Clay as Sustainable Building Material and its Benefits for Protection in the Built Environment

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Abstract. This examination looks at the properties and advantages of clay use as building material that improves natural assurance. The reasoning for this assessment originates from the perspectives held by researchers that clay earth blocks are more liked as supportable structure materials; nonetheless, there is restricted examination into whether the decision of mud materials is impacted simply by its natural advantages. To accomplish the particular exploration targets a blended examination strategy was utilized. The techniques adopted incorporate writing audit, subjective (inquiries questions) and quantitative (poll questionnaire) research strategies, including the review of the chose building and common development firms in Katsina, Kano and Kaduna provinces of Nigeria. The exploration information gathered dependent on the financial, social and ecological properties of clay earth and its advantages in natural properties was examined utilizing unmistakable factual strategies. The examination tracked down that the financial parts of clay earth make it more critical as a structural material that is helpful in built environment. The examination findings suggest further investigation into the improvement of clay as a structural material that tends to the manageable triple main concern of economics matters, social and natural necessities.

1. Introduction
Clay earth is an economical structure material that has been utilized by people on the planet for quite a long time. It is not difficult to unearth from the beginning little preparing is required, which implies that energy and tedious cycles is decreased. Clay goes about as Mud blocks, clay bricks, rooftop, floor tiles and clean apparatuses are made of the normal mixes of clay and water in close by creation plants and utilized locally. That maintains a strategic distance from long vehicle courses. They are flexible, energy proficient, tough, stylish and financial [1]. Furthermore, it is utilized for protection to get a good deal on numerous conventional structure strategies. Saving expense on energy bill is additionally conceivable; given that structures will save more energy with clay as warmth separator [1], satiated that clay structures don't utilize more power than required, this will permit homes to keep up their warmth throughout the cold weather months and keep up the agreeable temperatures throughout the mid-year months. Clay earth is perceived as an economical assurance building material since it gives amazing protection properties and warmth stockpiling limit, assists with lessening energy utilization in structures.
Clay earth building materials are healthy, stable and warmth protections. In this way, structures made of earth building items can last over 100 years' life expectancy. The earth block is inherently feasible and assists with limiting the inward temperature vacillation occasionally. They additionally have low encapsulated carbon, it thusly less harming than some other structural materials and gives low upkeep cost in the existence circle of structures. Likewise, clay stores heat in the colder time of year and coolness in the late spring and contributes significantly to energy reserve funds. Low energy is needed for the readiness and handling, working with clay is harmless to the ecosystem in the assembled climate. This exploration is expected to address the accompanying examination questions (RQ):

1.1 Research Questions
i. What are the current issues with the use of clay for building in the built environment?
ii. What are the elements influencing the usage of clay for building in the built environment?
iii. What angle can limit the usage issues of clay building structures?
iv. What arrangement is expected to support the viable aspects use for clay in the built environment?

1.2 Aim and Objectives
The aim of this research is to identify protection and benefits of clay as protection building materials. The main objectives are:

i. To investigates the issues in the usage of clay as economic building materials
ii. To recognize the variables frustrating the use of clay as sustainable building materials.
iii. To recognize view points to encourage usage of clay as assurance building materials.
iv. To set up angles for improving use of clay S as economic building materials.

2. Research Methodology
To accomplish the particular examination goals some blended research techniques will be utilized. The techniques incorporate literature writing review, subjective (inquiries questions) and quantitative (research method) research strategies. Figure. 1 shows the inter related connections between the choosing research techniques related exercises expected and yields of the research. These areas momentarily summed up the research methods utilized.
3. Overview of the Property, Use and Protection Aspects of Clay as a Building Material

The orderly literature writing embraced is introduced under the accompanying sub-areas of this research.

3.1. Property of clay bricks as building material

The properties of clay bricks as a building materials are: acoustic protection, dimensional exactness, sturdiness, energy effectiveness fire protections, strength and natural cordial. [2] states that clay is a solid breathing construction material that really improves the air around it, retaining and delivering stickiness generally. These outcomes in a normally managed level of dampness and with it a sound room environment is accomplished. Truth be told, when the general stickiness ascends from half to 80%, non-consumed blocks can assimilate multiple times more moistness than normal consumed blocks inside a two-day duration [3]. Clay buildings structures likewise stores heat in the colder time of year and coolness in the late spring. In light of that planning and working with clay building items will contribute significantly to energy reserve funds. At the point when the factor of low energy is needed for the readiness, preparing and use of clay, working with clay earth is harmless to the ecosystem.
As indicated by [4] it takes just about 1% of the energy required for making bricks. As worldwide populaces increment, so likewise the requirement for convenience increments. Clay rooftop tiles and pavers are strong, moderate and give agreeable, protected and sound homes to a huge number of individuals. Clay bricks, blocks, rooftop tiles and pavers are strong, moderate and give agreeable, protected and sound homes to a great number of individuals. Moreover, they join customary design legacy with imaginative and future-situated development strategies. To wrap things up, clay earth items offer important answers for save energy and diminish ozone layer harming substance discharges in the environmental area.

