

# Analysis of Residential Building using Excel sheet

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Abstract:

Structural design is the process of investigating a building's stiffness, strength, and stability. The primary goal of structural analysis and design is to construct a structure that can withstand all applied loads without failing for the specified life. Several steps are involved in the structural design process, including load computation, analysis, member design, and specifics. The traditional structural analysis method is fraught with difficulties and time-consuming calculations. Excel software was used because fast software is used nowadays to complete analyses in an efficient manner. To facilitate structural analysis, an excel sheet with a simple user interface is created that can be used by almost anyone. Excel is designed to take as little input as possible while producing as much output as possible.

Key Words: computation of loads, structural analysis, Excel software.

## 1. INTRODUCTION

### 1.1 General

A structure in the context of civil engineering is a network of elements held together by connections to bear the weight of external loads. The goal of structural analysis is to predict how a structure will behave in response to arbitrary loads that have been specified in advance. During the preliminary stage of structural design, the potential external load of a structure is assessed, and the size of the structure's interconnected parts is determined based on the estimated loads. Structural analysis can be used to determine the relationship between a predicted external load on a structural member and the structure's corresponding produced internal stresses and displacements that occur within the member when it is in service. This is necessary to ensure that the structural members meet the standards of the local building code and the specifications of the area in which the structure is located in terms of both safety and use.

### 1.2 Objectives

The aim of the investigation is to analyse single storey residential building manually and using Excel.

### 1.3. SCOPE

The study includes the following:

- To know the importance of computation of loads.
- To analyse single storey residential building manually and using Excel.

## 2. LITERATURE REVIEW

**Sachin Tattimani., and Sri P.I Cholappanavar (2022)**, in this study the analysis and design of RC structures using FEM based software package needs basic knowledge of that software. This project focuses on creating an excel sheet with a simple user interface for analysing and designing RC structures without any prior software knowledge. This excel sheet only considers gravity loads. The sheet defines grids in the X and Y directions. The user can specify the distance between grids. This sheet specifies the design of the footing and column.

**Nitin Tiwari, Rashmi Sakalle (2019)**, in this work, the EXCEL spreadsheet software was utilized to analyze and calculate the rebar of various RC elements such as beams, columns, and slabs. Five different types of EXCEL spreadsheets were calculated in this project effort: simply supported beam, cantilever beam, short column and long column, one way and two-way slab. We used several compression member properties in this study, including effective span, nominal cover, and effective length. Aside from the incorporation of numerous attributes, the RC parts have undergone various checks. The source is RCC code IS 456:2000.

**Akhil Deshbhatar, Ankita Madavi, Akanksha Meshram, Nirali Thakur, Milind Kumbhare, Neha Arukia (2022)**, this study carried out a study to design various components using excel and VBA software. The manual calculation method is used. It results in a time-consuming and laborious

process of obtaining analysis results for VBA-created design sheets. A VBA software has been developed to retrieve the analysis results in MS-Excel, completely automating the design process and reducing manual intervention.

**R. Rajasekaran (2018)**, in this work Manual beam design and analysis for even a small structure is time consuming and laborious. The use of sophisticated design software is expensive and requires a high level of software expertise. This paper discusses the creation of a simple tool that uses a spreadsheet to analyse and design beams for small buildings. The structural beam layout, beam grouping, and loading diagrams are all done manually in the first step. Based on this, a spreadsheet in Excel was created to calculate the bending moment and shear force. Another spread sheet is created for the analysis of design moments and reinforcements. A sample analysis and design are presented, with a satisfactory result. The complexity of beam analysis and design using a spread sheet tool is reduced.

**Uziak, Jacek & Gandure, Jerekias & Martin, L.D. (2011)**, this paper describes how an Excel spreadsheet can be used as an educational tool for beam bending calculations. It discusses the benefits of using spreadsheets in engineering education. It also describes the spreadsheet for beam calculations that employs Macaulay's method. The spreadsheet can be used for statically determined as well as indeterminate beams. It computes reactions (both forces and moments), shear force, bending moment, and deflections for any of four common beam end-fixing conditions (simply supported, cantilever, propped, and built-in). The user specifies the dimensions of the beam, the loads, and their location. The spreadsheet is designed to be user-friendly and operates as a menu-driven programme.

