

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY



DEPARTMENT OF CIVIL ENGINEERING

CERTIFICATE

Certified that this is the bonafide report of the project work of

“Analysis and Design of Multi-storied building”

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Students of Final year during the academic year 2011-2012 in the partial fulfillment

For the award of the Degree BACHELOR OF ENGINEERING

PROJECT GUIDE

EXAMINAR

H.O.D OF CIVIL ENGG

Project Report
On
DESIGN AND ANALYSIS
OF
MULTI-STORIED BUILDING

DEPARTMENT OF CIVIL ENGINEERING
(2011-2012)

Under the guidance of

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A Dissertation submitted in partial fulfillment of
the requirement for the award of degree of

Bachelor of Technology

In

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CHAPTER – 1

INTRODUCTION

INTRODUCTION

AIM

Our main aim to complete a Multi-storey building is to ensure that the structure is safe against all possible loading conditions and to full fill the function for which they have built.

Safety requirements must be met so that the structure is able to serve its purpose with the maintain cost.

Detailed planning of the structure usually comes from several studies made by town planners, investors, users, architects and other engineers. On that, a structural engineer has the main influence on the overall structural design and an architect is involved in aesthetic details.

For the design of the structure, the dead load, live loads, seismic and wind load are considered. The analysis and design for the structure done by using a software package STAAD PRO.

In this project multistoried construction, we have adopted limit state method of analysis and design the structure. The design is in confirmation with IS456-2000.the analysis of one frame is worked out manually and simultaneously it has been checked using STAAD PRO.

Therefore an attempt has been made to present the multistoried building for residential purpose in the busy city of Hyderabad.The complex consisting of five storeys The structure is design based on the theory of LIMITSTATE METHOD which provides adequate strength,serviceability and durability besides economy

STATEMENT OF PROJECT

Salient Features : The design data shall be as follows.

- | | | |
|-------------------------|---|----------------------|
| 1. Utility Of Buildings | : | Residential Building |
| 2. Area of each floor | : | 160 sq.m |
| 3. No Of Storey | : | G+5 |

4. Shape of the Building : Rectangular
5. No. Of Staircases : Six
6. No. Of Lifts : One
7. Types Of Walls : Brick Wall
8. Geometric Details
- Ground Floor : 9.0 M
 - Floor-To-Floor Height : 3.0 M
 - Height of Plinth : 0.6 M above G.L
 - Depth of Foundation : 2 M below G.L
9. Material Details
- Concrete Grade : M25
 - All Steel Grades : HYSDREINFORCEMENT
ofGrade Fe415
 - Bearing Capacity of Soil : 200 KN/M²
10. Type Of Construction:R.C.C
FRAMED structure

CHAPTER – 2

LITERATURE SURVEY

LITERATURE SURVEY

Major advances in both design and new material assisted roman architecture. Design was enhanced architectural developments in the construction of arches and roof domes. Arches improved the efficiency and capability of bridges and aqueducts (fewer supports columns were needed to support the structure), while domed roofs not only permitted the building of larger open areas undercover, but also lent the exterior an impressive.

The social unit that lives in a house is known as a household. Most commonly, a household is family unit of a same kind, though households can be other social groups, such as single person, or groups of unrelated individuals. Settled agrarian and industrial societies are composed of household units living permanently in housing of various types, according to a variety of forms of land tenure. English-speaking people generally call any building they routinely occupy "home". Many people leave their houses during the day for work and recreation, and return to them to sleep or for other activities.

CHAPTER – 3

ARCHITECTURE

ARCHITECTURE

Architecture is the art and science of designing buildings and structures. A wider definition would include within its scope also the design of the total built environment, from the macro level of creating furniture. In the field of building architecture, the skill demanded of an architect range from the more complex, such as for a hospital or stadium, to the apparently simpler, such as planning residential houses. Many architectural works may be seen also as cultural and political symbols, and /or work of art. The role of architect though changing, has been central to the successful design and implementation of pleasing built environments in which people live.

Scope: Architectural is an interdisciplinary field, drawing upon mathematics, science, art technology, social sciences, politics, history and philosophy. Vitruvius states: “architecture is a science, arising out of many other sciences, and adorned with much and varied learning: by the help of which is judgment is formed of those works which are result of other arts”.

Most modern-day definition of “good buildings” recognize that because architecture does not exist in a vacuum, architectural form cannot be merely a completion of historical precedent, fictional necessities ; and socially aware concerns, but most also be a transcendents synthesis of all of the former and a creation of worth in and of itself. As Nunziarodanini stated, “through its aesthetic dimension architecture goes beyond the functional aspects that it has in common with other human sciences...through its own particular way of expressing values, architecture can stimulate and influence social life without presuming that, in and of itself, it will promote social development. To restrict the meaning of formalism to art for art’s sake is not only reactionary; it can be a purposeless quest for perfection or originality which degrades form, into a mere instrumentally”

The term can be used to connect the implied architecture of abstract things such as music or mathematics the apparent architecture of natural things, such as geological formations or the structure of natural things such as geological formations or the structure of natural things such as geological formation or the structure of biological cells, or explicitly planned architectures of human made things such as software, computers, enterprises, and databases, in addition to buildings. In every usages an architecture may be seen as subjective mapping from a human perspective (that of the user in the case of abstract or physical artifacts) to the elements or components.

Architecture is both the process and product of planning designing and constructing space that reflects functional, social and aesthetic considerations. It requires the manipulation and coordination of material. Technology, light and shadow. Architecture also encompassed the pragmatic aspects of realizing designed spaces, such as project planning, cost estimating and construction administration.

Architectural works are often perceived as cultural and political symbols and as work of art. Historical civilization is often identified with their surviving architectural achievements. Brunelleschi, in the building of the dome of Florence cathedral, not only transformed the cathedral and the city of Florence, but also the role and status of the architecture.

With the consolidation of knowledge in scientific such as engineering and the rise of new building material and technology; the architect began to lose ground on the technical aspect of building. Therefore he concerned playing field that of aesthetics.

There was the rise of the “gentlemen architect” who usually dealt with wealthy clients and concentrated predominantly on visual qualities derived usually from historical prototypes. In

the 19th century, Ecole des Beaux Arts in France, the training was toward producing quick sketch schemes involving beautiful drawings without much emphasis on context. The rise of profession of industrial design is usually placed here. Following this lead, the Bauhaus school, founded in Germany in 1919, consciously rejected history and looked at architecture as synthesis of art craft and technology.

Architects such as Mies van der Roë worked to reject the virtually all that had come before, trading handcrafted details and sentimental historic forms for a machine driven architectural geometry made possible by the Industrial Revolution. They felt that architecture was not a personal philosophical or aesthetic pursuit by individual rather it had to consider everyday needs of people and use technology to give a livable environment. That design Methodology Movement involving people such as Charles Jones, Christopher Alexander started for more people-oriented designs.

Extensive studies on areas such as behavioral, environmental, and social science were done started informing the design process. As many other concerns began to be recognized, complexity of buildings began to increase in terms of aspect to be recognized, and complexity of buildings began to increase in terms of aspect such as services, architecture started becoming more multi-disciplinary than ever. While the notion that structural and aesthetic consideration should be entirely subject to functionality, which met with both popularity and skepticism, it had the effect of introducing the concept of “function” in the place of Vitruvius “utility”. “Function” came to be seen as encompassing all criteria of the use, perception and enjoyment of a building, not only practical but also aesthetic, psychological and cultural.

“Now-a-day’s Architecture required a team of professionals in its making”.

