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Effective Designing of RCC Structure by Applying Computer Application

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ABSTRACT: The report titled "Effective Use of Computer Applications in Designing of R.C.C Framed Structure" aims to explore the benefits and challenges of using computer applications in the design of reinforced concrete (R.C.C) framed structures. The report discusses the computer applications commonly used in the design of R.C.C framed structures, including software such as EXCEL, ETABS. The report outlines the advantages of using computer applications in the design of R.C.C framed structures, such as increased accuracy, reduced design time, and improved cost-effectiveness. It also discusses the challenges that arise from using computer applications, such as the need for specialized training and potential errors in input data. The report also provides a detailed methodology for the effective use of computer applications in the design of R.C.C framed structures, including the preparation of input data, model creation, analysis, and design optimization. Additionally, it discusses the importance of quality control and verification of results. Finally, the report provides case studies of real-world R.C.C framed structures designed using computer applications. These case studies highlight the advantages and challenges of using computer applications and demonstrate the effectiveness of the methodology outlined in the report. Overall, the report provides a comprehensive overview of the effective use of computer applications in the design of R.C.C framed structures, and serves as a valuable resource for engineers and designers in the construction industry.

KEYWORDS: EXCEL, ETABS, R.C.C Framed Structure,

I. INTRODUCTION

Computers are used considerably in nearly every phase of structural design practice. A wide variety of computer-backed drafting and structural analysis programs are being used in everyday work. More lately a large number of programs have also appeared that automatically perform all material design law checks despite all these tools typical design office practice still requires numerous tedious and repetitious computations. Part of the reason is the nature of the design process itself which is further of an art than wisdom and hence delicate to completely automate. As a result, the use of spreadsheets and small special-purpose programs, generally written by the contrivers themselves, is veritably common. Tremendous advances have been made in the development of spreadsheets and computer algebra (CA) systems. These systems are able of performing complex computational tasks involving numerical and emblematic computations, plates, and vitality. The design conditions from applicable canons are entered as equations using basically the same memorandum in which similar equations appear in books and design primers. After defining suitable equations for design conditions, the developer specifies values for the design variables, the system performs computations, and the developer also examines the results to see if the conditions are satisfied or not. The same set of equations can also be turned into an optimization problem by defining an expression for an objective function and suitable constraint functions. Rather of using big and expensive software exceed wastes can be used for this purpose. And also, is easy to use as compared to other software. Numerous software is fixed to do specific operations. We can program the excel distance in such a way that we can do all colourful types of computations in one place. Substantially the needed knowledge is to know every formula of RCC designing structure and apply it completely and duly in the distance, as a slight mistake can be veritably problematic in the future. The main motive is to design different RCC structures using an excel distance and minimize the use of the software and homemade computations. As an excel distance provides an ease to design structure. The achievement of a respectable structure that's being designed using MS- Excel and will perform satisfactorily compared to other software. To maximize the use of excel wastes and to ameliorate its knowledge as it's accessible to use other than colourful software. Designing can be done fluently in MS-



Excel as compared to colourful software like STAAD Pro, Revit, etc. The design structure should sustain all loads and distort within limits for construction and use. For a strong, ductile, and durable construction the underpinning needs to have the following parcels at least to be satisfied high relative strength, high toleration of tensile strain, and good bond to the concrete, irrespective of ph, humidity, and analogous factors, thermal comity, not causing inferior stresses in response to changing temperatures, continuity in the concrete terrain, irrespective of erosion or sustained stress. There are three styles used for designing RCC structures i.e., working stress system, ultimate cargo system, and limit state system.