### 3. METHODOLOGY

The following flowchart shown in figure 1, shows the flow of the project.

This study demonstrates how to use excel, a programme or software that can calculate reaction, shear force, and bending moment values for specified loads and beam spans. Excel sheets are design sheets that have an inbuilt cell-based structure and a simple boundary that are simple to use even for inexperienced users. It aids in the calculation of loads in slabs and beams and is used for beam analysis in a single-story residential building using the MS EXCEL

Figure 2 shows the plan view and section AA view of a single storey residential building.

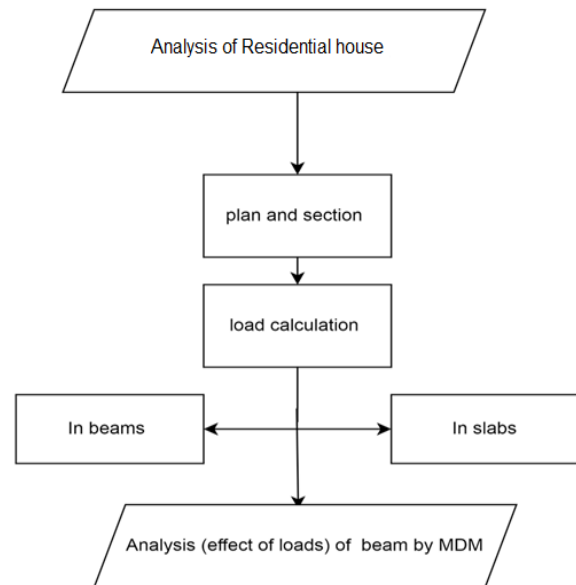


Figure -1: Flow chart

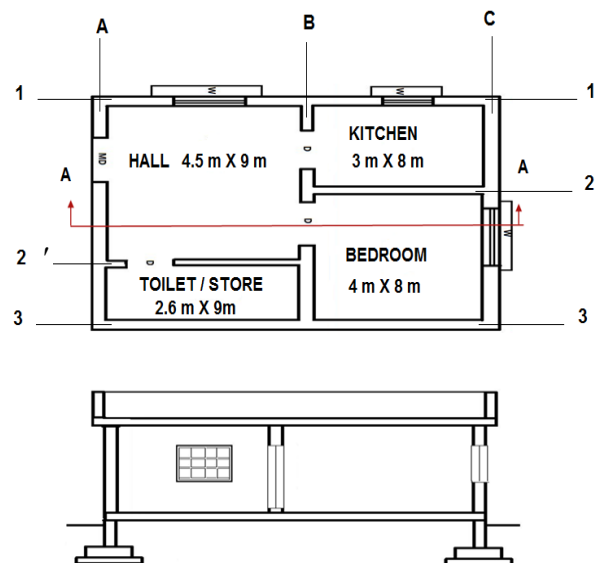


Figure -2: Plan and section A-A

**Load calculation for Slabs**

**Table - 1:** Calculation of load for Bedroom slab

		bedroom	
	SPAN	4200	mm
	Depth ratio	26	
	D=4200/26	165	mm
	Φ	10	mm
	cover	25	mm
	$h=d+\Phi/2+25$	195	mm
	D.L= $h*25+f.f$	6.37	
	L.L	2.5	
U.L	$1.35*DL+1.5*LL$	12.35	KN/m <sup>2</sup>
	$2*8*U.L$	197.6	KN

**Table - 2:** Calculation of load for kitchen slab

		kitchen	
	SPAN	3200	mm
	Depth ratio	26	
	D=3200/26	125	mm
	Φ	10	mm
	cover	25	mm
	$h=d+\Phi/2+25$	155	mm
	D.L= $h*25+f.f$	5.37	
	L.L	2.5	
U.L	$1.35*DL+1.5*LL$	10.99	KN/m <sup>2</sup>
	$1.5*8*U.L$	131.9	KN

