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Analysis And Design Of Commercial Building by using Etab

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ABSTRACT: *This Project deals an overview of the key aspect in the design of Commercial Building structures by using ETAB. the main aim of this review is to introducing the different types of structural elements in commercial building structure that are design and supports , of column, Beams, Footing, Slabs . they may also be used to support different types of RCC elements are used in commercial building structures that have similarities to structural steel building. The design requirements of RCC structures the Analysis, codes and industry practice, design criteria, design loads and other designed conditions.*

KEYWORDS: Design Modeling; Rcc structure; Analysis; Axial Force: Shear Force : Beam Reaction

I. INTRODUCTION

The goal of structural design is to create a building that is safe, functional, and long-lasting while also being aesthetically pleasing and economically sound. Structural engineering is a science that encompasses not only creative thinking and conceptualization (the art of design), but also practical considerations (such as familiarity with applicable design codes and bylaws), as well as a wealth of experience, institutional knowledge, and professional judgment. The first step in design is designing the structure, with the main goal of making sure it can fulfill the building's functional needs. It is common practice for architects to focus on aesthetics and practical needs, while structural designers ensure the building is safe, serviceable, durable, and economical for its intended use throughout its lifetime. In some cases, a structural engineer will need to play dual roles in these roles.

1.2 Stages in Structural Designs: Process of structural design involves following stages.

I. Structural Planning , II. Estimation of Loads , III. Analysis of Structure, IV.Member Design

V. Drawing,detailing and preparation of Schedule

1.3 Structural Planning: determining structure's shape, material, structural system, component arrangement, analytical technique, and design philosophy are all part of this process. A R.C.C. building frame primarily consists of the following components: Slabs to cover large area

I. Beams to support slabs and walls , II. Column to support beams , III.Footing to distribute concentrated column loads over a large area Of the supporting soil

Obtaining a building's architectural design is first step in structural planning frame. Determining following is involved in this. (a) Column position (b) beam location (c) panning of slabs (d) Layout and planning of stairs (e)Type of footing

a)Positioning of columns:A few of principles that aid in determining the locations of the columns are as follows. As its primary purpose is to support beams often installed under walls, columns are best positioned at or near building corners & wall intersections. However, if the columns are located in walls that adjoin property line, an exemption may apply. To accommodate column footing inside property, it might be necessary to move column inside along transverse wall, since footing demands specific space beyond column.

Orientation of Column: Standard for constructing columns is a rectangular shape, with a width that is equal to or greater than the supported beam's width, to provide efficient weight transmission. Additionally, in order to prevent deviations, the breadth of the column should not surpass the wall's thickness.

In order to achieve the required load bearing capacity within the width restrictions, the other sides of the columns must

be bigger.

b) Positioning of Beams: When deciding where to put beams, keep in mind the following guidelines:

1. It is common practice to place beams behind walls or under a concentrated heavy load to divert weight away from slabs. Quickest approach to foundation must carry most weight when planning arrangement of component parts.
2. Maximum span of slabs will determine spacing of beams, since their primary purpose is to support slabs. When compared to other components, slab's volume-to-load ratio is very high, meaning that it takes the maximum amount of concrete to support a given load. For that reason, you should not make the slab any thicker than necessary. A minimum of 100 mm and a maximum of 200 mm is considered practical for use in residential, commercial, and public structures. Loading and limiting thickness dictate maximum and minimum slab spans, which in turn determine spacing of beams, as shown above.

C) Spanning of Slabs: The placement of the walls and beams that support the structure determine this. If supports are perpendicular to slab or run in only one direction, we say that the slab is one-way supported. A two-way supported slab is one that has two sets of supports that are perpendicular to one other. A number of factors, including slab's support method, aspect ratio & boundary circumstances, determine two actions of slab. As a result, the designer has complete discretion over boundary conditions. So, it's up to the designer to determine whether the slab should be one-way or two-way. The following considerations could go into making this call:

- Slabs with an aspect ratio of $L_y/L_x > 2$ are intended as one-way slabs, whilst slabs with an aspect ratio of L_y/L_x less than 2 function as two-way slabs.
- Since main steel in a two-way slab runs length of both spans, transferring weight to all four supports, it is often more cost-effective than a one-way slab, which only uses main steel along the short span and transmits the load to the two opposing supports. No load-transferring capabilities exist in the long span's steel; it only serves as distribution steel.
- Slab can be made to function as a one-way slab across the short span if it has supports on all sides but a L_y/L_x value less than 2. This is achieved by adding main steel along short span and distribution steel along long span. Increasing the amount of steel in one direction makes the slab stiffer in that direction.

d) Layout of Stairs

Readily accessible staircase room's dimensions & placement of beams and columns around staircase's perimeter are primary determinants of the steps' kind and arrangement. In order to help you decide on a staircase arrangement, we have included some helpful recommendations.

1. In general, stair slabs are heavier than floor slabs for two reasons: (i) the dead load is higher on stairs than on floors because of inclined length of slab acting over the horizontal span, & (ii) added weight of the steps makes slab even heavier. Hence, flights should not have a lengthier duration if at all feasible. Beams or walls should ideally support stair flights. Avoid voiding landing slab supports as much as feasible. Particularly when the landing slabs' span is more than double the stair's width, since this places extra strain on the landing slabs' supporting structure where they meet.

e) Choice of Footing Type:

Column's weight & soil's bearing capability determine kind of footing. Unless the soil has very poor bearing capacity, isolated column footings are usually the way to go for the framed structure under consideration. For deeper pile foundations, this kind of soil or black cotton soil may be suitable. A raft foundation is another option to consider in cases when the spacing of the columns is very near and the soil's carrying capability is poor.

Marking of Frame Components: Marking or designating R.C. frame components is usually important before beginning structural design in order to enable identification, listing, and scheduling. The many forms that the SP-34 Code of practice suggests for identifying, listing, and scheduling substances.

1.5 Common Building Components are: (1) Super Structure: (2) Sub structure

Everything above ground that contributes to building's functionality is known as superstructure. It comprises Plinth

2. Wall and columns 3. Beams 4. Arches 5. Roofs and slabs 6. Lintel and ches 7. Chejjas 8. Parapet 9. Steps and

stair. **Loads on superstructure:** Here are some of loads that are being studied for structure:

- a) Dead load & super imposed dead load (IS875 part-I)
- b) Live load (IS875 Part-II), Since wind load is not taken into account for buildings up to G+3 storeys, it is necessary to include it with dead load and live load when designing a structure.

1. **Substructure:** Substructure transports weight of superstructure to subsoil; it is placed below ground level and

comprises, **Foundation:** This is what the foundation needs: The foundation has to be sturdy enough to avoid uneven and excessive settling.

2. Properly, the code has cautioned against building on such loose soils that may subside after an earthquake, leading to significant differential settlement.
3. Foundation's design must take the carrying capability of the soil into account.
4. Utilize raft or pile foundation if the soil contains black cotton, loose fine sand, or costly clay.

II. LITERATURE REVIEW

VARALAKSHMI V ET.AL [2014]^[1] EXAMINED A G+5 RESIDENTIAL BUILDING AND PLANNED ITS FOUNDATION, SLAB, BEAM, AND COLUMNS. FOR THIS PROJECT, WE USED THE GUIDELINES LAID FORTH BY IS 875(PART I & II)-1987 TO DETERMINE THE LIVE AND DEAD LOADS, AND WE EMPLOYED HYSD BARS, NAMELY Fe 415, IN ACCORDANCE WITH IS 1986-1985. ACCORDING TO THEIR FINDINGS, THE STRUCTURAL ANALYSIS, DESIGN, AND REINFORCEMENT DETAILING OF THE BUILDING FRAME ARE CRUCIAL FACTORS IN DETERMINING THE SAFETY OF REINFORCED CONCRETE BUILDINGS. THESE FACTORS CONTRIBUTE TO THE STABILITY AND DUCTILE PERFORMANCE OF THE BUILDING'S ELEMENTS.

