Design And Analysis of The Behavior of Reinforced Concrete Slab

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Abstract- *This study compares the thermal performance of conventional slabs and flat slabs in building construction. Using advanced thermal analysis software, we simulated various environmental conditions and assessed indoor comfort and energy consumption. The flat slab system generally outperformed the conventional slab, showing reduced heat gain, more uniform temperature distribution, and lower cooling energy requirements. This suggests potential energy savings and improved efficiency. Consideration of insulation materials can further enhance performance. These findings inform architects and engineers in choosing structural systems for better thermal performance in buildings, with scope for future research on insulation materials and design variations.*

Keywords- Thermal analysis reinforced concrete slabs, flat slabs, heat transfer, thermal insulation, temperature distribution.

I. INTRODUCTION

In terms of energy efficiency and thermal comfort, thermal analysis is indispensable for the design and evaluation of conventional and flat surfaces. The thermal analysis of conventional and flat slabs requires the evaluation of heat transfer mechanisms, thermal insulation properties, and temperature distribution within these structural elements. It takes into account a number of variables, including external climatic conditions, solar radiation, internal heat accumulation, and thermal properties of the employed materials. Standard and flat slabs are extensively utilised structural systems in contemporary construction. Unlike conventional slabs, which are horizontal structural elements supported by beams or columns, flat slabs are distinguished by their simplicity, lack of beams, and direct contact with their supports. Both systems are subject to thermal loading imposed by external temperature fluctuations, solar radiation, and internal heat sources. It is necessary to analyse their thermal performance in order to assess their behaviour in various climatic conditions.

Thermal analysis of conventional slabs and flat slabs involves the investigation of heat transfer mechanisms, temperature distribution, and the impact of a number of factors on thermal behaviour. Insulation materials, surface coatings, thickness, and environmental conditions have a substantial effect on their thermal performance. By understanding these factors and their effects, it is possible to maximise the design and construction of slabs so as to minimise energy consumption, reduce thermal bridging, and create thermally comfortable interior environments.

Conventional and flat slabs are subject to a range of thermal loads, including external temperature fluctuations and solar radiation. Thermal analysis helps determine how these surfaces respond to conduction, convection, and radiation heat transfer. By understanding these heat transfer mechanisms, engineers and designers can identify potential areas of heat loss or gain, thereby enabling the implementation of energy-saving strategies.

1.1 Thermal Analysis

Thermal analysis is a technique used to examine the response of materials and systems to changes in temperature. It involves analysing heat transfer, temperature distribution, and thermal properties to determine how materials and systems react to thermal demands.

Thermal analysis is used for several reasons across various industries and fields. Here are some key reasons why thermal analysis is employed:

a) Understanding Material Behavior: Thermal analysis aids the study of how materials respond to temperature variations. It explains thermal properties such as specific heat capacity, thermal conductivity, thermal expansion, phase transitions, and thermal stability. This comprehension is essential for material selection, performance evaluation, and quality management.

b) Design and Optimization: Thermal analysis aids in the design and optimization of systems and structures. By analyzing heat transfer, temperature distribution, and thermal behavior, engineers can optimize the design of components, ensure proper insulation, and enhance energy efficiency. It helps identify areas prone to excessive heating or cooling, leading to improved system performance and reduced energy consumption.

c) Product Development: The use of thermal analysis in the creation of novel products and materials is advantageous. It permits the evaluation of thermal performance, thermal compatibility, and thermal stability of products under different temperature conditions. This ensures that products function effectively and meet performance specifications.

d) Safety Evaluation: Thermal analysis is an essential component of safety evaluation. By analysing the thermal behaviour of materials and systems, it is possible to identify and mitigate potential dangers, such as fire risks. It helps determine the response of materials to high temperatures and permits the design of fire-resistant materials and structures.

e) Process Optimization: Thermal analysis is utilised to optimise manufacturing process parameters such as heating or cooling rates, curing periods, and temperature profiles. By comprehending the thermal behaviour of materials during processing, it is possible to increase process efficiency, reduce defects, and maintain product quality consistency.

f) Research and Development: Thermal analysis is utilised extensively in research and development. It aids in the exploration of new materials, the comprehension of their thermal properties, and the investigation of their behaviour under varying temperature conditions. This information is valuable for advancing scientific comprehension, creating innovative technologies, and enhancing existing systems.

g) Quality Control: To ensure the consistency and dependability of materials and products, thermal analysis is used for quality control purposes. By monitoring thermal properties and behaviour, manufacturers can ensure that their products meet specifications, identify any deviations or defects, and maintain quality consistency throughout the production process.

1.2 comparative study of conventional(rcc) slab and flat slab

A comparative analysis of Conventional slabs and Each structural system with flat slabs reveals distinctive characteristics and design considerations. Flat slabs are directly supported by columns or walls without beams, whereas conventional slabs are supported by beams that distribute the load to columns or walls. The implementation of beam formwork increases the construction complexity of conventional slabs, whereas beam formwork is superfluous for flat slabs, resulting in a simplified and speedier construction process. Conventional slabs with columns decrease the clear height between floors and restrict layout flexibility, whereas flat slabs increase the clear height and permit greater design and service installation flexibility. Due to the additional depth of the supports, conventional slabs typically have a higher floor height, whereas flat slabs have a lower floor height, maximising space and possibly reducing the overall building height. Cost-wise, conventional slabs tend to be more expensive due to the additional materials and personnel required for beam formwork, whereas flat slabs can offer cost savings due to simplified formwork and reduced materials. Conventional slabs with columns have a higher load-bearing capacity, making them more appropriate for larger loads or longer spans, whereas flat slabs are better suited for lighter loads or shorter spans. Due to beam-column connections, maintenance and restorations can be more difficult for conventional slabs with beams, whereas horizontal slabs provide easier access and maintenance in general. As there are no pillars to impede with the arrangement or positioning of partitions, flat slabs offer greater architectural flexibility compared to conventional slabs, which may restrict architectural freedom. Conventional slabs with columns are generally more resistant to shear forces than planar slabs, which may require additional shear reinforcement. The choice between a conventional slab and a flat slab depends on project-specific requirements such as span, stresses, architectural design, and construction schedule, which should be meticulously analysed to determine the most suitable structural system.

1.3 Formwork of conventional (rcc) and flat slab

Fig. no. 1 Shuttering of flat slab

The initial formulation of the framework system includes a comprehensive geometric description of the column spacing and overhang. Even though this portion of the design is provided by the architect, the engineer should emphasise the following:

a) Three continuous spans in each direction or have an overhang at least one-forth times adjacent span length in case of only two continuous spans.
b) Typical panel must be rectangular
c) The spans must be similar in length i.e. adjacent span in each direction must not differ in length by one-third

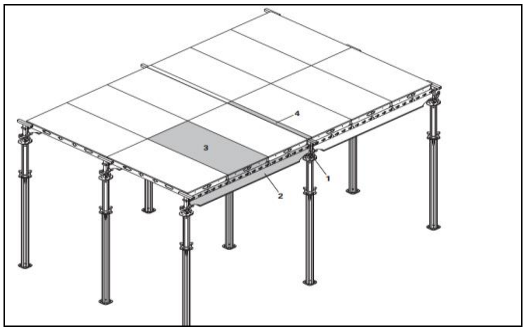


Fig. no.2 Flat slab

Main Components

1. Drop head SFK
2. Main Beam SLT 225
3. Panel SDP
4. Cover Strip SAL

1.4 Aim

To study the thermal performance of Conventional slabs and Flat slabs in order to improve energy efficiency and occupant comfort.

1.5Objective

1. To study the effect of thermal performance of Conventional slabs and Flat slabs in terms of temperature distribution and thermal behavior.
2. To assess the impact of different insulation strategies on the thermal performance of Conventional slabs and Flat slabs.
3. To compare the axial force, bending moment, base shear, time period of Conventional and Flat slab at higher temperature.

1.6Scope of study

In the scope of the study on "Thermal Analysis of Conventional Slab and Flat Slab," my work involves conducting a comprehensive analysis to evaluate the thermal performance of both conventional slabs and flat slabs. This analysis includes studying factors such as heat transfer, thermal conductivity, and thermal insulation properties of the slabs. Also investigate the impact of different construction materials and design parameters on the thermal behavior of these slab types. By comparing and contrasting the thermal characteristics of conventional slabs and flat slabs, this study aims to provide insights into their respective thermal efficiencies and potential energy-saving benefits. The findings of this research can contribute to optimizing building designs and improving energy efficiency in construction projects.

II. REVIEW OF LITERATURE

To comprehend the current status of the undertaking, journals, proceedings, books, and websites, among others, have been consulted. From this literature, the current work is constructed. These are described in the next section.

2.1Literature based on software work

Parvathi Devi A This study seeks to evaluate the effectiveness of thermal analysis of concrete surfaces by incorporating various insulation materials into ANSYS simulations. Using concrete density, regression equations were proposed to predict thermal conductivity. As these simulation and regression analyses are indispensable in the design of thermal insulation concretes with varying densities, they sequentially reduce the associated time, effort, and expense. The thermal analysis simulates the experimental heat transmission across the concrete platform with precision. The obtained regression equations were useful in the design of thermal insulation concrete.