**Table - 3:** Calculation of load for hall slab

		hall	
	SPAN	4700	mm
	Depth ratio	26	
	D=4700/26	185	mm
	Φ	10	mm
	cover	25	mm
	$h=d+\Phi/2+25$	215	mm
	D.L= $h*25+f.f$	6.87	
	L.L	2.5	
U.L	$1.35*DL+1.5*LL$	13.03	KN/m <sup>2</sup>
	$2.25*9*U.L$	263.88	KN

**Table - 4:** Calculation of load for toilet/store slab

		toilet	
	SPAN	2800	mm
	Depth ratio	26	
	D=2800/26	110	mm
	Φ	10	mm
	cover	25	mm
	$h=d+\Phi/2+25$	140	mm
	D.L= $h*25+f.f$	5	
	L.L	2.5	
U.L	$1.35*DL+1.5*LL$	10.5	KN/m <sup>2</sup>
	$1.3*9*U.L$	122.85	KN

In this study, the calculation of load for bedroom slab, kitchen slab, hall slab and toilet are shown in tables 1, 2, 3 and 4. The span was taken and overall depth of the slabs were calculated and ultimate loads were found for all slabs.

**Load calculation for Beams**

**Table - 5:** Calculation of load for beam B3-C3

	Beam B3-C3	
d=span/20	410	mm
span	8200	8
h=d+cover+10+20/2	455	mm
b=h/1.5	303.3	mm
D.L=B/1000*H/1000	3.45	kN/m
W=1.35DL	4.66	kN/m
W*span	37.26	kN/m
total load on beam	234.86	kN

**Table -6:** Calculation of load for beam A3-B3

	Beam A3-B3	
d=span/20	460	mm
span	9200	9
h=d+cover+10+20/2	505	mm
b=h/1.5	336.7	mm
D.L=B/1000*H/1000	4.25	kN/m
W=1.35DL	5.74	kN/m
W*span	51.64	kN/m
total load on beam	174.49	kN

**Table -7:** Calculation of load for beam C1-B1

	Beam C1-B1	
d=span/20	410	mm
span	8200	8
h=d+cover+10+20/2	455	mm
b=h/1.5	303.3	mm
D.L=B/1000*H/1000	3.45	kN/m
W=1.35DL	4.66	kN/m
W*span	37.26	kN/m
total load on beam	169.16	kN

**Table -8:** Calculation of load for beam B2-C2

	Beam B2-C2	
d=span/20	410	mm
span	8200	8
h=d+cover+10+20/2	455	mm
b=h/1.5	303.3	mm
D.L=B/1000*H/1000	3.45	kN/m
W=1.35DL	4.66	kN/m
W*span	37.26	kN/m
total load on beam	234.86	kN

**Table -9:** Calculation of load for beam A2`-B2`

	Beam A2`-B2`	
d=span/20	460	mm
span	9200	9
h=d+cover+10+20/2	505	mm
b=h/1.5	336.7	mm
D.L=B/1000*H/1000	4.25	kN/m
W=1.35DL	5.74	kN/m
W*span	51.64	kN/m
total load on beam	438.37	kN

**Table -10:** Calculation of load for beam A1-B

	Beam A1-B1	
d=span/20	460	mm
span	9200	9
h=d+cover+10+20/2	505	mm
b=h/1.5	336.7	mm
D.L=B/1000*H/1000	4.25	kN/m
W=1.35DL	5.74	kN/m
W*span	51.64	kN/m
total load on beam	315.52	kN

**Table -11:** Calculation of load for beam C1-C2

	Beam C1-C2	
d=span/20	160	mm
span	3200	3
h=d+cover+10+20/2	300	mm
b=h/1.5	200	mm
D.L=B/1000*H/1000	1.50	kN/m
W=1.35DL	2.03	kN/m
W*span	6.08	kN/m
total load on beam	6.08	kN