CHANDRASEKHAR ET.AL [2015]^[2] PERFORMED ETABS ANALYSIS AND DESIGN FOR THE MULTI-STORY STRUCTURE. THE RESEARCH USED ETABS TO ANALYZE THE LATERAL LOADING EFFECTS OF WIND AND EARTHQUAKE ON A G+5 STORY STRUCTURE. THEY HAVE ALSO TAKEN INTO ACCOUNT THE POTENTIAL FOR FIRE SPREAD AND THE SIGNIFICANCE OF USING FIREPROOF MATERIALS THAT MEET OR EXCEED ALL PERFORMANCE AND RELIABILITY REQUIREMENTS. IN ORDER TO CUT DOWN ON DESIGN TIME, THEY RECOMMENDED ETABS, A PROGRAM THAT IS BOTH CREATIVE AND EASY TO USE FOR HIGH-RISE PROJECTS.

BALAJI.U AND SELVARASAN M.E ET.AL [2016]^[3] DESIGNED AND ANALYZED MULTI-STORY BUILDINGS USING ETABS FOR BOTH STATIC AND DYNAMIC LOADING SCENARIOS. THIS STUDY USED ETABS TO ANALYZE THE SEISMIC STRESSES ON A G+13 STORY RESIDENTIAL STRUCTURE. PERFORMING STATIC AND DYNAMIC STUDIES, THEY PRESUPPOSED THAT THE MATERIAL PROPERTIES WOULD BE LINEAR. WE CONDUCTED THE NON-LINEAR ANALYSIS TAKING SEVERE SEISMIC ZONES INTO ACCOUNT, AND WE EVALUATED THE BEHAVIOR TAKING TYPE II SOIL CONDITIONS INTO ACCOUNT. WE PLOTTED AND EVALUATED SEVERAL OUTCOMES, INCLUDING DISPLACEMENTS AND BASE SHEAR.

GEETHU ET.AL [2016]^[4] COMPARED THE CAPABILITIES OF STAAD.PRO AND ETABS IN THE CONTEXT OF MULTI-STORY BUILDING ANALYSIS AND DESIGN. THEY SUPPLIED PLANS FOR BOTH COMMERCIAL AND RESIDENTIAL STRUCTURES. WE USED AUTO CAD TO DEVELOP THE PLANS, AND THEY WERE ALL IN LINE WITH THE NATIONAL BUILDING CODE. AFTER LOOKING AT THE FINDINGS FROM BOTH PROGRAMS, THEY CAME TO THE CONCLUSION THAT THE BENDING MOMENT AND AXIAL FORCE VALUES SHOWN BY ETABS ARE GREATER.

AMAN,ET.AL[2016]^[5] KALABURAGI, KARNATAKA, INDIA: STAAD PROAIET ANALYSIS AND DESIGN OF A MULTI-STORY BUILDING STRUCTURAL ENGINEERS ARE FEARLESS WHEN IT COMES TO DESIGNING STRUCTURES THAT CAN WITHSTAND A WIDE RANGE OF LOADING CONDITIONS, AND THEIR PRIMARY GOAL IS TO ENSURE THE SAFETY OF COMPUTER TECHNOLOGY. IT WAS FORMERLY BELIEVED THAT ALL LOADS ACTING ON A STRUCTURE WERE STATIC, BUT IN REALITY, ALL LOADS ON A STRUCTURE ARE DYNAMIC, WITH THE EXCEPTION OF THE SELF-WEIGHT, ALSO KNOWN AS A DEAD LOAD. THE DISCIPLINE OF CIVIL ENGINEERING NOW HAS ACCESS TO A PLETHORA OF APPLICATION SOFTWARE. ALL OF THESE PROGRAMS SERVE AS THE FOUNDATION FOR MORE COMPLEX ONES. IN THIS RESEARCH, WE LOOK AT THE EFFICACY OF CERTAIN CIVIL ENGINEERING APPLICATION SOFTWARE USING FINITE ELEMENT ANALYSIS, WHICH TAKES INTO ACCOUNT THE IMPACT OF DYNAMIC LOADS LIKE WIND AND EARTHQUAKE EFFECTS. WE HAVE CHOSEN AN ONGOING PROJECT FOR THIS REASON. THE UNITY BUILDERS IN GULBARGA CITY ARE RESPONSIBLE FOR THIS INITIATIVE. "BHARAT PRIDE" IS THE PROJECT'S NAME.

C.V.S.LAVANYA ET.AL[2017]^[6] IN THIS MODERN ERA, A GREAT DEAL OF COMPLEX AND IRREGULAR STRUCTURES HAVE BEEN DESIGNED TO WITHSTAND THE EARTH'S QUICK AND WIND. TO DESIGN THESE STRUCTURES, ENGINEERS HAVE TURNED TO SOFTWARE LIKE ETABS, STAAD Pro, AND TEKLA. ON THIS PARTICULAR PROJECT, WE FOLLOWED THE COMPANY'S RECOMMENDATION AND UTILIZED ETABS TO DETERMINE THE BEAM'S SHEAR FORCE, THE COLUMN'S AREA REINFORCEMENT, THE FOUNDATION'S REACTION, THE SITE'S SAFE BEARING CAPACITY OF SOIL, AND THE HEIGHT OF THE FOUNDATION. ADDITIONALLY, WE DESIGNED THE RETAINING WALL USING THIS SOFTWARE.

III. OBJECTIVES

CONSTRUCT MULTI-STORY COMMERCIAL BUILDING UTILIZING ETABS FOR ANALYSIS AND DESIGN.

*Creating structural plan *Modeling *Loading *Analysis *To design structural components like beam, slab, column

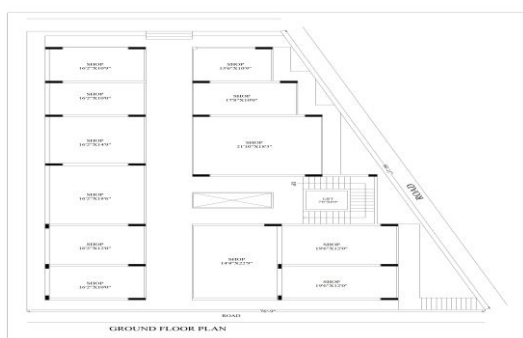
and footing.

To draw and give reinforcement details of structural components by using Auto Cad, Design by using IS456-2000

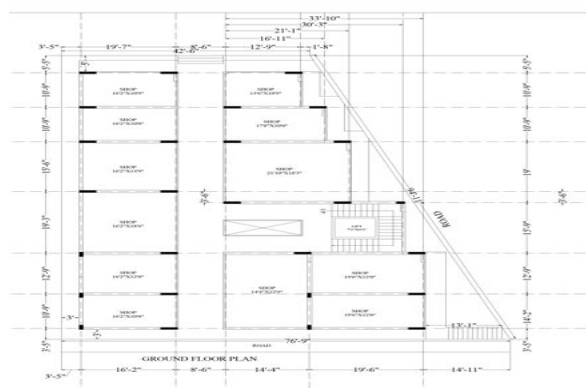
IV. DESIGN PROCEDURES

1.1 STRUCTURAL PLANNING : Using execution plan in figure 4.1 as a guide, a structural frame plan is created, outlining placements of columns and beams in a way that distributes building's weight equally. All of the columns are bound together in both the X and Y axes by the beams' placement. Figure 4.2 illustrates the structural plan, which also displays the c/c spacing between the columns. This is useful for building ETABS structural models.

