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Prospects for Sustainable Housing in Northern Ghana with the use of Local Walling Materials

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Abstract
In 2006 the World Bank described Ghana as a third World country having only 1 out of 3 persons sheltered. Suggestions were made that locally available materials instead of imported materials be used in building so as to cut down on costs and subsequently increase supply of housing units. In response, this study, focusing on Northern Ghana, conducted a cross-sectional survey of seventy respondents with a structured questionnaire to identify the major locally available walling material in use as well as find benefits and challenges associated with it. Unburnt earth bricks were identified as the major locally available walling material in use in Northern Ghana. Benefits found to be promoting its use were the thermal comforts it provided, the manner housing became cheaper, the cultural heritage that it promoted and the fact that only simple tools and methods were employed in its use as a building component. Challenges associated with the unburnt earth brick wall were, lack of recognition by Statutory Authorities, lack of strength and durability, challenges in satisfying new needs in building forms and functions, invasion by termites and rodents as well as its weakness in withstanding vagaries of the weather. Recommendations were made to overcome challenges associated with the use of the material with the aim of enhancing prospects of adopting it for sustainable housing. The study concluded that the Locally available walling material in the form of unburnt earth brick had a huge potential for sustainable housing in Northern Ghana if only government would, through competitive tenders among building technologists utilise existing research findings to get the material stabilised to the required strengths and characteristics so as to pave the way for its recognition by statutory authorities and subsequent packaging for commercial use in the building industry. This paper contributes to the body of knowledge in the areas of Environment, Architecture, Construction Management and Building Materials in a middle income country setting.
Keywords: Local, Walling materials, Housing, Northern Ghana, Sustainability, Middle income country

1. INTRODUCTION

Housing is a structurally separate and independent place of abode within which a person or group of persons can isolate themselves from the hazards of the climate. It is a basic need that provides security and privacy all of which one considers as a human right. In 2006 the World Bank described Ghana as a third World country having only 1 out of 3 persons sheltered (UN- Habitat, 2006). The Short fall in housing stock was blamed on the inclusion of expensive imported material components in the total costs of procurement. The suggestion was therefore made that more locally available materials instead of imported materials be used in building so as to cut down on costs and subsequently increase supply of housing units (Lilly *et al.*, 2001).

Okereke (2003) categorized locally available materials into naturally occurring raw material deposits such as soil and stones, agricultural products or residue such as mulch and products of manufacturing processes such as landcrete blocks or mud bricks.

Besides cost savings, the use of locally available materials comes with many benefits. Laterite for instance is described as environmentally friendly and a renewable natural resource which can be found free and in abundance everywhere in Ghana (Gidigasu, 2005).

Notwithstanding the benefits already mentioned, locally available materials pose various challenges when used for building. Laterite again is said to be lacking strength, stability and durability. It is also noted to be deficient in satisfying new needs of building forms and functions. As a result of all these deficiencies, no matter the type of wall it has been used for laterite tend to require high labour intensive maintenance (Mahgoub 1997; Riza *et al* 2011; Haper, 2011).

The objectives of this study were to identify the major locally available walling material in use in Northern Ghana, find the benefits promoting its use and identify the challenges associated with it. Subsequent recommendations are to correct the defects found so as to improve the material for sustainable housing schemes.

2. THE STUDY AREA

The study area was the Bunania Community which is 11 kilometres away from Navrongo in Northern Ghana. It has climate conditions just like the rest of Northern Ghana namely; a hot-dry climate with day time temperatures on the average rising to 40 ^{O}C and night time temperatures dropping to as low 14 ^{O}C on an average (Schrechenback ,1983). Buildings in this community just as in the entire Northern Ghana are generally circular, arranged as cells around an inner yard. The roofs are either made of thatch laid on rafters, flat mud roofs or

aluminium sheets. Timber used for construction is from the Shear- butter tree. Finishes for mud walls, mud floors and mud flat roofs are combination of cow-dung, residual meal from Shear-butter-nut and vanish produced by boiling empty pods of Dawa-Dawa tree (*Parkia clappertoniana*) used especially on 250mm thick walls to reflect the sun's rays and make the walls water resistant. Bunania Community however, also has some housing units built by Government using sandcrete blocks and Portland cement. The John Bosco College of Education which is just a kilometre away from the study area also has several buildings put up with sandcrete materials and thus making it possible for residents to compare easily houses made of imported materials and those made of locally available materials.

