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ABMT HANDBOOK

A platform for Green Alternative, Appropriate & Emerging Building Materials & Technologies.

KENYA-GREEN-BUILDING-SOCIETY/GREENTHUMB - **2023 ISSUE 01**

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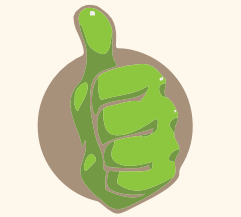
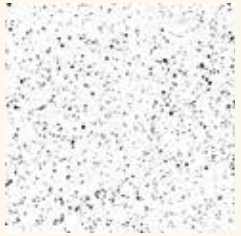
Alternative Building Materials & Technologies





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Readers of the enclosed data sheets are cordially encouraged to delve further into the subject matter or, as required, to reach out to KGBS for clarification or rectification of the data. We extend an invitation to the mentioned companies to periodically review this data, as it may be subject to updates and modifications.

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contents

acronyms & definitions

Appropriate/Alternative Building Materials and Technologies (ABMTs):
ABMT refers to processes, materials, elements, and tools that are compatible with the local socio-cultural, economic as well as physical and ecological environment of an area.

Affordable Housing:
Housing that is adequate and costs not more than 30% of the household income per month to rent or acquire. In the context of this report, the various building materials both conventional and ABMTs are analysed based on their level of affordability.

Affordable Housing Programme (AHP):
The Affordable Housing Programme (AHP) is an initiative by the Kenyan Government as one of the pillars under the 'Big 4 Agenda' which ensures that low- and middle-income households have access to decent and affordable housing units.

State Department for Housing and Urban Development (SDHUD):
This is a unit in the national government mandated with facilitation of access to adequate and decent housing and preparation of urban plans for sustainable development.

Kenya Green Building Society (KGBS):
This is an organization that champions integration of green / sustainable building and construction practices in Kenya. It is a member of the World Green Building Council (WGBC).

Kenya Building Research Centre (KBRC):
Kenya Building Research Centre (KBRC) is one of the institutions domiciled under the State Department for Housing and Urban Development that reinforces the institutions mandate to spearhead the Building Research Services in Kenya.

FSD Kenya:
Financial Sector Deepening Kenya (FSD Kenya) is an independent trust dedicated to the achievement of a financial system that delivers value for a green and inclusive digital economy while improving financial health and capability for women and micro and small enterprises (MSEs).

www.archdaily.com/951667/what-is-vernacular-architecture

© Yves Saint Laurent Museum in Marrakesh, Morocco, Inspirted by Vernacular techniques and materials...Image by Dan Glesser

"Alternative Building Materials and Technologies (ABMTs) can provide significant climatic benefits by reducing greenhouse gas emissions, minimizing energy consumption, and promoting sustainable resource use.

By using these materials and technologies, we can help create a more sustainable built environment."

introduction

The growing global population presents significant challenges to the efforts being championed by various governments in facilitating access to affordable and adequate housing for their citizens. According to the UN-HABITAT, 2020, half of the world's population now lives in cities, and this is projected to increase to two-thirds by 2050. Urban areas drive innovation, consumption, and investment worldwide, making them a positive and potent force for addressing sustainable economic growth, urban development, and prosperity. However, the rapid urban growth rate of towns and cities has led to dramatic problems, including huge shelter needs, the emergence of squatter settlements and slums, and deficient infrastructure in many low-income settlements.

The Universal Declaration of Human Rights (UN, 1948) declared housing a basic human right, stipulating under Article 25(1) that everyone has the right to a standard of living adequate for their health and well-being, including food, clothing, housing, medical care, and the necessary social amenities. The Habitat Agenda challenges governments to use shelter development as a tool to break the vicious cycle of poverty, homelessness, and unemployment. Agenda 2063; The Africa We Want emphasizes the need to provide opportunities for all Africans to have access to decent and affordable housing in clean, secure, and well-planned environments in sustainable human settlements. The Sustainable Development Goal 11 seeks to make cities and human settlements inclusive, safe, resilient, and sustainable, while target 11.1 specifically envisages ensuring access for all to adequate, safe, and affordable housing and basic services and upgrading slums by 2030.