S. Lakshmi kiran Using Etabs, compare the seismic performance of conventional and flat slab systems in commercial buildings of varying heights and zones. These days, flat slab construction is prevalent due to its superior efficacy, low cost, and ease of construction. On the basis of these benefits of flat slab, this project compares grid slab and flat slab with drop panels and is comprised of a double basement, G+5, and G+10 with terrace floors. To determine the seismic efficacy of structures, this study relies heavily on Response spectrum analysis. Analysis were done by dynamic method as per IS: 1893-2016, and all the RCC members were designed as per IS: 456-2000. Load Calculations were performed in accordance with IS: 875 Codes.

Jyoti Makate By varying the temperature from 15oC to 50oC, the present work examined the thermal effect of conventional RC slabs and flat slabs. The response of structural parameters was investigated and contrasted with normal loading (i.e., inert load and active load). Long structures devoid of expansion connections are now required due to the increasing demands of architecture and the current industrial trend. According to the Indian Standard code IS-456:2000, buildings longer than 45m must be analysed for thermal stresses, and the structural system must be fixed with the appropriate measures.

Nyome Tinevaluating the seismic behaviour of an RC structure with a flat slab and a conventional slab on a 16-story, full-scale representative of a high-rise building in various seismic regions. The analysis is performed using ETABS software based on Uniform Building Code 1997 (UBC 97) for environmental loading and American Concrete Institute (ACI 318-99) for design requirements of structural elements. On the structure, a linear dynamic response spectrum analysis will be performed. The seismic behaviour of storey displacement, storey drift, and storey shear for conventional RC frame and pure flat slab has been investigated, and the analytical results in the various seismic zones are being compared.

Faria Aseem The use of rectangular slabs in modern construction has become quite common. Flat-slab building structures have significant advantages over conventional slab-beam-column structures due to the freedom of space design, reduced construction time, architectural–functional and economical factors. In India, flat surface construction is an emerging technology. The seismic performance of R.C.C. flat slabs was evaluated in this investigation.

Sanjay P,focuses on the systematic methodology to be used in the analysis and design of flat slab structures when thermal loads are present. Due to the predominance of sagging moment in the design of structures, top reinforcement mesh in the middle section may not be required in structures analysed without temperature load consideration. However, when temperature loads are present, it is necessary to provide top reinforcement mesh to accommodate tensile stresses on the extreme top surface, even in the intermediate sections.

Essam Eltayeb Changes in temperature could generate tensions in concrete structures of the same order of magnitude as the dead and live masses, according to the research. However, temperature-induced stresses are only produced when thermal expansion or contraction is restrained. A number of researchers have examined the performance of reinforced concrete bridge superstructures subjected to temperature variation, and various protocols provide the values of temperature gradients over the bridges' cross sections that must be accounted for in thermal stress analysis.

Baolin Yu [9]Perform an examination to produce research results on NSM-enhanced participants, substance and functional grade experimental analysis were conducted. In order to evaluate the dependability, bonding, and physical manifestation characteristics of NSM FRp over a wide temperature range, exhaustive high temperature product experiments were conducted as part of the product characterization process. As part of the structural characterization, four NSM FRP reinforced concrete T-columns were tested for fire resistance.

2.2Literature based on experimental work

Pratik Bhatt et. al Establishes a finite element (FE) dependent computational model in ABA QUS. (SFRC) in order to assess the reaction of steel concrete (SFRC) columns to the cumulative influence of fire and design load. The model employs a sequentially coupled thermo-mechanical research technique to map the fire reaction of concrete columns. The FE system is founded on temperature-related SFRC properties, steel reinforcement, and nonlinearity in materials and geometry. The adequacy of the scale for forecasting the SFRC columns' total fire reaction was determined by comparing data from fire experiments with the model's predictions, such as temperatures or axisymmetric misdirection.

Shujaat H. Buch,determine The decrease in tie separation at room temperature was favourable because it enhances the segment's capacity to increase momentum for containment. In the event of a burn, however, beneficial effects of distance reductions greater than 100 mm were not observed. Due to the presence of cross and ring fractures in columns as a result of temperature fluctuations, the diamond crack arrangement in reinforced cement columns has been introduced. Each of the three full-scale, 3.15-meter reinforced concrete columns was filled with a cumulatively projected eccentricity of charge (two controls and one with a diamond configuration). The boiler's normal fire characteristics were ISO-834. The fire resistance of diamond-shaped columns was discovered to be 150 percent greater than that of rectangular columns with crosslines.

Shujaat Hussain Buch Include the construction method based on the type of concrete used. Experiments conducted on full-scale columns are utilised for determining the fire rating of columns on various design systems. In the simulation of columns susceptible to fire, column corrosion and column strength reduction are utilised. The failure period was compared to the low exposed column strength loss calculated as fire deformations in filled columns. Then, fire ratings of various design regimes were compared with reinforced concrete structural and fire frameworks in order for the numerous aforementioned criteria to establish updated Guidelines for RC columns.

N. Girish,the objective of this study is to investigate the efficacy of reinforced concrete flat slabs with varying piercing shear reinforcement parameters. Three flat slab specimens were cast, two of which contain shear stirrups and structural shear bands for piercing shear reinforcement. The test specimens have dimensions of 1000mm in length and breadth and 185mm in thickness for the slabs. The slabs are connected to a central column with dimensions of 300mm in length and width and 700mm in depth.

III. RESEARCH METHODOLOGY

This chapter discusses the thermal analysis of conventional slabs and flat slabs, as well as the methodology and techniques used to collect and analyse data for the research.

3.1Flat slabs

In general, A reinforced concrete slab with or without slopes is referred to as a level slab. primarily supported without columns. by columns containing or lacking flaring column ends. A flat slab may be solid sabot and may have recesses formed into the soffit, so that the soffit has a series of ridges in two orientations. Recesses may be created with removable or permanent infill blocks. Flat Slabs are deemed appropriate for the majority of construction as well as asymmetrical column configurations, such as floors with curved shapes and staircases, etc. There are numerous advantages to using flat slabs, including depth solution, level soffit, and design layout flexibility.

For the purpose of this clause, the following definitions shall apply:

Column Strip-Column strip refers to a design strip with a width of 0.25, but no more than 0.25 I, on each side of the column centre-line, where, is the span in the direction moments are being determined, measured centre to centre of supports, and I, is the span transverse o measured centre to centre of supports.

3.2 Proportioning

Thickness of Flat Slab

In general, the thickness of the flat surface shall be determined by span-to-effective-depth ratios. For slabs with conforming dips, the span-to-effective-depth ratios given in shall be directly applied; otherwise, the span-to-effective-depth ratios determined in accordance with the provisions of 23.2 shall be multiplied by 0.90. For this purpose, the lengthier span shall be taken into account. The minimal slab thickness shall be 125 millimetres.

Drop

When provided, the droplets must be rectangular in plan and have a length in each direction equal to or greater than one-third of the panel's length in that direction. For exterior panels, the width of drops at right angles to the non-continuous edge and measured from the centerline of the columns shall be one-half of the width of drop for interior panels.

Column Heads

Where column heads are present, the portion of the column head that lies within the greatest right circular cone or pyramid with a vertex angle of 90 degrees and can be included entirely within the outlines of the column and the column head shall be considered for design purposes.

Determination of Bending Moment

- **Methods of Analysis and Design**

It shall be permissible to design the slab system by one of the following methods:

a) The direct design method as specified in 31.4.and
b) The equivalent frame method as specified in 31.5.

In each case the applicable limitations given in 31.4 and 31.5 shall be met.

- **Bending Moments in Panels with Marginal**

Where the slab is supported by a marginal beam with a depth greater than 1.5 times the thickness of the slab, or by a wall, then:

a) the total load to be carried by the bear or wall shall comprise those loads directly on the wall or beam plus a uniformly distributed load equal to one-quarter of the total load on the slab, and
b) the bending moments on the half-column strip adjacent to the beam or wall shall be one-quarter of the bending moments for the first interior column strip.

- **Transfer of Bending Moments to Columns**

When unbalanced gravity load, wind, earthquake, or other lateral loads cause transfer of bending moment between slab and column, the flexural stresses shall be investigated using a fraction, a of the moment given by:

$$\alpha = \frac{1}{1+\frac{2}{3}\sqrt{a_1/a_2}}$$

a_1 - overall dimension of the critical section for shear in the direction in which moment acts.

a_2- overall dimension of the critical section for shear transverse to the direction in which moment acts.

Effective is a slab width between lines that are one-and-a-half slab or drop panel thickness: 1.5 D. on each side of the column or capital, where D is the measure of the column.

It is possible to resist the moment on this section by concentrating reinforcement over the column head via closer spacing or by adding reinforcement.

