

CONSTRUCTABILITY ANALYSIS OF POROTHERM BLOCKS FOR HIGH RISE BUILDINGS

A Thesis

Submitted in partial fulfillment of the requirements for the award of
Master of Architecture degree in Building Management

by

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**DEPARTMENT OF ARCHITECTURE
SCHOOL OF BUILDING AND ENVIRONMENT**

**SATHYABAMA
INSTITUTE OF SCIENCE AND
TECHNOLOGY (DEEMED TO BE
UNIVERSITY)
Accredited with Grade "A" by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

MAY 2021



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BONAFIDE CERTIFICATE

This is to certify that this Report is the bonafide work of
DARRYL CHRISTOPHER (39840005) who carried out the Thesis entitled
“Constructability Analysis of Porotherm Blocks in High-Rise Buildings” under our
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I **DARRYL CHRISTOPHER** hereby declare that the Thesis Report entitled “**Constructability Analysis of Porotherm Blocks in High-Rise Buildings**” done by me under the guidance of **Ar. SELVENDIRAN** (Internal) and **Mr. S. KAVIN KUMAR, Director, EPMCR** (External) at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Master of Architecture degree in Building Management

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ABSTRACT

External walls are one of the main contributors of increased indoor temperature. Porotherm is a breathable, natural material that helps maintain a healthy indoor environment. Besides Clay, Porotherm blocks are made up entirely of natural ingredients such as Rice Husk Ash, Sawdust, Coal Ash, etc.

Hence, there is no release of harmful toxins into the atmosphere. They are also recyclable and save a considerable amount of energy from being wasted. Porotherm bricks are approved as 100% eco-friendly by GRIHA (Green Rating for Integrated Habitat Assessment) and IGBC (Indian Green Building Council).

This Research was dealt with the study and the findouts of the properties of Porotherm Blocks and its Thermal Conditions. And also an Analysis was done in order to find out the Construction Cost of a High Rised Building by using Porotherm Blocks and Comparing it with the Traditionally used Materials in the Current Industry ie. AAC Blocks and Clay Bricks. This Applies by Calculating the Cost of the Bricks, Number of Bricks required according for the Walling Area of the Building, Mortar Cost, Plastering and the Painting Cost for the building using these three types of Blocks Respectively. A Detailed Project Scheduling was also done to find out the Duration of Construction of the Porotherm Blocks for the High Rised Building, and shows how Faster the Porotherm Block built High Rise Building was constructed when compared to the Traditional Blocks in the Industry.

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CHAPTER 1 INTRODUCTION

1.1 AIM

The Aim is to analyse the Futuristic Benefits and Challenges of using Porotherm Blocks in High Rise Buildings, including its Cost efficiency and Duration of its Construction.

1.2 SCOPE FOR THE STUDY

We know that Porotherm Blocks have been used in Villas and Small scale houses Successfully. This Research is to find out the scope of Porotherm blocks in High Rised Buildings as well. That is, to Find out whether its Functions are applicable for the High rised Buildings too.

1.3 OBJECTIVES OF THE STUDY

- To Analyse the techniques used for porotherm brick in the construction of High Rise buildings.
- To work on the Detailed construction scheduling and compare with the Traditional method.
- To Analyse and compare the Cost and the Time difference between the Porotherm block and the Traditional brick constructed buildings.



Fig 1.1 - On going High-rised Porotherm Constructed building in Chennai

METHODOLOGY -

STAGE: 1

Introduction
Aim & Scope of the Study.
Objectives of the Study

STAGE: 2

Methodology
Journal Papers Study
& Its Analysis

STAGE: 3

Literature Study
Manufacturing Process of
Porotherm Blocks
Benefits & its Applications
Literature Case Study

STAGE: 4

Live Case Study
Identification of the Study
Scheduling & Cost
Comparative Study

STAGE: 5

Documentation
Findings
Inference
Conclusion

CHAPTER 2 LITERATURE REVIEW

2.1 JOURNAL 1 - EXPERIMENTAL STUDY ON POROTHERM BRICK MISTREAT GRANITE POWDER

Author Names - R. Soundarya Devi
V. Mohana Priya
C. Saranya
M. Selvalakshmi

2.1.1 ABSTRACT

Bricks are presently wide used as a construction and building tool within the world. Bricks are made of natural waste materials throughout this sample, that embrace granite powder and rice husk ash. the first goal of this study is to eliminate clay use and substitute it with natural waste. On the other hand, economical natural waste disposal could also be a significant factor concerning solid waste management. So, they exchange the massive aspects of granite powder and rice husk ash in creating light-weight brick up applicable proportions that gave compressive strength as similar as typical brick.

2.1.2 OBJECTIVES

- To study the characteristics of granite powder among the porotherm brick.
- To compare the compressive strength of porotherm brick with customary brick.
- To minimize the worth.
- To utilize most of the artefact.

2.1.3 DESCRIPTION OF POROTHERM BRICKS

- Porotherm Bricks offer a faster, nearly dry build, still as high strength and thermal potency. It is a clay brick structural walling device with typical principles. Porotherm brick could be a sophisticated good clay brick that may be utilized in a range of structures, as well as multi-story dwellings, single-family homes, massive residences, villas, instructional establishments, and hospitals.
- It is associate degree innovative product specially created for dynamical climate, keeping homes naturally cool and cozy throughout the year..
- These Porotherm bricks are eco-friendly, efficient, and easy to use. It additionally has properties as associate degree integral style feature that improves thermal insulation, permitting homes to remain naturally cool. it's inherently solid associate degreeed has an unbelievably long era with very little or no maintenance.
- The Strength of this brick makes the merchandise terribly hearth resistive which suggests it doesn't burn, since it's already discharged at a thousand degrees centigrade and has adopts a fireplace rating of F240. one porotherm brick is adequate to the house combined by 9 Clay bricks, that results toless mortar usage, and makes porotherm a favorite material to builder's.

MATERIALS USED



fig 2.1 - Clay soil



fig 2.2 - Granite Powder



fig 2.3 - Rice Husk Ash

2.1.4 SPECIMEN TESTS

Two necessary tests are done to ascertain the standard of the brick before victimization it in any construction activities. They are -

- Water Absorption Test.
- Compressive Strength Test

1. Water Absorption Test

- The water absorption take a look at on bricks are done in order to work out the property of the bricks like degree of burning, quality of the bricks in weathering.
- Water absorption tests are accustomed to verify the compactness of the blocks since water is absorbed by pores in bricks. As a result, glassy bricks are those with a water absorption rate of but 3%.

This take a look at provides the water share absorbed by the brick and it mustn't exceed two hundredth of average weight of dry bricks.

To Find Water Absorption Percentage, $\text{Water Absorption (\%)} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}}$

Water Absorption Test Results were -

Table 2.1 - Water Absorption Ratio for Porotherm Brick

Mix Design Ratio	Weight of Brick (Kg's)	Weight of Brick after absorbing water (Kg's)	Percentage (%) of water Absorption
1% rice husk ash + clay	3.95	4.2	6.69
1% rice husk ash + 2% granite powder + clay	4.0	4.45	11.25
1% rice husk ash + 4% granite powder + clay	4.15	4.75	14.75
1% rice husk ash + 6% granite powder + clay	4.3	4.9	15.2

Table 2.2 - Water Absorption Ratio for Conventional Brick

Mix Design Ratio	Weight of Brick (Kg's)	Weight of Brick after absorbing water (Kg's)	Percentage (%) of water Absorption
Trial 1	3	3.25	12.2
Trial 2	3.25	3.5	12.4
Trial 3	3.5	3.7	12.6

2. Compressive Strength Test

- Compressive strength take a look at ar distributed to validate the bricks load carrying capability beneath compression. This take a look at is distributed with the assistance of Compression Testing Machine.
- Load-bearing masonry walls and columns ar typically created with bricks. The compressive masses ar witnessed by these supporting masonry structures. As a result, knowing the compressive strength of bricks is very important for determinative their quality for building.
-

To Find Compressive Strength, (N/mm²) = $\frac{\text{Max. Load at Failiure (N)}}{\text{Avg. Area of the bed faces in mm}^2}$

Table 2.3 - Compressive Strength for Porotherm Brick

Mix Design Ratio	Load (KN)	Compressive Strength (N/mm ²)
1% rice husk ash + clay	3.95	4.2
1% rice husk ash + 2% granite powder + clay	4.0	4.45
1% rice husk ash + 4% granite powder + clay	4.15	4.75

Table 2.4 - Compressive Strength for Conventional Brick

Mix Design Ratio	Load (KN)	Compressive Strength (N/mm ²)
Trial 1	70	4.1
Trial 2	85	4.25
Trial 3	80	4.2

2.1.5 LITERATURE REVIEW

- This paper shows the study that, the Porotherm Blocks used here are ready comprising of Granite Powder and Rice Husk Ash. because the main objective was to scale back the number of Clay. they're with efficiency exchange Clay with the Granite powder and Rice Husk Ash to form light-weight bricks that provided a similar Compressive Strength because the typical Bricks.
- This Porotherm block was discovered to be associate degree Innovative product that was created specially for dynamical climate and keeping homes naturally cool and cozy throughout the year. The Blocks were additionally discovered to be Environmental Friendly, price Effective with Zero Maintenance and simple to Handle..
- The Strength of the Porotherm Block created the merchandise hearth Resistant since it's already discharged at a thousand Degrees Anders Celsius throughout its manufacture, and incorporates a hearth Rating of 240 Minutes (F240)
- In The Water Absorption take a look at, the Blocks that have water Absorption but three-d are referred to as as glassy.
- The share of Water Absorbed by the Brick shouldnt exceed two hundredth..
- After varied Trials, the share of Water Absorption didnt exceed two hundredth with success. because it was tested with a pair of, four-dimensional .