Kenya has also been experiencing rapid population growth as a result of increased fertility rates. The population increase has been tremendous over the years, with the 2019 Housing and Population Census results estimated at 47.5 million people and 12.2 million households (KNBS, 2019). The continued increase in population size has led to increased housing demand for the low, middle, and high-income groups in society. Over time, the number of urban households has increased mainly due to rural-urban migration and natural population growth, which has led to an upsurge in demand for affordable housing in urban areas. For this reason, there has been a need for cheap and appropriate technology to assist in alleviating the problem of inadequate housing and affordable construction costs.

“The Africa We Want emphasizes the need to provide opportunities for all Africans to have access to decent and affordable housing in clean, secure, and well-planned environments in sustainable human settlements.”

building typology

The typology used in this analysis is a single storey, 56 sqm, 2 Bedroom house, with a gable roof. Its space efficient and sufficient for a family and is complete with windows and doors, however, no other services (water, power, sanitation connections) or finishes (tiles or floor finishes, kitchen fittings, toilet and shower fittings etc) are accounted for.

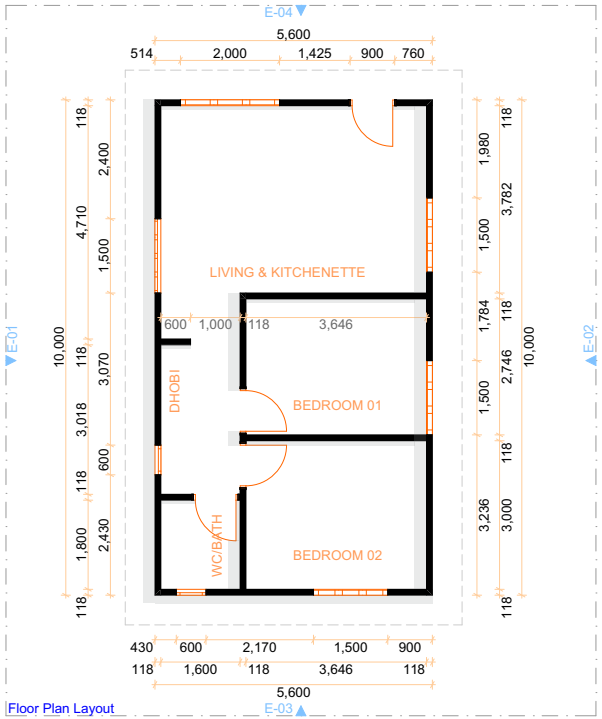
The single storey unit is selected as:

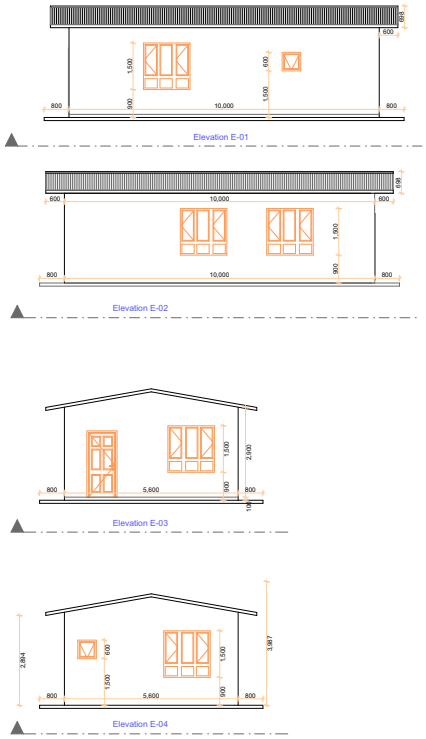
i. It is a simpler technology than multi-storey, which needs a lot more structural strength, space within the building for circulation etc. For this reason, single storey buildings should be much more cost efficient in terms of construction cost.

ii. This is how an estimated 80% of housing in Kenya is currently built.

iii. There is room to make the delivery of such housing better in terms of cost, time of delivery and green targets. Green targets encapsulate longer term resilience and quality.

