ESTIMATION AND DESIGN OF 1-BHK RESIDENTIAL HOME

Thesis submitted in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision of

Mr. Lav Singh

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To

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT SOLAN – 173234

HIMACHAL PRADESH INDIA

May, 2017

DECLARATION

I hereby declare that the work reported in the B.Tech. thesis entitle **"ESTIMATION AND DESIGN OF 1-BHK RESIDENTIAL HOME"** submitted at **Jaypee University of Information Technology, Waknaghat, India,** is an authentic record of my work carried out under the supervision of **Assistant Prof. Lav Singh**. I have not submitted this work elsewhere for any other degree or diploma.

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CERTIFICATE

This is to certify that the work reported in the B.Tech. thesis**"EntitledEstimation and Design of 1-BHK Residential Home"** submitted by **Parth Agarwal, ShishirShekhar and VasudevRathore** at **Jaypee University Of Information Technology,Waknaghat,Solan** is a bonafide record of his original work carried out under my supervision. This work has not been submitted partially or wholly to any other university or institution for award of this or any other degree program.

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Parth Agarwal

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Vasu Rathore

LIST OF ABBREVIATIONS & SYMBOLS

SYMBOL	DESCRIPTION
A	Total area of section.
A_b	Equivalent area of helical reinforcement.
A_s	Area of compressive steel.
A_e	Equivalent area of section.
A_k	Area of concrete core.
A_m	Area of steel or iron core.
A_{sc}.	Area of longitudinal reinforcement
A_{st}	Area of steel (tensile)
A_l	Area of longitudinal torsional reinforcement
A_{sv}	Total cross-sectional area of stirrup legs or bent up bars within distance s_v
A_Φ	Area of cross-section of one bar.
a	Lever arm.
a_c	Area of concrete.
b	Width.
b_r	Width of rib
C	Compressive force.
c	Compressive stress in concrete.
c'	Stress in concrete surrounding compressive steel.
c_s	Permissible tensile stress in concrete.
c_1	Compressive stress at the junction of flange and web.

D	Depth.
d	Effective depth.
dc	Cover to compressive steel.
d_s	Depth of slab.
e	Eccentricity
F	Shear force
F_d	Design load
F_r	Radial shear three.
f	Stress (in general).
Tu	Torsional moment (limit state design)
t	Tensile stress in steel.
t_c'	Compressive stress in compressive steel.
V_u	Shear force due to design load (limit state design)
V_{us}	Strength of shear reinforcement (limit state design)
W	Point load; Total load.
x_u	Depth of neutral axis (limit state design)
Z	Distance.
Z_B, Z_L	Bending moment coefficients.
α	Inclination coefficient.
β	Surcharge angle.
γ	Unit weight of soil.
γ'	Submerged unit weight of soil.
γ_f	Partial safety factor appropriate to the loading

γ_m	Partial safety factor appropriate to the material.
σ_{cc}	Permissible stress in concrete (direct comp).
$\sigma_{cc'}$	Direct compressive stress in concrete.
σ_{cbc}	Permissible compressive stress in concrete due to bending
σ_{cu}	Ultimate compressive stress in concrete cubes.
σ_{sc}	Permissible compressive stress in bars.
σ_{sh}	Permissible stress in helical reinforcement.
σ_{sp}	Permissible punching shear stress.
σ_{st}	Permissible tensile stress in reinforcement.
σ_{sy}	Yield point compressive stress in steel.
μ	Coefficient of friction.
Φ	Diameter of bar ; angle of internal friction
θ	Angle
τ_{bd}	Design bond stress,
τ_c	Shear stress in concrete
τ_{cmax}	Max. shear stress in concrete with shear reinforcement.
τ_v	Nominal shear stress.

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ABSTRACT

Softwares used in designing-

- Planning in Auto CAD 2015
- Building Information Modelling using Revit 2017
- Structure Analysis using SAP 2000
- Cost estimation using MS-Excel

CHAPTER 1. INTRODUCTION

1.1 Study area

- Our proposed site is located in hilly region, in this regions temperature is usually low and building should be located in the southern slope of hill.
- The opening should be placed as to avoid undesirable cold in winter.
- Total plot size is 14.4m x 15.4m
- Total plinth area is 119 sq. meter.

1.2 Selection of plot and study

Site selection is the most crucial step for building a residential home. The proposed location should not be in an isolated place where the rate of crimes are substantially less; and it should be in a place with good community. However, it should not be too noisy neighborhood either as it may cause inconvenience to members of the family. In addition, the location should be in a place where mode of convenience is good and shopping facilities are easily available. These factors also increase the chance of future growth of property rate. One should check the future possibility of development of roads in the area.

The factor to be considered while selecting the building site are as follows: -

- Access to park & playground.
- Agriculture polytonality of the land.
- Availability of public utility services, especially water, electricity & sewage disposal.
- Distance from places of work.
- Ease of drainage.
- Location with respect to school, collage & public buildings.
- Transport facilities.
- Wind velocity and direction.

Table 1: Limitation of built up area

Area of plot	----	Maximum permissible built up area
Up to 200sq.m (240sq.yd)	----	60% of site area on floor only.
201 to 500sq.m (241to 600sq.yd)	----	50% of the site area.
501 to 1000sq.m (601 to 1200sq.yd)	----	40% of the site area
More than 1000sq.m	----	33% of the site area.

1.3 Residential Building

Requirements of every individual is different according to their social status, lifestyle and income category. A rich man may require a luxurious apartment while a lower income group guy may live in a 1 BHK house.

Table 2: MINIMUM FLOOR AREA & HEIGHT OF ROOMS

	FLOOR AREA	HIEGHT (m)
LIVING	10sqm (100sqft)	
	(breadth min 2.7 m or 9')	3.3 (11')
KITCHEN	6sqm (60sqft)	3.0 (10')
BATH	2sqm (20sqft)	2.7 (9')
LATTRINE	1.6sqm (16sqft)	2.7 (9')
BATH & WATER CLOSET	3.6sqm (36sqft)	2.7 (9')
SERVANT ROOM	10sqm (100sqft)	3.0 (10')
GARAGE	2.5*4.8 m (8'*16')	3.0 (10')
MIN. HIEGHT OF PLINTH		
FOR MAIN BUILDING	-------	0.6 (2')
MIN. HIEGHT OF PLINTH FOR		
SERVANT QUARTES	-------	0.3 (1')
MIN. DEPTH OF FOUNDATION	-------	0.9 (3')
THICKNESS OF WALL	20cms to 30cms	------
	(9" to13.5")	
DAMP PROOF COURSE	2cms to 2.5cms	thick full width of plinth wall

	(3/4” to1”)	

1.4BUILDING BYE LAWS & REGULATIONS

- Line of building frontage and minimum plot sizes.
- Open spaces around residential building.
- Minimum standard dimensions of building elements.
- Provisions for lighting and ventilation.
- Provisions for safety from explosion.
- Provisions for means of access.
- Provisions for drainage and sanitation.
- Provisions for safety of works against hazards.
- Requirements for off-street parking spaces.
- Requirements for landscaping.
- Special requirements for low-income housing.
- Size of structural elements.

1.5 ARRANGEMENT OF ROOMS

- Living room – This is the area for general use where family spends much of their time. It is usually near the entrance of the house. During winters, this area receives much of the sunshine and in summer, the sunrays enter from southern part.

- Kitchen – this is usually made in the eastern side of the plot for morning sunshine, which refreshes and purifies the air.

- Storeroom– Generally, the storeroomis provided at the backside of the home where it is away from daily activities and proper ventilation is provided.

- Bedroom– this area should provide privacy to the members and should provide provision for table, chairs, and cupboards. Attached toilets may be provided for ease of convenience.

- Office room –Eastern aspects are preferred for office rooms to provide the morning sunrays for freshness. In addition, it should be in a spot with less disturbance from the surrounding areas.

- Bath & W.C. – Usually, bath and W.C. are combined in a single room and attached to bedroom for increase of convenience and privacy. The bathroom is usually made white with glazed tiles with complete showers, bathtubs etc.

- Verandah – A residential building must be provided with open verandahs at the front and rear side of the home. This verandah provides protection to the home from sunrays, wind and rain. It also provides with a place to sit and enjoy. This area varies between 10%-20% of the total area.

- Stair case– The staircase should be placed in the front of the building if it is intended for visitors and should be placed at the back of the home if family members would use it more. Rises & treads should be uniform to smooth movement.

1.6 ORIENTATION OF ROOMS

After having selected the site, the next step is proper orientation of building. Orientation means proper placement of rooms in relation to sun, wind, rain, topography and outlook and at the same time providing a convenient access to both the street and back yard.

The factors that affect orientation most are as follows.

- Solar heat
- Wind direction
- Humidity
- Rain fall
- Intensity of wind site condition
- Lightings and ventilation

CHAPTERCHAPTER 2: LITERATURE REVIEW

2.1 Structural analysis of framed structure

Reinforced concrete structure mainly contains of-

1) Slabs, which will be there to cover most of the areas

2) Beams are supporting the slabs and the wall

3) The columns are there for supporting the beams

4) The footing play a vital role as they distribute the concentrated loads acting on the column to minimize the bearing capacity of the soil.

In any of the framed structure, the load is mainly conveyed from the slab to the beam, and then conveyed from beam to column and then conveyed to the foundation and at the end to the soil, which is below it.

2.2 Stages in structural design

There are different stages in designing of a structure. They are-

1) Planning of the structure

2) Direction and impact of forces and the calculations of the loads

3) Method of analysis

4) Designing of a member

5) Scheduling, detailing and preparation of drawings

2.3 Structural Planning

When once we are through our architectural plan of our residential building, then we come across our structural planning. Structural planning involves some of the following points:-

1) Orientation of the columns and their positioning

2) Positioning of the beams

3) Traversing of the slabs

4) Geometrical design of stairs

5) Selection of foundation

It is very necessary to know that the loads are transferred to the footing and that too in the shortest path from the compact members .

2.4 POSITION OF THE COLUMNS

1) Columns should be positioned mainly at or near the corners where there is intersection of beams and walls in a residential building. Since we know that the function of the column is to provide support to the beams which is mainly put under the walls to bear the load.

2) Selection of the position of the columns in such a way as it will be reducing the bending moment in beams. The two columns should not be placed too near and if it is so then provide one column instead of two at a perfect position so that it reduces the bending moment.

3) Do not take larger length of the beams. When the centre to centre distance between the intersection of walls is large or when there are no cross walls, the spacing between two columns is governed by limitations of spans of supported beams because spacing of columns decides the span of beam. As the span of the beam increases, the required depth of the beam, and hence its self weight, and the total load on beam increases.

We know that the moment in the beam mainly varies with the square of the span length and is directly proportional with the load. Hence if we increase the span it will considerably increase the size of the beam.

And if we see in case of columns there is negligible change in the column if we increase the total load as long as the column is short. From here we came to know that the cost of the beam per unit length increases very much if we increase the span as compared to the beams. Therefore the larger span of the beams should be avoided to minimize the cost.

4) There should be minimum center to center distance between the columns because larger spacing of columns not only increases the load on the column at each floor posing problem of stocky columns in lower storeys of a multi storeyed building.

5) Since column footing requires certain area beyond the column, difficulties are encountered in providing footing for such columns. In such cases, the column may be shifted inside along a cross wall to make room for accommodating the footing within the property line.

2.5 POSITION OF BEAMS

1) Beams should be placed under the walls or under a heavy concentrated load so that the load should not act directly on the slabs. Since beams are placed under the slabs mainly to support them, the maximum span length of slabs shall compute its spacing.

2) To carry a given load slab wants the maximum volume of concrete. Therefore, the thickness

should be minimum in the slabs. The maximum practical thickness for residential/office/public buildings is 200mm while the minimum is 100mm.