II. OBJECTIVES OF WORK

1. Design and Analysis of RC structure by developing independent Excel sheet and validating result using ETABS software.
2. The objective of developing a computerization system is to reduce the paper work and safe of time in management.
3. Use of Excel to enhance the concept and efficiency of structural analysis and design when design sheet is used.
4. To determine the safe load carrying capacity of a structure.
5. This increases the efficiency and decreasing the work load

III. RELATED WORK

RCC (Reinforced Cement Concrete) structural components are the elements that make up the load-bearing parts of a reinforced concrete structure. Some common RCC structural components include:

1. Beams.

RCC (Reinforced Cement Concrete) beams are horizontal structural elements that span between columns or walls and support the weight of the structure above them. They are typically made of reinforced concrete to resist bending and shear forces. RCC beams consist of two main parts: the concrete and the reinforcement steel bars. The concrete provides compressive strength and the reinforcement steel bars provide tensile strength. The reinforcement bars are placed within the concrete in such a way that they can resist tensile forces and provide stability to the structure. The design of an RCC beam depends on the span length, the load it will be subjected to, and the design requirements of the structure. The cross-section of an RCC beam can be rectangular, T-shaped, L-shaped, or circular, depending on the design requirements. RCC beams can be categorized based on their shape and size. Some common types of RCC beams are:

a) Simply supported beam:

A simply supported beam is a type of RCC (Reinforced Cement Concrete) beam that is supported at its two ends and is free to rotate at these supports. This means that the ends of the beam can rotate or pivot, allowing the beam to bend under the load it is subjected to. A simply supported beam is used to span a distance between two columns or walls, and it is the most commonly used type of beam in construction. The beam can be made of rectangular, T-shaped, L-shaped, or circular cross-section depending on the design requirements. The design of a simply supported beam depends on the span length, the load it will be subjected to, and the design requirements of the structure. The beam is designed to resist bending and shear forces, which are the main types of forces that a beam can be subjected to. The maximum bending moment occurs at the centre of the beam, where the load is concentrated, and the maximum shear force occurs at the supports. The reinforcement steel bars are placed in the bottom of the beam, where the tensile stresses are highest, to provide additional strength and resistance to bending. Simply supported beams are commonly used in the construction of floors, roofs, and bridges. They are a crucial component of a reinforced concrete structure and are designed to withstand the loads and forces it is subjected to during its lifetime.

b) Cantilever beam:

A cantilever beam is a type of RCC (Reinforced Cement Concrete) beam that is supported at one end and projects beyond its support, providing a projecting element in a building. This type of beam is commonly used in construction for balconies, canopies, and overhanging structures. The cantilever beam is designed to resist bending and shear forces, which are the main types of forces that a beam can be subjected to. The maximum bending moment occurs at the support, where the beam is fixed, and the maximum shear force occurs at the free end of the beam. The design of a cantilever beam depends on the length of the overhang, the load it will be subjected to, and the design requirements of the structure. The beam is reinforced with steel bars to resist the tensile stresses that occur at the bottom of the beam and to provide additional strength and resistance to bending. Cantilever beams can be made of rectangular, T-shaped, L-shaped, or



circular cross-section depending on the design requirements. They are commonly used in the construction of buildings, bridges, and other structures, and their design must be carefully considered to ensure that they can withstand the loads and forces they are subjected to during their lifetime.

e) Continuous beam:

A continuous beam is a type of RCC (Reinforced Cement Concrete) beam that spans multiple supports and is used to distribute the load to multiple points. It consists of multiple spans, where each span is supported by columns or walls, and the beam is continuous across these supports. The design of a continuous beam depends on the number of spans, the length of each span, the load it will be subjected to, and the design requirements of the structure. The beam is reinforced with steel bars to resist bending and shear forces, which are the main types of forces that a beam can be subjected to. The maximum bending moment occurs at the centre of each span, where the load is concentrated, and the maximum shear force occurs at the supports. The reinforcement steel bars are placed in the bottom of the beam, where the tensile stresses are highest, to provide additional strength and resistance to bending. Continuous beams can be made of rectangular, T-shaped, L-shaped, or circular cross-section depending on the design requirements. They are commonly used in the construction of buildings, bridges, and other structures, where large spans are required. The design of a continuous beam is more complex than a simply supported beam or a cantilever beam because of the multiple spans and supports. The beam must be carefully designed to ensure that it can withstand the loads and forces it is subjected to during its lifetime. RCC beams are an important component of a reinforced concrete structure and are designed to resist the loads and forces it is subjected to during its lifetime. They are commonly used in the construction of buildings, bridges, and other structures.

