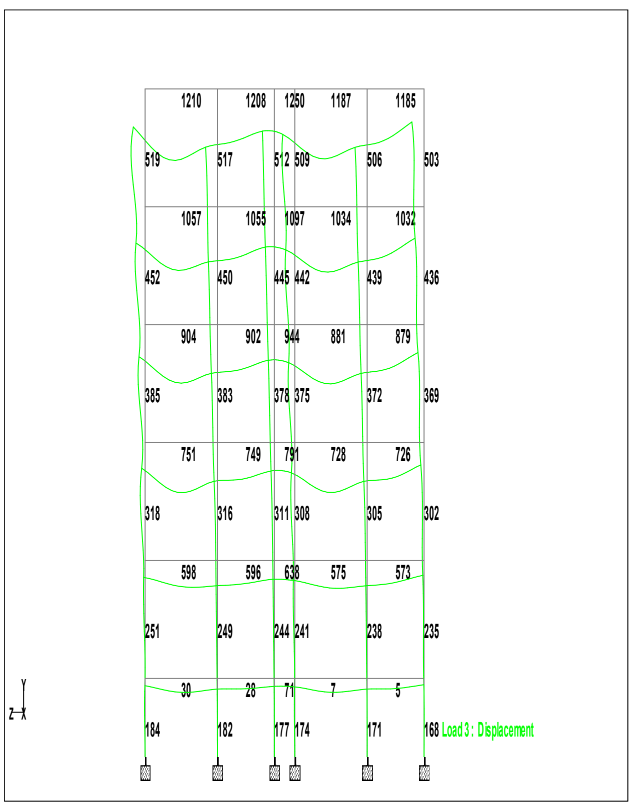
Volume 8, Issue 5, May-2023, http://ijmec.com/, ISSN: 2456-4265