3) The maximum and minimum spans of slabs, which decide the spacing of beams, are governed by loading and limiting thickness given above. However, in case of buildings, where the live load is less than 5kN/m^2, the maximum spacing corresponds to the value of maximum span of slabs given in the table below .

Table 3 : Span of slabs according to spacing provided

Support condition	*Cantilevers*	*Simply supported*	*Fixed/continuous*
One-way Two-way	*One-way Two-way*	*One-way Two-way*	*One-way Two-way*
Maximum Recommended span of slabs	*1.5m 2.0m*	*3.5m 4.5m*	*4.5m 6.0m*

4) Avoid larger spacing in between beams to fulfill the deflection and cracking criteria. There should be no larger span in the beams to control the deflection and cracking. That is why it is well known that deflection varies directly with the cube of span and inversely with the cube of depth *i.e.,*L^3/D^3. Consequently, increase in D is less than increase in span *L* that results in greater deflectionfor larger span.

5) However, for large span, normally higher *L/D* ratio is taken to restrict the depth from considerations of headroom, aesthetics and psychological effect. Therefore, in beams where it is required span depth to be greater than one meter should not be used.

2.6 SPANNING OF SLABS

This is calculated by supporting arrangements. If the supports are on opposite edges or pointing in the one direction, the slab behaves as a one way supported slab. If rectangular slab is supported along its four edges, it behaves as a one way slab when Ly/Lx>2 and vice versa for two way slab if Ly/Lx<2. However, this two-way slab not only depends on the Ly/Lx ratio but also on the ratio of their reinforcement in the two directions. Therefore, it is the designer's decision whether he wants to design it as a two way or one-way slab.

1) A slab is said to be one-way slab if the ratio of Ly/Lx > 2 and in this case one-way action is the main element. If there is one-way slab then the main steel will be provided in the direction of the short span and the load is transferred in the two opposite supports. The steel, which is provided along the longer span, is only a distribution steel and is not designed for transferring the loads but is designed to resist temperature stresses, shrinkage, and somewhere to distribute the load in the structure.

2) Whereas in case of two way slab the ratio of Ly/Lx<2 and is considered economical when compared with the one way slab because the steel provided along the span behaves like main steel and transfers the load to all the four supports. The two-way slab is very beneficial when taken in consideration in case of two slab and for live load greater than 3KN/m^2. If there are

short span and live loads, we need not to change the steel requirement for two-way slab as when compared with the one-way slab.

3) Spanning of the slab also depends on the continuity of the slab.

4) Determine the type of the slab. When determining the choice of the slab used whether a cantilever or simply supported or uniformly distributed loading it should be kept in mind that the maximum banding moment in cantilever is ($M = wL^2/ 2$) which is four times that of a simply supported slab with its maximum bending moment of ($M=wL^2/8$), while it is five to six times in a continuous slab or a fixed slab with their bending moment to be ($M=wL^2/10$ or $wL^2/12$) simultaneously for the same span length.

5) Similarly, when it comes to the case of deflection of the cantilever loaded by UDL is given by:

$$\delta = wL^4/8EI = 48/5 * (5wL^4 / 38EI)$$

Which is approximately ten times that of simply supported slab = ($5wL^4/ 384 EI$).

2.7 ACTION OF FORCES AND COMPUTION OF LOADS

2.7.1 BASIC STRUCTURAL ACTIONS

There are different structural actions that an engineer should keep in mind and they are as follows:-

Axial force action:-

It occurs when we take a case of 1-D members like columns, cables, arches and any member of truss and is mainly caused by the tensile and compressive forces stresses only.

Membrane action:-

It occurs when we consider 2-D structures like shells and plates. It includes forces in the longitudinal direction only.

Bending action:-

The forces, which are either parallel or traverse to the membrane axis and held in the plane of bending includes tensile or compressive stresses. Mainly the bending should be about one or both the axis and perpendicular to the member axis.

Shear action:-

In-plane parallel forces mainly including shear stresses cause this action.

Twisting action:-

The twisting action is caused by out plane parallel forces i.e. the forces that are not contained in the in the plane of axis of the member but in a plane perpendicular to the axis of the member producing torsional moment and hence inducing shear stresses in the member.

Combined action:-

When one or more actions combine and act then it is known as combined action. The complex stress condition is produced in the member.

2.7.2 ANALYSIS OF A STRUCTURE

The analysis of a structure can be done in different ways and they are-

1) Elastic analysis
2) Limit analysis

Elastic analysis is nothing but working stress method of design.

Limit analysis is further divided into ultimate load method of design and plastic theory applied as steel structures, and is later modified as Limit State Method for reinforced concrete structures, which contains designing for ultimate limit state at which the ultimate load theory implies and in the service state elastic theory.

Member Design: - the member design consist of the designing of slab, beam, column, and footing which we can do by limit state method .

2.8 LOADS AND MATERIAL

Properties of material and loads are the basic parameters that affect the design of a reinforced concrete structure. The correct loading of a structure is a vital step and serviceable design of structure.

Types of loads

There are many classifications of loads and are classified as horizontal loads, longitudinal loads and vertical loads. The vertical load is further divided in dead load, live load, impact load. The horizontal load is divided in wind load and earthquake loads and lastly the longitudinal load consist of braking forces, which are considered in special case of design of bridges and design of gantry girders etc.

Dead load:-

This load is permanent or stationary which the structure carries throughout their life span. Dead load is mainly due to the self-weight of the structural members, weight of different materials, permanent partition walls and fixed permanent equipment.

Live loads or Imposed loads:-

Movable load or Live load are mainly without any acceleration or impact. Theyare mainly assumed to be due to the intended use or occupancy of the building including weights of furniture or movable partition etc.

Impact loads:-

The vibrations, acceleration or impact mainly causes the impact loads. For example, a person walking will only produce a live load but soldiers marching or frames supporting lifts and hoists produce impact loads. Thus we can say that the impact load is equal to the imposed incremented by some percentage that depends on the intensity of impact.

Wind load:-

The wind load is mainly the horizontal load that is caused by the movement of air relative to the earth. The wind load is taken into consideration when the height of the building will exceed the two times dimensions traverse to the exposed wind surface. If the building is only having 2 to 3 storeys then the wind load is not critical because the moment of resistance provided by the continuity of floor system to the column connection and the walls provided between the column connection and the walls provided between the columns are sufficient to take the effect of these forces.

Now the changes are been made in limit state method for the design load and is reduced to 1.2(DL+LL+WL) when the wind is taken in consideration and to a factor of 1.5(DL+LL) when wind is not taken in consideration.

Earthquake load:-

These loads are horizontal loads, are caused due to earthquakes, and can be computed by the IS 1893. In massive reinforced concrete structures that are located in zone 2 and zone 3 which are not, more than threestoreys high and importance factor should be less than one then the seismic forces are not critical.

2.9 PROPERITIES OF CONCRETE

Compressive strength:-

Same as load the strength of the concrete is also a quantity, which changes considerably for the same concrete mix. Therefore,compressive strength is a main factor in arriving at statistical probabilistic principles.

Grade of concrete:-

The Concrete is mainly known by its grade and which is classified as M15, M20, M25, M30 etc. in which the M letter refers to the concrete mix and the number 15, 20, 25 defines that the compressive strength of a 150mm size cube at a time lapse of 28 days which is expressed in N/mm^2. Therefore, the concrete is known by its compressive strength. We take M20 orM25 for a reinforced concrete work but for extreme environment higher grade of concrete can be taken.

Characteristic strength:-

It is defined as that value of the strength below which not more than 5% of the test results are suspected to fall,(i.e., there is 95% probability of achieving this value, or only 5% probability of not achieving the same).

Characteristic strength of concrete in flexural member:-

It may be noted that the strength of concrete cube does not truly represent the strength of concrete in flexural member because factors namely, the shape effect, the prism effect, state of stress in a member and casting and curing conditions for concrete in the member. Taking this into consideration the characteristic strength of concrete in a flexural member is taken as 0.67times[2.6] the strength of concrete cube.

Design strength (f_d) and partial safety factor (f) for material strength:-

The strength to be taken for the purpose of design is known as design strength and is given by

$$\text{Design strength } (f_d) = \frac{\text{characteristic strength } (f_{ck})}{\text{Partial safety factor(f)}}$$

The value of f depends upon the type of material and upon the type of limit state. According to I.S. code,

f = 1.5 for concrete and f = 1.15 for steel.

Design strength of concrete in member = $0.67 f_{ck} / 1.5 = 0.446\, f_{ck} \approx 0.45\, f_{ck}$

Tensile strength (f_{cr}):-

The estimate of flexural tensile strength or the modulus of rupture or the cracking strength of concrete from cube compressive strength is obtained from the relation:

$$f_{cr} = 0.7\sqrt{f_{ck}}\ \ N/mm^2$$

We can obtain the tensile strength of the concrete in direct tension experimentally by the split cylinder strength and it varies in the range of 1/8 to 1/12 of the 150mm cube compressive strength.

Creep:-

It is defined as the plastic deformation under any sustained load.
The ultimate creep strain is calculated from the creep coefficient è given by:

$$è = \text{creep strain / elastic strain} = å_{cc} / å_{i}$$

Creep strain $å_{cc}$ depends on the time of the sustained loading. According to the code, we take the ultimate creep coefficient to be 1.6 at a time of 28 days of loading.

Shrinkage:-

The process of change in volume during the drying and hardening of concrete is termed as shrinkage.

Shrinkage depends mainly on the time for which it is exposed .There is development of cracks if the strain is prevented as it produces tensile stresses in the concrete. The shrinkage is calculated by shrinkage strain, $å_{cc}$ = 0.0003 for design purposes.

Short-term modulus of elasticity (E_c)

The short-term modulus of elasticity is obtained by testing a 150mm concrete specimen at a time lapse of 28 days under specified rate of loading because inelastic deformations under this loading are practically zero.

According to the code,short-term modulus of elasticity of concrete is given by:

$$E_c = 5000 \sqrt{f_{ck}} \, N/mm^2$$

Long-term modulus of elasticity (E_{ce}):-

The creep and shrinkage mainly effect the long-term elasticity as it reduces it with time. Therefore, the long-term modulus of elasticity of concrete takes into account the effect of creep and shrinkage and is given by-

$$E_{ce} = E_c / (1 + è)$$

Where,

E_{ce} = long term modulus of elasticity

E_c = short term modulus of elasticity

è = creep coefficient.

There should be reduction in Ece with time to increase the deflection and cracking with time. That is why it plays a very important role in serviceability and in the calculation of deflection and cracking.

It is said that in IS modular ratio is defined as Es/Ec

Where Es= modulus of elasticity of steel = 2×10^5 N/mm^2.

$E_c = 5000 \sqrt{f_{ck}}$ N/mm^2.

Table 4 : Modular Ratio for different grades of concrete

	Modular ratio for different grades of concrete	
Grade of concrete	*modular ratio 'm'*	
	Short term	*long term*
M_{20}	*8.9*	*13.3*
M_{25}	*8.0*	*11.0*

CHAPTER 3: 2-D DESIGNING IN AUTO-CAD

3.1 Introduction

AutoCAD is mainly a computer aided drafting software which is used mainly by the drafters engineers surveyors to create the design of buildings, bridges etc. it has many benefits like shorter time span in preparation of drawings, reduces manpower, very much efficient in drafting etc.

It has many advantages over manual methods as if it is faster as it take very less time. Repetition of work is not there as one can start from where one had left, as it is stored in the computer memory. The previous drawings can be combined to make the newer drawings. It increases the accuracy of the work.

Once the drawing is drawn on a screen, it can be easily drawn on paper with a plotter and this will result in neat, clean and accurate drawings with sharp and consistent lettering. It is very economical and affordable to drafting design officers.

