# A Study on Multi Storied Building Manual Calculation Design in Guntur

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*Abstract*— A multi storey building is a building that has multiple floors above ground in the building. Multi-storey buildings aim to increase the floor area of the building without increasing the area of the land and saving money. Analysis of multi-storey building frames involves lot of complications and edacious calculations by conventional methods. To carry out such analysis is a time consuming task. Substitute frame method for analysis can be handy in approximate and quick analysis instead of bidding process. Till date, this method has been applied by designers for vertical loading conditions. The represented plan given to office purposes can accommodate with minimum facilities. Generally buildings may be failed by bending moments, shear forces acting on members of the building. By keeping these failures in mind, we designed beams, columns, footings by considering maximum loads on members. For loads calculation, substitute frame method is used for reducing the complexity of calculations and saving time. This total G +3 office building designed with only manual calculations based on values here taken from the standard code books (IS 456:2000, SP 16)

*Index Terms*— Designed beams, Columns, Footings

## I. INTRODUCTION

The development of the high-rise building has followed the growth of the city closely. The process of urbanisation, that started with the age of industrialisation, is still in progress in developing countries like India. Industrialisation causes migration of people to urban centres where job opportunities are significant. The land available for buildings to accommodate this migration is becoming scarce, resulting in rapid increase in the cost of land. Thus, developers have looked to the sky to make their profits. The result is multi-storeyed buildings, as they provide a large floor area in a relatively small area of land in.

## II. METHODS OF STRUCTURAL ANALYSIS

When the number of unknown reactions or the number of internal forces exceeds the number of equilibrium equations available for the purpose of analysis, the structure is called as a statically indeterminate structure. most of the structures designed today are statically indeterminate. This indeterminacy may develop as a result of added supports or extra members, or by the general form of the structure. While analysing any indeterminate structure, it is essential to satisfy equilibrium, compatibility, and force-displacement requisites for the structure. When the reactive forces hold the structure at rest, equilibrium is satisfied and compatibility is said to be satisfied when various segments of a structure fit together without intentional breaks or overlaps. Two fundamental methods to analyse the statically indeterminate structures are discussed below.

FORCE METHODS:
Originally developed by James Clerk Maxwell in 1864, later developed by Otto Mohr and Heinrich Muller-Breslau, the force method was one of the first methods available for analysis of statically indeterminate structures. As compatibility is the basis for this method, it is sometimes also called as compatibility method or the method of consistent displacements. In this method, equations are formed that satisfy the compatibility and force-displacement requirements for the given structure in order to determine the redundant forces. Once these forces are determined, the remaining reactive forces on the given structure are found out by satisfying the equilibrium requirements

DISPLACEMENT METHODS:
The displacement method works the opposite way. In these methods, we first write load-displacement relations for the members of the structure and then satisfy the equilibrium requirements for the same. In here, the unknowns in the equations are displacements. Unknown displacements are written in terms of the loads (i.e. forces) by using the load-displacement relations and then these equations are solved to determine the displacements. As the displacements are determined, the loads are found out from the compatibility and load- displacement equations. Some classical techniques used to apply the displacement method are discussed.

SLOPE DEFLECTION METHODS:
This method was first devised by Heinrich Manderla and Otto Mohr to study the secondary stresses in trusses and was further developed by G. A. Maneyextend its application to analyze indeterminate beams and framed structures. The basic assumption of this method is to consider the deformations caused only by bending moments. It's assumed that the effects of shear force or axial force deformations are negligible in indeterminate beams or frames. The fundamental slope-deflection equation expresses the moment at the end of a member as the superposition of the end moments caused due to the external loads on the member, while the ends being

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assumed as restrained, and the end moments caused by the displacements and actual end rotations.