3.4 Direct design method

Limitations

The following conditions must be met by slab systems designed via direct design:

a) There shall be minimum of three continuous spans in each direction.
b) The panels shall be rectangular, and the ratio of the longer span to the shorter span within a panel shall not be greater than 2.0.
c) It shall be permissible to offset columns to a maximum of 10 percent of the span in the direction of the offset notwithstanding the provision in (b)
d) The successive span lengths in each direction shall not differ by more than one-third of the longer span. The end spans may be shorter but not longer than the interior spans, and
e) The design live load shall not exceed three times the design dead load.

Total Design Moment for a Span

In direct design, the total design moment for a span is determined for a strip bounded laterally by the panel's centerline and the centerlines of the supports.

The sum of the positive and average negative bending moments in each direction shall be calculated as:

$$M_0 = \frac{W l_n}{8}$$

Where

M= total moment;

W = design load on an area $1_2,1_m$;

L_0 = clear span extending from face to face of columns, capitals, brackets or walls, but not less than 0.65.

1 = length of span in the direction of M; and = length of span transverse to 1.
a) Circular supports shall be treated as square supports having the same area.
b) When the transverse span of the panels on either side of the centre-line of supports varies, /, shall be taken as the average of the transverse spans.

3.5 ACI-318 PROVISIONS FOR FLAT SLAB

ACI evaluates the design of flat slabs from two distinct perspectives. One is the "Intermediate Frame" structure consisting of a horizontal surface and columns. The second component consists of level surfaces with columns that do not contribute to resisting seismic forces. All lateral forces are resisted by a well-defined system, such as shear walls, within the structure. However, solid slab and column structures cannot be considered Intermediate Frames. These structures are prohibited in seismically active regions. In addition, there are stringent specifications regarding the quantity of steel rebar (typically non-PT) required in an average berth to withstand these forces. Intermediate frame provisions include requiring a minimum number of rebar and PT tendons to pass through the column cage. ASCE-41-03 "Seismic evaluation of Existing Buildings" states that a building cannot be deemed "Immediate Occupancy" or "Life Safety" if it does not have continuous bottom steel. It also specifies that the ductile rotation capacity and residual strength of a connection are null if neither the bottom bars nor the PT TENDON pass through the column cage. In the United States, the authors discovered that the use of the intermediate frame concept is uncommon, and shear walls are used even in the lowest seismic zones (such as New York). The other approach, which excludes the flat surface from the lateral force-resisting system, is more prevalent and strongly supported by the authors. This method relates the storey drift to the punching shear tension in the column-slab connection (which is not reinforced for punching). Note that according to the ACI, the moment of the column is transmitted to the slab via bending and eccentric striking shear. Further it requires the total piercing shear stress (direct plus eccentric) to include the effect of moment at the slab/column joint. For high punching shear stresses (in the absence of punching shear reinforcement), less storey drift is permissible. Therefore, anyone designing using this method would need to stiffen the shear walls to reduce storey drift, but shear reinforcement is not necessary in the joint. If piercing shear reinforcement cannot be avoided, it may be provided as a "shear stud rail" system. Due to the ineffectiveness of conventional stirrup reinforcement in narrow slabs, this is preferred. Traditional stirrups should not be supplied in segments narrower than 250 millimetres in thickness.

Materials Properties

The characteristics of the "A3" column and the material's actual properties are presented in Table 3.1. Notably, this analysis also considered the adapters' quantity, height, and diameter in other configurations. The following are Composite Column's material properties:

Table 1. Material Properties

Sr.No.	Material	Property	Value
1	Structural steel	Yield stress f_{sy} (MPa)	265
		Ultimate strength f_{su}(MPa)	410
		Young's modulus Es(MPa)	205×10^3
		Poisson's ratio μ	0.3
		Ultimate tensile strain e_t	0.25
2	Reinforcing bar	Yield stress f_{sy} (MPa)	250
		Ultimate strength f_{su} (MPa)	350
		Young's modulus Es(MPa)	200×10^3
		Poisson's ratio μ	0.3
		Ultimate tensile strain e_t	0.25
3	Concrete	Compressive strength f_{sc}(MPa)	42.5
		Tensile strength f_{sy}(MPa)	3.553
		Young's modulus E_c(MPa)	32920
		Poisson's ratio μ	0.15
		Ultimate compressive strain e_s	0.045

Material Modeling

In the ANSYS standard code repository a specification for the theoretical simulation analysis was rendered with finite elements. SOLID186 is a solid, 20-node, higher-order, three-dimensional element with quadratic displacement action. The item is represented by twenty nodes, each of which contains three free degrees: x, y, and z node translations. The factor facilitates cognitive function, excessive elasticity, creep, stress intensification, high deflection, and high strain capacity. It even has the hybrid formulation potential to simulate deformations of nearly incompressible elastoplastic materials and nearly compressible hyperelastic materials. Figure 3.5 from SOLID185 depicts the geometric representation.

In order to achieve discretion, a concrete sheet was developed that models the fracture action of tensed (in three dimensions) concrete and compressing compression in order to estimate the non-linear content of this SOLID186 3 -D 20-node structural block. The outcome is the incorporation of reinforcements. The element SHELL43 contains four nodes with six degrees of freedom each. The deformational forms are linear in both dimensions. It has viscoelastic properties, creep, stress intensification, extensive diffractions, and a high load capacity. The SHELL43 elements represented the steel segment, taking into consideration the non-linearity of the structure and displaying linear deformation in the region where it exists. The COLUMN 189 components have been modelled to make it possible to configure the shear connectors' cross section, taking into account non-linearity including its product and bending stresses, as seen in Fig. 3.5. Touch and sliding between the 3-D targeting surfaces (TARGE170), as described by that aspect, are used to represent a contact surface. Wetness and sliding. The factor is for combined structural 3-D and field contact investigations. Fig. 3.2 depicts the geometric representation of CONTA174. Contact pairs of three-dimensional elements that are generally axisymmetric. A node-to-surface contact feature represents the interactions between two substrates by identifying one surface as the node community. OBJECTIVE 170 Fig. 3.3 depicts its geometric representation.

For the slab/column communication interface, TARGET 170 and C0NTA 174 components were utilised. These components will simulate the presence of pressure between the two when there is contact and no distinction between them. Conflict and stability between both parties are frequently included in the two information exchanges.

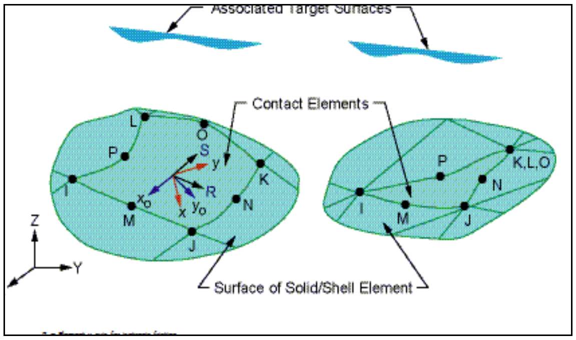


Fig.no. 4 CONTA 174

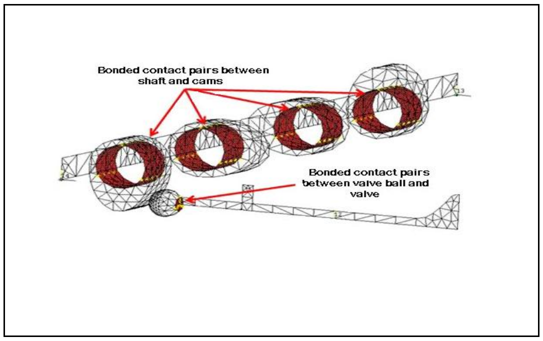


Fig. no. 5 TARGET 170

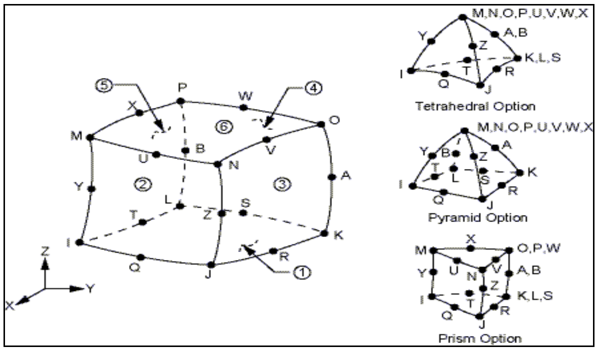


Fig. no. 6 Solid 186

Failure Criterion

For each final factor evaluation, two limits are established to determine the maximal strength: a low and an absolute limit corresponding to 0.2% and 0.35 % of the compressive stress strands, respectively. These two limits define a duration during which the compression member is loaded. A third limit fulfils its responsibilities The Stud damage state can also be reached when the composite column's heaviest stud reaches its ultimate burden, as described by the pertinent pumping-out tests. If a doctor failure point is located before the bottom belt of concrete (i.e., the resultant load of the dock failure point is less than the low limit load), the failure mode of the composite column will be buckling. In contrast, concrete compression is believed to be the cause of failure where the fragment failure argument rests after the concrete's upper extremity. If the level of the stub defect lies between the lower and upper limits of a pavement, the failure mode could be one. Thus, the current finite element system is able to predict the failure mechanism of plank or stock collapse. When conducting a thermal analysis of conventional slabs and flat slabs, the failure criterion is an important factor to consider. In addition to these criteria, other factors, such as concrete creep and thermal contraction, should be considered. The term "creep" refers to the time-dependent deformation of concrete under sustained loading, whereas "shrinkage" refers to the volume reduction of concrete caused by moisture loss. Both decline and contraction have the potential to effect the structural behaviour of the slabs and should be considered in the failure criterion.