Table 5: Building specifications (acc. to NBC 2015)

	Norm (m)	Applied in project (m)
Living Room	4.2 X 4.8 – 5.4 x 7.2	4 x 5.2
Dining Room	4.2 x 4.8 – 4.8 x 6	4.2 x 4.8
Bed Room	4.2 x 4.8	4.2 x 4.3
Kitchen	3 x 3 (min)	3.5 x 4
Dressing Room	1.5 x 3 (min)	3.5 x 1.5
Bathroom + W.C.	1.8 x 2.5 (min)	3 x 2.5
Verandah	10% -20% of total plot area	3.3 x 1.5
Garage	3 x 6	3 x 6
Staircase	Width- 0.9 (min.) Clear Railing- 1.5 (max.) Clear headway-2.1 (max.) R=18-T, or R=66/T, or R=(24-T)/2	Width- 1 Clear Railing – 1.2 Clear headway – 2.1 Rise= 0.2 Tread=0.3 No of steps= 19 (9+1+9)

3.2 Design Plans

Figure 1: Architectural Plan

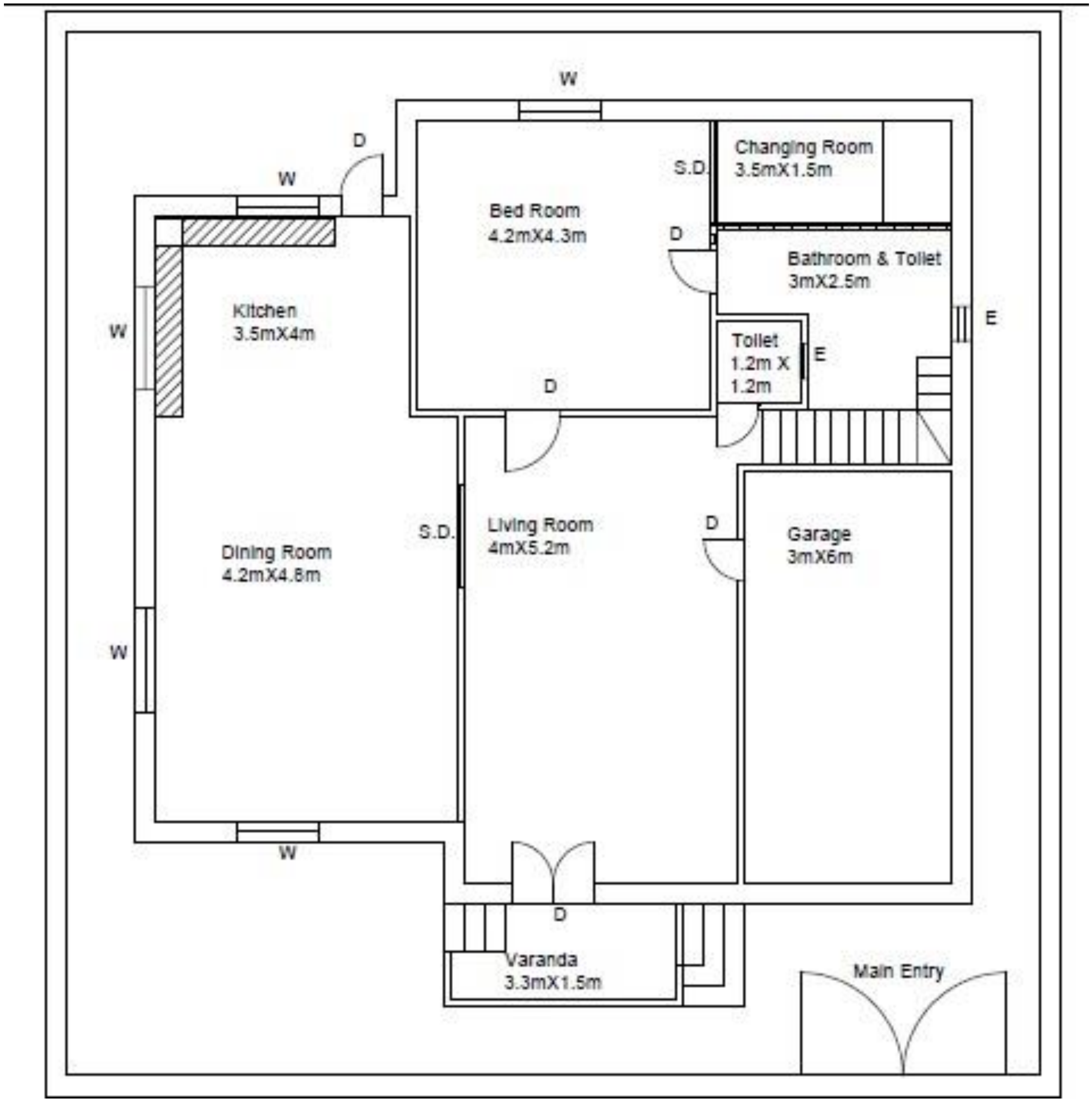

W
D
W
Bed Room
4.2mX4.3m
S.D.
Changing Room
3.5mX1.5m
D
Bathroom & Toilet
3mX2.5m
Kitchen
3.5mX4m
W
E
Toilet
1.2m X
1.2m
E
D
S.D.
Living Room
4mX5.2m
D
Garage
3mX6m
Dining Room
4.2mX4.8m
W
W
D
Varanda
3.3mX1.5m
Main Entry

