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Analysis and Design of G + 1 RCC Building

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Abstract*: Due to advancement of technology humans are creating software to make things easier and time saving. As a result in the civil engineering point of view the manual design of buildings has lost its importance. It is true that design using a software is easy and time saving and mostly results are accurate. On the other hand manual design is a cumbersome job and a time consuming process, but for a beginner manual design helps to understand the basic fundamentals that are involved in designing a building. Once a person gains knowledge in manual design he will be knowing the elements involved in designing and can easily understand the usage of software. The main objective of the project is to use the knowledge that we have learn during our graduation and learn to deal with practical cases. We wish this project will fulfil our purpose.*

Keywords: RCC

I. INTRODUCTION

The structural design of a building should ensure that the building can stand safely, operate without excessive deformation or movement that could lead to fatigue of structural elements, cracks or failure of fixtures, fittings or partitions, or failure. Causing inconvenience to occupants. It must consider the moments and forces due to temperature, creep, cracks, and imposed loads. It must also be verified that the design is nearly buildable within acceptable manufacturing tolerances of the materials. It must allow the architecture to function and the building services to adapt to the building functionally (ventilation, lighting, etc.)

Based on the analysis, the design of the structure is done mainly following IS specifications. The requirements of a properly designed building structure are:

a) Good Structural Configuration: The size, shape and structural system taking loads are such that they ensure a direct and smooth flow of inertia forces to the ground.

b) Lateral Strength: The limit transverse force that it can resist is such that the damage induced in it does not result in collapse.

c) Adequate Stiffness: Its transverse load resisting system is such that the earthquake induced deformations in it do not damage its filling under low-to moderate shaking.

Reinforced Concrete (RC), also called Reinforced Cement Concrete (RCC) and Ferroconcrete, is a composite material in which concrete's relatively low tensile strength and ductility are compensated for by the inclusion of reinforcement having higher tensile strength or d' utility.Now a days due to the over Population in the Urban Cities and High cost of the land, there is a need to Residentials building Is high. The determination of forces developed in the elements is known as structural analysis, so that it will perform the function for which it is built and will safely withstand the influences which will act on throughout its useful life. The entire process of structural planning and designing requires not only imaginations and calculations, but also thorough knowledge of structural engineering, knowledge of practical aspect, such bye-laws and design codes, backed by sample experience and judgment.

In every aspect of human civilization, we need structures to live. The structures should be built in an efficient manner so that it can serve people and save money. In simple words, the building means an empty structure surrounded by walls and roofs, in order to give shelter for human beings

Nowadays we can see that various old structures in many parts of India are collapsing due to various reasons and there is a loss of life on a large scale. Such old structures are present in many parts of our country and many of them are on

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the verge of collapse. Hence it is very essential to assess the properties of such structures and reanalyze and rehabilitate them so as to prevent their collapse and loss of life.

In early times humans have lived in caves to protect themselves from wild animals, rain etc. Then, humans developed and built their homes using timbers and lived.

Nowadays the recent homes are developed into individual and multi-storey buildings. Buildings are the necessary indicator of social progress of the county. At current situation, many new techniques have been developed for constructions. So, that the buildings are built economically and quickly to fulfil the needs of the people.

A building frame is a three-dimensional structure which consists of column, beams and slabs. Because of growing population, high rise buildings are coming into demand. Buildings constitute a part of the definition of civilizations, a way of life advanced by the people. The buildings should be constructed for human requirements and not for earning money. Buildings are built in different sizes, shapes and functions.

The procedure for analysis and design of a given building will depend on the type of building, its complexity, the number of stories etc. First, the architectural drawings of the building are studied. structural system is finalized, sizes of structural members are decided and brought to the knowledge of the concerned architect. The procedure for structural design will involve some steps which will depend on the type of building and also its complexity and the time available for structural design. Often, the work is required to start

1.1 AIM AND OBJECTIVES

AIM: To Analysis and design G + 1 storey building

OBJECTIVES:

1. To prepare a plan of G + 1 storeyRCC building.
2. To analyse the G + 1 storey building for vertical loading.
3. To design the G + 1 storeybuilding.

1.2 METHODOLOGY

Project topic finalization.
Literature survey.
Planning of building
Calculation of load
Analysis of building
Design of building
Result and conclusion

1.3 PROBLEM STATEMENT

Analysis the frame shown in the figure for vertical loading by approximate method of analysis as given below.

The building will be used as a duplex with live load of 2kN/m² everywhere. All other loads may be assumed as per IS. 875 & IS 1893. It is located in

The spacing of frames in the longitudinal direction is designated as B and there are 10 pays in that direction. The slab thickness may be adopted as per L/d requirements of IS. 456-2000 with uniform, thickness of slab throughout.

Assume suitable roof covering and floor finish.

All outer walls are 230 mm brick masonry and the inner walls 150 mm brick masonry.

Assume column size 230×450mm

Beam size 230×450mm

Use M20 grade of concrete and

Use of Fe500 grade steel

II. LITERATURE REVIEW

Various research papers have been published on building planning and analysis is on tall buildings by using the STAAD Pro. The research papers have been gathered and are as follows. The study of seismic and wind load response of G+1storey RCC.

Adhiraj A. Wadekar, "Analysis and Design of a Multi-Storey Building", April 2024.

The structure is inspected against the base shear and roof displacement and they are in permissible limits (Ramaraju et al., 2013). An RCC high rise building G+30 stories combined seismic load and wind loads. In the top beam of the structure requires more reinforcement required for static analysis as compare to dynamic analysis. Deflection and shear bending are less in static analysis compare to dynamic analysis. In column area of steel is always less for static load compared todynamic load (Kulkarni et al., 2016; Raju et al., 2015). The study of bending moment and shear force of the structure. Examination of stability, non-linear behaviour of a structure shown in fig.1. For high rise (G+1) building it is very important to resist the critical sagging moment and hogging moment (Sharma and Maru, 2014). The planning, analysis and design of the G+1storey residential building.

The dimensions of structural members are specified and the loads such as dead load, live load and wind load are applied. Shear and deflection tests are examined for beams, column and slab and they are safe with both theoretic and practical work (Sanjaynath and Kumar, 2018).Analysis and design of the G+19 Story building using STAAD Pro. The load was maximum when applied in the x-direction (parallel to shorter span) and the deflection increases as the height of the building increases. For base shear was 5% more in the case of STAAD Pro as compared to manually (Deshmukh et al., 2016). The wind load in structure is more critical for tall structures than the earthquake load. Analysis G+|1 storied structure is taken into account and loads like wind, static load and results are calculated and related to wind or without wind load. Deflection is maximum in wind load as compare to without wind load (Trivedi and Pahwa, 2018). A building [G+10] has the planning involves load ard many load combinations also analyzing the entire building by STAAD Pro with help of limit state method. From the result verification as shown in fig.2 (Kumar et al., 2019)39.

Dinesh Ranjan.S, Aishwaryalakshmi.V, "Design and Analysis of an Institutional Building", Volume 1, Issue 2, March 2017.

The aim of the project is to analyze and design of an institutional building. A lay out plan of the proposed building is drawn by using AUTO CADD 2010.Using this so many standard books analysis of bending moment, shear force, deflection, end moments and foundation reactions are calculated. The structure was analyzed using STA AD.ProV8i. The method we are design the entire structure is limit state Method. The R.C.C.detailing in general shall be as per SP 34 and as per ductile detailing codeI.S. 13920.1993. The design was carried as per IS 456:2000 for the above load combinations. As a result, the training, taken through a period of onemonth allowed to have sample exposure to various field practices in the analysis and design of multistorey buildings and also in various construction techniques used in the school.

Natasha Khalil, "Design and Analysis of a Building" Volume 08, Issue 1, Jan 2021.

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Arjunsahu, Anurag Verma, Aryanpaul, "Design and analysis of framed structure" Volume 08, Issue 1, Jan 2021.

There are several methods for analysis of different frames like cantilever method, portal method, and Matrix method. The present project deals with the design & analysis of an institutional building. The dead load live loads are applied and the design for beams, columns, footing is obtained STAAD Pro with its new features surpassed its predecessors and compotators with its data sharing capabilities with other major software like AUTOCAD.