**Table -12:** Calculation of load for beam A1-A2`

	Beam A1-A2`	
d=span/20	235	mm
span	4700	4.5
h=d+cover+10+20/2	300	mm
b=h/1.5	200	mm
D.L=B/1000*H/1000	1.50	kN/m
W=1.35DL	2.03	kN/m
W*span	9.11	kN/m
	Beam C2-C3	
d=span/20	210	mm
span	4200	9.11 kN 4

h=d+cover+10+20/2		
b=h/1.5		
D.L=B/1000*H/1000		
W=1.35DL		
W*span		
total load on beam		
total load on beam		

**Table -13:** Calculation of load for beam C2-C3

	Beam A1-A2`	
d=span/20	235	mm
span	4700	4.5
h=d+cover+10+20/2	300	mm
b=h/1.5	200	mm
D.L=B/1000*H/1000	1.50	kN/m
W=1.35DL	2.03	kN/m
W*span	9.11	kN/m
total load on beam	9.11	kN

**Table -14:** Calculation of load for beam A2`-A3

	Beam A2`-A3	
d=span/20	140	mm
span	2800	2.6
h=d+cover+10+20/2	300	mm
b=h/1.5	200	mm
D.L=B/1000*H/1000	1.50	kN/m
W=1.35DL	2.03	kN/m
W*span	5.27	kN/m
total load on beam	5.27	kN

**Table -15:** Calculation of load for beam B2`-B3

	Beam B2`-B3	
d=span/20	140	mm
span	2800	2.6
h=d+cover+10+20/2	300	mm
b=h/1.5	200	mm
D.L=B/1000*H/1000	1.50	kN/m
W=1.35DL	2.03	kN/m
W*span	5.27	kN/m
total load on beam	5.27	kN

**Table -16:** Calculation of load for beam B1-B2

	Beam B1-B2	
d=span/20	160	mm
span	3200	3
h=d+cover+10+20/2	300	mm
b=h/1.5	200	mm
D.L=B/1000*H/1000	1.50	kN/m
W=1.35DL	2.03	kN/m
W*span	6.08	kN/m
total load on beam	6.08	kN

**Table -17:** Calculation of load for beam B2-B2`

	Beam B2-B2`	
d=span/20	80	mm
span	1600	1.4
h=d+cover+10+20/2	300	mm
b=h/1.5	200	mm
D.L=B/1000*H/1000	1.50	kN/m
W=1.35DL	2.03	kN/m

W*span	2.84	kN/m
total load on beam	2.84	kN

In this study, the calculation of load for beams is shown in tables 5 - 17. The span was taken and overall depth of the beams were calculated and ultimate loads were found for all beams.

	Beam B1-B2	
d=span/20	160	mm
span	3200	3
h=d+cover+10+20/2	300	mm
b=h/1.5	200	mm
D.L=B/1000*H/1000	1.50	kN/m
W=1.35DL	2.03	kN/m
W*span	6.08	kN/m
total load on beam	6.08	kN

### MOMENT DISTRIBUTION METHOD

In 1930, Hardy Cross developed and formally reported the moment distribution method for beam and frame analysis. Although this method, like the slope-deflection method, is a deformation method, it is an approximate method that does not require solving simultaneous equations. The number of subsequent approximations or iterations determines the degree of accuracy of the results obtained by the moment distribution approach.

The approach for analysing indeterminate beams using the moment distribution method is summarised below:

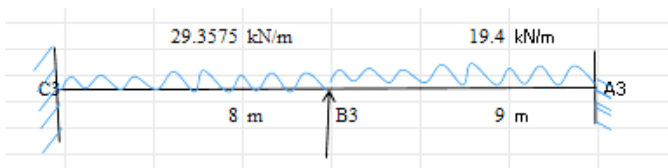
Procedure of the Moment Distribution Method to analyze indeterminate beams is as follows.