Figure 2: Front view

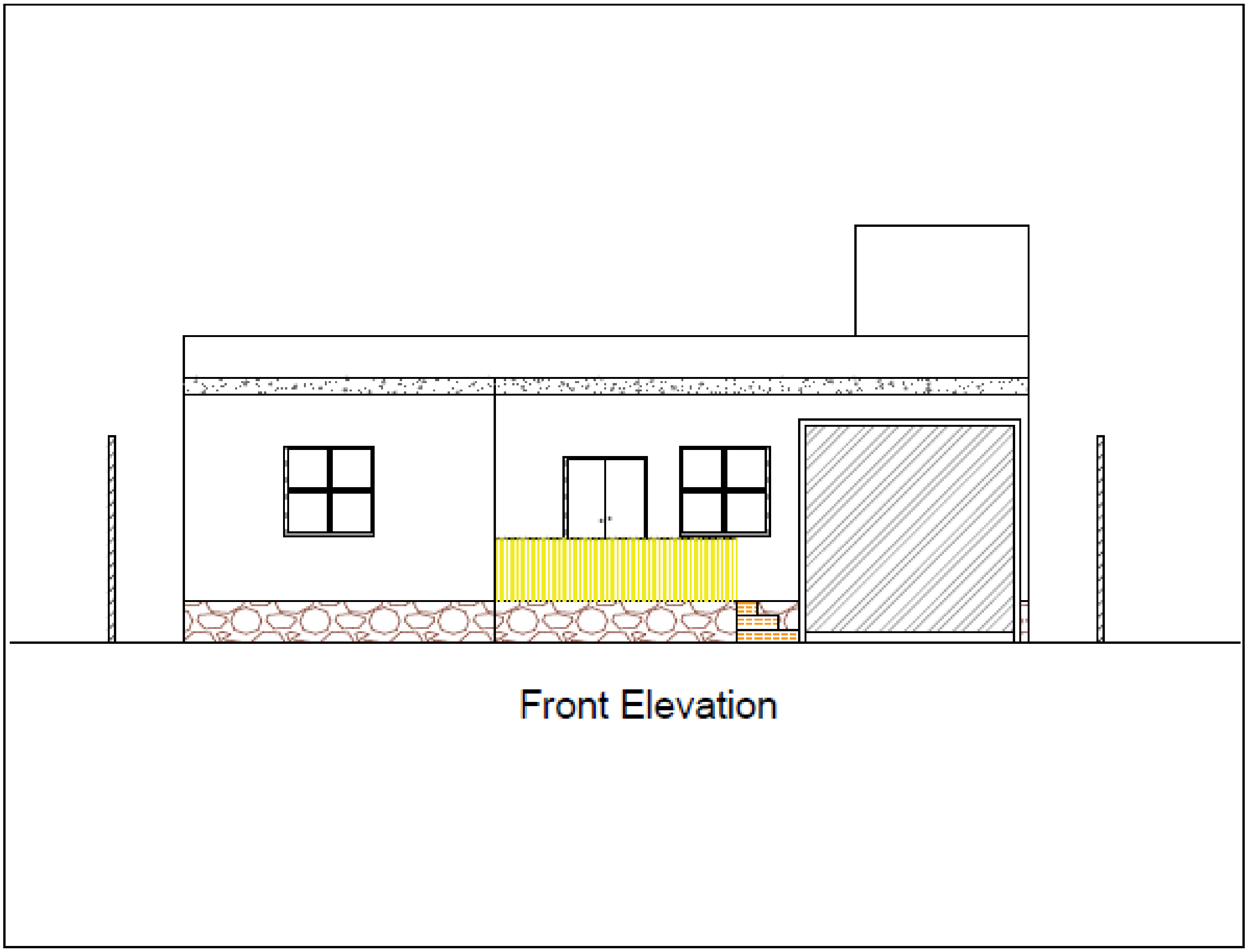


Figure 3: Isometric View

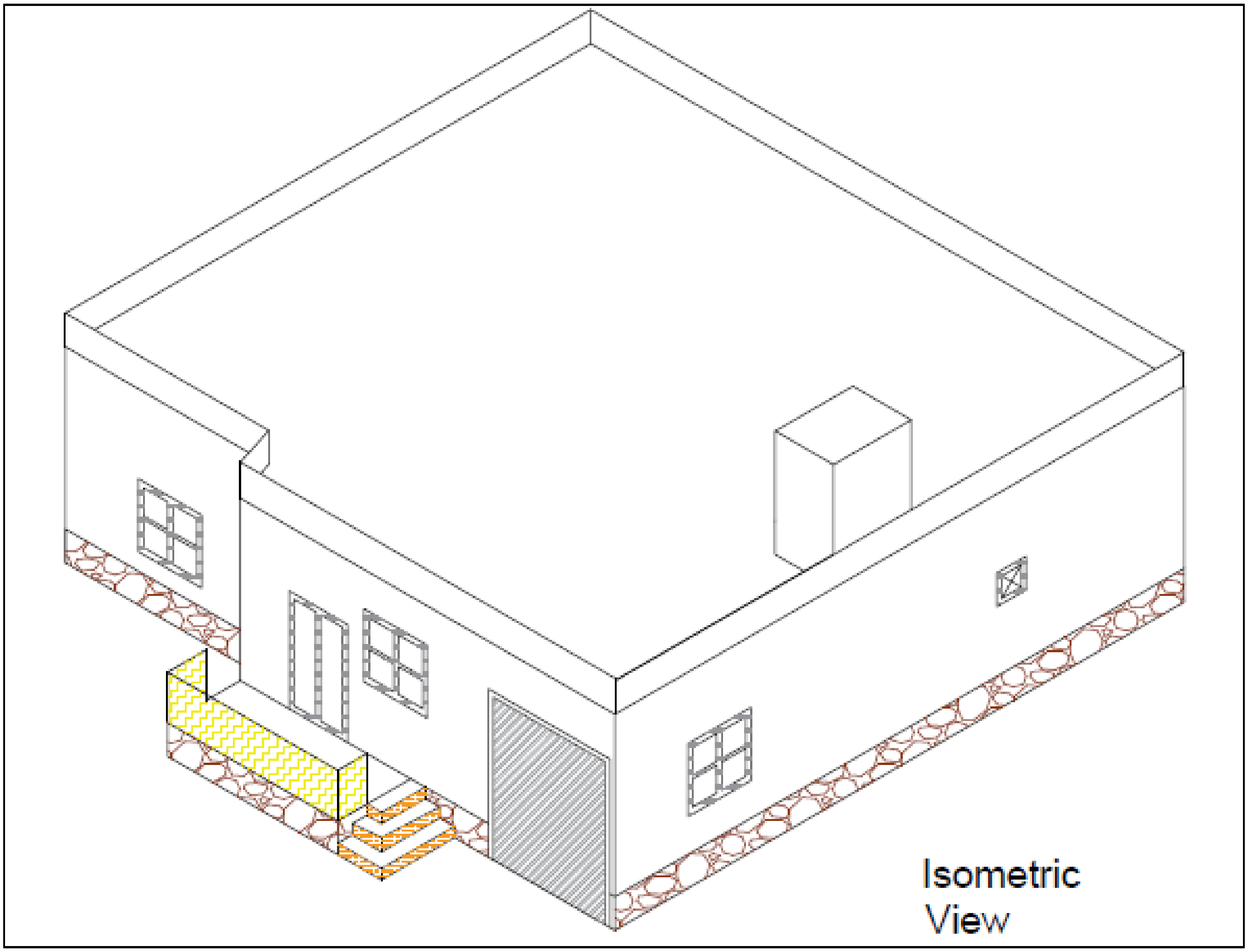


Figure 4 : Right side view

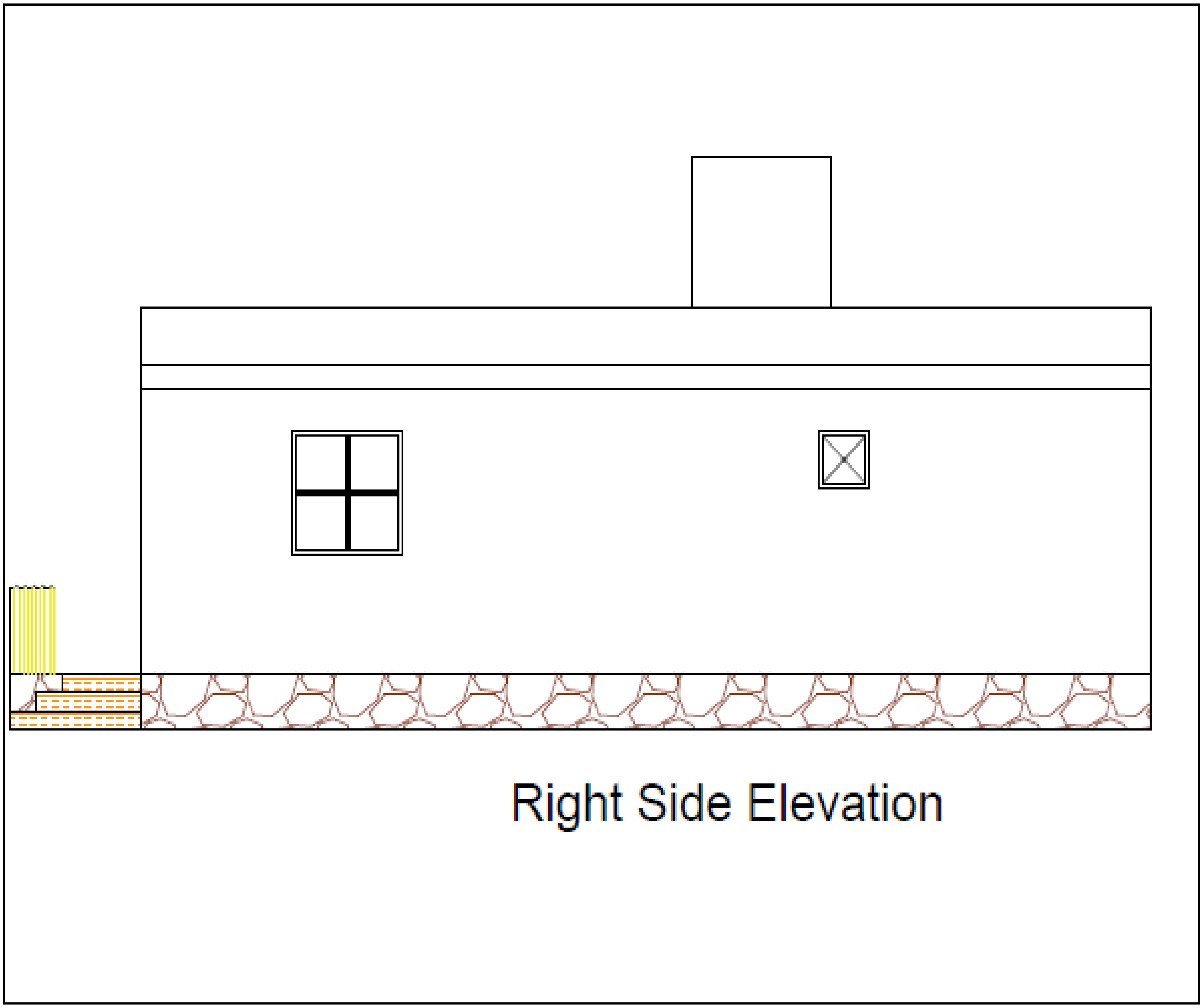


Figure 5: Beams & Columns layout plan

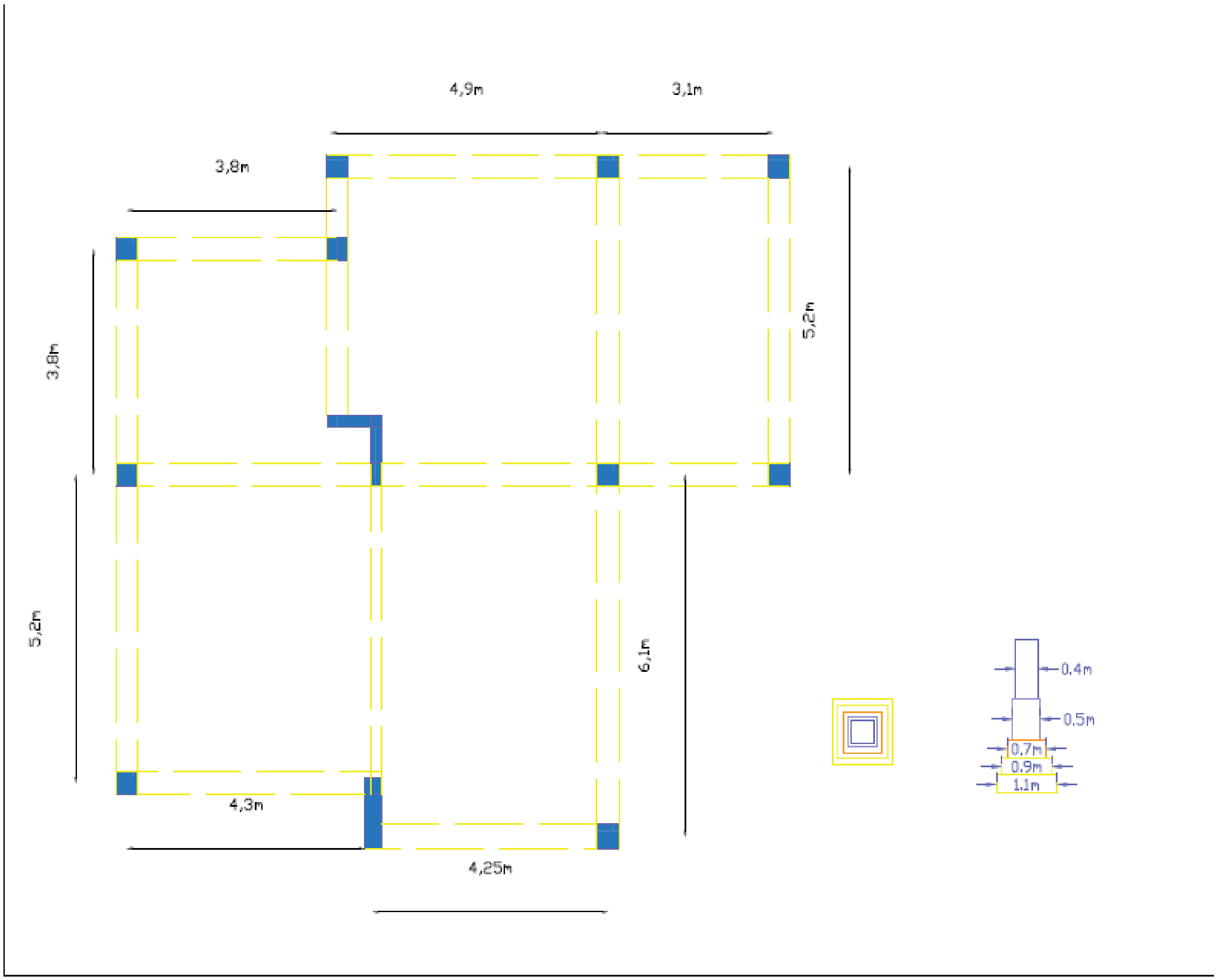


Figure 6: Electrical drawing

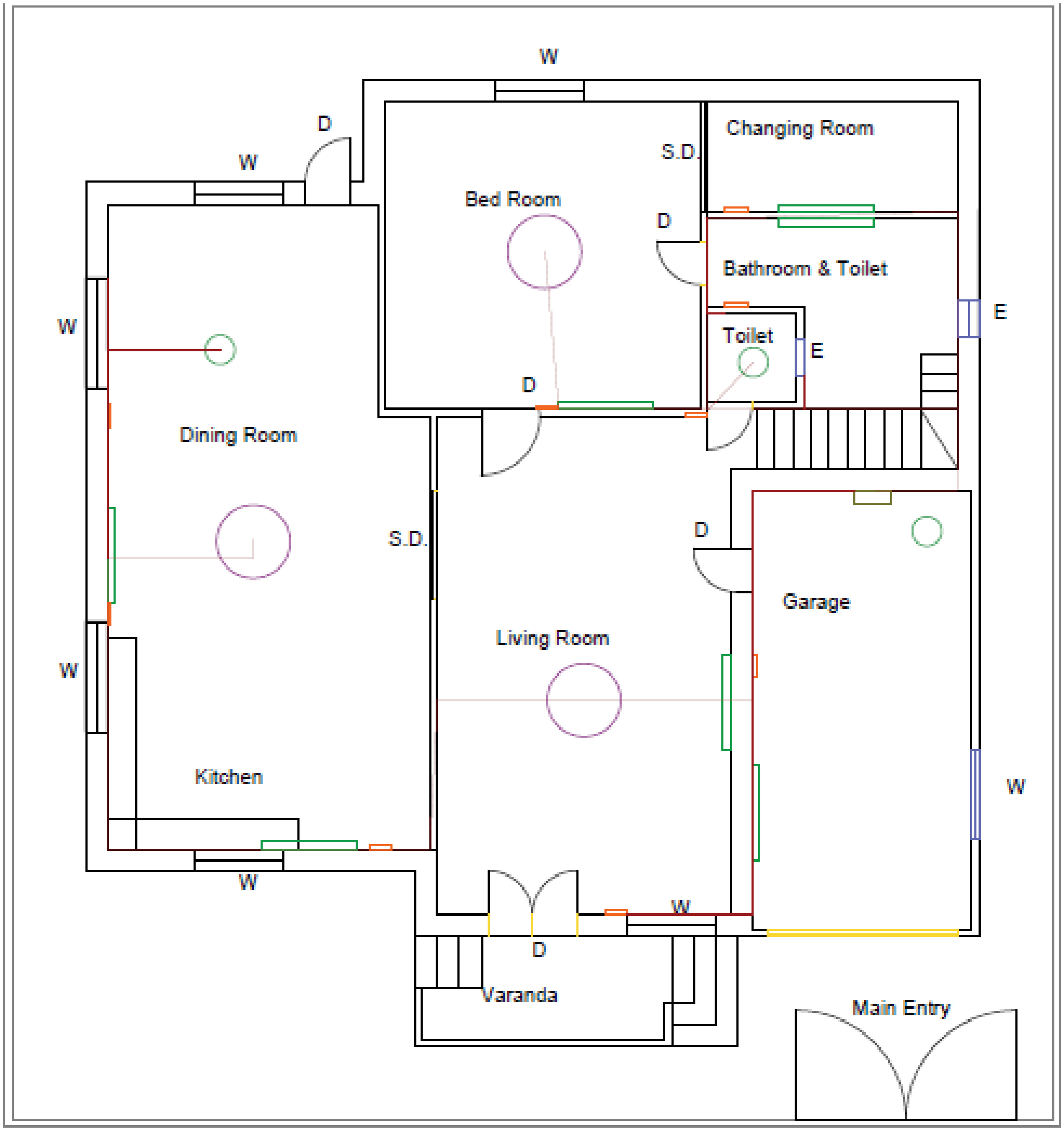
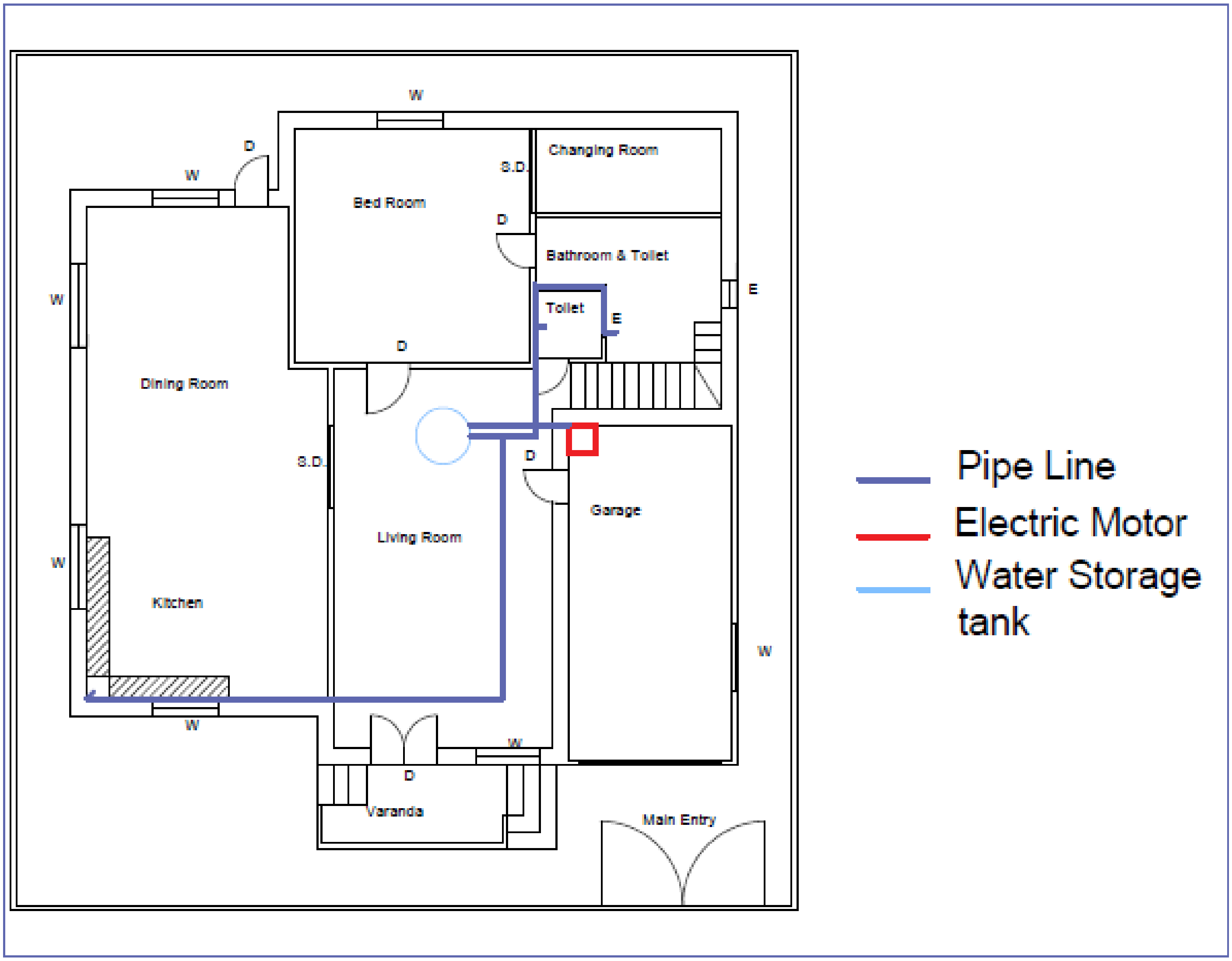


Figure 7: Water pipeline



CHAPTER 4: 3D MODELLING IN REVIT

4.1 Introduction

It is a modeling software used by the designers ,structural engineers, architects and contractors. When we use revit it design a building and structure in 3D and gives explanation of the model with 2D drafting elements. Revit is mainly a tool to plan and track various stages in building construction till its demolition.

The revit work allows users to operate whole buildings or assemblies or individual 3D shapes. An experience user can make any realistic and accurate design by the use of autodeskrevit. It can create parametric models with its dimensions and properties.it can modify a given component such as changing its height, width and number in case of an array.

4.2 Rendered models

Figure 8: Front view

Figure 9: Top view

Figure 10: Right side view

Figure 11: Dining room render

CHAPTER 5: DESIGN CALCULATIONS

5.1 Design of Rectangular Slab:

Design of a rectangular slab of size 13.8mX13.2m

superimposed load for the slab is 3KN/m^2

using M20 and Fe415

Solution: Design constant for:

k_c=0.284, j_u=0.404 and r_c=0.414

Length of panel (L)=13.8m

Width of panel (B)=13.2m

Along length l_1= L=13.8m and l_2= B=13.2m

Width of Column Strip=0.25B=0.25X13.2=3.3m

with upper limit of 0.25L=0.25X13.8=3.45m

Width of middle strip=13.8-6.9=6.9m

Along length l_1= L=13.2m and l_2 B=13.8m

Width of Column Strip=0.25B=0.25X13.8=3.45m

with an upper limit of 0.25L=0.25X13.2=3.3m

width of middle strip=13.2-6.6=6.6m

We provided drops also the drops should be rectangular in plan having a length in each direction not less than one third the panel length in that direction.

This is direction in length

along length L:-

Min length of drop=l_1/3=13.2/3=4.4m

(however keep it equal to the total width of column strip l_2 =6.6m)

Along with B:-

Min length of drop=l_1/3=13.8/3=4.6m

(however keep it equal to the total width of column strip l_2 =6.6m)

Let the column have a column load of side of square column one fifth of average span.

$l= \frac{L+B}{2}= \frac{13.8+13.2}{2}= 13.5m$

Hence D $=\frac{13.5}{2}=2.7m$

Loading:-

The thickness of flat slab is generally controlled by consideration of
span of effected depth ratio: $\frac{span}{d} \leq 2.6$

Assuming balanced section percentage reinforced for M20 concrete= 0.72% and modification factor for mild steel = 1.6

$\frac{span}{d} = 26X1.6$

$d=\frac{13.2}{26X1.6}=0.317m$

Assuming a nominal lover of 15mmand using 12mm diameter bars total thickness
=317+15+12+6
=350mm

The thickness of drops is normally 25% more than thickness of slab
We assumed thickness of 400mm for the calculation of dead load .

Weight of Slab $/m^3= \frac{400X1X25000}{100}$= 10000N= 10KN$/m^3$

Superimposed load = 3kN/m^2

Snow load:

$S=\mu S_0$

$\beta=30^0$

$15\leq\beta\leq30$

$\mu_2=0.8+0.4\frac{\beta-15}{15}= 0.8+0.4\frac{30-15}{15}= 1.2$

$S=\mu S_0$

=1

Ground snow load $p_g = 20psf$

1 psf= 0.96kPa= 0.96kN/m^2

Total W=13.96 kN/m^2