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III. DESIGN SLAB

GEOMETRIC OF BUILDING

Given LL = 2 kN/m^2
Assume column size = 230×450 mm
Beam size = 230×450mm
Use M20 grade of concrete and
Use of Fe500 grade steel

Design slab

Ground Level (Imposeload / Live load) = 2 kN/m
Given:
Use M20 grade of Concrete
Use F500 gradeof Steel.
Length = 4m,Breath = 3.2m Impose Load = 2 kN/m

Step 1: Calculation of Slab

If the ratio of L/D less than 2 We will consider Slab astwo-way slab.
L/D is greater than 2. We will take it is as one way Slab System.
Where;
L= Length of Slab. D= Width of slab
For present Slab Section while as have
dimension. 4m × 3.2m

$$\frac{L}{D} = \frac{8}{4} = 2m. \qquad \frac{4}{3.2} = 1.25m$$

$$\therefore 1.25 < 2$$

So; We have taken two-way Slab System

STEP 2: Calculation Of Slab Thickness

As L = 4m > 3.5
M.F =1.68 and Fe 500 is used
$d_{assume} = \frac{4000}{26 X 1.68} = 91.57mm \cong 100$ mm
D_{assume} = 100 +30 …….(assume)
=130 mm
∴ d= D+d^1…($d^1 = 25mm$)
$= 130 - 25 = 105mm$

Step 3 : Calculation Of Effective Span

Lx = Lx_e= Lx + d
= 3200 + 105
= 3.30m.
Ly = Ly_e=Ly+ d
=4000 + 105
= 4.10m.

Step 4: Load & Bending Moment Calculation

Dead Lead of Slab = B×D $_{assume}$×25
Assume; B = 1000mm.
Dead Lead of Slab = 1000×130×25 = 3.25kN/m

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= 1×0.13 ×025= 0.0325kN/m

Live Load of Slab=2×1×1

=2 kN/m

Floor Finish Load =1×1×1

=1 kN/m

Total load=3.25+2+1

=6.25 kN/m

Factor Load (Wu)=1.5×6.25

=9.375 kN/m

Step 5: Bending Moment Calculation:

$$\frac{\mathrm{Ly}}{\mathrm{Lx}} = \frac{4.10}{3.30} = 1.242$$

From IS 456-2000:

αx^{+}=0.064 & αx^{-}=0.048

αy^{+}=0.084 & αy^{-}=0.065

$\mathrm{Mu}x^{+} = \mathrm{Wu}\times\alpha x^{+}\times \mathrm{L}x^{2}$

$= 9.375\times0.064\times3.30^{2}$

= 6.534kN.m

$\mathrm{Mu}y^{+} = \mathrm{Wu}\times\alpha y^{+}\times \mathrm{L}x^{2}$

$= 9.375\times0.048\times3.30^{2}$

= 4.9 kN.m

$\mathrm{Mu}x^{-} = -\mathrm{Wu}\times\alpha x^{-}\times \mathrm{L}x^{2}$

$= -9.375\times0.084\times3.30^{2}$

=-8.57 kN.m

$\mathrm{Mu}y^{-} = -\mathrm{Wu}\times\alpha y^{-}\times \mathrm{L}x^{2}$

$= -9.375\times0.084\times3.30^{2}$

=-6.63 kN.m

Step 6: Check For Depth

Mu max = $\mathrm{Mu}x^{-}$

$0.134\times\mathrm{fck}\times\mathrm{B}\times dreq^{2}$=8.57

$0.134\times25\times1000\times dreq^{2}$=8.57

d req =50.57mm

d req< d assume

50.57< 130 ……..its safe

Step 7 : Main Steel and its Spacing in 'X&Y' all Direction

$$\mathrm{Ast}x^{+} = \frac{0.5fck}{fy}\times\left[1-\sqrt{1-\frac{4.6\times mu\ x^{+}}{fck\times bd^{2}}}\right]\times \mathrm{bd}$$

$$= \frac{0.5\times25}{500}\times\left[1-\sqrt{1-\frac{4.6\times6.534\times10^{6}}{25\times1000\times105^{2}}}\right]\times1000\times130$$

$\mathrm{Ast}x^{+}=182.31 mm^{2}$

$$\mathrm{Ast}x^{-} = \frac{0.5fck}{fy}\times\left[1-\sqrt{1-\frac{4.6\times mu\ x^{-}}{fck\times bd^{2}}}\right]\times \mathrm{bd}$$

$$= \frac{0.5\times25}{500}\times\left[1-\sqrt{1-\frac{4.6\times8.57\times10^{6}}{25\times1000\times105^{2}}}\right]\times1000\times130$$

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Astx^{-}=241.38mm^2

Asty^{+}=$\frac{0.5fck}{fy}$×$\left[1-\sqrt{1-\frac{4.6\times mu\,y^{+}}{fck\times bd^2}}\right]$×bd

=$\frac{0.5\times 25}{500}$×$\left[1-\sqrt{1-\frac{4.6\times 4.9\times 10^6}{25\times 1000\times 105^2}}\right]$×1000×130

Asty^{+} =135.72 mm^2

Asty^{-}=$\frac{0.5fck}{fy}$×$\left[1-\sqrt{1-\frac{4.6\times mu\,y^{-}}{fck\times bd^2}}\right]$×bd

=$\frac{0.5\times 25}{500}$×$\left[1-\sqrt{1-\frac{4.6\times 6.63\times 10^6}{25\times 1000\times 105^2}}\right]$×1000×130

=185.07 mm^2

Ast min =0.0012×(1000×130)

=156 mm^2

Spacing of x bar min of:-

Sx =$\frac{1000\times A}{Ast\max x^{-}}$ = $\frac{\frac{\pi}{4}\times 10^2}{241.38}$ = 325.37 mm≅ 300 mm

Sx = 3d =3×105 = 315 mm

Sx = 300 mm

Sx = 300 mm C/C

Provide 10mm ⌀ bar 300 mm C/C

Mu max = Mux^{-}

0.134×fck×B×d req^2= 8.57 KN.m

0.134×25×1000×d req^2= 8.57×10^6 KN.m

d req=50.57 mm

d req < D assume

50.57 < 130 ……………. It is Safe

Spacing of y bar max of

Sy =$\frac{1000\times A}{Ast\max y^{-}}$ = $\frac{\frac{\pi}{4}\times 10^2}{185.07}$ = 424.37 mm ≅400 mm

Sy = 3d =3×105 = 315 mm

Sy = 300 mm

Sy = 300 mm C/C

Provide 10mm ⌀ bar 300 mm C/C

Mu max = Mux^{-}

0.134×fck×B×d req^2= 6.63 KN.m

0.134×25×1000×d req^2= 6.63×10^6 KN.m

d req=44.48 mm

d req < D assume

50.57 < 130 ……………. It is Safe

Spacing for Distribution Steel 12%

Astdis =0.0012 × (1000×130)

=156 mm^2

Sx =$\frac{50.265\times 1000}{156}$ = 322.21 mm≅ 300 mm

Sx = 5d =5×105 = 525 mm

Sx= 300 mm

Sx = 300 mm C/C

Provide 8mm ⌀ bar 300 mm C/C

Mu max = Mux^-

0.134×fck×B×d req^2= 8.57 KN.m

0.134×25×1000×d req^2= 8.57×10^6 KN.m

d req=50.57 mm

d req < D assume

50.57 < 130 ……………. It is Safe

Step 8: Check For Shear

Vux = $\frac{WuLx}{2}$

$=\frac{9.375\times3.30}{2}$

= 15.46 KN/

τV=$\frac{\boldsymbol{Vux}}{\boldsymbol{bd}}$

$=\frac{\mathbf{15.46\times1000}}{\mathbf{1000\times130}}$

= 118.92×10^{-3} N/mm

Step 9: Check For Deflection

$\delta = \frac{Lx}{d} \leq \alpha$

$=\frac{3.30}{105}$

$\delta = 31.42 \times 10^{-3}$ N/mm^2

2. FIRST FLOOR PLAN

Given: Use M20 grade of Concrete

Use Fe grade of steel

Length = 4.1m; breadth = 3.1m

Step 1: Calculation of slab

Where; L = length of slab

D = Width of slab

For present slab section while as have 4.1 m × 3.1 m dimension

$\frac{\mathbf{L}}{\mathbf{D}}=\frac{4.1}{3.1} = 1.32m$

: 1.32 < 2

∴So, we have taken two-way slab system

STEP 2: Calculation of slab thickness:

As L= 4.1 m>3.5

M.F = 1.68 and Fe 500 is used

d assume = $\frac{4500}{26\ X\ 1.68}$ = 93.86 mm≅ 100 mm

∴D_{Assume} = 100 + 30 = 130 mm

∴d = D- d^1=130 – 25= 105 mm

STEP 3: CALCULATION OF EFFECTIVE SPAN

Lx = Lxe =Lx + d

= 3100 + 105

= 3.20 m

Ly = Lye = Ly + d
= 4100 + 105
= 4.20 m

STEP 4: load and bending moment calculation

1) Dead load of slab = B × D∴Assume; B = 100 mm
= 100 × 130 × 25
= 3.25 kN/m^2

2). Live load of slab = 1.5×1×9
= 1.5 kN/ m

3). Floor finish load = 1×1×1
= 1 kN/ m

∴Total load = 3.25 + 1.5 + 1
= 5.75 kN/ m.