IV. PROBLEM STATEMENT AND MODELING

4.1General

The primary purpose of this investigation is to evaluate and contrast the thermal performance of RCC Conventional slabs and flat slabs in terms of temperature distribution and thermal behaviour. The analysis is conducted using the ETABS and ANSYS programmes.

4.2 Problem statement

To begin, we used the ETABS programme to do modelling for a building's RCC conventional and flat slab components. After that, we checked the thermal behaviour of both models using the same model that we had previously evaluated in ANSYS.The research will involve modeling the RCC Conventional slab system and flat slab system using ETABS software, and then analyzing the results of the simulation to determine the differences between the two systems. The study will contribute to the understanding of the structural behavior of conventional and flat slab systems, which could inform the selection of appropriate slab systems in future construction projects. The G+13-storey structure of a regular building with 3.5 m floor to floor height has been analysed by doing seismic analysis of Multi-storey R.C.C Buildings using ETABS software.

4.3 Preliminary data required for analysis: -

Table 2 Parameters to Be Consider for Rectangular Geometry Analysis

Parameter	**Values**
Number of stories	G+13
Base to plinth	4m
Grade of concrete	M40

Grade of steel	Fe 500
Floor to Floor height	3.5 m
Total height of Building	53m
Soil Type	Medium
Dead Load	Self-weight of structure
Live load on floors	5 kN/m2
Frame size	30m X 30m building size
Grid spacing	6 m grids in X-direction and Y-direction.
Size of column	700mm x 700 mm
Size of beam	350mm x 500 mm
Depth of slab	250 mm
Importance factor for office building	1
Damping percent	5 %

4.3.1 Assumptions:

- All materials are homogenous and isotropic
- For modeling of flat slab plate element is used
- For modeling of beam and column beam element is used
- The load from slab directly transferred to column

Model 1 Conventional slab building
Model 2 Flat slab with drop panel building

4.4 Modeling in ETABS

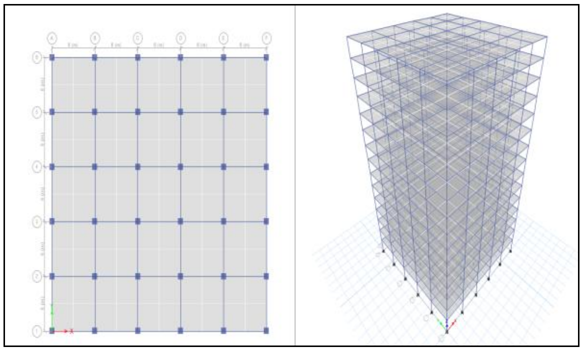


Fig. no. 7Conventional slab building

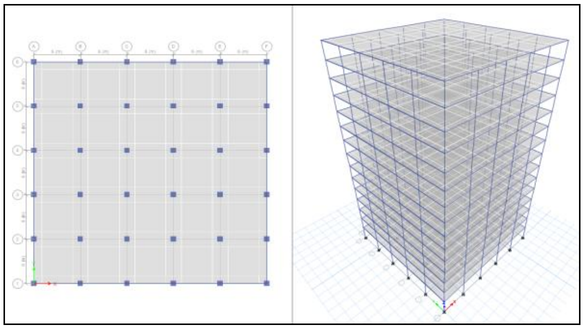


Fig. no. 8Flat slab with drop panel building

4.5 Modeling in ansys

a) Conventional (RCC) slab

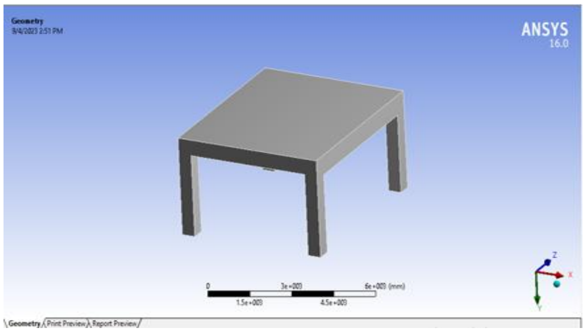


Fig. no. 9Geometry

The above Fig 9 shows geometry of conventional slab.

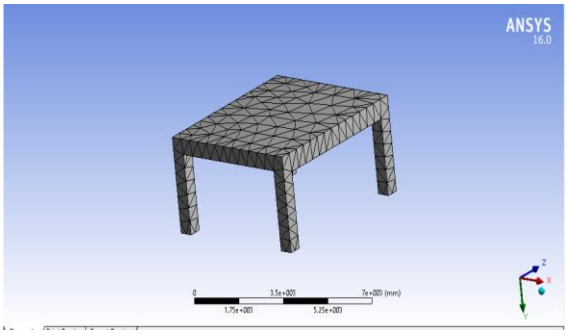


Fig. no. 10 Mesh

The above Fig 10 shows Meshing of conventional slab.

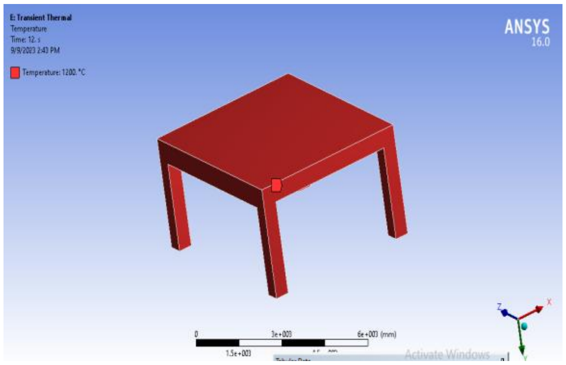
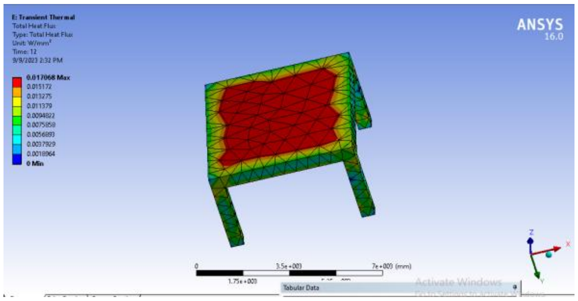


Fig. no. 11Temperature

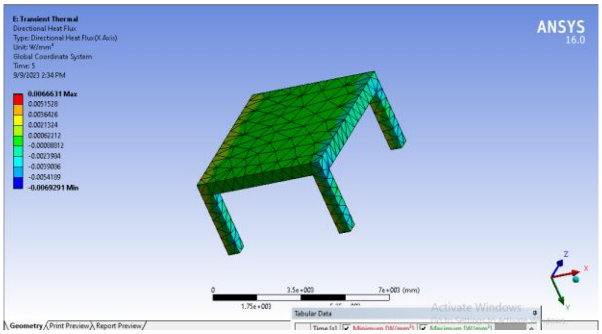
The above Fig 11 shows temperature (transient thermal) in temperature 1200^{0} C.



E: Transient Thermal
Total Heat Flux
Type: Total Heat Flux
Unit: W/mm²
Time: 12
9/9/2023 2:32 PM

Fig. no. 12 Total Heat Flux

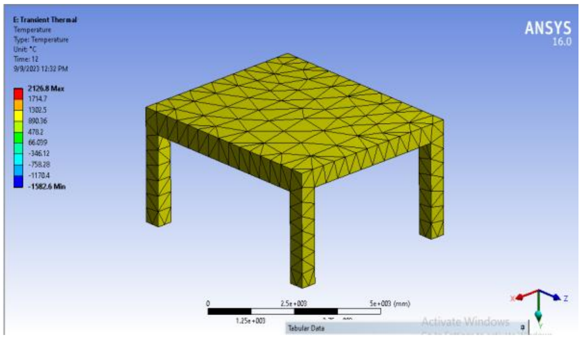
The above fig 12 shows total heat flux in W/mm^2 for flat slab without drop panel and column head model. The total heat flux is 0.017068W/mm^2 and minimum is 0 W/mm^2.