STRUCTURE AS COSTED IN THIS REVIEW





technologies

The appropriate technology for building materials was introduced in the year 2003 with the formal launch of the Appropriate Building Technology (ABT) Programme undertaken in 2006, an initiative that has since spread to most parts of the country. This study reviews the financial and environmental implications of 14 different walling technologies and 2 different roofing technologies, commonly available in Kenya.

- Burnt Bricks
- Stabilized Soil Blocks (SSB)
- Interlocking Stabilized Soil Blocks (ISSB)
- Hollow Concrete Blocks
- Interlocking Hollow Concrete Blocks
- Machine-cut Natural Stone
- Kwangu Kwako Pre-cast Concrete Panels
- Expanded Polystyrene (EPS)
- Rammed Earth
- Cross Laminated Timber (CLT)
- Light Gauge Steel(LGS)
- Aluminium Formwork Poured Concrete
- Recycled Plastic Blocks
- 3D Printing
- Mabati Roofing Sheets.
- Recycled Plastic Roofing Sheet

BURNT BRICKS

MATERIAL SPECIFICATIONS

Burnt bricks is a prevalent technology particularly in rural areas. Bricks can be made manually or mechanically moulded and then fired. Various fuels are used for firing including firewood, coffee and rice husks, saw dust and coal. Soils with high clay content work best for permanent construction (70% clay : 30% sand).

Standard Dimensions - L190xW90xH90mm

APPLICATION - WALLING, FLOORING & CLADDING

- Load bearing for single story buildings.
- As an Infill for multi-story buildings.
- Used both in urban and rural arears.

GENERAL DESCRIPTION

Burnt bricks are a viable option in very low-income settings as local people already have existing knowledge in this type of construction and it's easy to manufacture. It's also very low cost for a durable product.

From an environmental perspective it lacks sustainable qualities related to carbon impacts and deforestation.

Given this material is a known and well-used technique in East Africa, it is important to refer to it but should not be advocated for due to its environmental footprint.

EMBODIED CARBON

The need to burn bricks in kilns where wood or charcoal is burned as fuel increases the embodied carbon impact of burnt bricks. The raw material, in this case, earth or soil, is likely to be local, so minimal transport is needed and extraction impacts are not severe.

The use of cement mortar when bricks are laid and likely need for plaster further impacts the carbon footprint of burnt bricks.

PRODUCTION IMPACTS

As with any earthen material, brick will be the most sustainable when the raw material is sourced from the same site as the building itself (eg. taken from excavation activities for the foundations or utilities etc).

However, it should also be noted that if extraction of the soil is too heavily concentrated on one location, this can cause negative impacts, which vary depending on the ecological value of the location.
Voi river bank in Kenya has experienced degradation of the river bank due to unsustainable soil harvesting and deforestation caused by the wood needed to burn kilns.

When clay extraction is done sustainably, the topsoil is removed and put aside and put back afterwards to be used for farming or other purposes. The most considerable production impact is the wood fuel used to burn the bricks, which is likely extracted from natural forests which increases deforestation.

Socially, the production is low-skilled and the knowledge already exists in most communities. It's an easy and accessible option with local people benefitting economically. They have low maintenance and high durability.

EQUIPMENT & SKILLS REQUIRED

Low skill level required which is readily available, Bricks can be made manually with a wooden or metal mould, or in small factories. They can be aesthetically pleasing if built well, however, poor workmanship is telling on the final product.

REUSABILITY & RECYCLABILITY

Burnt bricks can be reused, but not easily. It depends on the quality of the brick and the type of mortar used.

Some bricks can be of lower quality and strength due to over or under-firing during production. If cement mortar is used to lay the bricks, they could break as the brick is softer than the cement. It is more feasible to reuse bricks if they are laid with lime mortar as it is softer and easier to remove.

Bricks can also be crushed into low-grade fill/aggregate.

POLICY CONSIDERATIONS

Internationally recognized as a durable building material as long as they meet basic set standards that are still relevant for rural builds.