- Determine the fixed-end moments of members, assuming the joints are restrained against rotation.
- Determine the distribution factor for each element connected at the joint.
- Calculate and distribute the unbalanced moment at each joint to the ends of members connected at that joint.

- Transfer one-half of the distributed moment to the other members' endpoints.
- Add or subtract these subsequent moments (acquired in stages three and four) from the original fixed-end moments.
- Apply the determined end moments to the provided structure's joints.
- Draw a free-body diagram of each span of the supplied beam, displaying the loads and moments produced using the moment distribution method at the joints.
- Determine the support reactions for each span. Calculate and draw shearing force and bending moment diagrams for each span.
- Combine the figures in step 9 to create one bending moment and one shearing force diagram for the provided beam.

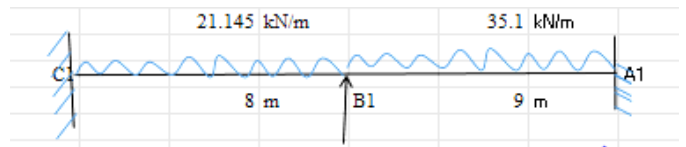
Fixed end moment for Beams is shown in tables 18 to 21 calculated by the Moment Distribution Method.

**Table -18:** Fixed end moment for beam C3-B3-A3



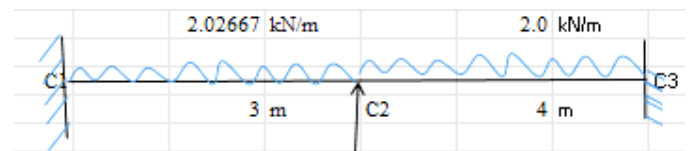
	C3	B3		A3
Member	C3-B3	B3-C3	B3-A3	B3-A3
Stiffness				
$k = I/L$	0.0003	0.0003	0.0004	0.0004
DF	1	0.42595	0.57405	1
Fixed end moment	-156.573	156.573	-130.868	130.868
Balancing		-10.9495	-14.7563	
COF	-5.47475			7.3782
Final moment	-162.048	145.624	-145.624	123.489

**Table -19:** Fixed end moment for beam C1-B1-A1



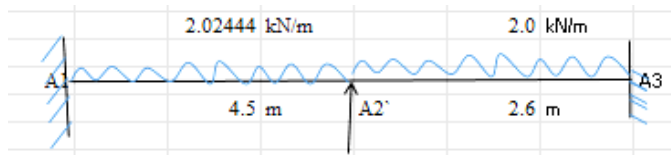
	C1	B1		A1
Member	C1-B1	B1-C1	B1-A1	A1-B1
Stiffness				
$k = I/L$	0.0003	0.0003	0.0004	0.0004
DF	1	0.42595	0.57405	1
moment	-112.773	112.773	-236.64	236.64
Balancing		52.7615	71.1052	
COF	26.3807			85.5526
Final	-86.3926	165.535	-165.535	272.193

**Table -20:** Fixed end moment for beam C1-C2-C3



	C1	C2		C3
Member	C1-C2	C2-C1	C2-C3	C3-C2
Stiffness				
$k = I/L$	0.00015	0.00015	0.00011	0.00011
DF	1	0.57143	0.42857	1
moment	-1.52	1.52	-2.7	2.7
Balancing		0.67429	0.50571	
COF	0.33714			0.25286
Final	-1.18286	2.19429	-2.19429	2.95286

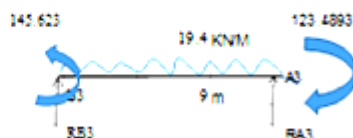
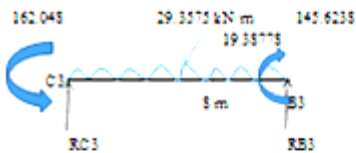
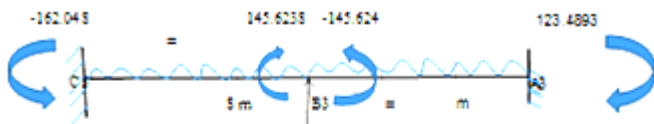
**Table -21:** Fixed end moment for beam A1-A2'-A3



