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An Overview of Skyscrapper Design as Per IS 456

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Abstract— **Structural design is the primary aspect of civil engineering. The very basis of construction of any building, residential house or dams, bridges, culverts, canals etc. is designing. Structural engineering has existed since humans first started to construct their own structures. The foremost basic in structural engineering is the design of simple basic components and members of a building viz., Slabs, Beams, Columns and Footings. In order to design them, it is important to first obtain the plan of the particular building that is, positioning of the particular rooms (Drawing room, bed room, kitchen toilet etc.) such that they serve their respective purpose and also suiting to the requirement and comfort of the inhabitants. Thereby depending on the suitability; plan layout of beams and the position of columns are fixed. Thereafter, the loads are calculated namely the dead loads, which depend on the unit weight of the materials used (concrete, brick) and the live loads.**

Index Terms— **residential house,beams,column.**

I. INTRODUCTION

Now a days It is undergoing a rapid phase of urban development and resulting in a large number of multi-storey building projects which are coming up, not only in the big cities but also in moderate towns. In the era of globalization, many such projects are designed and executed by multinational companies based on international codes and practices, especially related to seismic-resistant buildings. It is therefore desirable that structural engineers of India get familiar with provisions of international standards.

The main advantages of these buildings are efficient in limited land space. The upper floors are often mere repetition of lower floor, so, lower cost of construction per square foot of floor space is another advantage.

Here, G+21 multistorey RCC building is designed as per IS 456. Normally above 20 stories steel structurs are preffered due to economy, but. As per Indian choice RCC is always preferable. In this paper trial will be done over steel with different loading condition.

A novel formulation aiming to achieve optimal design of reinforced concrete (RC) structures is presented here. Optimal sizing and reinforcing for beam and column members in multi-bay and multistory RC structures incorporates optimal stiffness correlation among structural members and results in cost savings over typical state-of-the-practice design solutions. The design procedures for RC structures that are typically adapted in practice begin by assuming initial stiffness for the structural skeleton elements.This is necessary to calculate the internal forces of a statically indeterminate structure.The final member dimensions are then designed to resist the internal forces that are the result of the assumed stiffness distribution.This creates a situation where the internal forces used for design may be inconsistent with the internal forces thatcorrespond to the final designdimensions.

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II. LITERATURE REVIEW

2.1 Title-Behaviour of RCC Multistorey Structure With and Without Infill Walls .2005,2006.

Abstract :

Framed reinforced concrete structures are most commonly types of structures constructed all over the worlddue to ease of construction and rapid progress of work. Generally brick or block work masonry is done in these frames which act as an infill panels in the framed structure. Infill walls provide the lateral stiffness to the structure. Its behaviour is very different from the bare frame structure.

Behaviour of masonry infilled concrete frames under the lateral load is studied. Investigations showed that, one of the most appropriate ways of analyzing the masonry infilled concrete frames is to use the diagonally braced frame analogy.RCC buildings are generally analyzed and designed as bare frame. But after the provision of infill walls, mass of the building increases and this will result in the increase of the stiffness of the structure. During the seismic activities,response of the structure with infill walls is quite different for the structure without infill walls.

Paulay & Priestley proposed a theory about the seismic behaviour of masonry infilled frame and a design method for infilled frames. Authors said that although masonry infill may increase the overall lateral load capacity, it can result inaltering structural response and attracting forces to different or undesired part of structure with asymmetric arrangement.

2.2 TITLE-Design optimization of reinforced concrete structures ,2008.

Abstract :

A novel formulation aiming to achieve optimal design of reinforced concrete (RC) structures is presented here. Optimal sizing and reinforcing for beam and column membersin multi-bay and multistory RC structures incorporates optimal stiffness correlation among all structural members and results in cost savings over typical-practice design solutions. A Nonlinear Programming algorithm searches for a minimum cost solution that satisfies ACI 2005 code requirements for axial and flexural loads.Material and labor costs for forming and placing concrete and steel are incorporated as a function of member size using RS Means 2005 cost data.Successful implementation demonstrates the abilities and performance of Sequential Quadratic Programming algorithm for the design optimization of RC structures. A number of examples are presented that demonstrate the ability of this formulation to achieve optimal designs.