4.2 BUILDING DETAILS : Floor to floor height 3 mts, Number of floor = G+3, Base to ground floor height = 1.5 mts
Size of building = (76'9"x89')=445m², Over all height of



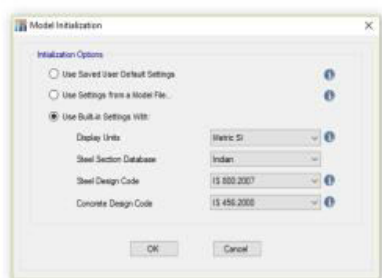
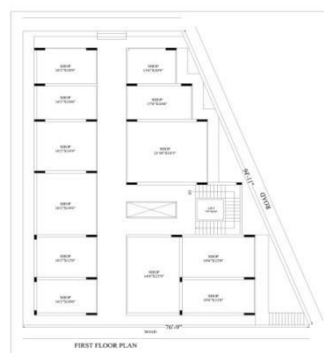
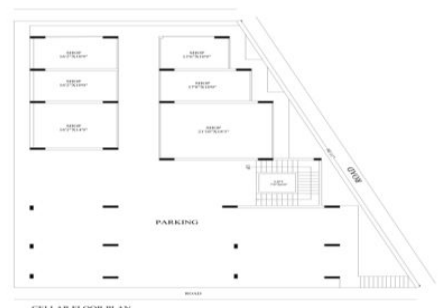
the
buildin
g =
10.5mts
, Shape
of the
buildin
g =
unsym
metrical
, SBC



of soil considered = 180 Kn/sq mts , Type of building =
180kn/sq mts ,
Type of building = COMMERCIAL BUILDING ,
Minimum clear width of stair =1.3mts

4.3 MODELLING

Modeling using ETABS



- 1)Open the ETABS Program
- 2)Click the File menu > New model command

Get System Data

Get System Name (1)

System ID: 1234567890
System Type: 1234567890
System Status: 1234567890
System Date: 12/31/2023

Reference Data

System Name: 1234567890
System ID: 1234567890
System Type: 1234567890
System Status: 1234567890
System Date: 12/31/2023

Reference Tables

Reference Name: 1234567890
Reference ID: 1234567890
Reference Type: 1234567890
Reference Status: 1234567890
Reference Date: 12/31/2023

Buttons: OK, Cancel, Help

Material Property Data

General **Mechanical**

Material Name:

Material Type:

Orthotropic Symmetry Type:

Material Display Color:

Material Notes:

☐ Specify Mass Density

MPa

Mechanical

Modulus of Elasticity, E:

Poisson's Ratio, ν:

Coefficient of Thermal Expansion, α:

Shear Modulus, G:

Design Property Data

Advanced Material Properties

☒ Nonlinear Material Data

☒ Material Damping Properties

☐ Time Dependent Properties

File Edit View Window Help

Material1 Properties

General Data

Material Name: HYPO415

Factor: 1.0

Directional Symmetry Type: Isotropic

Material Display Color: Material1 Change...

Material Notes: Moldy/Show Notes

Material Weight and Mass

☒ Specify Weight Density ☐ Specify Mass Density

Weight per Unit Volume: 15.3725 lb/in³

Mass per Unit Volume: 7388.627 kg/m³

Mechanical Properties Data

Modulus of Elasticity, E: 200000 MPa

Coefficient of Thermal Expansion, A: 5.0000E-17 1/°C

Design Property Data

Advanced Material Properties

[illegible]

Reinforcement Data

Design Type

- ☐ F18024S Design (Columns)
- ☒ M10 Design (Beam)

Rebar Material

Longitudinal Bars: H10241S

Confinement Bars: H10241S

Create's Reinforcement Rebar Group Control

Top Bars: 25 mm

Bottom Bars: 25 mm

Reinforcement Bar Schedules for Double Bars

Top Bars at 1/End: 0 mm

Top Bars at 1/End: 0 mm

Bottom Bars at 1/End: 0 mm

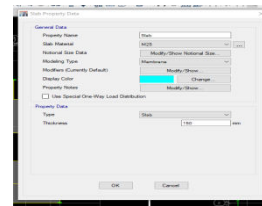
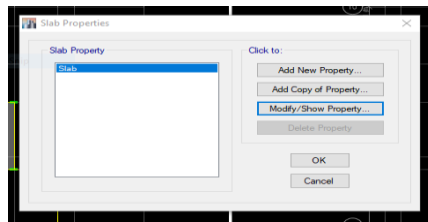
Bottom Bars at 1/End: 0 mm

OK Cancel

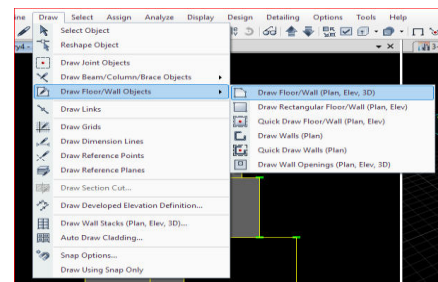
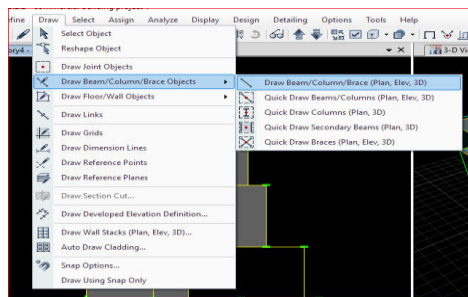
Design 500 mm Currently Default

[illegible]

635



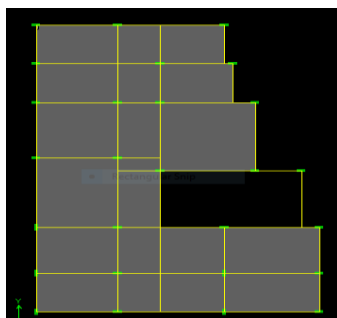
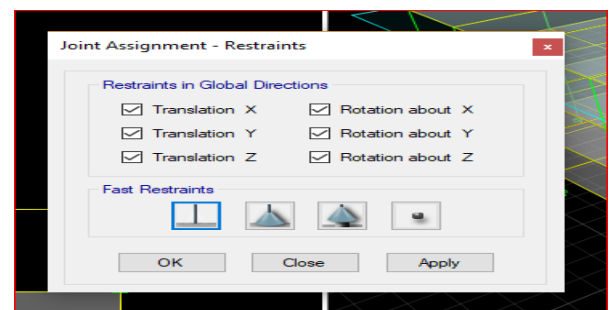
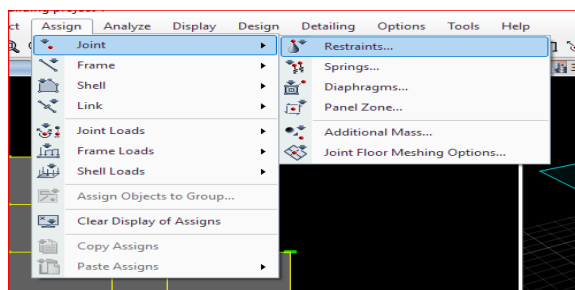
9) Generate the model Draw beam using Create Line Command and draw column using Create Column command



Above creating option used to generate the model as shown in below figure.

