

**EFFECTIVE COST ESTIMATION AND DESIGN OF
RESIDENTIAL BUILDING (1 BHK)**

A PROJECT

*Submitted in partial fulfillment of the requirements for the award of the degree
of*

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision of

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to



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DECLARATION

I hereby declare that the work reported in the B-Tech thesis entitled “**EFFECTIVE COST ESTIMATION AND DESIGN OF RESIDENTIA BUILDING (1 BHK)**” submitted at **Jaypee University of Information Technology, Waknaghat, Indian** is an authentic record of my work carried out under the supervision of **Assistant Prof. Saurav**. 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 which is being presented in the project report titled **“EFFECTIVE COST ESTIMATION AND DESIGN OF RESIDENTIAL BUILDING (1BHK)”** in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the **Department of Civil Engineering, Jaypee University of Information Technology, Wagnaghat, India** is an authentic record of work carried out by **Ajay Singh Rana (13160), Aditya Gupta (131688), Mohit Pandey (131698)** during a period from July 2016 to June 2017 under the supervision of **Assistant Professor Saurav** Department of Civil Engineering, Jaypee University of Information Technology, Wagnaghat.

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LIST OF SYMBOLS AND ABBREVIATIONS

- A = total area of section
- A_c = Area of compressive steel
- A_{sc} = Area of longitudinal reinforcement
- A_{st} = Area of steel
- A_{sv} = Area of web reinforcement
- A_Φ = Area of cross-section of one bars
- b = width
- C = compressive force
- D = depth, d = effective depth
- D_c = cover of compressive steel
- D_s = depth of slab
- D_t = cover of tensile steel
- F = shear force characteristics load
- F = stress
- F_d = design load
- F_{ck} = characteristics compressive stress
- F_y = characteristics strength of steel
- H = height
- L = length
- L_d = development length
- M = bending moment
- M_r = moment of resistance
- M_u = bending moment
- n = depth of neutral axis
- n_c = depth of critical neutral axis
- P_u = axial load on the member
- P = percentage steel
- P' = reinforcement ratio

- V_u = shear force due to design load
- V_{us} = strength of shear reinforcement
- W = point load
- X = coordinate
- X_u = depth of neutral axis
- Z = distance
- s = spacing of bar
- cum = cubic meters
- nos = number of labours
- kg = kilogram
- sqft = square feet
- rmtrs = running meters for wires
- sqm = square metres

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ABSTRACT

The high volume of construction is going on in today's world of advancement and technology which leads to production of pollution on a large scale and also because of which natural aggregates are getting depleted day by day so we need to use our resources efficiently and sustainably for which there is sudden need of effective cost estimation by replacing aggregates with alternatives and utilizing resources to their maximum use by deducing wastage of resources and their use in a planned manner .

Papercrete being eco friendly is a good alternative to concrete, and in our project we have studied the various aspects of papercrete and its suitability as alternative to concrete and chemistry of papercrete and its production procedures and it has no harmful byproducts being released during the production of papercrete as we have replaced the inner walls with papercrete and perform calculation over the cost reduction of the building after using papercrete.

CHAPTER- 1

INTRODUCTION

The basics needs for the existences of human being are food, clothing and a place for his shelter . From the past time human being are making efforts in improving their standard of living. These efforts are done to provide an economical shelter for humans. The need of a shelter is a basic need, gives a feeling of security, responsibility and shown the social status of man in society.

Every human being want a peaceful environment for his living, this can be achieved by living at the safe location. For comfortable and quality following points should be considered and kept in mind.

- A peaceful environment.
- Availability of resource and type of climate conditions.

The engineer should keep in mind the topographical conditions, building should be according to rules, and environment should not get affect by these construction practices, they should be economical, water supply should be there, sewage arrangement should be a major concern, provision of future, aeration, ventilation should be there.

A. Introduction of Auto-Cad

Auto-Cad is defined as commercial computer-aided design (cad) and also as drafting software application. It was developed and marketed by Autodesk Auto-cad and was first released in December 1982 as desktop app that was first made to run on micro-computers with the help of

internal graphics controllers . Most of the CAD programs run on the mainframe computers or mini-computers, with each CAD operator working at a separate graphics terminals.

i. Compatibility of Auto-Cad with other software

Civil 3D also reads the Auto-cad files as LANDXML. Third-party file simulator also exist for specific formats such as Bentley MX-GENIO Extension , ISYBAU for Germany , OKSTRA for UK and also the conversion of .pdf files is also available in this software. The accuracy of the results cannot be predicted. For example: curve edges may appear sometime.

ii. Availability of languages

Auto-cad and Auto-cad LT give the user a lot of option in languages. English, German, French, Italian, Spanish, Korean, Chinese etc. Auto-cad is popular in most various countries because of the translation of the product and also its documentation. The command is set localized as a part of the software localization.

iii. Advantages of using Auto-cad

AutoCAD software is one of the best software for designing a project and also as a drafting software that fulfill the needs of mechanical and civil engineers. It has a good set of useful drafting and detailing features if someone has to do a professionals work .

AutoCAD is not a time consuming software and also uses less time if we draft manually. As, it saves time it is economical also . Auto-cad has a user friendly interface and can be easily operated. It is very helpful in designing a 3D structure.

As it has a large arrange of feature which you can use in making use design look good and feature able .You can also add dimensions in your design and those can be controlled easily.

Auto-cad is designed according to the International Drafting Standards , Compliance that meets the standards of various countries and industry which can rely on its results. It comes with in built system such as IGES and STEP which helps in easy sharing of files or design to other users also. Auto-cad also have a salient feature comprising of different symbols, texture which helps in defining the design in more better way. In Auto-cad we can draw in 2-D and 3-D designs .

The drawing can be printed in various formats. It simplifies the complex designs by separately showing the elements. Gives more accuracy then manually i.e. hand made drawing. If error occurs it can we edited and also if any problem occurs will doing the drawing happens then you can also save that file and do it later on.

Design which has been made can be send to a large number of users through e-mails or can be received . it also helps the designer to check whether the design he or she has made in within specify limits. It does not give number of option for designer but also to customers who has give that job to the designer. He or she can get daily update of how much work has been completed.

B. Introduction Of Revit

Autodesk Revit is a modeling software that gives information about the building structure, interiors and other elements to the architects and structural engineers, Mechanical engineers, designers and contractors . It allows designer to design the structure and its component in 3D. we can also direct use the 2D model in revit for designing. It comes with such tools that it can track various stages of building period. for example it can tell the period of construction to its detonations .

i. Use and implementation

This software can be used to keep the work going according to time as suggested by Revit. The industries that use this software first check the present work flow with respect to this software, and if that period seems to be somewhat matching with it then goes with it.

ii. Modeling in Revit

In revit designer can manipulate whole buildings and its dimension according to their requirement in 3D Modeling tools can be used with pre-made solid objects or imported geometric models .

But in revit we cannot change certain items i.e. roofs, slabs and terrains. There are many types of objects which are categories into two or three groups.

First one is the System Families i.e. walls, floors, roofs and ceilings which are built inside the project.

Second one is the Loadable Families or Components that are built with separately from the project and are added into the project for later use.

An expert designer can place furniture and lighting positions. In Revit user can change certain parameter such as height , width and numbers of certain elements.

iii. Rendering in revit

When a designer uses revit for designing he or she they have to use revits rendering engine to make the design more virtually realistic. If they don't use that the design the will one be like a diagram. The designer can use various materials that are already present in revit and can also use other materials which are not there.

The user can also use generic material , by using these materials they can define rotation , size , contract and other properties such as colour of the wall ,their texture, and different types of maps such gloss, transparency, oblique reflection etc.

If the designer uses cloud based rendering with plug-in dubbed project neon that are available on auto-desk side.

The designer can also use auto-desk labs in beta phases that allows the users to render their images through their Auto-desk account instead of using their own personal computer.

The designer can also directly link their design to auto-desk 3D to auto desk 3D max for more accurate models and their features can be detailed more precisely. A function known as en-scape 3D that allows user for live rendering and fly around the whole design. It also gives live update and with the help of this we can also add sound which can be tested .

C. Introduction of MS-Excel

Microsoft Excel is a type of spreadsheet which was developed by Microsoft that runs on Windows, Mac-OS, Android and iOS system. It allows user to calculate, can also be used as graphing tools, for making pivot tables, and also for macro programming language also known as Visual Basic for Applications. It has been a very widely used in spreadsheet in very industry .MS-Excel is part of Microsoft Office.

i. Advantages of MS-Excel

It is very useful for collecting and storing a large amount of data in form of tables, charts quickly.