This paper presents a novel optimization approach for the design of reinforced concrete (RC) structures.

Optimal sizing and reinforcing for beam and column members in multi-bay and multistory RC structures incorporates optimal stiffness correlation among structural members and results in cost savings over typical state-of-the-practice design solutions. The design procedures for RC structures that are typically adapted in practice begin by assuming initial stiffness for the structural skeleton elements.This is necessary to calculate the internal forces of a statically indeterminate structure.The final member dimensions are then designed to resist the internal forces that are the result of the assumed stiffness distribution.This creates a situation where the internal forces used for design may be inconsistent with the internal forces thatcorrespond to the final designdimensions.

III. LOADS CONSIDERED

3.1 HORIZONTAL LOAD :

Horizontal loads comprises of wind load and earthquake load. The longitudinal loads i.e. tractive and braking forces are considered in special case of design of bridges, gantry girders etc.

3.2 VERTICAL LOAD :

The vertical loads consist of dead load, live load and impact load.

3.3 LIVE LOAD :

Live loads are either movable or moving loads with out any acceleration or impact. There are assumed to be produced by the intended use or occupancy of the building including weights of movable partitions or furniture etc. The floor slabs have to be designed to carry either uniformly

distributed loads or concentrated loads whichever produce greater stresses in the part under consideration. Since it is unlikely that any one particular time all floors will not be simultaneously carrying maximum loading, the code permits some reduction in imposed loads in designing columns, load bearing walls, piers supports and foundations.

3.4 DEAD LOADS :

All, partitions floor finishes, false ceilings, false floors and the other permanent constructions permanent constructions of the structure form the dead loads. The dead load comprises of the weights of walls in the buildings. The dead load loads may be calculated from the dimensions of various members and their unit weights. the unit weights of plain concrete and reinforced concrete made with sand and gravel or crushed natural stone aggregate may be taken as 24 kN/m” and 25 kN/m” respectively.

3.5 IMPOSED LOADS :

Imposed load is produced by the intended use or occupancy of a building including the weight of movable partitions, distributed and concentrated loads, load due to impact and vibration and dust loads. Imposed loads do not include loads due to wind, seismic activity, snow, and loads imposed due to temperature changes to which the structure will be subjected to, creep and shrinkage of the structure, the differential settlements to which the structure may undergo.

3.6 WIND LOAD :

Wind is air in motion relative to the surface of the earth. The primary cause of wind is traced to earth’s rotation and differences in terrestrial radiation. The radiation effects are primarily responsible for convection either upwards or downwards. The wind generally blows horizontal to the ground at high wind speeds. Since vertical components of atmospheric motion are relatively small, the term ‘wind’ denotes almost exclusively the horizontal wind, vertical winds are always identified as such. The wind speeds are assessed with the aid of anemometers or anemographs which are installed at meteorological observatories at heights generally varying from 10 to 30 metres above ground.

3.7 SEISMIC LOAD :

Design Lateral Force :

The design lateral force shall first be computed for the building as a whole. This design lateral force shall then be distributed to the various floor levels. The overall design seismic force thus obtained at each floor level shall then be distributed to individual lateral load resisting elements depending on the floor diaphragm action.

Design Seismic Base Shear :

The total design lateral force or design seismic base shear (Vb) along any principal direction shall be determined by the following expression:

Vb = Ah W

Where,

Ah = horizontal acceleration spectrum

W = seismic weight of all the floors

IV. ANALYSIS AND DESIGN

Analysis and Design of G+21 Multistorey building as a RCC structure of beam and column.

WORKING WITH STAAD.Pro :

4.1 Input Generation:

That input file is a text file consisting of a series of commands which are executed sequentially. The commands contain either instructions or data pertaining to analysis and/or design. The STAAD input file can be created through a text editor facility. In general, any text editor may be utilized to edit/create the STD input file.