Moment along shorter span:

For the shorter span length l_1= L=13.2m and l_2 B=13.8m
the column head is circular of Diameter 2.7m

Size of equivalent square support =$\sqrt[2]{\frac{\pi}{4}2.7^2}$ = 2.39m

L_{nl}= l_1-2.39 = 10.8m

w_l= total design load on l_2 XL_{nl}
= (13.8X 13.2) 13960
= 2082542.88 N

M_{ol}= $\frac{w_l+L_{nl}}{8}$ = 2814.011 kN.m

Moment along Longer span:

For the longer span length l_1= B =13.8m and l_2 = L=13.2m

The column head is circular of diameter 2.7m.

Size of equivalent square support =$\sqrt[2]{\frac{\pi}{4}2.7^2}$ = 2.39 m.

L_{nB}= l_2 - 2.39 =11.4 /m.

w_B= total design load on l_2 XL_{nl}
= (13.2X 11.4) 13960
= 2104543.52 N

M_{oB}= $\frac{w_B+L_{nB}}{8}$ = 2998.752 kN.m

Thickness of Slab and Drop

Width of column strip on longer span L= 6.6m

$d = \sqrt{\frac{M_{2L}}{R_c.b}} = \sqrt{\frac{680746.68}{0.914X6600}}$ =335mm

Provide total thickness = 400 mm we will provide 12 mm diameter bars and nominal cover of 20 mm.

Available d= 400-12-20 =378 mm

for Shorter Span = 368mm

5.2 Design of Isolated Rectangular Footing of Uniform Thickness

For R.C. Column

Base size = 300mm X 500mm

Load = 650kN

Assuming q0 = 120kN/m^2

Design Contrast M20 Fe415

$$\frac{x_{u\,max}}{d} = .479$$

$$R_u = 2.761$$

Size of the Footing

w=650kN

W= 1.1w = 715kN

A= 715/120 = 5.95 m^2

$\frac{B}{L}$ =2:3

So, B= 1.93m and L= 2.9m

Footing size we take will 3m X 2m

5.3 Design of Section:

Based on Bending Moment:

About section X-X

M=$\frac{P_0B}{8}(L-a)^2$= 144X$10^6\ N-mm$

$$M_{1u} = 216X10^6\ N-mm$$

About Section Y-Y

M=$\frac{P_0L}{8}(B-b)^2$= 96X$10^6\ N-mm$

$$M_{2u} = 144X10^6\ N-mm$$

$$d = \sqrt{\frac{M_{1u}}{R_uB}} = 198mm = 200mm$$

D=260mm

Based on one way shear

$$V = P_0B\frac{L}{2} - \frac{a}{2} - d$$

=2X$10^5(1.2-0.001d)$

$V_u = 1.5V$ =3X$10^5(1.2-0.001d)$

$$\tau_v = \frac{V_u}{Bd} = \frac{150}{d}\ (1.2-0.001d)$$

P= 0.3%

$$\tau_v = 0.384\ N/mm^2$$

D ≥ 300mm

Permissible Shear Stress= 1X0.384 =0.38

Equating it with V_u

d= 337mm = 340mm

5.4 Reinforcement Design:

$A_{st} = \frac{0.5\,f_{ck}}{f_y}\left[1 - \sqrt{1 - \frac{4.6M_{1u}}{f_{ck}Bd_1^2}}\right]$ Bd_1

=1752mm^2

No. Of Bars having 12 mm diameter= 1752/113= 16

Effective depth d_2 = 348mm

$A_{st}$of short bars

$$A_{st2} = 1175mm^2$$

No of 12mm Diameter =$\frac{117.5}{113} = 1.04$

Min 3 bars in each end band width = $\frac{(L-B)}{2}$ =0.5m

5.5 Design for Column:

Unsupported length = 3m (restrained from one side, unrestrained from other)

Axial Load = 600 kN

Using M20 and Fe415

Effective Length = .65X 3000 = 1950mm

Assuming 1% steel b= $\frac{D}{2}$

e_{min}≤0.5D

$P_u = 0.4f_{ck}A_c + 0.67\ f_yA_{sc}$

1.5X600X10^3= 0.4X 20($A_g - 0.01A_g$) + 0.67 X 415 X 0.01A_g

$$A_g = 112144.2$$

bd = $\frac{D^2}{2}$

d = 473.59mm

D = 500mm

b = 250mm

$$A_g = 250\ X\ 473.59 = 1121.44\ mm^2$$

Area of each bar =1121.44/8 =140.18 mm^2

Bar Diameter = 13.35mm

So 6 Bars of 12 mm diameter

Aø= 173.04 mm^2

Percentage Steel = $\frac{6\ X 113.04\ X\ 100}{250\ X 275}$ = 0.98% > 0.8%

$\frac{L_e}{b} = \frac{1950}{250}$ = 7.8

$$\frac{L_e}{b} = 7.8$$

$\frac{L_e}{b}$ = 9.4

Hence Column is short in both direction

In one direction

emin = $\frac{L}{500} + \frac{D}{30}$ = 26mm

e =.06D = 30mm >emin

So column is preferable to be rectangular with **a = 300 mm** and **b= 500mm** in the presence of 6 number of bars of diameter 12 mm.