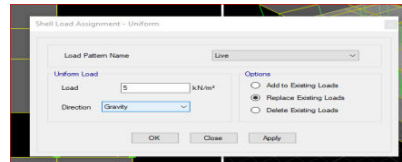
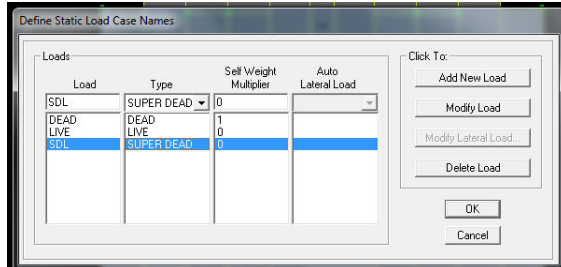
10) Assign support condition

Drop-down box in the lower right-hand corner of the ETABS window, Select only bottom single storey level to assign fixed support using assign > Joint/Point>Restrain (Support)



Materials

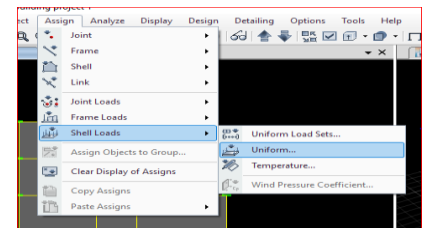
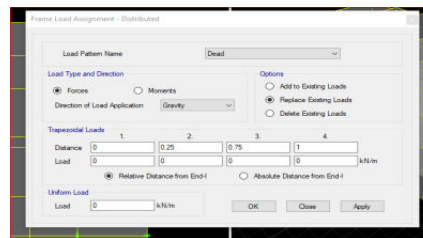
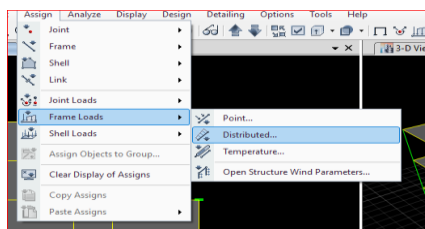
- Grade of steel = Fe 415, Grade of concrete = M25, Density of concrete = 2500 kg/m³, **Assumed sections**
Beam = B230x500 = B 230x550, Column = C1 – 230x450 Rectangular, C2 – 230x500 mm Rectangular
Slab = TW150 -150 mm thick (two way) =OW150 -150 mm thick (one-way)
- Supports** : Fixed supports are provided at all the column bases.

4.4.1 **LOADING :** Define various loads (Dead load, Live load, SDL)

Dead Load: The default value for the self-weight multiplier for calculating dead load is 1.

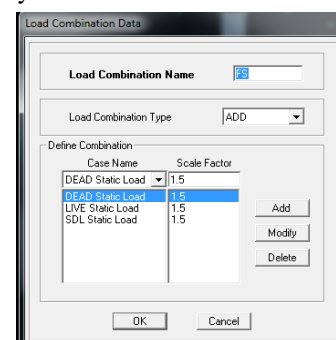
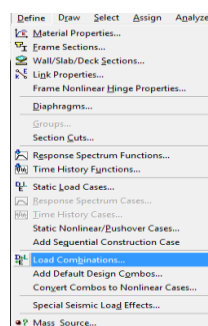
There will be a live load case by default. Super dead load, please.

First, click the assign button once you've chosen the person to whom you want to allocate the load.



Load Combinations	Remarks
1.5(DL+SDL)	DL = Dead Load of The Structure LL = Live Load on the structure SDL= Super Dead Load
1.5 (DL+SDL+LL)	

4.4.2) Define Load combination, Define>load combinations>add new/ modify combo/add auto load combination



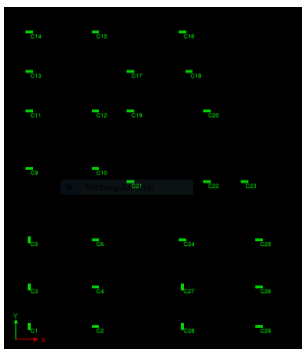
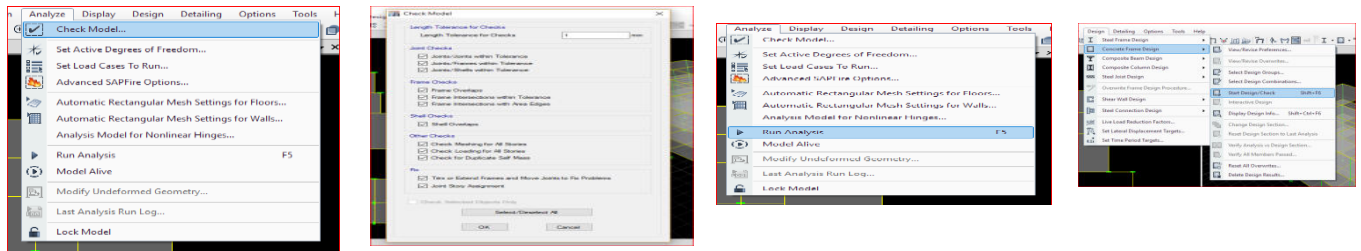
Only static vertical loads are considered, **Types of loads :** Dead loads (DL) as per IS 875 part-I, Live Load (LL) = 2kn/m^2 as per IS 875 part – II, For staircase = 3kn/m^2 , For balcony & passage = 3kn/m^2 , Super dead Load (SDL) Floor Finish = 1.5kn/m^2 (Assumed), 230 thick wall load = $(3.2-0.45)\times 20\times 0.23=12.65\text{kn/m}$, 150 thick wall Load = $1.2\times 20\times 0.15=3.6\text{kn/m}$, Density of masonry wall consider as 20kn/m^3

Load Combination:-

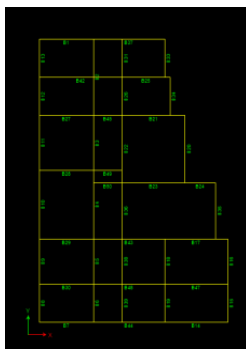
Load Combinations	Remarks
1.5(DL+SDL)	DL = Dead Load of The Structure LL = Live Load on the structure SDL= Super Dead Load
1.5 (DL+SDL+LL)	

4.5 Analysis: (a) Check model for errors in line

elements, points, area elements with tolerance factor 0.001mAnalyze>check model command. , Static analysis of structureAnalyze>Run analysis command



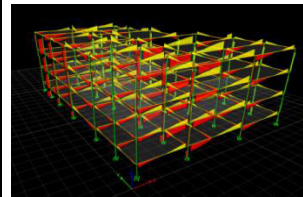
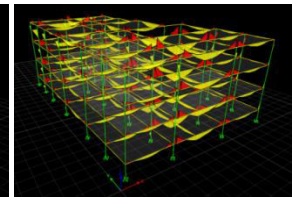
COLUMN NUMBERING



BEAM NUMBERING



SLAB NUMBERING


AXIAL FORCE DIAGRAM
BENDING MOMENT DIAGRAM


4.5 OUTPUT FILES:

4.6.1 LOAD COMBINATIONS

LOAD COMBINATIONS				
COMBO	COMBO TYPE	CASE	CASE TYPE	SCALE FACTOR
DCON1	ADD	DEAD	Static	1.5
		SDL	Static	1.5
DCON2	ADD	DEAD	Static	1.5
		SDL	Static	1.5
		LIVE	Static	1.5