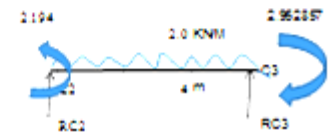
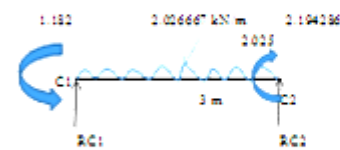
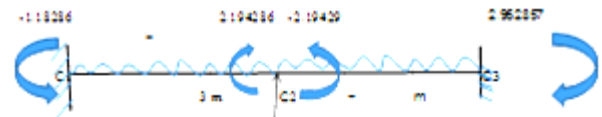
	A1		A2'		A3
Member	A1-A2'	A2'-A1	A2'-A3		A3-A2'
Stiffness					
$k = I/L$	0.0001	0.0001	0.00017		0.00017
DF	1	0.3662	0.6338		1
moment	-3.41625	3.41625	-1.14183		1.14183
Balancing		-0.83288	-1.44153		
COF	-0.41644				0.7208
Final	-3.83269	2.58337	-2.58337		0.42107

Reactions for Beam supports are shown from 22 to 25 calculated by the Moment Distribution Method.

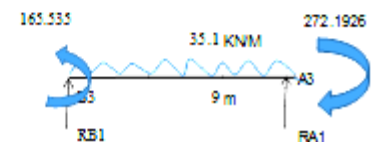
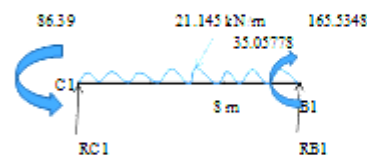
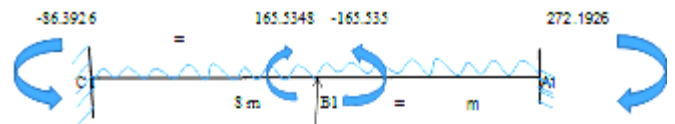
**Table -22:** Support reaction for beam C3-B3-A3