3. METHODOLOGY

The study employed both qualitative and quantitative methods of data collection in realizing a sequential explanatory design where responses from questionnaires were substantiated by interviews and observations (Creswell, 2003).

The Bunania community was adopted as a case study because it offers a holistic opportunity for data collection useful for the study in terms of its location within a place of a peculiar climate, material deposit, architecture and a socio- cultural representative of the entire Northern Region of Ghana.

Due to the small size and the high requirement for qualitative study of specific characteristics the purposive sampling technique was used. Respondents were selected through snowball technique and were envisaged to have had the opportunity and experience in residing in houses built in both locally available and imported materials. The main instrument used was a structured questionnaire containing items on respondents' demography which are: age, gender and their usage of locally available building materials. A five-point Likert Scale was also used ranging from strongly disagree (1) to strongly agree (5) to solicit responses on benefits as well as challenges encountered in the use of Locally available walling materials. For validity and reliability the instrument was peer reviewed, pilot-tested on 15 professionals working in the building industry and subjected to the Cronbach's Alpha Reliability analysis resulting in reliability coefficient above the recommended 0.70 (Straub *et al.*, 2004).

Questionnaires were handed over to respondents individually and a total of 70 out of 100 were returned, attaining a 70.0 % response rate. The Data was analysed using descriptive statistics to determine the main findings; SPSS 20 was used to find the mean ratings which was subsequently used to compare with theoretical mean ratings of 4.0 to determine the major factors as regards the benefits and challenges encountered in the use of locally Available Walling Materials assuming normal distribution of responses above neutral.

4.0 RESULTS AND DISCUSSION

The results gathered are presented and discussed under the following sub headings: Respondents' demographics, Benefits associated with the use of Locally Available Walling Material in building houses and Challenges associated with the use of Locally Available Walling Material in building houses.

4.1 Respondents' Demographics.

Table 1 presents the characteristics of respondents including the building materials used by them

Table1: Demographic profile of respondents (n =70)

Category	Number of respondents	Percentage
Gender		
Male	53	75.7
Female	17	24.3
Age		
< 30 years	8	11.5
30-39 years	12	17.1
40-49 years	22	31.4
50-59 years	18	25.7
≥60 years	10	14.3
Roofing Materials used by Respondents		
Aluminium and other metallic sheets	46	65.7
Thatch and other Plant Materials	16	22.9
Asbestos	6	08.5
Clay Tiles	2	02.9
Walling Materials used by Respondents		
Mud/Swish Rammed earth (pisé)	25	35.7
Unburnt earth bricks/blocks	50	50.0
Sandcrete, concrete or reinforced concrete	10	14.3
Materials used for Floors by Respondents		
Sand- Cement Screed	42	60.0
Rammed Earth	28	40.0

Source: Author's field survey, August, 2016.

In terms of gender the characteristic profile of the respondents showed the males to be in the majority with 75.7% while indicating the female to be in the minority with 24.3%.

The profile also showed that 11.5% of respondents were below 30 years of age with 17.1% falling between 30 to 39 years of age. Those who were between 40 to 49 years of age represented 31.4% while those between 50 and 59 years of age accounted for 25.7% of the respondents. Those who were 60 years and above constituted 14.3% of the respondents.

In terms of roofing material selection for their dwellings, 65.7% of respondents used aluminium and other similar materials. The next popular material was the thatch used by 22.9% of respondents. Asbestos was used by 8.5% of respondents while clay tiles were used by only 2.9% of respondents.

Majority of respondents constituting 60% used sand-cement screed as flooring material while the rest constituting 40% used the traditional rammed earth.

In terms of walling materials, majority of respondents constituting 50% used unburnt earth bricks followed by 35.7% using mud, rammed earth or pise walls. Only 14.3% of respondents used sandcrete and concrete walls. The report can conclude that the totality of respondents using materials made of earth or laterite constituted a majority of 85.7%.

4.2 Benefits associated with the use of the Locally Available Walling Material.

A comparison of mean differences by ranking arranges the factors that influence positively the choice and the use of the locally available walling material from the most important to the least important based on the experience, preferences and other considerations of the respondents in the Bunania community.

Table 2.0 Benefits obtained in building houses using Locally Available Walling Materials (LAWM)

Item	Mean	Std. Deviation	Rank
(LAWM) provide thermal comfort.	5.130	0.513	1st
The use of (LAWM) make housing cheaper	4.710	1.252	2nd
(LAWM) promote Cultural Heritage.	4.590	1.105	3rd
Only Simple methods and tools are used to build	4.570	1.163	4th
(LAWM) are environmentally friendly.	3.090	1.258	5th
(LAWM) has high fire resistance	2.790	1.260	6th

Source: Author's field survey, August, 2016.

