IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

"Advancing Sustainable Construction Practices: Exploring the Potential of Interlocking Bricks"

Naresh.R

Faculty of Architectur,

Dr. M.G.R. Educational And Research Institute university,India

Abstract: Cement is frequently used extensively in traditional construction processes, which increases carbon emissions and environmental degradation. An other approach is to use interlocking bricks, which are an affordable, environmentally friendly building material that requires less time to produce. In addition to evaluating the advantages of interlocking bricks over conventional building materials, this dissertation will investigate the potential of interlocking bricks in encouraging sustainable construction practices.

1.1 Aim:

To Explore the Potential of Interlocking Bricks in Life cycle Assessment, and its Environmental impact.

1.2 Research Objectives:

To investigate the technical characteristics of interlocking bricks, including their design, manufacturing process.

To assess the environmental benefits of interlocking bricks compared to traditional construction materials, such as their potential for reducing carbon emissions, energy consmption, and waste generation.

To analyze the economic feasibility of using interlocking bricks in construction projects, considering factors such as material costs, labor requirements.

To analyze how the construction time, and maintenance expenses can be reduced using interlocking bricks.

To provide recommendations and guidelines for construction industry stakeholders on integrating interlocking bricks into sustainable construction practices, addressing technical considerations, promoting awareness.

1.3 Scope:

To find the Environmental impact by using this interlocking brick.

Comparison of various brick with interlocking bricks .

How can we promote mud inter lock bricks over cement inter lock bricks.

Comparison between mud interlock bricks and cement interlock bricks.

1.4 Methodology:

This dissertation will employ a mixed-methods research approach. A comprehensive literature review will be conducted to establish the technical characteristics, environmental impact, and economic feasibility of interlocking bricks.

Case studies of construction projects utilizing interlocking bricks and how is it manufactured will be analyzed, combining qualitative data from interviews and project documentation with quantitative data on project performance and costs.

Environmental assessments will be conducted using life cycle analysis methodologies.

The collected data will be analyzed using statistical techniques, cost-benefit analysis, and comparative evaluation methods.

1.4.1 Methodology Flow chart :

PHASE-1

- RESEARCH MODEL DEVELOPMENT
- Literature Review
- Conceptual Frame work
- Technical characteristics

PHASE -2

- CASE STUDY
- Case studies of construction projects utilizing interlocking bricks will be analyzed

PHASE-3

- DATA COLLECTION
- Environmental assessments will be conducted using life cycle analysis methodologies.
- economic feasibility of interlocking bricks

PHASE-4

- REPORT
- Collected data will be analyzed using statistical techniques, cost-benefit analysis, and comparative evaluation methods.

INTRODUCTION

2.1 Carbon emission

carbon compound (such as carbon dioxide) released into the atmosphere, often through human activity such as the burning of fossil fuels such as coal or gas.

Example:

Many of our daily activities cause emissions of greenhouse gases. For example, we produce greenhouse gas emissions from burning gasoline when we drive, burning oil or gas for home heating, or using electricity generated from coal, natural gas, and oil.

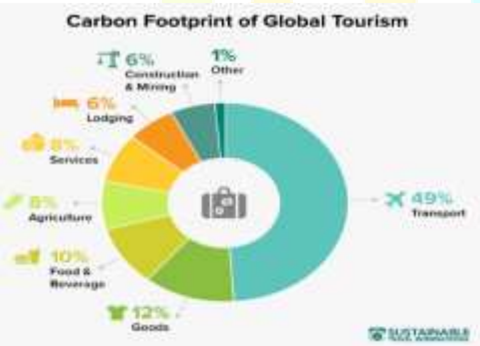

Fig 2.1 Emission of carbon

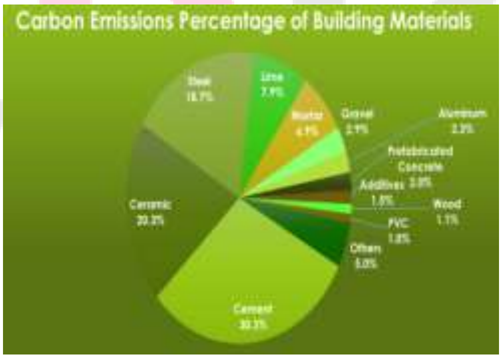

Fig 2.2 Emission of carbon in Construction field

2.2 Carbon footprint :

A measure of the amount of carbon dioxide released into the Atmosphere as a result of the activities of a particular individual, Organization, or community.

It is calculated by summing the emissions resulting from every Stage of a product or service's lifetime (material production, Manufacturing, use, and end-of-life).

2.3 Carbon Emission in Construction :

Traditional construction methods often involve the extensive use of cement, which contributes to environmental degradation and carbon emissions. Interlocking bricks offer an alternative solution, as they provide a sustainable and cost-effective building material with reduced environmental impact. This dissertation aims to explore the potential of interlocking bricks in promoting sustainable construction practices, evaluating their technical, environmental, and socio-economic aspects.

Carbon emissions, primarily in the form of carbon dioxide (CO_2), play a significant role in environmental concerns, particularly in the context of global climate change. One industry that contributes substantially to carbon emissions is the construction sector. The construction process involves a complex interplay of activities, materials, and energy consumption, all of which can result in the release of carbon dioxide into the atmosphere. Understanding the sources and impacts of carbon emissions in construction is essential for adopting sustainable practices and mitigating the industry's environmental footprint.

2.3.1 Sources of Carbon Emissions in Construction:

2.3.1.1 Energy Consumption: Construction activities require substantial energy inputs for running machinery, equipment, and tools. Fossil fuels, such as diesel and gasoline, are commonly used on construction sites, releasing CO_2 when burned.

2.3.1.2 Raw Material Extraction and Production: The production of construction materials like cement, steel, and concrete involves energy-intensive processes. Cement production, for instance, releases significant CO_2 due to the chemical reactions required to produce clinker.

2.3.1.3 Transportation: The movement of construction materials, equipment, and workers to and from the site generates carbon emissions. Inefficient transportation and long distances can exacerbate these emissions.

2.3.1.4 Heating and Cooling: Energy is often needed for site heating, cooling, and maintaining suitable working conditions, particularly in extreme weather.

2.4 INTER LOCKING BRICKS

2.4.1 INTRODUCTION

Interlocking bricks are a type of construction material characterized by their ability to fit together like puzzle pieces without the need for mortar or other bonding agents.

They are designed to interlock with one another, creating a strong and stable structure when stacked or laid in place. Interlocking bricks have gained popularity for their ease of use, cost-effectiveness, and sustainability.

Fig 2.4 Constructed using interlocking bricks

2.4.2 Interlocking Mechanism:

The defining feature of interlocking bricks is their ability to fit together snugly due to specific designs or features on their surfaces. This eliminates the need for traditional mortar, which reduces construction time and labor.

2.4.3 Modularity:

Interlocking bricks are designed to be uniform in size and shape, which makes them easy to handle and install. Their modular nature allows for efficient construction and the creation of various patterns and designs.

Fig 2.5 Inter locking brick

2.4.4 Materials:

Interlocking bricks can be made from different materials, including stabilized soil, compressed earth, concrete, or other locally available materials. This makes them adaptable to different regions and reduces the need for transporting building materials over long distances.

2.4.5 Sustainability:

Interlocking bricks typically require less cement compared to conventional brick construction, leading to lower carbon emissions and reduced environmental impact. Additionally, their use of local materials minimizes resource consumption.

Fig 2.6 Inter locking brick

2.4.6 Versatility:
These bricks can be used for various construction projects, including walls, floors, pavements, and even roofing. They can be dry-stacked or interlocked with slight pressure, eliminating the need for more labor.
2.4.7 Thermal Insulation:
Depending on the material used, interlocking bricks can provide good thermal insulation, helping to regulate indoor temperatures and reduce energy consumption for heating or cooling.