∴floor load (wu) = 1.5 × 5.75
= 8.625 kN/ m

STEP 5: BENDINGMOMENTCALCULATRION

$$\frac{Ly}{Lx} = \frac{4.20}{3.20} = 1.312$$

From IS code 456 – 2000:
$\propto^{x+}$ = 0.064, $\propto^{y+}$= 0.048

$\propto^{x-}$= 0.048 , $\propto^{y-}$= 0.064

Mux^+ = Wu ×∝ $x^+ X\ Lx^2$
= 3.625× 0.064 ×3.20^2
= 5.652 kN/m

$Mux^- = -Wu\ x \ \propto x - x\ Lx^{\ 2}$
= - 3.625 × 0.064 ×3.20^2
= - 4.230 kN.m

Muy^+ = Wu ×∝ y^+×Lx^2
= 8.625 × 0.048 ×3.20^2
= 4.239 kN.m

Muy^-= - Wu ×∝ $y^+\ x\ Lx^2$
= - 3.625 × 0.064 ×3.20^2
= - 1.766 kN.m

STEP 6: CHECK FOR DEPTH

Mu max = Mux^+
0.134 ×fck× B ×d req^2 = 5.652 kN.m
0.134 × 25 × 100 ×d req^2 = 5.652 ×10^6
∴ d req = 41.07 mm

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D req< d assume

41.07 < 130………. (it is safe)

STEP 6: MAIN STEEL AND ITS SPACING IN 'X AND Y' ALL DIRECTION

$\therefore \text{Astx}^{+} = \frac{0.5xfck}{fy} x \left[1 - \sqrt{1 - \frac{4.6xMu^{+}}{fckxbd^{2}}}\right]$

$$= \frac{0.5x25}{500} x \left[1 - \sqrt{1 - \frac{4.6x5.652x10^{6}}{25x1000x105^{6}}}\right] \frac{x1000}{x105}$$

$\text{Astx}^{+} = 126.87mm^{2}$

$$Astx^{-} = \frac{0.5x25}{500} x \left[1 - \sqrt{1 - \frac{4.6x4.239x10^{6}}{25x1000x105^{2}}}\right] \frac{x1000}{x105}$$

$\text{Astx}^{-} = 94.55mm^{2}$

$$Asty^{-} = \frac{0.5xfck}{fy} x \left[1 - \sqrt{1 - \frac{4.6x1.766x10^{6}}{25x1000x105^{2}}}\right] \frac{x1000}{x105}$$

$Asty^{-} = 38.97mm^{2}$

Spacing of x- bar man of

a) Sx = $\frac{1000\ xA}{Astmaxx^{+}} = \frac{\frac{\pi}{4}x50^{2}}{126.87} = 619.05 \cong 600\ mm$

b) Sx = 3d = 3×105 = 315 mm

c) Sx = 300 mm

Sx = 300 mm $^{c}/_{c}$

10 mm $\emptyset bar\ 300\ mm\ ^{c}/_{c}$

Mu max = Mux^{+}

0.134 ×fck× B × d req ^{2} = 5.652 kN.m

0.134× 25 × 1000 × d req ^{2} = 5.652 x 10 ^{6}

∴ d req = 41.07 mm

∴ d req< D assume

41.07 < 130 …………………it is safe

SPACING OF YBAR MAX OF

a) Sy = $\frac{1000\ x\ A}{Ast\ \max y^{+}} = \frac{\frac{\pi}{4} x\ 10^{2}}{94.55}$

= 830.66 ≅ 800 mm

b) Sy = 3d = 3×105 = 315 mm

c) Sy = 300 mm

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$\therefore Sy = 300\ mm\ {}^{c}/_{c}$

Provide 10 mm $\emptyset\ bar$ 300 mm ${}^{c}/_{c}$
Mu max = Muy^{+}

$0.134 \times fck \times B \times d\ req^{2} = 4.239$ kN. M
$0.134 \times 25 \times 1000 \times d\ req^{2} = 4.239 \times 10^{6}$

d req = 35.57 mm
d req < D Assume
35.57 < 130 ……………………it is safe

SPACING OF DISTRIBUTION STEEL 12 %
∴Ast dist. = 0.0012 × (1000) × 130
= 156 mm^2

A) $Sd = \frac{50.265 \times 1000}{156} = 322.217$ mm

B) $Sd = 5d = 5 \times 10^{5} = 525$ mm

C) Sd = 450 mm
∴ Sd = 300 mm

Provide 8 mm $\emptyset\ bar$ 300 mm ${}^{c}/_{c}$
Mu max = Mux^{+}

$0.134 \times fck \times B \times dreq^{2} = 5.652$ kN. M
$0.134 \times 25 \times 1000 \times dreq^{2} = 5.652 \times 10^{6}$

∴ d req = 41.07 mm^2
$\therefore d\ req < D\ assume$
41.07 < 13…………………… (it is safe)

STEP 7: CHECK FOR SHEAR
$Vux = \frac{Wu\ L\ x}{2}$
$= \frac{8.625\ x\ 3.20}{2}$
= 13.8 kN

$\therefore \tau v = \frac{Vux}{b\ x\ d} = \frac{13.8\ x\ 1000}{1000\ x\ 105}$
$131.42 \times 10^{-3}\ N/mm^{2}$

STEP 8:CHECK FOR DEFLECTION
$\delta = \frac{Lx}{a} = \frac{3.20}{105} = \leq \propto \beta\delta\delta$
$\delta = 30.47 \times 10^{-3}$ N/mm

$\leq \propto \beta\delta\delta$

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IV. LOAD CALCULATION

1st floor slab

Room 2.3m

We considering

Total area = L × b

= 2.3 × 1.7 E F

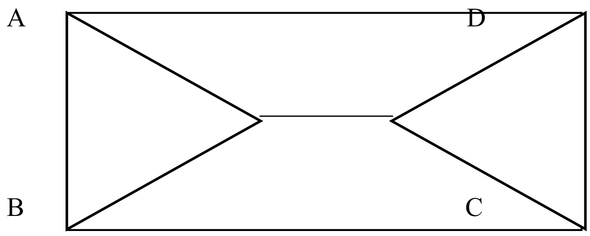
= 3.95 mm^2 1.7 m

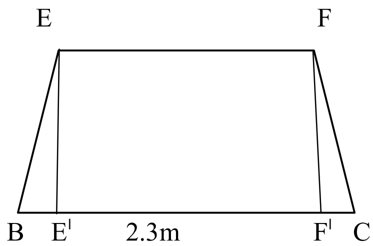
In Δ AEB ;

Tan $\theta = \frac{adj}{hyp} = \frac{EE^1}{AE^1} = \frac{h}{0.85}$

∴ tan 45° $= \frac{h}{0.85}$

Similarly ; BEFC :





∴BC = 2.3 m

∴ BE^1 = 0.85 = FC = 0.85

∴ E^1F^1 = BC - $BE^1 + F^1C$

= 2,3 – 1.7

E^1F^1 = 0.6 m

∴ Δ F^1FC ;