In reference to Table 2, respondents ranked provision of thermal comfort as the first (1st) beneficial factor for the use of locally available walling materials with mean rating of 5.130 with a standard deviation of 0.513, followed by the use of locally available walling materials making housing cheaper as the second ranked (2nd) factor with mean rating of 4.710 and standard deviation of 1.252. The third (3rd) factor concerning benefits

was promotion of Cultural Heritage with mean rating of 4.590 and standard deviation of 1.105. The benefit stating that only simple methods and tools were employed in connection with the use of locally available walling materials became fourth (4th) in rank with mean rating of 4.570 and standard deviation of 1.163.

Locally available walling material rated as environmentally friendly was ranked fifth (5th) as a minor benefit with mean rating of 3.090 and standard deviation of 1.258. The beneficial factor describing the locally available walling material as fire resistant was ranked sixth (6th) with mean rating of 2.790 and standard deviation of 1.260 also as a minor benefits. The fact that majority of 85.7% of respondents used locally available walling material either as unburnt earth bricks or rammed earth for their buildings can best be justified by the benefit ranking first which identified the material to be the most reliable in ensuring thermal comfort in a climate having very high diurnal temperatures.

Koenigsberger *et al.* (1983) established that the light weight brick wall has a low temperature conductivity of 0.374 W/mdegC and a high resistivity of 2.68 mdegC/W and if compared to a sandcrete wall of a higher conductivity of 0.532 W/mdegC and lower resistivity of 1.88mdegC/W, the mud or unburnt earth brick walls which are similar to the light weight brick walls, can be described as more insulating because, during the day they admit very little heat into the interior of buildings and in the like manner release lesser heat out of the interior. These properties of the material ensure the users thermal comfort day and night. No added cost is incurred for cooling nor heating in the running of the houses. The large thermal capacities of the material also safeguard rampant movement and for that matter prevent cracks that lead to constant repair works (Heathcote, 1995 and Sarkar, 2006).

The making of housing cheaper through the use of locally available walling materials ranked second as a factor, probably because laterite, the dominant material used is found in abundance everywhere within Northern Ghana (Gidigasu, 2005; Arumala and Gondala 2007).

Another argument for making housing cheaper relates to the suggestion made by Kern (2004) that materials alone constituted the largest cost input of 50% into any housing project. Reckoning the fact that the local material in use is free and readily available in every locality one can easily appreciate the perceived quantum of cost saving made by adopting the local material for building.

Another angle from which cost saving can be appreciated is the free communal labour input which Schreckenback (1981) maintained constituted 30% of the overall cost of procuring houses in Northern Ghana. Members of the community are able to provide free labour for construction since the processes involved in building, using laterite, are simple and not requiring the use of any sophisticated equipment. Ahadzie and Badu (2011) also confirmed that the self-build procurement practise, a very popular culture prevail among the people of Bunania yield to tremendous cuts on costs in building.

The third most important benefit in connection with the use of locally available walling materials to the respondents was the promotion of cultural heritage. Respondents considered the architecture characterised by round huts, built with lateritic walls which provided thermal comfort in a rather harsh climate as a heritage bequeathed onto them by their fore fathers. Apart from identifying them as a social group of people within the same geographic and climatic region, the architecture also served as a medium for the preservation of their socio-cultural values.

The processes of building as observed by Schreckenback (1981) provided opportunities for the observation of socio-cultural norms and practises. Traditionally, March and April were referred to as "building months" and were reserved for building activities which always began with the performance of religious rituals. As men built the walls and roofs women applied the finishes which included such mural works as inscriptions of cultural symbols on their main facades, an activity Rumana (2007) agreed to be reflecting the people's identities and promoting their cultural heritage. Using simple traditional methods and tools, the entire community provided free labour to build for one another. Ahadzie and Badu (2011) referred to this practice as a 'self-build' culture aimed at cutting down costs in providing usually domestic houses.

The factor that ranked fourth is the benefit in employing simple tools and construction technologies that come along with the use of the locally available walling material. As pointed out by Rumana (2007) the simple traditional methods of building are familiar and easily employed. If housing is to be made affordable and cheaper than in addition to the free material, labour has to be gotten equally cheap and the community efforts in this scenario become very relevant granted that tools, equipment and technologies would not be out of the reach of the indigenes.