Fig 2.7 Inter locking bricks

2.5 TYPES OF MATERIAL USED IN INTERLOCKING BRICKS:

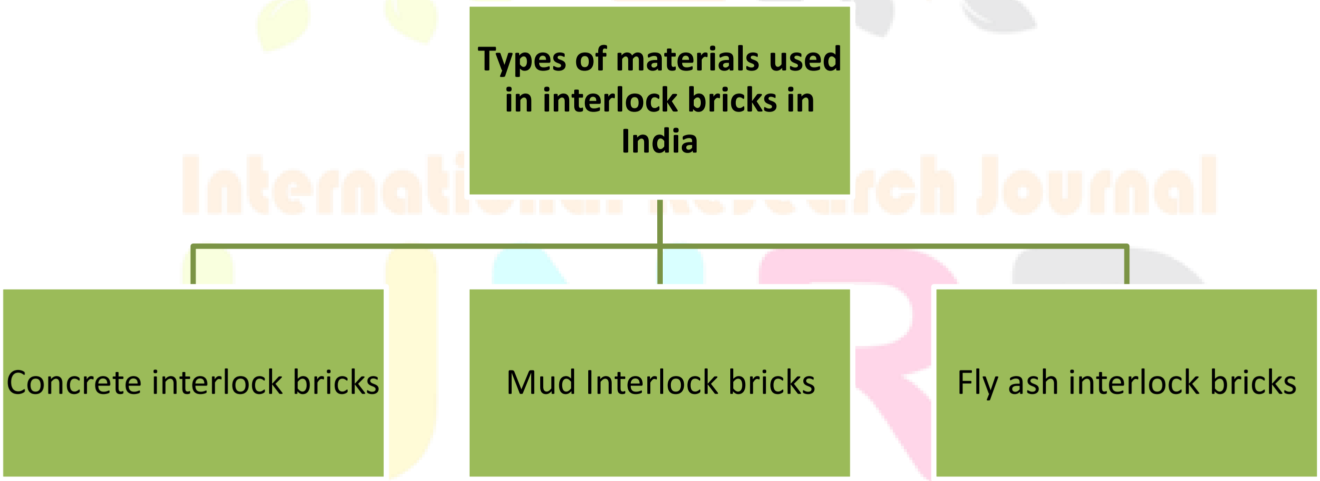

Fig 2.8 Concrete interlocking bricks

Fig 2.9 Mud interlocking bricks

Fig 2.10 Fly ash inter locking brick

CHAPTER 3
JOURNAL STUDY

Impact of carbon foot print in construction industry

- The carbon footprint of construction industry: A review of direct and indirect emission
- Factors Contributing to Carbon Emission in Construction Activity
- Carbon Footprint Associated with Construction Industry and Determination of its Theoretical Amount.
- Carbon Emission Efficiency in the Construction Industry and Its Carbon Emission Control Measures: A Case Study of Henan Province, China
- Green construction for low-carbon cities: a review

Environmental impact of interlock bricks

- INTERLOCKING BRICK FOR SUSTANABLE HOUSING DEVELOPMENT
- Interlocking compressed earth bricks as low carbon footprint building material
- Development of eco-efficient bricks – A life cycle assessment approach
- Finite Element Modeling of Low Heat Conducting Building Bricks

Interlocking bricks General study

- RESEARCH ON INTER LOCKING STABILISED SOIL BRICKS
- Comparative cost analysis between interlocking bricks and sandcrete blocks for residential buildings in Ghana
- Construction of Walls with Self Interlocking Bricks
- Mechanized of Interlocking Brick and Its Structural Behavior as Load Bearing and Non-Load Bearing Element-Review

Material

- FLY ASH INTERLOCKING BRICK BY USING GEOPOLYMER CONCRETE
- MANUFACTURING OF INTERLOCKING BRICKS USING FLY ASH
- Development and performance evaluation of interlocking bricks using industrial waste materials
- Development of rubberized geo polymer interlocking bricks
- EXPERIMENTAL INVESTIGATION ON INTERLOCKING BLOCKS BY PARTIAL REPLACEMENT OF CEMENT WITH SILICA FUME
- The Innovation of Interlock Bricks with A Mixture of Bagasse Ash Without Combustion
- Mechanical and Thermal Properties of Interlocking Bricks Utilizing Wasted Polyethylene Terephthalate

3.1 TITTLE :The carbon footprint of construction industry: A review of direct and indirect emission
AUTHOR :Yahaya Hassan, Vivek Shankar MATHUR
SOURCE:esearchgate.net/publication/354978932_The_carbon_footprint_of_construction_industry_A_review_of_direct_and_indirect_emission
YEAR:Sep-21
Abstract:
2015 to 2050 period can be considered as an era of transition phase toward net-zero emissions for both buildings as well as the physical
envi-ronment refecting the agreement reached by the numerous countries attending the Paris .
Conclusion
this subject to help construction companies meet their low-carbon targets. As a result, this paper reviewed the contributions of researchers across the globe towards carbon dioxide and other GHGs emissions from the industry.
Inference :
The construction industry is considered to be among the major sectors that contribute sig-nicantly toward the emission of GHGs in our environment, which have a major effect on the climate change, and is approximately responsible for about 19 percent of the overall GHG emission globally, rendering it a pollution hotspot requiring urgent mitigation measures.

3.2 TITTLE :Factors Contributing to Carbon Emission in Construction Activity
AUTHOR :Nadzirah Zainordin, Dhuny Bibi Fatimah Zahra
SOURCE:file:///C:/Users/19192/Downloads/125950017.pdf
Abstract:
The construction industry has become one of the world's biggest carbon emitter with the rapid urbanization process and rapid economic growth.
The carbon emissions connected with the built environment include CO2 emissions from the built environment's operational stage. which is known as operational carbon emissions and carbon emissions from other stages, such as stages of material production and construction.

Conclusion :
There are a few considerations that construction player should take note while doing construction activity, such as, using low carbon emission for machinery and also transportation.
Inference :
This is one of the Agenda of Sustainable Development Goal 2030 which to protect the environment.
such as, using low carbon emission for machinery and also transportation
carbon emission may contribute a major harmless to the construction activities from initial stage to the delivery stage.

3.3 TITTLE :Green construction for low-carbon cities: a review
AUTHOR :Lin Chen, ·Lepeng Huang
SOURCE:file:///C:/Users/19192/Downloads/s10311-022-01544-4.pdf
Abstract:
The construction industry is a major user of non-renewable energy and contributor to emission of greenhouse gases, thus requiring to achieve net-zero carbon emissions by 2050. Indeed, construction activities account for 36% of global energy consumption and 39% of global carbon dioxide emissions.
Conclusion:
Green construction technology is more complicated than conventional technology and is not widely known among. Due to the more stringent requirements of green construction implementation, the lack of training and experience of construction personnel, the lack of awareness of green construction, and the inability to obtain government support will make it difcult to promote green construction implementation .
Inference :
green building technologies are more costly and require more time to implement than conventional technologies.

3.4 TITTLE : Carbon Emission Efficiency in the Construction Industry and Its Carbon Emission Control Measures: A Case Study of Henan Province, China .
AUTHOR : Qing jing Shi and Chun Bai
SOURCE:https://neptjournal.com/upload-images/(36)G-197-Final.pdf
YEAR:2020
Abstract:
the Chinese construction industry has generated a large quantity of carbon emission and brought about challenges to sustainable development while making enormous contributions to national economic development.
Conclusion :
This study constructed a carbon emission efficiency model that took carbon emission as an environmental factor and calculated carbon emission efficiency of Henan construction industry in the period of 2012-2018. The study results indicated that the total-factor carbon emission efficiency of Henan construction industry was 1.084 from 2012 to 2018, and the elevated 0.84% part was derived from 0.35% elevation of technological progress and 0.47% improvement of technical efficiency. The average value of pure technical efficiency was slightly reduced by 0.03%, while that of scale efficiency was elevated by 0.51%.
Inference :
The carbon emission efficiency of the construction industry could be improved by advocating the use of low-carbon energy sources in buildings, reasonably and scientifically organizing building construction, reinforcing propaganda of low-carbon use of buildings,

and motivating related interest subjects to participate in the emission reduction of the construction industry to reduce environmental pollution caused by the construction industry.

3.5 TITTLE :Carbon Footprint Associated with Construction Industry and Determination of its Theoretical Amount
AUTHOR :Z Krejza, J Chovancová
SOURCE:https://iopscience.iop.org/article/10.1088/1755-1315/222/1/012013/pdf
Abstract:
In recent years, great emphasis has been put on the ecology issue and human impact on the environment, as the existence of global warming and
the greenhouse effect due to human activity has been evident.
Conclusion:

Table 4. Carbon footprint comparison for the low-energy and standard house.