Tan $\theta = \frac{FF^1}{F^1C} = \frac{h}{0.85}$

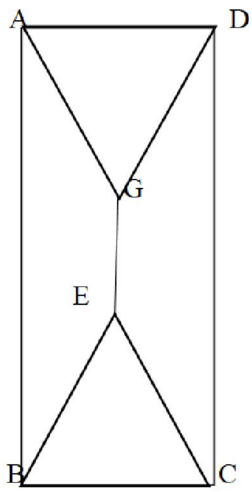
Tan 45° $= \frac{h}{0.85}$

∴ h= 0.85 m

∴ Intensity = Wu × h

= 9.375 × 0.6

= 5. 625 kN



CHANGING ROOM

We consider

Total area =

= 1.2 × 1.7

= 2.04 mm²

In Δ BEC

By formula we get

Tan $\theta = \frac{adj}{hyp} = \frac{EF}{BF} = \frac{h}{0.6}$

∴ h = 0,6 m

Similarly

AGEF

∴ $AB = 1.7\ m$

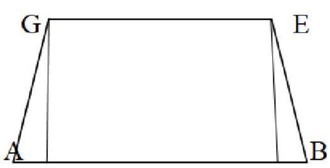
∴ $EF = 0.6 = GH = 0.6\ m$

G^1E^1 = 1.7 – 1.2

= 0.5 m

Again Δ AGG^1

Tan $\theta = \frac{GG^1}{AG^1} = \frac{h}{0.6}$



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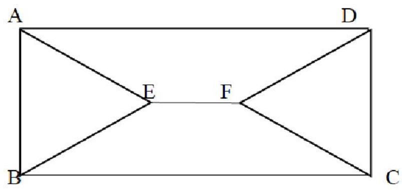
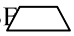
∴ h = 0.6 m
∴ Intensity = Wu × h
= 9.375 × 0.6
= 5. 625 kN
∴ wall load = 9 kN/m (0.15× 1 × 3 × 2000)
∴ partition wall (6inch)

2nd FLOOR SLAB

Master Bedroom 2:



We considering A
Total area = L × b
= 3.8 × 2.9
= 11.02 mm^2
∴ In Δ ACB
By formula we get
Tan $\theta = \frac{adj}{hyp} = \frac{EF}{BF} = \frac{h}{1.45}$B
∴ h = 1.45 m

Similarly, BE 
∴ BC = 3.8 m
∴ BE^1 = 1.45 m and $F^1\ C$ = 1.45 m
∴ E^1F^1 = 0.9 m

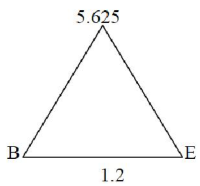
∴ Intensity = Wu × h
= 8.625 ×1.45
= 12.5kN.

Calculation of Point Load:

∴ point load = $\frac{\text{Int. of C.R. + Int. of toilet}}{2}$
= $\frac{5.625 + 7.96}{2}$
=6.79 kN.

CONVERTING INTO EQUIVALENT UDL

Fixed end moment of tringle



$M_{BE} = \frac{5\,udl^2}{96} = \frac{5 \times 5.625 \times 1.2^2}{9.6}$= 0.42 kN.m

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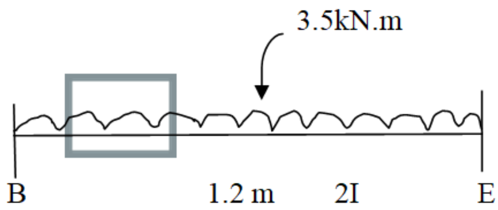
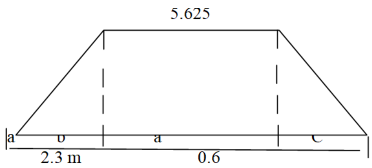


CamparingM_{BE}= M_{UDL}

$$\frac{ul^2}{12} = 0.42$$

$$W = \frac{0.42 \times 12}{1.2^2}$$

W = 3.5 kN.m



$$M_{EC} = \frac{W}{12L}[L^3 - a^2(2L - a)]$$

$$= \frac{5.625}{12 \, x \, 2.3}[2.3^3 - 0.6^2(2 \, x \, 2.3 - 0.6)]$$

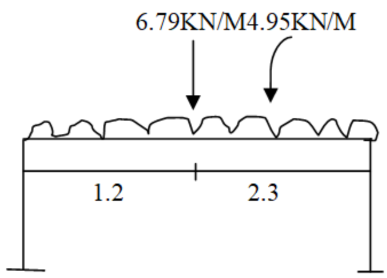
= 2.186 kN.

$$\frac{Wl^2}{12} = 2.186$$

$$\frac{W \ X \ 2.3^2}{12} = 2.186$$

$$W = \frac{2.186 \ X \ 12}{2.3^2}$$

= 4.95 KN/M



MAXIMUM LOAD
MAXIMUM INTENSITY
TOTAL LOAD = UDL +WALL LOAD
4.9+ 9KN = 13.95 KN/M
LOAD + WALL LOAD

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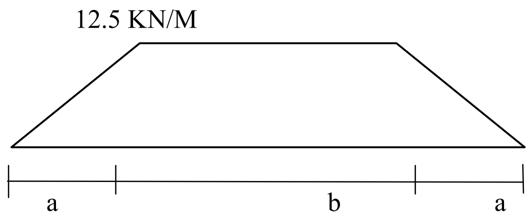


$$M_{FG} = \frac{W}{12L}[L^3 - a^2(2L - a)]$$

$$= \frac{12.5}{12 \times 3.5}[3.5^3 - 0.9^2(2 \times 3.5\text{-}0.9)]$$

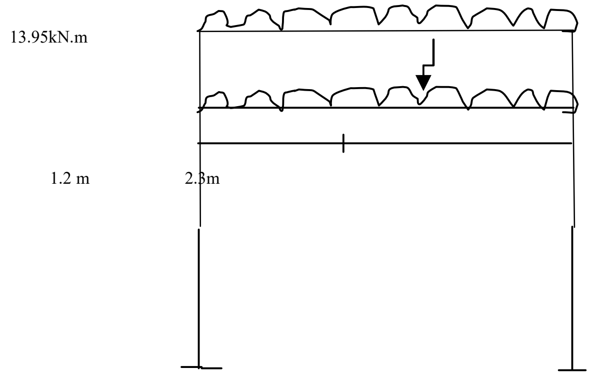
=11.28 kN.m   11.04 kN.m

Comparing $M_{FG} = M_{UDL}$

$$\frac{Wl^2}{12} = 11.28$$

$$\frac{W \times 3.5^2}{12} = 11.28$$

$$W = 11.04 \text{ kN.m}$$



V. MOMENT DISTRIBUTION METHOD

Analysis

By using moment distribution method

Fixed end moment:

1. Span AB, BE, CF & CD

$M_{AB}=M_{BA}=M_{CD}=M_{DC}=M_{BE}=M_{EB}=M_{CF}=M_{FC}=0$

2. Span BC

$$M_{BC} = \frac{-Wl^2}{12} - \frac{Wab^2}{l^2}$$

$$= \frac{-13.95(3.5)^2}{12} - \frac{6.76(1.2)(2.3)^2}{3.5^2} = -17.74\ KN.m$$

$$M_{CB} = \frac{Wl^2}{12} - \frac{Wba^2}{l^2}$$

$$= \frac{13.95(3.5)^2}{12} + \frac{6.76(2.3)(1.2)^2}{3.5^2} = 16.06 KN.m$$

3. Span EF

$$M_{EF} = \frac{-Wl^2}{12} = \frac{-11.04(3.5)^2}{12} = -11.27\ KN.m$$

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$M_{EF} = \frac{Wl^2}{12} = \frac{11.04(3.5)^2}{12} = 11.27\ KN.m$

Stiffness factor and Distribution factor

Joint	Member	M=EI	L	K	Σk	D.F=$\frac{k}{\Sigma k}$
	BA	1	4	$\frac{4EI}{L} = 1$		0.22
B	BC	2	3.5	$\frac{4EI}{L}$ =2.28	4.61	0.49
	BE	1	3	$\frac{4EI}{L} = 1.33$		0.29
	CB	2	3.5	$\frac{4EI}{L} = 2.28$		0.49
C	CD	1	4	$\frac{4EI}{L} = 1$	4.61	0.22
	CF	1	3	$\frac{4EI}{L} = 1.33$		0.29
	EB	2	3	$\frac{4EI}{L} = 1.33$		0.36
E					3.61	
	EF	2	3.5	$\frac{4EI}{L} = 2.28$		0.64
	FE	2	3.5	$\frac{4EI}{L} = 2.28$		0.64
F					3.61	
	FC	1	3	$\frac{4EI}{L} = 1.33$		0.36

Moment Distribution Factor :