Table 3.0 Challenges experienced in building houses using Locally Available Walling Materials (LAWM)

Item	Mean	Std. Deviation	Rank
Lack of recognition for (LAWM) by Authorities	5.070	0.802	1st
(LAWM) Lack strength and durability	4.830	1.301	2nd
(LAWM) have Challenges in satisfying new Needs in Building forms and functions	4.670	1.348	3rd
(LAWM) are easily invaded by termites and Rodents	4.610	0.812	4th
(LAWM) cannot withstand vagaries of the Weather	4.030	1.052	5th

Source: Author's field survey, August, 2016.

In reference to Table 3.0, respondents ranked Lack of recognition for locally available walling material by Authorities as the first (1st) challenging factor for the use of locally available walling materials with the mean rating of 5.070 and standard deviation of 0.802, followed by the Lack of strength and durability as the second ranked (2nd) factor with mean rating of 4.830 and standard deviation of 1.301. The third (3rd) factor concerning disadvantages was Challenges in satisfying new Needs in Building forms and functions with mean rating of 4.670 and standard deviation of 1.348. The challenging factor stating the ease at which termites and rodents invade the interior spaces of buildings using the locally available walling material became fourth (4th) in rank with mean rating of 4.610 and standard deviation of 0.812.

Respondents agreed that Lack of recognition for buildings put up with locally available walling materials by Statutory Authorities ranked first because it is the most incapacitating factor as it comes with a bias against the local materials and subsequent refusal to grant permits for their use, a situation which does not only frustrate the development of their traditional architecture but also tend to hinder the role, according to Botchie (2000), the statutory authorities owe the local communities in terms of developing their human settlements in conformity with Local Government Act of 1993 (Act 462). Several signs of neglect were noticed including a glaring absence of physical planning for the Bunania community and absence of roads and drains leading to gully erosions at many places.

The united nation listed atakpame walls, wet moulded mud balls, Adobe walls, wattle and daub walls swish walls and unburnt brick walls, materials which are all derived from laterite, as not approved by the Ghana standard board (UN- Habitat,2011).

In order to play safe with building regulations and tender conditions most project managers on government projects favoured imported materials which have known standards or specifications (Nyenke, 2004). The use of such foreign materials as sandcrete and reinforced concrete for building ensure structural stability but because they have little thermal capacities, as high diurnal temperatures in Northern Ghana begin to take toll on them they do not only experience multiple cracks over time but also fail to provide thermal comfort the way the local materials would.

Notwithstanding the justifications Sanusi (1993) made that statutory authorities dismissed buildings put up with local materials as temporal structures and refused to grant permits due to technical limitations as well as fears over legal matters the use of the materials continue to proliferated due to the thermal comfort they provided, lower cost at which they were procured, the ease at which they were maintained, the high level of environmental safety associated with their use and for the fact that they preserved and portrayed socio- cultural values of the indigenes among other benefits. A study of respondents' profile showed 85.7 % patronizing this traditional architecture comprising of mud or unburnt earth brick walls as against only 14.3% dwelling in homes constructed with imported materials such as sandcrete or reinforced concrete walls.

The factor that placed second in rank regarding challenges encountered in the use of locally available walling materials was lack of strength and durability.

Compressive strength is the most important requirement for load bearing walls but when laterite is used all alone without any binders this strength tend to lack in the walls. Closely associated with this defect is the vulnerability of walls towards moisture as well as its low abrasive resistance (Venkatarama and Prasanna, 2009; Riza, 2011; Adogla *et al* 2016).

Due to lack of strength of the load bearing walls no room in the community measured more than 3 meters. The caution obviously was to avoid structural failures since any long span of space would require equally long span of roof with its relative load. The indigenes preferred to keep such technicalities simple and safe by adopting shorter spans of space no matter how insufficient these spaces may be. Signs of water ingress could be seen on walls in most rooms due to absorption of water from outside or from foundations of the buildings. Erosion of external walls especially at the plinth of buildings was also noticed on almost all the buildings in the community.

In their efforts to mitigate defects characterising the use of laterite as a building materials most builders used locally available binders as lime, fly ash, tars, bitumen, molasses and gum Arabic as identified by Yalley and Manu (2013) to stabilize their walls but still have to engage in frequent labour intensive

maintenance work all through the year in order to keep the buildings structurally sound.