Different properties of are that it can retain and store sunlight based warmth, empowering clay blocks to withstands even loads, like those from quakes, yet should be built up in regions subject to high seismic unsettling influences and furthermore give undeniable degrees of safety from intruders. Clay material tiles are dormant materials they are non-combustible and there is no emanation of poisonous gases in the event of fire, water overflow can be gathered and put away.

3.2. Utilization of clay in building structures

Utilization of clay as feasible structure material is turning into a need for building designers in the constructed environments, for tending to worldwide convenience in workplaces, private and different foundations, likewise clay is an essential fixing utilized in many structure procedures. Clay is utilized to make adobe, cob, string wood, smashed earth designs and building components, for example, clay mortar, clay, clay floor tiles and clay paints and clay earthenware production building materials (clay wienerberger.com). As a structure materials clay have been utilized in development since the earthman times. Dated back clay earth is utilized to make blocks, burnt bricks, tiles, clean and roofing materials. China clay, dominatingly kaolinite is utilized as filler and in drug fabricate. Extended clays are utilized as a lightweight total in the production of extended squares utilized for protection of environment. clay has been utilized in the assembling of the accompanying building structures segments. [5]

- Clay material and floor tiles: offer significant answers for energy reserve funds and diminish ozone harming substance discharges in the environmental area. Clay floor tiles are frequently called earthenware or porcelain tiles, produced using combinations that incorporate mud clay as a typical fixing, terminated in an oven and solidified. Mud floor tiles are coated, giving them an assortment of tones and a water-safe surface.

- Heat Sinks and Stacks: Warmth sinks are intended to draw heat away from explicit regions to abstain from overheating. Since earth is heat safe and can likewise move heat, mud floors are once in a while worked to go about as warmth sinks, drawing heat away from furnaces, stoves or different gadgets to forestall harm. Most smokestacks are worked of dirt blocks up to the rooftop level and afterward the stack polished off with red blocks; it was more normal for the whole chimney stack to have been worked of clay blocks on account of their solidarity, virtue of clay and capacity to withstand extraordinary warmth. Ball clay is altogether utilized as crude materials for sterile products, emergency clinic and latrine tiles due to its versatility, functionality and strength in case of fire state.

- Plasters and Rendering: Clay mortars have been utilized broadly for structures in the Assembled Realm and without a doubt everywhere on the world for millennia. In spite of the fact that it isn't generally known, there are most likely over 1,000,000 structures with earth materials in their construction in the Assembled Realm, and a large number of these have mud mortars. All the time clay mortars are not perceived in light of the fact that they are painted or have a slight lime clay skim coat over them, both inside and remotely. Numerous dirt mortars are as yet performing great after numerous hundreds of years, both in vernacular structures and in higher status properties remembering their utilization for mouldings, elaborate safeguards, etc. Clay mortars have unmistakable and, from various perspectives, extraordinary characteristics which are very
appropriate to noteworthy structure conditions for various reasons: breathability, adaptability, reversibility and tasteful characteristics [6]

- Clay as a Binder: Clay are widely used in construction as binders, also for castles, public and religious buildings, and monuments such as the 35-metre-high minaret of Tarim in Yemen and the long great of wall of China. Clay is used as wall binders. Although they have the limitation that they soften when wetted, they are also undoubtedly the cheapest binders, at sites [7].

4. Properties of clay for environmental protection
Clay building materials are sustainable and comply with numerous government rating and green buildings standards [1]. Also, clay has excellent insulating properties because of its high thermal mass. It absorbs stores and releases heat very effectively, making the building interior cooler in summer and warmer in winter. This makes the internal environment more comfortable and also reduces energy demand and associated carbon emissions [8]. The three essentials properties of clay that make it different from other building materials are plasticity, porosity and verification.

5. Protection aspects provided by clay components in buildings
Generally, people are realizing the benefits of building with clay in developing countries especially in tropical regions, the benefits range from warming rooms during cold and cooling in hot seasons, availability of the clay material in most areas, low in cost of extraction, processing and production of building products such as bricks, blocks, tiles, pipes and sanitary appliances. Another benefit is better properties and beauty can be obtained by adding colour additives.

5.1. Materials and methods
Clay material was used as the key tool in this research for the purpose of investigation the viability and key properties of clay for protection of building in the built environment. The methods adopted in this research are mixed methods research approach using qualitative and quantitative data collections, questionnaires and interview questions to collect data from suitable respondents in the construction industry, academicians and stake holders in built environment. and printed by other researchers. norms [1]. Likewise, clay has magnificent protecting properties due to its high warm mass. It retains stores and delivers heat successfully, making the building inside cooler in summer and hotter in winter. This makes the inside climate more agreeable and furthermore lessens energy interest and related fossil fuel by-products [8]. The three fundamentals properties of clay that make it not the same as other building materials are versatility, porosity and confirmation. Respondents’ percentage architects, builders’ engineers, years of experience, education etc.