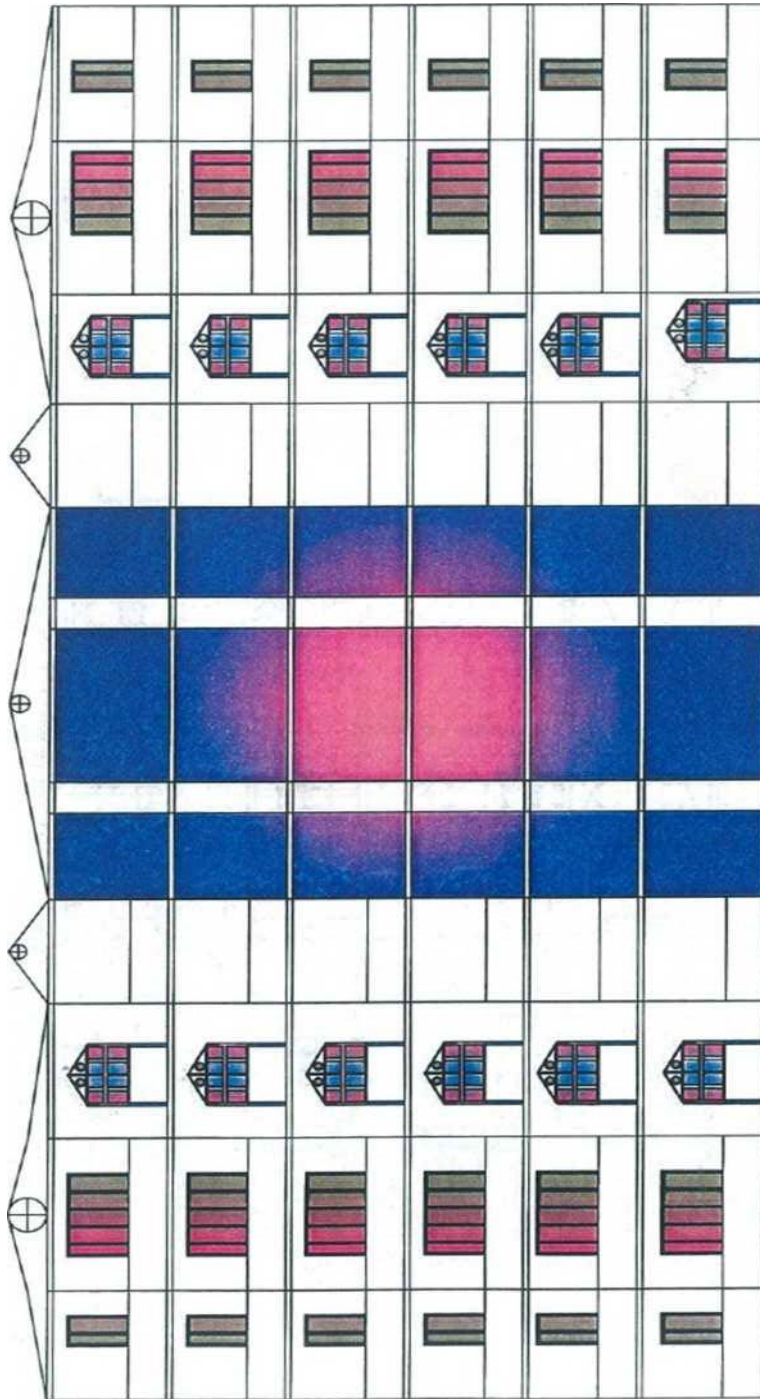
An architect is being one among the many and sometimes the leader. This is the state of the professional today, however, individually or still cherished and sought the design of buildings seems as cultural symbols – the museum of fine arts centre has become a showcase for new experiments in style, tomorrow may be something’s else.

In the late 20th century, a new concept was added to those include in the compass of both structure and function, the consideration of sustainability. To satisfy the contemporary ethos a building should be constructed in a materials, its impact upon the natural and built environment of its surroundings area and the demands that it makes upon non-sustainable power sources for the heating, cooling water and waste management and lighting. When modern architecture was first practiced, it was an avant-garde movement with moral, philosophical, and aesthetic

underpinnings. Modernist architects sought to reduce buildings to a pure form, removing historical references in favor of purely fictional structures.

The column arches and gargoyles of classical architecture were dubbed unnecessary. Buildings that flaunted their construction exposing steel beams and concrete surfaces instead of hiding them behind traditional forms were seen as beautiful in their own right. Architecture first evolved out of the dynamics between needs (shelter, security, worship etc.) and means (available building material and attendant skills). As human culture evolved and knowledge began to be formalized through oral tradition and practices, architecture became a craft.

CHAPTER – 4
ARCHITECTURAL LAYOUT
DRAWINGS



ELEVATION

Fig 01.



PLAN

Fig 02.

STRUCTURAL ANALYSIS

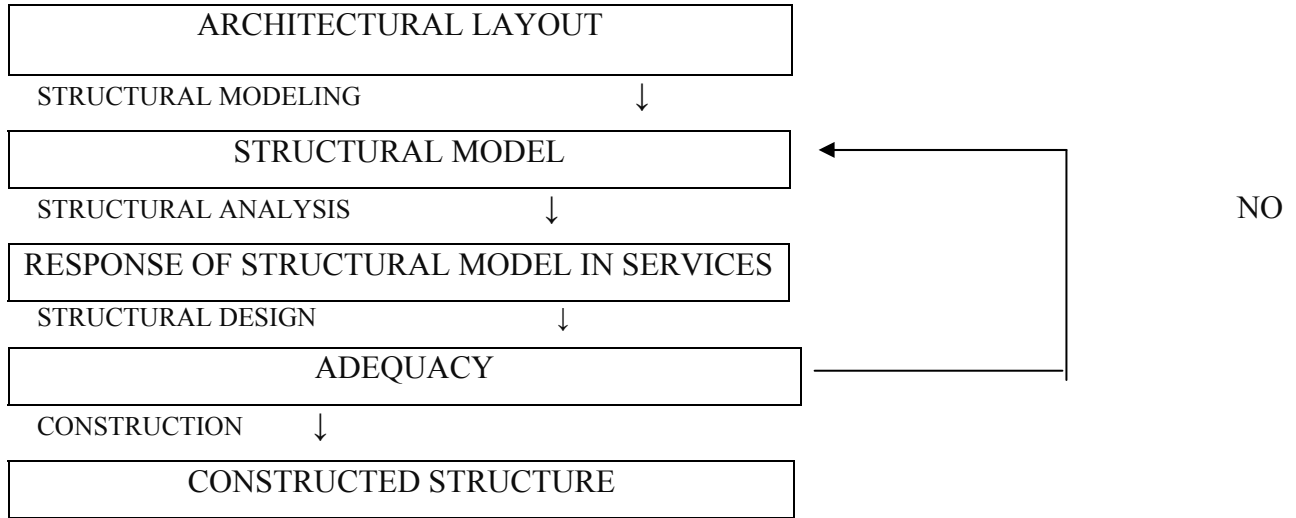
The procedure of structural analysis is simple in concept but complex. In detail. It involves the analysis of a proposed structure to show that its resistance or strength will meet or exceed a reasonable expectation. This expectation is usually expressed by a specified load or the demand and an acceptable margined of safety that constitutes a performance goal for a structure. The performance goals structural design is multifaceted. Foremost, a structure must perform its intended function safely over its useful life.

The concept of useful life implies consideration of durability and established the basis for considering the cumulative exposure to time varying risks (i.e. corrosive environments, that performance is inextricably linked to cost, owners, builders, and designer must considers economic limit to the primary goal of safety and durability.

In the view of the above discussion, structural designer may appear to have little control over the fundamental goals of structural design except to comply with or exceed the minimum limits established by law. While this is generally true, a designer can still do much to optimize the design through alternative means and methods that can for more efficient analysis techniques, creative design detailing, and the use of innovative construction materials and methods. In summary the goal of structural design are defined by law and reflect the collective interpretation of general public welfare by those involved in the development and local adoption of building could.

It is advantageous when kinematic indeterminacy < static indeterminacy. Alex Bendex first formulated this procedure in 1914 based on the applications of compatibility and equilibrium of compatibility and equilibrium conditions.

This method derives its name from the facts that supports and displacements are explicitly computed. Set up simultaneous equation is formed from the solution of these parameters and the join moment in each or computed from these values.



ROLE OF STRUCTURAL ANALYSIS IN DESIGN PROCESS OF A STRUCTURE

Literature Reviews

Method of analysis of statically indeterminate portal frame.

- I. Method of Flexibility Coefficients.
- II. Slope Displacement Methods (Iterative Methods)
- III. Moment Distribution Method.
- IV. Kani's Method (Approximate Method).
- V. Cantilever Method.
- VI. Portal Method.
- VII. Matrix Method.
- VIII. STADD Pro.

CHAPTER – 6

STAAD.Pro

This chapter reviews about some of the fundamental concepts of structural design and present them in a manner relevant to the design of light frame residential structures. The concepts from the basis for understanding the design procedures and overall design approach addressed in the remaining chapter of the guide. With this conceptual background, it is hoped that the designer will gain a greater appreciation for creative and efficient design of home, particularly the many assumptions that must be made.

The world is leading Structural Analysis and Design package for Structural Engineers.

- Starting the Program.
- Creating a New Structure.
- Creating Joints and Members.
- Switching On Node and Beam Labels.
- Specifying Member Properties.
- Specifying Material Constants.
- Specifying Member Offsets.
- Printing Member Information.
- Specifying Supports.
- Specifying Loads.
- Specifying the Analysis type.
- Specifying Post-Analysis Print Commands.
- Specifying Steel Design Parameters.
- Performing Analysis and Design.