2.2 JOURNAL STUDY 2 - EXPERIMENTAL STABILITY ANALYSIS OF POROTHERM INFILL SLABS

Department of Civil Engineering, Sri Krishna College of Technology, INDIA
Department of Civil Engineering, Nehru Institute of Technology, INDIA

Author Names - Ranjith.V
V. Sreevidya
M. Vadivel

2.2.1 ABSTRACT

Concrete is considered one in all the foremost essential building materials offered. Here's the way to use it to its full potential. In an exceedingly merely assisted RCC block, compressive forces square measure applied to the highest whereas tensile forces square measure applied to the lowest. Concrete is part compressible however encompasses a low lastingness. As a result, the steel reinforcement is positioned at intervals tension zone. During this section, the concrete is just accustomed hold the steel reinforcement in situ. As opposition associate degree RCC block, selecting the filler material with wisdom saves regarding 30-35 % of concrete. Additionally, a light-weight filler material reduces the loading, requiring less steel reinforcement. Finally, we are able to anticipate a value savings of regarding twenty fifth. As a result, Porotherm bricks square measure used rather than traditional RCC block.

2.2.2 INTRODUCTION

Porotherm could be a variety of clay brick utilized in masonry work. It functions as a really light-weight material. This material could be a lot of quicker, more cost effective, and environmentally friendly different to ancient materials. This compound is durable and encompasses a sort of edges. This kind of concrete utilized in roofing and sunshade accessories will face up to every kind of weather..

2.2.3 OBJECTIVES

- To analyze the steadiness of the pre forged block components.
- To minimize the self-weight of the block components..
- To Minimize the value.
- To build a higher end.

To build most of the employment of building materials.

2.2.4 TYPES OF POROTHERM BRICKS

It offers in no time, nearly dry construction and high strength with thermal potency, Porotherm could be a fashionable clay block structural walling system classified into 2 varieties

1. Porotherm HP (Framed Structure).
2. Porotherm VP (Load-Bearing Structure)

Table 2.5 - Porotherm block types and its Dimensions

Name	Size (L,H,W) in mm	Weight (Kg's)
HP400	400*200*200	11.6
HP150	400*150*200	8.5
HP100	400*100*200	6.2

Materials used to make the Pre-cast Slab -

- Concrete (M30).
- Steel Reinforcement Bars(Fe415).
- Steel fibre strips.
- Porotherm Bricks.

The formed block could be a technique to exchange concrete within the tension zone. The filler material, isn't a structural a part of the block. By reducing the number and weight of fabric, the roof dwindle big-ticket, however still retains the strength of the standard block.

2.2.5 Progress of Making the Pre-Cast Slab

STEP 1- Choosing the Porotherm HP 100mm Thick Block.

This Porotherm Block HP100 Brick is of size 400mm x 100mm x 200mm is employed within the block.



Fig 2.4 - Porotherm block of the size 400x100x200

STEP 2- Shuttering size for the slab is taken-

This Shuttering has the inner size of 1.5m x 0.6m is made of wood.



Fig 2.5 - Shuttering Placment

STEP 3- The Laying of the porotherm blocks in the shuttering-

The Blocks are placed in between the ends, which has space of 140mm.

STEP 4- Reinforcement Details-

10mm Diameter bars are provided in the Tension Zone.

4 Bars are kept Vertically and 2 Long bars Horizontally.



Fig 2.6 - Porotherm Bricks and Steel Bars

STEP 5- Concrete Placing-

M30 concrete is used in the slab, It is Kept over the reinforcement and the sides of Porotherm brick. Concrete was poured in the voids and the Reinforcements were provided in the tension zone.



Fig 2.7 - Casting of the Concrete Slab

STEP 6- Curing Process-

Post Casting work, the slab was held aside for 1 Day and then the curing process was done. Jute Bags were kept to help cure the process.



Fig 2.8 - Concrete Slab after 1 Day



Fig 2.9 - Curing of the Slab

2.2.6 CONCLUSION

- Porotherm bricks were provided between the steel ribs and concrete is poured into the gap to create a filler block.
- The structure needs less steel and cement and it's additionally an honest heat material.
- Cuts off the employment of concrete and saves cement and steel by regarding four-hundredth..
- It additionally reduces the loading of the block and thereby it provides strength and stability to the structure..
- It is a perfect choice for low-income users United Nations agency have restricted house for building a house.

2.2.7 LITERATURE REVIEW

- In this Journal Study, Porotherm Blocks replaces M30 Concrete within the Infill Slabs..
- Using of Porotherm Blocks within the Slabs have found to save lots of regarding 30-35% of concrete.
- Around twenty fifth of price are saved by exploitation Porotherm Blocks during this Experiment.
- The Experiment had offered a quicker, price Effective and Environmentally Sound different to Walling Materials.
- The 2 styles of Porotherm Bricks square measure Porotherm HP & Porotherm VP.
- Porotherm hollow bricks were placed between steel ribs and concrete was poured into the gap to create a filler block.
- The structure needed less steel and cement and it's additionally an honest heat material.
- Reduced the employment of concrete and saves cement and steel by regarding four-hundredth.
- It additionally reduces the loading of the block and thereby it provides strength and stability to the structure.
- It is a perfect choice for low-income users United Nations agency have restricted house for building a house

2.3 LITERATURE STUDY

2.3.1 INTRODUCTION

One of the most significant problems that developing countries face is providing adequate shelter for all citizens.

India also has a housing shortage of 17.6 million homes. Nowadays, owning a home, particularly for low- and middle-income families, is nearly impossible. As a result, acquiring cost-effective, innovative, and environmentally sustainable housing technologies for the construction of houses and buildings has become a necessity, allowing ordinary citizens to construct houses at a reasonable cost..

The factors that take precedence during cost reduction are the structure's strength and longevity, stability, protection, and mental satisfaction. When opposed to conventional building methods, it has been discovered that using low-cost housing technology will save 24 percent on construction costs..

The most critical factors in a building are the walls, floors, and roofs, which can be thought of depending on the needs, and Porotherm Bricks can be used as a legitimate substitute for increasing the time of construction and lowering the construction cost.

2.3.2 WHAT IS POROTHERM ?

- Porotherm is a clay brick which is used for the masonry works.
- It is made up of 70% Clay and the remaining 30% of Rice husk ash, Sawdust, Coal ash, etc.
- It works as a light weight infill material.
- It is a technology that provides a Rapid, Cost effective, Environmentally sound alternative to conventional walling material.
- This brick is a Sustainable material in construction due to its Strength, Durability, Loading, Compactness and lightweight characteristics.
- Its thermal insulation is 45% higher than conventional walling material. Also it has an exceptionally long life with no maintenance at all.
- It improves the time of construction without minimizing on quality and safety. And also reduces its weight as well as selling price.
- There is a great impact in Porotherm bricks worldwide towards recycling industrial waste by products and their utilization as renewable construction materials.
- Directly dumping waste into the atmosphere will result in environmental issues. Wastes may be used to create new products or as admixtures in existing products, allowing renewable resources to be used more effectively and the ecosystem to be spared from waste deposits.

2.3.3 MANUFACTURING PROCESS OF POROTHERM BRICKS

(As of Wienerberger Factory in Kunigal)

1. Clay Quarry -

Clay Excavation is initiated and is done from water tanks closer to the Factory.



Fig 2.10 - Clay Excavation Process

2. Dosage of Raw Materials -

- The Raw Materials are Fedded.
- Comprising Primary Clay & Other Filler materials.
- Dosage of these raw material are controlled by Feeders.



Fig 2.11 - Dosage of Raw Materials by Feeders

3. Clay Preparation -

- The Feeders start feeding the Raw Materials for preparing the Clay, by Grinding, Mixing and Homogenization.
- Then the Pan Mill grinds the Clay.



Fig 2.12 - Prepration of Clay

4. Porotherm HP Extruder -

The Clay Bricks get extruded.