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SSBs & ISSBs

Stabilised Soil Blocks & Interlocking SSBs

MATERIAL SPECIFICATIONS

These are blocks made from a mixture of soil and cement and sometimes lime and sand is added. The mixture is fed into a manual or mechanical block press, where it is subjected to high compressive pressures. Resultant block has a very high compressive strength and resistance to water erosion due to cement added. The soil used must have a high sand content of 60-70% - an exception is areas with black cotton soil are not suitable. In laying the SSB you also require mortar, but not with the ISSB.

APPLICATION - WALLING & FLOORING

- ISSB Load bearing for single story buildings as they have no mortar.
- SSB Load bearing for maximum two storeys.
- Used both in urban and rural arears.

GENERAL DESCRIPTION

SSBs & ISSBs are bricks made from mixed soil that can be found on or around the construction site which makes them a good option for low-income housing, especially in rural/ peri-urban low-rise areas.

They are an energy-efficient and low embodied carbon material alternative for structural masonry.

Standard Dimensions -
SSB - L120xW50xH40mm
ISSB - L240xW220xH110mm

EMBODIED CARBON

Provided soil is sourced on-site or nearby, and particularly if extracted manually (vs using a backhoe or other engine-powered machinery), the embodied carbon impact of stablised soil blocks is low.

Cement stabilisation (typically at approx. 8%) increases embodied carbon, but this is minimal compared to other products. Compressed blocks require an engine-powered machine to hydraulically press the earth, and this emits further carbon, but also gives a stronger, more durable block.

PRODUCTION IMPACTS

Soil is the abundantly available and oldest building material known to man and humans have been living in Earthen Dwellings since the beginning of time. Environmental impacts are generally low, especially if the soil is being taken from excavation activities already occurring on site.

There are positive social impacts as the blocks can be made on-site, and thus local jobs can be created.

Building design should consider the volume of material being excavated and try to design for this amount rather than relying on additional soil being required. Laying them can be simple (in the case of interlocking blocks) provided a skilled hand lays the first course properly.

EQUIPMENT & SKILLS REQUIRED

Manual block presses, shovels and basic masonry tools required for blocks production. Estimated equipment cost using manual equipment is 200K. Very high skill required in laying the blocks. From experience, this technology has fared poorly over time as the skill is lacking and the walls generally begin to crack over time.

REUSABILITY & RECYCLABILITY

Interlocking SSBs can be reused if they are still in good condition as walls can be easily dismantled.

POLICY CONSIDERATIONS

While ISSBs seem to have been promoted more heavily in Kenya, they can only go up 1 storey without further reinforcement and do require higher skill than SSBs.

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HOLLOW CONCRETE BLOCKS (HCBs)

MATERIAL SPECIFICATIONS

HCB made from special concrete mixes comprising of cement, sand and stone chippings. Hand molds, manual blocks making or mechanical/ electrical vibrators are used. Vibrated HCB are of higher strength and superior quality

Standard Dimensions - L400xW200xH200mm

APPLICATION - WALLING.

- Load bearing for single story buildings.
- As an Infill for multi-story buildings.
- Used both in urban and rural arears.

GENERAL DESCRIPTION

Hollow concrete blocks are relatively lightweight and simple to make. They also use less concrete compared to traditional concrete blocks. Compared with bricks, the amount of mortar used is lower.

However, they have no discernable benefits over natural stone (neither environmental, economic, durability, nor aesthetic).

EMBODIED CARBON

Cement manufacturing contributes to greenhouse gases both directly through the production of carbon dioxide when calcium carbonate is thermally decomposed, producing lime and carbon dioxide, and indirectly through the use of energy from fossil fuels.

The cement industry produces about 5% of global man-made C02 emissions, of which 50% is from the chemical process, and 40% from burning fuel.

The embodied carbon of the blocks can be improved by aerating the concrete so that it has a lower density, and consequently less concrete is used during the process. This also makes the blocks lighter, and thus easier to handle on-site.

PRODUCTION IMPACTS

Concrete manufacture is an extremely energy-intensive process and causes well-documented environmental impacts at all stages. These include emissions of airborne pollution in the form of dust, gases, noise and vibration when operating machinery and during blasting in quarries and damage to the countryside from quarrying limestone.