1. Columns

RCC columns are vertical structural elements that support the weight of the structure above them. They are typically made of reinforced concrete and can vary in size and shape depending on the design requirements. RCC column is a vertical structural member used to support the load of the structure above it. Columns are an essential part of RCC structures, and their design and construction are crucial for the overall strength and stability of the building. The design of RCC columns depends on the load they will be subjected to, the height of the building, and the design requirements of the structure. Columns are reinforced with steel bars to resist bending and axial forces, which are the main types of forces that a column can be subjected to. The reinforcement steel bars are placed in a vertical arrangement along the length of the column, and concrete is poured around them to create a solid structure. The concrete mix used for the columns is typically a high-strength mix with a minimum compressive strength of 20 N/mm². Columns can be circular, rectangular, or square in cross-section, depending on the design requirements of the structure. Circular columns are preferred in high-rise buildings because of their superior resistance to lateral loads, while rectangular or square columns are commonly used in smaller buildings. RCC columns are used in combination with beams and slabs to create a reinforced concrete frame structure. The columns provide vertical support for the structure, while the beams and slabs provide horizontal support. The design and construction of RCC columns are critical for the overall strength and stability of the building, and they must be carefully designed and constructed to ensure that they can withstand the loads and forces they are subjected to during their lifetime.

2. Slabs

RCC slabs are horizontal elements that provide a flat surface for floors and roofs. They are typically made of reinforced concrete and can vary in thickness and size depending on the design requirements. RCC slabs are flat, horizontal structural members used to provide a floor or roof surface in a building. The design and construction of RCC slabs are crucial for the overall strength and stability of the building. The design of RCC slabs depends on the load they will be subjected to, the span between the supporting beams or walls, and the design requirements of the structure. Slabs are reinforced with steel bars to resist bending and shear forces, which are the main types of forces that a slab can be subjected to. The reinforcement steel bars are placed in a grid pattern in the bottom of the slab, where the tensile stresses are highest, to provide additional strength and resistance to bending. The concrete mix used for the slabs is typically a high-strength mix with a minimum compressive strength of 20 N/mm². RCC slabs can be of various types, such as one-way slab, two-way slab, flat slab, waffle slab, and ribbed slab. There are various types of RCC (Reinforced Cement Concrete) slabs that can be used in building construction. Some of the common types of slabs are:

1. **One-way slab:** A one-way slab is a type of slab that is designed to span in one direction only. The reinforcement steel bars are placed in the bottom of the slab in the direction of the span.
2. **Two-way slab:** A two-way slab is a type of slab that is designed to span in two directions. The reinforcement steel bars are placed in a grid pattern in the bottom of the slab to provide additional strength and resistance to bending.
3. **Flat slab:** A flat slab is a type of slab that is used where a smooth ceiling surface is desired. The reinforcement steel bars are placed in the bottom of the slab in a grid pattern, and there are no beams between the columns.
4. **Waffle slab:** A waffle slab is a type of slab that is used in high-rise buildings to reduce the dead load on the structure. The slab is reinforced with a grid of ribs and beams, which create a waffle-like pattern on the underside of the slab.
5. **Ribbed slab:** A ribbed slab is a type of slab that is reinforced with a series of ribs in the underside of the slab. The ribs run in one or two directions, depending on the design requirements of the structure. The choice of slab type depends on various factors, such as the span of the slab, the loads it will be subjected to, the design requirements of the structure, and the architectural considerations. The design and construction of the slab must be carefully done to ensure that it can withstand the loads and forces it will be subjected to during its lifetime.