- **Viewing the Output File.**

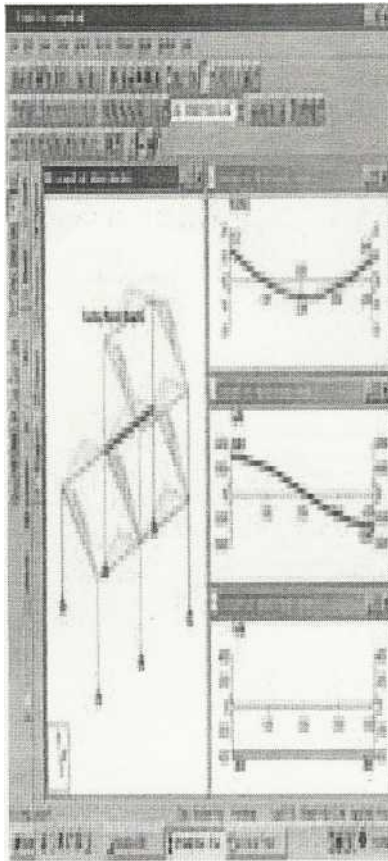
Verifying results on screen both graphically and numerically.

World's #1 Structural Analysis and Design software supporting Indian and major International codes.

The choice of 0.2 million Structural Engineers worldwide, STAAD pro is guaranteed to meet all your structural engineering needs.

STAADpro features state of the art user interface, visualization tools, powerful analysis and design engines with advanced finite element (FEM) and dynamic analysis and design to visualization and result verification STAADpro is the professional first choice. STAADpro was developed by practicing engineers around the globe. It has evolved over 20 years and meets the requirements of ISO 9001 certification.

STADDpro has building codes for most countries including US, Britain, Canada, Australia, France, Germany, Spain, Norway, Finland, Sweden, India, China, Euro Zone, Japan, Denmark and Holland.



Structural Analysis And Design :

STAAD-III, the world's most powerful and popular structural analysis and design software is in use across the globe since 1980. Now it is available in the form of STAAD.Pro which consists of STAAD + STARDYNE +FEMkit + Visual Draw .STAAD.Pro is a comprehensive, general purpose software for integrated structural analysis and design.

STAAD.Pro may be utilized for analyzing and designing practically all types of structures - buildings, bridges, towers, transportation, industrial and utility structures.

STAAD.Pro implements the most modern technologies in today's Computer-Aided-Engineering.

It unifies leading-edge graphics and visualization techniques with proven and time tested analysis and design. A live, unified database provides seamless integration across all mission critical application — from concept design/analysis to detail design, simulation and visualization.

STAAD.Pro Overview:

- “Concurrent Engineering” based user environment for model development, analysis, design, visualization and verification.
- Pull down menus, floating toolbars, tool tip help.
- Flexible Zoom and multiple views.
- Isometric and perspective views 3D shapes.
- Built-in Command File Editor.
- Simple Command Language.
- Graphics/Text input generation.
- State-of-the-art Graphical Pre and Post Processor.
- Rectangular/Cylindrical Coordinate systems.
- Joint, Member/element, Mesh Generation with flexible user-controlled numbering.
- Efficient algorithm minimizes disk space requirements.
- FPS, Metric or SI units.

Presentation quality printer plots of Geometry and Results as part of run output.

Graphics Environment:

- **Model Generation**

- Interactive Menu-driven Model Generation with simultaneous 3D display.
- 2D and 3D Graphic Generation using rectangular or polar coordinate system.
- Segments of repetitive geometry may be used to generate complex structural models.
- Generate Copy, Repeat, Mirror, Pivot, etc, or quick and easy geometry generation.
- Quick/easy mesh generation.
- Comprehensive graphics editing.
- Graphical Specification and Display of Properties, Loadings, Supports, Orientations.
- Import AutoCAD DXF files.
- Access to Text Editor.

- **Model Verification**

- 2D/3D drawings on screen as well as on plotter/printer.
- Full 3D shapes for Frames, Elements.
- Sectional views or views with listed members only.
- Isometric or any rotations for full 3D viewing.
- Display of properties, Loadings, Supports, Orientations, Joint/Member numbering, Dimensions, Hidden line removed, etc.
- Plot manipulation according to the size, rotation, viewing origin and distance.

- **Analysis & Design:**

- Static Analysis
- 2D/3D analysis based on state-of-the-art Matrix method to handle extremely large job.
- Beam, Truss, Tapered Beam, Shell/Plate Bending/Plane Stress.
- Full/partial Moment Releases.
- Member Offset Specification.
- Fixed, Pinned and Spring Supports with Releases. Also inclined Supports.

- Automatic Spring Support Generator.
- Linear, P-Delta Analysis, Non-Linear Analysis with automatic load and stiffness correction. Multiple Analysis within same run.
- Active/Inactive Members for Load-Dependent structures.
- Tension-only members and compression-only members, Multi-linear spring supports.
- CIMSTEEL Interface.

- **Dynamic/Seismic Analysis**

- Mass modeling, Extraction of Frequency and Mode shapes.
- Response Spectrum, Time History Analysis.
- Modal Damping Ratio for Individual Models.
- Harmonic Load Generator.
- Combination of Dynamic forces with Static loading for subsequent desing.

- **Secondary Analysis**

- Forces and Displacements at sections between nodes.
- Maximum and minimum force Envelopes.

Load Types and Load Generation:

- Loading for Joints, Members/Elements including Concentrated, Uniform, Linear, Trapezoidal, Temperature, Strain, Support Displacement, Prestressed and Fixed-end Loads.
- Global, Local and Projected Loading Directions.
- Uniform or varying Element Pressure Loading on entire or selected portion of elements.
- Floor/Area Load converts load-per-area to member loads based on one-way or two-way actions.
- Automatic Moving Load Generation as per standard AASHTO or user defined loading.

- UBC 1997.AIJ/IS 1893/Cypriot Seismic Load Generation.
- Automatic Wind Load Generation.

Factored Load Combinations including algebraic, absolute and SRSS combination schemes.

Finite Element Capabilities:

- Accurate and numerically Efficient Plate/Shell Element incorporating out-of-plane shear and in-plane rotation.
- Automatic Element Mesh Generation.
- Comprehensive Element Stress Output including in-plane stresses, out-of-plane shear, bending and principal stresses at nodal as well as user specified points.

Steel Design:

- Built-in steel tables including AISC, Australian, British, Canadian, Chinese, European, Indian, Japanese, Korean, Russian, and South African. Shapes include I-

Beam with or without cover plates, Channels, Angles, Double Angles,/Channels, Pipes and Tubes.

- User-specified Design Parameters to customize design.
- Code Check, Member selection and Optimized Member Selection consisting of Analysis/Design cycles.
- Design codes include AISC (ASD and LRFD), AASHTO. Optional codes include ASCE52, BS5950, Canadian, Chinese, French, German, Japanese, Indian and Scandinavian.
- Weld design for all steel shapes.

Concrete Design:

- Design of Concrete Beam/Column/Slab/Footing as per all major international codes.
- Numerical and Graphical Design outputs with complete reinforcement details.
- IS 456-2000 for RCC design implemented.
- RC detailer as per IS 456-2000 has been implemented which has given a new dimension to RCC design never witnessed in STAAD before.

Result Verification:

- Result verification and display.
- Deflected and Mode Shapes based on Joint/Section Displacement for user-specified loading or mode shape number.
- Bending Moment and Shear force diagrams of individual members as well as the entire structures.
- User-controlled Scale factors for Deflected or Mode shapes.
- Force/Moment Envelope Plots as max/min for all loads.
- Stress contour plots.
- Code Performance Plots for Steel Design.
- Powerful on-line Query for analysis/design results.

- Animation of Deflected/Mode shapes, Stress Contours.

Special Features: Query and Report Generator:

- These powerful graphics based facilities provide on-screen result verification and customized report generation. User-friendly navigation and organization of data helps you get the information you need with a few simple clicks.
- Point and click on a member to obtain all the information on its Geometry, Cross-sectional properties, Forces, etc. even design information such as Allowable Stresses, Governing Code Criteria, Reinforcement layout are available.

CHAPTER -7

STRUCTURAL DESIGN

Design of Multistoried Residential Building

General:

A structure can be defined as a body, which can resist the applied loads without appreciable deformations. Civil engineering structures are created to serve some specific like, Human habitation, transportation, bridges, storage etc. in safe and economical way.

A structure is assembling of individual elements like pinned elements (truss elements), beam elements, column, shear wall slab and arch. Structural engineering is concerned with the planning, designing and the construction of structures.

Structural analysis involves the determination of the forces and displacements of the structures or components of a structure that make up the structural system.

The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.