On another note, sand is a particularly rapidly depleting resource in the world, and its use is largely unregulated, so when it is extracted from sensitive areas, additional environmental risks are created.

Furthermore, interlocking moulds can be used to reduce the amount of cement mortar. However, interlocking blocks require more technical expertise - they must be laid very accurately otherwise the load bearing strain can lead to cracks. Users can be encouraged to leave walls unplastered and instead embrace a painted or an exposed block aesthetic.

EQUIPMENT & SKILLS REQUIRED

Can purchase ready blocks so do not need equipment, or can make with a hand mold, or a vibrator. Basic skill level required which is readily available.

REUSABILITY & RECYCLABILITY

Cement is corrosive and generally working in the production of cement products is not a healthy occupation, particularly due to the presence of silica dust.

Concrete buildings have a lower thermally insulative ability than some other materials such as timber and so may not be ideal for thermal comfort but may be suitable in climates where a high thermal mass is required.

Acoustically they generally perform well due to their mass.

POLICY CONSIDERATIONS

Need to evaluate the carbon factor of concrete materials in Kenya - they may be greener than other countries as 93% of Kenya's energy is made from Green Sources.

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NATURAL STONE - MACHINE CUT

MATERIAL SPECIFICATIONS

Indeginious material and available in different colours (grey, yellow, blue). Some stones are hard while others are soft. Mined or extracted from quarries.

Extraction includes use of explosives, diamond saws for machine cut stone. Alternatively they can be hand dressed.

Standard Dimensions - L220-330xW120-195xH140-215mm

APPLICATION - WALLING.

- Load bearing for single and double story buildings.
- As an Infill for multi-story buildings.
- Used both in urban and rural arears.

GENERAL DESCRIPTION

Natural stone can be very sustainable, as it is a durable naturally occurring material, that is available locally. In Kenya, its sustainability could be improved considerably (especially for single-or-two-storey houses), if:

- there is a switch from cement to lime mortar/plaster,
- loadbearing structures are used rather than concrete frame and stone infill structures.

EMBODIED CARBON

The carbon impact of natural stone is relatively low as it is a local resource which is used in its raw form and so doesn't require any, or any significant processing. That said, the carbon impact is variable according to a couple of factors:

Extraction method - stone is typically either hand cut or machine cut, the latter has a greater carbon impact due to the emissions associated with the cutting equipment.
(usually engine - powered).

However, machine-cut stone has a more regular-shaped block than hand-cut, which reduces the amount of cement mortar and/or plaster required.

Distance to source - depending on where the quarry is located in relation to the site, the carbon footprint will be affected due to the emissions associated with transportation/logistics. Heavy quarry equipment and trucks can also cause damage to public roads and even other buildings (due to vibrations).

This can have a negative environmental impact due to the associated carbon emitted for repair and maintenance.

PRODUCTION IMPACTS

Quarrying is damaging to the natural environment. The quarry pits may destroy natural landscapes, ecosystems, and biodiversity. This is especially true for stone types with shallow and widespread deposits (e.g. coral stone on the coast), which causes the quarries to have a much larger geographical footprint. They create dust and noise pollution, which can have negative impacts on worker health, as well as on the living environment for individuals or communities living or working nearby.

However, natural stone is one of the most durable building materials available in Kenya (it lasts even longer than concrete) and requires little maintenance. From an overall sustainability perspective, stone buildings will last longer and have fewer lifecycle maintenance emissions.

Quarrying creates local jobs, but as a finite mineral deposit, the quarries are often owned by corporates or wealthy landowners, meaning it is a less democratic material when compared with forest products, which can be operated renewably on a smaller scale.

EQUIPMENT & SKILLS REQUIRED

Low skill level required which is readily available & no upfront investment as stones purchased from quarry. Low maintenace and high durability.

REUSABILITY & RECYCLABILITY

Stone is reusable, as stone walls can generally be dismantled and re-used (unless the stone is a particularly soft variety, in which case a hard cement mortar would make reuse difficult).

In the worst-case scenario, it can be demolished and the rubble used as hardcore, for gabions, as gravel, or for various other purposes.