4.2 Types of Structures:

A STRUCTURE can be defined as an assemblage of elements. STAAD is capable of analyzing and designing structures consisting of frame, plate/shell and solid elements. Almost any type of structure can be analyzed by STAAD.

A SPACE structure, which is a three dimensional framed structure with loads applied in any plane, is the most general.

A PLANE structure is bound by a global X-Y coordinate system with loads in the same plane.

A TRUSS structure consists of truss members which can have only axial member forces and no bending in the members.

A FLOOR structure is a two or three dimensional structure having no horizontal (global X or Z) movement of the structure [FX, FZ & MY are restrained at every joint]. The floor framing (in global X-Z plane) of a building is an ideal example of a FLOOR structure. Columns can also be modeled with the floor in a FLOOR structure as long as the structure has no horizontal loading. If there is any horizontal load, it must be analyzed as a SPACE structure.

4.3 Generation of the structure*:* The structure may be generated from the input file or mentioning the co-ordinates in the GUI. The figure below shows the GUI generation method.

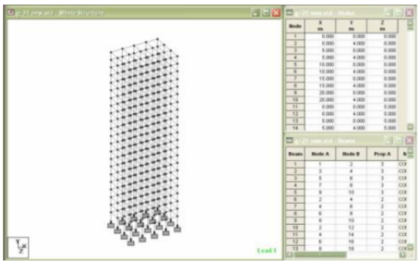

fig:Generation of structure

4.4 Supports:

Supports are specified as PINNED, FIXED, or FIXED with different releases (known as FIXED BUT). A pinned support has restraints against all translational movement and none against rotational movement. In other words, a pinned support will have reactions for all forces but will resist no moments. A fixed support has restraints against all directions of movement. Translational and rotational springs can also be specified. The springs are represented in terms of their spring constants.

4.5 Loads:

Loads in a structure can be specified as joint load, member load, temperature load and fixed-end member load. STAAD can also generate the self-weight of the structure and use it as uniformly distributed member loads in analysis. Any fraction of this self weight can also be applied in any desired direction.

Joint loads:

Joint loads, both forces and moments, may be applied to any free joint of a structure. These loads act in the global coordinate system of the structure. Positive forces act in the positive coordinate directions. Any number of loads may be applied on a single joint, in which case the loads will be additive on that joint.

4.6 Beam Design:

Beams are designed for flexure, shear and torsion. If required the effect of the axial force may be taken into consideration. For all these forces, all active beam loadings are prescanned to identify the critical load cases at different sections of the beams. For design to be performed as per IS: 13920 the width of the member shall not be less than 200mm. Also the member shall preferably have a width-to depth ratio of more than 0.3.

Design for Shear:

The shear force to be resisted by vertical hoops is guided by the IS 13920:1993 revision.Elastic sagging and hogging moments of resistance of the beam section at ends are considered while calculating shear force. Plastic sagging and hogging moments of resistance can also be considered for shear design if PLASTIC parameter is mentioned in the input file. Shear reinforcement is calculated to resist both shear forces and torsional moments

4.7 Column Design:

Columns are designed for axial forces and biaxial moments per IS 456:2000. Columns are also designed for shear forces. All major criteria for selecting longitudinal and transerse reinforcement as stipulated by

IS: 456 have been taken care of in the column design of STAAD. However following clauses have been satisfied to incorporate provisions of IS 13920:

1 The minimum grade of concrete shall preferably be M20

2. Steel reinforcements of grade Fe415 or less only shall be used.

3. The minimum dimension of column member shall not be less than 200 mm. For columns having unsupported length exceeding 4m, the shortest dimension of column shall not be less than 300 mm.

4. The ratio of the shortest cross-sectional dimension to the perpendicular dimension shall preferably be not less than 0.