The objectives of the design are,

I. Slab Design.

- II. Beam Design.
- III. column Design.
- IV. Foundation Design.

Foundation Design

Foundations are the structure elements that transfer loads from buildings or individual column to earth this loads are to be properly transmitted foundations must be designed to prevent excessive settlement are rotation to minimize differential settlements and to provide adequate safety isolated footings for the multistoried buildings. These may be square rectangle or circular in plan that the choice of types of foundation to be used in a given situation depends on a number of factors.

1. Bearing capacity of soil.
2. Types of structure.
3. Types of loads.
4. Permissible differential settlements.
5. Economy.

Column Design

A column may be defined as an element used primarily to support axial compressive loads and with a height of at least three times its lateral dimensions. The strength of column depends up on the strength of material, shape and size of cross section length and degree of proportional and dedicational restrains at the ends.

1. Shape of cross section.
2. Slenderness ratio ($A=L+D$)
3. Type of loading, land.
4. Pattern of lateral reinforcement.

The ration of effective coloumn length to least lateral dimension is released to as slenderness ratio.

Beam Design

A reinforced concrete beam should be able to resist tensile, compressive and shear stress induced in it by loads on the beam.

There are three types of reinforced concrete beams.

1. Single reinforced beams.
2. Double reinforced concrete.
3. Flanged beams

Slab Design

A slab is a thin flexural member used in floor and roofs of structure to carry loads,, which are usually supported by wall or beams along its edges. Slabs are plate elements forming floor and roofs of buildings carrying distributed loads primarily by flexure.

One- Way Slab

One-way slabs are those in which the length is more than twice the breadth it can be simply supported beam or continuous beam.

Two-Way Slab

When the slab is supported on four edges and aspect ratio(L_y/L_x) <2 the slabs are designed as two way slabs. When slabs are supported to four sides two wayspanning action occurs.

In two way slabs when loaded it bends in surface along both short and long span direction causing bending moments in both direction.

Corners held down and bending moments coefficient obtained from table 26 of IS 456-2000. In slabs M25 grade concrete and Fe415 grade steel is used.

Design of Slabs

Using M20 grade concrete

Fe415 Grade steel

Support width = 230mm

Span $L_x = 3.755\text{m}$

Longer Span $L_y = 4.53\text{m}$

Two adjacent edges discontinuous

$L_y/L_x = 1.21 < 2$

It is Two-way slab

Assume overall depth = 120mm

Effective depth = 100 mm

Design loads per m^2 of slab

$$\text{Dead load of slab} = (0.115 \times 1 \times 25) = 2.8875 \text{ KN/m}^2$$

$$\text{Live load} = 2.00 \text{ KN/m}^2$$

$$\text{Floor finish} = \underline{1.00 \text{ KN/m}^2}$$

$$\text{Factored load} = 6 \times 1.5 = 9 \text{ KN/m}^2 = \underline{6.00 \text{ KN/m}^2}$$

Bending Moment Calculations:

From pg. 91 table 26 IS 456-2000

Positive Coefficients

$$\alpha_x = 0.057$$

$$\alpha_y = 0.035$$

B.M in shorter direction

(-ve) B.M at continuous support

$$M_x = \alpha_x w l^2$$

$$= 0.057 \times 8.81 \times \alpha_y = 8.12 \text{ KN-m}$$

B.M in longer direction

(-ve) B.M at continuous support

$$M_y = \alpha_y w l^2$$

Negative Coefficients

$$\alpha_x = 0.077$$

$$\alpha_y = 0.047$$

$$= 0.047 \times 8.81 \times \boxed{} = 4.69 \text{ KN-m}$$

(+ve) B.M at mid span

$$\boxed{} = \boxed{} w \boxed{}$$

$$= 0.035 \times 8.81 \times \boxed{} = 3.69 \text{ KN-m}$$

Design Bending Moment = 8.12 KN-m

Check for effective depth

$$d = \boxed{}$$

$$= \boxed{} = 54.24 < 100 \text{ mm}$$

Calculation of Area of steel

Minimum $\boxed{}$ as per IS 456:2000

$$\boxed{} = \boxed{} \rightarrow A_{\boxed{}} = \boxed{}$$

$$A_{\boxed{}} = \boxed{} = 204.81 \boxed{}$$

(-ve) Reinforced along continuous support of short span

$$\boxed{} = 0.5 \boxed{} [1 - \boxed{}] bd$$

$$\boxed{} = 0.5 \boxed{} [1 - \boxed{}] 1000 \times 100$$

$$= 236.63 \boxed{}$$

Spacing of 8 mm Ø bars


$$S = \boxed{} \times 1000 \rightarrow \boxed{} \times 1000 = 212.39 = 210 \text{ mm c/c}$$

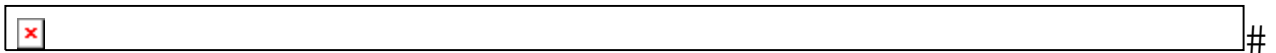
Spacing should be letter of

1. $3d = 3 \times 95 = 285 \text{ mm}$
2. 300 mm
3. Spacing calculated = 210 mm

Provide $8 \text{ mm } \emptyset$ bars @ 210 mm c/c

Bent alternate bars at  from the support @ 

Provide extra bars (top) at 400 mm c/c  from the support.



$$\boxed{} = 0.5 \boxed{} [1 - \boxed{}] 1000 \times 100$$

$$= 141.31 \boxed{} \boxed{}$$

Provide $\boxed{} = 204.81 \boxed{}$

Provide $8 \text{ mm } \emptyset$ bars @ 245 mm c/c

Check for shear

Shear force = $\boxed{} = \boxed{} = 15.24 \times \boxed{} \text{ N}$

Nominal shear stress $(\boxed{}) = \boxed{}$

$$\tau_v = \boxed{} = 0.16 \text{ N/mm}^2$$

$$\text{Percentage of steel} = \boxed{} \times 100$$

$$= \boxed{} \times 100 = 0.26$$

From IS 456:2000 table-19

$$\text{Permissible shear stress} = \boxed{} = 0.36 \text{ N/mm}^2$$

$\tau_v < \tau_{\text{permissible}}$ Slab is safe in shear.

Check for Deflection

From IS 456:2000 Cl.No:24.1 Pg. No. 39

$L/D = 40 \times 0.8$ (for high strength deformed bars)

$$D = \boxed{}$$

$$D = \boxed{} = 108.12 \text{ mm} < 120 \text{ mm safe}$$

Design of One – Way Slab

One-way slab = $\boxed{}$

Size = 9.20 x 3.81 m

$$\boxed{} = \boxed{} = 2.36$$

It is a one-way slab.

Factored load = 8.81 KN

Bending Moment

$$B.M = \boxed{} = \boxed{} = 15.99 \text{ KN} \boxed{}$$

Depth from moment consideration

$$d = \boxed{}$$

$$d = \boxed{} = 76.11 \text{ mm}$$

Depth from stiffness consideration

$$D = \boxed{} = 119.0 \text{ mm} \boxed{} 120 \text{ mm}$$

$$d = 120 - 20 = 100 \text{ mm.}$$

Calculation of area of steel

$$\boxed{} = 0.5 \boxed{} [1 - \boxed{}] 1000 \times 100$$

$$= 382.24 \text{ m} \boxed{}$$

Spacing of 8 mm Ø bars

$$\boxed{} \times 1000 = 131.48 \boxed{} 130 \text{ mm c/c}$$

Provide 8 mm Ø @ 120 mm c/c

Transverse reinforcement

$$A_{st} = 0.15\% \text{ of BD}$$

$$= \boxed{180} \times 1000 \times 120 = 180 \text{ m} \boxed{180}$$

Spacing of 8 mm \varnothing bars

$$A \boxed{157} \times 1000 = 157.00 \boxed{157} \text{ mm c/c}$$

Spacing should be lesser of

1. $5d = 5 \times 100 = 500 \text{ mm}$
2. 450 mm
3. 155 mm

Provide 6 mm \varnothing @ 155 mm c/c

Check for shear

$$\text{Shear force} = \boxed{16.78} = 16.78 \text{ KN}$$

$$\text{Nominal shear stress } (\boxed{0.16}) = \boxed{0.16} = \boxed{0.16} = 0.16 \text{ N/m} \boxed{0.16}$$

$$\text{Percentage of steel} = \boxed{0.38} \times 100 = 0.38$$

$$\text{From code IS 456 table-19} \rightarrow \boxed{0.39} = 0.39 \text{ N/m} \boxed{0.39} < \boxed{0.39}$$

Slab is safe in shear.

Loads for Residential Buildings

Loads are primary consideration in any buildings design because they define the nature and magnitude of hazards or external forces that a building must resist to provide reasonable performance (i.e.; safety and serviceability) throughout the structure's useful life.