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KWANGU KWAKO CONCRETE PANELS

MATERIAL SPECIFICATIONS

Reinforced concrete panels made at factory and sold as part of design and delivery contract by KKL

APPLICATION - WALLING.

- Load bearing for single story buildings.
- As an Infill for multi-story buildings.
- Used both in urban and rural arears.

GENERAL DESCRIPTION

Kwangu Kwako is a company that deals with precast concrete panels, specifically designed to allow for the fast construction of affordable homes, especially in low-income communities.

The use of concrete is not ideal from a carbon perspective, however, this is mitigated by the thinness of the panels. This also means that the walling takes up less floor area when compared to other materials like stone or timber.

EMBODIED CARBON

Concrete has an inherently high level of embodied carbon, particularly because of its use of cement.

Cement manufacturing contributes to greenhouse gases both directly through the production of carbon dioxide when calcium carbonate is thermally decomposed, producing lime and carbon dioxide, and indirectly through the use of energy from fossil fuels.

The cement industry produces about 5% of global man-made C02 emissions, of which 50% is from the chemical process, and 40% from burning fuel.

As the panels are thin, they perform better than aluminium formwork concrete walls, or concrete blocks, which are thicker and use more concrete. Consequently, however, they have a lower structural capacity. Furthermore, the lightweight nature of the panels means heavy machinery is not necessary.

PRODUCTION IMPACTS

Concrete manufacture is an extremely energy-intensive process and causes well-documented environmental impacts at all stages. These include emissions of airborne pollution in the form of dust, gases, noise and vibration when operating machinery and during blasting in quarries and damage to the countryside from quarrying limestone.

As the panel construction occurs locally, it creates local employment opportunities, capacity building and skills improvement, and promotes local spending to complement and support local businesses.

EQUIPMENT & SKILLS REQUIRED

Low skill level required which is readily available & no equipment require as panels are purchased from the suppliers. Limited maintenace and high durability.

REUSABILITY & RECYCLABILITY

The panels are recyclable as they can be dismantled and rebuilt elsewhere. Panels can also be crushed to form aggregates. The steel used in the panels can be recycled to create new elements.

POLICY CONSIDERATIONS

Need to evaluate the carbon factor of concrete materials in Kenya - they may be greener than other countries as 93% of Kenya's energy is made from Green Sources

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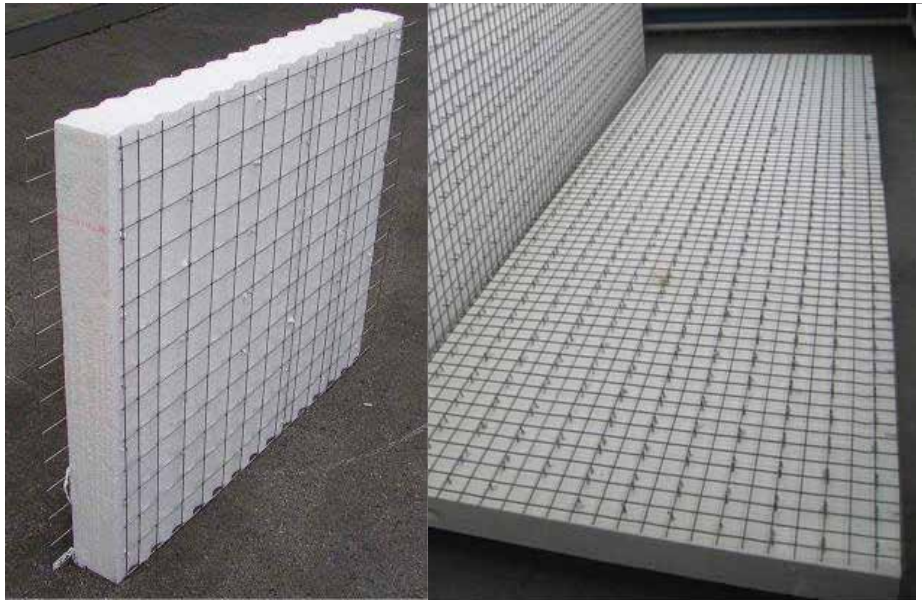
EXPANDED POLYSTYRENE (EPS)



MATERIAL SPECIFICATIONS

EPS panels are made from expanded polystyrene in factories to different sizes. The panels do not have structural strength and hence can be wrapped with a steel mesh, onto which cement can be plastered, or sandwiched between 2 alumninium sheets. The former are typically used as infill panels.