MOMENT DISTRIBUTION METHOD:

This method of analyzing beams and multi storyed frames using moment distribution was introduced by Prof. Hardy Cross in 1930 and is also sometimes referred to as Hardy Cross Method. It is alternative method in which one goes on carrying on the cycle to reach to a desired degree of accuracy.
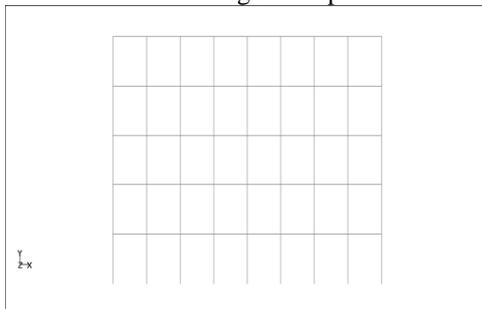
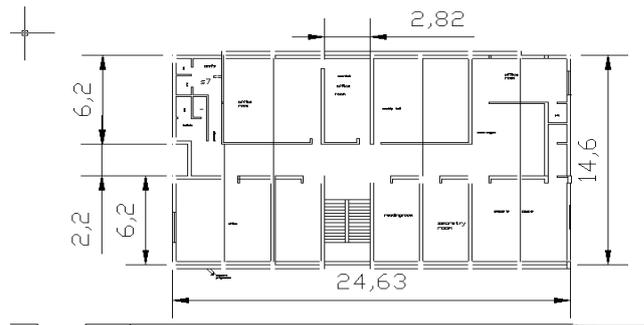### III. PLAN OF G+3 STRUCTURE AND DIFFERENT VIEWS
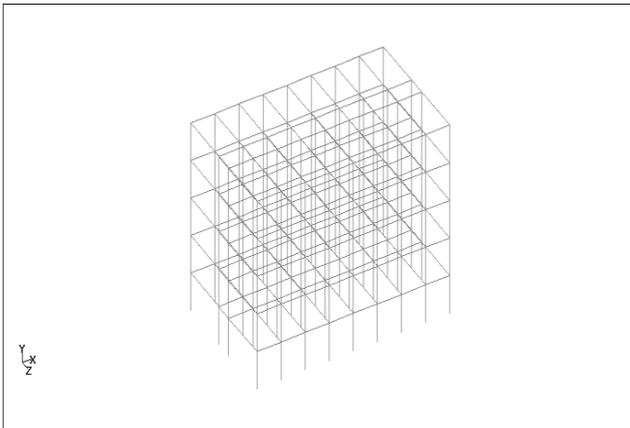


Isometric views
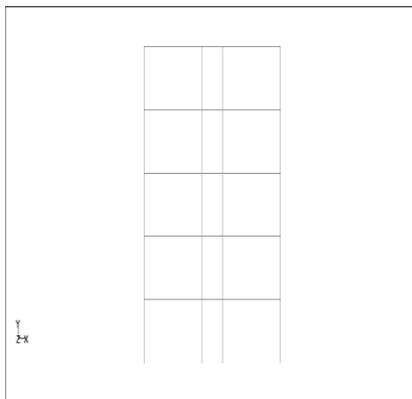


View along short span



view along long span

### IV. THE PLAN OF THE G +3 OFFICE BUILDING IS SHOWN BELOW OF AREA 24.6 X 14.6 M$^2$ WITH THE



*SLABS DESIGN*

*One way slab with two edge discontinuous and shorter edge continuous One way slab with two edge discontinuous and longer edge continuous*

*DESIGN OF SLAB TYPE 1*

*The ratio of loner span to the shorter span is greater than 2 is called as one way slab .one way slab bends only in one direction across the span , acts like a wide beam . the design of one way slab is same as that of beam of 1 meter width .*