E: Transient Thermal
Directional Heat Flux
Type: Directional Heat Flux(X Axis)
Unit: W/mm²
Global Coordinate System
Time: 5
9/9/2023 2:34 PM

Fig. no. 13Directional Heat Flux

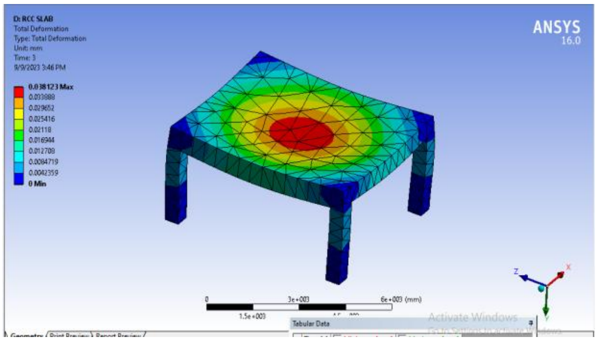
The above fig shows directional heat flux in W/mm^2 for flat slab. The total directional heat flux is 0.0066631 W/mm^2 and minimum -0.0069291 W/mm^2.



E: Transient Thermal
Temperature
Type: Temperature
Unit: °C
Time: 12
9/9/2023 12:32 PM

Fig. no. 14Temperature

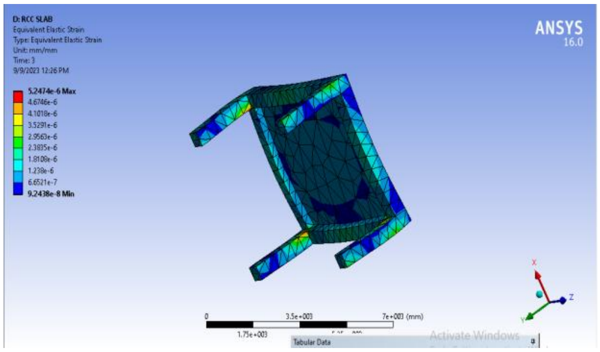
The above fig shows 14 temperature in ^{0}C for flat slab. The total temperature is 2126.8 ^{0}C and minimum -1582.6^{0}C.



D: RCC SLAB
Total Deformation
Type: Total Deformation
Unit: mm
Time: 3
9/9/2023 3:46 PM

Fig. no. 15 Total Deformation

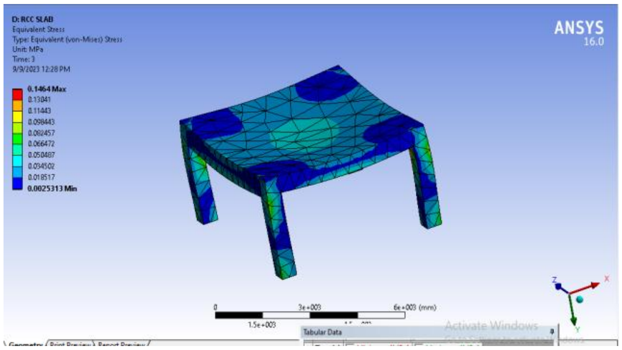
The above fig 15 shows the total deformation in mm for RCC slab without drop panel and column head model. The maximum total deformation is 0.038123 mm and minimum is 0 mm.



D: RCC SLAB
Equivalent Elastic Strain
Type: Equivalent Elastic Strain
Unit: mm/mm
Time: 3
9/9/2023 12:26 PM

Fig. no. 16Equivalent Elastic Strain

The above fig 16 shows equivalent elastic strain in mm/mm for RCC slab. The total equivalent elastic strain is 5.247E-6mm/mm and minimum 9.243E-8 mm/mm.



D: RCC SLAB
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 3
9/9/2023 12:28 PM

Fig. no. 17Equivalent Stress

The above fig 17 equivalent stress in MPa for RCC slab. The total equivalent stress is 0.1464 MPa and minimum 0.0025313 MPa.

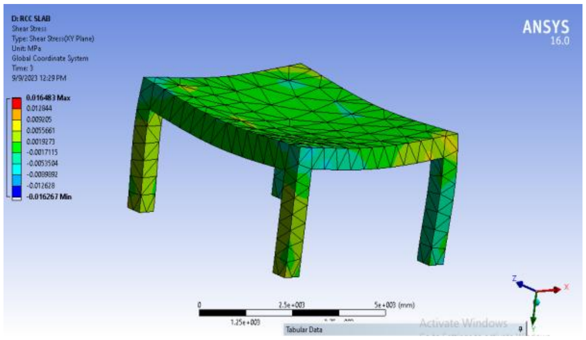


Fig. no. 18 Shear Stress

The above Fig 18 shear stress in MPa for RCC slab. The total shear stress is 0.016483 MPa and minimum -0.016267 MPa.

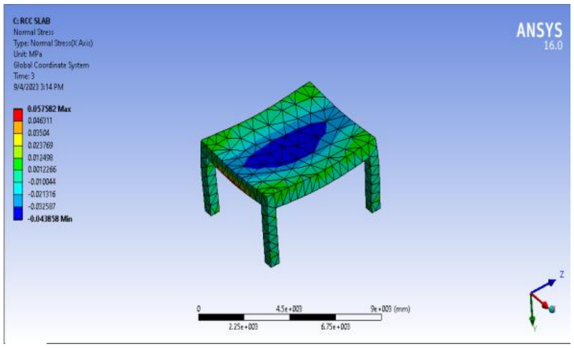


Fig. no. 19 Normal Stress

The above fig 19 shows normal stress in MPa for flat slab. The total normal stress 0.05758 max and minimum -0.043858 MPa.

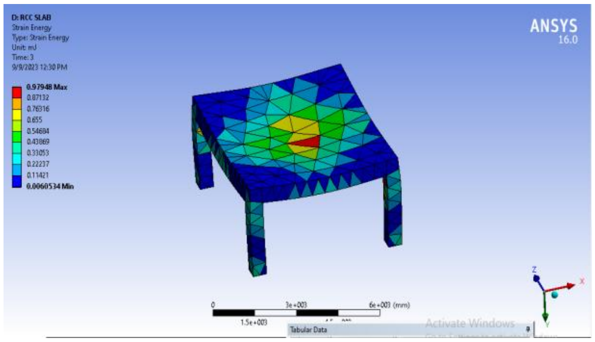


Fig. no. 20 Strain Enaergy

The above fig 20 shows Strain Energy of RCC slab. The Strain Energy is 0.97948 mj and minimum 0.0060534.

b) Flat slab with drop panel

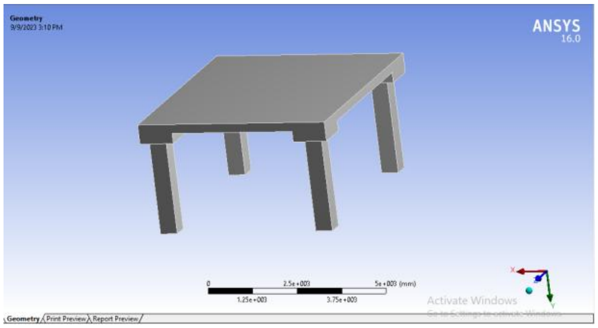


Fig. no. 21 Geometry

The above fig 21 shows geometry of flat slab with drop panel's

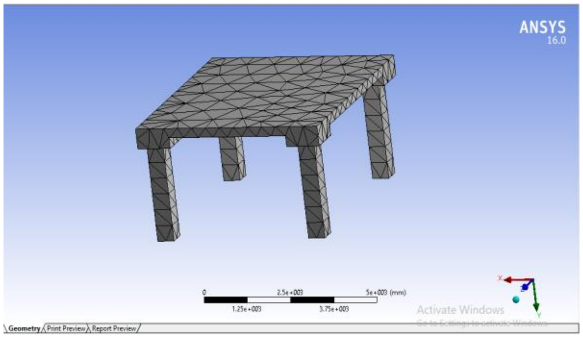


Fig. no. 22 Mesh

The above fig 22 shows meshing of flat slab with drop panel.

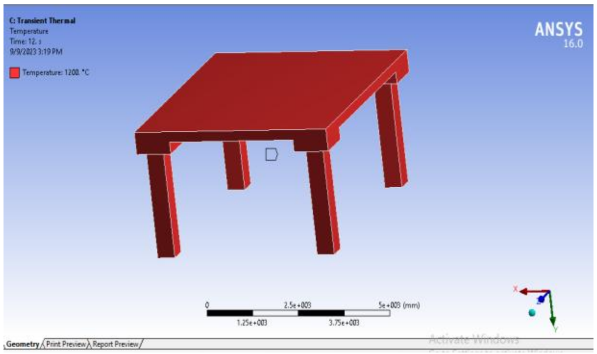


Fig. no. 23Temperature

The above fig 23 shows temperature of flat slab drop panel is 1200^0 C.