ANALYSIS OF G + 21 RCC FRAMED BUILDING USING STAAD.Pro:

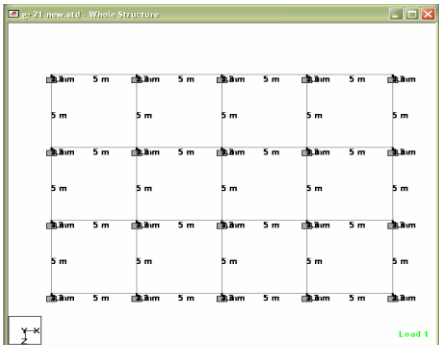

Fig:Plan of the G+21 storey building

All columns = 0.50 * 0.50 m (until ground floor)
Columns at the ground floor: 0.8 * 0.8 m
All beams = 0.3 * 0.5 m
All slabs = 0.20 m thick
Terracing = 0.2 m thick avg.
Parapet = 0.10 m thick RCC

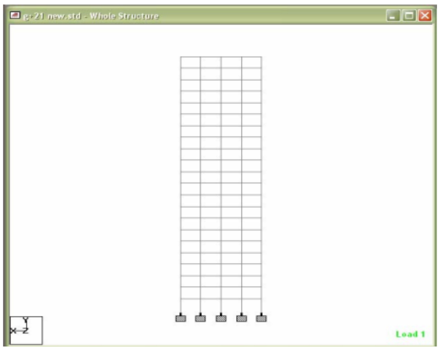

Fig:elevation of the G+21 storey building

Physical parameters of building:

Length = 4 bays @ 5.0m = 20.0m
Width = 3 bays @ 5 m =15.0m
Height = 4m + 21 storeys @ 3.3m = 73.3m
(1.0m parapet being non- structural for seismic purposes, is not considered of building frame height)

Live load on the floors is 2kN/m2
Live load on the roof is 0.75kN/m2

Grade of concrete and steel used:
Used M30 concrete and Fe 415 steel

Supports*:*
The base supports of the structure were assigned as fixed. The supports were generated using the STAAD.Pro support generator.

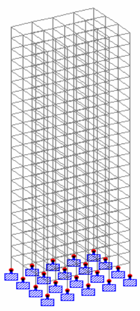

Fig:fixing supports of the structure

Loading:
The loadings were calculated partially manually and rest was generated using STAAD.Pro load generator. The loading cases were categorized as:

1. Self-weight
2. Dead load from slab
3. Live load
4. Wind load
5. Seismic load
6. Load combinations

Self-weight:
The self weight of the structure can be generated by STAAD.Pro itself with the self weight command in the load case column.

Dead load from slab:

Dead load from slab can also be generated by STAAD.Pro by specifying the floor thickness and the load on the floor per sq m. Calculation of the load per sq m was done considering the

weight of beam, weight of column, weight of RCC slab, weight of terracing, external walls, internal walls and parapet over roof.

The load was found to be:
14.482 KN/sq m [terrace]
13.5 KN/sq m [second floor]
14.37 KN/sq m [first floor]

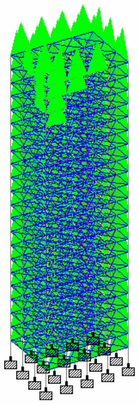

Fig:The structure under DL from slab

Live load:
The live load considered in each floor was 2.5 KN/sq m as per IS Code 456 and for the terrace level it was considered to be 0.75 KN/sq m. The live loads were generated in a similar manner as done in the earlier case for dead load in each floor. This may be done from the member load button from the load case column.

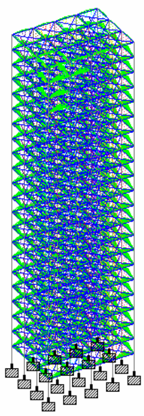

Fig :The structure under live load

Wind load:
The wind load values were generated by the IS 875.The wind intensities at various heights were calculated by the IS 875.Based on those values it generates the wind load at different floors.

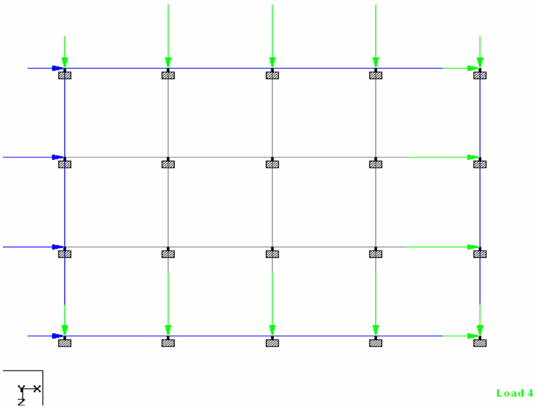

Fig:wind load effect on structure

Seismic load:

The seismic load values were calculated as per IS 1893-2002. STAAD.Pro has a seismic load generator in accordance with the IS code mentioned.