Joint	**A**	**B**			**C**			**D**	**E**		**F**	
Member	AB	BA	BC	BE	CB	CD	CF	DC	EB	EF	FE	FC
D.F	0	0.22	0.49	0.29	0.49	0.22	0.29	0	0.36	0.64	0.64	0.36
F.E.M	0	0	-17.74	0	16.06	0	0	0	0	-11.27	11.27	0
Bal	0	3.9	8.69	9.14	-7.86	-3.53	-4.65	0	4.05	7.21	-7.21	-4.05
COF	1.95	0	-3.39	2.02	4.34	0	-2.02	-1.76	2.57	-3.6	3.6	-2.32
Bal	0	0.42	0.93	0.55	-1.13	-0.51	-0.67	0	-0.37	-0.65	-0.81	-0.46
COF	0.21	0	0.56	-0.18	0.46	0	0.23	0.25	0.27	0.4	-0.32	0.33
Bal	0	0.08	0.18	0.11	-0.33	-0.15	-0.2	0	0.24	0.42	-0.0064	-0.0036
COF	0.04	0	0.16	0.12	0.09	0	0	0.07	0.05	0	0.21	0.1
Final M'	2.26	4.4	-11.31	7.64	11.63	-4.19	-7.3	-1.15	6.76	-7.49	6.73	-6.4

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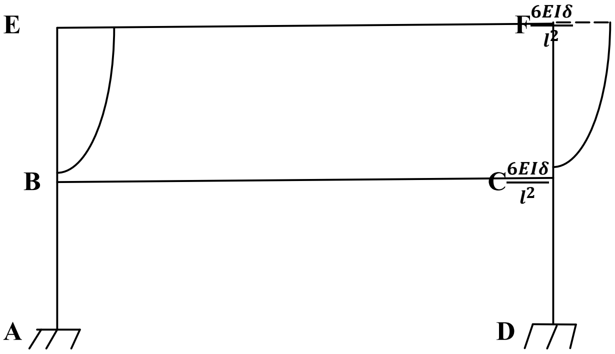
Volume 4, Issue 4, May 2024

For Top Frame sway analysis



Sway Analysis

Fixed end moment

$M_{BE} = M_{EB} = M_{CF} = M_{FC} = -10$

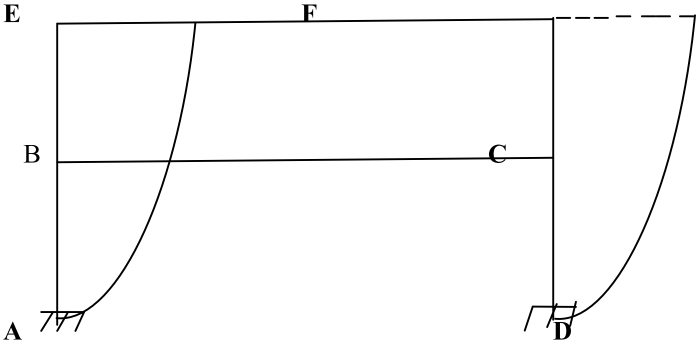
$M_{BC} = M_{CB} = M_{EF} = M_{FE} = 0$

MDM of Sway

Joint	A	B			C			D	E		F	
Member	AB	BA	BC	BE	CB	CD	CF	DC	EB	EF	FE	FC
D.F	0	0.22	0.49	0.29	0.49	0.22	0.29	0	0.36	0.64	0.64	0.36
F.E.M	0	0	0	-10	0	0	-10	0	-10	0	0	-10
Bal	0	2.2	4.9	2.9	4.9	2.2	2.9	0	0.36	6.4	6.4	3.6
COF	1.1	0	2.4	1.8	2.4	0	1.8	1.1	1.4	3.2	3.2	1.4
Bal	0	-0.9	-2	-1.2	-2	-0.9	-1.2	0	-1.6	-2.9	-2.9	-1.6
COF	-0.4	0	-1	-0.8	-1	0	-0.8	-0.4	-0.6	-1.4	-1.4	-0.6
Bal	0	0.3	0.1	0.05	0.8	0.3	0.5	0	0.7	1.2	1.2	0.7
COF	0.1	0	0	0	0.06	0	0	0	0	0	0	0
Final M^{ll}	0.8	1.6	4.4	-7.3	5.1	1.6	-6.8	0.7	-6.5	6.5	6.5	-6.5

For Full Frame sway analysis

Lower sway :-



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Volume 4, Issue 4, May 2024

Fixed end moment

$M_{BE} = M_{EB} = M_{CF} = M_{FC} = -10$

$M_{BC} = M_{CB} = M_{EF} = M_{FE} = 0$

MDM

Joint	**A**	**B**			**C**			**D**	**E**		**F**	
Member	AB	BA	BC	BE	CB	CD	CF	DC	EB	EF	FE	FC
D.F	0	0.22	0.49	0.29	0.49	0.22	0.29	0	0.36	0.64	0.64	0.36
F.E.M	-10	-10	0	0	0	-10	0	-10	0.36	0.64	0.64	0.36
Bal	0	2.2	4.9	2.9	4.9	2.2	2.9	0	0	0	0	0
COF	1.1	0	2.4	0	2.4	0	0	1.1	1.4	0	0	1.4
Bal	0	-0.5	-1.1	-0.6	-1.1	-0.5	-0.6	0	-0.5	-0.8	-0.8	-0.5
COF	-0.2	0	-0.5	-0.2	-0.5	0	-0.2	-0.2	-0.3	-0.4	-0.4	-0.3
Bal	0	0.15	0.34	0.2	0.34	0.15	0.2	0	0.25	0.44	0.44	0.25
COF	0	0	0	0	0	0	0	0	0	0	0	0
Final M^{II}	-9.1	-8.15	6.04	2.3	6.04	-8.15	2.3	-9.1	0.85	-0.76	-0.76	0.85

FINDING MOMENT (M)

1. $\frac{M_{BE}+M_{EB}}{L_{BE}} + \frac{M_{CF}+M_{FC}}{L_{CB}} = 0$

$$\frac{(764-73x+2.5y)+(6.76-6.5x+0.85y)}{3} + \frac{(-7.30-6.8x+2.3y\,)+(-6.4-6.5x+0.85y\}}{3} = 0$$

8.93x-2.10y = 0.27 equation 1 →

2 $\frac{M_{AB}+M_{BA}}{L_{AB}} + \frac{M_{CD}+M_{CD}}{L_{CD}} = 0$

$$\frac{2.2 + 0.8x - 9.14\ + 4.4 + 1.6x - 8.15y}{4} + \frac{-730 - 6.8x + 2.3y(-1.51 + 0.7x - 9.1y)}{4} = 0$$

0.925x +6.01y = -0.55 equation 2 →

From equation 1 and 2 we get

X= 8.41 x 10^{-3}kN.m

Y= - 0.05kN.m

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SFD & BMD DIAGRAM

TOTAL MOMENT

$M = M' + M''x + M'''y$

$M_{AB} = 2.2 + 0.8x + (-9.1)y$
$= 2.2 + 0.8\,(8.41 \times 10^{-3}) + (-9.1 \times (-0.09)$
$= 3.02$ KN.M

$M_{BA} = 4.4 + 1.6x + 6.04y$
$= 3.86$ KN.M

$M_{BC} = -11.31 + 4.4x + 6.04y$
$= -11.81$ KN.M

$M_{BE} = 7.64 - 7.3x + 2.3y$
$= 7.37$ KN.M

$M_{CB} = 11.63 + 1.9x + 6.04$
$= 11.12$ KN.M

$M_{CD} = -4.19 + 1.6\,x - 8.15\,y$
$= -3.44$ KN.M

$M_{CF} = -7.30 - 6.8x + 2.3y$
$= -7.56$ KN.M

$M_{DC} = -1.51 + 0.7x - 9.1y$
$= -0.68$ KN.M

$M_{EB} = 6.76 - 6.5x + 0.85y$
$= 7.36$ KN.M

$M_{EF} = -7.49 + 6.5\,x - 0.76\,y$
$= -7.36$ kN.m

$M_{FE} = 6.73 + 6.5\,x - 0.76\,y$
$= 6.85$ kN.m

$M_{FC} = -6.40 - 6.5\,X + 0.85\,Y$
$= -6.53$ kN.m

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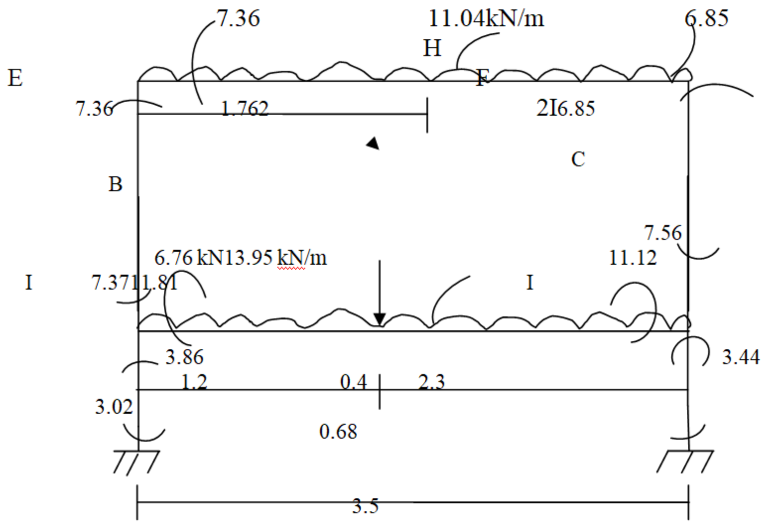