	Low-energy house	Standard house	Difference
The carbon footprint amount of individual materials	71,764.61 kg	64,960.00 kg	6,804.61 kg
Acquisition costs of material (without carbon footprint)	[illegible]	[illegible]	[illegible]
Carbon footprint price of individual materials	CZK 10,543.52	CZK 9,552.80	CZK 990.72
Acquisition costs of material (including carbon footprint)	[illegible]	[illegible]	[illegible]

Table 3.1

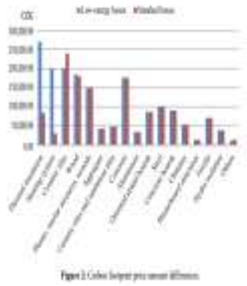

Fig 3.1

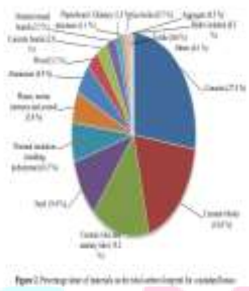

Fig 3.2

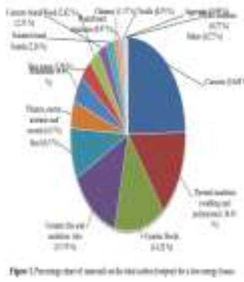

Fig 3.3

3.6 TITTLE : INTERLOCKING BRICK FOR SUSTANABLE HOUSING DEVELOPMENT
AUTHOR : R. K. Watile,S. K. Deshmukh .
SOURCE:https://www.academia.edu/35984866/INTERLOCKING_BRICK_FOR_SUSTANABLE_HOUSING_DEVELOPME
NT
Y
EAR:May 2014
Abstract:

The use of interlocking bricks masonry has gained rapid popularity in many foreign countries as an alternative to conventional bricks for sustainable housing.
This paper gives the results of an experimental investigation in which the compressive strength, water absorption and density were investigated by using varying percentage of fly ash, stone dust, and sand with different mix proportion
A manmade fiberglass fiber reinforce polymer (GFRP) utilize as reinforcing material to produce the interlocking blocks which gives appreciable results discuss in detail.
Strength of interlocking bricks with increasing fly ash increases with the age.

CONCLUSIONS
All mix proportions gives satisfactory higher values of compressive strength
Interlocking bricks with economically available fly ash in large proportion have sufficient strength for their use in low cost housing, non-load bearing construction and in regions where good quality burnt clay bricks are not available.

3.7 TITTLE :Interlocking compressed earth bricks as low carbon footprint building material
AUTHOR :N S A Asman, N Bolong
SOURCE:https://iopscience.iop.org/article/10.1088/17551315/476/1/012086/pdf
Abstract:
Therefore, the Interlocking Compressed Earth Bricks (ICEB) has been introduced as an alternative for low carbon building material.
This paper studies the carbon footprint of Interlocking Compressed Earth Bricks as a walling structure in buildings or residential houses
The Interlocking Compressed Earth Bricks system is an improvement from the conventional brick production where the brick is fabricated by compressed method (not fired), thus reducing the carbon emissions.
Conclusion
The value obtained for the carbon emission of ICEB as a walling material in building construction is less compared to the conventional FCB of RC structure by 35%reductionincomparison.
Choosing environmentally-friendly materials and sustainable practices would help in minimizing the carbon emission where in this case, ICEB can be considered as green and sustainable materials as the brick are not fired, and the process of construction also contributing to green building construction.
The result shows that the implementation of interlocking compressed earth bricks contributes to carbon footprint reduction and suitable to be used as a low carbon footprint building material.

3.8 TITTLE :Development of eco-efficient bricks – A life cycle assessment approach.

AUTHOR: Wahidul K. Biswas

SOURCE:https://www.sciencedirect.com/science/article/abs/pii/S2352710221002862

YEAR:October 2021

Abstract

Interlocking bricks perform better than the conventional bricks in terms of structural aspects, further assessment is required to determine whether this replacement could potentially yield environmental and economic benefits.

Conventional bricks have already been criticized for its environmental footprints. Interlocking bricks undoubtedly avoided the use of energy intensive cement by avoiding the use of mortar, but it at the same time uses energy intensive steel for reinforcement purposes for attaining the improved level of structural performance.

While the cost of cement is avoided when building walls using interlocking bricks, cost of steel is added to the construction process.

Conclusions

The interlocking bricks showed the same technical performance as conventional bricks with higher construction efficiency (i.e. less time as well as labor requirement).

environmental and economic assessments are required to compare the interlocking bricks with the conventional bricks to discern which brick could offer the required level of structural strength with reduced cost and environmental impacts.

The compressive strength for interlocking brick prism has been found to be better than the conventional clay brick made prism. Although the tensile strength of conventional bricks is higher than the interlocking bricks, the tensile strength of the latter is still acceptable for the structural purposes.

3.9 TITTLE :RESEARCH ON INTER LOCKING STABILISED SOIL BRICKS

AUTHOR : Swapnil H.Patil

SOURCE:https://ijret.org/volumes/2016v05/i03/IJRET20160503068.pdf

INFERENCE :

I.S.S.B. is one of the alternative for the normal Bricks. I.S.S.B. is getting more popular in Indian market because of its economy both in methods of production & construction.

Interlocking Stabilized Soil Bricks are bricks made up by mixing of soil with water ,(with different strength improving materials like fly ash, cement etc.) & Compact this mix by use of mechanical or Hydraulic compaction machine. I.S.S.B. is not only helps in raising the speed of construction but also it reduces the time required for completion of particular work or project.

I.S.S.B. having the simple technology & it mainly depends on the raw material which is available in surrounding area of construction this is the benefit which will help to complete the project/construction in short period.

This I.S.S.B. method will give the 35% - 40% reduction in the construction cost than using other construction methods.

I.S.S.B. material will allow to construct the small section of wall which provides the good quality of strength and resistance to water. Cement + Soil stabilised bricks will require the proper curing @ 3 – 4 weeks after the curing.

A Good soil for casting bricks having some proportion: Good Soil is the composition of Gravels 15% + Sand 50 % + Silt 15 % + clay 15%.

ISSB bricks on site then it reduce the transportation which will save cost of transportation, fuel, time & money. This product is energy efficient & environment friendly because it required 15 – 20 % less energy consumption per m3 than energy consumed by Fired bricks per m3 .

3.10 TITTLE :Comparative cost analysis between interlocking bricks and sandcrete blocks for residential buildings in Ghana.

AUTHOR : Emmanuel Nana Jackson

SOURCE:https://medcraveonline.com/MOJCE/comparative-cost-analysis-between-interlocking-bricks-and-sandcrete-blocks-for-residential-buildings.

YEAR:July 19, 2018

Abstract

The extensive use of Sandcrete blocks (SBs) for residential buildings as compared to interlocking bricks (IBs) has significantly increased its cost and has therefore affected the cost of housing delivery in Ghana.

Conclusion

The results revealed that the cost incurred in the use of interlocking bricks for construction of the proposed two bedroom single–storey self–contained building plan under study was cheaper than using sand Crete blocks for construction of the same building in terms of material and labor cost.

Interlocking bricks have been found to be better alternatives to sand Crete blocks and should, therefore, be used to promote affordable housing delivery in Ghana for building developers. This will facilitate cost efficiency and make housing provision available and more affordable.

Inference :

The total material cost for IBs was GH¢12,291.00 while SBs was GH¢7,175.81 making a cost and percentage difference of GH¢5,015.19 and 41.14% respectively.

3.11 TITTLE: FLY ASH INTERLOCKING BRICK BY USING GEOPOLYMER CONCRETE.

AUTHOR : Dipak phapale, Rutwik lokhande.

SOURCE: https://www.irjet.net/archives/V7/i3/IRJET-V7I3340.pdf

YEAR: Mar 2020

Inference :

Fly ash- generally fly ash is combustible by product thermal power plant. In class c fly ash having more caso4, free lime, calcium rich glass, . In f class fly ash having more glass, alumina, silicate glass.

1. It means that nearly cost of one brick is Rs.16.

2. Other normal brick having low cost require mortar + plaster inside, outside + Labor cost which is not required here.
3. Here if we use hollow interlocking bricks instead of solid interlocking bricks. Then the volume of brick can be reduced by 40%
4. If we consider above Rs.16 per brick is sufficient.

Economical benefit

1. it offers several economic benefit over PCC
2. 10 to 30%cheaper than that of PCC

3. Further more, the very little drying shrinkage, the low creep, the excellent resistance to sulphate attack and good acid resistant offer by GPC may yield additional economic benefit when it is utilized in practical application.
4. The same thing carried by precast product.

ADVANTAGES

1.Similar to traditional concrete
2. Low shrinkage
3. Low heat of hydration
4. Precast product made
5. High pressure taking
6. Reduction in drying shrinkage
7. Strong, durable and it increase performance
8. To replace cement which is the major contributor of greenhouse gas by GPC
9. Introducing binder material in concrete
10. Reduce CO2 emission and eco- friendly concrete
11. Develop cost efficient product
12. High tensile strength.