Bediako *et al* (2011) also mentioned pozzolana as a locally improved binder which was 24% cheaper than Portland cement due to the minimised energy intensive processes used in its manufacture but at Bunania only Portland cement an imported binder is used.

Using simple brick moulds Yalley and Manu (2013) improved upon the strength of compressed unburnt earth bricks measuring 4.56 MPa to 5.77MPa with 20% PES of cow dung. Similarly, Adogla *et al* (2006), in a separate experiment, achieved the strength of 2.87 N/mm^2 with 30% PES of eggshell powder stabilizer in comparism with the recommended strength for masonry wall of 2.5 N/mm^2 as per GS 297-1 (2000). Water absorption properties were also reduced alongside the same experiment from 16.89 g/cm^2 in a compressed lateritic brick without a stabilizer to 3.94g/cm^2 with the same material with the eggshell powder stabilizer. The same experiment yielded an improvement on abrasion resistance from 0.32cm^2/g to 1.56 cm^2/g.

Unburnt earth brick wall which constituted 50% majority usage on respondents' profile, holds great prospects for the delivery of sustainable housing in northern Ghana if innovative findings on the material mentioned above can be adopted and implemented. Apart from publishing their findings in journals, building technologists have failed to package their ideas into marketable products to be used in the building industry. According to Schrechenback (1981) where demonstration buildings were put up with the material, they were located in Southern Ghana university campuses where income and taste of target groups are high and where thermal comfort, the greatest beneficial characteristic of the material, is not appreciated due to low diurnal temperatures.

The factor that placed third in rank was challenges encountered in satisfying new needs in building forms and functions. Architecture in Northern Ghana characteristically evolves round the circular plan and form because a lateritic wall, according to Schrechenback (1981) can attain maximum compressive strength as a homogenous material only when it assumes the circular form or plan.

The circular form or plan of a building comes with complications in design as well as wastage, notwithstanding the interesting aesthetic appearance. To ensure harmony in design and usage, fixtures such as worktops, kitchen cabinets and wardrobes in a building have to be specially designed and constructed to fit into the circular shape and curvature of walls and spaces. In order to lay finishes such as wall and floor tiles, ceiling cards and fix roofing sheets to fit the circular shapes a lot of wasteful cut-offs are made.

A design for a modern domestic house would as a matter of standard and convenience provide for water closets and showers within the bedroom functional space but given the water absorbing properties of lateritic walls as maintained by Maghoub (1997), it will not be prudent to let toilet spaces share walls with bedrooms lest moisture from these wet areas be absorbed and introduced into the "dry" bedroom spaces. Characteristically all the households in Bunania have such wet functional spaces as kitchen and toilets built as out-houses a few meters away from the main dwelling units and thereby increasing circulation space and making every housing unit sprawl over a bigger land space. Stepping out of bedrooms to access such detached spaces as toilets and kitchens at night by family members always come with the risk of snake bites. Other challenges include the inability of the walls to hold and keep fixtures such as shelves, cabinets, conduit pipes for water and electricity supply as well as fittings such as wash hand basins, water closets, wall sockets and lighting switches due to lack of strength.

The factor placing fourth in rank was the inability of locally available walling material to withstand vagaries of the weather. Erosion was observed on most walls and foundations at Bunania and this, given the fact that the zone was an open savanna without windbreaks, could be blamed on the effects of torrential rains, winds and flooding. Lateritic walls, among other weaknesses, lack abrasive resistance and since the walls were usually left fare faced and without any further protective finishes they became susceptible to wear and tear. To keep the walls and buildings in good conditions, there is need for labour intensive maintenance in such area and as Harper (2011) observed, this is very necessary mainly after the rainy seasons.

The challenging factor ranking fifth was the invasion of houses built with locally available walling materials by termites and rodents. Termites, according to Targbor and Osei Frimpong (2011) are found in the sub-soil almost everywhere in Ghana and the Bunania community was no exception. Termites as they suggested continue to find conducive environment within lateritic walls long after construction works have been completed due to the continuous presence of moisture and wood debris in the walls. Termites easily infested the interior spaces of the houses as no stronger structural components were used other than mud as floors to separate the super substructure from the foundations. The lateritic walls used at Bunania were also not strong enough to prevent rodents from boring through to the interior. Most residents used Portland cement in sand-cement floor screeds to serve as physical barriers over their foundations to stop termite invasion. These efforts could not completely prevent the activities of termites as the soils were still not treated chemically.