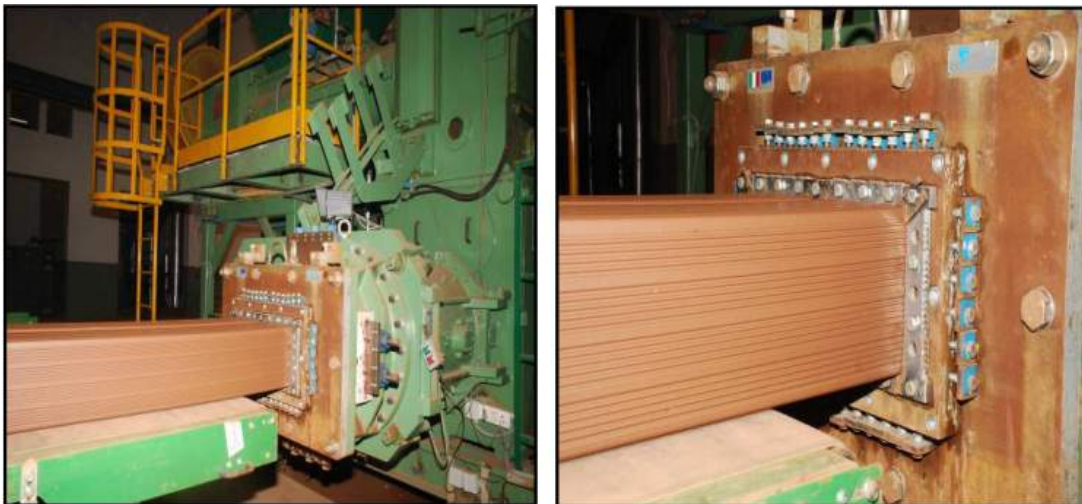


Fig 2.13 - Extruding of the Bricks

5. Automation of Production -

- The Bricks are taken for Cutting according to their Length.
- After the cutting process, the bricks are arranged in dryer cars.



Fig 2.14 - Automation of Production

6. The Bricks are then kept in the Dryer for drying the bricks prior to the Firing process.



Fig 2.15 - Bricks placed in Dryer

7. Kiln - Burning the Bricks -

- The bricks are taken in the Kiln car to process the firing.
- Fuel Injection Unit – For high temperature firing.
- Tunnel Kiln - 160m Long. The Clay bricks are fired at temperature of 1000°C.



Fig 2.16 - Burning of the Bricks

8. Laboratory Testing -

- The Bricks are sent to the Laboratory to get its tests done.
- It Receives its Certification for the Raw materials and Final finished Products.



Fig 2.17 - Testing of the Bricks

9. Factory - Stock & Clay Storage -

The final product stocks are ready and stored.



Fig 2.18 - Storage of Bricks

2.3.4 ADVANTAGES OF POROTHERM BLOCKS

1. Bigger Size -

- POROTHERM Block is similar in size as of concrete blocks.
- 1 POROTHERM HP 200 Block = 9 Clay Bricks.
- It Requires very Less mortar joints
- Very Rapid in construction.

2. Light Weight -

- It is Proved Easy in Handling and Transportation.
- Saves a lot of labor.
- Less dead load.
- Savings in Structural Cost of Steel & Concrete by 10 to 15%
- Savings on Mortar.
- Line & Leveled Plaster only if required.

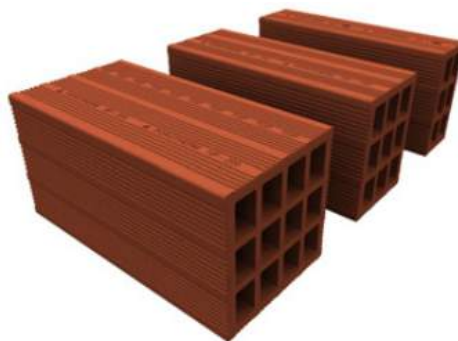


Fig 2.19 - Porotherm Block

2.3.5 BENEFITS OF POROTHERM BLOCK

FASTER -

The Porotherm system rises quickly because it needs no mortar in vertical joints and just a 1mm bed joint.

The Porotherm method allows you to build a storey in a single day.

Porotherm keeps current labor on the job instead of hiring subcontractors or skilled laborers.

DRYER -

Porotherm saves up to 95% of the water used in conventional block work.

Traditional blockwork uses 50 litres of water per 10m² of blockwork, while Porotherm uses 2.82 litres per 10m² of blockwork..

SAFER -

Since porotherm blocks are lighter than concrete blocks, staff can maintain consistent output without risking repetitive strain injuries.

Precision engineering eliminates sharp edges, which reduces the chance of cuts..

EFFICIENCY -

Helps to control temperature fluctuations by being thermally functional.

Acoustically soundproof.

Porotherm's fire resistance is exceptional, with a Class A1 rating for a 100mm wall.

Breathable – aids in humidity regulation.

Mortar may be mixed in small batches close to the work site, eliminating waste.

There is no moisture shrinkage and no finish

SUSTAINABLE -

Materials from alternative, recycled, or secondary sources account for 30% of the total (MARSS)

Blocks have a life expectancy of more than 150 years and are recyclable at the end of their useful life.

STRONGER -

Porotherm's core range compressive strengths are normally 10 N/mm², so one block can meet the majority of requirements.

As a result, there's no need to keep several blocks on-site, lowering the risk of incorrect block use and freeing up storage space.

ENERGY EFFICIENCY -

Because of the lower firing temperatures, there is less embodied energy.

PSI values increase the building's rating and are superior to conventional styles.

Building fabric quality has improved.

Thermal mass is significant..

2.4 LITERATURE CASE STUDY

2.4.1 LITERATURE CASE STUDY 1 -

- **Building Name** - The Housing Tower 1 in the Indian School of Business (ISB)
- **Location** - Hyderabad, INDIA
- **Typology** - Residential Building
- **No. of Floors** - 20
- **Contractor** - JayPee Contractors
- **Architect** - Inform Architects
- **Built-Up Area** - 2,10,000 Sq.ft, **Wall Area** - 1,00,000+ Sq.ft



Fig 2.20 - The Housing Tower-1 ISB

ISB, Hyderabad Features -

- The Indian School of Business, Hyderabad has achieved a Rating level of GOLD in IGBC's Leed India.
 - Saves its Energy upto 2 hundredth
 - Reduces Water upto half-hour
 - 99% of the development waste was collected from Landfills.
 - Double Walls were in-built the East and West directions.
-
- The Housing Tower one, could be a twenty structure LEED Gold certified Residential building within the ISB field at Gachibowli, Hyderabad.
 - The structure has many flats on every floor and is joined by service cores that square measure separated by a grounds within the center. the design strategy expands the vary of choices for cantilevered balconies.
 - POROTHERM HOLLOW CLAY BRICKS PROVIDED QUALITY WALLS IN each the inside AND EXTERIOR to avoid wasting TIME, and therefore the concrete combine style adds early strength to the structural parts by POROTHERM HOLLOW CLAY BRICKS PROVIDED QUALITY WALLS IN each the inside AND EXTERIOR to avoid wasting TIME.
 - The weather is influenced by the structure's orientation and thermal mass at a similar time.
 - The building develops its inexperienced standing through debuty passive strategies like UPVC windows with -
 - ✓ Performance glass
 - ✓ Rain water harvesting
 - ✓ Water saving fixtures
 - ✓ Solar energy and
 - ✓ **Efficiency Walls - POROTHERM** with effective cross ventillation.
 - The Housing Tower one could be a property High Rised inexperienced Building with quality residential and social areas that encourages accountable living amongst its community.

2.4.2 LITERATURE CASE STUDY 2 -

- **Building Name** - Clearview Homes Apartment
- **Location** - Greenford, England UK
- **Typology** - Residential Building
- **No. of Floors** - G+4 Floors
- **Contractor** - Bramall Construction



Fig 2.21 - Clear View Homes

SUMMARY

- To improve this building, climatically sensitive building materials and mechanical systems were used, together with Porothers Blocks for structural and cavity walls. Porothers Blocks were provided by the Organization to hurry up the giving birth method and increase the amount of points earned beneath the Section Code.
- It has been shown that the thermal potency of the walls is employed to scale back heating prices for flat tenants..
- The entire method of the building was made with Porothers blocks.
- Porothers permits respiration at intervals the Walls while not the usage of any Air Conditioners
- Windows during this building square measure positioned so as to recieve ample daylight to chop off the factitious lighting prices..



Fig 2.22 - Site Images of Clear View Homes

2.4.3 LITERATURE CASE STUDY 3 -

- **Building Name** - Geojit BNP Paribas Corporate Office
- **Location** - Kochi, Kerala
- **Typology** - Commercial Building
- **No. of Floors** - G+12 Floors
- **LEED Consultant** - M.Selvarasu
- **Porotherm Bricks Used** - Over 1,40,000



Fig 2.23 - Geojit BNP Paribas Corporate Office

4.3.1 SUMMARY

- This Building is constructed in order to think about the Environmental, Sustainability & the Comfort of the Residents.
- It significantly improves energy efficiency and water consumption in order to generate less waste and create a healthier atmosphere.