3.12 TITTLE :MANUFACTURING OF INTERLOCKING BRICKS USING FLY ASH
AUTHOR :G.Ghadvir, S. Kamble, V. Patil
SOURCE:https://www.irjet.net/archives/V8/i6/IRJET-V8I6739.pdf
YEAR:June 2021

Inference :

It has been challenging always for researchers to make interlocking brick light weight, low cost and improve the performance against aggressive environment. An experimental effort has been made in this concern.
This project gives the results of an experimental investigation in which the compressive strength, water absorption and density were investigated by using varying percentage of fly ash.
They are light in weight and hence are very suitable for multi-floored buildings. This is because as the height of the buildings increase, the stress and tension on the foundation and structure increase too. With light bricks, this stress and tension are reduced manifold.
Fly ash bricks absorb less heat and considering the Indian climate, it makes it better when compared to clay bricks.
The manufacturing of bricks using fly ash is environment friendly.
The fly ash 70 to 80% used in manufacturing bricks is beneficial to increase in compressive strength.

COST CALCULATION

Rate of 1 kg fly ash - 2 Rs
Rate of 50 kg cement bag - 350
Rs 1kg cement - Rs 7
Mix proportion 1:3
Where 1= Cement 3= fly ash
Mortor required for 1 block of interlocking brick is 6 kg So,
Fly Ash required is 4.5 kg
Cement required is 1.5 kg
Cost for fly Ash is 4.5 × 2 = 9 Rs .
Cost for cement is 1.5 × 7 = 10.5 Rs.
Cost for 1 block is =19.5 Rs

3.13 TITTLE : Development of rubberized geo polymer interlocking bricks
AUTHOR: Mohammed, Bashar S. Mohd Shahir Liew
SOURCE: https://www.sciencedirect.com/science/article/pii/S2214509518300044
YEAR: June 2018

Abstract

Waste tires contribute badly to the environment on a huge scale as they are bulky, non-biodegradable, and prone to fire and being a shelter for mosquitos and other insects.
In the concrete industry, crumb rubber (CR) particles from scrap tyres have been used as partial replacement of fine aggregates, producing rubber Crete Despite its multiple advantages, rubber Crete exhibits low mechanical properties and durability which is limiting its wide use in the construction industry

Mix design of geopolymer using response surface methodology

Response surface methodology (RSM) is one of the commonest available mathematical and statistical methods for analyzing and developing models between a single or more variables and the dependent variables (responses).
Interlocking rubberized brick production

Conclusion

A dry mixing procedure for rubberized geopolymer was established and the optimum contents of the constituents for typical geopolymer interlocking rubberized bricks of varying targeted strengths were reported.

The test results indicate that there was a reduction in the compressive and flexural strengths of the developed geopolymer interlocking rubberized bricks and an increase in water absorption. The average compressive and flexure strengths were obtained to be 3.98 MPa and 0.258 MPa, respectively.
-The bricks have been rated as non-effloresced and classified as 3rd class bricks which can be used as non-load bearing material. It is recommended to utilize Nano silica to increase the strength of the bricks.

3.14 TITTLE :Development and performance evaluation of interlocking bricks using industrial waste materials
AUTHOR : Vijay Adhithya A, Kalpana V. G.
SOURCE:https://www.ijariit.com/manuscripts/v7i4/V7I4-1207.pdf
Fly ash
Fly ash is a waste product from the coal power plant that contains fine particles of burned coal that are driven out of boilers together with the gases.
Hydraulic Lime
A hydraulic lime is made from limestone that either naturally contains or has artificially introduced some form of amorphous silica in the burning process.
GGBS
Ground Granulated Blast Furnace Slag (GGBS) is a by-product from the blast furnaces used to make iron. GGBS comprises mainly of CaO, SiO2, Al2O3, MgO. It has the same main chemical constituents as Ordinary Portland Cement but in different proportions.

- The compressive strength of the IB increased with an increase in lime and GGBS content.
- Based on rate analysis the interlocking brick masonry was around 40% cheaper than conventional red brick masonry.
- the Interlocking Brick proposed as low-cost, eco-friendly, sustainable and durable alternative to the conventional red bricks.

S.No	Description	Conventional Red Brick				Interlocking Brick			
		Quantity	Unit	Rate	Cost	Quantity	Unit	Rate	Cost
		Brickwork with first class bricks in super-structure in cement mortar 1:4				Brickwork with Interlocking brick in super-structure			
A	**Labour charges**								
1	Mason	8.83	Nos.	900	7947	4.42	Nos.	900	3978
2	Mazdoor	15.90	Nos.	700	11130	7.95	Nos.	700	5565
3	Bhishti	1.77	Nos.	450	797	0.885	Nos.	450	399
B	**Material**								
1	Brick	5000	Nos.	11	55000	1482	Nos.	27.38	40578
	Wastage	5%			2750	5%			2029
2	Cement	18.55	Bag	400	7420				
3	Sand	2.576	m^3	1362	3509				
4	Steel					175.59	kg	55	9658
C	**Scaffolding 1% extra**	1%			660	1%			503
D	**Transportation cost 1% extra**	1%			660	1%			503
E	**Other charges 2% extra**	2%			1320	2%			1006
F	**Add for water charges @1%**	1%			660	1%			503
		Cost of 10 cu.m.			**91853**	**Cost of 10 cu.m.**			**64722**
		Cost of 1 cu.m.			**9185**	**Cost of 1 cu.m.**			**6472**
		Round off cu.m.			**9200**	**Round off cu.m.**			**6500**

Table 3.2 Comparison of cost analysis between red brick and interlocking brick

3.15 TITTLE :Construction of Walls with Self Interlocking Bricks.
AUTHOR : Shubham Garad, Prathamesh Kadgi.
SOURCE:https://iarjset.com/wp-content/uploads/2021/07/IARJSET.2021.86159.pdf
YEAR: June 2021
Inference :
The bricks which are locked against each other without use of cement mortar to form a structurally stable wall that reduces the cost and time of construction to almost half.
Without the need for high skilled masons (except for the base course), by saving cement (less mortar) and with the speed of construction, the building costs are lower than for standard masonry construction.
Additional costs are saved by building load bearing walls, instead of infill walls between structural frameworks.
The structural stability and durability of interlocking block constructions can be far greater than for comparable timber constructions.
Grout holes and channel blocks provide means to insert steel reinforcements in vulnerable parts of buildings for increased wind and earthquake resistance.

Point	Sand Brick	Concrete Brick	Self-Interlocking Brick
Time required for construction	More	More	Less
Strength of the brick	Medium	High	High
Overall cost	Average	Economical	Economical
Weight	Medium	Heavy	Light
Surface Finish	Rough	Rough	Smooth
Tools required	More	More	Less
Water Curing	More	More	Less

Table 3.3 Comparison of sand brick, concrete brick,self interlocking brick

3.16 TITTLE :Mechanical and Thermal Properties of Interlocking Bricks Utilizing Wasted Polyethylene Terephthalate
AUTHOR : Wesam Salah Alaloul , Vivekka Olivia John
SOURCE:https://link.springer.com/article/10.1186/s40069-020-00399-9
YEAR:02 May 2020
Abstract
Plastic bottles are non-biodegradable material made up of Polyethylene Terephthalate (PET) and takes around 450 years to get decomposed.
The purpose of this research is to reuse plastic bottles comprised of Polyethylene Terephthalate and Polyurethane binder, by manufacturing interlocking brick that helps to reduce the waste on landfills and the pollution.
The plastic bottles were shredded and grinded to a size of 0.75 mm and mixed with the Polyurethane (PU) and the Polymer.
The mixed later casted and compacted in the interlocking brick machine mold.
Materials
To formulate the mix proportions for the interlocking bricks, the materials used were:
Ground polyethylene terephthalate (20%, 40%, 60%, 80%).
Polyurethane binder (20%, 40%, 60%, 80%).
Conclusion
A good compressive strength of 5.3 was obtained for a PET/PU of 60/40 ratio which is suitable to be used as non-load bearing masonry brick wall. Thus, it can also be used as partition wall. The highest tensile strength obtained was 1.3 MPa for a PET/PU of 60/40 ratio.
PET and PU incorporation in an interlocking brick have demonstrated good impact strength which was higher than other research project utilizing waste material.

3.17 TITTLE :The Innovation of Interlock Bricks with A Mixture of Bagasse Ash Without Combustion
AUTHOR :Z Erwanto , D D Pranowo
SOURCE:https://iopscience.iop.org/article/10.1088/1757899X/854/1/012002/pdf
YEAR: MAY 2021.
Abstract:
The wall building material is dominated by clay brick and the process requires combustion.
Therefore, the need for the development of interlock brick to introduce wall material that is easy to install, strong, without combustion and environmentally friendly.
The shape design of interlock brick is made with Modified Tanzanian Interlock Brick (MTIB).
The result was an MTIB that meet the requirements of SNI in a mixture with a ratio of 2 Clay: 3 Sand: 3.5 Portland Cement: 1.5 Bagasse Ash
The advantages of interlock bricks are the Modified Tanzanian Interlock Brick as follows:

1. The simple placement of connections between interlock brick cavities.
2. The composition of interlock bricks made from a mixture of bagasse ash waste which is environmentally friendly.
3. This interlock brick is environmentally friendly because it does not go through the combustion process.
4. In the implementation of the field, interlock bricks are faster than conventional bricks because they are mutually binding.