3. Footings

RCC footings are structural elements that transfer the weight of a structure to the soil. They are typically placed below ground level and are made of reinforced concrete to resist the loads from the structure above them. RCC (Reinforced Cement Concrete) footings are structural elements that transfer the load from a structure to the ground. Footings are typically designed and constructed to distribute the load of the structure over a larger area of the soil, thereby reducing the stress on the soil and preventing the foundation from settling or sinking. There are several types of footings used in building construction, including:

1. **Strip footing:** A strip footing is a type of shallow foundation that is used to support a load-bearing wall. The footing is typically a concrete strip that is laid on the soil and reinforced with steel bars.
2. **Pad footing:** A pad footing is a type of shallow foundation that is used to support a single column. The footing is typically a square or rectangular pad of concrete that is reinforced with steel bars.
3. **Raft footing:** A raft footing, also known as a mat foundation, is a type of deep foundation that is used to support a large structure or a structure on weak or compressible soil. The footing is typically a thick concrete slab that covers the entire area of the structure and is reinforced with steel bars.
4. **Pile foundation:** A pile foundation is a type of deep foundation that is used when the soil is too weak to support the load of the structure. The foundation consists of vertical columns, known as piles, which are driven into the soil and reinforced with steel bars. The design and construction of footings are critical for the overall stability and safety of the structure. Footings must be designed to resist the loads and forces they will be subjected to, and they must be constructed using high-quality materials and techniques to ensure their strength and durability.

4. Walls

RCC walls are vertical structural elements that provide support for the structure and divide the space into different areas. They can vary in thickness and height depending on the design requirements. RCC (Reinforced Cement Concrete) walls are structural elements that are used to provide support, stability, and enclosure to a building. Walls can be load-bearing or non-load-bearing, depending on their role in supporting the structure. Load-bearing RCC walls are designed and constructed to support the weight of the floors and roof above them and to resist lateral loads such as wind and seismic forces. These walls are typically made of reinforced concrete, which is a composite material that combines concrete and steel reinforcement bars (rebars). The concrete provides compression strength, while the rebars provide tensile strength. Non-load-bearing RCC walls, on the other hand, are not designed to support the weight of the structure. They are typically used as partitions or screens to separate spaces, provide privacy, or enhance the aesthetics of the building. These walls can be made of plain or reinforced concrete, depending on the design requirements. RCC walls can be constructed using various techniques, including cast-in-place concrete, precast concrete, and tilt-up concrete. Cast-in-place concrete involves pouring concrete into formwork on site, while precast concrete involves casting concrete panels or sections off-site and transporting them to the construction site for installation. Tilt-up concrete involves casting concrete panels on site and then tilting them into place using a crane. The design and construction of RCC walls must be carefully done to ensure that they can withstand the loads and forces they will be subjected to during their lifetime. The thickness, reinforcement, and spacing of the walls must be determined based on the structural and architectural requirements of the building.

5. Stairs

RCC stairs are structural elements that provide access between different levels of the structure. They are typically made of reinforced concrete and can vary in size and shape depending on the design requirements. RCC (Reinforced Cement Concrete) stairs are an important structural component in a building that provide safe and convenient vertical access between floors. RCC stairs can be constructed in a variety of designs and configurations, depending on the architectural and structural requirements of the building. The design of RCC stairs typically takes into account factors such as the height and width of the stairway, the number of steps, the riser height and tread depth, the shape of the steps, the width of the landing, and the slope of the staircase. The design should also consider factors such as the load-bearing capacity of the staircase, the materials used in construction, and the safety of the users. RCC stairs are typically constructed using cast-in-place concrete or precast concrete. Cast-in-place concrete involves pouring concrete into formwork that is constructed on-site, while precast concrete stairs are fabricated off-site and transported to the construction site for installation. There are different types of RCC stairs that can be constructed, including straight stairs, curved stairs, spiral stairs, and floating stairs. Straight stairs are the most common type and are used when space is not a constraint. Curved stairs are used when there are space constraints or when a more aesthetic design is desired. Spiral stairs are typically used in small spaces, while floating stairs are a modern design that uses hidden structural support to create the illusion of floating steps.

The construction of RCC stairs must adhere to building codes and standards to ensure that they are safe and durable. The reinforcement, spacing, and placement of the reinforcement bars must be carefully planned and executed to ensure that the stairs can withstand the loads and forces they will be subjected to during their lifetime.