The anticipated loads are influenced by a building's intended use (occupancy and function), configuration (shape and size) and location (climate and site conditions). Ultimately, the type and magnitude of the design loads affect critical decisions such as the material selection, construction details, and architectural configuration.

Thus to optimize the value (i.e. performance versus economy) of the finished product, it is essential to apply design loads realistically. While the building consider in this guide are primary single-family detached and attached dwellings, the principles and concepts related to building loads also apply to other similar types of construction, such as low-rise apartment's buildings.

In general, the design loads recommended in this guide are based on:

1. Dead load.
2. Live load.
3. Imposed loads.

Dead Loads

This is the permanent of the stationary load like self weight of the structural elements.

This include the following

- a) Self-weight
- b) Weight of the finished structure part.
- c) Weight of partition walls etc.

Dead loads are based upon the unit weights of elements, which are established taking in account materials specified for construction, given IS 1911-1967

Dead loads consists of the permanent construction material loads compressing the roof, floor, wall, and foundation system, including claddings finishes and fixed equipment. Dead load is the total load of all of the components of the building that generally do not change over time, such as the steel columns, concrete floors, bricks, roofing material etc.

Live loads

These loads are not permanent or moving loads. The following loads includes in this type of loading: imposed loads(fixed) weight of the fixed seating in auditoriums, fixed machinery, partition walls these loads through fixed in positions cannot be relieved upon to act permanently throughout the life of the structure.

Imposed loads (not fixed) these loads change either in magnitude or position very often such as the traffic loads, weight of the furniture etc.

Live loads are produced by the use occupancy of the building. Loads include those from human occupants, furnishings, no fixed equipment, storage, and constriction and maintenance activities. As required to adequately define the loading condition, loads are presented in terms of uniform are loads, concentrated loads, and uniform line loads.

Imposed loads:

Loads produced by intended use occupancy of a building including the weight movable portions distributed concentrated loads and loads that vibration and impact called imposed loads estimated by IS 456-2000.

ANALYSIS BY USING STAAD PRO.

The building frame has five storeys. Concrete mix design of grade M25 and HYSD Fe415 for all the member of the structure.

Total dead load on slab=3.8 KN/M² Total live
on slab =2KN/M²

The structural plan has drawn using AUTOCAD, which later imported to STAAD. Pro for analysis is presented.

The STAAD program for the multi storey building is as follow.

STAAD SPACE START JOB

INFORMATION END JOB INFORMATION

INPUT WIDTH 79 UNIT METERR KN

JOINT COORDINATES

1 0 ; 2 3.1623 0 0; 3 8.9916 0 0; 4 11.2014 0 0; 5 15.0495 0 0 6 18.9357 0 0; 7
22.479 0 0; 8 15.0495 0 0.9144; 9 18.9357 0 0.9144 10 18.9357 0 4.3815; 11
22.479 0 4.3815; 12 0 0 6.8199; 13 3.1623 0 6.8199 14 5.8293 0 6.8199; 15 8.9916 0 6.8199;
16 11.2014 0 7.84867 15.0495 0 7.8486; 18 18.9357 0 7.8486; 19 22.479 0 7.8486; 20 0 0
9.982221 3.1623 0 9.9822; 22 8.9916 0 9.9822; 23 11.2014 0 9.982224 15.0495 0 9.9822; 25
18.9357 0 9.9822; 26 22.479 0

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388 362 1129 422 421 402 403; 1130 416 423 422 415; 1131 417 424 423 4161132 418 425 424
417; 1133 420 429 428 419; 1134 421 430 429 420 1135 422 448 447 421

ELEMENT PROPERTY

940 TO 1053 1063 1071 TO 1077 1101 TO 1135 THICKNESS 0.12

DEFINE MATERIAL START

ISOTROPIC CONCRETE

E 2.17185E+007

POISSON 0.17

DENSITY 23.5616

ALPHA IE-005

DAMP 0.05

END DEFINE MATERIAL

MEMBER PROPERTY AMERICAN

/

1 TO 79 130 TO 139 141 TO 152 154 TO 214 265 TO 274 276 TO 287 289 TO 349 -400 TO
409 411 TO 422 424 TO 484 535 TO 544 546 TO 557 559 TO 619 - 670 TO 679 681 TO 692
694 TO 754 805 TO 814 816 TO 827 829 TO 889 -1055 TO 1058 1078 1080 1082 1084 1086

1088 1090 1092 TO 1100 1136 TO 1230 - 1231 PRIS YD 0.3 ZD 0.480 TO 129 215 TO 264
350 TO 399 485 TO 534 620 TO 669 755 TO 804 890 TO 939 -1054 1059 TO 1062 1064 TO
1067 1069 1070 PRIS YD 0.45 ZD 0.45

CONSTANTS

MATERIAL CONCRETE ALL

SUPPORTS 55 TO 104 465 FIXED

DEFINE WIND LOAD TYPE 1

INT 0.001 HEIG 24

LOAD 1 LOADTYPE DEAD TITLE SELF WEIGHT

SELFWEIGHT Y -1

LOAD 2 LOADTYPE DEAD TITLE MEMBER LOAD MEMBER

LOAD

1 24 6TO 16 18 TO 26 28 29 31 33 TO 38 40 TO 44 46 TO 50 52 TO 55 -57 TO 61 63 TO 70
72 73 75 76 78 79 130 131 133 135 TO 139 141 TO 152 154 -155 157 158 160 161 163 166 TO
182 190 TO 210 214 265 266 268 270 TO 274 -276 TO 287 289 290 292 293 295 296 298 301
TO 317 325 TO 345 349 400 401 -403 405 TO 409 411 TO 422 424 425 427 428 430 431 433
436 TO 452 460 TO 480 - 484 535 536 538 540 TO 544 546 TO 557 559 560 562 563 565 566
568 -571 TO 587 595 TO 615 619 670 671 673 675 TO 679 681 TO 692 694 695 697 698 -700
701 703 706 TO 722 730 TO 750 754 821 824 829 865 868 1055 TO 1058 1078 - 1080 1082
1084 1086 1088 1090 1092 1136 TO 1143 1152 TO 1159 1168 TO 1175 -1184 TO 1191 1200

TO 1207 1216 TO 1223 UNI GY -1227 156 291 426 561 696 UNI GY -65 32 74 134 159 165
211 TO 213 252 269 294 300 346 TO

348 387 404 429 435 -481 TO 483 522 539 564 570 616 TO 618 657 674 699

705 751 TO 753 792 805 -806 TO 810 833 834 837 840 TO 844 853 TO 855 861

862 870 871 875 876 881 883 -884 TO 885 887 888 UNI GY -4

LOAD 3 LOADTYPE ROOF LOAD

FLOOR LOAD

YRANGE 0 16 FLOAD -2 GY

LOAD 4 LOAD TYPE FLOOR LOAD

FLOOR LOAD

YRANGE 16 19 FLOAD -3 GY LOAD 5 LOAD TYPE WIND LOAD WIND LOAD X 1

TYPE 1 WIND LOAD Z 1 TYPE 1 PERFORM ANALYSIS PRINTSTATICS CHE

ORIGINAL/FINAL BAND-WIDTH= 483/ 70/ 426 DOF

TOTAL PRIMARY LOAD CASES = 5, TOTAL DEGREES OF FREEDOM -

SIZE OF STIFFNESS MATRIX = 1166 DOUBLE KILO-WORDS REQD/AVAIL. DISK
SPACE = 27.2/ 57202.0 MB

STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO. 1 LOADTYPE
DEAD TITLE SELF WEIGHT

***TOTAL APPLIED LOAD (KN METER) SUMMARY (LOADING 1) SUMMATION
FORCE-X = 0.00 SUMMATION FORCE-Y = -18573.12 SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-

$M_x = 199928.68$ $M_y = 0.00$ $M_z = -200709.68$

**TOTAL REACTION LOAD (KN METER) SUMMARY (LOADING 1)

SUMMATION FORCE-X = 0.00

SUMMATION FORCE-Y = 18573.12

SUMMATION FORCE-Z - 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-

$M_x = -199928.67$

$M_y = 0.00$

$M_z = 200709.68$

MAXIMUM DISPLACEMENTS (CM /RADIANS) (LOADING 1)

MAXIMUMS AT NODE

$X = 2.99097E-02$ 451

22.486= $-2.56605E-01$ 450

$Z = -7.4606$ IE-02 462

$RX = 8.75701E-04$ 450

$RY = 2.50279E-05$ 443

$RZ = -2.57029E-04$ 506

STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO. LOADTYPE

DEAD TITLE MEMBER LOAD

***TOTAL APPLIED LOAD (KN METER) SUMMARY (LOADING 2) SUMMATION

FORCE-X = 0.00 SUMMATION FORCE-Y = -18938.73 SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-