*Design procedure for one way slab :*

*Ly/lx=6200/3050=2.032*

*Span =2820+2(110)=3.05 m*

*Live load=2 Kn/mm2*

*Fy=415 N/mm*

*Thickness of the slab:*

*Depth(d)=span/26=3050/26=117.3 mm*

*Total depth =20 mm+5 mm+117 mm = 142.3 mm*

*Loads calculation:*

*Self weight =25*0.14=3.5KN/m*

*Dead load= 45 kn/mm*

*Live load=4kn/m2*

*Total working load =8,5Kn/m2*

*Total working load=8.5kn/m2Ultimate load =1.5*8.5=12.75kn/m*

*The slab is two edge discontinuous and one shorter edge continous*

*ly/lx=2.032      (from IS 456:2000, table 26 conditions )*

$\alpha_{x(neg)} = 0.09, \alpha_{x(pos)} = 0.069$

$\alpha_{y(neg)} = 0.4, \alpha_{y(pos)} = 0.035$

$M_{ux}(-ve) = a_x \, wl^2 = (0.091*12.75)*3.05^2$
             $= 10.79KNM$

$M_{ux}(+ve) = a_x \, wl^2 = 0.069*12.75*3.05^2$
             $= 8.18knm$

$M_{uy}(-ve) = a_y \, wl^2 = 0.047 *12.75 *3.05^2$
             $= 5.574 \, Knm$

$M_{uy}(+ve) = 0.035*(12.75)3.05^2$
             $= 4.151$

*Depth required :*

$M_{ux} = 0.138 f_{ck} bd^2$

$10.79x10^6 = 0.138x25x1000xd^2$

$D = 62.52\ mm$

*Reinforcement details about the slab type 1 between columns (11-12-20-21) FRAME ANALYSIS*

*In case of middle frame, both side ends are fixed*

*Firstly we considered live load as combination of maximum and dead loads at particular section for determining maximum moment between span 4-5 and dead load in another section for determine minimum moment at that section 5-6 .*

*After finding maximum moments between span 4-5 by taking maximum loads , next section 5-6 carried out maximum loads and 4-5 carries dead loads .*

*LOAD CASE :*

*Loadings on transverse beam are already calculated maximum load is 39 KN-M and minimum load is 13 KN-M for uniform distributed load and 35 KN for point load (see loads on transverse beam)*
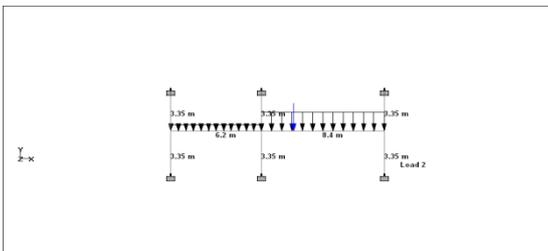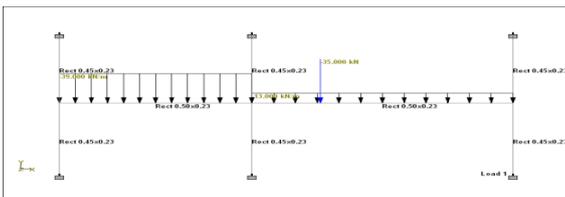




Maximum load between 5-6 and dead load between 4-5 :

Calculation of fixed end moments :

SPAN 5-6 :

Maximum

$M_{F5-6} = 39\ X\ 8.4\ X8.4\ /\ 12 + 72\ X\ 2.2X6.2X6.2\ /\ 8.4^2$
$= 315.61\ KNM$

$M_{F6-5} = 39\ X\ 8.4\ X8.4\ /\ 12 + 72\ X\ 2.2X2.2X6.2\ /\ 8.4^2$

$= 259.94\ KNM$

Minimum

$M_{F5-6} = 13\ X\ 8.4\ X8.4\ /\ 12 + 35\ X\ 2.2X6.2X6.2\ /\ 8.4^2$

$= 118.39\ KNM$

$M_{F6-5} = 13X\ 8.4\ X8.4\ /\ 12 + 72\ X\ 2.2X2.2X6.2\ /\ 8.4^2$

$= 91.32\ 1\ KNM$

Stiffness factor = I / y

Moment of inertia for section = $BD^3$ / 12

$= (230*500^3)\ /\ 12$

$= 2396*10^6\ mm^4$
(column wide sections )
$= 2(2396 * 10^6)$
$= 4792*10^6\ mm^4$
(for flanged sections)