Conclusions
In adding bagasse ash to the composition of the interlocking brick without combustion process with the Modified Tanzanian Interlock Brick (MTIB) form, it dramatically affects the quality of the interlocking brick.

3.18 TITTLE :Finite Element Modeling of Low Heat Conducting Building Bricks
AUTHOR : Oluleke Oluwole , Jacob Joshua
SOURCE:https://file.scirp.org/pdf/JMMCE20120800003_70523808.pdf
YEAR: June 9, 2012

Abstract:

Heat conduction through conventional and interlocking building bricks with cavities was studied in this work

The conventional old form of building bricks in the tropics with two rectangular cavities are known for their high heat conduction property which causes so much discomfort in homes especially in hot and arid areas of the world.

Conclusions

In conventional bricks, increasing the number of cavities played a substantial role in decreasing heat flow into the building and hence enhanced thermal insulation. After the four-hole arrangement, increasing the number of holes only gave marginal thermal resistance over the four-hole arrangement.

In the case of interlocking bricks, it was observed that staggered hole arrangement helped in decreasing heat flow into the brick wall.

Four-staggered-hole arrangement gave the same thermal resistance as an ordered eight-hole arrangement.

The 8-hole brick arrangement may also tend to compromise the strength of the brick.

3.19 TITTLE :EXPERIMENTAL INVESTIGATION ON INTERLOCKING BLOCKS BY PARTIAL REPLACEMENT OF CEMENT WITH SILICA FUME

AUTHOR : Prasanna Jenifer Golda.J, Anitha.P

SOURCE:https://ijcrt.org/papers/IJCRT2106049.pdf

YEAR: 6 June 2021

Abstract:

Traditional bricks are made up of clay which is treated in high temperature kiln firing.

The removal of top layer of the soil and clay from the resources cause soil erosion.

The conventional technique of masonry bricks production has caused severe environmental pollution due to the massive emissions of greenhouse gases which lead to several climate changes such as haze, fog, air pollution, acid rain and global warming.

To study the development of eco-friendly interlocking bricks for masonry applications by incorporating silica fume. Interlocking bricks are the enhanced form of conventional clay bricks. Each brick is constructively designed to lock itself to the other bricks around without the use of mortar.

CONCLUSIONS

Compressive strength of interlocking block was found greater than that of ordinary clay block .

Because of the pattern of interlock, it provides better matrix strengthening, wall stability, disallows movements and reduces mortar.

Therefore, the interlocking block masonry can be adopted as a suitable substitute for traditional masonry.

And in conclusion, interlocking masonry can be recommended for housing projects as an alternative method that is cheaper than the conventional.

MATERIALS (Kg/m^3)	MIX 1 0% SILICA FUME	MIX 2 5% SILICA FUME	MIX3 10% SILICA FUME	MIX4 15% SILICA FUME	MIX5 20% SILICA FUME	MIX 6 25% SILICA FUME	MIX 7 30% SILICA FUME
CEMENT	0.842	0.800	0.759	0.702	0.655	0.608	0.562
COARSE AGGREGATE (6MM JELLY)	5.928	5.928	5.928	5.928	5.928	5.928	5.928
FINE AGGREGATE (M SAND DUST)	3.627	3.627	3.627	3.627	3.627	3.627	3.627
FLY ASH	0.080	0.080	0.080	0.080	0.080	0.080	0.080
SILICA FUME	0	0.010	0.020	0.30	0.40	0.50	0.60

Table 3.4

3.20 TITTLE :Mechanized of Interlocking Brick and Its Structural Behavior as Load Bearing and Non-Load Bearing Element-Review

AUTHOR :M.Dhanraj,P.Vasanth

SOURCE:https://journals.asianresassoc.org/index.php/irjmt/article/view/281/240

YEAR:02 November2019

Abstract:

Conventional bricks are the most elementary building materials for houses construction.

In searching for a new building technique that may result in even greater economy, more efficient and durable as an alternative for the conventional brick.

Moreover, the high demands for having a speedy and less labor and cost building systems is one of the factor that cause the changes of the masonry conventional syste

CONCLUSION:

The concept of interlocking system has been widely used as a replacement of the conventional system where it has been utilized either as load bearing or non-load bearing masonry system.

Strength of interlocking bricks with increasing fly ash increases with the age.

Interlocking bricks with economically available fly ash in large proportion have sufficient strength for their use in low cost housing, non-load bearing construction and in regions where good quality burnt clay bricks are not available.

CHAPTER 4
CASE STUDY

NET STUDY 1

Residence at Virudhunagar

NET STUDY 2

Residence at Ammapettai,Erode

NET STUDY 3

FlexLock House in Magnolia

NET STUDY 4

Residence at Madurai

NET STUDY 5

Building at United Kingdom

LIVE CASE STUDY

Residence at Tirunelveli

4.1 NET CASE STUDY -1
LOCATION: Virudhunagar,Tamil Nadu
Total built up area is 550sqft
Total budget: 15 lakhs
Brick: Mud interlock

fig 4.1 Exterior of building.

Fig 4.2 Interior of the building

Foundation :
Soil :Black Soil.
Foundation: Random rubble foundation and Natural stone(karung kallu) in used.

Fig 4.3 During construction stage

Door And Joineries :
Old karaikudi chettinad style are bought.
And the total is 2 lakhs including transportation.

Fig 4.4 Exterior of the house

Fig 4.5 Filler material used .

Pointing:
For pointing Mud mortar is used.
Open court yard:
Size: 7’0”x5’0”

Fig 4.7 Flooring used .

Fig 4.6 During construction stage

Living Room:
Size: 10’0x16’0”
Double layered filler slab is used
No plastering is done in roof. Polythene sheet cover is placed under for polished surface.
So only putty is done.
100 years old terracotta roof tile is used as filler material.
The cost of the construction is Rs 70 per sqft . Which includes the transporation,labour charge .

Flooring:
Clay tile is used for flooring .
It has been got from Pavoorchathiram
The cost of the tile is Rs35 per sqft.
Sit out Area :
Paver blocks has been used .
And the cost is Rs 28 per sqft.

Fig 4.8 Exterior of house

4.2 NET CASE STUDY -2
LOCATION:
Ammapettai,Erode
Tamil Nadu
Brick :Mud interlock
Total Built up Area 1800Sqft
Ground Floor :1200 Sqft
First floor : 600 Sqft

Fig 4.9 During Construction stage

Foundation Detail :
Soil : Clay soli
Foundation : Pile Foundation
Size: 10’0” Depth
Total budget: 30 lakhs
Total duration to complete the work is 3 years .Delay is due to Corona

Fig 4.10 During construction stage

Fig 4.11 interior of the house.

Door And joineries details:
Main Door : Teak wood
Other joineries : Neem wood

Living Room:
Hall cum open dining
Size :26’0”x12’0”

Master Bed Room :
Size :16’0”x10’0”
Filler slab is used .
Filler Material :Double layered Terracotta tile used .

Fig 4.12 Filler slab used

Fig 4.13 Bed room.

Flooring is done terracotta tile which is be imported from Vietnam.
At initial cost of the tile is 40 Rupees per sqft .And in later stage the price has increased to 70 Rupees per sqft.

Fig 4.14 Flooring

Fig 4.15 Filler material used

Pointing is done using Cement based in wall.
Rain water harvesting capacity :20,000 liters
From user point of view :
The building has to ecofriendly .
So he used Terra cotta tile for flooring.
Filler slab in roof .
And for wall interlocking bricks.

Fig 4.16 Exterior of house

4.3 NET CASE STUDY -3
LOCATION:
Madurai,Tamil Nadu
Total Built up Area 1150Sqft
Brick :Cement interlock bricks
No of Floor :Ground floor.

Fig 4.17 Living room

Foundation Detail :
Soil : Clay soli
Foundation : Raft Foundation
Door And joineries details:
Main Door : Teak wood
Other joineries : pine wood

Roof:
Normal RCC concrete is used .
Rectangular mould is used for design purpose
Racks have done using Ferro cement where steel and wire mesh is used .
When we use plywood the cost will 800 per sqft.Where as by using Ferro cement the cost reduced in half of the amount.