Table 1 and 2 shows the outcome of the interview questions for qualitative data, this answer research question one and objective one of the research.7 respondents are projects/construction managers, 5 are project managers 2 are construction managers, 5 are members of the Nigerian council of residents’ engineers (COREN) and Nigeria society of engineers (NSE). While 2 are construction managers of medium construction company members of Nigerian Institute of Building (NIOB). The projects managers have 5 to 25 years’ experience while construction managers have 25 years’ experience in the construction industry. The respondents have a wide experience in various types of projects with good familiar with projects that involved clay building projects.

5.2. Materials and techniques
Clay material was utilized as the vital device in this research with the end goal of examination the suitability and key properties of clay for protection of working in the environmental climate. The techniques embraced in this examination are blended strategies research approach utilizing subjective and quantitative information assortments, surveys and inquiries to gather information from reasonable respondents in the construction sector, academicians and partners in built environment. also, printed by different analysts.
### Table 1. Respondents' background

| Respondent | Post of Respondents | Professional Body | Type of company | Types of Projects | Years of Experience |
|------------|---------------------|-------------------|-----------------|-------------------|---------------------|
| 1          | Project Manager     | CORREN            | Civil Engineering | Building & Roads  | 12                  |
| 2          | Project Manager     | NSE               | Civil Engineering | Roads & Dams     | 5                   |
| 3          | Project Manager     | NIA               | Building Construction | Building Works    | 24                  |
| 4          | Project Manager     | NSE               | Civil Engineering | Roads & Dams     | 20                  |
| 5          | Project Manager     | NSE               | Civil Engineering | Roads & Dams     | 15                  |
| 6          | Construction Manager| NIOB              | Building Const.  | Building Works    | 25                  |
| 7          | Construction Manager| NIOB              | Building Const.  | Building Works    | 25                  |

### Table 2. Respondents Perceptions for utilization of Clay as Building Material.

|                         | Respondents |
|-------------------------|-------------|
| 1 Familiar with characteristics of clay | Respondents |
| Very familiar           | 4           |
| Familiar                | 2           |
| Not familiar            | 1           |
| 2 Used in the past and present projects | Respondents |
| Very familiar           | 2           |
| Just familiar           | 4           |
| Not familiar            | 1           |
| 3 Percentage of incorporating clay in projects | Respondents |
| 60% - 90%               | 2           |
| 25% - 80%               | 1           |
| 20% - 30%               | 2           |
| 3% - 8%                 | 1           |
| 4 Percentage of clay products used in most projects | Respondents |
| 70% - 90%               | 2           |
| 60% - 80%               | 3           |
| 25% - 70%               | 1           |
| 20% - 30%               | 1           |
6. Result and Discussion
Table 3 is the correlation between economic, environmental and social factors to establish elements for improving utilization of literate and clay in as sustainable building materials in construction industry. This is based on linked scale (i) strongly agree, (ii) disagree, (iii) not sure, (iv) agree, (v) strongly disagree.

Table 3. Table of Correlation of Economic, Environmental and Social Factors

| Factors       | Economic | Environmental | Social |
|---------------|----------|---------------|--------|
| Economic      | Pearson  | .634**        | .739** |
|               | Correlation |               |        |
|               | Sig. (2-tailed) | .006          | .001   |
|               | N         | 17            | 17     | 17     |
| Environmental | Pearson  | .634**        | 1      |
|               | Correlation |               |        |
|               | Sig. (2-tailed) | .006          | .004   |
|               | N         | 17            | 17     | 17     |
| Social        | Pearson  | .739**        | .659** |
|               | Correlation |               |        |
|               | Sig. (2-tailed) | .001          | .004   |
|               | N         | 17            | 17     | 17     |

**. Correlation is significant at the 0.01 level (2-tailed).

7. Protection Aspects of Clay components in Buildings
The discoveries above depended on the insights that any mean underneath 3.0 of the Likert scale is considered as not concur and mean above 3.0 to 4.5 is considered as concur, while 4.5 to 5.0 is considered for this investigation as profoundly concur. Based on Table 4, most of the respondents demonstrate adoption aspects for influencing use of proficient clay as feasible building structure materials and concur for improving variables.

Table 4. Protection Aspects of Clay

| Aspects of Clay as Protection Materials in the Built Environment | Categorical Mean (x) |
|---------------------------------------------------------------|----------------------|
| Economic Aspects                                             | 4.25                 |
| Environmental Aspects                                        | 4.24                 |
| Social Aspects                                               | 4.01                 |
| Mean average                                                 | 4.17                 |

8. Conclusion and Recommendations
The research investigates the properties, advantages and benefits of clay and its utilization as a development material, is seen by development partners to upgrade built environment protection. In view of these discoveries, the investigation reasons that monetary aspects of clay gives more importance and advantages to clients in the built environments.

The investigation in this manner suggests:
- Governments, Partners, Non-Administrative Associations and scientists to plan a program that will improve use of clay items especially in provincial and metropolitan zones in non-industrial nations.
• The research additionally prescribes further examination that will add to social, monetary and natural supportability aspects for environmental climate,
• The research likewise prescribes further examination that will add to social, monetary and environmental supportability aspects for environmental climate.

9. References

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