Length of the beam = 6200 mm

Distribution factor = k / Σk

Calculation of distribution factors :

A. *Calculation of final end moments :*

B. *TOP FRAME ANALYSIS*

C. *In case of top frame only one ends are fixed and another side is roof .*

D. *we already calculated loadings on longitudinal external beam so here taken maximum and minimum loads loads . maximum load is 35KN minimum load is 18 KN .*

E. *I value same for vertical and flanged sections and y value taken respect to beam*

F. *So stiffness factor = I / y*

G. *Distribution factor = k / Σ k*

H. *The distribution factors are calculated as given*

| JOINT | MEMBER | STIFFNESS FACTOR | SUM | D.F |
|---|---|---|---|---|
| 1 | 1-2 | 0.77 | 1.485 | 0.52 |
|  | 1-4 | 0.715 |  | 0.48 |
| 2 | 2-3 | 0.77 | 2.055 | 0.37 |
|  | 2-3 | 0.57 |  | 0.28 |
|  | 2-5 | 0.715 |  | 0.34 |
| 3 | 3-2 | 0.570 | 1.287 | 0.44 |
|  | 3-6 | 0.715 |  | 0.56 |

*With Maximum load SPAN 1-2*

*Maximum $M_{F1-2} = -WL^2 / 12 = 35X6.2X6.2 / 12$*

*= 112.12 kNM*

*Minimum $M_{F1-2} = WL2 / 12$*

*= 18X6.2X6.2 / 12*

*= 57.66 KNM*

*SPAN 2-3*

*Maximum*

$$M_{F1\text{-}2} = WL^2 / 12$$

$$= 35 \times 8.4 \times 8.4 / 12$$
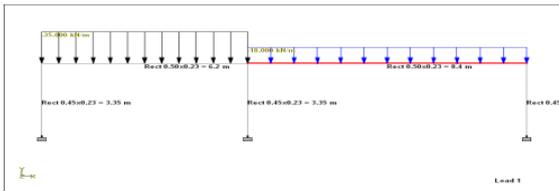
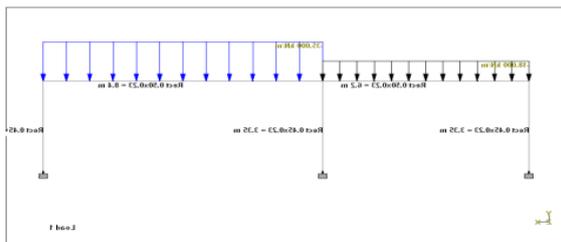$$= 205.8 \ kNM$$

Minimum

$$M_{F1\text{-}2} = WL2 / 12$$

$$= 18 \times 8.4 \times 8.4 / 12$$

$$= 105.84 \ KNM$$

Load case 1 :



Load case 2 :



*TOP FRAME ANALYSIS*

*In case of top frame only one ends are fixed and another side is roof .*

*we already calculated loadings on longitudinal external beam so here taken maximum and minimum loads loads . maximum load is 35KN minimum load is 18 KN .*

*I value same for vertical and flanged sections and y value taken respect to beam*

*So stiffness factor = I / y*

*Distribution factor = k / Σ k*

*The distribution factors are calculated as given bellow*

| Joint | Member | Stiffness factor | Sum | d.f |
|-------|--------|------------------|------|------|
| 1 | 1-2 | 0.77 | 1.485 | 0.52 |
|   | 1-4 | 0.715 |       | 0.48 |

| Joint | Member | Stiffness factor | Sum | d.f |
|-------|--------|------------------|------|------|
| 2 | 2-3 | 0.77 | 2.055 | 0.37 |
|   | 2-3 | 0.57 |       | 0.28 |
|   | 2-5 | 0.715 |       | 0.34 |