CHAPTER 6: STRUCTURAL ANALYSIS ON SAP 2000

6.1 Introduction

In designing of the bridges, residential buildings SAP2000 can do the moving load analysis that none of the other software can do. This program can do torque and other reaction even in case of curved and inclined system. SAP2000 is very simple as it can easily apply loads and assign supports and restraints in the skewed direction. It is very efficient in case of braced or sloped beams.

SAP2000 analysis makes it easy to interpret the direction or forces without much time consuming. The user to define the selected list of sections can compute steel member sizes. It minimizes the error as analyze one section at a time. The forces and moments can be summed using SAP2000's force sum option in order to obtain useful results of shear force and bending moment.

6.2 Structural analysis on SAP 2000

Figure 12: (a): Deformed shape

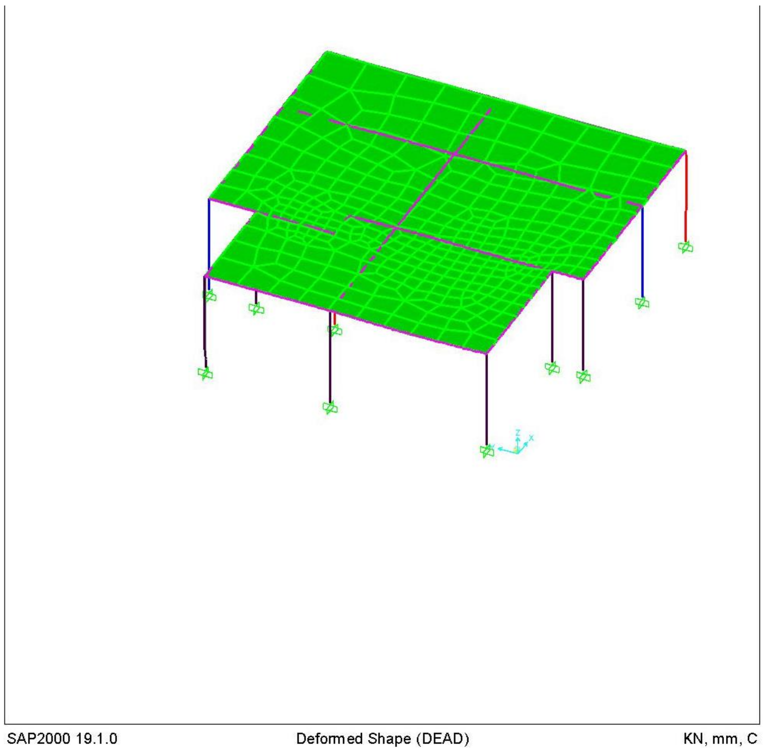


Figure 12 b: Deformed shape (Contours)