- This structure has a total area of 1,04,580 square feet and uses 25% less energy than traditional structures..
- It has succeeded in obtaining high-quality windows, porotherm blocks, energy-efficient air conditioning equipment, and low-energy light fixtures.
- The exterior walls of this building were built with 20cm thick Porotherm Clay Bricks, which have a higher u-value than traditional clay bricks.



Fig 2.24 - Geojit BNP Paribas Corporate Office

- The windows in this case are Double Glazed Units with a 6mm gap.
- The exposed roof was insulated with 20mm thick thermacol.
- Water Efficiency To reduce the energy load on air conditioning, chilled chillers are used. Ventilation system is designed to provide 30% more fresh air than the ASHRAE 2004 standards.
- Occupancy Sensors are used in non-regularly used parts of the building to reduce energy usage.

- Low-emitting materials, such as low-VOC paints, adhesives, and sealants, low-flow dual-flush toilets, and other water-saving fixtures, are used.
- This Geojit BNP Paribas received all seven points needed to apply for LEED certification in categories such as Sustainable Sites, Water Efficiency, Energy, Materials & Resources, and Indoor Environmental Quality.

CHAPTER 3 LIVE CASE STUDY

- Building Name - Tamil Nadu Housing Board-117 (TNHB)
- Location - Chennai, Tamilnadu
- Typology - Residential Building
- No. of Floors - G+13
- Contractor - Engineering Projects Limited
- Built-Up Area - 1,01,153 Sq.ft
- Walling Area - 1,31,560 Sq.ft



Fig 3.1 - Tamil Nadu Housing Board - 117 (TNHB)

TNHB-117 Features -

- Energy savings upto 20%
- Water use reduction upto 30%

CHAPTER 4 ANALYSIS AND RESULT

4.1 Scheduling of the Project

Table 4.1 - Scheduling

	Task Mode ▾	Task Name ▾	Duration ▾	Start ▾	Finish ▾
1		Construction of a High Rise Building with POROTHERM BLOCKS	986 days	Sat 08-05-21	Fri 14-02-25
2		Procurement of Labours	20 days	Sat 08-05-21	Thu 03-06-21
3		Site Clearance	12 days	Fri 04-06-21	Mon 21-06-21
4		Fencing	5 days	Tue 22-06-21	Mon 28-06-21
5		Temporary Power Supply	12 days	Tue 29-06-21	Wed 14-07-21
6		Temporary Water Supply	12 days	Mon 19-07-21	Tue 03-08-21
7		PRE-CONSTRUCTION	47 days	Wed 04-08-21	Thu 07-10-21
8		Excavation	47 days	Wed 04-08-21	Thu 07-10-21
9		CONSTRUCTION	481 days	Fri 08-10-21	Fri 11-08-23
10		GROUND TO TERRACE FLOORS	481 days	Fri 08-10-21	Fri 11-08-23
11		Column - Rebar	481 days	Fri 08-10-21	Fri 11-08-23
12		Column - Shuttering	481 days	Fri 08-10-21	Fri 11-08-23
13		Column - Concreting	481 days	Fri 08-10-21	Fri 11-08-23
14		Column - Deshuttering	481 days	Fri 08-10-21	Fri 11-08-23
15		Beam & Slab - Rebar	481 days	Fri 08-10-21	Fri 11-08-23
16		Beam & Slab - Shuttering	481 days	Fri 08-10-21	Fri 11-08-23
17		Beam & Slab - Concreting	481 days	Fri 08-10-21	Fri 11-08-23
18		Beam & Slab - Deshuttering	481 days	Fri 08-10-21	Fri 11-08-23
19		Staircase - Rebar	481 days	Fri 08-10-21	Fri 11-08-23
20		Staircase - Shuttering	481 days	Fri 08-10-21	Fri 11-08-23
21		Staircase - Concreting	481 days	Fri 08-10-21	Fri 11-08-23
22		Staircase - Deshuttering	481 days	Fri 08-10-21	Fri 11-08-23
23		Lift Wall - Rebar	481 days	Fri 08-10-21	Fri 11-08-23
24		Lift Wall - Shuttering	481 days	Fri 08-10-21	Fri 11-08-23
25		Lift Wall - Concreting	481 days	Fri 08-10-21	Fri 11-08-23
26		Lift Wall - Deshuttering	481 days	Fri 08-10-21	Fri 11-08-23

	Task Mode ▾	Task Name ▾	Duration ▾	Start ▾	Finish ▾
27	🚀	▸ BLOCKWORK	308 days	Mon 14-08-23	Wed 16-10-24
28	🚀	▸ GROUND FLOOR	22 days	Mon 14-08-23	Tue 12-09-23
29	🔧	Blockwork till Sill Level	3 days	Mon 14-08-23	Wed 16-08-23
30	🔧	Window Level Marking	1 day	Thu 17-08-23	Thu 17-08-23
31	🔧	Sill Beam	1 day	Fri 18-08-23	Fri 18-08-23
32	🔧	Blockwork till Lintel	3 days	Mon 21-08-23	Wed 23-08-23
33	🔧	Lintel Slab Shuttering	2 days	Thu 24-08-23	Fri 25-08-23
34	🔧	Rebaring	4 days	Mon 28-08-23	Thu 31-08-23
35	🔧	Concreting	2 days	Fri 01-09-23	Mon 04-09-23
36	🚀	Deshuttering	1 day	Tue 05-09-23	Tue 05-09-23
37	🚀	Curing	2 days	Wed 06-09-23	Thu 07-09-23
38	🚀	Blockwork till Slab	3 days	Fri 08-09-23	Tue 12-09-23
39	🚀	▸ FIRST FLOOR	22 days	Wed 13-09-23	Thu 12-10-23
40	🔧	Blockwork till Sill Level	3 days	Wed 13-09-23	Fri 15-09-23
41	🔧	Window Level Marking	1 day	Mon 18-09-23	Mon 18-09-23
42	🔧	Sill Beam	1 day	Tue 19-09-23	Tue 19-09-23
43	🔧	Blockwork till Lintel	3 days	Wed 20-09-23	Fri 22-09-23
44	🔧	Lintel Slab Shuttering	2 days	Mon 25-09-23	Tue 26-09-23
45	🔧	Rebaring	4 days	Wed 27-09-23	Mon 02-10-23
46	🔧	Concreting	2 days	Tue 03-10-23	Wed 04-10-23
47	🔧	Deshuttering	1 day	Thu 05-10-23	Thu 05-10-23
48	🔧	Curing	2 days	Fri 06-10-23	Mon 09-10-23
49	🔧	Blockwork till Slab	3 days	Tue 10-10-23	Thu 12-10-23
	Task Mode ▾	Task Name ▾	Duration ▾	Start ▾	Finish ▾
50	🚀	▸ SECOND FLOOR	22 days	Mon 16-10-23	Tue 14-11-23
51	🔧	Blockwork till Sill Level	3 days	Mon 16-10-23	Wed 18-10-23
52	🔧	Window Level Marking	1 day	Fri 20-10-23	Fri 20-10-23
53	🔧	Sill Beam	1 day	Mon 23-10-23	Mon 23-10-23
54	🔧	Blockwork till Lintel	3 days	Tue 24-10-23	Thu 26-10-23
55	🔧	Lintel Slab Shuttering	2 days	Fri 27-10-23	Mon 30-10-23
56	🚀	Rebaring	4 days	Mon 30-10-23	Thu 02-11-23
57	🚀	Concreting	2 days	Fri 03-11-23	Mon 06-11-23
58	🚀	Deshuttering	1 day	Tue 07-11-23	Tue 07-11-23
59	🚀	Curing	2 days	Wed 08-11-23	Thu 09-11-23
60	🚀	Blockwork till Slab	3 days	Fri 10-11-23	Tue 14-11-23
61	🚀	▸ THIRD FLOOR	22 days	Wed 15-11-23	Thu 14-12-23
62	🔧	Blockwork till Sill Level	3 days	Wed 15-11-23	Fri 17-11-23
63	🔧	Window Level Marking	1 day	Fri 17-11-23	Fri 17-11-23
64	🔧	Sill Beam	1 day	Mon 20-11-23	Mon 20-11-23
65	🔧	Blockwork till Lintel	3 days	Tue 21-11-23	Thu 23-11-23
66	🔧	Lintel Slab Shuttering	2 days	Fri 24-11-23	Mon 27-11-23
67	🔧	Rebaring	4 days	Tue 28-11-23	Fri 01-12-23
68	🔧	Concreting	2 days	Mon 04-12-23	Tue 05-12-23
69	🔧	Deshuttering	1 day	Wed 06-12-23	Wed 06-12-23
70	🔧	Curing	2 days	Thu 07-12-23	Fri 08-12-23
71	🔧	Blockwork till Slab	3 days	Mon 11-12-23	Wed 13-12-23