| | | | | |
|---|---|---|---|---|
| 3 | 3-2 | 0.570 | 1.287 | 0.44 |
|   | 3-6 | 0.715 |       | 0.56 |
| 4 | 4-1 | 0.715 | 2.2 | 0.325 |
|   | 4-5 | 0.77 |     | 0.35 |
|   | 4-7 | 0.715 |    | 0.325 |
| 5 | 5-2 | 0.715 | 2.77 | 0.26 |
|   | 5-8 | 0.715 |      | 0.20 |
|   | 5-6 | o.570 |      | 0.26 |
|   | 5-4 | 0.77 |       | 0.28 |
| 6 | 3-6 | 0.715 | 2.00 | 0.36 |
|   | 6-9 | 0.715 |      | 0.36 |
|   | 6-5 | 0.570 |      | 0.28 |

| JOINT | 4 | | 5 | 6 |
|-------|------|------|------|------|
| MEMBERS | 4-5 | 5-4 | 5-6 | 6-5 |
| D.F | 0.35 | 0.25 | 0.25 | 0.28 |
| FEM | -124.93 | 124 | -118.39 | 91.32 |
| BAL | 43.73 | -1.83 | -1.31 | -25.57 |
| COM | -0.92 | 21.86 | -12.78 | -0.66 |
| BAL | 0.32 | -2.54 | -1.82 | 0.18 |
| COM | -1.27 | 0.16 | 0.09 | -0.91 |
| BAL | 0.44 | -0.07 | -0.05 | 0.25 |
| FINAL | -82.63 | 142.51 | -134.26 | 64.61 |

## V. CONCLUSION

We have calculated details about this structure are manually . By designing this structure , we have clarity on structures and known knowledge about the structures In this design , we used approximate method is substitute frame method why because is we don't have sufficient time . By doing manual design we have gained more knowledge than design using software and this project we are more familiar with code books. We have faced the real engineering practice in this project. We have applied our gained knowledge during our project

REFERENCES

[1] AgarwalPankajShrikhande Manish, "Earthquake resistant design of structures", PHI learning private limited, New Delhi, 2009.
[2] ArlekarJaswant N, Jain Sudhir K. and Murty C.V.R, (1997), Seismic Response of RC Frame Buildings with Soft First Storeys". Proceedings of the CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, 1997, New Delhi.
[3] Awkar J. C. and Lui E.M, "Seismic analysis and response of multi-storeysemirigidframes", Journal of Engineering Structures, Volume 21, Issue 5, Page no: 425442, 1997
[4] Kulkarni J.G., Kore P. N., S. B. Tanawade, "Analysis of Multistorey Building Frames Subjected to Gravity and Seismic Loads with Varying Inertia", International Journal of Engineering and Innovative Technology (IJEIT), Volume 2, Issue 10, April 2013
[5] B. SrikanthV.Ramesh "Comparative Study of Seismic Response for Seismic Coefficient and Response Spectrum Methods", Journal of Engineering Research and Applications,ISSN:224-9622, Vol. 3, Issue 5, SepOct 2013, pp.1919 -1924

[6] IS: 1893:2000, Part 1, "Criteria for EarthquakeResistantDesignofStructuresGeneralProvisions for Buildings", Bureau of Indian Standards, New Delhi, 2002.

[7] ETABSNon linear version 9.7.1

## BIOGRAPHY

[1] DESIGN OF REINFORCED CONCRETE STRUCTURES BY **KRISHNA RAJU**

[2] SRUCTURAL ANALYSIS VOL -2 BY **BHAVIKATTI**

**[3]** Design of reinforced concrete structures by **Mr. Dheerendra Babu.**

**[4]** Design of reinforced concrete structures by **B.C PUNMIA.**

[5] TAHORET OF STRUCTURES BY **S. RAMAMRUTHAM**

[6] Concrete structures by **V.N. Vazirani and M.M. Ratwani.**

[7] **IS: 456 -2000** (Indian standard plain and reinforced concrete code of practice).

[8] **IS: 875 -1987** (Code of practice for design loads).

[9] **SP: 16 -1980 (**Design Aids for reinforced concrete to IS: 456**).**