These RCC structural components work together to create a strong and stable structure. Manual Design Vs Software Based Calculation.

Advantages of manual calculation:

- Greater understanding: Manual calculation requires a deeper understanding of structural mechanics and design principles. This can provide a greater understanding of how the structure behaves and may help identify potential issues that may not be apparent with software-based calculation.
- Flexibility: Manual calculation allows for greater flexibility in the design process, as the designer has complete control over the process and can easily make changes as required.
- Cost-effective: Manual calculation is more cost-effective than software-based calculation, as it does not require expensive software licenses or equipment.
-

Disadvantages of manual calculation

- Time-consuming: Manual calculation can be a time-consuming process, especially for larger or more complex structures.
- Prone to errors: Manual calculation is more prone to errors, as it relies on human calculation and can be affected by fatigue or distractions.
- Limited accuracy: Manual calculation may have limited accuracy compared to software-based calculation, especially for complex structures.

Advantages of software-based calculation

- Speed and efficiency: Software-based calculation is faster and more efficient than manual calculation, especially for large or complex structures.
- Accurate results: Software-based calculation provides accurate results, as it eliminates human error and takes into account complex structural behaviour.
- Visualization: Software-based calculation allows for visualization of the structure's behaviour under different loads and conditions, providing a better understanding of the structure's behaviour.

Disadvantages of software-based calculation

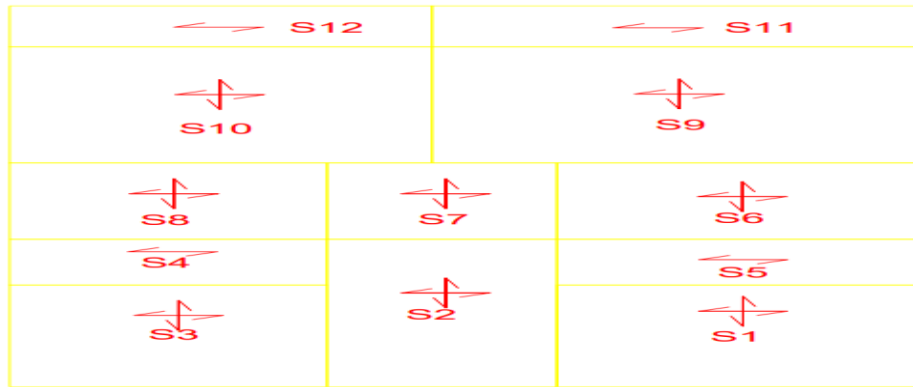
- Cost: Software-based calculation can be expensive, as it requires licenses and specialized equipment.
- Limited flexibility: Software-based calculation may have limited flexibility in the design process, as it is based on the software's algorithms and limitations.
- Requires expertise: Software-based calculation requires expertise in the software and the underlying principles of structural design, which may require additional training or hiring of specialized personnel.



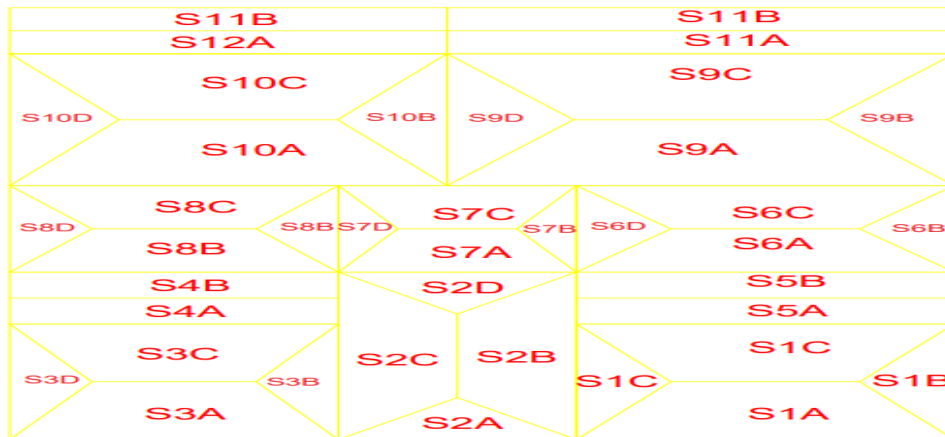
IV. METHODOLOGY

Design codes used. IS 456-2000, SP-16 (Design aid to IS 456), IS:875-1987, SP-34 (Handbook on concrete reinforcement and detailing)