4.6.2 SUPPORT REACTIONS

TABLE: Design Reactions						
tory	FX	FY	FZ	MX	MY	MZ
Base	28.8924	17.6921	576.0964	-8.3047	14.5157	0.0248
Base	42.8883	15.4359	1262.556	-7.9723	20.9315	0.0977
Base	39.0223	7.5789	918.8117	-4.3269	19.2315	0.0741
Base	74.8778	3.7859	2020.861	-2.3416	32.6461	0.0264

Base	40.5278	39.5118	1227.413	-17.3292	19.762	0.0338
Base	54.2371	13.8804	2133.996	-7.2336	23.0885	0.0647
Base	59.1041	-12.4232	1371.736	5.6654	23.4065	0.0497
Base	-39.5153	-18.0574	1482.15	8.1368	-16.09	0.0433
Base	57.098	-6.068	1096.012	2.5778	21.2833	0.0414
Base	-47.1812	35.4897	1554.227	-17.7477	-20.3986	0.0588
Base	108.8482	0.6469	1140.765	-0.6554	40.7284	0.0844
Base	21.0547	-9.1711	446.9689	4.0939	4.571	0.0689
Base	40.662	-66.6995	1526.159	31.5131	12.6387	0.0498
Base	-79.2969	-23.8677	799.9187	10.4845	-34.4804	0.0679
Base	-52.8963	19.0371	1623.918	-9.9744	-23.3803	0.082
Base	-46.2754	-24.6011	807.9243	10.8333	-20.5113	0.0316
Base	61.3548	-29.5187	1707.81	13.4909	23.4227	0.0436

TABLE: Beam Forces

Story	Beam	P	V2	V3	T	M2	M3
Story4	B1	-7.287	-32.0947	0.0034	1.9432	-0.0411	-25.8877
Story4	B2	-2.9995	-61.8831	-0.0063	-2.963	0.0381	-64.6215
Story4	B5	-3.7325	44.9421	0.002	-0.3694	-0.0058	-41.6339
Story4	B6	-0.087	5.0559	-0.0154	0.2508	-0.0072	13.9491
Story4	B7	-4.0447	-43.9546	0.0013	-0.8117	0.0096	-19.985
Story4	B8	-1.8761	-0.9026	-0.0041	0.7658	-0.0017	10.8444
Story4	B9	0.8329	37.3787	-0.0219	0.0543	0.0515	-24.7827
Story4	B10	-2.8526	65.272	0.0031	-1.6017	-0.0217	-57.4988
Story4	B11	0.639	-51.998	-0.0023	0.1653	0.0296	-48.2955
Story4	B12	0.3964	-36.5034	0.0356	0.9091	0.0114	-26.4903
Story4	B13	-0.2413	2.331	-0.0317	-1.091	0.0401	11.6317
Story4	B14	-11.0152	-62.6414	0.0038	-0.3718	-0.0213	-63.4728
Story4	B15	0.2656	-4.2456	-0.0037	-0.1248	0.0719	13.0301
Story4	B16	-2.0118	-2.443	0.0125	0.6276	-0.093	24.3416
Story4	B17	-9.3819	-44.5056	0.0194	-0.3117	-0.0102	-43.4519
Story4	B18	-1.6299	-5.9503	-0.0089	0.1463	0.0605	27.9616
Story4	B19	-1.2337	-35.9775	0.0085	-0.21	-0.0508	-22.391
Story4	B20	-4.8452	-1.5664	0.0031	-0.3459	-0.0118	66.9251
Story4	B21	-9.5017	74.7339	0.0029	1.9929	-0.0238	-58.906
Story4	B22	-4.4831	67.7393	-0.0078	0.6289	0.0272	-58.1816
Story4	B23	-9.1436	44.063	-0.003	-1.3716	0.0116	-35.9058
Story4	B24	-12.0667	20.043	-0.013	9.4203	-0.0203	-13.7871
Story4	B25	-5.5312	60.4286	0.0068	3.0324	-0.0022	-29.343
Story4	B26	-2.8253	-36.0688	-0.0128	-2.4692	-0.047	-42.1495
Story4	B27	-6.375	-56.2106	-0.0048	-1.3712	-0.0412	-37.959
Story4	B28	-4.9715	9.7693	-0.0012	0.2931	0.0257	38.5549
Story4	B29	-2.8321	1.948	0.0041	-0.0548	-0.0125	43.5091

Story4	B30	-2.8997	2.0343	0.0086	-0.3228	0.0014	39.5359
Story4	B30	-2.8997	57.5196	0.0086	-0.3228	-0.0181	-39.3326
Story4	B31	0.1352	-33.2695	-0.0008	0.9831	0.0279	-24.8646
Story4	B33	-0.5854	-0.808	-0.0137	0.1984	-0.0317	16.8829
Story4	B34	-1.0575	32.942	-0.0055	1.8198	0.0187	-19.2831
Story4	B35	-13.7599	28.6946	0.0307	0.7052	-0.0589	-23.725
Story4	B36	-7.1142	26.7617	0.0057	-0.1123	0.0002	-30.1991
Story4	B37	-17.7725	65.6828	0.0136	-1.008	-0.0772	-58.7833
Story4	B38	-0.0522	36.8839	0.0012	-0.6081	-0.0194	-26.4029
Story4	B39	0.3379	5.7957	0	-0.0642	0	25.16
Story4	B42	-12.502	-73.5639	-0.0037	-0.8789	0.0214	-71.3121
Story4	B43	-8.6027	-78.5781	0.0384	6.9933	0.0223	-71.1026
Story4	B44	-9.7246	-70.926	0.064	0.5815	0.0253	-69.0467
Story4	B45	-1.3154	14.6701	0.0217	2.3546	0.0004	-6.1993
Story4	B47	-7.3624	-65.8067	-0.0037	-0.0306	0.037	-41.9399
Story4	B48	-12.6731	-86.6298	-0.029	-6.7622	-0.0035	-87.1408
Story4	B49	-1.7217	-21.3779	-0.0192	-3.9698	-0.0335	-15.6968
Story4	B50	-0.0344	19.2165	-0.0019	-4.7274	0.0019	-10.6913
Story4	B56	-4.5154	71.5806	-0.0057	-0.6359	0.0457	-68.6378
Story4	B57	-3.7858	-50.4662	0.0012	0.0373	-0.021	-53.0071
Story3	B1	0.3335	-66.3713	0.0006	5.4928	-0.0008	-48.203
Story3	B2	-0.6808	-164.771	0.0035	-9.0082	0.0014	-159.029
Story3	B3	-0.1522	124.8163	-4E-05	-1.7329	0.0044	-122.749
Story3	B4	-0.1237	124.5955	-0.0017	-1.7329	0.0038	-116.439
Story3	B5	0.2317	104.9906	0.0021	-0.581	0.0016	-79.6971
Story3	B6	0.2317	78.4845	-0.0006	1.3605	-0.0106	-35.8269
Story3	B7	-0.5784	104.0993	-0.0011	-1.3377	0.0098	-77.3345
Story3	B8	-0.3991	-55.1822	0.0018	1.8234	0.0106	-20.9201
Story3	B9	-0.6729	72.6676	-0.0022	0.2273	-0.0031	-43.1445

Story3	B10	-0.9361	128.4462	0.0002	-2.4612	0.0009	-115.148
Story3	B11	-0.18	-104.133	-0.0014	0.1225	-0.0043	-94.0216