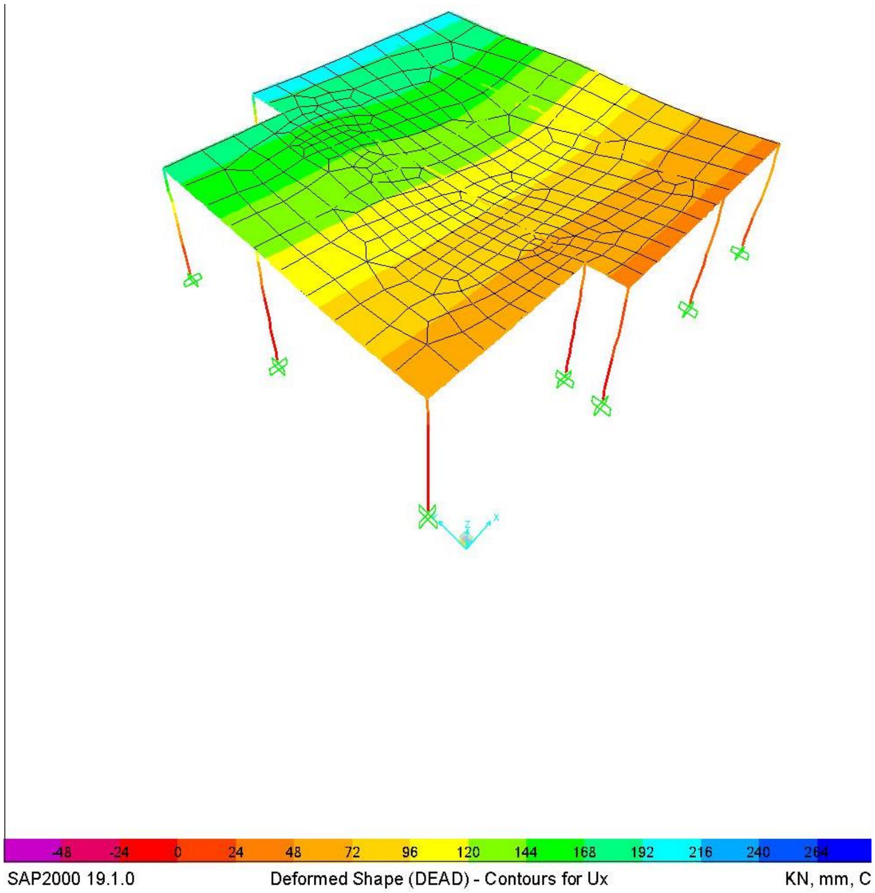


Figure 12 c: Deformed shape of Front Beams

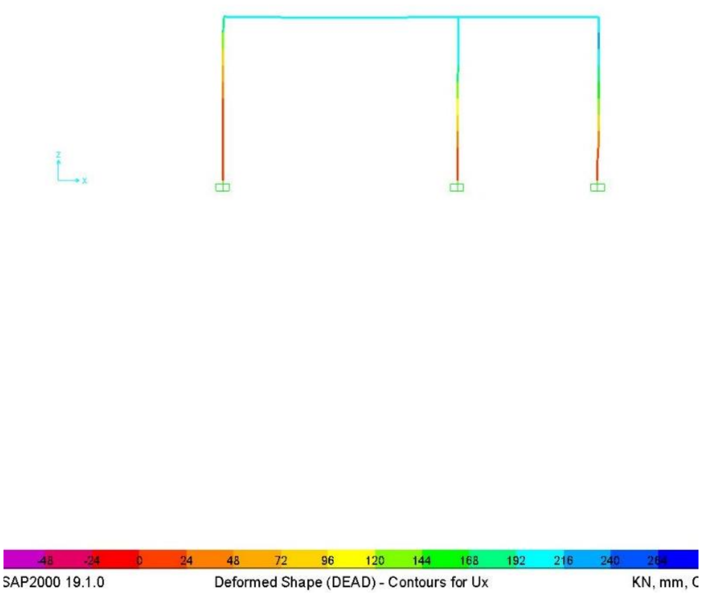


Figure 12 d : Deformed shape of Column at Front Kitchen

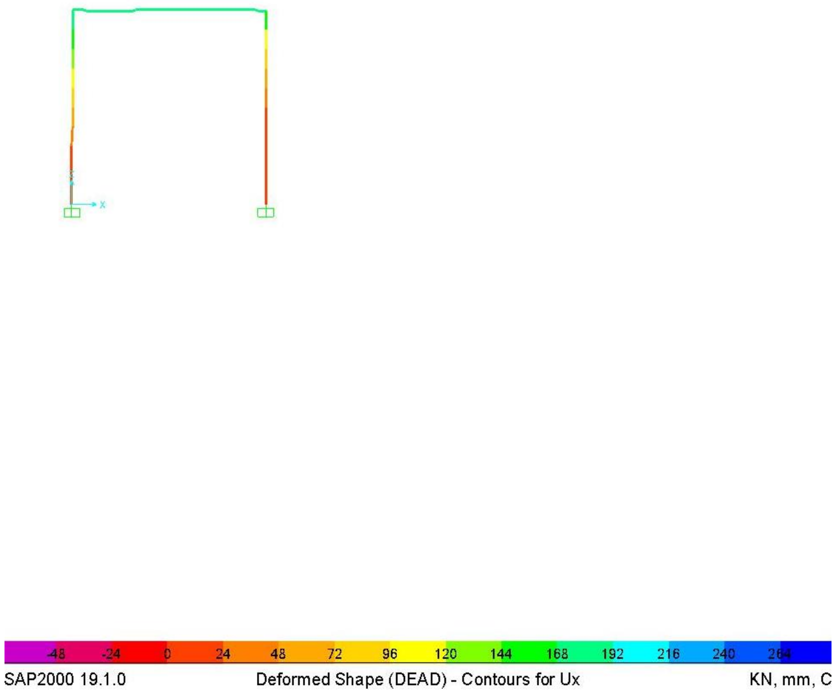


Figure 12 e: Deformed shape of Column and beam at Dining Room

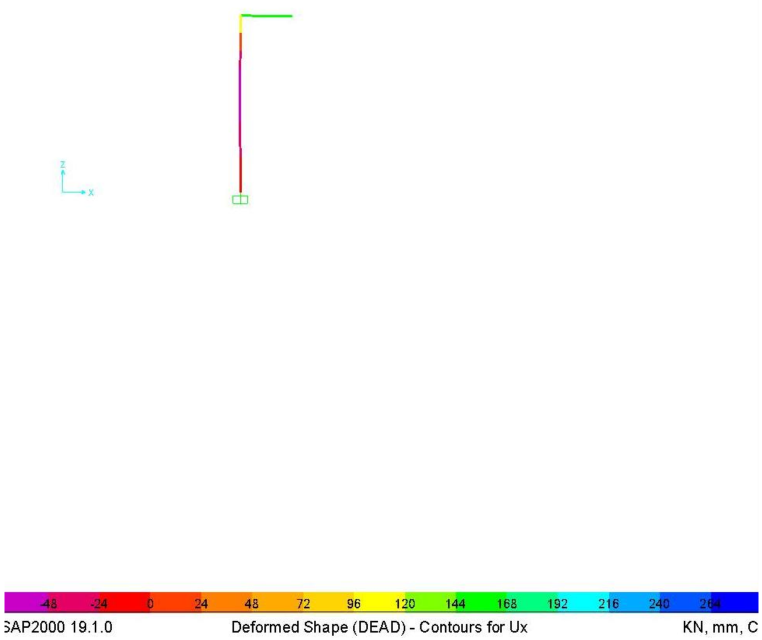


Figure 12 f: Deformed shape of Column and Beam

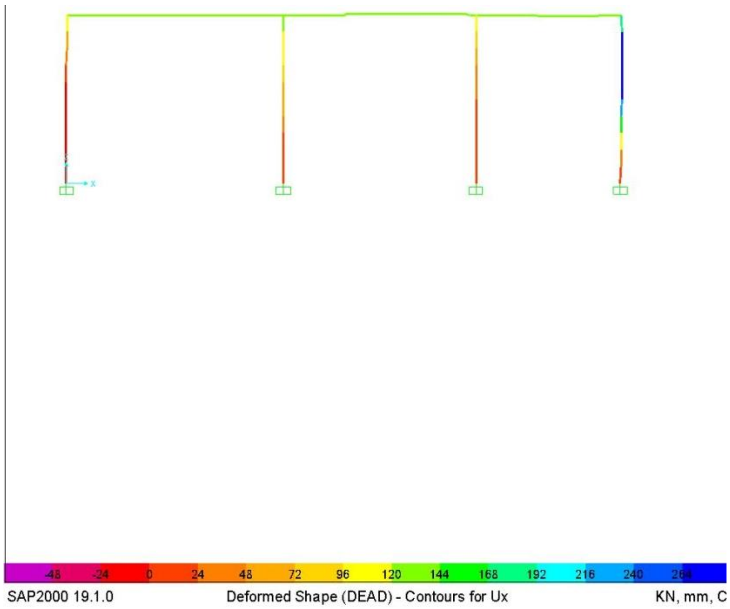


Figure 12 g: Deformed shape of Beam and Column

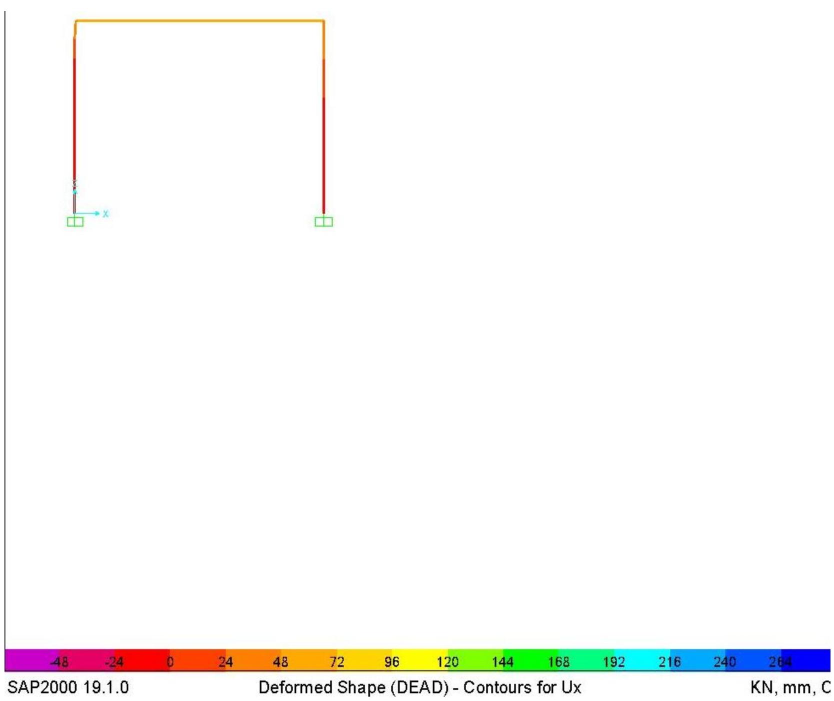


Figure 12 h: Deformed shape of Beam and Column

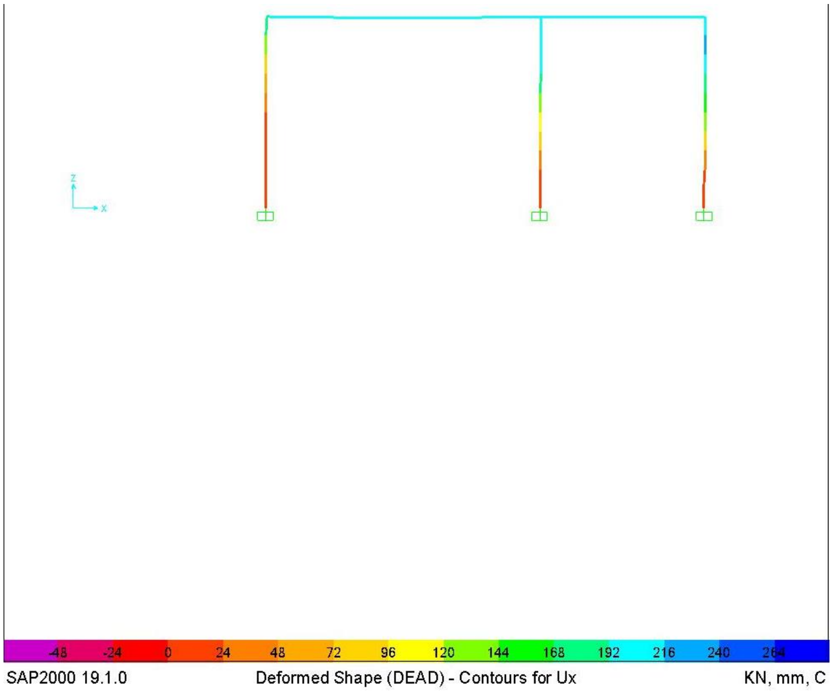


Figure 13 a: Stress Diagram

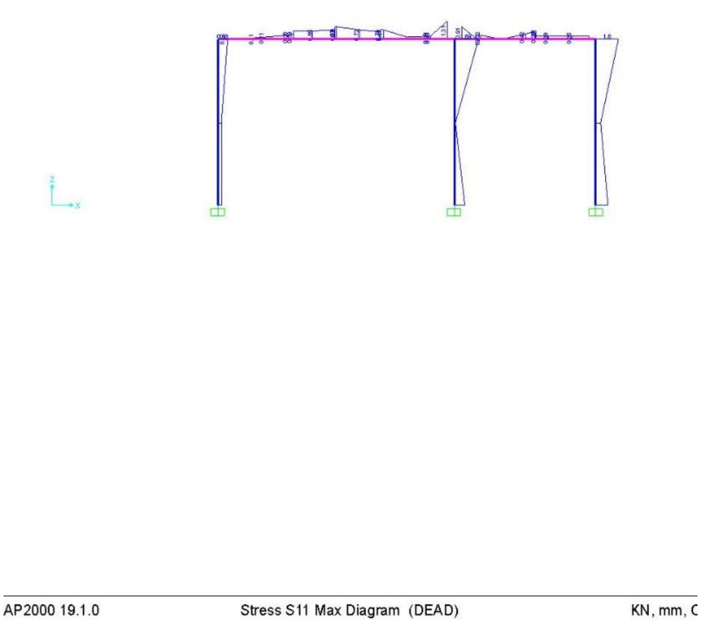


Figure 13 b: Stress Diagram

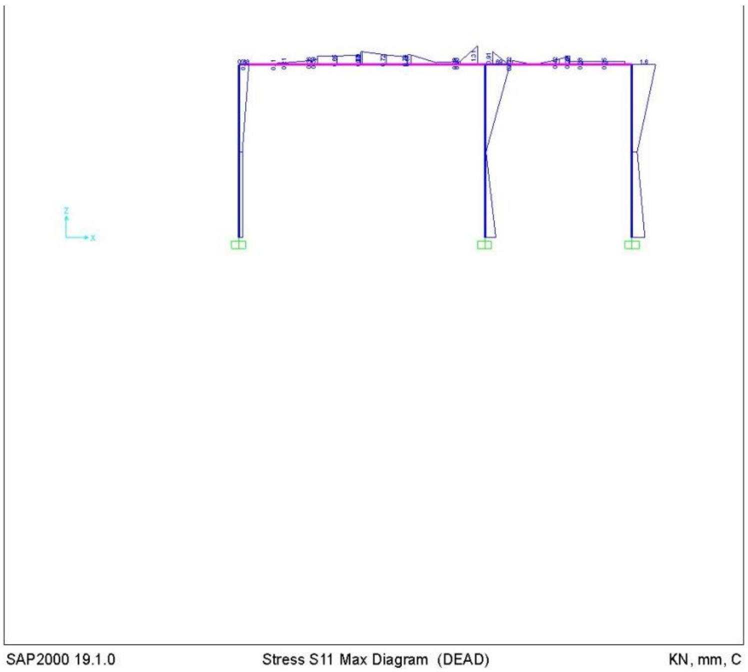


Figure 13 c: Stress Diagram

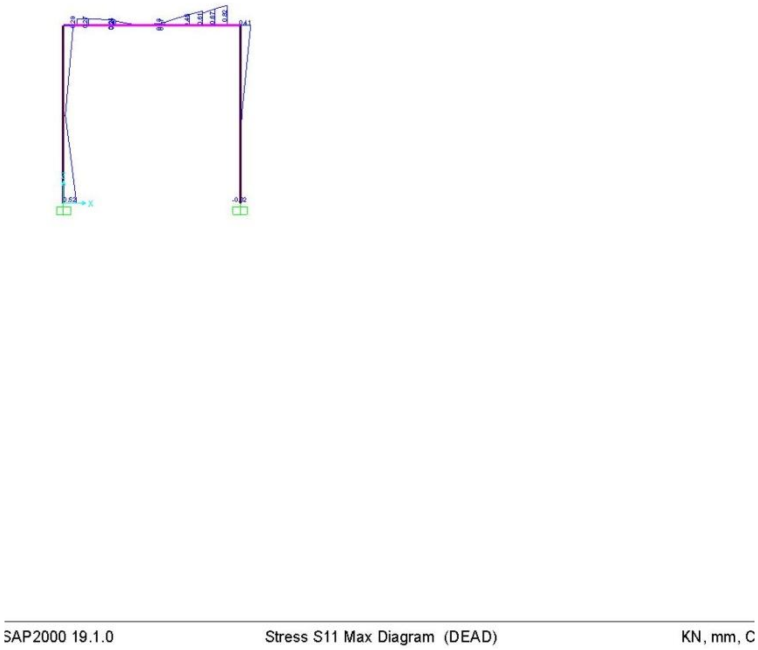


Figure 13 d: Stress Diagram

Figure 13 e: Stress Diagram

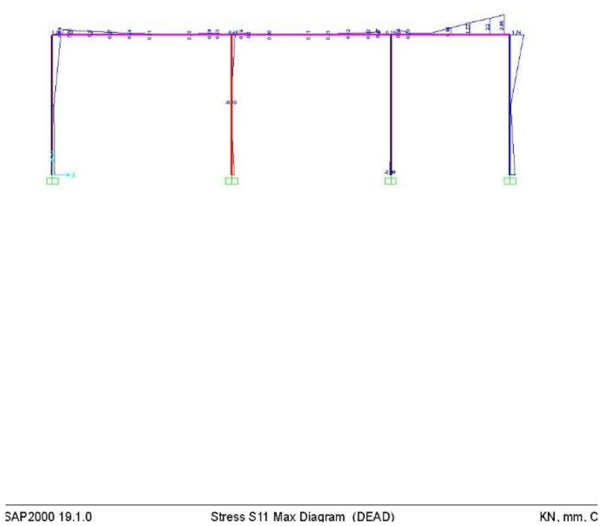


Figure 13 f: Stress Diagram

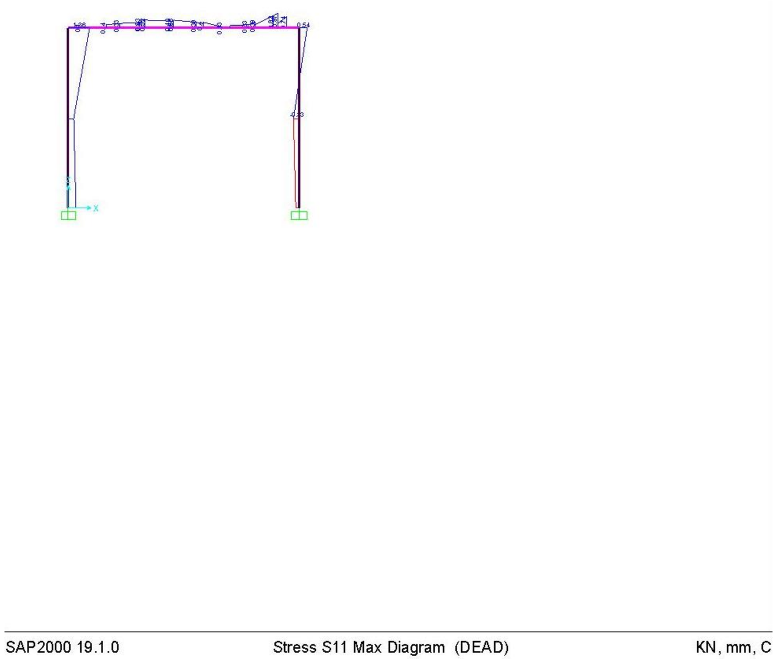


Figure 13 g: Stress Diagram

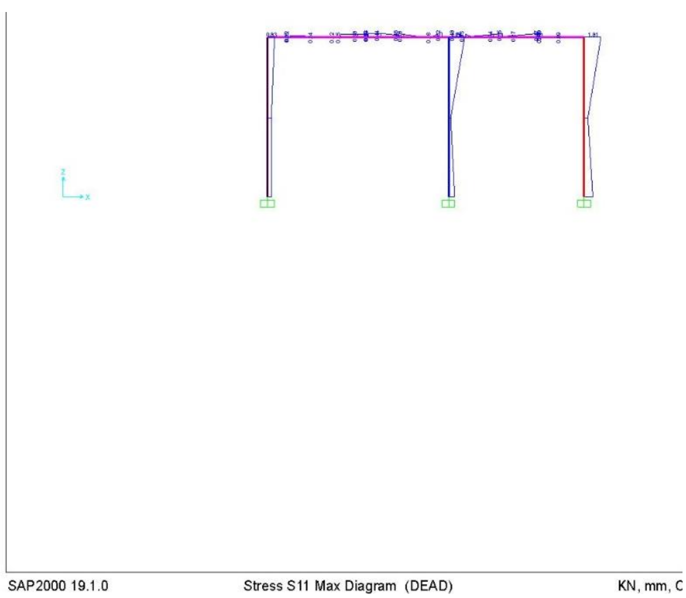
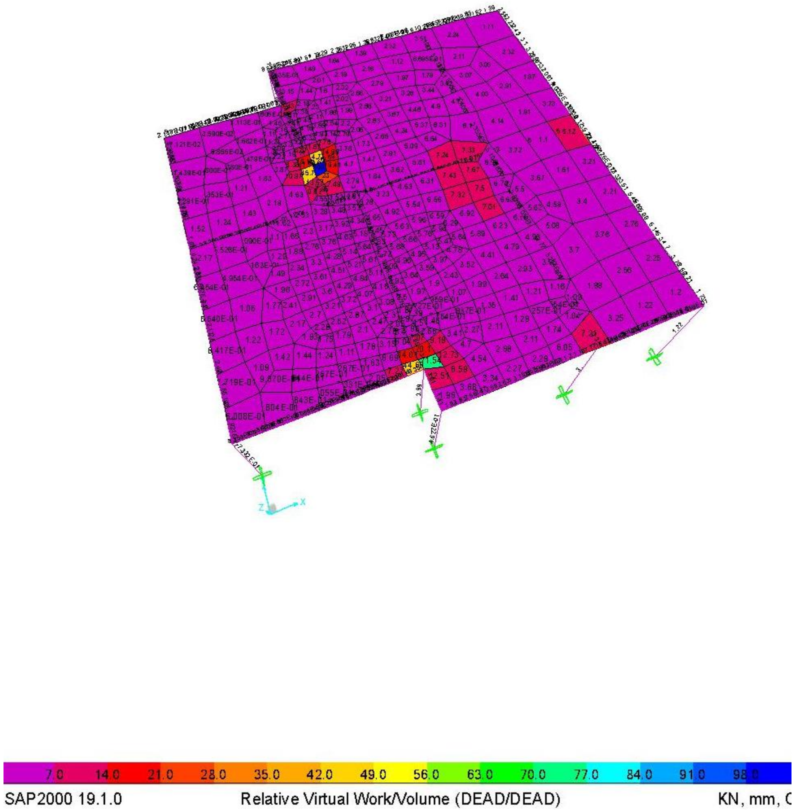


Figure 14: Relatibe Virtual Work done by Loads



CHAPTER 7: COST ESTIMATION USING MS-EXCEL

7.1 Introduction

It is a software designed for contractors to estimate construction cost for a particular project. An estimator will do cost estimation to bid on the project which is a main part of getting a tender and will result in getting the contract for that particular construction. Some architects, engineers and construction managers also do the cost estimation to calculate the profit or losses for the project. There are many other benefits also which includes speed, accuracy, going through the reports and overall process standardization. This estimation programs are becoming more and more popular in these coming years because of its advanced features and trade specific calculations.

Figure 15 (a-f): Cost Estimation in Excel

A	B	C	D	E	F	G	H
Description	**Item Details**	**Unit of measurement**	**Total area**	**Total quantity**	**Rate per unit**	**Total amount**	
Foundation- plain cement concrete							
	Cement 43 grade	bag	1536.44	32.27	400	12908	
Material cost	Coarse sand	cum	1536.44	3.07	1200	3684	
	Aggregate 10 & 20 mm	cum	1536.44	4.92	900	4428	
Manpower cost	Mens	nos	1536.44	16	550	8800	
						0	
2) Superstructure work						0	
Column work						0	
	TMT 8,10,12,16 mm	Kg	1536.44	384.11	36	13827.96	
	Cement 43 grade	bag	1536.44	23	400	9200	
Material cost	Coarse sand	cum	1536.44	4.61	1400	6454	
	Aggregate 10 & 20 mm	cum	1536.44	6.15	1200	7380	
	Shuttering material	sft	1536.44	222.78	50	11139	
						0	
						0	
Manpower cost	Mens	nos	1536.44	14	550	7700	
						0	
Slab work						0	
	TMT 8,10,12,16 mm	Kg	1536.44	806.63	36	29038.68	
	Cement 43 grade	bag	1536.44	84.5	400	33800	
Material cost	Coarse sand	cum	1536.44	35.34	1400	49476	

	Aggregate 10 & 20 mm	cum	1536.44	21.51	1200	25812
	Shuttering material	sft	1536.44	537.75	50	26887.5
						0
Brick work						0
Material cost	Cement 43 grade	bag	1536.44	145.96	400	58384
	Coarse sand	cum	1536.44	30.73	1400	43022
	Bricks	nos	1536.44	34738	4.5	156321
						0
Manpower cost	Men	nos	1536.44	31	550	17050
						0
3) Plaster work						0
Material cost	Cement 43 grade	bags	1536.44	125.37	400	50148
	Fine sand	cum	1536.44	14.26	1000	14260
	Coarse sand	cum	1536.44	15.79	1400	22106
						0
Manpower cost	Men	nos	1536.44	12	600	7200
						0
4) Flooring work						0
Material cost	Cement	bags	1536.44	207	400	82800
	Fine sand	cum	1536.44	23	1000	23000