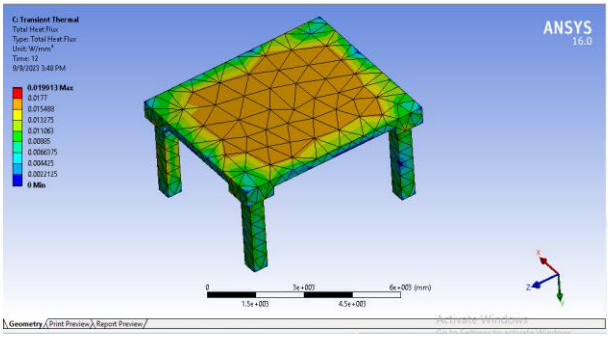


Fig. no. 24Total Heat Flux

The above fig 24 shows total heat flux in W/mm^2 for flat slab without drop panel and column head model. The total heat flux is 0.019913 W/mm^2 and minimum is 0 W/mm^2.

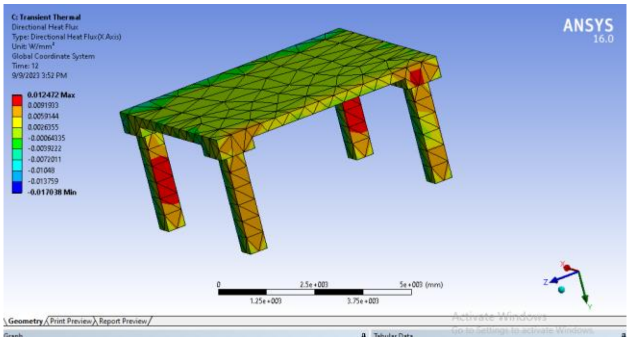


Fig. no. 25Directional Heat Flux

The above fig 25 shows directional heat flux in W/mm^2 for flat slab. The total directional heat flux is 0.012472 W/mm^2 and minimum -0.017038 W/mm^2.

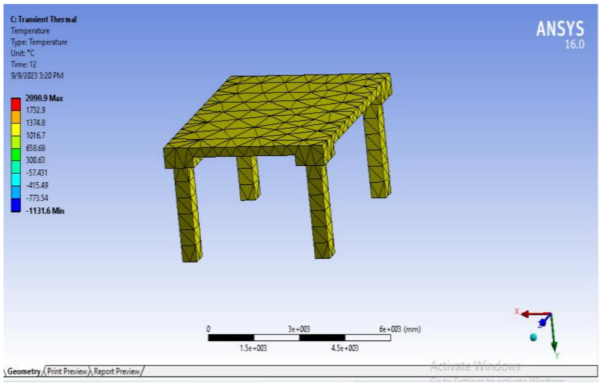


Fig. no. 26Temperature

The above fig 26 shows temperature (transient thermal) for flat slab drop panel in ^{0}C. The maximum temperature range is 2090.9^0 C and minimum -1131.6^{0}C.

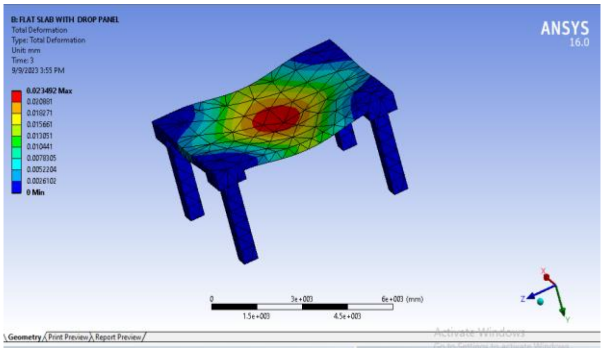


Fig. no. 27Total Deformation

The above fig 27 shows the total deformation in mm for RCC slab without drop panel and column head model. The maximum total deformation is 0.023492mm and minimum is 0 mm.

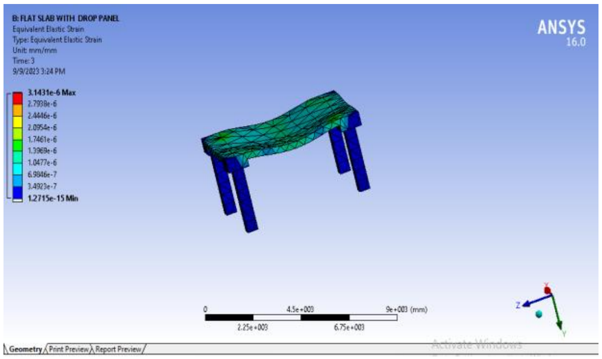


Fig. no. 28Equivalent Elastic Strain

The above fig 28 shows equivalent elastic strain in mm/mm for flat slab. The total equivalent elastic strain is 3.143E-6mm/mm and minimum 1.2715E-15 mm/mm.

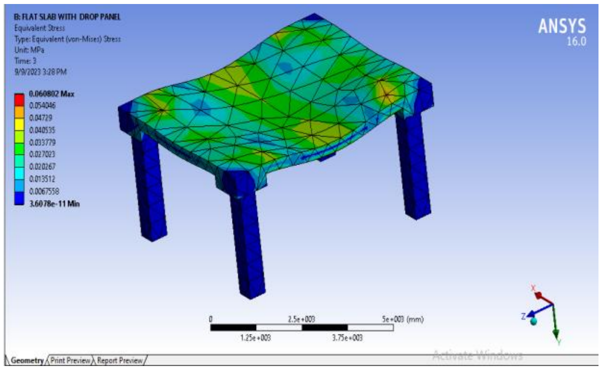


Fig. no. 29Equivalent Stress

The above fig 29 equivalent stress in MPa for flat slab. The total equivalent stress is 0.060802 MPa and minimum 3.6078E-11 MPa.

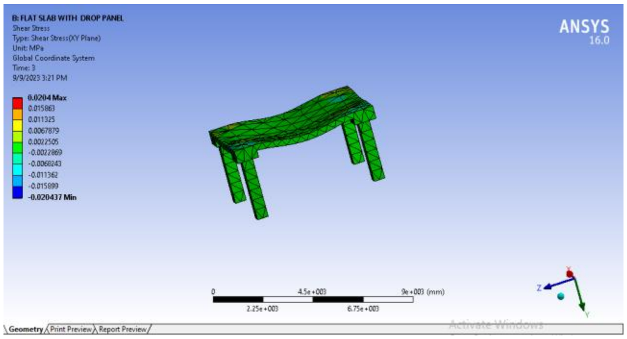


Fig. no. 30 Shear Stress(XY plane)

The above fig 30 shows shear stress (XY panel) for flat slab drop panel in MPa. The total shear stress (XY panel) 0.0204 MPa and minimum -0.020437 MPa.

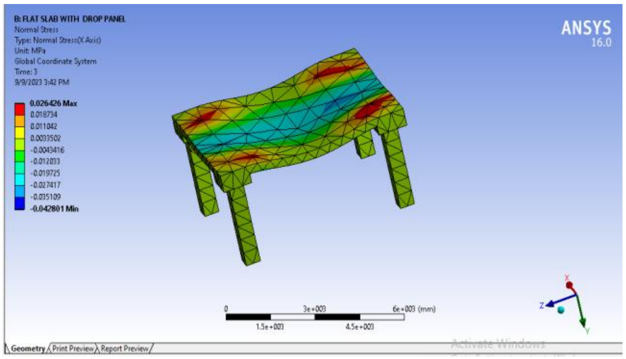


Fig. no. 31Normal Stress

The above fig 31 shows normal stress in MPa for flat slab. The total normal stress 0.026426 max and minimum -0.042801 MPa.

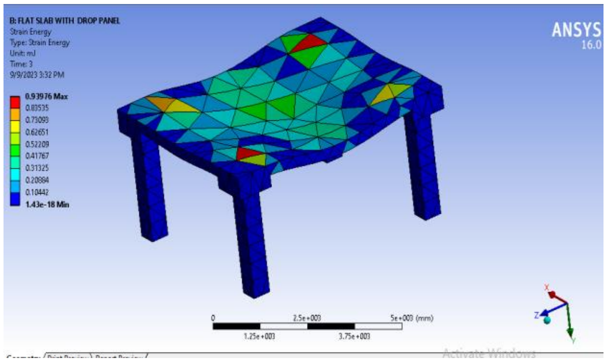


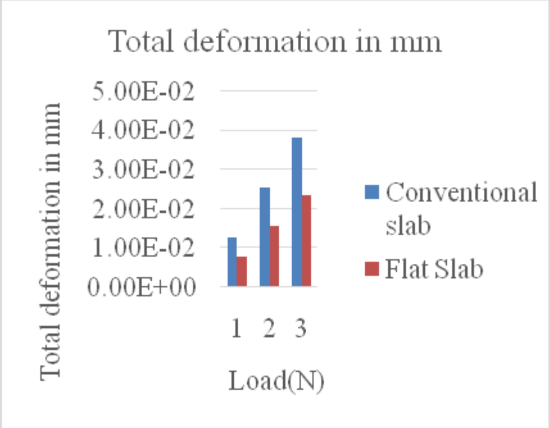
Fig. no. 32 Strain Energy

The above fig 32 shows Strain Energy of flat slab. The Strain Energy is 0.93976 mj and minimum 1.43E-18 mj.