DESIGN OF TWO WAY SLAB

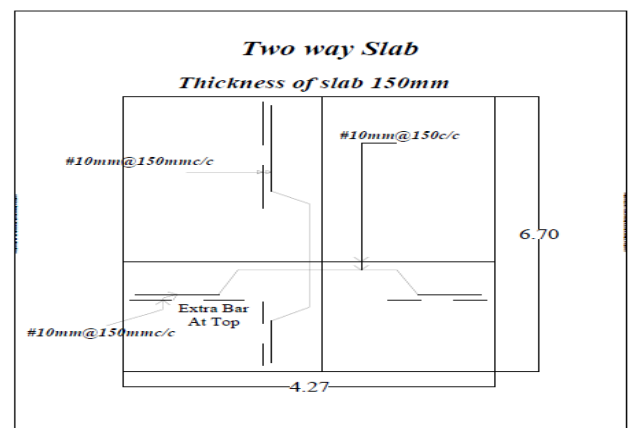
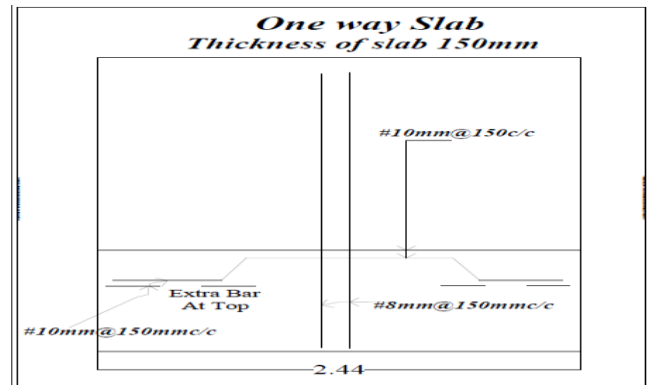
Short span S= 4.27 mts thickness
 Long span L= 6.70 mts
 Assumed slab thickness t= 0.15 mts greater than 'min. eff depth reqd'. Hence ok
 Grade of concrete fck= 25 N/mm²
 Grade of reinforcement fy= 415 N/mm²

Type of panel Interior panel

Loads
 Self-weight of slab w1= 2.00 kN/m² 6.70 Mts
 Floor finish w2= 1.00 kN/m²
 Live load w3= 4.00 kN/m²
 Wall load w4= kN/m²
 Miscellaneous w5= kN/m² TOTAL 5.00 kN/m² 4.27 mts
 Ratio of long span to short span R= 1.6
 Design Load with load factor of 1.5 Wu= 7.50 kN/m²

Design

	Coeff	BM	k	pt	Ast	Dia	Spacing	D
Short span direction								
Negative moment at continuous edge	0.056	7.70	0.46	0.13	180	10	249	130
Positive moment at midspan	0.043	5.88	0.35	0.10	180	10	328	130
Long span direction								
Negative moment at continuous edge	0.032	4.38	0.30	0.09	180	10	409	120
Positive moment at midspan	0.024	3.28	0.23	0.06	180	10	436	120
Minimum effective depth reqd	dre=	47.24	mm					
Clear cover to top reinforcement	c=	20	mm					
Clear cover to bottom reinforcement	c=	20	mm					
Minimum effective depth provided	dpr=	120	mm					greater than 'min. eff depth reqd'. Hence ok
Minimum reinforcement	Amin=	180	mm ²					
Deflection check								
Reinf provided at midspan along short direction		523	mm ²		Dia	10	at	150
Stress in reinforcement	fs=	109.29	N/mm ²					
Percentage of reinforcement provided	pt=	0.4	%					
Modification factor as per fig 4 of IS:456-2000	MF=	2.000						
Type of slab for deflection check 1								
Basic span to effective depth ratio		26						
Minimum effective depth reqd from deflection criteria		82.12	mm					
Effective depth provided		130	mm					greater than 'min. eff depth reqd'. Hence ok



5. DESIGN OF SLAB

6. DESIGN OF BEAMS

Consider B6 at First floor plan beam for design since it is subjected to maximum Bending Moment and Shear Force.
 $b = 230\text{mm}$, $D = 550\text{mm}$, $f_{ck} = 25\text{ N/mm}^2$, $f_y = 415\text{ N/mm}^2$, $M_u = 255.0868\text{ KN m}$, Check for depth: Since $M_u > M_{ulim}$ (Doubly Reinforced beam) For $f_y = 415\text{ N/mm}^2$ From IS456-2000 $M_{ulim} = 0.148 f_{ck} b d^2$, $M_{ulim} = 212.75\text{ kNm}$
 $F_{sc} = \epsilon_{sc} * E_s = \{(0.0035((0.48 \times 500) - 50) / (0.48 \times 500)\} \times (2 \times 10^5)$

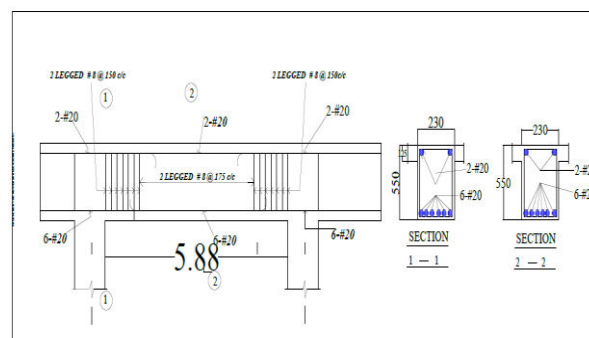


Fig 6.1 BEAM REINFORCEMENT DETAILS

$= 554.16 \text{ N/mm}^2 > 0.87 f_y = 361 \text{ N/mm}^2$ $A_{sc} = \{(M_u - M_{ulim}) / (f_{sc}(d - d'))\}$ $A_{sc} = 169.77 \text{ mm}^2$
 $A_{st2} = A_{sc} = 169.77 \text{ mm}^2$ Provide #2-20mm dia,
 $A_{st1} = \{0.36 \times f_{ck} \times b \times X_{ulim} / (0.87 \times f_y)\}$, $A_{st1} = 1375.98 \text{ mm}^2$ Provide #6-20mm dia
Shear reinforcement: $V_u = 254.62 \text{ KN}$

$\tau_v = \frac{V_u}{bd} = \frac{254.62 \times 10^3}{230 \times 500} = 2.21 \text{ N/mm}^2$, $P_t \text{ provided} = \frac{100 A_{st}}{bd} = \frac{100 \times 1545.75}{230 \times 500} = 1.3\%$, From IS 456, Table No: 19, $\tau_c = 0.29 \text{ N/mm}^2$, $V_{us} = V_u - \tau_c \times b \times d = 211.97 \times 1000 - 0.29 \times 230 \times 500$,
 $= 221.27 \text{ KN}$, From IS 456, 40.4(a), $S_v = \frac{0.87 f_y A_{sv} d}{V_{us}}$,
 $= \frac{0.87 \times 415 \times 2 \times \pi / 4 \times 8 \times 8 \times 500}{221.27 \times 10^3}$, $= 82 \text{ mm c/c}$, Provide 2L-8mm dia stirrups @ 80mm c/c,

Design of mid-span section as T-Beam: Effective width of flange $= b_f = l_o / 6 + b_w + 6 D_f = \frac{5880}{6} + 230 + 6 \times 200 = 2396.67 \text{ mm}$, $M_u = 255.0868 \text{ KN-m}$, Assuming the neutral axis lies within the flange, $M_u = 0.36 f_{ck} b_f x X_u (d - 0.42 X_u)$
 $255.0868 \times 10^6 = 0.36 \times 25 \times 2396.67 \times X_u (500 - 0.42 X_u)$,
 $X_u = 24.14 \text{ mm}$, Hence assumption is correct, Area of steel $= M_u = 0.87 f_y A_{st} d (1 - \frac{A_{st} x f_y}{b_f x d x f_{ck}})$, $255.0868 \times 10^6 = 0.87 \times 415 \times A_{st} \times 500 (1 - \frac{A_{st} \times 415}{2396.67 \times 500 \times 25})$, $A_{st} = 1441.8 \text{ mm}^2$,
 Provide 5 bars of 20mm diameter.