	Brick blast	cum	1536.44	12.29	700	8603

	Coarse sand	cum	1536.44	3	1400	4200
						0
Manpower cost	Labour	nos	1536.44	25	550	13750
						0
5) Woodwork						0
(a) Door frame						0
Material cost	Material	sq ft	1536.44	1025	115	117875
Manpower cost	Labour	nos	1536.44	1025	20	20500
						0
						0
6)(a) Kota stone						0
Material cost	Cement 43 grade	bags	1536.44	44.56	400	17824
	Fine sand	cum	1536.44		1000	0
	Brick blast	cum	1536.44		700	0
	Coarse sand	cum	1536.44	23.05	1400	32270
	Kota stone	sqft	1536.44	1536.44	45	69139.8
	Polishing material	cum	1536.44	460.93	15	6913.95
Manpower cost	Labour	nos	1536.44	737.49	25	18437.25
						0
6) (b) Flooring Material Water Proofing						0
Water proofing	Applicable areas	area	1536.44	153.64	55	8450.2
						0

6) (c) Tiles in bathroom and other areas						0
	Cement 43 grade	bags	1536.44	15.67	400	6268
	Fine sand	cum	1536.44	10.91	1000	10910
Material cost	Coarse sand	cum	1536.44	1.24	1400	1736
	Tile	sqft	1536.44	307.29	23	7067.67
	White cement	bags	1536.44	1.54	850	1309
Manpower cost	Labour	nos	1536.44	15.36	350	5376
						0
6) (d) Cement Pavers						0
Material\Labour	Material + Labour	lump sum	1536.44	1536.44	2.5	3841.1
						0
6) (e) Kitchen Granite Stone Counters						0
Material\Labour	Material + Labour	lump sum	1536.44	8757.51	5.7	49917.807
						0
6) (f)Over Head Water Tank 1500 lts						0
Material\Labour	Material +Labour	lump sum	1536.44	1536.44	3.5	5377.54
						0
6) (g) Underground Water Tank 1000 lts						0
Material\Labour	Material +Labour	lump sum	1536.44	1536.44	25	38411
						0
6) (h) Motor for submersible and boring						0
Material\Labour	Material +Labour	lump sum	1536.44	1536.44	10	15364.4

6) (i)Iron Grill for railing and windows						0
Material Cost	Material	kg	1536.44	300	65	19500
Manpower Cost	Labour	nos	1536.44	300	25	7500
						0
7) Paint Work						0
(a) Internal paint	Material + Labour	bags	1536.44	3278	25	81950
						0
(b)External paint	Material+Labor	sq.mtr	1536.44	1997.37	85	169776.45
						0
c) Paint on wooden doors/windows	Material+labor	sq.mtr.	1536.44	150	55	8250
						0
8) Electrical Work						0
Flexible wires	Wires & Cables	RMtr	1536.44	1000	25	25000
						0
Modular switches & Sockets, including Modular base plates	Switch & Sockets	Complete work	1536.44	1000	10	10000
						0
Electrical Switch Gear	Switch-Gear and control panel	Complete set	1536.44	1000	3	3000
						0
Misc	MS boxes, etc	Complete set	1536.44	1000	5	5000

8) Electrical Work						0
Flexible wires	Wires & Cables	RMtr	1536.44	1000	25	25000
						0
Modular switches & Sockets, including Modular base plates	Switch & Sockets	Complete work	1536.44	1000	10	10000
						0
Electrical Switch Gear	Switch-Gear and control panel	Complete set	1536.44	1000	3	3000
						0
Misc	MS boxes, etc	Complete set	1536.44	1000	5	5000
Labor charges for installation and fittin	Labor	Complete work	1536.44	lumpsum	25	13500
9)Cp fitting and sanitaryware						
1 Toilet + 1 Kitchen + Crome Plated Fitting + Sanitary Pipes (Sewerage)	Material	Misc	1536.44	768.22	100	22000
	Labor	Misc	1536.44	153.64	50	3150
TOTAL						1556994
Contractor charge @10%						155699
GRAND TOTAL						1712693

Conclusion

In the plot area of 222 sq. m. we constructed 1 BHK building having plot area of 119sq.m. Building planning is done in Autocad, 3D design is created in Revit. The calculation is done manually which is analyzed in Sap 2000. All the results are satisfactory. The total cost of construction is estimated to be Rs.1712693.

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