SLAB



Plan 4.1- Slab Drawing



Plan 4.2- Slab Section Drawing

Hall

Hall Size- 5.74 X 4.26 M

By Manual Method.

Given data:-

Shorter Span $L_x = 4.26$ m

Longer Span $L_y = 5.74$ m

Live load = 15 KN/m²

Floor finish = 5 KN/m²

Grade of Concrete $F_{ck} = 25$

Grade of Steel $F_y = 415$

Modification Factor $MF = 1.4$

Width support = 230mm

Clear cover = 20mm

Assume bar = 10 mm

$\alpha_x = 0.096$ N/mm²

$\alpha_y = 0.035$ N/mm²

Step 1:- **Effective depth**

$$L/d = 20 \times M. f$$

$$4260 / d = 20 \times 1.4$$



$d = 298.2 \cong 300 \text{ mm}$
 Assume 20 mm as clear cover
 $D = d + c/c = 300 + 20 = 320 \text{ mm}$

Step 2:- Effective span

$L_x = 4260 + 230 = 4490 \text{ mm}$
 $L_x = 4260 + 300 = 4560 \text{ mm} = 4490 \text{ mm}$
 $L_y = 5740 + 230 = 5970 \text{ mm}$
 $L_y = 5740 + 300 = 6040 \text{ mm}$
 $L_y = 5970 \text{ mm}$

Step: -3 Load calculation:

Dead load = $b \times d \times \gamma_{\text{rcc}} = 1 \times 0.320 \times 25 = 8 \text{ KN}$
 Live load = 15 KN/m²
 Floor finish = 5 KN/m²
 Total load = 8+ 15 +5 = 28 KN/m
 Ultimate load = 28 x 1.5 = 42 KN/m²

Step: -4 Bending moment

$\alpha_x = 0.096 \text{ N/mm}^2$ $\alpha_y = 0.035 \text{ N/mm}^2$
 $M_{ux} = \alpha_x \times w_u \times l_x^2 = 0.096 \times 42 \times 4490^2 = 81.285 \text{ KN}$
 $M_{uy} = \alpha_y \times w_u \times l_y^2 = 0.035 \times 42 \times 4490^2 = 29.635 \text{ KN}$

Step 5: - Check for Depth

$M_u = 0.36 \times f_{ck} \times b d^2 \times x_{\text{max}}/d \times [1 - 0.42 \times x_{\text{max}}/d]$
 $29.695 \times 10^6 = 0.36 \times 25 \times 1000 \times d^2 \times 0.48 \times [1 - 0.42 \times 0.48]$
 $D = 92.69 \text{ mm}$
 i.e., safe

Step 6:- Steel Reinforcement

$A_{stX} = (0.5 \times f_{ck})/F_{yX} [1 - \sqrt{1 - (4.6 \times M_{ux}) / (f_{ck} b d^2)}] \times b d$
 $= (0.5 \times 25)/415 \times [1 - \sqrt{1 - (4.6 \times 81.28 \times 10^6) / (25 \times 1000 \times 300^2)}] \times 1000 \times 300 = 784.86 \text{ mm}^2$
 $\therefore 10 \text{ mm } \phi$
 Spacing = $(1000 \times \pi/4 \times \phi^2)/A_{st}$
 $= (1000 \times \pi/4 \times 10^2)/784.86 = 100.06 \cong 100 \text{ mm}$