Working on excel in very user friendly and data can be easily stored , edited and formatted. Its also have the capability of creating graphs for the various data you have stored in that.

You can also merge excel with your business for recording the data of profit and other issues related to your business. Can also be use for data analysis. Also help professor or teachers to put your grade according to the number by just simply applying auto grading and after that student can see what the number they got for their different exams for which they have appeared.

The data that you have stored in the spreadsheet can be easily share with other user through emails and print outs. It also works on smart phones so the user don't have to wait for opening the data on its personal computer.

As it is a part of ms-office so it is totally free for all users. You don't have to by it and also don't have to download it separately.

Ms-excel is also being taught in various institute to make the user more familiar with it . All type of function such as addition , subtraction ,etc are preinstalled in it . You don't have to do these mathematics own your own , the sheet will do it for you by just giving certain commands. It also provides user to protects their data as it allow uses to set a password on sheet they want to add so that no one can modifies the data which is stored on it .

The user can also connect or link their data to OLAP databases and that can be sown in Pivot tables. The user can also can analyse their data effectively with the help of powerful tools that are present in excel. You can also see a large amount of data to check the trends that will tell whether you are going write or not .

A tool known as Microsoft Excel's graphing that allows user to summarize data and present it in a structure way. Ms- Excel contain thousands of rows and column for storing your data in the form of records.

It makes work easier, if a person has to enter a huge amount of data and also have to add and subtract things , have to use a calculator , which is a very difficult job.

An expert can also solve equations by applying different formulas.

The spread sheet can be easily attached to other tools such as ms office ,ms powerpoint , to make the presentations look more effective. You can also take the spreadsheet in your phone as it is available on types of platforms.

D. Introduction of papercrete

Since a large volume concrete is being used day by day which is producing pollution on large scale and also sources of aggregates (which are natural resources), are getting depleted so we need an alternative for the problem and papercrete is one of the best solution for this problem.

This concrete material is been recently developed by Eric Patterson and Mike McCain.

It is made by repulped paper as a fiber and with the combination of sand and Portland cement or clay.

Papercrete is considered as environment friendly material. It is a type of industrial strength paper Mache made with cardboards , sand and Portland cement.

This material is developed to make the cost effective and rigid in walls of the building.

Contractors should be pressurized to use of this sustainable material for the construction of inner walls of the building.

As it is a new developed material it is not being used in large numbers.

There is no harmful by product or excessive use of energy in production of papercrete

CHAPTER- 2

LITERATURE REVIEW

A. National Building Code Of India (2005)

The national building code is also known as a complete building code. It is a national tool providing guidelines for regulating the building construction activities across the country, it serves as a specific for adoption by all companies involved in construction sector, the code mainly contains rules and regulations regarding development control and general building requirements like fire safety , structural design and other things related to construction

The code was first published in 1970 and then revised in 1983 and thereafter amendments are being implemented in year 1987 and 1997, considering further advancement of techniques used in building construction, the revised NBC is now available as NBC 2005, which we have used in our project.

i. Contents of NBC

National building code of 2005 is comprised of many such things as development control rules and general building requirements and fire and safety rules for different class of buildings and various norms for foundation , slab design and ventilation considerations according to the topography of the site

It has also a different for judging the section of plot which comprises of various limitation over built up area and site must be in a good place where there is proper facilities available such as proper convenience, source of transportation which can be valued by reading contours of the site and distance from utility structure as hospitals, schools and colleges

ii. Important features of NBC 2005

1. Includes a complete package of directions for successful accomplishment of building projects.
2. A series of amendments and reforms in previous code available for building norms.
3. Provision to insure safety of building against natural hazards.
4. Providing empowerment to engineers and architects for sanctioning plans of building up to 500 m².
5. Revision of space requirements and technical specifications for metro and mega cities.
6. Inclusion of special provisions for low income housing in rural and urban areas.
7. Fire safety norms and new categories are also included for starred hotels , heritage structures and monuments.
8. Details of multi disaster prone districts and complete revision on prefabricated and plumbing services.
9. It also include some advance features such as rain water harvesting and landscaping needs.
10. Design and construction using bamboo.

iii. Classification of building

Group A : Residential buildings

These buildings comprised of such buildings in which living facilities are being provided for residential purposes , such as sleeping accommodation , cooking and dining facilities .

They can be single or multiple stories like apartments , lodges , residential hotels and dormitories

Group B : Educational buildings

These buildings are used for educational purposes such as buildings of schools , institutional buildings .

Group C : Institutional building

Those buildings which are used for different purposes such as buildings where mentally challenged or physically disabled persons are being treated , and some provide sleeping accommodation for orphans

Group D : Assembly building

These are buildings in which group of people meet or gather for social and religious purposes like marriage halls, assembly halls etc.

Group E : Business buildings

this type of buildings are being used for business meetings and works such as office ,bank

Group F: Mercantile buildings

These buildings are used for shops, sale, market of wholesale and retail and in these buildings storage facilities are also provided

Group G : Storage buildings

These are generally used for storage of goods , wares or merchandises such as gold stores , garages

Group H : Industrial buildings

Those buildings where different materials and products are being made and assembled such as laboratories , production house etc

Group I : Hazardous buildings

These are those buildings which are used for highly explosive and poisonous materials

iv. Arrangement of rooms

Living room

This is the region is for general utilize. Consequently the living and drawing room ought to be arranged close to the passage south east perspectives. Amid colder day the sun is towards the south and will get daylight which is an inviting element. Amid summer daylight toward the northern side and section of sunrays from southern or south – east viewpoints don't emerge.

Kitchen

Eastern perspectives to concede morning sun to invigorate and immaculateness the air.

Store room

It can be decided on the availability of space and orientation of rooms

Bed room

Bed may likewise be furnished with appended toilets, their size relies on the quantity of beds, they ought to be found in order to give protection and ought to oblige beds, seat, cabinet, and so on., and they ought to have north or – west south – west perspective.

Bathroom or washing area

Shower and washing areas are typically consolidated in one room and appended to the bed room and ought to be all around wrapped up. This ought to be loaded with bath, shower, wash-hand bowl, washing clothes racks, towels racks sections, and so on., all of white coated tiles. Floor ought to be mosaic or white coated documents. Rather than furnishing all bed live with connected shower and W.C isolated showers and restrooms may likewise be given.

Verandah

There ought to verandah in the front and additionally in the back. The front verandah serves setting place for male individuals and weighting place for guests. The back verandah serve a women flat for there sitting, working controlling, kitchen works and so forth., verandah extend the room against direct sun, rain and climate impact. They utilized as dozing spot amid the mid year and blustery season and are utilized to keep different things verandah likewise offer appearance to the building. The range of a building may differ from 10% to 20% of the building.

Staircase

This ought to be situated in an effortlessly open to all individuals from the family, when this is expected for guests it ought to be in the front, might be on one side of verandah. It implied for family utilize just, the staircase ought to be put the back. The stairs case ought to be all around ventilated and lit the center to make it simple and agreeable to climb. Rises and strings ought to be uniform through to keep cadence while climbing or dropping.

Some accommodating focuses with respect to the introduction of a building are as per the following:-

- Long mass of the building ought to face north south, short divider ought to confront.
- East and west in light of the fact that if the long dividers are given in east-bound, the divider.
- Absorb more warmth of sun which causes uneasiness amid night.
- A verandah or overhang can be given to wards east and west to keep the rooms cool.
- To keep sun's beams and rain from going into a room through outer entryways and windows sunshades are required every which way.

v. Minimum floor area and height of rooms

	FLOOR AREA(sqm)	HEIGHT (m/ft)
Living	10sqm (100sqft) Breath min. 2.7m or 9'	3.3m (11')
Kitchen	6sqm (60sqft)	3m (10')
Bath	2sqm (20sqft)	2.7m (9')
Latrine	1.6sqm (16sqft)	2.7m (9')
Bath and water cloest	3.6sqm (36sqft)	2.7m (9')

Min. height of plinth for building		0.6m (2')
Min. depth of foundation		0.9m (3')
Thickness of wall	20cm to 30cm (9" to 13.5")	
Damp proof course	2cm to 3cm (3/4" to 1")	Thick full width of the plinth wall

B. Papercrete

This material was developed by Eric Patterson and Mike McCain .

It is generally made by repulped paper as fiber with Portland cement and clay .

It is environment friendly material it was designed to build rigid and cost effective and economical inner walls of the building .

Contractors should be pressurized to use this sustainable construction material as it is recently developed material its use is limited.

It is mainly used for low cost homes with limited longevity and durability.

It can also be used as a plaster.

i. Properties of papercrete

Provides good insulation.

R-value of papercrete is 2-3 per inch.