V. RESULT AND DISCUSSION

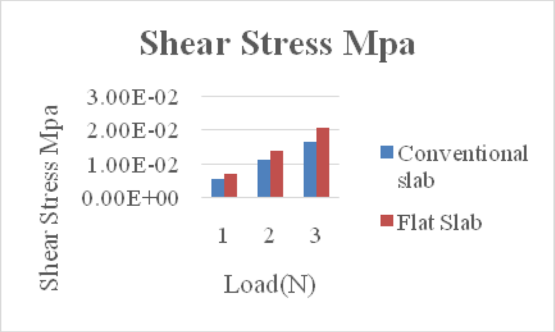
5.1 Introduction

This chapter includes the obtained results by experimental study and discusses causes for variation in result from standard results.



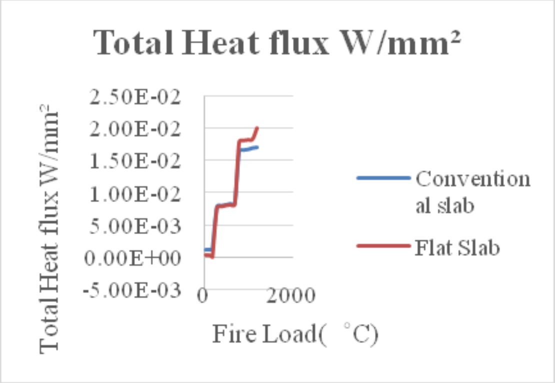
Graph 1 Total Deformation

In above graph shows "Total Deformation" in millimeters (mm) under various applied loads in Newton (N) for two kinds of slabs: conventional slab and Flat Slab. There is an increase in deformations for both slab types as the load rises from 5000 N to 15000 N. For instance, the conventional slab deforms by 0.0127 mm at 5000 N, whereas the Flat Slab deforms by 0.00783 mm at the same force.



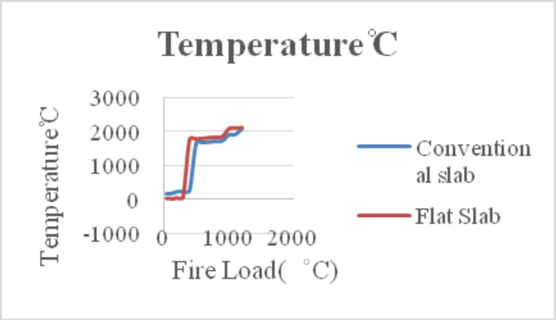
Graph 2Shear Stress

In above graph shows "Shear Stress" data for two kinds of slabs—conventional and flat slabs—under different applied loads in Newton (N). The measurements are in megapascals (MPa). Higher shear stresses are experienced by both kinds of slabs as the load rises from 5000 N to 15000 N. For example, at 5000 N, the shear stress on the conventional slab is 0.00549 MPa, but the shear stress on the Flat Slab is 0.00680 MPa.



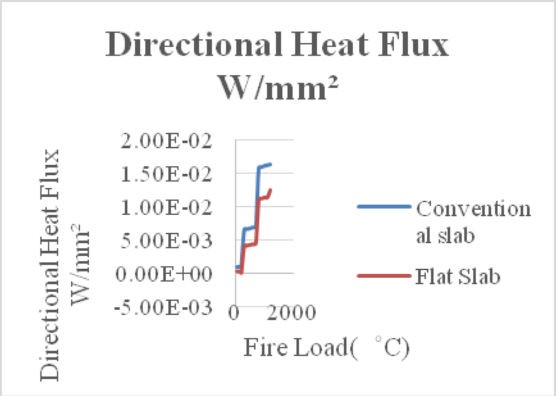
Graph 3 Total heat flux

The above graph shows Total Heat Flux for two kinds of slabs, conventional slab and Flat Slab, with different fire loads in degrees Celsius (°C) is measured in watts per square millimeter (W/mm²). Both kinds of slabs show shifting heat flow values as the fire load rises from 50°C to 1200°C. The conventional slab has a heat flux of 0.00113 W/mm² at 50°C, while the Flat Slab displays a heat flux of 0.000355 W/mm².



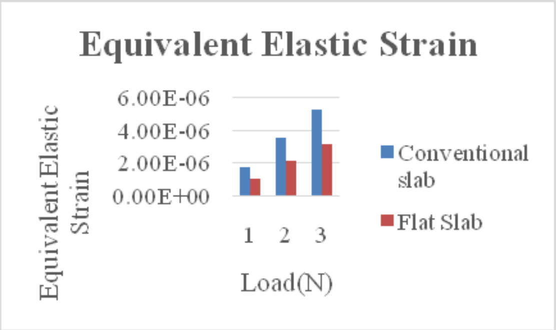
Graph 4 Temperature

In above graph shows the temperature0C data for two kinds of slabs—conventional and flat slabs—exposed to different fire loads in degrees Celsius (°C). Significant Temperature0C fluctuations are seen in both kinds of slabs when the fire load rises from 50°C to 1200°C. For example, the conventional slab achieves 161.58°C at 50°C fire load, whereas the Flat Slab reaches 42.619°C. These numbers show how the slabs' Temperature0C rises with increasing fire loads, which is vital information for evaluating the thermal performance of the materials and the effect of fire exposure on Temperature0C in degrees Celsius.



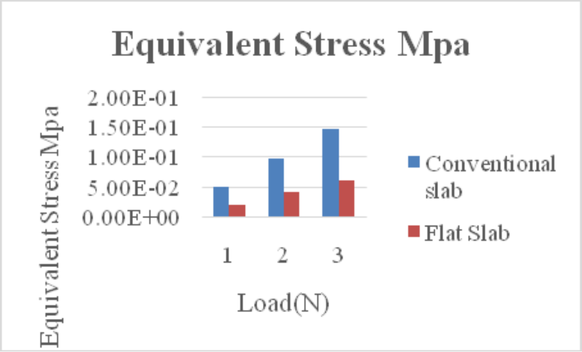
Graph 5 Directional heat flux

In above graph shows Directional Heat Flux for two kinds of slabs— conventional and flat slabs—at different fire loads, expressed in watts per square millimeter (W/mm²). The directional heat flux values of both kinds of slabs change as the fire load rises from 50°C to 1200°C. For instance, the conventional slab exhibits a directional heat flow of 0.00109 W/mm² at a fire load of 50°C, while the Flat Slab displays a heat flux of 0.000304 W/mm².



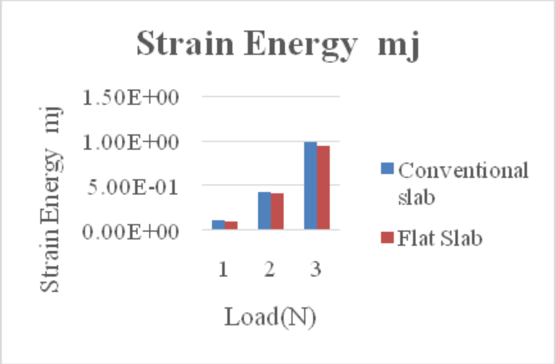
Graph 6 Equivalent Elastic Strain

In above graph shows Equivalent Elastic Strain" for conventional and flat slabs under different applied loads expressed in Newtons (N). When slabs are exposed to varying loads, the deformation they undergo within their elastic limit is represented by the corresponding elastic strain. Increasing the load from 5000 N to 15000 N results in larger equivalent elastic stresses for both slab types. For example, at 5000 N, the corresponding elastic strain of the conventional slab is 1.75E-06, but the strain of the Flat Slab is 1.05E-06.



Graph 7 Equivalent Stress

In above graph shows "Equivalent Stress" for two kinds of slabs— conventional and flat slabs—under different applied loads in Newtons (N). The measurements are in megapascals (MPa). Higher equivalent stresses are experienced by both kinds of slabs as the load rises from 5000 N to 15000 N. For example, with 5000 N, the equivalent stress of the conventional slab is 0.0488 MPa, but the stress of the Flat Slab is 0.0203 MPa.



Graph 8 Strain Energy

In above graph shows "Strain Energy" for two kinds of slabs: conventional slab and Flat Slab, measured in millijoules (mj). With an increase in load from 5000 N to 15000 N, the strain energy of both slab types rises. For instance, the strain energy of the conventional slab is 0.109 millijoules at 5000 N, but the Flat Slab has 0.104 millijoules at the same pressure.

VI. CONCLUSION

In conclusion, the objective of the thermal analysis of RCC Conventional slabs and flat slabs was to compare and analyse their thermal performance in order to improve energy efficiency and occupant comfort. Several objectives were established to reach this objective.