Moment diagram

SHEAR FORCE CALCULATION

$V_{EF} = \frac{1}{3.5}[7.36\text{-}6.85\text{+}11.04(\frac{3.5)^2}{2}] = 79.46\ kN.m$

$$V_{EF} = 11.04(3.5) - V_{EF} = 19.18kN.m$$

$V_{BC} = \frac{1}{3.5}\left[11.81 - 11.12 + 6.76(2.3) + 13.95\left(\frac{3.5^2}{2}\right)\right] = 29.05\ kN.m$

$V_{CB} = 6.76 + 13.95(3.5) - V_{CB} = 26.53kN.m$

$V_{AF} = V_{EF} + V_{BC} = 19.46 + 29.05 = 48.51kN.m$

$V_{DF} = V_{FE} + V_{BC} = 19.18 + 26.53 = 45.51\ kN.m$

$H_{BE} = \frac{1}{3}[11.81 + 7.36] = 6.39\ kN.m$

$H_{CF} = \frac{1}{3}[11.81 + 7.36] = 6.39\ kN.m$

$H_{AB} = \frac{1}{4}[3.86 + 3.02] = 1.72kN.m$

$H_{DA} = \frac{1}{4}[3.86 + 3.02] = 1.72kN.m$

BENDING MOMENT DIAGRAM

$\frac{EH}{19.46} = \frac{3.5 - EH}{19.18} = EH = 1.762kN.m$

$M_H = 19.46(1.76^2) - 7.36 - 11.04\frac{(1.762)^2}{2}$

$$= 9.79\ kN.m$$

Distance of GI =0.4

$M_I = 29.05(1.76^2) - 11.81 - 13.95\frac{(1.6)^2}{2} - 6.76(0.4)$

$$= 14.11\ kN.m$$

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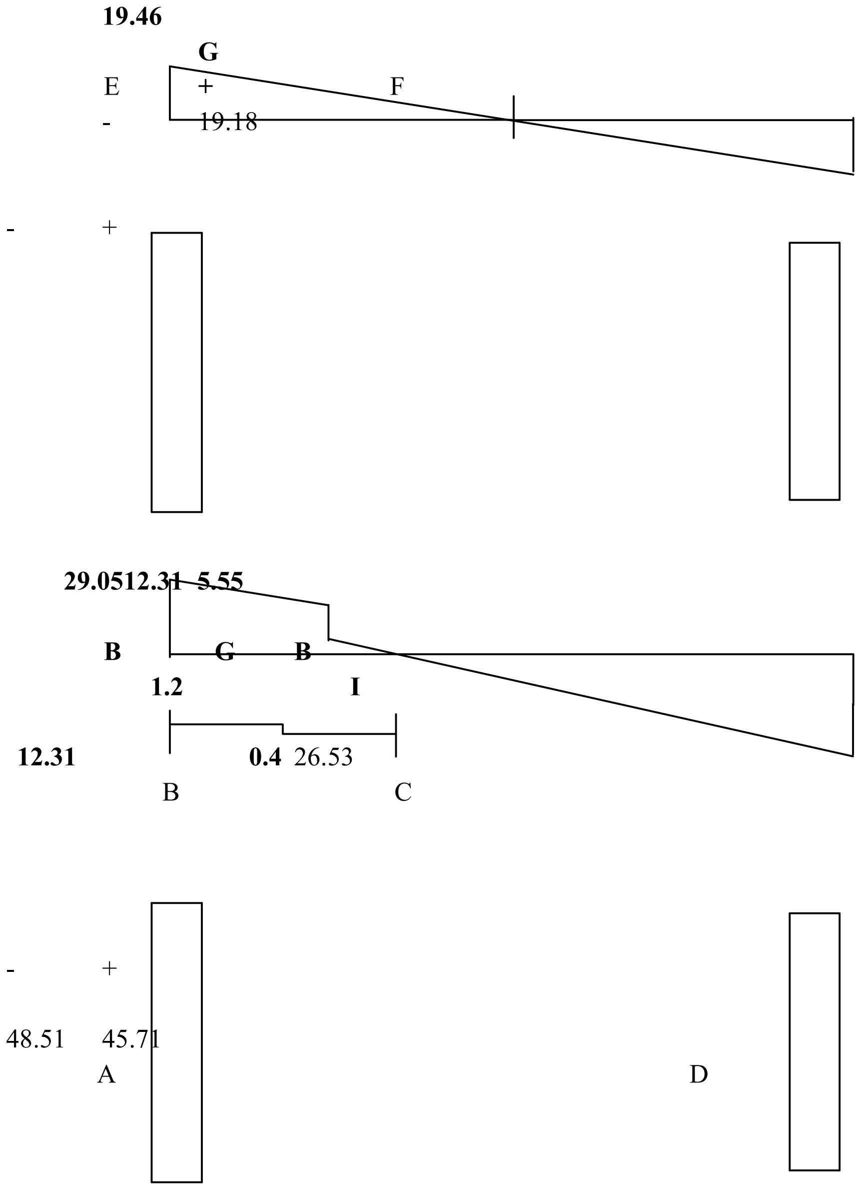
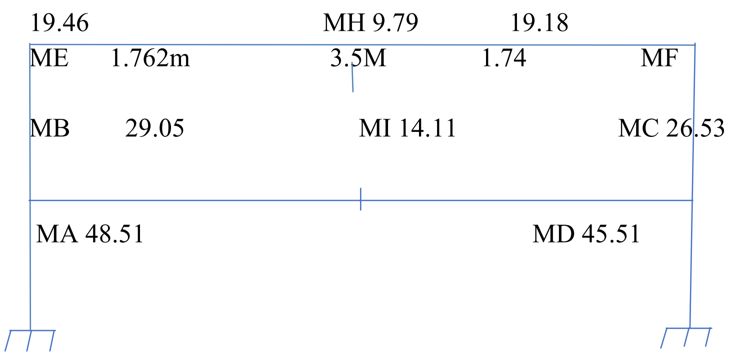
SHEAR FORCE DIAGRAM



VI. DESIGN OF BEAM



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For ME, MH, MF

Given data: SF E = 19.46

(B) Breadth = 230 mm ME = -19.46 (H)

(C) Depth = 450mm MH = 9.79 (S)

MF = -19.18 (H)

Length = 3.5 m

Effective cover (d') = 35mm

Clear cover (a') = 30 mm

∴ Effective depth (d) = D – d' = 450- 30 = 415 mm

Concrete: $\frac{\text{M20}}{(fck)}$ $and\ \ steel : \frac{Fe500}{(fy)}$

CHECK FOR MOMENT RESISTANCE:

For given section:

$M_{r'}$ = 0.36 ×fck× b ×xu×(d – 0.42 ×xumax)

xu max = 0.48 d

= 0.48 d × 415

= 199.2 mm

$M_{r'}$> Mu

Hence its safe ……

Calculation of main steel:

Depth provided = 415 mm

∴ Ast min = $\frac{0.85 \times b \times d}{fy}$

= $\frac{0.85 \times 230 \times 415}{500}$

= 162.26 mm^2

∴ Mu = 0.87 ×fy×Ast× d ×$\left(1 - \frac{Ast\ x\ fy}{fck\ x\ bd}\right)$

16.90 = 0.87 × 500 ×Ast× 415 ×$\left(1 - \frac{Ast\ x\ 500}{20\ x230\ x\ 415}\right)$

∴ Ast = 111.02 mm^2

Provide 10 mm ∅ Fe500

As main steel at top and at mid span.

∴ no. of bars ≅ 3 NOS

Ast provide = 3 ×$\frac{\pi}{4}$×10^2

= 235.61 mm^2

∴ Ast pro. > Ast required.