As it is a mould resistant material so it can be used as sound proofing material.

It is dimensionally very stable and fire resistant material.

As it can absorb water and become spongy so it cannot be used near coastal areas.

Only one or two floor buildings can be constructed using papercrete.

Compressive strength of papercrete is 261 psi as compared to 1600 psi of brick.

Papercrete is a light weight material which is less than a third of the weight of brick and hence reduces the total weight of building.

This material is also fungus retardant and also lighter than concrete.

Raw materials being used with paper and Portland cement for the production of papercrete are :

- sand
- fly ash
- rice hull ash
- Styrofoam
- Paper mill sludge with fly ash
- Glass
- Clay

ii. Chemistry involved in papercrete:

Paper is comprised of wood cellulose which is a fibrous material , cellulose is the second most abundant material present on earth after rocks , cellulose are the main components of the plant cell walls and also basic building material for textiles , cellulose is a natural polymer having long chain of linked sugar molecules made by linking of smaller other molecules.

Cellulose are monomer glucose polysaccharides, the links between cellulose particles are of β -D-glucose ,cellulose contain a good amount of hydroxyl group in spite of which they are soluble in water , the reason behind this is the stiffness of the chain and hydrogen bonding between two OH groups .

The chains pack effectively in voids to form a hard and stable crystalline surface , that provides more stability and strength to the chain , hydrogen bonding is the main parameter of the papercrete ,when force is applied on paper the hydrogen bond between water and cellulose are broken .The coating of Portland cement over the cellulose creates a cement matrix , which provides extra strength to the mix.

iii. Manufacturing of papercrete

- Make wooden frame or we can use the plastic forms used to make concrete
- Soak newspaper overnight
- Make the paper pulp.
- Weight cement and sand
- Pour cement and sand into the paper pulp
- Mix all the ingredients for approx. 10 minutes
- drop the mix into the wooden or plastic forms
- Shake the mix to remove the air
- Let the specimens dry for at least one week (drying time varies in different climatic conditions and humidity percentage of the mix)

iv. Manufacture at various scale

- There are various blenders, separated for the most part by limit and portability. The entire thought of blending is to destroy the paper in water to create slurry, and afterward blend in added substances like Portland concrete and sand. This technique is taken after all the time - when working with little groups in a five-gallon pail or with 1000 gallon (4500 liter) clumps on the back of a 4-wheel drive truck. Get the paper and water blended initially, and afterward include alternate parts.

- A number of specialists want to buy paper, which has as of now been tore separated by running it through a sledge process. Truth be told, it is a similar material without dampness safe and fire retardant chemicals. The benefit of working with mallet processed paper is that most added substances can be blended in utilizing regular solid blenders. Other exceptional procedures require specific gear.

- The best-known papercrete blender must be Mike McCain's tow blender. Mike concocted taking the back hub of a back drive auto or truck and basically turning around its outlined utilize. In His plan raise drive vehicles, the motor turns a drive shaft, which is associated with a gearbox called a differential, incorporated with the back hub of the auto. The differential behaviors control from the drive shaft to the back wheels. Mike's vision was this procedure in switch.

- Transfers control from the wheels to the drive shaft. He isolates the back hub from whatever remains of an old back drive auto or truck. He then mounts a 900 liter tank over the differential. Turning the differential toward the sky, he jabs a short segment of drive shaft from the differential through the base of the tank. He then connects a yard cutter sharp edge to the abbreviated drive shaft. At the point when the tank is towed behind another vehicle, the wheels on the blender turn the drive shaft, and the trimmer cutting edge turns. Since the cutter edge is being driven by the energy of the vehicle towing the blender, it turns with moderately low speed, however huge compel. This drive tears separated daily papers and magazines easily.

C. Cost estimation

The reason for cost estimation is to discover the cost of the assembling operations. It might be characterized as the way toward deciding the likely cost of the item before the beginning of construction.

i. Application of Cost Estimation:

To give a sensibly precise thought of the cost .A gauge is important to give the proprietor a sensibly precise thought of the cost to help him choose whether the works can be embraced as proposed or should be diminished or relinquished, contingent on the accessibility of assets and forthcoming immediate and aberrant advantages. For government works legitimate authorize must be gotten for apportioning the required sum. Works are frequently let on a singular amount premise, in which case the Estimator must be in a position to know precisely how much consumption he will bring about on them, While the significance of knowing the plausible cost needs no accentuation, evaluating materials, work, plant and time is tremendously valuable in arranging and execution of any work.

To settle the offering cost of the item to help the contractual workers to present the exact tenders to gauge the advance of creation and cost to set the different Standards.

1. Assessing Materials

From the gauge of a work it is conceivable to figure out what materials and in what amounts will be required for the works so that the plans to get them can be made.

2. Evaluating Labor

The number and sort of laborers of various classes who should be utilized to finish the work in the predetermined time can be found from the gauge.

3. Assessing Plant

A gauge will help in deciding sum and sort of hardware expected to finish the work.

4. Evaluating Time

The gauge of a work and the past experience empower one to evaluate nearly the period of time required to finish a thing of work or the work in general.

While the significance of knowing the plausible cost needs no accentuation, evaluating materials, work, plant and time is tremendously valuable in arranging and execution of any work.

ii. Components of Cost Estimation

1. Design cost

Configuration cost of the item is evaluated by guaranteeing the normal time for the plan of that venture.

Configuration time can be assessed on the premise of comparable ventures effectively composed or on the premise of practical insight of architect.

2. Drafting expense

After the plan is finished, the drawing will be set up by the artist

3. Research and development cost

Extensive time and cash must be spent on research and formative work.

The assessed cost and time on it are chosen by the judgment or the past experience.

4. Material cost

Taking after strides included

1. Prepare the rundown of all materials required to fabricate the item
2. Estimate the volume of the considerable number of materials expected (the stipend for the material wastage, deterioration and scrap are likewise included)

Evaluated materials cost = Estimated volume of every material x
Estimated future cost

At last, the evaluated cost of the considerable number of parts is added to get the aggregate assessed material cost of the item

iii. Cost estimation procedure

Step 1

Analyze the venture and choose the prerequisites and particulars of the venture

Step 2

Prepare the rundown of the considerable number of employments of the venture and their bill of Materials

Step 3

Estimate the materials cost for the parts to be produced in the plant.

Step 4

Determine the cost of the parts to be acquired from outside.

Step 5

Estimate the machining time for every operations recorded in the assembling procedure arrange.

Step 6

Determine the immediate work cost.

Step 7

Determine the prime cost by including direct costs, coordinate material cost, and direct work cost.

Step 8

Estimate the production line overheads, which incorporate all backhanded uses.

Step 9

Estimate the regulatory costs.

iv. Important points about estimation

(1) Before beginning any gauge of building, street and extension, it ought to be seen that the arrangements are completely dimensioned , inward and external measurements ought to be checked before beginning the gauge to keep away from inconveniences later on.

(2) The gauge ought to be drawn sub-head-wise, to dodge exclusion of any thing.

(3) The classification of each thing ought to accord to the authorized calendar of rates to keep away from cases of the temporary workers later on.

(4) All things ought to be figured in units, as per which the installment is to be made (section on, units)

(5) A natty gritty answer as per the sub-heads ought to be connected. This ought to act naturally illustrative giving complete data.

(f) Detailed drawings ought to be connected with each definite gauge, with north line on the arrangement.

(g) Detailed particulars of each thing ought to be appended so that the work ought to be done in like manner and the determinations ought to accord to the most recent version of the P.W.D. particulars.

(h) with a specific end goal to make the gauge a far reaching one, arrangement of electric and water supply ought to be made.

(i) In the finish of gauge, a conceptual of cost giving expense of each sub-head and aggregate cost ought to be appended. An arrangement of possibilities and frivolous foundation @ 5% ought to be included the finish of conceptual of cost.

(j) The rate per sq. meter ought to be worked out and it ought to be given toward the finish of unique of the building gauge. This aides in future reference.

(k) in the event of Road gauge, rate per Km. ought to likewise be worked out.

(l) The street gauge ought to say the unique components of the arrangement so took after and likewise whether the soling is of blocks or of stone, ought to be specified in the report of gauge.

(m) if there should arise an occurrence of scaffolds and courses, rate per meter (width) to be worked out.

(n) Current material premium above C.S.R. ought to be included before discovering the unit rate i.e., plinth or per km rate.