	Task Mode ▾	Task Name ▾	Duration ▾	Start ▾	Finish ▾
72		▴ FOURTH FLOOR	22 days	Fri 15-12-23	Mon 15-01-24
73		Blockwork till Sill Level	3 days	Fri 15-12-23	Tue 19-12-23
74		Window Level Marking	1 day	Wed 20-12-23	Wed 20-12-23
75		Sill Beam	1 day	Thu 21-12-23	Thu 21-12-23
76		Blockwork till Lintel	3 days	Fri 22-12-23	Tue 26-12-23
77		Lintel Slab Shuttering	2 days	Wed 27-12-23	Thu 28-12-23
78		Rebaring	4 days	Fri 29-12-23	Wed 03-01-24
79		Concreting	2 days	Thu 04-01-24	Fri 05-01-24
80		Deshuttering	1 day	Mon 08-01-24	Mon 08-01-24
81		Curing	2 days	Tue 09-01-24	Wed 10-01-24
82		Blockwork till Slab	3 days	Thu 11-01-24	Mon 15-01-24
83		▴ FIFTH FLOOR	22 days	Tue 16-01-24	Wed 14-02-24
84		Blockwork till Sill Level	3 days	Tue 16-01-24	Thu 18-01-24
85		Window Level Marking	1 day	Fri 19-01-24	Fri 19-01-24
86		Sill Beam	1 day	Mon 22-01-24	Mon 22-01-24
87		Blockwork till Lintel	3 days	Tue 23-01-24	Thu 25-01-24
88		Lintel Slab Shuttering	2 days	Fri 26-01-24	Mon 29-01-24
89		Rebaring	4 days	Tue 30-01-24	Fri 02-02-24
90		Concreting	2 days	Mon 05-02-24	Tue 06-02-24
91		Deshuttering	1 day	Wed 07-02-24	Wed 07-02-24
92		Curing	2 days	Thu 08-02-24	Fri 09-02-24
93		Blockwork till Slab	3 days	Mon 12-02-24	Wed 14-02-24
	Task Mode ▾	Task Name ▾	Duration ▾	Start ▾	Finish ▾
94		▴ SIXTH FLOOR	22 days	Thu 15-02-24	Fri 15-03-24
95		Blockwork till Sill Level	3 days	Thu 15-02-24	Mon 19-02-24
96		Window Level Marking	1 day	Tue 20-02-24	Tue 20-02-24
97		Sill Beam	1 day	Wed 21-02-24	Wed 21-02-24
98		Blockwork till Lintel	3 days	Thu 22-02-24	Mon 26-02-24
99		Lintel Slab Shuttering	2 days	Tue 27-02-24	Wed 28-02-24
100		Rebaring	4 days	Thu 29-02-24	Tue 05-03-24
101		Concreting	2 days	Wed 06-03-24	Thu 07-03-24
102		Deshuttering	1 day	Fri 08-03-24	Fri 08-03-24
103		Curing	2 days	Mon 11-03-24	Tue 12-03-24
104		Blockwork till Slab	3 days	Wed 13-03-24	Fri 15-03-24
105		▴ SEVENTH FLOOR	22 days	Mon 18-03-24	Tue 16-04-24
106		Blockwork till Sill Level	3 days	Mon 18-03-24	Wed 20-03-24
107		Window Level Marking	1 day	Thu 21-03-24	Thu 21-03-24
108		Sill Beam	1 day	Fri 22-03-24	Fri 22-03-24
109		Blockwork till Lintel	3 days	Mon 25-03-24	Wed 27-03-24
110		Lintel Slab Shuttering	2 days	Thu 28-03-24	Fri 29-03-24
111		Rebaring	4 days	Mon 01-04-24	Thu 04-04-24
112		Concreting	2 days	Fri 05-04-24	Mon 08-04-24
113		Deshuttering	1 day	Tue 09-04-24	Tue 09-04-24
114		Curing	2 days	Wed 10-04-24	Thu 11-04-24
115		Blockwork till Slab	3 days	Fri 12-04-24	Tue 16-04-24

	Task Mode ▾	Task Name ▾	Duration ▾	Start ▾	Finish ▾
116		▲ EIGHTH FLOOR	22 days	Wed 17-04-24	Thu 16-05-24
117		Blockwork till Sill Level	3 days	Wed 17-04-24	Fri 19-04-24
118		Window Level Marking	1 day	Mon 22-04-24	Mon 22-04-24
119		Sill Beam	1 day	Tue 23-04-24	Tue 23-04-24
120		Blockwork till Lintel	3 days	Wed 24-04-24	Fri 26-04-24
121		Lintel Slab Shuttering	2 days	Mon 29-04-24	Tue 30-04-24
122		Rebaring	4 days	Wed 01-05-24	Mon 06-05-24
123		Concreting	2 days	Tue 07-05-24	Wed 08-05-24
124		Deshuttering	1 day	Thu 09-05-24	Thu 09-05-24
125		Curing	2 days	Fri 10-05-24	Mon 13-05-24
126		Blockwork till Slab	3 days	Tue 14-05-24	Thu 16-05-24
127		▲ NINTH FLOOR	22 days	Fri 17-05-24	Mon 17-06-24
128		Blockwork till Sill Level	3 days	Fri 17-05-24	Tue 21-05-24
129		Window Level Marking	1 day	Wed 22-05-24	Wed 22-05-24
130		Sill Beam	1 day	Thu 23-05-24	Thu 23-05-24
131		Blockwork till Lintel	3 days	Fri 24-05-24	Tue 28-05-24
132		Lintel Slab Shuttering	2 days	Wed 29-05-24	Thu 30-05-24
133		Rebaring	4 days	Fri 31-05-24	Wed 05-06-24
134		Concreting	2 days	Thu 06-06-24	Fri 07-06-24
135		Deshuttering	1 day	Mon 10-06-24	Mon 10-06-24
136		Curing	2 days	Tue 11-06-24	Wed 12-06-24
137		Blockwork till Slab	3 days	Thu 13-06-24	Mon 17-06-24
	Task Mode ▾	Task Name ▾	Duration ▾	Start ▾	Finish ▾
138		▲ TENTH FLOOR	22 days	Tue 18-06-24	Wed 17-07-24
139		Blockwork till Sill Level	3 days	Tue 18-06-24	Thu 20-06-24
140		Window Level Marking	1 day	Fri 21-06-24	Fri 21-06-24
141		Sill Beam	1 day	Mon 24-06-24	Mon 24-06-24
142		Blockwork till Lintel	3 days	Tue 25-06-24	Thu 27-06-24
143		Lintel Slab Shuttering	2 days	Fri 28-06-24	Mon 01-07-24
144		Rebaring	4 days	Tue 02-07-24	Fri 05-07-24
145		Concreting	2 days	Mon 08-07-24	Tue 09-07-24
146		Deshuttering	1 day	Wed 10-07-24	Wed 10-07-24
147		Curing	2 days	Thu 11-07-24	Fri 12-07-24
148		Blockwork till Slab	3 days	Mon 15-07-24	Wed 17-07-24
149		▲ ELEVENTH Floor	22 days	Thu 18-07-24	Fri 16-08-24
150		Blockwork till Sill Level	3 days	Thu 18-07-24	Mon 22-07-24
151		Window Level Marking	1 day	Tue 23-07-24	Tue 23-07-24
152		Sill Beam	1 day	Wed 24-07-24	Wed 24-07-24
153		Blockwork till Lintel	3 days	Thu 25-07-24	Mon 29-07-24
154		Lintel Slab Shuttering	2 days	Tue 30-07-24	Wed 31-07-24
155		Rebaring	4 days	Thu 01-08-24	Tue 06-08-24
156		Concreting	2 days	Wed 07-08-24	Thu 08-08-24
157		Deshuttering	1 day	Fri 09-08-24	Fri 09-08-24
158		Curing	2 days	Mon 12-08-24	Tue 13-08-24
159		Blockwork till Slab	3 days	Wed 14-08-24	Fri 16-08-24