5.0 CONCLUSION AND RECOMMENDATION

Based upon the findings and discussions above the following recommendations are made.

1. To put in place a sustainable housing scheme in Northern Ghana, unburnt earth brick as a locally available walling material, is being recommended due to the benefits identified with its use.
   The highest ranking benefit making it most appropriate as a material to be used in Northern Ghana where diurnal temperatures are very high was the thermal comfort it provides.
   The second highest ranking benefit justifying its use for sustainable housing in the locality is the fact that it is cheap, abundant and for that matter affordable, given the low levels of income of people in the locality. Another factor heightening prospects of the material for adoption for sustainable housing was the preferences the people have for it as a cultural heritage, a merit which ranked as the third beneficial factor.
   The advantage ranking fourth which related to the use of simple tools and methods in construction can be said to be another justification for the recommendation of unburnt earth brick wall to be used as locally available walling material.
2. Government must take cognisance of the cost saving "self-build" culture of the people by allowing for their direct participation in building processes as plans for housing projects are made. The concept of 'self-build' was one of the practices associated with the promotion of cultural heritage, the third beneficial factor.
3. In order to facilitate participation in their own building activities the recommendation is being made, in conformity with the fourth benefit, that constructional processes be made simple and should entail the use of only simple tools and not sophisticated equipment and complex construction technologies.
4. Since the highest ranking challenge encountered in the use of unburnt earth brick was lack of strength, government should be cognisant of the fact that many scientific research works have already been done towards the improvement of the material. Government should also consider conducting an open competitive tender among building technologists to obtain improved samples and method statements that would meet the standards as well as establish specifications for unburnt earth bricks acceptable to Statutory Authorities. It is envisaged that once improvement is attained for strength, all challenges already mentioned by this study would be resolved and thereby enhance prospects of the material for sustainable housing especially for Northern Ghana.
5. Once standardised, projects involving the use of unburnt earth bricks must be granted the necessary recognitions through the issuance of building permits by statutory authorities. These buildings must also be recognised and included in all planning schemes by the authorities with the objective of preventing the communities to be created from degenerating into overcrowded neighbourhoods with faulty layout of buildings which will in turn hamper efficient services layout as well as road accesses.
6. The invasion of termites and rodents into the interior of houses, the fourth ranking problem associated with the use of locally available walling material, must be prevented not only, as stated earlier, by improving on the characteristics of the material but also through chemical treatment of the soil and grounds within which the houses will be sited.
7. Aside the improvements to be made on unburnt earth brick as a locally available walling material, tackling the fifth ranked problem, which was inability of the material to withstand vagaries of the weather, must be done by adopting appropriate construction technologies which will provide for long roof overhangs and resilient finishes to protect walls and foundations of the buildings.
   Budgets must be made for establishing landscape schemes that would include planting of trees to serve as windbreaks, grass cover to check erosion as well as constructing drains to conduct storm water away.

CONCLUSION

The objectives of this study were to identify the major locally available walling material in use in northern Ghana, empirically examine as well as analyse the major benefits and challenges associated with its use and subsequently make appropriate recommendations for its adoption for sustainable housing in northern Ghana.

Unburnt earth brick was found to be the most popular locally available walling material in use in Northern Ghana. Benefits found to be promoting its use were the thermal comforts it provided, the manner it made housing cheaper, the cultural heritage that it promoted and the fact that only simple tools and methods were employed in its construction as a building component. On the other hand, the lack of recognition by Statutory Authorities, lack of strength and durability, challenges in satisfying new needs in building forms and functions, invasion of the interior space by termites and rodents as well as weakness in withstanding vagaries of the weather were found to be challenges to be solved if the material could be adopted for any sustainable housing scheme.

Unburnt earth brick, as a locally available walling material has a huge prospect for supporting sustainable housing schemes in Northern Ghana if only government would, utilise existing research findings to get the material stabilised to the required strengths and characteristics so as to pave the way for its recognition by statutory authorities and subsequent packaging for commercial use in the building industry.

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Figure 1. Staff bungalows at Navrongo College of Education built with sandcrete blocks developing multiple cracks due to high diurnal temperature.

Figure 2. Rehabilitated Round hut Dormitories at Bagabaga College of Education, Tamale built with unburnt earth bricks. Tubular posts were used to provide octagonal base for a new octagonal roof superimposed on the round huts after numerous cut-offs of the new aluminium roofing material.