CHAPTER-3

CALCULATIONS

A. Design of beam

M20, HYSD, Fe415

UDL = 3kN/m

Clear span = 6m

$$f_y = 415 \text{ N/mm}^2$$

$$f_{ck} = 20 \text{ N/mm}^2$$

$$\text{Limiting depth of section- Fe415} = \frac{x_{u_{lim}}}{d} = \frac{700}{1100 + 0.87 \times 415} = 0.48$$

$$\frac{L}{D} = 20$$

$$P_t = 0.96$$

$$F_s = 0.58 \times 415 = 240 \text{ (for Fe415)}$$

$$d = \frac{L}{25} = \frac{6000}{25} = 240 \text{ mm}$$

$$D = 400 + 30 = 430 \text{ mm} \quad \text{keep } b = 300$$

$$\text{Self-weight of beam} = 0.43 \times 0.3 \times 1 \times 2500 = 3225 \text{ N/m}$$

$$\text{Weight of slab/m}^2 = \frac{400}{1000} \times 1 \times 1 \times 2500 = 10000 \text{ N/m}$$

$$\text{Superimposed Loading} = 3 \text{ kN/m}^2$$

$$\text{Snow Loading} = 0.96 \text{ kN/m}^2$$

Total Loading, $w = 13.96 + 3.2 = 17.16$ kN/m

$W_u = 1.5w = 1.5 \times 17.16 = 25.74$ kN/m

Effective span = $l+d = 6.3$ m

$$M_u = W_u \frac{L \times L}{8} = \frac{17160 \times 6.3 \times 6.3}{8} = 85.135 \text{ kN.m}$$

Computation of effective depth, d

$$M = 0.36 f_{ck} \frac{x_u \max}{d} (1 - 0.416 x_u) b d^2 = R_u b d^2$$

$$R_u = 0.36 \times 20 \times 0.479 (1 - 0.46 \times 0.479) = 2.761$$

$$d = \sqrt{\frac{M_u}{R_u b}} = \sqrt{\frac{85.135}{2.761 \times 300}} = 320 \text{ mm}$$

$$D = 320 + 25 + 8 + 10/2 = 358 \text{ mm}$$

$$A_{st} = 0.5 \frac{f_c}{f_y} \left[1 - \sqrt{1 - \frac{4.6 M_u}{f_{ck} b d X_d}} \right] = 920 \text{ mm}^2$$

$$\text{No of 10 mm bars} = \frac{920}{314.5} = 3 \text{ bars}$$

$$A_{st} = 3 \times 314.5 = 943.5$$

$$\text{actual moment} = 0.87 f_y A_{st} d \left[1 - \frac{f_y A_{st}}{f_{ck} b d} \right] = 80.77 \text{ kN/m}$$

$$M_{u,lim} = 2.761 b d^2 = 84.81 \times 10^6 \text{ N/mm}$$

$M_u < M_{u,lim}$, Hence OK

$$\text{Bending Moment at } x_1 = \frac{w u L}{2} x_1 - \frac{w u x_1 x_1}{2} \text{ [should be 2/3 of max BM]}$$

$$X_1 = 0.211L = 0.211 \times 6.3 = 1.3292 \text{ m}$$

However bars are to be taken further by a distance d of 12 mm dia = $1.33 - 0.33 = 1.03$ m or at 0.655m

Hence bend bar at a distance of 0.7m from support and continue the remaining bars into support

Shear reinforcement

Critical section for shear at a distance $d = 0.365\text{m}$

$$V_u D = \frac{w_u L}{2} - w_u \left[\frac{0.75}{2} + 0.365 \right] = 62 \times 10^3 \text{ kN}$$

$$T_v = \frac{62000}{300 \times 320} = 0.645$$

$$P_t = \frac{A_s \times 100}{bd} = 57\%$$

$$T_c = 0.5 \text{ N/mm}^2$$

$T_v < T_c$, hence OK

Now providing 8mm dia bars

$$A_{sv} = \frac{\pi}{4} \times 8^2 = 100.5 \text{ mm}^2$$

$$S_v = 2.175 \times 100.5 \times \frac{4.15}{300} = 302 \text{ mm}$$

B. Design of Column

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

Axial Load = 600 kN

Using M20 and Fe415

Effective Length = $0.65 \times 3000 = 1950 \text{ mm}$

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

$$e_{min} \leq 0.5D$$

$$P_u = 0.4 f_{ck} A_c + 0.67 f_y A_{sc}$$

$$1.5 \times 600 \times 10^3 = 0.4 \times 20(A_g - 0.01A_g) + 0.67 \times 415 \times 0.01A_g$$

$$A_g = 112144.2$$

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

$$d = 473.59 \text{ mm}$$

$$D = 500 \text{ mm}$$

$$b = 250 \text{ mm}$$

$$A_g = 250 \times 473.59 = 1121.44 \text{ mm}^2$$

$$\text{Area of each bar} = 1121.44/8 = 140.18 \text{ mm}^2$$

$$\text{Bar Diameter} = 13.35 \text{ mm}$$

So 6 Bars of 12 mm diameter

$$A_{\phi} = 173.04 \text{ mm}^2$$

$$\text{Percentage Steel} = \frac{6 \times 173.04 \times 100}{250 \times 275} = 0.98\% > 0.8\%$$

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

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

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

Hence Column is short in both direction

In one direction

$$e_{\min} = \frac{L}{500} + \frac{D}{30} = 26 \text{ mm}$$

$$e = .06D = 30 \text{ mm} > e_{\min}$$

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

C. Design of Isolated Rectangular Footing of Uniform Thickness

For R.C. Column

Base size = 300mm × 500mm

Load = 650kN

Assuming $q_0 = 120\text{kN/m}^2$

Design Contrast M20 Fe415

$$\frac{x_u \max}{d} = .479$$

$$R_u = 2.761$$

Size of the Footing

$$w=650\text{kN}$$

$$W= 1.1w = 715\text{kN}$$

$$A= 715/120 = 5.95 \text{ m}^2$$

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

So, B= 1.93m and L= 2.9m

Footing size we take will 3m × 2m

Design of Section:

On the basis of Bending Moment:

About section X-X

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

$$M_{1u} = 216 \times 10^6 \text{ N} - \text{mm}$$

About Section Y-Y

$$M = \frac{P_0 L}{8} (B - b)^2 = 96 \times 10^6 \text{ N} - \text{mm}$$

$$M_{2u} = 144 \times 10^6 \text{ N} - \text{mm}$$

$$d = \sqrt{\frac{M_{1u}}{R_u B}} = 198 \text{ mm} = 200 \text{ mm}$$

$$D = 260 \text{ mm}$$

On the basis of one way shear

$$V = P_0 B \frac{L}{2} - \frac{a}{2} - d$$

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

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

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

$$P = 0.3\%$$

$$\tau_v = 0.384 \text{ N/mm}^2$$

$$D \geq 300 \text{ mm}$$

$$\text{Permissible Shear Stress} = 1 \times 0.384 = 0.38$$

Equating it with V_u

$$d = 337 \text{ mm} = 340 \text{ mm}$$

Reinforcement Design:

$$A_{st} = \frac{0.5 f_{ck}}{f_y} \left[1 - \sqrt{1 - \frac{4.6 M_{1u}}{f_{ck} B d_1^2}} \right] B d_1$$

$$= 1752 \text{ mm}^2$$

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

Effective depth $d_2 = 348\text{mm}$

A_{st} of short bars

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

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

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

D. Design of Rectangular Slab

Design of a rectangular slab of size $13.8\text{m} \times 13.2\text{m}$

Superimposed load for the slab is $3\text{kN}/\text{m}^2$

using M20 and Fe415

Solution: Design constant for :

$$k_c=0.284, j_u=0.404 \text{ and } r_c=0.414$$

$$\text{Length of panel (L)}=13.8\text{m}$$

$$\text{Width of panel (B)}=13.2\text{m}$$

Along length $l_1 = L = 13.8\text{m}$ and $l_2 = B = 13.2\text{m}$

$$\text{Width of Column Strip} = 0.25B = 0.25 \times 13.2 = 3.3\text{m}$$

$$\text{with upper limit of } 0.25L = 0.25 \times 13.8 = 3.45\text{m}$$

$$\text{Width of middle strip} = 13.8 - 6.9 = 6.9\text{m}$$

Along length $l_1 = L = 13.2\text{m}$ and $l_2 = B = 13.8\text{m}$

$$\text{Width of Column Strip} = 0.25B = 0.25 \times 13.8 = 3.45\text{m}$$

$$\text{with an upper limit of } 0.25L = 0.25 \times 13.2 = 3.3\text{m}$$

$$\text{width of middle strip} = 13.2 - 6.6 = 6.6\text{m}$$

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:-

$$\text{Min length of drop} = l_1/3 = 13.2/3 = 4.4\text{m}$$

(however keep it equal to the total width of column strip $l_2 = 6.6\text{m}$)