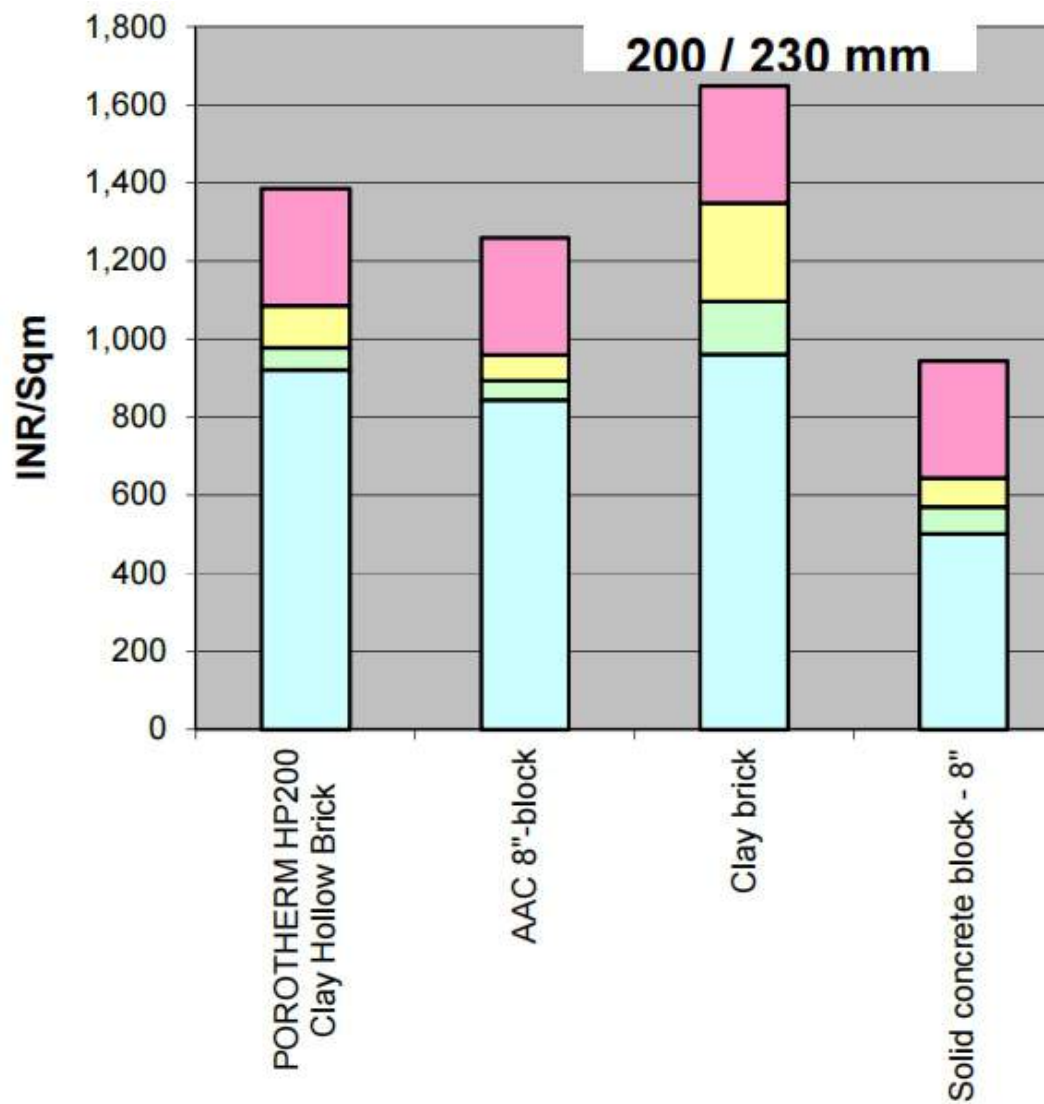
	Task Mode ▾	Task Name ▾	Duration ▾	Start ▾	Finish ▾
160		▸ TWELFTH FLOOR	22 days	Mon 19-08-24	Tue 17-09-24
161		Blockwork till Sill Level	3 days	Mon 19-08-24	Wed 21-08-24
162		Window Level Marking	1 day	Thu 22-08-24	Thu 22-08-24
163		Sill Beam	1 day	Fri 23-08-24	Fri 23-08-24
164		Blockwork till Lintel	3 days	Mon 26-08-24	Wed 28-08-24
165		Lintel Slab Shuttering	2 days	Thu 29-08-24	Fri 30-08-24
166		Rebarring	4 days	Mon 02-09-24	Thu 05-09-24
167		Concreting	2 days	Fri 06-09-24	Mon 09-09-24
168		Deshuttering	1 day	Tue 10-09-24	Tue 10-09-24
169		Curing	2 days	Wed 11-09-24	Thu 12-09-24
170		Blockwork till Slab	3 days	Fri 13-09-24	Tue 17-09-24
171		▸ THIRTEENTH FLOOR	21 days	Wed 18-09-24	Wed 16-10-24
172		Blockwork till Sill level	3 days	Wed 18-09-24	Fri 20-09-24
173		Window Level Marking	1 day	Mon 23-09-24	Mon 23-09-24
174		Sill Beam	1 day	Tue 24-09-24	Tue 24-09-24
175		Blockwork till Lintel	3 days	Wed 25-09-24	Fri 27-09-24
176		Lintel Slab Shuttering	2 days	Mon 30-09-24	Tue 01-10-24
177		Rebarring	4 days	Wed 02-10-24	Mon 07-10-24
178		Concreting	2 days	Tue 08-10-24	Wed 09-10-24
179		Deshuttering	1 day	Thu 10-10-24	Thu 10-10-24
180		Curing	2 days	Fri 11-10-24	Mon 14-10-24
181		Blockwork till Slab	2 days	Wed 18-09-24	Thu 19-09-24
	Task Mode ▾	Task Name ▾	Duration ▾	Start ▾	Finish ▾
182		▸ PLASTERING	100 days	Fri 20-09-24	Thu 06-02-25
183		▸ Interior Plastering	56 days	Fri 20-09-24	Fri 06-12-24
184		Ground Floor	14 days	Fri 20-09-24	Wed 09-10-24
185		First Floor	14 days	Fri 20-09-24	Wed 09-10-24
186		Second Floor	14 days	Tue 01-10-24	Fri 18-10-24
187		Third Floor	14 days	Tue 01-10-24	Fri 18-10-24
188		Fourth Floor	14 days	Thu 10-10-24	Tue 29-10-24
189		Fifth Floor	14 days	Thu 10-10-24	Tue 29-10-24
190		Sixth Floor	14 days	Mon 21-10-24	Thu 07-11-24
191		Seventh Floor	14 days	Mon 21-10-24	Thu 07-11-24
192		Eighth Floor	14 days	Wed 30-10-24	Mon 18-11-24
193		Ninth Floor	14 days	Wed 30-10-24	Mon 18-11-24
194		Tenth Floor	14 days	Mon 11-11-24	Thu 28-11-24
195		Eleventh Floor	14 days	Mon 11-11-24	Thu 28-11-24
196		Twelfth Floor	14 days	Tue 19-11-24	Fri 06-12-24
197		Thirteenth Floor	14 days	Tue 19-11-24	Fri 06-12-24
198		▸ Exterior Plastering	44 days	Mon 09-12-24	Thu 06-02-25
199		Scaffolding	30 days	Mon 09-12-24	Fri 17-01-25
200		North Wall	14 days	Mon 20-01-25	Thu 06-02-25
201		South Wall	14 days	Mon 20-01-25	Thu 06-02-25
202		East Wall	14 days	Mon 20-01-25	Thu 06-02-25
203		West Wall	14 days	Mon 20-01-25	Thu 06-02-25

	Task Mode ▾	Task Name ▾	Duration ▾	Start ▾	Finish ▾
204		▸ PAINTING	92 days	Thu 10-10-24	Fri 14-02-25
205		▸ Interior Painting	48 days	Thu 10-10-24	Mon 16-12-24
206		Ground Floor	6 days	Thu 10-10-24	Thu 17-10-24
207		First Floor	6 days	Thu 10-10-24	Thu 17-10-24
208		Second Floor	6 days	Mon 21-10-24	Mon 28-10-24
209		Third Floor	6 days	Mon 21-10-24	Mon 28-10-24
210		Fourth Floor	6 days	Wed 30-10-24	Wed 06-11-24
211		Fifth Floor	6 days	Wed 30-10-24	Wed 06-11-24
212		Sixth Floor	6 days	Fri 08-11-24	Fri 15-11-24
213		Seventh Floor	6 days	Fri 08-11-24	Fri 15-11-24
214		Eighth Floor	6 days	Tue 19-11-24	Tue 26-11-24
215		Ninth Floor	6 days	Tue 19-11-24	Tue 26-11-24
216		Tenth Floor	6 days	Fri 29-11-24	Fri 06-12-24
217		Eleventh Floor	6 days	Fri 29-11-24	Fri 06-12-24
218		Twelfth Floor	6 days	Mon 09-12-24	Mon 16-12-24
219		Thirteenth Floor	6 days	Mon 09-12-24	Mon 16-12-24
220		▸ Exterior Painting	6 days	Fri 07-02-25	Fri 14-02-25
221		North Wall	6 days	Fri 07-02-25	Fri 14-02-25
222		South Wall	6 days	Fri 07-02-25	Fri 14-02-25
223		East Wall	6 days	Fri 07-02-25	Fri 14-02-25
224		West Wall	6 days	Fri 07-02-25	Fri 14-02-25

4.2 Cost Comparison of the Walling Materials

Table 4.2 - Cost Comparison of Walling Materials (INR/SQM)