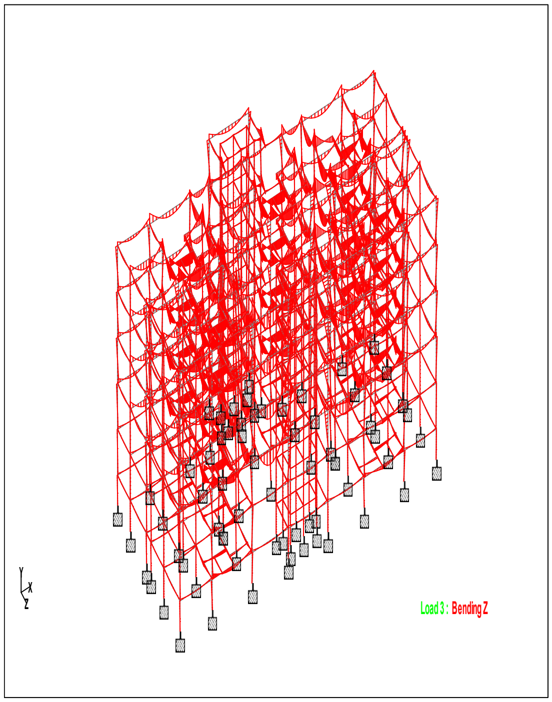
SHEAR FORCE DIAGRAM OF FRAMES



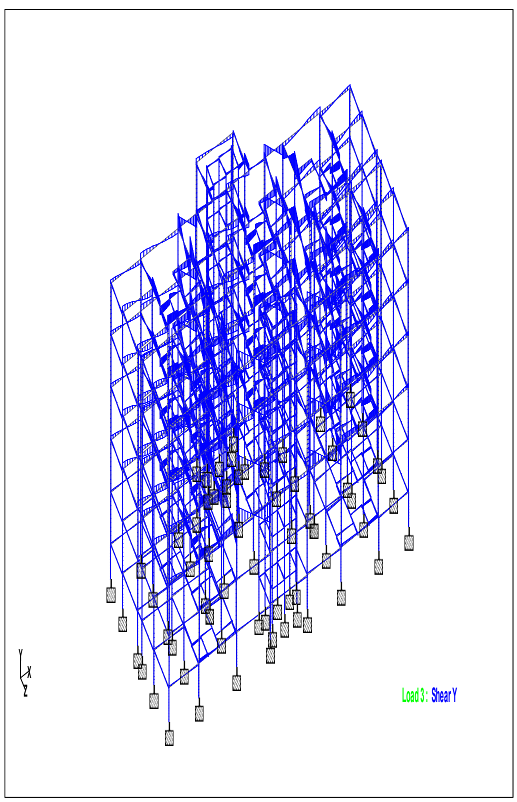
DEFLECTION DIAGRAM OF FRAMES



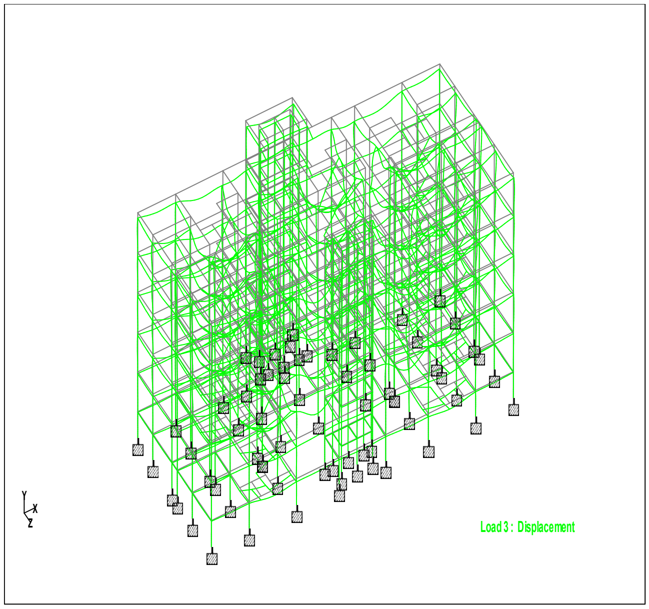
BENDING MOMENT DIAGRAM OF WHOLE STRUCTURES



SHEAR FORCE DIAGRAM OF WHOLE STRUCTURES



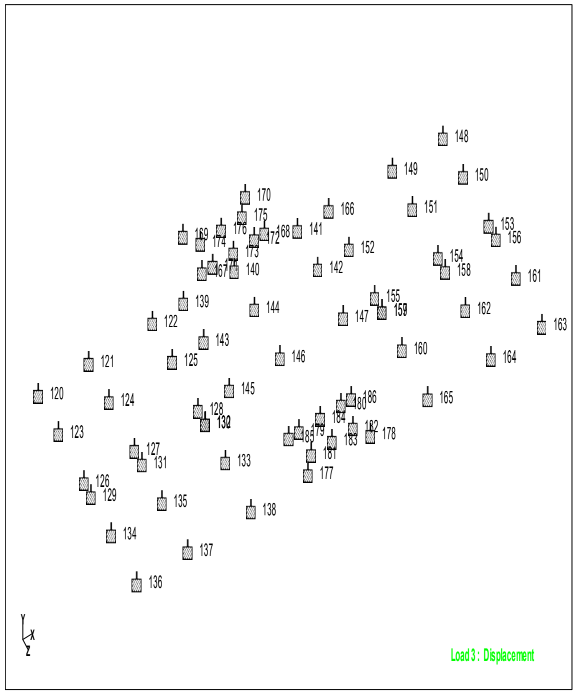
DEFLECTION DIAGRAM OF WHOLE STRUCTURES



Unfactored Support Reactions Summary:

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	155	11	34.986	995.972	-7.734	-5.394	-0.127	-36.493
Min Fx	154	15	-34.61	1065.896	-9.369	-5.954	-0.02	36.137
Max Fy	138	9	-17.23	2451.533	-10.071	-6.494	0.01	10.961
Min Fy	183	8	-0.002	-173.491	23.61	30.859	0.001	0.002
Max Fz	133	25	-9.68	1085.159	38.505	48.601	0.425	7.766
Min Fz	183	29	-0.013	467.017	-37.1	-47.734	0.008	0.014
Max Mx	179	25	0.608	441.686	37.001	51.833	1.784	-0.353
Min Mx	180	29	0.362	23.593	-36.191	-51.576	1.562	-0.205
Max My	185	25	1.105	382.275	22.795	26.683	2.51	-0.556
Min My	186	25	-1.362	383.626	22.681	26.546	-2.488	0.905
Max Mz	154	27	-29.595	613.422	-3.334	-2.004	-0.013	36.467
Min Mz	127	26	29.988	612.883	-3.273	-1.92	-0.007	-37.032