$M_x = 203808.62$

$M_y = 0.00$

$M_z = -202029.82$

*TOTAL REACTION LOAD (KN METER) SUMMARY (LOADING 2) SUMMATION
FORCE-X = 0.00 SUMMATION FORCE-Y = 18938.73 SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN- $M_x = -203808.62$ $M_y = 0.00$ $M_z =$
202029.82

STAADSPACE

MAXIMUM DISPLACEMENTS (CM /RADIANS) (LOADING 2)

MAXIMUMS AT NODE

X = 5.16893E-02 451

Y = -1.77420E-01 404

Z = -7.25395E-02 410

RX = -5.50874E-04 6

RY = 3.95189E-05 443

RZ = -4.23797E-04 507

STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO. LOADTYPE

ROOF LIVE TITLE ROOF LOAD

***TOTAL APPLIED LOAD (KN METER) SUMMARY (LOADING 3)

SUMMATION FORCE-X = 0.00

SUMMATION FORCE-Y = -5533.48

SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN-

$M_x = 57168.13$

$M_y = 0.00$

$M_z = -59584.70$

***TOTAL REACTION LOAD(KN METER) SUMMARY (LOADING 3) SUMMATION

FORCE-X = 0.00 SUMMATION FORCE-Y = 5533.48 SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN- $M_x = -57168.13$ $M_y = 0.00$ $M_z = 59584.70$

MAXIMUM DISPLACEMENTS (CM /RADIANS) (LOADING 3)

MAXIMUMS AT NODE X=

2.26720E-02 451 Y = -

5.67172E-02 391 Z =-1.79116E-
02 460 RX= 2.69493E-04 45
RY= 1.39599E-05 443 RZ=
1.56836E-04 45

STATICLOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO. LOADTYPE
ROOF LIVE TITLE FLOOR LOAD

***TOTAL APPLIED LOAD (KN METER) SUMMARY (LOADING 4) SUMMATION
FORCE-X = 0.00 SUMMATION FORCE-Y = -1383.87 SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN- $M_x = 14300.99$ $M_y = 0.00$ $M_z = -$
14905.93

STAADSPACE

TOTAL REACTION LOAD (KN METER) SUMMARY (LOADING 4) SUMMATION
FORCE-X = 0.00 SUMMATION FORCE-Y = 1383.87 SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN- $M_x = -14300.99$ $M_y = 0.00$ $M_z =$
14905.93s

MAXIMUM DISPLACEMENTS (CM /RADIANS) (LOADING 4) MAXIMUMS AT
NODE X= 1.16754E-02 460 Y = -4.89477E-02 450

STATICLOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO. LOADTYPE
ROOF LIVE TITLE FLOOR LOAD

***TOTAL APPLIED LOAD (KN METER) SUMMARY (LOADING 4) SUMMATION
FORCE-X = 0.00 SUMMATION FORCE-Y = -1383.87 SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN- $M_x = 14300.99$ $M_y = 0.00$ $M_z = -14905.93$

STAADSPACE

TOTAL REACTION LOAD (KN METER) SUMMARY (LOADING 4) SUMMATION
FORCE-X = 0.00 SUMMATION FORCE-Y = 1383.87 SUMMATION FORCE-Z = 0.00

SUMMATION OF MOMENTS AROUND THE ORIGIN- $M_x = -14300.99$ $M_y = 0.00$ $M_z = 14905.93$

MAXIMUM DISPLACEMENTS (CM /RADIANS) (LOADING 4) MAXIMUMS AT
NODE X= 1.16754E-02 460 Y = -4.89477E-02 450

Z = -7.71392E-03 458 RX=
4.02223E-04 401 RZ= 2.19684E-04
430

STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO. LOADTYPE
WIND TITLE WIND LOAD

TOTAL APPLIED LOAD (KN METER) SUMMARY (LOADING 5)

SUMMATION FORCE-X = 0.47

SUMMATION FORCE-Y = 0.00

SUMMATION FORCE-Z = 0.47

SUMMATION OF MOMENTS AROUND THE ORIGIN-

$M_x = 3.54$

$M_y = -0.11$

$M_z = -3.50$

TOTAL REACTION LOAD(KN METER) SUMMARY (LOADING 5) SUMMATION
FORCE-X = -0.47 SUMMATION FORCE-Y = 0.00 SUMMATION FORCE-Z = -0.47

SUMMATION OF MOMENTS AROUND THE ORIGIN-

$M_x = -3.54$

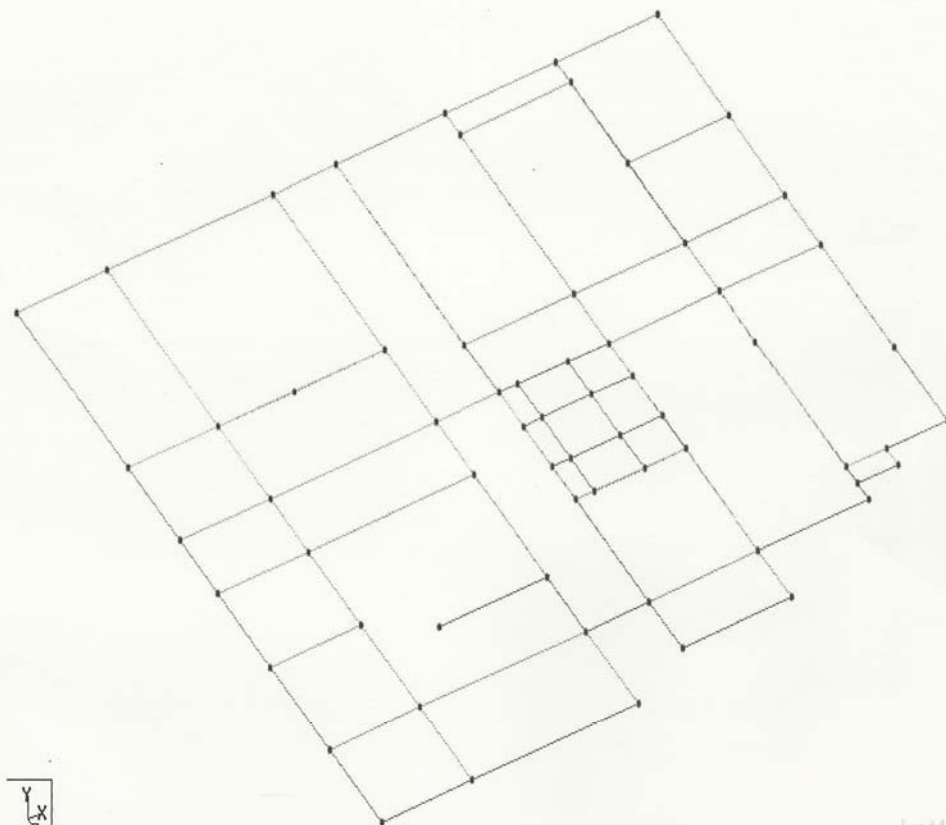
$M_y = 0.11$

$M_z = 3.50$

MAXIMUMDISPLACEMES(CM /RADIANS) (LOADING 5)