	A	B	C	D	E	F	G	H	I
1	Id of Slab	S1	S2	S3	S4	S5	S6	S7	S8
2	Lx(Shorter)	4.26	3.22	2.1	1.371	1.371	2.28	2.28	2.28
3	Ly(Longer)	4.26	3.48	6.7	3.708	3.7	3.22	2.33	3.7
4		1.00	1.080745342	3.19047619	2.704595186	2.698760029	1.412280702	1.021923825	1.622807018
5	Type of Slab	Two Way Slab	Two Way Slab	One Way Slab	One Way Slab	One Way Slab	Two Way Slab	Two Way Slab	Two Way Slab
6									
7									
8									
9	S1	Two Way Slab							
10	S2	Two Way Slab							
11	S3	One Way Slab							
12	S4	One Way Slab							
13	S5	One Way Slab							
14	S6	Two Way Slab							
15	S7	Two Way Slab							
16	S8	Two Way Slab							

Fig-4.1- Identification of Type of Slab

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2	Shorter Span	Lx	4.26	M		Main Steel along X axis	10 mm ϕ	50 c/c				
3	Longer Span	Ly	5.74	M		Main Steel along Y axis	10 mm ϕ	170 c/c				
4	Live Load	LL	15	KN/M ²		Effective Depth (d)	160 mm					
5	Floor Finish	F.F	5	KN/M ²		Depth (D)	180 mm					
6	Grade of Concrete	Fck	25	N/mm ²		Clear cover	20 mm					
7	Grade of Steel	Fy	415	N/mm ²								
8	Modification Factor	M.F	1.4									
9	Width Support		230	mm								
10	Clear Cover		20	mm								
11	Assume Bar		10	mm		Total Materials	Cement	34.8 Nos.				
12	α_x		0.096	N/mm ²			Sand	1.8 Cum.				
13	α_y		0.035	N/mm ²			Aggregate	3.6 Cum.				
14							Steel	302.8 Kg.				
15												

Fig 4.2- Input Data and Output

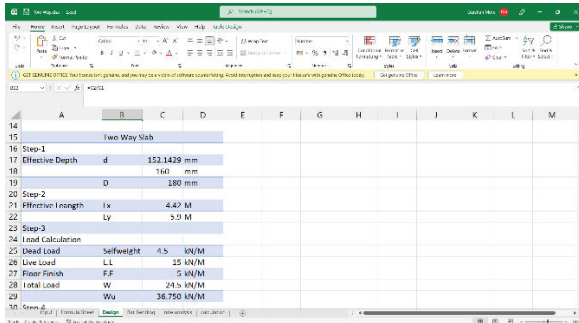


Fig 4.3- Design Step 1 To 3

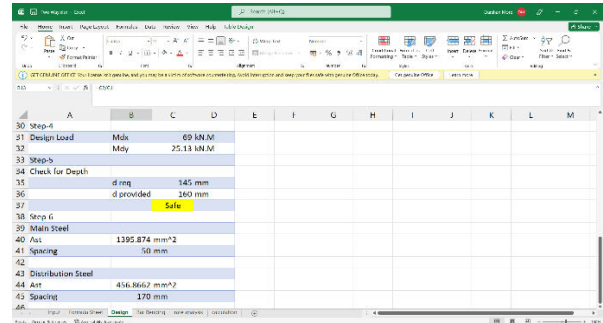


Fig 4.4- Design Step 4 to 6

V. CONCLUSION

1. Excel Software can be co-effective and efficient approach for small and medium sized project.
2. Excel provides a user free interface.
3. Designing of R.C.C in excel software requires a thorough understanding of the design principles. Hence, we have successfully designed the Slab, Beam, Column, and Footing.
4. It brings downs the time required to solve the lengthy Numerical.
5. It is very effective and economical for RCC design.
6. In excel it easy to analysis the R.C.C frame structure.
7. It provides a faster and more accurate method of designing.
8. However, it is important to follow the relevant IS codes.
9. To obtain safety and stability of structure.
10. It provides a cost-efficient result and also provides results as per IS specifications.
11. Excel Result can be accepted and it is also safe for public structure.
12. Considering excel software human error can be reduced.

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