Fig 4.18 Racks have made using Ferro cement.

Fig 4.19 Rectangular mould is used In celling

Fig 4.20 Flooring is done using normal ceramic tile.

Fig 4.21 Landscape area is designed .

Fig 4.22 Pointing is done.

Fig 4.23 During construction stage.

.
Cement interlock bricks is used because the cost less when compared to mud interlock bricks

From user point of view :

The building has to be cost effective. They do not waste much cost on materials .They mainly focused on interior.

4.4CASE STUDY -4 :FlexLock House in Magnolia, Texas

The Flex Lock Wall System, developed by Cercorp Initiatives, was chosen as the primary building material for a project in Magnolia, Texas in order to study the benefits of mortar less blocks.

The scope of work for the project consisted of a 275 m2 (2,958 ft2) house with construction starting in June 2006 (Cercorp Initiatives)

Fig 4.24 Exterior of building

Fig 4.26 Dry stacking the wall

Flex Lock performed a comparative cost analysis based on installed cost of standard 8" masonry in the region:

Total masonry costs declined by 24% Productivity increased by 100%.

Fig 4.25 Pouring the bond.

The Flex Lock Wall System is comprised of interlocking, mortar less masonry units.

The blocks are similar to other products with interlocking mechanisms at both the bed and head joints, but the manufacturer recommends that the **walls be post-tensioned.**

Fig 4.27 During the construction

The project consisted of all of the standard elements included within a typical masonry structure: lintels, jambs, sills, and bond beams.

This provided a comprehensive comparison with conventional masonry units.

The labor crews were inexperienced with the mortar less product, yet were still capable of stacking blocks at an average rate of 164 blocks an hour.

At the time of construction, the Magnolia region had an average installed price of roughly $75 per m2 for conventional masonry units.

After breaking down the cost of the Flex Lock System project, the price came to $57.24 per m2 (Cercorp Initiatives, 2010).

The labor crews were inexperienced with the mortar less product, yet were still capable of stacking blocks at an average rate of 164 blocks an hour.

Source:https://www.scribd.com/doc/148137930/morterless-interlocking-blocks

4.5 CASE STUDY -5
SPECIFICATION:
Architects: Bureau de Change Architects
Area: 300 m²
Year: 2018
Country: United Kingdom
TYPE: Residential
SPECIAL: Brick Façade

Fig 4.28 Exterior of the building.

Fig 4.29 Exterior of the building.

Information:
Bureau de Change has completed The Interlock, a mixed-use building in London with a facade made from matt blue bricks that "appear to twist like cogs“m.
The five-storey building was designed by Bureau de Change for developer HGG London to sit within a 19th century terrace in Fitzrovia.
they were interested in taking these very traditional proportions and in some way subverting it, like a puzzle box that seems familiar and reveals a hidden complexity that increases the more you interact with it.
About the brick:
The Interlock's facade comprises a total of 5,000 bespoke bricks in 44sizes, which are made from Staffordshire Blue clay.
Prior to construction, the facade was modelled extensively to ensure the desired arrangement could be attained structurally. A one-to-one template was then used on site to set out the location of each brick during construction.

Fig 4.30 Interlocking brick used for exterior.

Fig 4.31 Pattern followed.

Evolution of brick:
Staffordshire Blue Clay was selected as a contrast to the areas existing brickwork.
The marl clay was set into 14 hand-crafted steel molds and fired in oxidation to create the matt blue finish.
After firing, these 14‘parent’ bricks were divided to form the 30 ‘offspring’.
Construction of the 5,000 block landscape took place over three months.
The fabrication team used 1:1 printed templates that set out the number, typology and location of each brick.
When collated on site, these 188 templates appeared like a construction manuscript, with each brick a different note to lay.

Fig 4.32

Fig 4.33

Fig 4.32 & Fig 4.33 BRICK MOULDS USED:
THESE ARE THE BRICKS USED IN FACADE, OF THE BULIDING “THEINTERLOCK”

4.6 LIVE CASE STUDY -1

LOCATION:
Tirunelveli,Tamil Nadu
LAND AREA :2445 Sqft
Total Built up Area 1055Sqft
PASSAGE AREA :165 sqft
Total budget : 36 lakhs
Foundation Detail :
Soil : Clay soli
Structure :Load bearing structure
Random Rubble is used

Door And joineries details:
Main Door : Teak wood

Fig 4.34 Exterior of the building.

Fig 4.35 Random rubble is used.

Fig 4.36 Entrance of Building.

Fig 4.37 Finished wall

Fig 4.38 Fountain is placed.

Fig 4.39 Living Room.

Fig 4.40 Flooring tile used .

Fig 4.41 Court yard

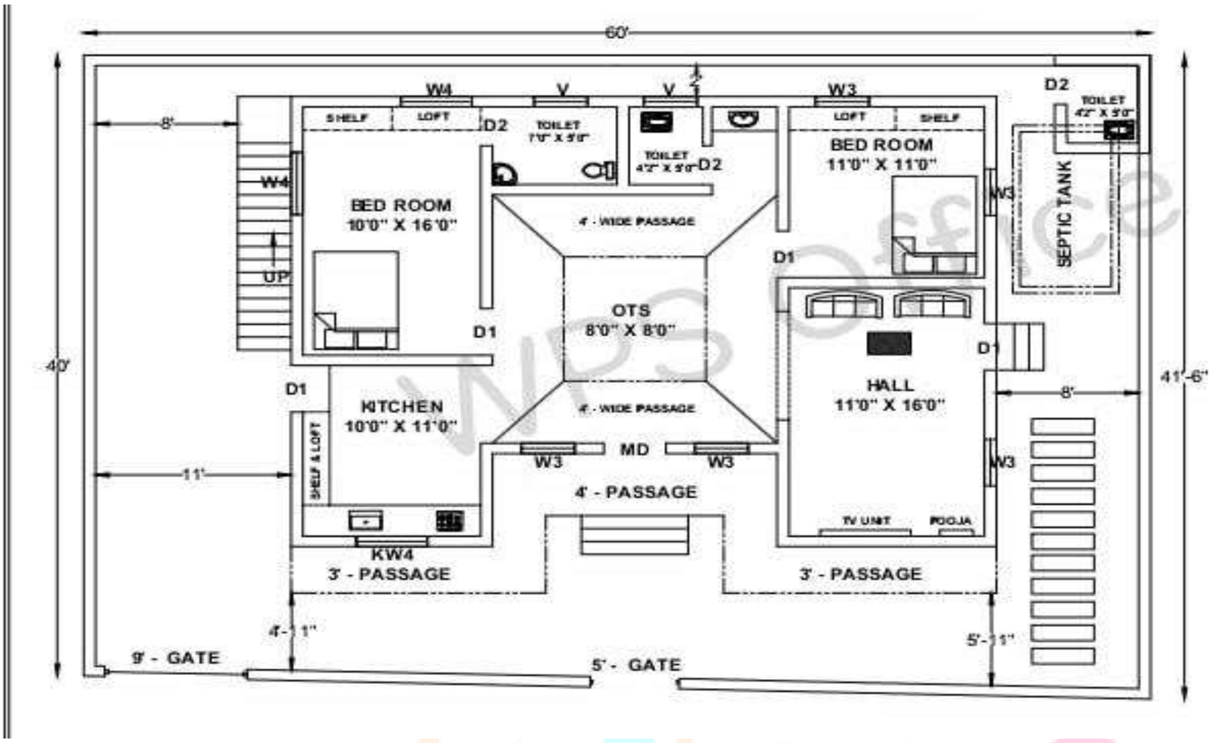

Fig 4.42 Floor plan

Master Bed Room :
Size :10’0”x16’0”
Filler slab is used .
Filler Material :Double layered Terracotta tile used.

In Pooja Room fountain is present.

Filler slab is used in Roof.
Filler material used is pot cap.
Living Room:
Size:11’0”x16’0”
In Living room levels has Been given.

Inference:
26.2% cost can be saved if we use locally available brick.

Pointing would have done properly.