MAXIMUMS AT NODE X =

	5 WIND	-	BER	2	2 MEMBER	2	MEMBER
	LOAD		LOAD	LOAD	LOAD	LOAD	LOAD
74 +ve	0	494.049	0.011	2.157	0.067		55.117



Load 1

TYPICAL GRID VIEW

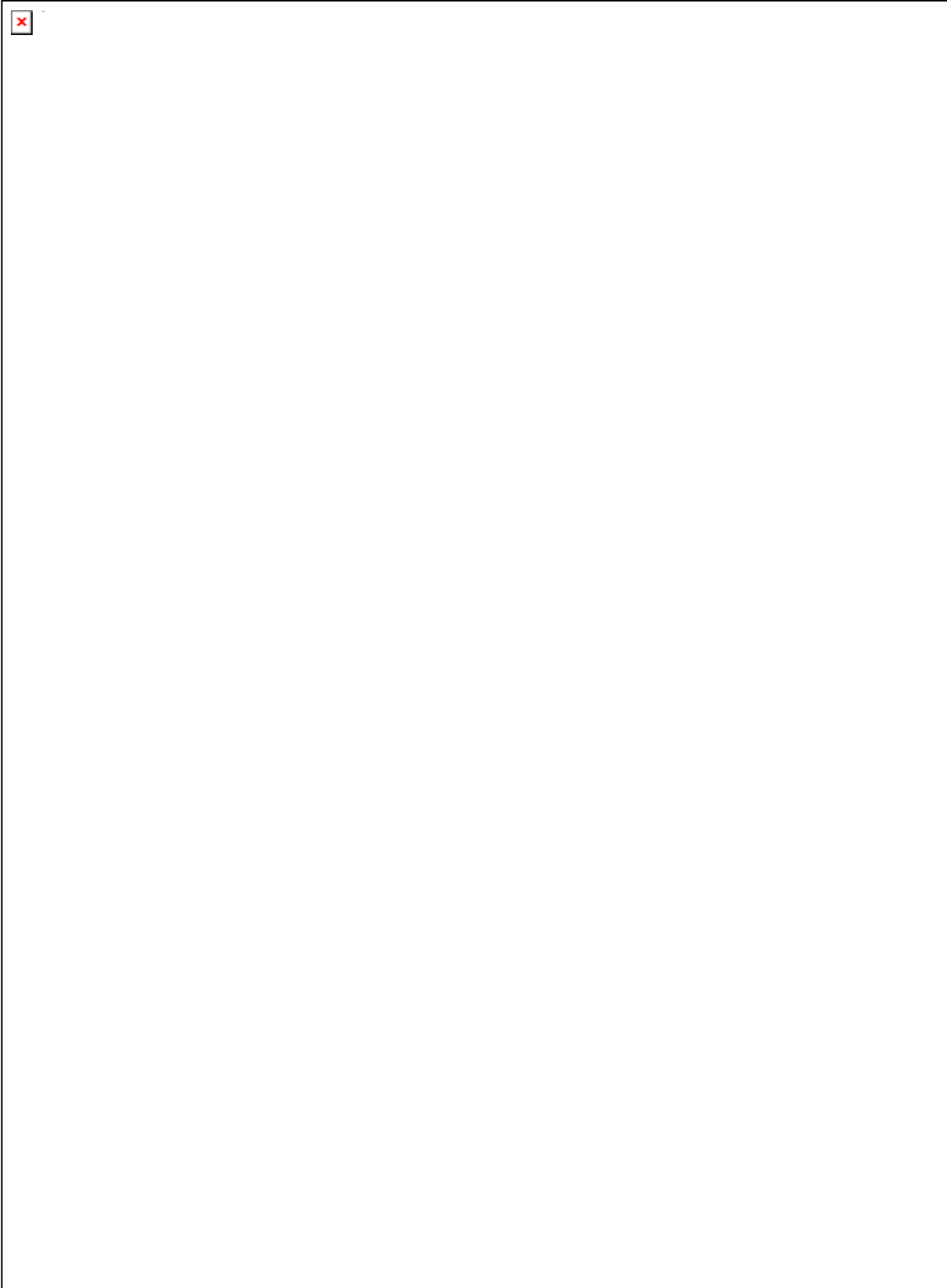


Fig 04.

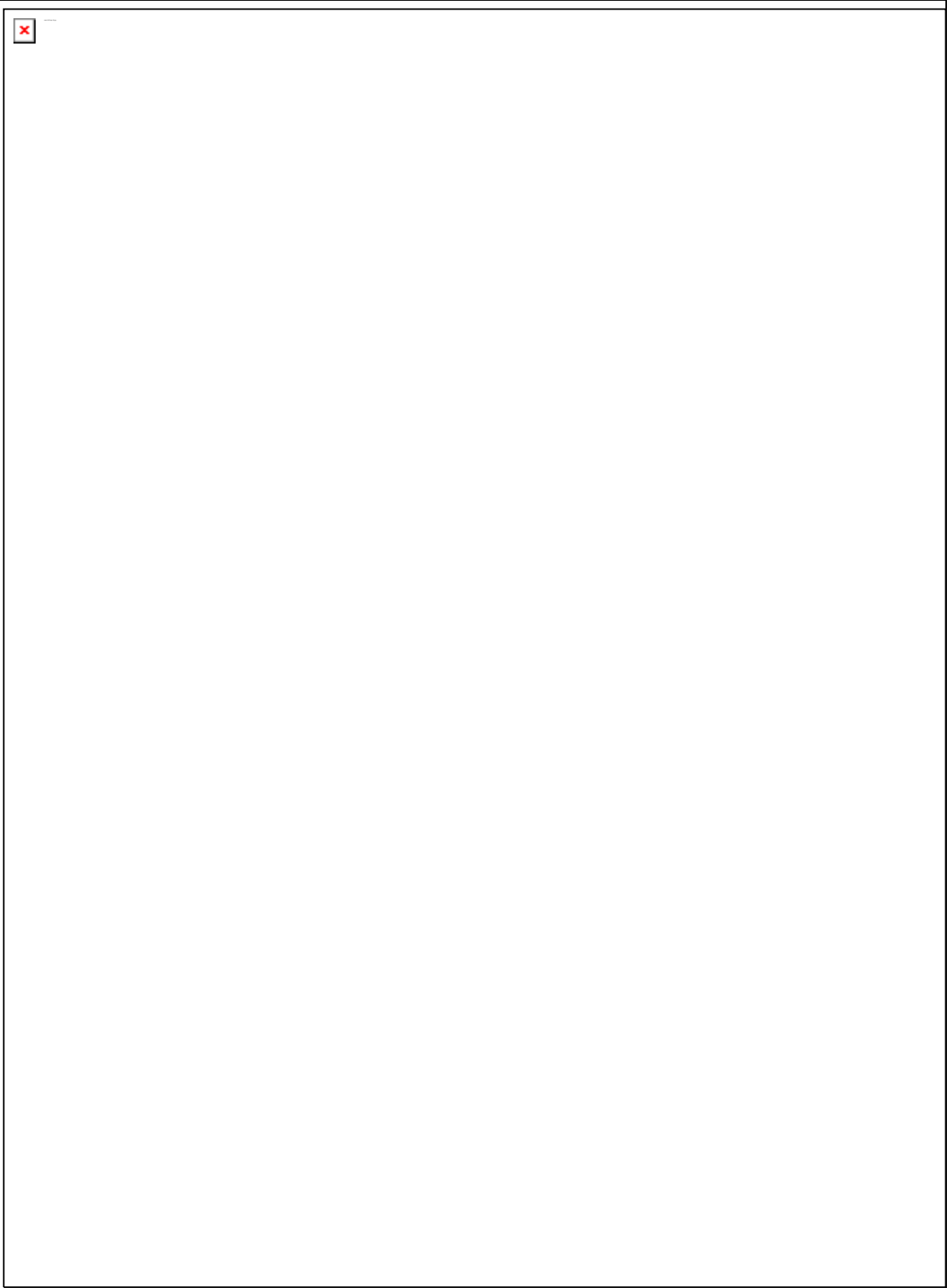


Fig 05



Fig 06.