Along with B:-

$$\text{Min length of drop} = l_1/3 = 13.8/3 = 4.6\text{m}$$

(however keep it equal to the total width of column strip $l_2 = 6.6\text{m}$)

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

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

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

Loading:-

The thickness of flat slab is generally controlled by consideration of

span of effected depth ratio: $\frac{\text{span}}{d} \leq 2.6$

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

$$\frac{\text{span}}{d} = 26 \times 1.6$$

$$d = \frac{13.2}{26 \times 1.6} = 0.317\text{m}$$

Assuming a nominal cover of 15mm and using 12mm diameter bars total thickness

$$= 317 + 15 + 12 + 6$$

$$= 350\text{mm}$$

The thickness of drops is normally 25% more than thickness of slab

We assumed thickness of 400mm for the calculation of dead load .

$$\text{Weight of Slab /m}^3 = \frac{400 \times 1 \times 25000}{100} = 100000 \text{N} = 10 \text{kN /m}^3$$

$$\text{Superimposed load} = 3 \text{kN/m}^2$$

Snow load:

$$S = \mu S_0$$

$$\beta = 30^\circ$$

$$15 \leq \beta \leq 30$$

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

$$S = \mu S_0$$

$$= 1$$

$$\text{Ground snow load } p_g = 20 \text{psf}$$

$$1 \text{ psf} = 0.96 \text{kPa} = 0.96 \text{kN/m}^2$$

$$\text{Total } W = 13.96 \text{ kN/m}^2$$

Moment along shorter span:

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

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

$$L_{nl} = l_1 - 2.39 = 10.8 \text{m}$$

$$w_l = \text{total design load on } l_2 \times L_{nl}$$

$$= (13.8 \times 13.2) 13960$$

$$= 2082542.88 \text{ N}$$

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

Moment along Longer span:

For the longer span length $l_1 = B = 13.8\text{m}$ and $l_2 = L = 13.2\text{m}$

The column head is circular of diameter 2.7m.

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

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

$$\begin{aligned} w_B &= \text{total design load on } l_2 \times L_{nl} \\ &= (13.2 \times 11.4) 13960 \\ &= 2104543.52 \text{ N} \end{aligned}$$

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

Thickness of Slab and Drop

Width of column strip on longer span $L = 6.6\text{m}$

$$d = \sqrt{\frac{M_{2L}}{R_{c,b}}} = \sqrt{\frac{680746.68}{0.914 \times 6600}} = 335\text{mm}$$

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

Available $d = 400 - 12 - 20 = 378 \text{ mm}$

for Shorter Span = 368mm

E. Cost estimation using concrete

Description	item details	unit of measurement	quantity	Rate per unit	Amount
Foundation work (pcc- (1:2:4))					
material cost	cement -43 grade	bag	27.07	375	10151.25
	coarse sand	cum	2.58	1200	3096

	aggregates 10 and 20 mm				
menpower cost					
	Mistry	nos	4	400	1600
	labour	nos	10	300	3000
superstructure work					
column work					
material cost	tmt 8,10,12,16 dia	Kg	322.25	44	14179
	cement 43 grade	Bags	20	375	7500
	coarse sand	Cum	3.87	1400	5418
	aggregate (coarse10 &20 mm)	Cum	5.16	1200	6192
	shuttering material	Sqft	186.91	50	9346
menpower cost	mens				
	Mistry	Nos	4	400	1600
	labour	Nos	10	300	3000
slab work (laying ,cutting etc)					
material cost	tmt 8,10,12,16 dia	Kg	676.73	44	29776.12
	cement 43 grade	Bags	71	375	26625
	coarse sand	Cum	29.65	1400	41510
	aggregate (coarse10 &20 mm)	Cum	18.05	1200	21660
	shuttering material	Sqft	451.15	50	22557.5
menpower cost	menpower cost				
	Mistry	Nos	4	400	1600
	labour	Nos	10	300	3000
brick work (masonry work 9")					
material cost	cement 43	Bags	122	375	45750

	grade				
	coarse sand	Cum	25.78	1400	36092
	bricks	Nos	29144	5	145720
menpower cost	mens				
	mistry	Nos	20	400	8000
	labour	Nos	40	300	12000
brick work (masonry work)(4.5")					
material cost	cement 43 grade	Bags	34.8	375	13050
	coarse sand	Cum	17.14	1400	23996
	bricks	Nos	18845	5	94225
menpower cost	mens				
	mistry	Nos	20	400	8000
	labour	Nos	40	300	12000
plaster work(1:6)(cement:coarse & fine sand)					
	cement 43 grade	Bags	105	375	39375
	fine sand	Cum	11.96	1000	11960
	coarse sand	Cum	13.25	1400	18550
menpower cost	mens				
	mistry	Nos	20	400	8000
	labour	Nos	40	300	12000
flooring work					
	cement	bags	174	375	65250
	fine sand	Cum	19.34	1000	19340
	brick ballast	Cum	10.31	700	7217
	coarse sand	Cum	2.58	1400	3612
	labour	Nos	50	300	15000
menpower cost	mens				
	mistry	Nos	10	400	4000
	labour	Nos	20	300	6000

Wood work					
main door	wood	Nos	1	6000	6000
inner doors	wood	Nos	4	4000	16000
washroom door	PVC fiber material	Nos	1	2200	2200
door shutter					
main door	iron	Nos	1	2600	2600
inner doors	iron	Nos	4	2200	8800
washroom door	iron	Nos	1	1800	1800
window shutters	iron	Nos	7	2600	18200
wood work for windows	wood	Nos	7	4000	28000
men power cost of all door and window wok	mens				
	mistry	Nos	1	500	500
	labour	Nos	2	300	600
modular kitchen					32250
flooring work					
kota stone	cement 43 grade	bags	37.38	375	14017.5
	coarse sand	Cum	19.34	1400	27076
	kota stone	Sqft	1289	45	58005
	polishing material	cum	386.7	15	5801
menpower cost					
	labour	Nos	10	400	4000
	minstry	Nos	20	300	6000
waterproofing	applicable area	Sqft	128.9	55	7090
tile in dado , bathroom and other areas					
material cost	cement 43 grade	bags	13.15	375	4931.25
	fine sand	cum	9.15	1000	9150

	coarse sand	cum	1.04	1400	1456
	tile	Sqft	257.8	23	5929
	white cement	bags	2	850	1700
menpower cost	mens				
	mistry	Nos	6	400	2400
	labour	Nos	12	300	3600
kitchen granite stone	material				
menpower cost	mens				
	mistry	Nos	1	400	400
	labour	Nos	2	300	600
overhead tank(2000 ltr)	material	Nos	1	7500	7500
motor for pumping	material	Nos	1	4000	4000
menpower cost for setting of tank ank pump	mens				
	mistry	Nos	1	400	400
	labour	Nos	2	300	600
iron grilling for railing and windows					
material cost	material(iron)	kg	300	65	19500
menpower cost	men				
	labour	Nos	4	500	2000
	mistry	Nos	4	300	1200
painting work					
internal paint (putty)	material	Kg	10	500	5000
external paint	material	Sqmt	1675	50	83750
paint on wooden doors and window frames	material	sqmt			
menpower cost	mens				
	painter	Nos	10	600	6000
electrical work					
flexible wires	wires and cables	rmtrs	1000	25	25000
modular switches and	switch and	nos `	10	1000	10000

sockets(including base plates)	sockets				
electrical switch gears	control panel	complete set	1	3000	3000
labour charge	electrician		3	1000	3000
fitting and sanitary work					
toilet +kitchen +chrome plated fitting +sanitary pipes	material	Total			22000
labour charge	men		2	500	1000
				total	1276003.62