4.7 COMPARATIVE ANALYSIS OF CASE STUDY :

S.No		CASE STUDY -1	CASE STUDY -2	CASE STUDY-3	CASE STUDY-4
1	Location	Virudhunagar, Tamil Nadu	Ammapettai,Erode Tamil Nadu	Magnolia, Texas	Madurai,Tamil nadu
2	Area	550sqft	Total Built up Area 1800Sqft Ground Floor :1200 Sqft First floor : 600 Sqft	2,958 ft2	1150sqft
3	Budget	15 lakhs	30 lakhs		13 lakhs
4	Foundation	Load bearing structure	Pile foundation	Load bearing structure	Isolated footing
5	Material of bricks	Mud inter lock bricks	Mud inter lock bricks	Cement inter lock blocks	Cement interlock blocks
6	Pointing	Mud mortar	Cement mortar	Cement Mortar	Cement mortar
7	Flooring	Clay tile	terracotta tile which is be imported from Vietnam.		Ceramic tile
8	Roof	Filler slab	Filler slab	Normal Rcc concrete	Normal Rcc concrete

Tab 4.1 comparison of case study

CHAPTER 5
STUDY OF INTERLOCKING BRICKS

5.1 MANUFACTURING OF INTERLOCKING BRICKS:

Composition of materials :
1.Mud inter locking
1:4:6 =(one part cement, four parts quarry dust, and six parts red soil)
2.Cement inter locking
1:3:2 =(one part cement, three parts M.Sand, and two parts quarry dust)
And chemical adhesive is added based on the need.

Fig 5.1 Brick made using mud

Fig 5.2 Brick made using cement

Fig 5.3 The material which is required for these bricks is batched and mixed proportionately.

Fig 5.4 It is then compressed to form bricks with desirable interlocking patterns when the required mix is prepared.

Fig 5.5 Then by using a hydraulic compression system, the compression is achieved.

Fig 5.6 Then for about 7 days, these bricks are subjected to wet curing and next days dry curing

5.2 Constructing structures using interlocking bricks involves the following steps:

Fig 5.7 **STEP** 1 **Site Preparation:**

Clear the construction area of any vegetation, debris, or obstacles.
Ensure the site is level and properly compacted.

Fig 5.8 : **STEP 2 Foundation Preparation:**

Excavate the foundation to the required depth and dimensions.
Compact the soil or prepare a suitable base, depending on the project requirements.

*Fig 5.9:***STPE 3 :Base Layer:**

Add a layer of crushed stone or gravel to create a stable base.

Compact the base material to ensure it's firm and level.

*Fig 5.10***STEP 4: Begin Laying Interlocking Bricks:**

Start laying the bricks from one corner or edge of the project area.

Place the first brick and tap it gently with a rubber mallet to ensure it's level and securely seated in the sand bed.

*Fig 5.11:***STEP 5:Follow the Pattern:**

Continue laying bricks in your chosen pattern (e.g., herringbone, running bond).

Ensure each brick is aligned both horizontally and vertically with the surrounding bricks.

5.12

STEP 7 :Cutting Bricks (if needed):

Use a masonry saw or a specialized paver splitter to cut bricks when necessary to fit into corners or along edges.

Fig 5.13

STEP 8 :Pointing:

Once all bricks are in place, sweep fine sand (Cement or regular jointing sand) into the gaps between the bricks.

Fig 5.14

STEP 9 :Clean Up:

Sweep off excess jointing sand or cement from the surface of the interlocking bricks.

5.3 COST COMPARISION BETWEEN CLAY BRICK AND INTERLOCKING BRICK For Construction 100 sqft wall

MATERIAL PART					
S.NO	MATERIAL NAME	QUANTITY	UNIT	RATE(INR)	AMOUNT (INR)
1	BRICK	1275	nos	11	14025
2	SAND(including transport)	30	cft	60	1800
3	CEMENT	4	bags	400	1600
4	Labour	100	sqft	30	3000
5	Scaffolding			500	500
6	Curing			500	500
SUBTOTAL					25,675
	PLASTER				
1	Cement	1.5	bag	400	600
2	Sand	10	cft	60	600
3	Labour	20	Per sqft	100	2000
4	Curing			300	300
5	Scaffolding			500	500
SUBTOTAL					4,000

Tab 5.2 calculation for interlocking brick for 100sqft wall

MATERIAL PART					
S.NO	MATERIAL NAME	QUANTITY	UNIT	RATE(INR)	AMOUNT (INR)
1	BRICK	288	nos	47	13,536
2	Labour	100	sqft	30	2000
3	Pointing	100	sqft	15	1500
4	Cement +sand				500
SUBTOTAL					17,536

Tab 5.1 calculation for clay brick for 100 sqft wall

5.4 Calculation of interlocking bricks
Brick size = 10”x5”x9” =450 Cubic inch
Wall size =120”x120”x9” =1,29,600 Cubic inch
=1,29,600/450 =288
Totally 288 Bricks
The total cost for constructing 100sqft clay brick including plaster is Rs29,675.
And the cost of constructing inter locking bricks for 100Sqft wall is Rs17,536
The Amount saved by using interlock brick is Rs 12,136
Pointing
For pointing the cost includes cement, sand, waterproofing and scaffolding.
25.7% cost can be reduced while using interlocking bricks.
This exclude painting cost in clay brick.

5.4 SPACE CALCULATION OF CLAY BRICKS OVER INTERLOCKING BRICKS
Area of interlocking brick :450 cubic inch
Area of clay brick :93.91 cubic inch
4.8 times of clay brick in one interlock brick
Cost of one clay brick is Rs 11
Cost of one interlock brick is Rs 50
Around 5 clay brick is Rs 55
Amount saved is Rs 5

5.5Construction of 10'x10' Room for 1 pair

S.No	CLAY BRICK	Days
1	From P.C.C to sill level	2
2	From sill level to lintel	2
3	Shuttering for lintel and concrete	1
4	From lintel to Finish level	2
	Total No.Of .Days	7
S.No	**INTERLOCK BRICK**	**Days**
1	From P.C.C to sill level	1
2	From sill level to lintel	1
3	Shuttering for lintel and concrete	1
4	From lintel to Finish level	1.5
	Total No.Of .Days	4.5

Tab 5.4 calculation for clay brick for construction of 10'x10' room .

5.5.1 Inference :

- The 1.5 days can be reduced by using interlocking bricks, So time can be saved .
- And the cost of the labor will also be reduced by using interlocking bricks.

ADVANTAGES AND DISADVANTAGE OF INTERLOCKING BRICKS :

5.6 .1Advantages of interlocking bricks :

Ease of Installation: Interlocking bricks are designed to fit together seamlessly, eliminating the need for mortar. This makes installation quicker and more straightforward compared to traditional bricklaying techniques.

Cost-Effective: Interlocking brick construction typically requires fewer labor hours and materials, reducing overall construction costs. Additionally, the absence of mortar means there is no need for skilled masons, further reducing labor expenses.

Durability: Interlocking bricks are known for their durability. When properly installed, they can withstand heavy loads, resist erosion, and endure harsh weather conditions.

Sustainability: Many interlocking bricks are made from sustainable materials like concrete or mud. Their eco-friendly nature, along with the fact that they do not require firing like traditional clay bricks, makes them an environmentally responsible choice.

No Cracking: Because interlocking bricks do not rely on mortar, there is a reduced risk of cracking due to the settlement of mortar joints. This contributes to the long-term stability of the structure.

Aesthetic Appeal: Interlocking bricks offer a visually appealing finish. Their various patterns and colors can enhance the overall aesthetic of a project, creating attractive and inviting outdoor spaces.

Reduced Maintenance: Interlocking brick surfaces are relatively low maintenance. Regular cleaning and occasional re-sanding of the joints can keep them looking fresh and in good condition.

Quick Use: Interlocking bricks can often be used immediately after installation, as there is no curing or drying time required, unlike other construction materials like concrete.

5.6.2 Disadvantages of interlocking bricks :

Limited Load-Bearing Capacity: Interlocking bricks are generally not suitable for heavy-load-bearing structures, such as multi-story buildings or industrial facilities. They are best suited for applications like driveways, walkways, and low-height retaining walls.

Inconsistent Quality: The quality of interlocking bricks can vary depending on the manufacturer, the materials used, and the manufacturing process. It's important to source bricks from reputable suppliers to ensure consistent quality.

Not Ideal for Freeze-Thaw Cycles: In regions with frequent freeze-thaw cycles, interlocking bricks may be susceptible to cracking or damage over time if not properly designed and installed.

Weed Growth: The gaps between interlocking bricks can allow weed growth if not adequately maintained. Regular weeding and joint sand replacement may be necessary to prevent weed infiltration.

Color Fading: The color of interlocking bricks can fade over time due to exposure to sunlight and weather. Sealing the bricks can help mitigate this issue.

Installation Expertise: While the installation of interlocking bricks is generally simpler than traditional masonry, it still requires some skill and expertise to ensure proper alignment, drainage, and durability. Inexperienced installers may not achieve optimal results.

Color Variations: Even when sourced from the same manufacturer, interlocking bricks may exhibit slight color variations between batches, which can affect the overall appearance of the project.