7. DESIGN OF COLUMN :

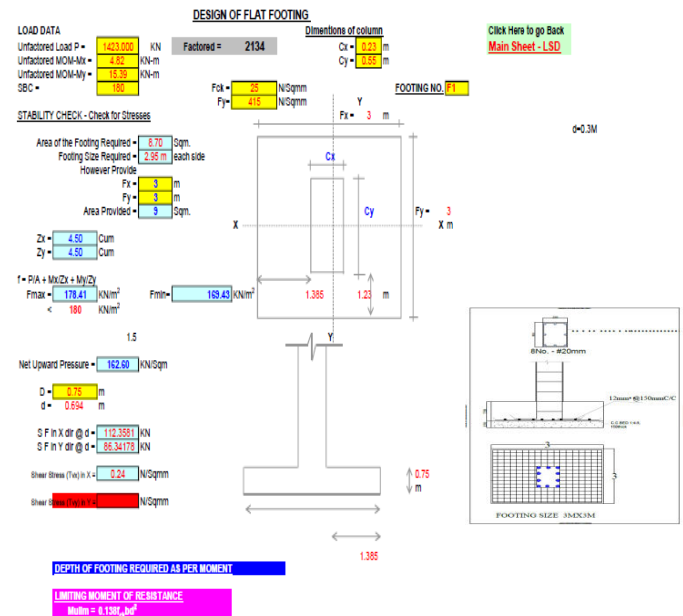
One definition of a column is an element whose primary function is to bear the axial compression loads applied by a beam. Axial force and a few seconds act on every column. The column is a uniaxial column in design. The SP 16 Code practice influenced the column's design. We may infer the column's resistance to the maximum axial load and moment axial from the Etabs output numbers.

Member Number	Axial Load KN (Max)	Moment KNm
C6	2133.996	23.0885

Location Base Floor to Ground Floor:

$P_u = 2133.996 \text{ kN}$, $M_u = 23.0885 \text{ kNm}$, $f_{ck} = 25 \text{ N/mm}^2$
 $f_y = 415 \text{ N/mm}^2$, $L = 1.5 \text{ m}$, From IS 456-2000 Page No.94
 $L_{eff} = 0.65 l = 0.65 \times 1.5 = 0.975 \text{ m}$, Assuming 1% reinforcement, then cross sectional area of column A_g is calculated by using SP16 Page No.110 chart 25.

$A_g = 100000 \text{ mm}^2$, $B = 230 \text{ mm}$, $D = 100000 / 230 = 434.78 \text{ mm}$ Say 450mm, Check for minimum eccentricity along depth. $E_{min} = (l_e / 500) + (D / 30)$, $= 97.5 / 500 + 45 / 30 = 1.695 \text{ cm}$, $E_{min} / D = 1.695 / 60 = 0.028 < 0.0365$ Hence Safe



5. CRITICAL SECTION FOR TWO WAY SHEAR

The critical section for two way shear is taken at a distance equal to half the effective depth from the column face around.

$d = 1.35 \text{ m}$
 $(d/4) = 0.34 \text{ m}$
 $(d/4) = 0.34 \text{ m}$
 $(d/4) = 0.34 \text{ m}$
 $(d/4) = 0.34 \text{ m}$

Shear Force at this critical section = $S_v = 191473.80 \text{ N}$

Permissible Shear Stress (psi)

$q_s = 0.54 \text{ N/mm}^2$

$\rho_c = \frac{\text{short side of the column}}{\text{long side of the column}} = 0.42$

$K_s = 0.5 - \rho_c = 0.80$
 But K_s is limited to 1.00

Permissible Maximum Shear Stress (psi)

$q_s = 0.54 \times 0.80 = 0.432 \text{ N/mm}^2$

DESIGN OF REINFORCEMENT

For 1.35 m Cantilever

Moment = 155.95 KN-m

Mu0 = 0.49

Pt = 0.14 %

Ast_{min} = 955.92 Sqmm

Provide Y = 12 @ 110.3674875 mm oc

However Provide Y = 12 @ 110 mm oc

Ast_{min} = 1009 Sqmm

For 1.025 m Cantilever

Moment = 122.00 KN-m

Mu0 = 0.38

Pt = 0.11 %

Ast_{min} = 743.96 Sqmm

Provide Y = 12 @ 150.040918 mm oc

However provide Y = 12 @ 150 mm oc

Ast_{min} = 754 Sqmm

For 1.35 m Cantilever

Moment = 155.95 KN-m

Ultimate Bending Moment = $M_u = 233.93$

b (UNIT WIDTH) = 1000

Equating the limiting moment of resistance to the ultimate bending moment

$d = \sqrt{\frac{M_u}{\rho_s f_y}}$

d = 0.26

CHECK FOR SHEAR STRESSES

1) CRITICAL SECTION FOR ONE WAY SHEAR

The critical section for one way shear is taken at a distance equal to the effective depth from the column face.

Shear Force at critical section along X direction

S F_X = 505.61 KN

Shear Force at critical section along Z direction

S F_Z = 388.54 KN

Permissible Shear Stress (psi)

$q_s = 0.243 \text{ N/mm}^2$

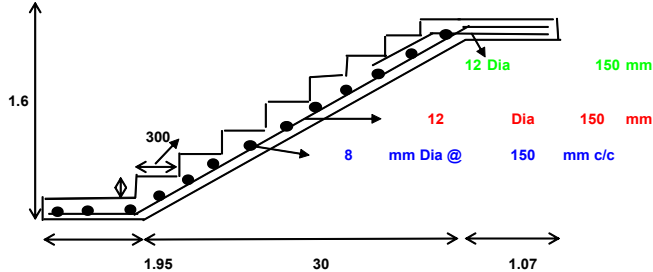
$q_s = 0.19 \text{ N/mm}^2$

DESIGN OF DOG -LEGGED STAIR CASE

INPUT DATA

The Vertical distance between the floors	=	1.6	mtrs
weight of finishes	=	1.5	kn/m ²
live load	=	3	kn/m ²
Rise	=	150	mm
Tread	=	300	mm
width of each flight	=	1.07	m
No of Risers required	=	11	
No of treads required	=	10	
Width of landing	=	1.07	mtrs
Grade of Concrete	=	20	N/mm ²
Grade of Steel	=	500	
The bearing of the landing slab in beam	=	230	mm
Assume the depth of slab	=	200	mm
Dia of main Bar	=	12	mm
Dia of distribution bar	=	8	mm

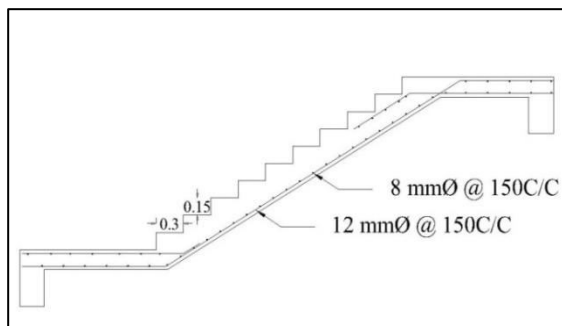
OUT PUT DATA



9. DESIGN OF STAIR CASE

The primary function of a staircase is to facilitate the movement of pedestrians inside a building. Depending on the specifics of each scenario, staircases may take on a wide variety of geometric shapes. In most cases, there are two primary considerations when designing a staircase: its form and its structural arrangement.