**Table -23:** Support reaction for beam C1-C2-C3

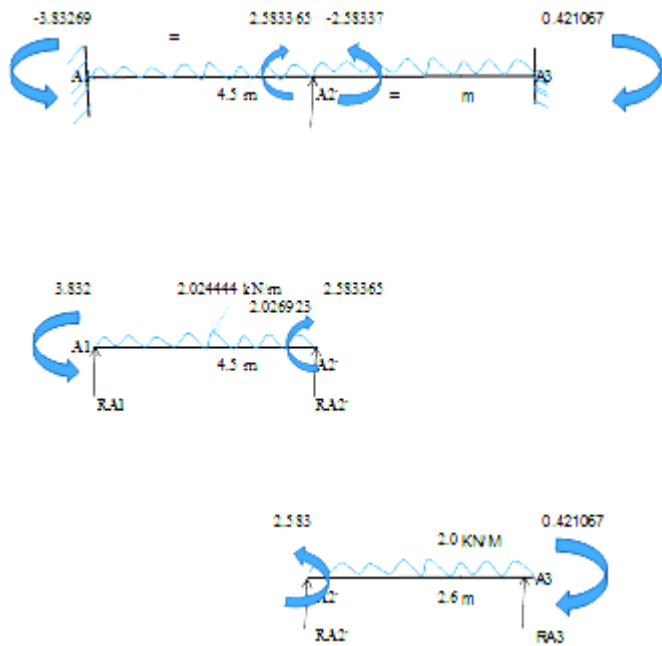


**Table -24:** Support reaction for beam C1-B1-A1

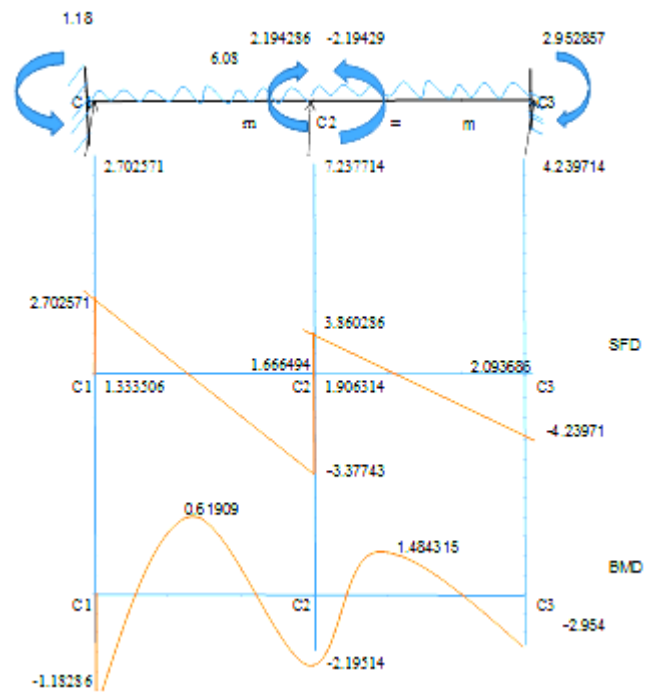




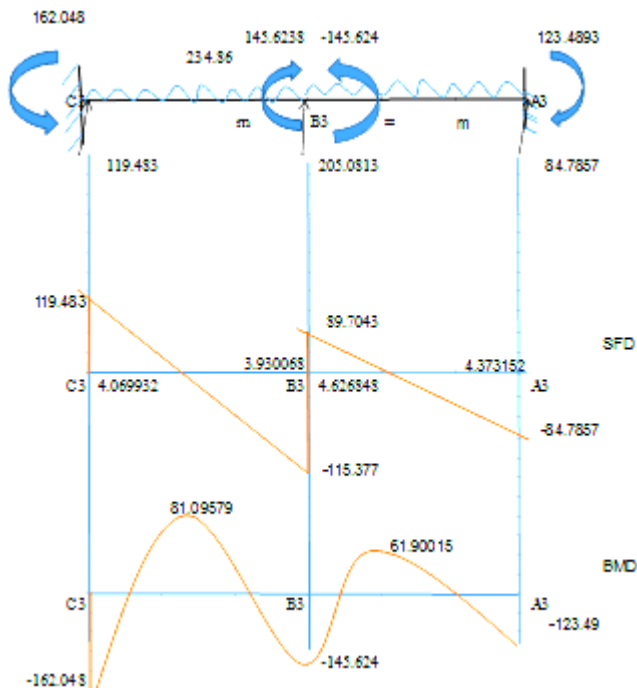
**Table -25:** Support reaction for beam A1-A2'-A3



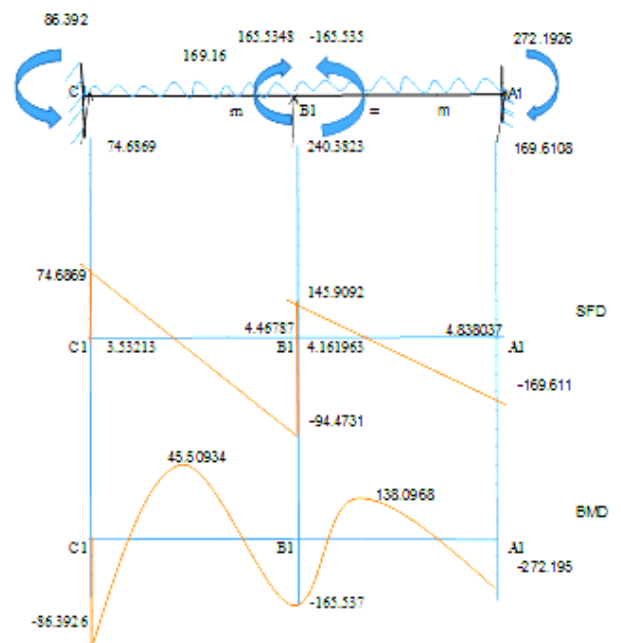
**Table -27:** Shear force and bending moment diagram for beam C1-C2-C3