Support Numbers



DELECTION CHECK

Deflection Summary of Whole Structure

			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	487	27	14.839	-6.861	0.465	16.355	0	0.001	-0.004
Min X	460	14	-16.366	-9.491	-0.386	18.923	0	-0.001	0.004
Max Y	529	5	3.139	0.929	0.173	3.279	0	0	0
Min Y	655	9	-4.234	-35.566	0.39	35.819	-0.002	0.001	0.009
Max Z	513	29	0.035	-4.807	29.022	29.418	0.001	0.001	-0.001
Min Z	512	25	0.037	-4.077	-26.271	26.586	0	0.001	0.001
Max rX	689	9	-1.637	-5.501	2.617	6.308	0.002	0	0
Min rX	649	9	-2.748	-13.989	0.391	14.262	-0.007	0	0.001
Max rY	501	13	-1.672	-7.569	-12.799	14.963	0.002	0.003	0
Min rY	457	13	-1.713	-7.629	-13.729	15.799	0.002	-0.002	0
Max rZ	671	9	-4.613	-32.458	2.397	32.872	-0.002	0	0.009
Min rZ	595	9	-1.413	-32.131	0.246	32.163	-0.002	0	-0.009
Max Rst	655	9	-4.234	-35.566	0.39	35.819	-0.002	0.001	0.009

Lateral deflection developed in the structure = 4.927 mm

Permissible limit = H/500

= 20500/500 = 41 mm

= 4.927 < 41 mm (SAFE)

Vertical deflection developed in the structure = 0.068

Permissible limit (minimum of) = L/350 or 20 mm

= 26160/350 = 74.74 mm

= 0.068 < 74.74 (SAFE)

BEAM NO. 57 DESIGN RESULTS

M30 Fe415 (Main) Fe415 (Sec.)

LENGTH: 5000.0 mm SIZE: 500.0 mm X 500.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	1250.0 mm	2500.0 mm	3750.0 mm	5000.0 mm
TOP REINF.	787.63 (Sq. mm)	481.33 (Sq. mm)	481.33 (Sq. mm)	481.33 (Sq. mm)	828.86 (Sq. mm)
BOTTOM REINF.	481.33 (Sq. mm)	481.33 (Sq. mm)	481.33 (Sq. mm)	481.33 (Sq. mm)	481.33 (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	1250.0 mm	2500.0 mm	3750.0 mm	5000.0 mm
TOP REINF.	11-10í 1 layer(s)	7-10í 1 layer(s)	7-10í 1 layer(s)	7-10í 1 layer(s)	11-10í 1 layer(s)
BOTTOM REINF.	7-10í 1 layer(s)	7-10í 1 layer(s)	7-10í 1 layer(s)	7-10í 1 layer(s)	7-10í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 180 mm c/c	2 legged 8í @ 180 mm c/c	2 legged 8í @ 180 mm c/c	2 legged 8í @ 180 mm c/c	2 legged 8í @ 180 mm c/c

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

SHEAR DESIGN RESULTS AT 820.0 mm AWAY FROM START SUPPORT
VY = 103.39 MX = -0.11 LD= 21
Provide 2 Legged 8í @ 180 mm c/c

SHEAR DESIGN RESULTS AT 820.0 mm AWAY FROM END SUPPORT
VY = -106.02 MX = -0.12 LD= 17
Provide 2 Legged 8í @ 180 mm c/c