F. Cost estimation using papercrete

Description	item details	unit of measurement	quantity	Rate per unit	Amount
Foundation work (pcc-(1:2:4))					
material cost	cement -43 grade	Bag	27.07	375	10151.25
	coarse sand	Cum	2.58	1200	3096
	aggregates 10 and 20 mm				
menpower cost					
	mistry	Nos	4	400	1600
	labour	Nos	10	300	3000
superstructure work					
column work					
material cost	tmt 8,10,12,16	Kg	322.25	44	14179

	dia				
	cement 43 grade	Bags	20	375	7500
	coarse sand	Cum	3.87	1400	5418
	aggregate (coarse10 &20 mm)	Cum	5.16	1200	6192
	shuttering material	Sqft	186.91	50	9346
menpower cost	mens				
	mistry	Nos	4	400	1600
	labour	Nos	10	300	3000
slab work (laying ,cutting etc)					
material cost	tmt 8,10,12,16 dia	Kg	676.73	44	29776.12
	cement 43 grade	Bags	71	375	26625
	coarse sand	Cum	29.65	1400	41510
	aggregate (coarse10 &20 mm)	Cum	18.05	1200	21660
	shuttering material	Sqft	451.15	50	22557.5
menpower cost	menpower cost				
	mistry	Nos	4	400	1600
	labour	Nos	10	300	3000
brick work (masonry work- 9")					
material cost	cement 43 grade	Bags	122	375	45750
	coarse sand	Cum	25.78	1400	36092
	bricks	Nos	29144	5	145720
menpower cost	mens				
	mistry	Nos	20	400	8000
	labour	Nos	40	300	12000
papercrete (masonry work)(4.5")					

material cost	cement 43 grad	Bags	7.65	375	2868.75
	coarse sand	Cum	3.77	1400	5278
	bricks	Nos	18845	3	56535
menpower cost	mens				
	mistry	Nos	20	400	8000
	labour	Nos	40	300	12000
plaster work(1:6)(cement:coarse & fine sand)					
	cement 43 grade	Bags	105	375	39375
	fine sand	Cum	11.96	1000	11960
	coarse sand	Cum	13.25	1400	18550
menpower cost	mens				
	mistry	Nos	20	400	8000
	labour	Nos	40	300	12000
flooring work					
	cement	bags	174	375	65250
	fine sand	Cum	19.34	1000	19340
	brick ballast	Cum	10.31	700	7217
	coarse sand	Cum	2.58	1400	3612
	labour	Nos	50	300	15000
menpower cost	mens				
	mistry	Nos	10	400	4000
	labour	Nos	20	300	6000
Wood work					
main door	wood	Nos	1	6000	6000
inner doors	wood	Nos	4	4000	16000
washroom door	PVC fiber material	Nos	1	2200	2200
door shutter					
main door	iron	Nos	1	2600	2600
inner doors	iron	Nos	4	2200	8800
washroom door	iron	Nos	1	1800	1800

window shutters	iron	Nos	7	2600	18200
wood work for windows	wood	Nos	7	4000	28000
men power cost of all door and window wok	mens				
	mistry	Nos	1	500	500
	labour	Nos	2	300	600
modular kitchen					32250
flooring work					
kota stone	cement 43 grade	bags	37.38	375	14017.5
	coarse sand	Cum	19.34	1400	27076
	kota stone	Sqft	1289	45	58005
	polishing material	cum	386.7	15	5801
menpower cost					
	labour	Nos	10	400	4000
	minstry	Nos	20	300	6000
waterproofing	applicable area	Sqft	128.9	55	7090
tile in dado , bathroom and other areas					
material cost	cement 43 grade	bags	13.15	375	4931.25
	fine sand	cum	9.15	1000	9150
	coarse sand	cum	1.04	1400	1456
	tile	Sqft	257.8	23	5929
	white cement	bags	2	850	1700
menpower cost	mens				
	mistry	Nos	6	400	2400
	labour	Nos	12	300	3600
kitchen granite stone	material				
menpower cost	mens				

	mistry	Nos	1	400	400
	labour	Nos	2	300	600
overhead tank(2000 ltr)	material	Nos	1	7500	7500
motor for pumping	material	Nos	1	4000	4000
menpower cost for setting of tank ank pump	mens				
	mistry	Nos	1	400	400
	labour	Nos	2	300	600
iron grilling for railing and windows					
material cost	material(iron)	kg	300	65	19500
menpower cost	men				
	labour	Nos	4	500	2000
	mistry	Nos	4	300	1200
painting work					
internal paint (putty)	material	Kg	10	500	5000
external paint	material	Sqmt	1675	50	83750
paint on wooden doors and window frames	material	sqmt			
menpower cost	mens				
	painter	Nos	10	600	6000
electrical work					
flexible wires	wires and cables	rmtrs	1000	25	25000
modular switches and sockets(including base plates)	switch and sockets	nos `	10	1000	10000
electrical switch gears	control panel	complete set	1	3000	3000
labour charge	electrican		3	1000	3000
fitting and sanitary work					
toilet +kitchen +chrome plated fitting +sanitary pipes	material	total			22000
labour charge	men		2	500	1000

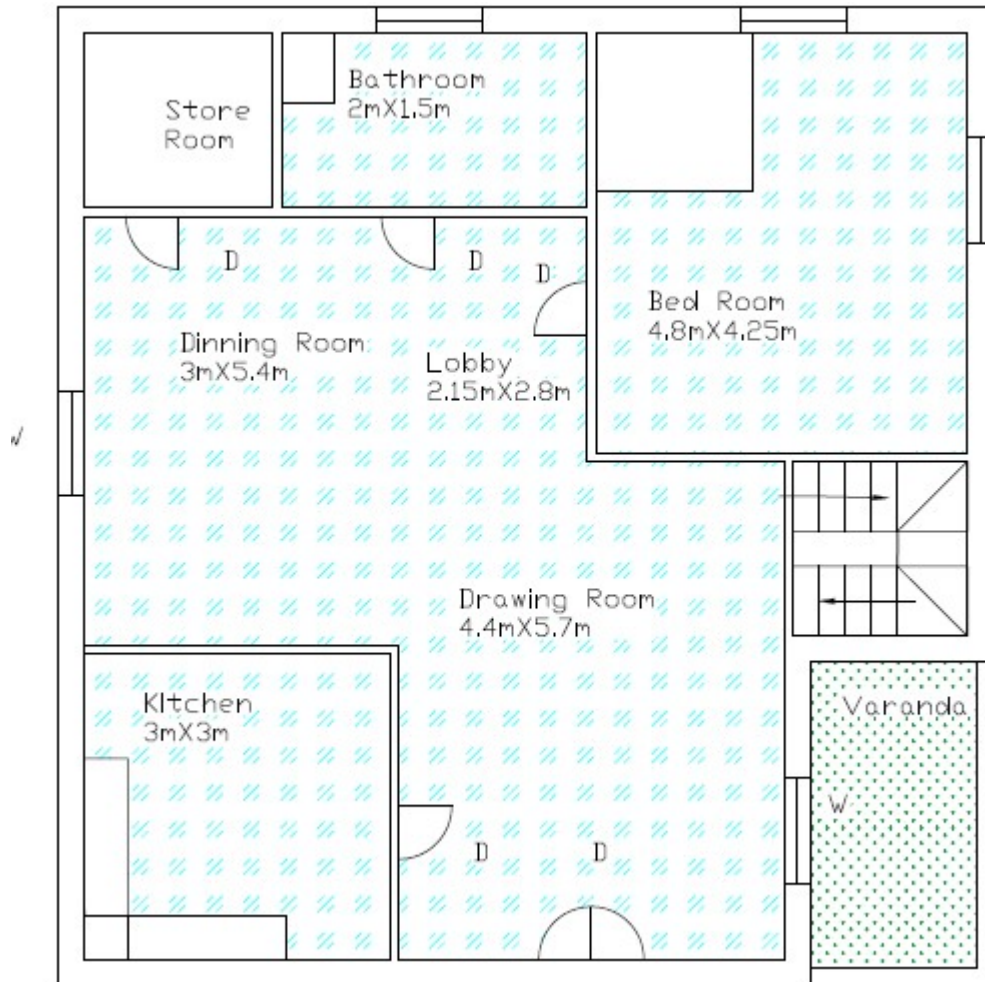
				total	1209413
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CHAPTER – 4