	POROTHERM H P200 BLOCK	AAC 8" BLOCK	CLAY BRICK
Length (mm)	400	600	110
Width (mm)	200	200	230
Height (mm)	200	200	75
Price (INR/pc)	78.0	100.0	8.5
Volume (cu.cm)	16,000	24,000	1,898
Block Cost (INR/sqm)	920	843	961
Cement Cost (INR/sqm)	59	51	137
Sand Cost (INR/sqm)	107	66	251
Labour (INR/sqm)	300	300	300
Wall Cost per SQM (INR/sqm)	1,386	1,260	1,648



4.3 Comparison of Construction Cost for Porotherm Block vs AAC Block vs Clay Brick

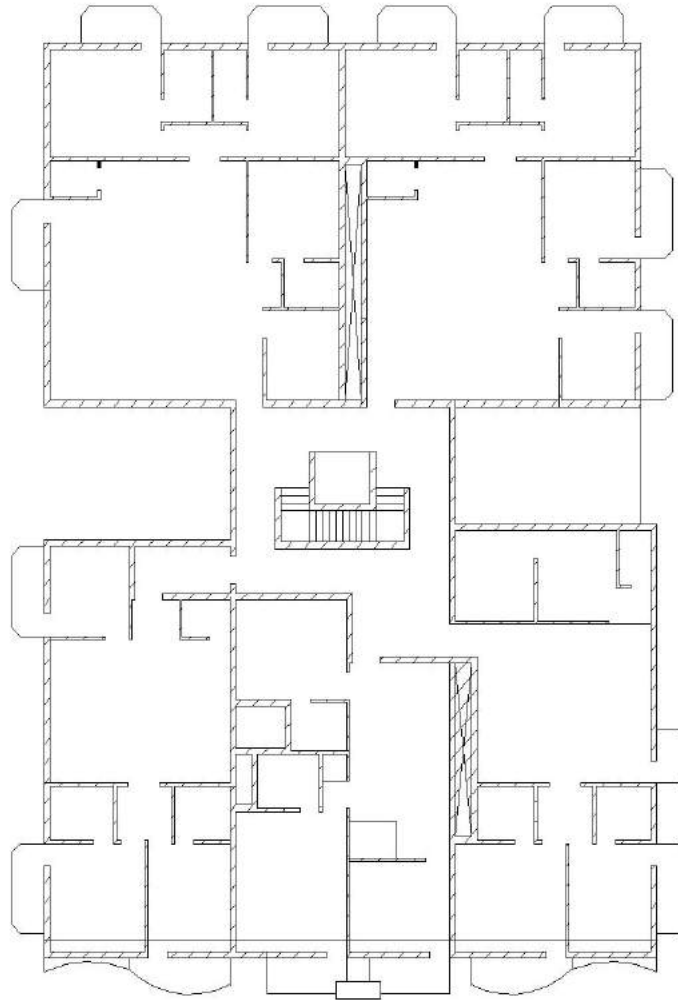


Fig 4.1 - Plan of Tamil Nadu Housing Board 117

4.4 POROTHERM Block Construction Cost Analysis -

Total Walling Area - 1,31,560 Sq.ft

No. of Floors - G+13

Exterior Walls - HP200 Blocks

Dimensions - 400 x 200 x 200(mm)

Cost of 1 POROTHERM Block - INR 78

1 Floor Wall Length - 308m

Volume of the Wall = Length x Height x Thickness of the Wall (m)
= $308 \times 3 \times 0.2$
= **184.8 cu.m**

Number of Bricks = $\frac{\text{Volume of the Wall}}{\text{Volume of 1 POROTHERM Block with Mortar}}$
= $\frac{184.8 \text{ cu.m}}{0.022 \text{ cu.m}}$ = **8,400 No.of Bricks**

So, Now we know that 8,400 Blocks are required for 1 Floor
Total No. of Floors in the Building - 13

8,400 No. of Blocks x 13 Floors
= **1,09,200 Blocks** are required for the Entire Building.

Cost of 1 POROTHERM Block = INR 78
1,09,200 Blocks x INR 78 = **85,17,600 INR**

1 Floor Walling Area = 940 Sq.m
940Sqm x 13 Floors = **12,220 Sq.m**

Labour Cost is INR 300 per Sq.m
12,220 Sq.m x INR 300 = 36,66,000 INR

Plastering Cost = 131534 Sq.ft x INR 37/Sq.ft
= **48,66,758 INR**

Material Cost + Plastering Cost + Labour Cost
= 85,17,600 + 48,66,758 + 36,66,000 = **1,70,50,358**

The Total Cost of Construction of this Building built with Porotherm Blocks is **INR 1,70,50,358**



Fig 4.2 - Porotherm Blocks

4.5 AAC Block Construction Cost Analysis -

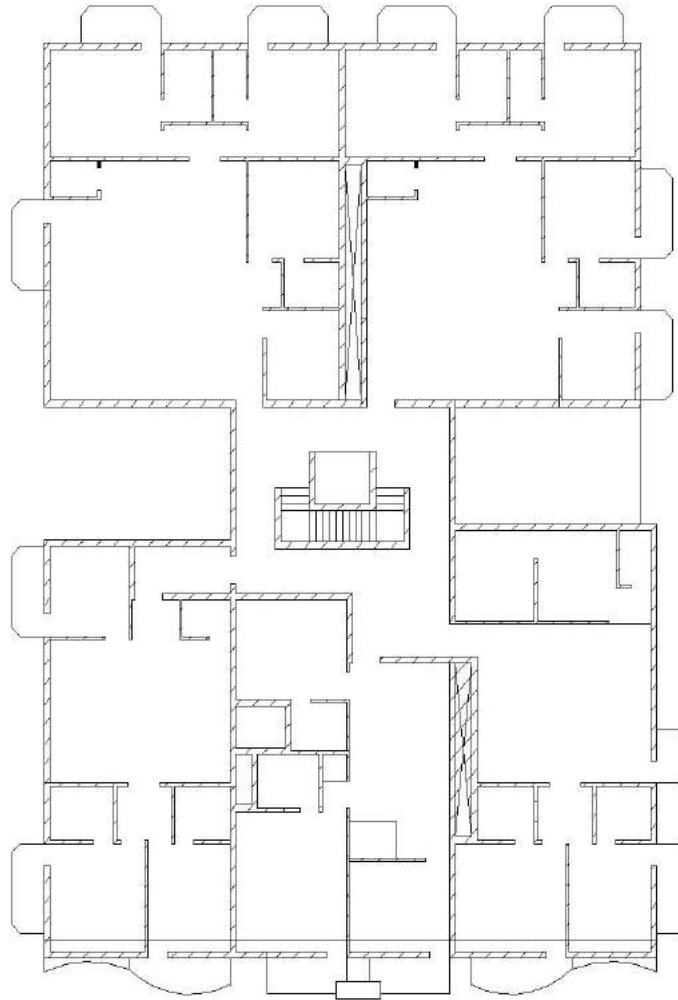


Fig 4.3 - Plan of Tamil Nadu Housing Board 117

Total Walling Area - 1,31,560 Sq.ft

No. of Floors - G+13

Exterior Walls - 8" Bricks

Dimensions - 600 x 200 x 200(mm)

Cost of 1 AAC Block - INR 90

1 Floor Wall Length - 308m

Volume of the Wall = Length x Height x Thickness of the Wall (m)
= 308 x 3 x 0.2
= 184.8 cu.m

Number of Bricks = $\frac{\text{Volume of the Wall}}{\text{Volume of 1 AAC Block with Mortar}}$

$$= \frac{184.8 \text{ cu.m}}{0.026 \text{ cu.m}} = 7,107 \text{ No.of Bricks}$$

So, Now we know that 7,106 Blocks are required for 1 Floor
Total No. of Floors in the Building - 13

7,106 No. of Blocks x 13 Floors
= **92,378** Blocks are required for the Entire Building.

Cost of 1 AAC Block = INR 90
92,378 Blocks x INR 90 = **83,14,020 INR**

1 Floor Walling Area = 940 Sq.m
940Sqm x 13 Floors = **12,220 Sq.m**

Labour Cost is INR 300 per Sq.m
12,220 Sq.m x INR 300 = **36,66,000 INR**

Plastering Cost = 131534 Sq.ft x INR 37/Sq.ft
= **48,66,758 INR**

Material Cost + Plastering Cost + Labour Cost
= 83,14,020 + 48,66,758 + 36,66,000 = **1,68,46,778**

The Total Cost of Construction of this Building built with AAC Blocks is **INR 1,68,46,778**.