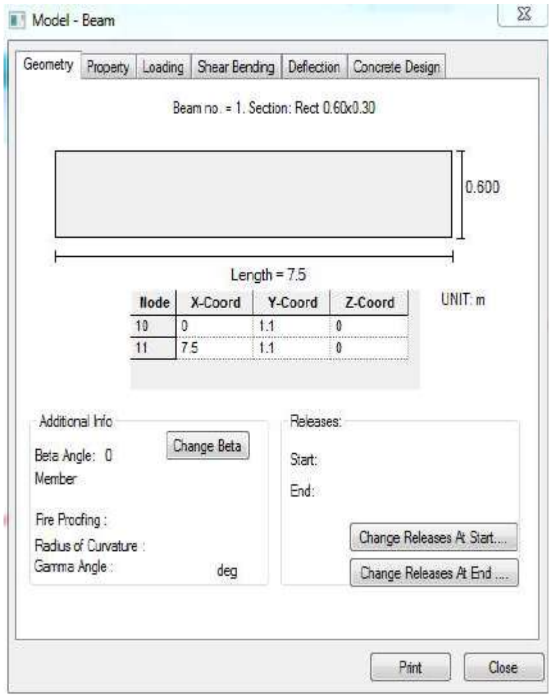


Fig 8.1: Geometry of beam no. 1

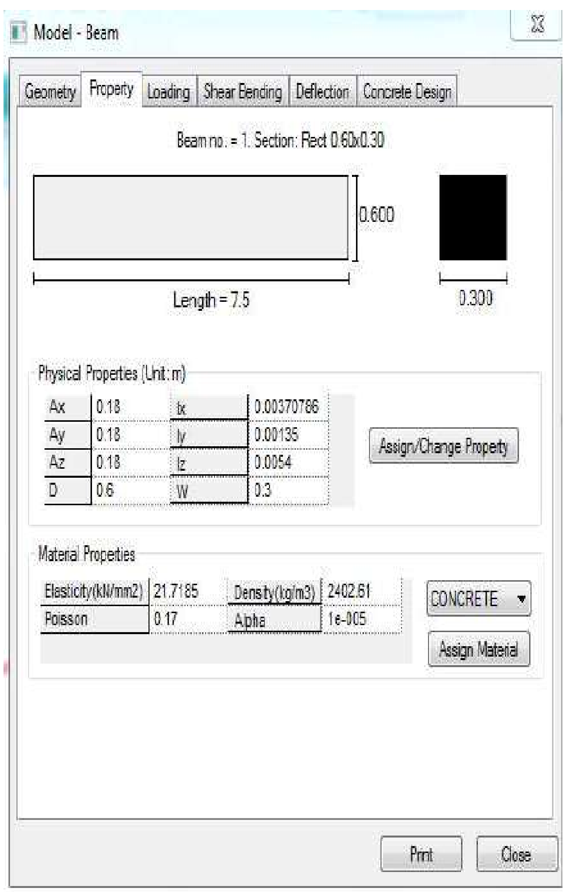
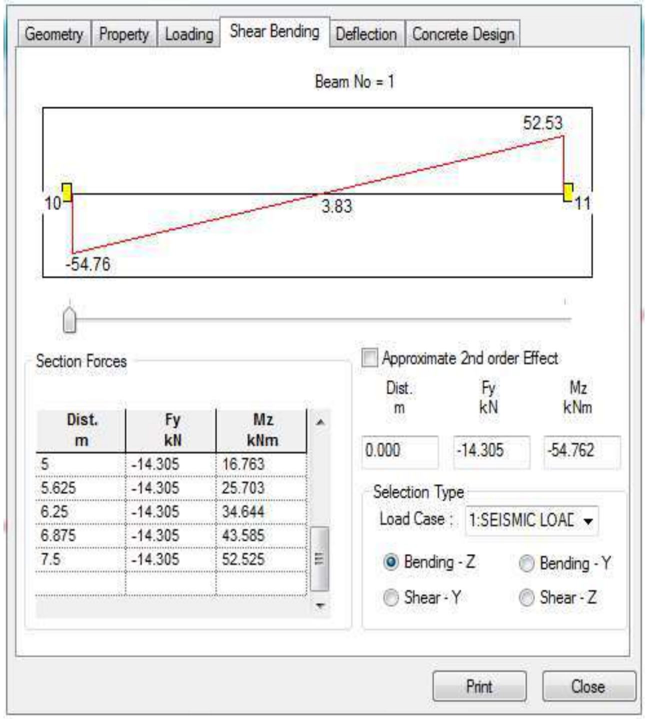
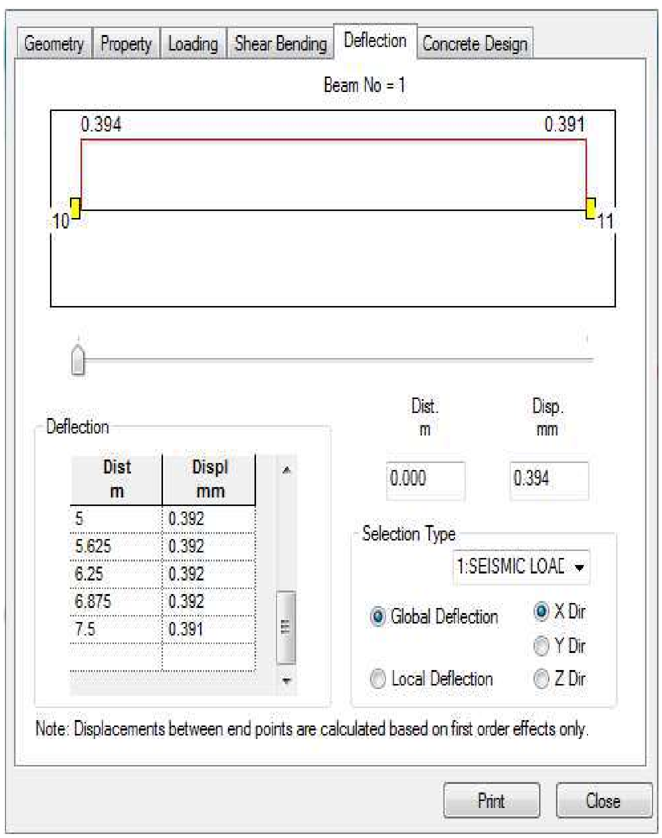