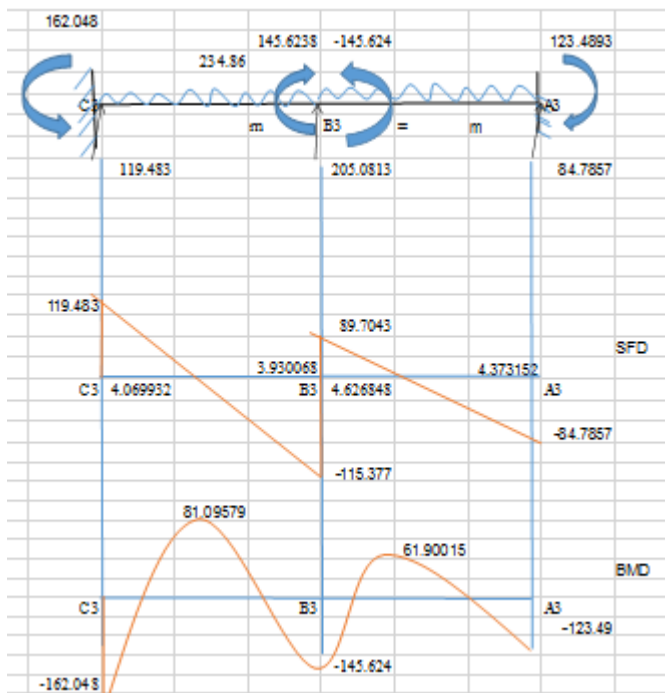
**Table -26:** Shear force and bending moment diagram for beam C3-B3-A3



**Table -28:** Shear force and bending moment diagram for beam C1-B1-A1



**Table -29:** Shear force and bending moment diagram for beam A1-A2'-A3



#### 4. CONCLUSION

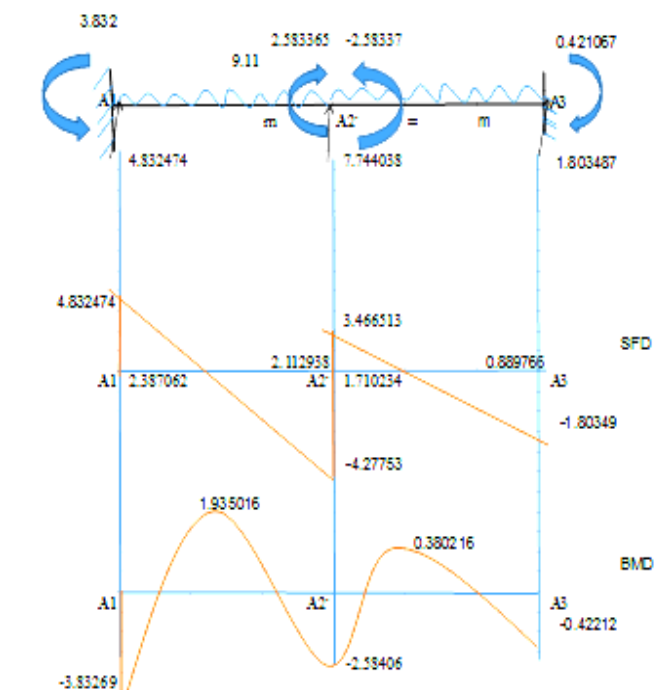
In this study, an excel sheet was used to study a single-story residential building. It was discovered that processing in Excel is significantly more accurate and faster than processing by hand; many cases can be completed faster by simply modifying the formula and the provided data in a short period of time.

While using an Excel sheet, was able to improve the concept and efficiency of structural analysis.

Paperwork was reduced and time was saved by using a computerized application. This increased efficiency and decreased workload.

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Shear force and bending moment diagrams are shown from 23 to 29.