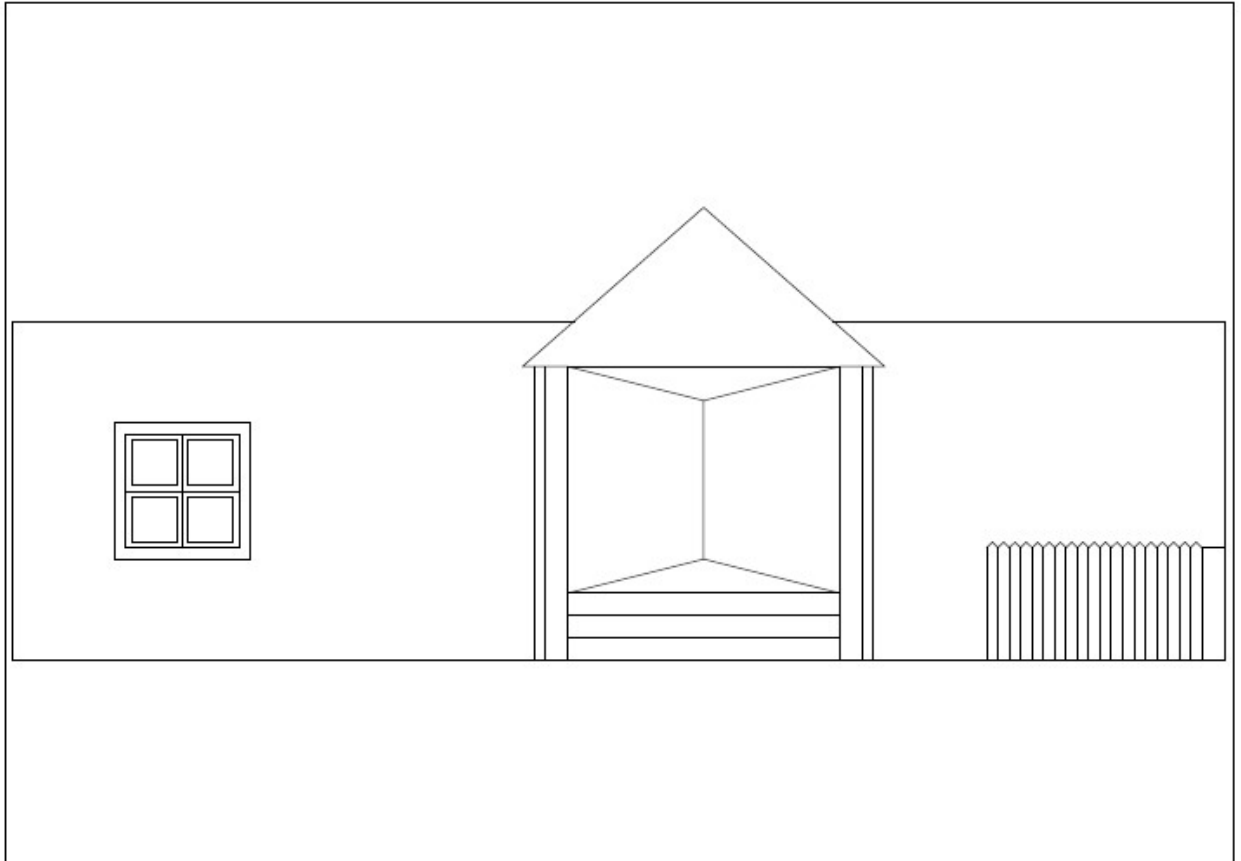
DESIGN PLAN

A. Design in 2-D in Auto-CAD

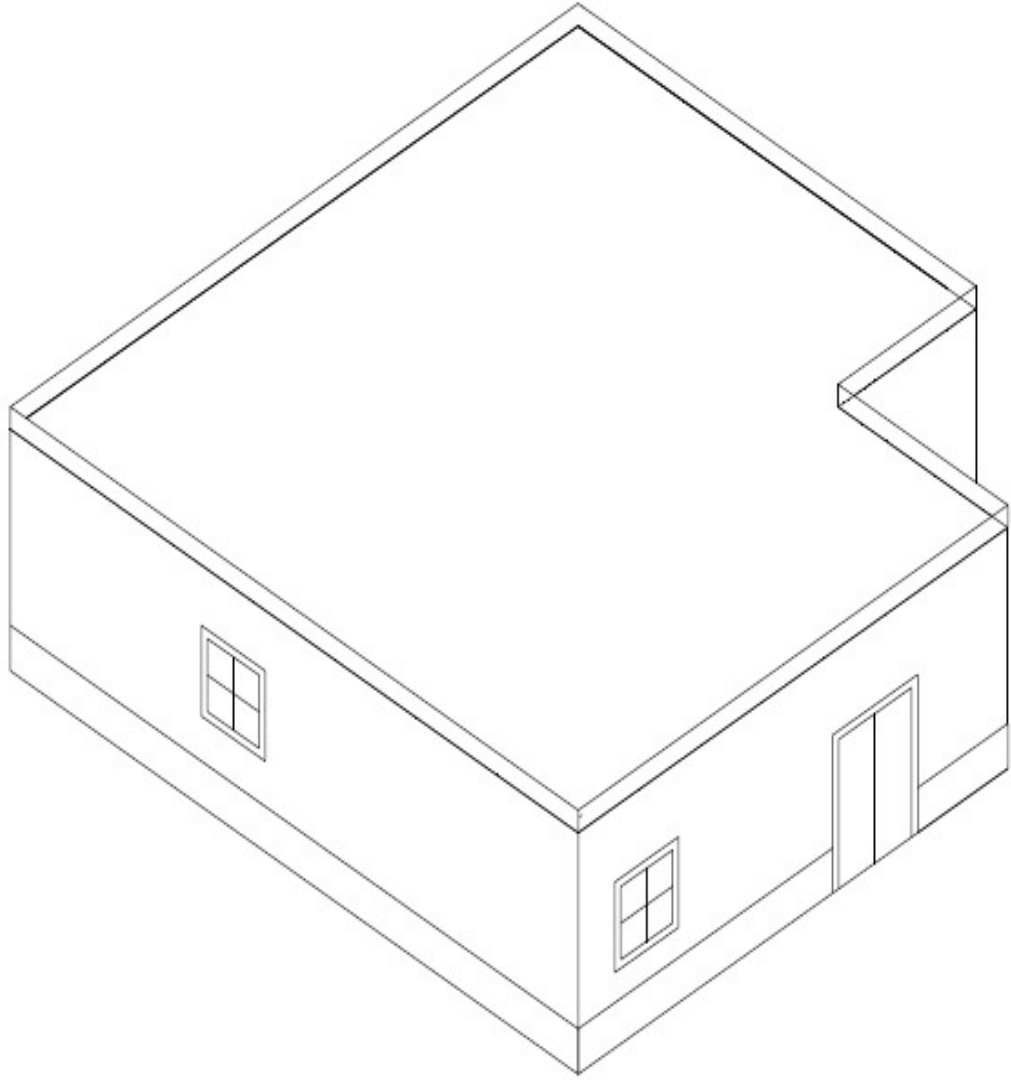
i. Top view of plan



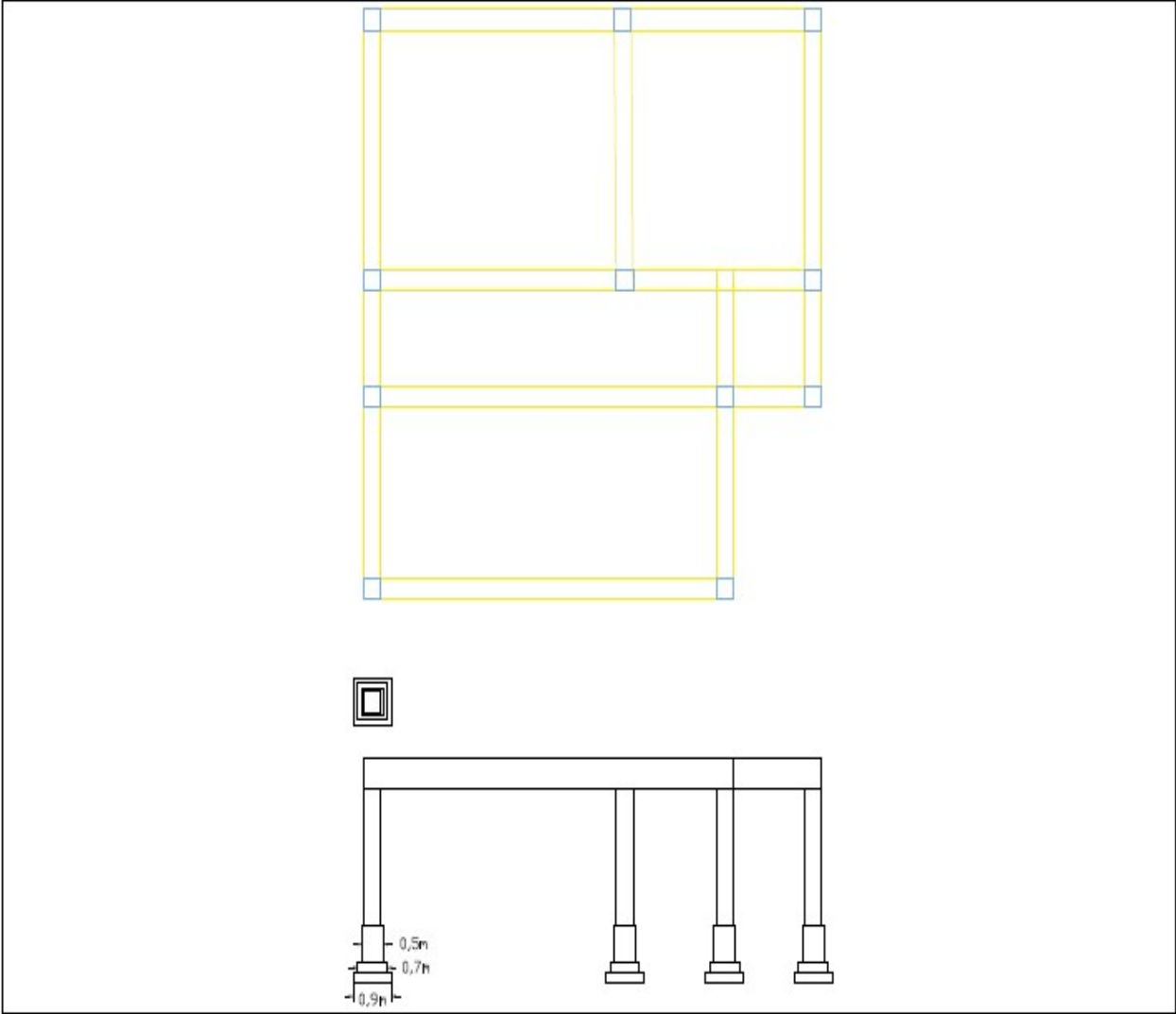
ii. Front view of the plan



iii. Isometric view of the plan



iv. Design plan of beam and columns



v. Mix plan of the design

Area Statement

Kitchen: $3m \times 3m = 9sq.m.$

Drawing Room: $4.4m \times 5.7m = 25.08sq.m.$

Garden Area: $1.9m \times 3.5m = 6.65sq.m.$

Dinning Room: $3m \times 5.4m = 16.2sq.m.$

Lobby: $2.15m \times 2.8m = 6.02sq.m.$

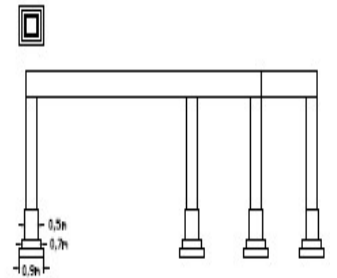
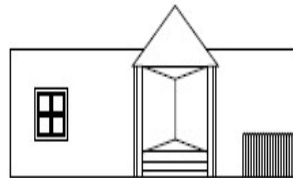
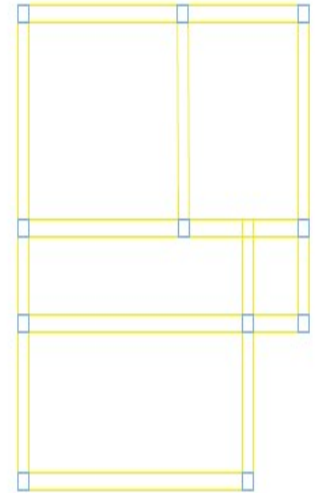
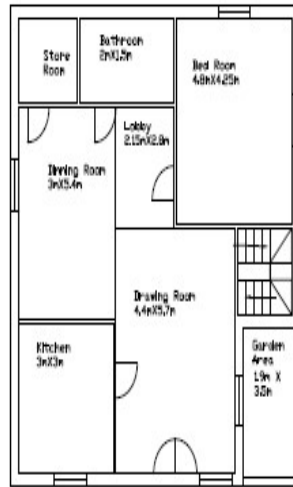
Bed Room: $4.8m \times 4.25m = 20.4sq.m.$

Bathroom: $2m \times 1.5m = 3sq.m.$

Store Room: $1.5m \times 1.5m = 2.25sq.m.$

Total area = 119.84sq.m

Total floor area = 88.6 sq.m



B. Design in 3-D in Revit

i. Front view of the plan



ii. Side view of the plan



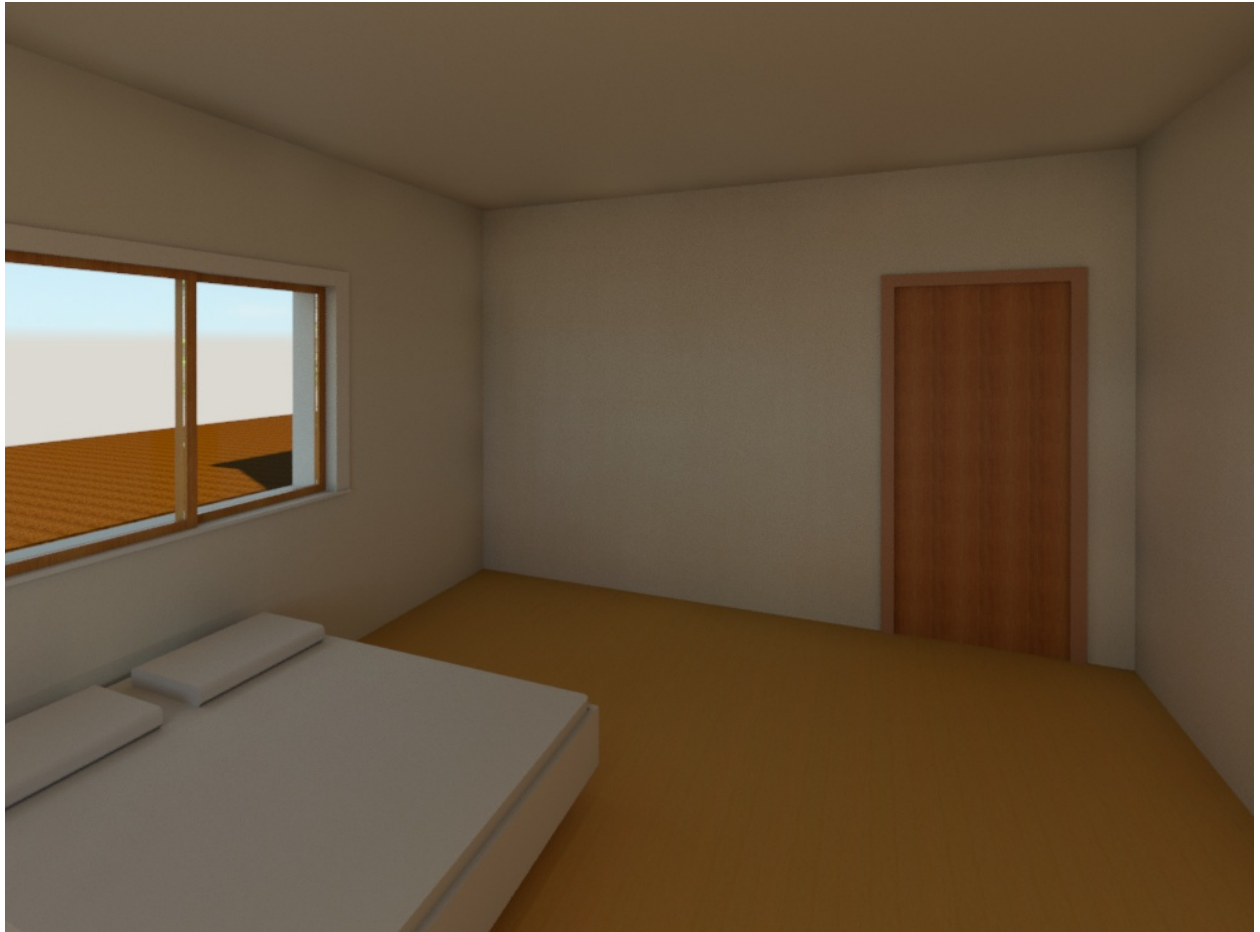
iii. **View of staircase**



iv. View of bed room without rendering



v. **View of bedroom after rendering**



RESULT AND CONCLUSION

A. Result

Total cost of building using concrete = 12,76,003 INR

Total cost of building using papercrete= 12,09,413

% cost reduced of total building = 5%

% cost reduced of inner walls =49%

B. Conclusion

We can conclude that there is difference between the theoretical and practical work done. As the scope of understanding will be much more when practical work is done.

Knowing the loads we have designed the slabs depending upon the ratio of longer to shorter span of panel. In this project we have designed slabs as two way slabs depending upon the end condition, corresponding bending moment.

The coefficients have been calculated as per I.S. code methods for corresponding l_x/l_y ratio. The calculations have been done for loads on beams and columns and designed frame analysis by moment distribution method. Here we have a very low bearing capacity, hard soil and isolated footing done.

Also we have replaced the inner walls with papercrete which proves to be effective alternative to concrete as it reduces the cost upto 50% and also learnt that it can only be used for one or two story building and are suitable for non load bearing walls only and due to low weight of bricks the total dead load of building is reduced.

Since papercrete bricks are sound absorbent so they can be easily used in auditoriums and there is no harmful product being produced during the production of papercrete so it is eco-friendly.

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