Fig 8.2: Property of beam no. 1



Dist. m	Fy kN	Mz kNm
5	-14.305	16.763
5.625	-14.305	25.703
6.25	-14.305	34.644
6.875	-14.305	43.585
7.5	-14.305	52.525

Fig 8.3: Shear bending of beam no. 1



Dist m	Displ mm
5	0.392
5.625	0.392
6.25	0.392
6.875	0.392
7.5	0.391

Fig 8.4: Deflection of beam no. 1

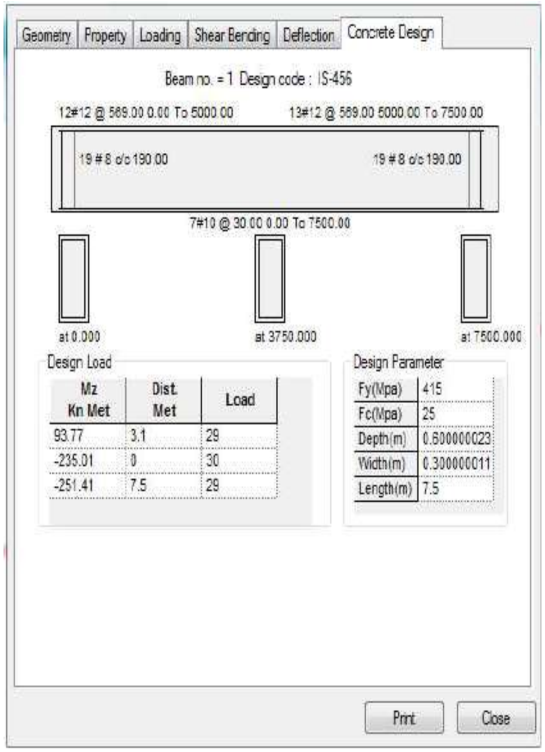


Fig 8.5: Concrete design of beam no. 1

COLUMN NO.7 DESIGN RESULTS

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 1500.0 mm CROSS SECTION: 300.0 mm X 400.0 mm COVER: 40.0 mm

** GUIDING LOAD CASE: 4 END JOINT: 1 SHORT COLUMN

REQD. STEEL AREA : 315.60 Sq.mm.