Description*:*

The seismic load generator can be used to generate lateral loads in the X and Z directions only. Y is the direction of gravity loads. This facility has not been developed for cases where the Z axis is set to be the vertical direction using the "SET Z UP" command.

Methodology:

The design base shear is computed by STAAD in accordance with the IS: 1893(Part 1)-2002.

V = Ah*W

Where, Ah = (Z*I*Sa)/ (2*R*g)

STAAD utilizes the following procedure to generate the lateral seismic loads. User provides seismic zone co-efficient and desired "1893(Part 1)-2002 specs" through the DEFINE 1893 LOAD command.

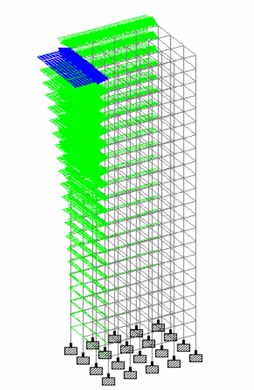

Fig:structure under seismic load

Load combination:

The structure has been analyzed for load combinations considering all the previous loads in proper ratio. In the first case a combination of self-weight, dead load, live load and wind load was taken in to consideration. In the second combination case instead of wind load seismic load was taken into consideration.

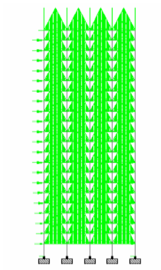

Fig:under combination wind load

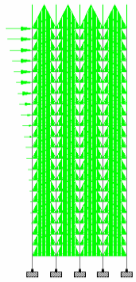

Fig:under combination with with seismic load

DESIGN OF G + 21 RCC FRAMED BUILDING USING STAAD.Pro:

The structure was designed for concrete in accordance with IS code 456. The parameters such as clear cover, Fy, Fc, etc were taken for design for R.c.c. Then it has to be specified which members are to be designed as beams and which member are to be designed as columns.

V. ANALYSIS AND DESIGN RESULTS

Some of the sample analysis and design results have been shown below for beam and column which is at the roof level of 1st floor are shown.

Beam :1st floor Rectangular section and by giving length want to describe that all values came are different

Section	0 mm	1250 mm	2500 mm	3750 mm	5000 mm
Top r/f	1714.02	0	273.43	1691.96	3487.9
Bottom r/f	3487.98	1692.06	293.58	273.43	1713.94

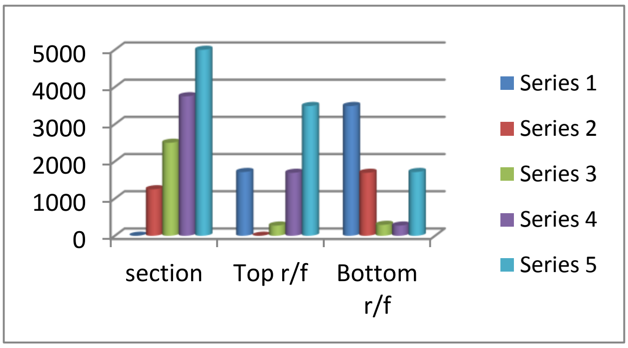

Fig:graph showing values of rectangular section.by this we see increase & decrease in top n bottom r/f.

Series 1-shows section value
Series 2-shows top r/f value.
Series 3-shows bottom r/f value.

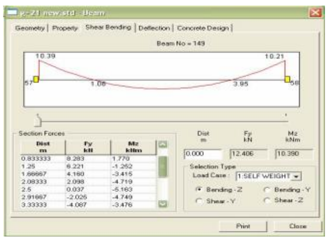

Fig:Shear bending of rectangular section beam which shows circular curve in +ve(upward) & -ve(downward)direction.