- In terms of temperature distribution and thermal behaviour, the first objective was to evaluate and compare the thermal performance of RCC Conventional slabs and flat slabs. Through exhaustive analysis and evaluation, the temperature distribution and thermal behaviour of both varieties of slabs were investigated, enabling a comparison of their thermal performance. The effectiveness of these strategies in enhancing the thermal performance of the slabs was analysed and contrasted by employing various insulation techniques. Comparing the axial force, bending moment, base shear, and time period of RCC Conventional slabs and flat slabs at elevated temperatures was the third objective. This analysis provided valuable insights into the structural behaviour and performance of both types of slabs under elevated temperature conditions, which assisted in determining their dependability and safety.
- Overall, this research has aided in the comprehension of the thermal properties and performance of RCC Conventional slabs and flat slabs. The findings can inform the design and construction processes, allowing for the development of more energy-efficient and comfortable buildings. On the basis of these findings, additional research and experimentation can be conducted to develop innovative strategies for optimising the thermal performance of slabs and fostering sustainable building practises.
- There is an increase in deformations for both slab types as the load rises from 5000 N to 15000 N. For instance, the conventional slab deforms by 0.0127 mm at 5000 N, whereas the Flat Slab deforms by 0.00783 mm at the same force. Total deformation of conventional slab is higher than flat slab with drop panel by 38.3%.
- These values give crucial information for evaluating the structural integrity of the slabs and their capacity to tolerate shear pressures in megapascals. They also show how shear stress changes with increasing load, shear stress of flat slab is lower than conventional slab by 19.26%.
- The conventional slab has a heat flux of 0.00113 W/mm² at 50°C, while the Flat Slab displays a heat flux of 0.000355 W/mm². These numbers show how the slabs' heat flux varies as the fire load increases, which is important information to know when assessing the slabs' heat resistance and performance in terms of watts per square millimeter. Total Heat flux flat slab is lower than conventional slab by 68.58%
- The conventional slab achieves 161.58°C at 50°C fire load, whereas the Flat Slab reaches 42.619°C. These numbers show how the slabs' Temperature0C rises with increasing fire loads, which is vital information for evaluating the thermal performance of the materials and the effect of fire exposure on Temperature0C in degrees Celsius. The Temperature0C of conventional slab is higher than flat slab with drop panel by 73.62%.
- For instance, the conventional slab exhibits a directional heat flow of 0.00109 W/mm² at a fire load of 50°C, while the Flat Slab displays a heat flux of 0.000304 W/mm². These figures provide crucial information for evaluating the slabs' thermal performance and heat resistance in watts per square millimeter by showing how the directional heat flux they encounter changes with increasing fire load. The directional heat flux of conventional slab is higher than flat slab with drop panel by 72.11%.
- At 5000 N, the corresponding elastic strain of the conventional slab is 1.75E-06, but the strain of the Flat Slab is 1.05E-06. These results provide crucial information for evaluating the structural behaviour and resilience of the slabs under various loading scenarios by illustrating how the elastic deformation of the slabs varies with increasing load.
- With 5000 N, the equivalent stress of the conventional slab is 0.0488 MPa, but the stress of the Flat Slab is 0.0203 MPa. These values provide crucial information for evaluating the structural integrity and megapascal stress

tolerance of the slabs by showing how the stress within them rises with increasing loads.

- For instance, the strain energy of the conventional slab is 0.109 millijoules at 5000 N, but the Flat Slab has 0.104 millijoules at the same pressure. These results show how the strain energy in the slabs grows as the load increases, providing a millijoule-based representation of the energy absorbed and stored in the materials during deformation.

VII. FUTURE SCOPE

The future scope of this undertaking contains significant potential for further research and development in the field of thermal analysis of RCC Conventional slabs and flat slabs. This study's findings and implications can be expanded through a number of avenues. Future research can concentrate on the development and validation of sophisticated numerical models and simulation techniques to improve the precision and dependability of thermal analysis. The thermal behaviour of slabs can be better comprehended by incorporating more complex factors such as solar radiation, exterior weather conditions, and thermal mass effects.

For the purpose of enhancing the energy efficiency of RCC conventional slabs and flat slabs, innovative insulation materials and strategies can be investigated. Given the dynamic character of building systems, it would be advantageous to investigate the long-term performance and durability of insulated RCC conventional slabs and flat slabs. Lastly, expanding the scope of this study to include other types of structural elements, such as beams and walls, can result in a more comprehensive understanding of the thermal dynamics within buildings. Evaluating the interactions and thermal behaviour of various components in conjunction with slabs can provide exhaustive insights into the overall energy efficiency and thermal comfort of a structure.

REFERENCES

[1] S. L. Kiran and S. R. M. E, "Comparative analysis of conventional slab and flat slab system of commercial building on different zones and heights by using etabs," International Research Journal of Engineering and Technology (IRJET)., vol. 05, Aug 2020.

[2] P. A and N. S. K. Ch, "Thermal analysis of concrete slabs with insulating materials using ANSYS," World Journal of Engineering., vol. ahead-of-print, no. ahead-of-print, 2022.

[3] S. L. Kiran and S. R. M. E, "Comparative analysis of conventional slab and flat slab system of commercial building on different zones and heights by using etabs," International Research Journal of Engineering and Technology (IRJET)., vol. 05, Aug 2020.

[4] J. Makate, P. Lohar, and R. Shetti, "Effects of thermal loads on RCC conventional slab and flat slab," International Research Journal of Engineering and Technology (IRJET)., vol. 06, no. July, pp. 1352–1356, July 2019.

[5] N. Tin and K. T. Htun, "Comparative Study of Seismic Behavior of Reinforced Concrete Building with Flat Slab and Conventional Slab Floor System," International Journal of Engineering Trends and Applications (IJETA)., vol. 5, no. 5, pp. 13–17, Sep-Oct 2018.

[6] F. Aseem, W. Sohail, and A. Quadir, "Analysis and Comparison of R. C. Conventional Slab & Flat Slab Under Seismic & Temperature Load," International Research Journal of Engineering and Technology (IRJET)., vol. 4, no. 10 Oct 2017, pp. 1370–1376, 2017.

[7] S. P. Shirke, H. S. Chore, and P. A. Dode, "Effect of temperature load on flat slab design in thermal analysis," Advances in Structural Engineering., vol. 3, pp. 2275–2284, Jan. 2015.

[8] E. Eltayeb, "Analysis of flat slab multistory buildings for temperature variation," Journal of Civil Engineering., vol. 44, May 2021.

[9] V. K. R. Yu, Baolin, Kodur, "Evaluating the Fire Response of Concrete Beams Strengthened with Near-Surface-Mounted FRP Reinforcement," Journal of Composites for Construction., vol. 17, no. 4, pp. 517–529, 2013.

[10] V. Kodur, E. Aziz, and M. Dwaikat, "Evaluating Fire Resistance of Steel Girders in Bridges," Journal of Bridge Engineering., vol. 18, no. 7, pp. 633–643, 2013.

[11] W. Khaliq and V. Kodur, "High temperature mechanical properties of high-strength fly ash concrete with and without fibers," ACI Materials Journal., vol. 109, no. 6, pp. 665–674, 2012.

[12] S. W. Shin, H. Kang, J. M. Ahn, and D. W. Kim, "Flexural capacity of singly reinforced beam with 150 MPa ultra-high-strength concrete," Indian Journal of Engineering and Materials Sciences., vol. 17, no. 6, pp. 414–426, 2010.

[13] A. M. B. Martins and J. P. C. Rodrigues, "Fire resistance of reinforced concrete columns with elastically restrained thermal elongation," Journal of Engineering Structures., vol. 32, no. 10, pp. 3330–3337, 2010.

[14] G. G. Wang, "Performance of Reinforced Concrete Flat Slabs Exposed to Fire," Department of Civil Engineering., vol. Master of, p. 293, 2006.

[15] D. J. Naus et al., "H. Durability of Carbon-Fiber Composites," Automotive Lightweighting Materials., vol. 865, pp. 260–267, 2009.

[16] S. L. Suhaendi, T. Horiguchi, and N. Saeki, “Permeability of heated fiber reinforced high strength concrete,” Department of Civil Engineering., vol. 2022.

[17] Neel Pratik Bhatt, “Infrastructure-Aided Localization and State Estimation for Autonomous Mobile Robots,” vol. Journal of, pp. 1–16, 2022.

[18] S. H. Buch and U. K. Sharma, “Empirical model for determining fire resistance of Reinforced Concrete columns,” Construction and Building Materials., vol. 225, pp. 838–852, 2019.

[19] S. H. Buch and U. K. Sharma, “Fire Resistance of Eccentrically Loaded Reinforced Concrete Columns,”, Fire Technology., vol. 55, no. 5. Springer US, 2019.

[20] N. Girish and N. Lingeshwaran, “A Comparative Study of Flat Slabs Using Different Shear Reinforcement Parameters,” International Journal of Engineering & Technology., vol. 7, no. 2.20, p. 321, Apr. 2018.

[21] IS 456-2000 Plain and Reinforced Concrete - Code of Practice Is an Indian Standard Code of Practice for General Structural Use of Plain and Reinforced Concrete

[22] IS 1893 (Part1) :2002 Criteria for Earthquake Resistant Design of Structures Part 1 General Provisions and Buildings

[23] V.M. Shah and S. Karve: analysis and design of G+3 muiltistoreyed building.