REQD. CONCRETE AREA: 39450.56 Sq.mm.

MAIN REINFORCEMENT: Provide 8 - 12 dia. (0.75%, 904.78 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT: Provide 8 mm dia. rectangular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)

Puz: 1444.68 Muz1: 71.40 Muy1: 52.60

INTERACTION RATIO: 0.21 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)

WORST LOAD CASE: 3

END JOINT:4 Puz:1621.43 Muz:94.79 Muy:68.10 IR:0.35

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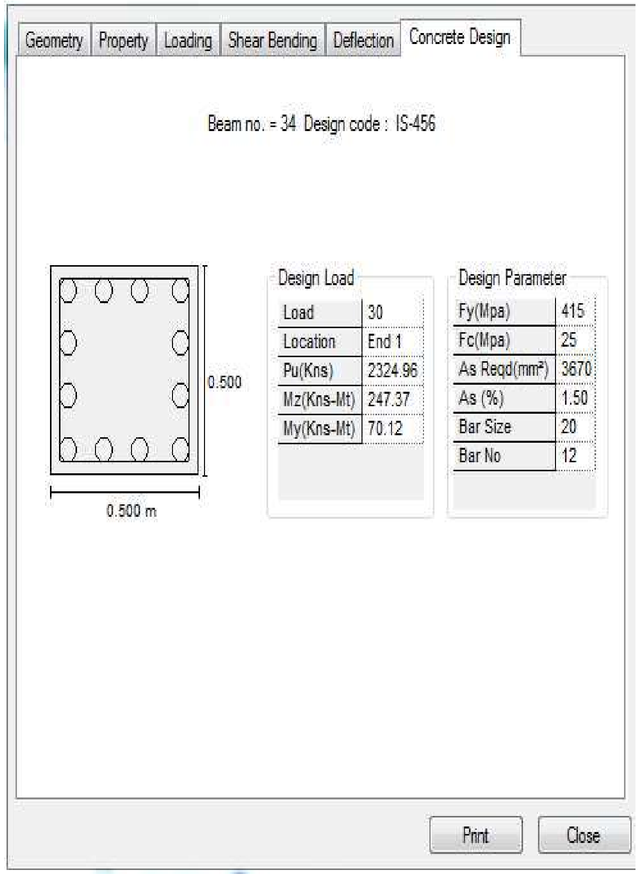

Fig 8.6: Concrete design of column no. 34

CONCLUSIONS:

The present G+5 structure is analyzed for both gravity and lateral loads (wind and seismic loads). The analysis data base is prepared for worst load combination. The following conclusions are drawn from the analysis. Fixed end moments in the frames of beam ends arrived by Moment distribution methods are par with the moments arrived by Numerical methods. Calculated Steel quantities and provided sizes in the structural members are found to be practical. Beams designs are carried in Limit state method and checked for important limit states (Flexure and serviceability). Same is the case with Columns and others. Moment distribution method is applied for all three cases of Substitute frame with different load combinations for the Frame at 3rd story floor and in second bay and comparison is made for the max forces. Loads and Design guidelines are considered from IS -456:2000, IS -875-part1, Part-2 .Column and beam designs are followed as per SP: 16 and detailing is followed as per SP: 34. Slabs are designed as one way and the depth, output steel quantities are found to be practical.

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8. www.Bentley.com
9. www.staadpro.com

IS CODES:

- IS 456-2000 (Design of RCC structural elements)
- IS 875-Part 1 (Dead Load)
- IS 875-Part 2 (Live Load)
- IS 875-Part 3 (Wind load)
- IS 875-Part 4(Snow load)
- IS 875-Part 5 (Combination loads)
- IS 1893-2002 (Earthquake load)
- SP-16 (Depth and Percentage of Reinforcement)

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