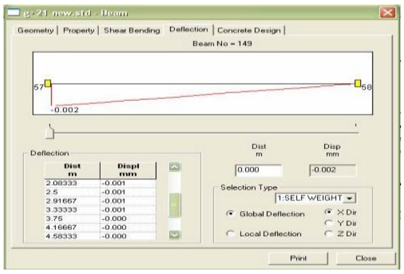

Fig:Deflection of rectangular section beam

Which shows straight line in –ve(downward) direction

In both these we can see shear and deflection of rectangular beam came are different.which shows different curves while designing.

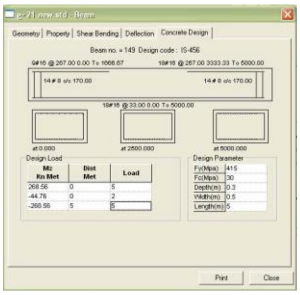

Fig:Concrete design of rectangular section beam

Column :

LENGTH: 4000.0 mm CROSS SECTION: 800.0 mm X 800.0 mm COVER: 40.0 mm

Puz : 15042.82 Muz1 : 1951.59 Muy1 : 1951.59

INTERACTION RATIO: 0.98 (as per Cl. 39.6, IS456:2000)

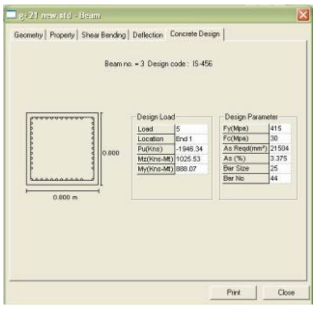

Fig:concrete design of rectangular section column Concrete design of column came are different as bygiven length 4000 ,cross section 800 x 800 and the interaction ratio came is 0.98 in design.

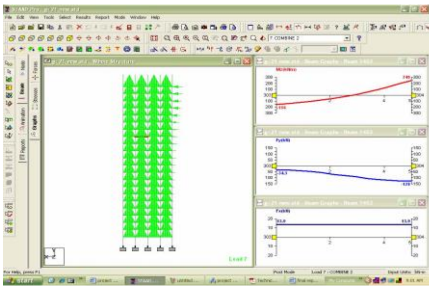

Fig:graph for shear force and bending moment for a beam Shear force and bending moment diagram for a rectangular beam which shows 156(-ve)direction & 249(+ve)direction values.

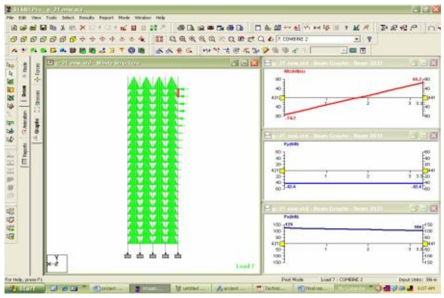

Fig:graph for shear force and bending moment for a column Shear force and bending moment diagram for a column which shows 74.2 (-ve)direction & 64.2(+ve)direction values.

VI. CONCLUSION

STAAD PRO has the capability to calculate the beam r/f and shear,deflection details.The program contains a number of parameters which are designed as per IS: 456(2000). From which Beams and columns are designed.

Beam Design :

The design output of the beam contains top n bottom reinforcement & shear ,deflection figures provided along the length of the beam.and details are given above in design.

Column Design :

Columns are designed for axial forces and biaxial moments at the ends.The loading which yield maximum reinforcement is called the critical load.Column design is done for square section. Square columns are designed with longitudinal & transverse reinforcement distributed on each side equally for the sections under biaxial moments.All major criteria for selecting longitudinal and transverse reinforcement as stipulated by IS: 456 have been taken care of in the column design of STAAD.

The problem which can analyse is having a differences of each floor in designing & further can modify by designing as per steel IS code.

VII. FUTURE SCOPE

Further we can analyse and design by using steel IS Code 800 and show various details of multistorey building.and compare from rcc &can describe earthquake effects on dis.

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[4] IS 1893-2000-IS Code for different types of loads.

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