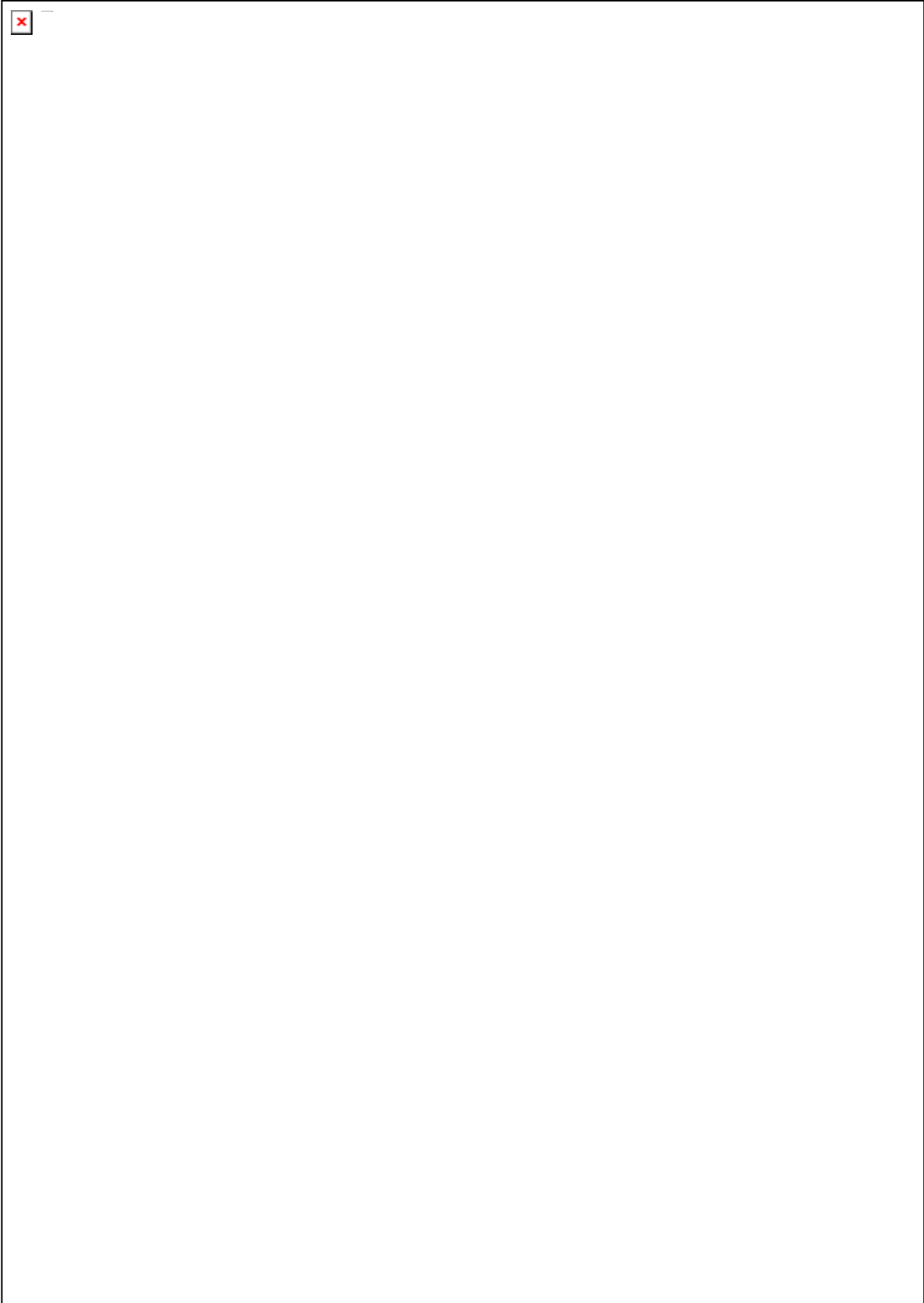
Fig 07.



Fig 08.







**POST PROCESSING
OF
STRUCTURE**





**POST PROCESSING
OF
MEMBERS COLOUMS
AND BEAMS**







ANALYSIS OF LOADING ON SLAB

















Fig 23.

CHAPTER -10

FOOTINGS

DESIGN OF FOOTING

Design of footing under column 'K'

Factored load on column $\square = 1090.1 \text{ KN}$

Size of column -230x450mm

SBC of soil (Hard Morram) is 300 per code *for working load*

Self weight of footing = 10% of $\square =$
 $= 0.1 \times 1090.1 = 09.01 \text{ KN}$

Area footing = \square
 $= [1090.1 + 09.01] / 300 = 4 \text{ m}^2$

Provide a square footing of size = 1.5m x 2.7m

Net upward pressure intensity = $1090.1 / [1.5 \times 2.7] = 269.14 \text{ KN/m}^2$

Design of flexure:

Critical section occurs at the face of column

$$L = (2.7 - 0.45) / 2 = 1.125$$

$$\square = \square = (269.14 \times 1.5 \times 1.125 \times 1.125) = 510.92 \text{ KN M}$$

$$L_u = (1.5 - 0.23) / 2 = 0.635 \text{ m}$$

$$\square = (1.5 \times 269.14 \times 0.635 \times 0.635) / 2 = 81.39 \text{ KN.M}$$

Depth of footing:

$$D = [510.95 \times 10^6 / 2.3 \times 1000]^{0.5} = 430 \text{ mm}$$

Increase depth to account for shear

Taking $d = 700\text{mm}$

Slope height = 300

Flat height = 300mm

Check for One –Way shear

Critical shear force occurs at a distance of 'd' from face of the column

$$X = [2.7 - 4.45]/2 - 0.7 = 0.425$$

$$\text{Shear force } V = 0.425 \times 1.5 \times 269.4 = 257.6 \text{ KN}$$

Nominal shear stress

$$\tau_v = 257600 / [1500 \times 408] = 0.42 \text{ N/mm}^2$$

For 0.46% of steel τ_{cr} from IS456:2000 table- 19

Permissible shear stress (τ_{cr}) = $K\tau_v$ where $K=1$

$$= 1 \times 0.47 = 0.47\text{N/mm}^2$$

$\tau_v < \tau_{cr}$ Footing is safe in shear

Check for Two- way shear

Critical shear occurs at a distance of $d/2$ from face of the column

$$\text{Nominal shear stress} = \tau_v$$

$$\text{Shear force} = 1090.1 - [1.15 \times 0.93 \times 269.1] = 802.29 \text{ KN}$$

$$\tau_c = 802290 / [2(1.15 - 0.93) \times 1000 \times 530] = 0.36 \text{ N/mm}^2$$

Permissible shear stress $\tau_c^1 = k \tau_c$

Where $K = 0.5 + \beta = 0.5 + (0.23/0.45) = 1.11 > 1$ from IS456:2000

$$\tau_c^1 = 0.25 \sqrt{f_{ck}} = 0.25 \sqrt{20} = 1.11 \text{ N/mm}^2$$

$\tau_c^1 > k \tau_c \rightarrow$ Safe

Calculations of Area of steel

$$A_s = 0.5 [1 - \sqrt{1 - \frac{f_{yk}}{f_{ck}}}] b d$$

$$= 2534.457 \text{ mm}^2$$

Using 18 mm bars @ 90 mm c/c

$$A_s = 403.35 \text{ mm}^2$$

Using 10 mm ϕ bars

$$\text{Spacing of bar} = 78.5 \times 1000 / 403.3 = 190 \text{ mm c/c}$$

Provide 300 mm thickness at the edge of footing

CHAPTER 11

STAIR CASE

DESIGN OF STAIR CASE

Vertical Distance between floors = 3000mm

Providing Dog-legged stair case

General arrangements

Width of landing = 2500mm

Height of rise	=150mm
Width of landing	=2.00m
Width of flight	=105m
Height of flight	=125mm
No. of rises in each flight	= (1500/150)=10
No. of treads in each flight	= 10-19 no'

Load Calculations

D.L of waist slab	= 1066x 1x 1.025 x 25 = 3.625
Steps	= 0.5 x 0.78 x 0.15 x 25 = 1.837
Floor finish load	=1.000
Live load	= <u>3.000</u>
Total load =	9.462 KN/m ²

Bending Moment Calculations:

Factored load = 9.75 x 1.5 = 14.9 KN/m²

Effective length = 4.3m

Moment at the ends

$B.M = \boxed{\times} = \boxed{\times} = 21.86 \text{KN/m}^2$

Moment at the center

$$\text{B.M} = \boxed{\times} = \boxed{\times} = 10.93 \text{ KN/m}^2$$

Check for depth:

$$\sqrt{M/2.76 \times 1000}$$

$$= \sqrt{21.86 \times 10 / 2.76 \times 1000} = 88.99 < 125 \text{ mm safe}$$

Check for depth from deflection consideration

$$l/d = 32$$

$$\rightarrow d = 1000 / 32 = 21.25 < 125 \text{ m}$$

Area of steel:

$$\begin{aligned} A_{\text{stend}} &= \frac{22.34 \times 10}{0.87 \times 425 \times (125 - 0.42 \times 0.48 \times 125)} \\ &= 531.58 \text{ mm}^2 \end{aligned}$$

Using 10mm \emptyset bar

$$\text{Spacing of bars} = \frac{78.53}{531.58} \times 1000 = 147.7 - 145 \text{ mm}$$

Provide 10 mm \emptyset bars @ 145mm c/c

Distribution Reinforcement:

$$=0.15 B.D$$

$$= \frac{0.15 \times 1000 \times 125}{100} = 187.5 \text{ mm}^2$$

Using 6mm \emptyset bars @ 150 mm c/c

CONCLUSIONS

Staad Pro software has become more and more critical in the analysis of engineering and scientific problems. Much of the reason for this change from manual methods has been the advancement of computer techniques development by the research community and in particular universities.

As technology and engineering adoptions are advertising new methodology of interlinking and completing the industries via computer applications are created with a similar improvement in hardware capacities. This in turn facilitates the implementations of more effective and professional engineering software. As the applications adventure in functionality, one can hope that they will be more affordable to promote their widespread usage amongst civil engineering at a global scale.

Taking into account the technological advance, this project has been dealt with using the latest design software.

References

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2. IS: 875(part – 3)- 1987 code of practice for design loads for building and structures.
3. SP: 16 designs for reinforce concrete.
4. AUTO CAD & STAAD PRO- 2007
5. Reinforcement concrete design by N.KRISHNA RAJU & R.N.PRANESH
6. Design of reinforced concrete structure by S.RAMAMURTHAM.