Ast (c) = 2 ×$\frac{\pi}{4}$×10^2 = 157.07 mm^2 ∴ Ast pro (c)

Check For Development Length

Ld = $\frac{0.65}{4\ x\ r\ x\ \sigma bd}$

τ bd = 1.2 N/ mm^2 k = 0.46 FOR Fe500

Ld = $\frac{12\ x\ 0.87\ x\ 500}{4\ x\ 0.46\ \ x\ 1.2}$ = 2.36 ×10^3

= 2364.13 mm

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Design of shear reinforcement

$\tau_{ve} = \frac{VUE}{b\ x\ d} = = \frac{19.46\ x\ 100}{230\ x\ 415} = 0.2\ 0\ \text{N}/mm^2$

% of Ast $= \frac{Ast\ Pro.}{b\ x\ d} x\ 100 = \frac{235.61}{230\ x\ 415}\ x\ 100 = 0.24\ \%$

$\tau_{c=}\ 0.36\ \text{N}/mm^2$

∴ Comparing τ_v and τ_c

= 0.24 <0.36 Therefore, τ_c is consider

Let Us Provide 8 mm Ø -2 legged vertical stirrup

Asv $= 2 \times \frac{\pi}{4} \times 8^2$

$= 100.53\ mm^2$

Spacing

A) $\frac{0.87 \times \text{fy}\ x\ 100.53}{0.4\ x\ 230} = 473.33\ mm$

B) 0.75 d = 0.75 × 415 = 311.25 mm

C) 300 m

Check for development length

Ld$\geq \frac{M1}{V} + L_0$

$M_1 = 0.87 \times 500 \times 235.61 \times \left(1 - \frac{314.16\ X\ 500}{20X\ 230\ X\ 415}\right)$

$M_1 = 94.05\ X\ 10^3$ N.mm

∴ $L_0 = \text{d} = 415$ mm

$= \frac{94.05 \times 10^3}{19.46\ x\ 100} + 415$

= 419.83 mm

∴ Ld $> \frac{M_1}{V} + L_0$

∴ Hence it safe

Check for deflection

Ast Required = 162.26 mm^2

Ast provided = 235.61 mm^2

% Of Ast $= \frac{Ast\ pro.}{b\ x\ a.} \times 100 = \frac{235.61}{230\ x\ 415} \times 100 = 0.24\ \%$

δ= ? from graph. ∴ $\delta = 1.07$

$\frac{L}{d} > \beta \propto \beta\gamma\delta \curlywedge \frac{l}{d} = \frac{4160}{415} = 10.02$

$\propto = 26, \beta = 1, \curlywedge = 1, r = ?$

For r :

Fs = 0.58 $\times = \frac{Ast\ requ.}{Ast\ provi.}$

$= 0.58 \times 500 \times 290 \times 0.68 \times \frac{162.26}{235.61}$

∴ Fs = 197.2 N/mm^2

% OF Asc $\frac{Ast\ provided}{bd}\ x\ 100$

$= \frac{235.61}{230\ x\ 415}\ x\ 100$

= 0.24 %

7. From IS Code 450 : 2000

r = 2 $\delta = 1.07$

$20 \times 1 \times 2 \times 1 \times 1 = 40 > \frac{L}{d}$

R = 2 ,$\delta = 1.07$

Hence it is safe ……

(BC) 8. For MB , MI, MC :

Given data :

MB = -29.05

MI = 14.11

MC = -26.53

Check of moment resistance

For given section

Mr\` = 0.36 ×fck× b × xu ×(d – 0.42 ×$xu\ min$)

$xu\ min = 0.48\,d$

$= 0.48 \times 415$

= 199.2 mm

Mr' = 0.36 × 20 × 230 ×199.2 × (415 – 0.42 ×199.2)

= 109.29 kN

Mr' > Mu

∴ hence it is safe……

Calculation of main steel

∴ Ast min = $\frac{0.85\ x\ b\ x\ d}{fy}$

$= \frac{0.85\ x\ 230\ x\ 415}{500}$

$= 162.26\ mm^2$

∴ Mu = 0.87 ×fy×Ast× d ×$\left(1 - \frac{Ast\ x\ fy}{fck\ x\ b\ x\ d}\right)$ 29.05 ×10^6

= 0.87 × 500 ×Ast× 415 ×$\left(1 - \frac{Ast\ x\ 500}{20\ x\ 230\ x\ 415}\right)$

∴ Ast req. = 168.36 mm^2

= 2 bar 10 ∅

Provided 10 mm ∅ Fe 500

As main steel at high span at mid span

∴ for compression

∴ No. of bars = 2 nos

Ast pro. (c) = 2 ×$\frac{\pi}{4}\ x\ 10^2$ =157.07 mm^2

∴ Ast pro. < Ast req.

For torsion :3 Nos Ast pro. (T) = 3 ×$\frac{\pi}{4}$×10^2

= 235.61 mm^2

∴ Ast pro. > Ast req.

Check for development length :

Ld = $\frac{\emptyset 6s}{4\ x\ k\ x\ \tau\ bd}$

∴ $\tau\ bd$ = 1.2 N/mm^2 and k = 0.46 for Fe 500

∴ Ld = $\frac{12 \times 0.87 \times 500}{4\ x\ 0.46\ x\ 1.2}$ = 2364.13 mm

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esign of shear reinforcement

$\tau VB = \frac{\text{VuB}}{b\,x\,d} = \frac{29.05 \times 100}{230\,x\,415} = 0.30\ N/mm^2$

$\tau VB = 0.30\ \text{N}/mm^2 > \tau\ C\ max$, For M20 = 2.8 N/mm^2

Let us provide 10 mm Ø - 2 legged vertical stirrups

$\therefore$ Asv = $\times\frac{\pi}{4}\times 10^2 = 157.07\ mm^2$

Spacing

$\frac{0.87 \times \text{fy} \times 100.53}{0.4\,x\,230} = 473.33$ mm

$= 0.75 \times 415 = 311.25$ mm

$= 300$ mm

5. Check for development length

Ld$\ngtr \frac{m_1}{V} + L_0$

$m_1 = 0.87 \times 500 \times 235.61 \times \left(1 - \frac{314.16\ X\ 500}{20\ X\ 230\ X\ 415}\right)$

$\therefore m_1 = 94.05 \times 10^3$ N.mm

% of Asc $= \frac{\text{Ast pro}}{b\,x\,d} \times 100 = \frac{235.61}{230\,x\,415}\ x\ 100$

$= 0.24$ %

$\therefore L_0 = \text{D} = 415$ mm

$= \frac{94.05\ \text{x}10^3}{29.05} + 415$

$= 3652.52$ mm

$\therefore$Ld $> \frac{\text{m1}}{V} + L_0$ hence safe…………

Check For Deflection

Ast required = 168.34 mm^2

Ast provided = 235.61 mm^2

$\frac{\text{L}}{d} > \propto \beta\gamma\delta \curlywedge = \frac{\text{L}}{d} = \frac{4160}{415} = 10.02$

$\propto = 26$,$\beta = 1$, $\curlywedge = 1$,

For r :

Fs $= 0.58 \times \frac{\text{Ast.req.}}{Ast\ pro.}$

$= 0.58 \times 500 \times \frac{1{,}51}{314.16}$

$\therefore$ Fs = 1.39 N/mm^2

From graph we get ; r = 2, $\delta = 1.07$

% steel $= \frac{\text{Ast}.pro.}{bd} \times 100$

$= \frac{235.61}{230\,x\,415} \times 100$

$= 0.34$ %

From IS code 456 : 2000 r = ?