Fig 4.4 - AAC Block

4.6 Clay Brick Construction Cost Analysis -

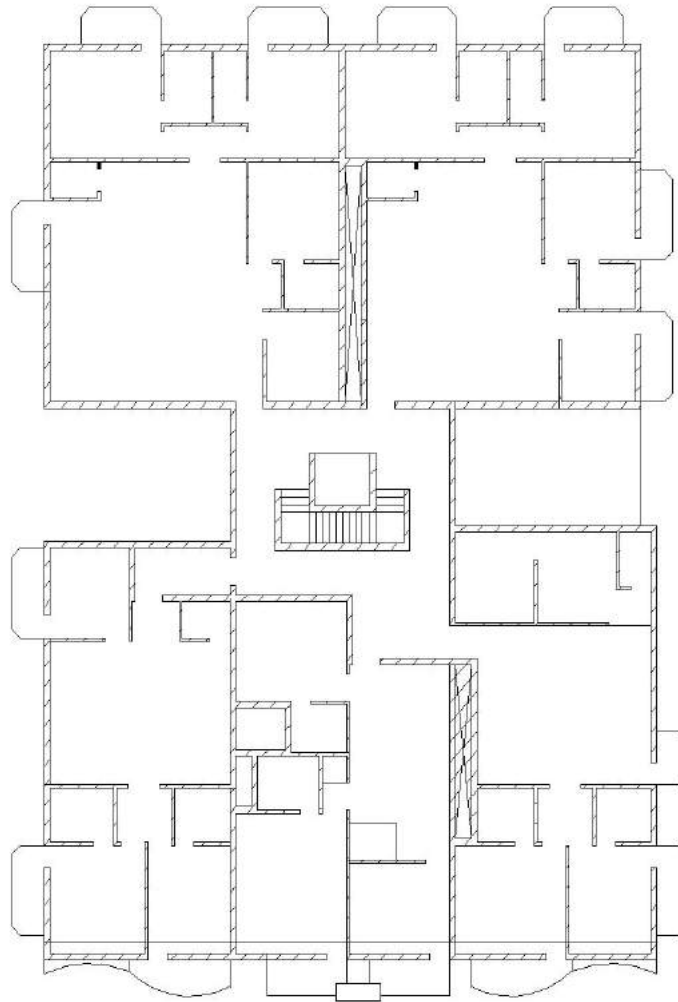


Fig 4.5 - Plan of Tamil Nadu Housing Board 117

Total Walling Area - 1,31,560 Sq.ft

No. of Floors - G+13

Exterior Walls - 9" Bricks

Interior Walls - 4.5" Bricks

Cost of 1 Brick - INR 8.5

1 Floor Wall Length - 308m

For 1 Brick Wall,

Volume of the Wall = Length x Height x Thickness of the Wall (m)

$$= 308 \times 3 \times 0.2$$

$$= \mathbf{184.8 \text{ cu.m}}$$

$$\begin{aligned} \text{Number of Bricks} &= \frac{\text{Volume of the Wall}}{\text{Volume of 1 Brick with Mortar}} \\ &= \frac{184.8 \text{ cu.m}}{0.002 \text{ cu.m}} = \mathbf{92,400 \text{ No.of Bricks}} \end{aligned}$$

So, Now we know that 92,400 Bricks are required for 1 Floor
Total No. of Floors in the Building - 13

92,400 No. of Bricks x 13 Floors
= **12,01,200** Bricks are required for the Entire Building.

Cost of 1 Brick = INR 8.5
12,01,200 Bricks x INR 8.5 = **1,02,10,200 INR**

1 Floor Walling Area = 940 Sq.m
940Sq.m x 13 Floors = **12,220 Sq.m**

Labour Cost is INR 300 per Sq.m
12,220 Sq.m x INR 300 = **36,66,000 INR**

Plastering Cost = 131534 Sq.ft x INR 37/Sq.ft
= **48,66,758 INR**

Material Cost + Plastering Cost + Labour Cost
= 1,02,10,200 + 48,66,758 + 36,66,000 = **1,87,42,958**

The Total Cost of Construction of this Building built with Clay Bricks is **INR 1,87,42,958**



Fig 4.6 - Clay Bricks

4.7 COMPARITIVE ANALYSIS OF POROTHERM vs AAC BLOCK vs CLAY BRICKS IN TERMS OF COST -

Table 4.3 - Cost Comparison of Porotherm vs AAC Block vs Clay Bricks

	POROTHERM HP200	AAC 8" BLOCK	CLAY BRICK
No. of Bricks Required	1,09,200	92,378	12,01,200
Cost of 1 Brick (INR)	78	90	8.5
Plastering Charges (INR/ Sq.ft)	37	37	37
Labour Charges (INR/ Sq.m)	300	300	300
Total Cost of Construction (INR)	1,70,50,358	1,68,46,778	1,87,42,958

4.8 Data Collection from Questionnaires -

1. Supply and Demand of Porotherm Blocks from the Factory to the Site ?

The Wienerberger Factory is in Kunigal, Karnataka. Based on the Project Requirement and its Location, it takes around 2-3 Days for delivering the Materials anywhere in India from the date of order recieved.

2. Production Capacity of Porotherm Blocks per Day ?

The Production Capacity of the Kunigal Factory is around 600 Tonnes per Day. Sufficient enough capacity for delivering to High rise Projects Site (One Way).

3. What is the Plastering Thickness required ?

The Recommended Plastering Thickness for the Internal walls are 12mm & for the External Walls are 20mm. But it can vary as per the Site conditions.

4. Drilling Works for Electrical and Plumbing ?

Default and Conventional way, the same method followed for the Conventional Bricks despite its Hollow properties.

CHAPTER 5

SUMMARY AND CONCLUSION

5.1 FINDINGS FROM LIVE CASE STUDY-

- This Porotherm Block Material resulted to be found out as a very Energy Efficient Material which turned out to be very innovative for the Construction Process. When compared with all the other materials in the Industry, this Block provides a very Good and Qualitative Performance in the Industry.

FAST -

- It is a very Faster progressive material to be built in with, as this Block help to build within an average speed of 25-30sq.m per man a day, whereas the Conventional Masonry helps to build around 12-15sq.m per man a day.
- This Material has found out to be very much Lighter in Weight when compared to the other Blocks and very less Mortar is required here to join up multiple Porotherm Blocks.
- This Material was also found out to be very Rigid in structure when compared to the Conventional blocks. And helps to construct One Floor Height Construction in a Day.
- The mortar which is used here is Zeroplus.

DRY -

- After finding out the Progress of the Dry State, The Porotherm Blocks saves water by upto 95% when compared with the Conventional Blocks.
- While talking an example, for an area of 200 Sq.m, The Porotherm Block built structure consumes just 72 Litres whereas the Conventional Blocks consumes over 1060 Litres of Water.
- The Porotherm Block hence found out to be very much Dry when compared with the other Materials, And it also tends to come up with 30% Moisture Content when added up with 1000 Litres of Water into the Mortar Content for its Mix.

STRONG -

- After the various Tests and Comparisons, The Porotherm Blocks Core is situated to around 10 N/sq.m, finds out to be stronger in its strength whereas the Traditional Concrete ranges around only 7 N/sq.m
- Moreover, these Porotherm Blocks find out to be very much Versatile, since it has the tendency to fit almost all the requirements in it. All the blocks are not mandatory needed to be within the site.

SAFE -

- The Blocks are found out to be very much lighter in weight when compared to the traditional concrete blocks. So this Feature permits the helpers and the workers to equip and perform their production rates with no certain injuries onsite. This definitely reduces the Risk of Cuts as well.
- Reducable Mortar Content provide even more lighter Quality so that, it is even more safe within the Site to be handled with.
- This Porotherm Block is trended out to be an A1 Material which is not Combustible at

all and is very much Fire Resistive in nature.

SUSTAINABLE -

- This Porotherm Block Found out to be very Sustainable in nature and an excellent solution for Cost Reduction in High Rise Buildings.
- It doesn't provide any Risk towards Nature since it is totally Inert Material and easy to Use.
- They Provide a very much Long Valid Sustainability and provides very much less Carbon Product in nature and gives up a good life quality towards the building to around 150 Years with literally Zero Maintenance.
- More than 30% of the Materials here were collected from the (Materials from Alternative, Recycled or Secondary Sources).
- It proved to be very much Efficient in its Acoustic Properties.
- It also tends to be a very much breathable material in high rised structures as well, which helped in reducing the temperature marginally.
- There were found out to be No Moisture Content and Shrinkages among the building, which shows that there are less chances for Cracking of the Walls.

5.2 CONCLUSION -

- From the Live Case Study Analysis being done. It has proved that the Porotherm Block constructed Building have been Costed Rs. 1,70,50,358 which is slightly Costlier than the AAC Block constructed Building Rs. 1,68,46,778.
- The Construction of Porotherm Blocks shows an increase in 1.21% of the Total Cost. But Provides additional features to the Building in terms of Thermal Comfort in and Around the Building by reducing the Temperature to around 2-3 Deg. C and Sustainability where the AAC Block Building doesn't provide.
- While Analysing the Clay Bricks Constructed Building, The Porotherm Block Constructed Building is 9.93% more Cost Efficient in its Construction. Where the Clay bricks Construction did cost Rs. 1,87,42,958.
- The Analysis also resulted the Duration of the Construction being the Fastest in the Porotherm Block built High Rise Building.