5.7 ENVIRONMENTAL EFFECTS OF INTERLOCKING BRICK :

5.7.1Positive Environmental Effects:

Reduced Energy Consumption: Interlocking bricks made from stabilized soil typically require less energy during manufacturing compared to traditional clay bricks that require firing in a kiln. This reduced energy consumption can lead to lower carbon emissions.

Local Sourcing: Many interlocking bricks are made from locally sourced materials, reducing the need for long-distance transportation and associated carbon emissions. This can also support local economies.

Durability: Interlocking bricks are known for their durability, which means they have a longer lifespan than some other construction materials. This reduces the need for frequent replacement and decreases the environmental impact associated with material disposal.

Low-Waste Construction: Interlocking bricks can be precision-cut and fit together without the need for mortar, resulting in less material waste during the construction process.

5.7.2Negative Environmental Effects:

Resource Extraction: The production of concrete interlocking bricks often involves the extraction of natural resources, such as sand and gravel, which can lead to habitat disruption and environmental degradation if not managed sustainably.

Energy Intensive Manufacturing: While interlocking bricks generally require less energy than fired clay bricks, the manufacturing of concrete bricks can still be energy-intensive, especially if not produced using energy-efficient methods.

Cement Content: Some interlocking bricks contain cement as a stabilizing agent. Cement production is known to be energy-intensive and produces significant carbon dioxide (CO_2) emissions.

Chemical Additives: Depending on the formulation, interlocking bricks may contain chemical additives or stabilizers, which can have environmental implications if not properly managed.

5.7.3 To minimize the negative environmental effects and maximize the positive ones when using interlocking bricks, it's important to consider the following:

Choose bricks made from sustainable materials and manufactured using energy-efficient and environmentally friendly methods.

Opt for locally sourced materials to reduce transportation impacts.

Implement proper construction practices, such as efficient design, site preparation, and waste management, to minimize environmental harm.

5.8 COMPARISION BETWEEN MUD INTERLOCKING BRICKS AND CEMENT INTERLOCKING BRICKS

S.No		**Mud Interlocking Bricks**	**Cement Interlocking Bricks**
1	**Material Composition:**	Mud interlocking bricks are primarily made from locally sourced soil, water, and, in some cases, stabilizers like cement or lime.	Cement interlocking bricks are made from a mixture of cement, aggregates (such as sand and gravel), water, and sometimes additives like pigments.
2	**Sustainability**	Mud bricks are often considered more sustainable due to their use of natural, locally available materials. They have a lower environmental impact and may not require firing in a kiln, reducing energy consumption.	Cement bricks can have a higher environmental impact due to the energy-intensive process of cement production. However, they can be made more sustainable if the cement is blended with supplementary cementitious materials (SCMs) like fly ash or slag, or if the manufacturing process is optimized for energy efficiency.
3	**Strength and Durability**	Mud bricks can be durable when stabilized properly. However, they may be less resistant to moisture and erosion compared to cement bricks, making them more suitable for certain applications.	Cement bricks tend to be stronger and more durable, with better resistance to moisture, weathering, and erosion. They are often preferred for load-bearing structures and high-traffic areas.
4	**Construction Cost**	Mud bricks are generally more cost-effective, especially when stabilized with minimal amounts of cement or lime. Labor costs for mud brick construction can also be lower.	Cement bricks may have a higher initial material cost due to the use of cement and aggregates. However, they are often easier and faster to install, potentially reducing labor costs.
5	**Maintenance**	Mud bricks may require more frequent maintenance, such as re-stabilization, sealing, and protection from moisture, to ensure their longevity.	Cement bricks typically require less maintenance and are more resistant to environmental factors. Cleaning and occasional sealing of the joints are usually sufficient.

6	**Aesthetic Variety**	Mud bricks can have a natural, earthy appearance and may come in limited color options. Their aesthetic appeal is often well-suited for certain architectural styles and eco-friendly projects.	Cement bricks offer a wider range of design possibilities, including various colors, textures, and surface finishes. They can be used for modern, traditional, or customized architectural designs
7	**Application**	Mud bricks are suitable for applications like low-rise residential buildings, landscaping features, and eco-friendly construction	Cement bricks are versatile and can be used in a wide range of applications, including residential, commercial, industrial, and infrastructure projects.
8	**Material Sourcing and Sustainability**	**Pros:** Mud bricks are made from locally sourced soil, reducing the environmental impact of transportation. They often require minimal energy for manufacturing, especially when stabilized with natural materials like lime. Mud bricks can be considered sustainable when sourced and produced responsibly.	**Pros:** Cement bricks can incorporate recycled materials like fly ash and slag, reducing the demand for virgin raw materials. The use of supplementary cementitious materials (SCMs) can lower carbon emissions associated with cement production.
9		**Cons:** In some regions, excessive soil extraction for brick production can lead to soil erosion and habitat disruption. Careful soil management is essential to maintain sustainability.	**Cons:** Cement production is energy-intensive and produces substantial carbon dioxide (CO2) emissions, making it less environmentally friendly when compared to mud bricks in terms of carbon footprint.
10	**Energy Consumption**	The manufacturing of mud bricks typically involves less energy consumption, especially when firing in a kiln is not required.	Cement production is energy-intensive, and this energy consumption contributes significantly to the environmental impact of cement bricks.

5.8.1 Inference :

The choice between mud interlocking bricks and cement interlocking bricks depends on your project's specific requirements, budget, and sustainability goals. Mud bricks are often preferred for eco-friendly and cost-effective projects, while cement bricks offer greater strength and versatility, making them suitable for a broader range of applications.

Mud interlocking bricks tend to have a lower immediate environmental impact due to their lower energy consumption, local material sourcing, and potentially sustainable practices. However, the environmental impact of cement interlocking bricks can be reduced by using recycled materials, energy-efficient manufacturing processes, and careful resource management. Ultimately, the choice between the two types of bricks should consider the specific project's sustainability goals, local environmental conditions, and regulatory requirements.

5.9 Promoting mud interlock bricks over cement interlock bricks can be beneficial for several reasons, including environmental sustainability, cost-effectiveness, and cultural heritage preservation. Here are some strategies to promote mud interlock bricks:

5.9.1.Raise Awareness:

Educate the public about the benefits of mud interlock bricks through workshops, seminars, and community meetings.

Utilize social media, websites, and brochures to disseminate information about the advantages of mud bricks, such as their eco-friendliness and cost savings.

5.9.2. Environmental Sustainability:

Emphasize the ecological advantages of mud bricks, such as their low carbon footprint, biodegradability, and reduced energy consumption during production.

Highlight the mud brick's ability to regulate indoor temperatures, reducing the need for heating and cooling, which in turn saves energy.

5.9.3.Training and Skills Development:

Offer training programs and workshops to builders, masons, and construction workers on proper techniques for working with mud bricks.

Encourage the development of a skilled workforce proficient in mud brick construction.

5.9.4.Publicize Success Stories:

Share stories of successful mud brick construction projects in local and national media to inspire others.

Highlight the beauty and uniqueness of mud brick architecture to create a sense of cultural pride and identity.

CHAPTER 6
RECOMMENDATION & INFERENCE

Inference :

Interlocking brick construction typically requires fewer labor hours and materials, reducing overall construction costs.
Additionally, the absence of mortar means there is no need for skilled masons, further reducing labor expenses.
25.7% cost can be reduced while using interlocking bricks over clay bricks for 100sqft wall this excludes painting cost .
The 1.5 days can be reduced by using interlocking bricks, So time can be saved
Interlocking bricks can provide good thermal insulation, helping to regulate indoor temperatures and reduce energy consumption for heating or cooling.
Mud bricks are often preferred for eco-friendly and cost-effective projects, while cement bricks offer greater strength and versatility, making them suitable for a broader range of applications.
Interlocking bricks made from stabilized material typically require less energy during manufacturing compared to traditional clay bricks that require firing in a kiln.

Recommendation :

Interlocking bricks typically require less cement compared to conventional brick construction, leading to lower carbon emissions and reduced environmental impact.
Using of interlocking bricks over clay bricks can save time and cost of the construction.
Mud interlocking bricks tend to have a lower immediate environmental impact due to their lower energy consumption, local material sourcing, and potentially sustainable practices over cement interlocking bricks.
The environmental impact of cement interlocking bricks can be reduced by using recycled materials, energy-efficient manufacturing processes, and careful resource management.
In abroad using waste re-cycled materials interlocking bricks are made. We can implement various others materials to manufacture the interlocking bricks.
To promote awareness about interlocking bricks, conduct various workshop and seminar.
Government can provide subsidy for interlocking bricks while constructing the house , Or government can instinct people to use interlocking bricks while they are using availing government loans.