$20 \times 1 \times 2 \times 1 \times 1 = 40 > \frac{\text{L.}}{d}$ 40 > 10.02

$\therefore$ r = 2 ,$\delta = 1.07$

Hence it is safe

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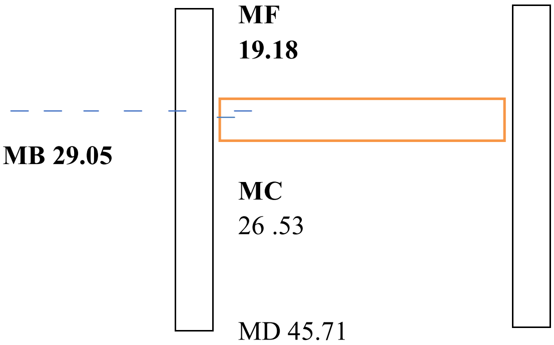
VII. DESIGN OF COLUMN



GIVEN DATA
BREADTH (b) = 230mm
DEPTH (D) = 450MM
EFF DEPTH = 415
CONCRETE USING
Fck = M20 and fy = fe500
Calculation of effective length
Let the column be short

$\frac{Leffy}{b} = 12$

Leffx= $12 \times b$
$= 12 \times 230$
$= 2760$ mm

$\frac{Leffx}{D} = 12$

Leffx= $12 \times D$
$= 12 \times 450$
$= 5400$ mm

FOR COLUMN TO BE SHORT
Leffy = 2.76 m
Leffx = 5.4m

ECCENTRICITY CRITERIA
ALONG MAJOR AXIS

$e_{minx} = \frac{L}{500} + \frac{D}{300}$

$= \frac{5400}{500} + \frac{450}{300}$

$= 12.3$mm

$e_{minx} \cong 10mm$

$M_u max = 3.86 \text{ X } 10^6$

Pu = [Va +D. Lof column] × 1.5
$= [48.51 + 103.5 \times 10^3] \times 1.5$
$= 155.32 \times 10^3$

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$$e_x = \frac{\text{Mun}}{\text{Pu}} = \frac{3.86 \times 10^6}{155.32 \times 10^3}$$
$$= 24.85\text{mm}$$

DESIGN OF ECENTRICITY =24.85mm >> 0.05D

ALONG MINOR AXIS

$$e_{min\,y} = \frac{L}{500} + \frac{B}{300}$$
$$= \frac{2760}{500} + \frac{230}{300}$$
$$= 6.278\text{mm}$$
$$e_{miny} \cong 10mm$$

$$e_y = \frac{Mun}{Pu} = \frac{3.02\,X10^6}{155.32\,X10^3} = 13.44\text{mm}$$
$$e_y \cong 20\text{mm}$$

DESIGN ECENTRICITY = 20MM >> 0.05D

THE COLUMN IS SHORT AND AXIALLY LOADED

LOAD CALCULATION -

FACTORED AXIALLY LOADED –

$$P_U = 155.32KN$$

FACTOR BM (major)

$$M_{max} = P_u \times e_x$$
$$= 155.32 \times 10^3 X24.85$$
$$= 3.85\text{KN.M}$$
$$M_{max} = P_u \times e_y$$
$$= 155.32 \times 10^3 X20$$
$$= 3.10\text{KN.M}$$

DESIGN OF MAIN STEEL

FROM INTERACTION CURV GIVEN

$$\frac{d'}{d} = 0.1$$

Calculation of Asc $= \frac{P_U}{\text{fck} \times \text{b} \times \text{d}}$

$$= \frac{155.32\,X\,10^3}{20\,X\,230\,X\,450} = 0.07$$

$$\frac{M_{u\times}}{\text{fck} \times \text{b} \times \text{d}^2} = \frac{3.86 \times 10^6}{20 \times 200 \times 450^2} = 0.004$$

FROM INTERACTION CURVE

$$\frac{\%P}{fck}\ 0.01$$

$$\%\text{P} = 0.01 \times 20$$
$$= 0.2\%$$

$$\text{Ast} = \frac{0.8}{100} \times \text{b} \times \text{D}$$
$$= \frac{0.8}{100} \times 230 \times 450$$
$$= 828\ mm^2$$

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LET US PROVIDE 12 MM
Fe 500 S LONG REINFORCEMENT EQUALLY ON ALL SIDE
NUMBER OF BAR = 8 NOS
Ast provide $= 12\times\frac{3.4}{4}\times 8^2$
$= 603.18mm^2$
%Asc =%p $=\frac{603.18}{230X450}\times 100$
=0.58

$$\frac{\%P}{fck}=\frac{0.58}{20}=0.029$$

CHECK FOR L.C.C

$$\frac{Pu}{fck.bd}=0.07$$

$$\frac{P}{fck}=0.029$$

$$\frac{Mux\ cal}{fck.bD^2}=0.045$$

Mux cal= $0.04\times 20\times 230\times 450^2$
= 41.91 KN .M
Mux cal= $0.04\times 20\times 230^{2\ X\ 450}$
= 21.42 KN.M
$(\frac{Mux}{Mux\ cal})\alpha n+\left(\frac{Muy}{Muy\ cal}\right)\alpha n$
For αn
$\frac{pu}{puz}$
Puz = 0.45fck × Ac+0.75 ×fy.Asc
= 0.45× 20 ×(230 × 450 × -828) +0.75 × 500 × (500 × 828)
Puz = 156.17 $\times 10^6$

$$\frac{Pu}{Puz}=\frac{155.32\ \times 10^2}{156.17\ \times 10^6}$$

= 0.0099

TRANSVERSE REINFORCEMENT
$\emptyset=\frac{\emptyset 4}{4}OR6MM$
$=\frac{12}{4}OR6MM$
= 3 OR 6 MM
TRANSVERSE REINFORCEMENT BY 8MM AT PITCH OF 16
=16 ×8 = 128 MM
≅300MM
FORWIDE PITCH OF 120MM
For P = 0.8% AND P< 0.8%
Ast = $\frac{0.8}{100}\times 230\ \times\ 450$
$= 828\ mm^2$
NO of bar of 12 mm ∅
bars = 8 nos
For P = 1.2 %

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$Ast = \frac{1.2}{100} \times 230 \times 450$

$= 1242 mm^2$

NO of bar of 12 mmØ bar

= 10 nos

For P = 4.8 %

$Ast = \frac{4.8}{100} \times 230 \times 450$

$= 4968 mm^2$

No of bar of 22 mm Øbar = 12 nos

Design of pitch :

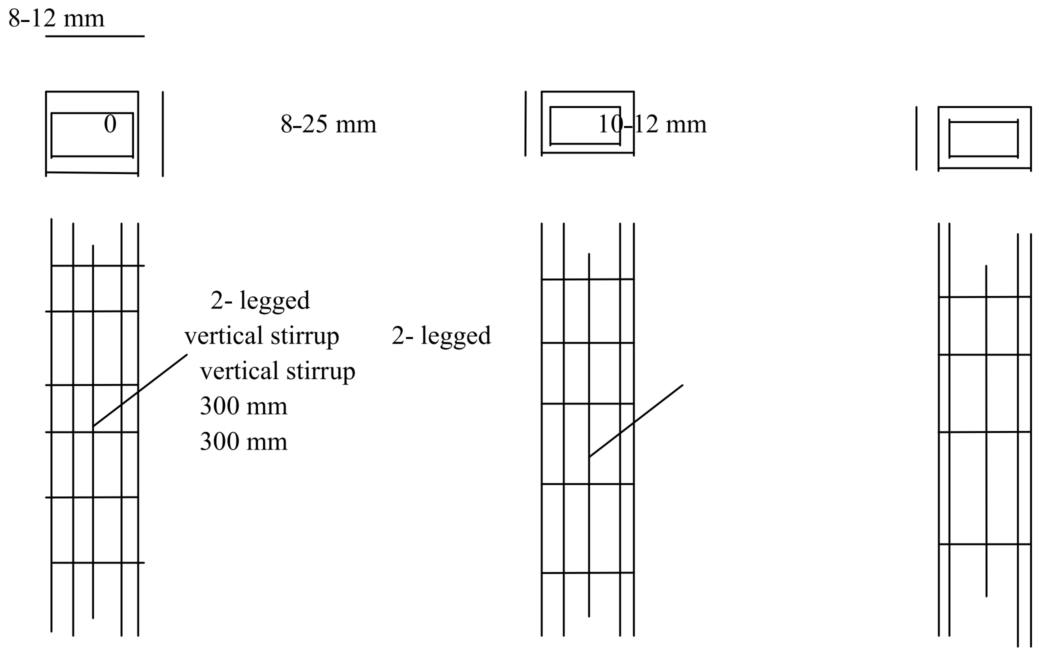
a) least lateral dimension = 230 mm

b) 16 x diameter of main steel bar

= 16 x 35 = 560 mm

c) 300 mm

minimum of the above values is considered



Column reinforcement

VIII. CONCLUSIONS

We have designed the flat scheme by using limit state method and analysis is done by moment distribution method. This project explains the basic concept behind the structural design and detailing. With the help of manual design and drawing should be done with the help of drafting software (Auto-cad) Seismic analysis can be included for future extension of the project.

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