1. Kind of structure that surrounds the staircase, such as a brick structure or a reinforced concrete and brick structure.
2. Availability of space. Planned structure has a bifurcated staircase with two stories. Both flights begin at different levels; the first ascends from the plinth to the lintel, while the second descends from the lintel to the ceiling.



Assuming 12mm ϕ bars with clear cover of 50mm, $d' = 50 + \frac{12}{2} = 56\text{mm}$, Ratio $d'/D = 56/500 = 0.112$, $P_u/f_{ck}bD = \frac{2133.996 \times 10^3}{25 \times 230 \times 500}$

$$= 0.74, M_u/f_{ck}bD^2 = \frac{23.088 \times 10^6}{25 \times 230 \times 500^2} = 0.016, \text{ Using}$$

above ratios

$$\frac{d'}{D} = \frac{56}{500} = 0.112, \text{ From SP 16 Page No. 117 Chart 32}$$

$P_u/f_{ck} = 0.10$, $P_t = 0.10 \times 25 = 2.5\%$, Area of steel $A_{st} = (2.5/100) \times 230 \times 450 = 2587.5\text{mm}^2$, Provide 8 bars of 20mm ϕ

$A_{st} = 2587.5\text{mm}^2$, **Design of lateral ties:** According to IS 456-2000 Page No.49, Diameter of lateral ties = $0.25 \times 20 = 5\text{mm}$, adopt 8mm ϕ

Spacing of lateral ties: lesser of the following

1. Least lateral dimension = 230mm, 16 times diameter of bar = $16 \times 20 = 320\text{mm}$, 230mm, Let us provide 8mm ϕ lateral ties @ a pitch of 200mm c/c.

The Vertical distance between the floors	=	1.6 m
live load	=	3 kn/m ²
Rise	=	150 mm
Tread	=	300 mm
width of each flight	=	1.07 m
No of Risers required	=	11
No of treads required	=	10
Width of landing	=	1.07 m
Grade of Concrete	=	20 N/mm ²
Grade of Steel	=	500 N/mm ²
The bearing of the landing slab in beam	=	230 mm
Assume the depth of slab	=	200 mm
Dia of bar	=	12 mm

Calculation

Space occupied by treads	=	300 cm
Effective span	=	4.2 m
effective depth	=	179 mm
Weight of Slab	=	6.5 kn/m ²
Dead Weight of horizontal Area	=	7.27 kn/m ²

$$w_1 = W \cdot \sqrt{R^2 + T^2} / T$$

Dead weight of step	=	1.88 kn/m ²
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Total load	=	13.64 kn/m
------------	---	------------

Factored load	=	20.46 kn/m
---------------	---	------------

Bending moment	=	45.12 kn-m
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Shear force	=	42.97 kn
-------------	---	----------

$x_{u\max}/d$	=	0.42
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$R_u = .36 \cdot f_{ck} \cdot x_{u\max}/d \cdot (1 - 0.416 \cdot x_{u\max}/d)$	=	2.50
--	---	------

$d_{req} =$	=	134.46 mm
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DEPTH IS OK

Steel Reinforcement A_{st}	=	637 mm ²
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Area of 12mm bar	=	114 mm ²
------------------	---	---------------------

Spacing of bars	=	179.0 mm
-----------------	---	----------

No. of 12mm bars	=	6.0
------------------	---	-----

Distribution Reinforcement	=	300.0 mm ²
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Area of Distribution bar 8mm	=	50.3 mm ²
------------------------------	---	----------------------

Spacing of 8mm bars	=	168.0 mm
---------------------	---	----------

V. CONCLUSION

1. ALL HORIZONTAL MEMBERS EXHIBIT A SHORT-TERM DEFLECTION OF LESS THAN 20 MM.
2. BUILDING STRUCTURAL COMPONENTS ARE SHEAR AND FLEXURE SAFE.
3. BOTH THE COLUMN AND THE BEAM MUST NOT EXCEED DIMENSIONS OF 230 MM X 550 MM.
4. WE CAN ONLY PROVIDE SLABS WITH A MAXIMUM THICKNESS OF 150MM.
5. ANALYSES OF ETABS DO NOT SHOW A SIGNIFICANTLY DIFFERENT PATTERN.
6. IT IS POSSIBLE TO CREATE THIS STRUCTURE USING THE SPECIFIED DIMENSIONS OF THE COMPONENTS.
7. PROVIDED QUANTITY OF STEEL FOR THE BUILDING IS ECONOMICAL.
8. CUTTING DOWN ON ANALYSIS AND DESIGN TIME IS POSSIBLE WITH THE HELP OF ETABS SOFTWARE.

VI. FUTURE SCOPE OF STUDY

- Designing members individually or in groups might make the design more inexpensive while preserving the same software analysis outcomes.
- It is possible to achieve precise load distribution by meshing the slab element.

REFERENCES

- [1] Varalakshmi V,G shivakumar and R S Sarma (2014) “Designed and d G+5 residential building by ETABS”, International Conference on Advance in Engineering and Technology.
- [2] Chandrashekar and Rajashekar (2015), “Analysis and Design of Multi Storied Building by Using ETABS Software”, International journals of scientific and research vol.4: issue.7: ISSN no. 2277-8179.
- [3] Balaji and Selvarasan (2016), “Design and Analysis of multi-storeyed building under static and dynamic loading conditions using ETABS”, International Journal of Technical Research and Applications e-ISSN: 2320-8163, www.ijtra.com Volume 4, Issue 4, PP. 1-5
- [4] Geethu S N, Depthi M, Abdul Nasir N A and Izzudeen K M(2016) “Comparative study on design and analysis of multi storied building by STAAD.Pro and ETABS softwares”.
- [5] Aman, Manjunath Nalwadgi, Vishal, Gajendra Analysis And Design Of Multi-Storey Building By Using STAAD ProInternational Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 06 | June-2016
- [6].C.V.S. Lavanya, Emily.P.Pailey, Md. Mansha Sabreen and U.P.B.C. Sekhar, Analysis and Design of G+4 Residential Building Using ETABS. InternationalJournal of Civil Engineering and Technology, 8(4), 2017, pp. 1845-1850.
- [7] P. Jayachandran and S. Rajasekaran, Structural Design of Multi-story Residential Building for in Salem, India, mini project report, PSG College of Technology, Coimbatore, Tamil Nadu, India-2006.
- [8] IS: 1893-2002, Part 1, “Criteria for Earthquake Resistant Design of Structures -General Provisions and Buildings”, Bureau of Indian Standards, New Delhi, India.
- [9] IS: 875 (Part 1), “Indian Standard Code of Practice for design loads for building and structures, Dead Loads” Bureau of Indian Standards, New Delhi.
- [10] IS: 875 (Part 2), “Indian Standard Code of Practice for design loads for building and structures, Live Loads” Bureau of Indian Standards, New Delhi.
- [11] IS: 875 (Part 3), “Indian Standard Code of Practice for design loads (Other than earthquake) for building and structures, Wind Loads” Bureau of Indian Standards, NewDelhi.
- [12] IS 456:2000, “Indian Standard plain and reinforced concrete-Code of Practice”, Bureau of Indian Standards, New Delhi, 2000.
- [13]Indian standards code of practice for design SP-16 and detailing SP-34.



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