APPLICATION - WALLING & ROOFING INSULATION

- Infill panels in framed (will require a framed structure to go higher rise) structures both for single storey or multi-storey buildings, or as a roofing panel.

GENERAL DESCRIPTION

Expanded polystyrene (EPS) has some positive aspects as a construction material - the panels are easy to install on-site as they are lightweight and have very good thermal properties - but might not be feasible for more rural areas as it has to be manufactured in factories and then transported.

Concerns around the usage of crude oil and degradation of natural resources also need to be questioned.

EMBODIED CARBON

EPS production uses fossil fuels in the form of crude oil and natural gas to create steam, which is then used to expand polystyrene beads and create the final product.

Steam consumed in the manufacturing process is then condensed back into water and reused many times over in the process.

Apart from production, factors that add to its carbon footprint are the transportation costs from a specialised factory and the fact that it must be clad in a steel mesh/ cement plaster. However, it is a very lightweight material, which eases the transportation load.

Another factor for consideration is that it can generate a positive carbon footprint during its application, as EPS insulation saves more energy than is consumed during its manufacture. However, given Kenya's climate and low usage of mechanical heating/ cooling equipment, it is not clear how much this applies in our context.

PRODUCTION & USAGE IMPACTS

Extraction of crude oil has health impacts and disturbs land and marine ecosystems. However, EPS is made up of approximately 98% air, leaving 2% as plastic derived from crude oil. Furthermore, no residual waste is generated during the manufacturing process.

It is easy to install on site, but production requires highly skilled workers, so site production is not possible.

Pentane used in the production process is replaced by air and doesn't emit any harmful gas that could affect indoor air quality and is, therefore, non-toxic. The material itself has high thermal insulation values that don't decrease during its lifetime.

EQUIPMENT & SKILLS REQUIRED

No equipment require as panels are purchased from the suppliers. High skill level required, some uptake in Kenya but workforce needs to be trained for specialised projects as limited trained workers available

REUSABILITY & RECYCLABILITY

During manufacture, any leftover or flawed material generated during production is recycled back into the process. The material is also unaffected by moisture and doesn't degrade over time, so is very durable. Reused EPS waste can be mixed with other materials such as concrete to produce building products like prefabricated lightweight concrete blocks, and recycled into new non-foam consumer products.

In reality, however, most of it ends up in landfills even if it's recyclable.

POLICY CONSIDERATIONS

It is recognised by the Government of Kenya as one of the affordable housing materials that are locally available and has been used by government agencies to construct a number of affordable homes which are being offered to Kenyans under the Boma Yangu programme..

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RAMMED EARTH

MATERIAL SPECIFICATIONS

Rammed Earth is a vernacular building technology that comprises of monolithic rammed earth, compacted between formwork, resulting in a wall thickness of between 150-300mm. The rammed earth needs to be stabilised with 10% cement to be water resistant.

This technology has had very little application in Kenya to date.

Standard Dimensions - 150-300mm thick

APPLICATION - WALLING & FLOORING.

- Single Storey only.

GENERAL DESCRIPTION

Very suitable for low-rise buildings and is a local and natural construction method as materials can be found on site or within close proximity. It takes a long time to cure a rammed earth wall, so the length of the building project needs to be taken into consideration.

Earthbags: Buildings can be erected simply and quickly with little equipment. Construction method creates substantial walls that can resist severe weather, including floods, but creates rather thick and heavy walls that can limit space for interior walls. Not that suitable for colder, wetter, climates as it will promote dew and mould that can eat away at the bags.

EMBODIED CARBON

Soils can be found on-site or within close proximity, which lowers the carbon footprint. Rammed earth construction on a small scale uses little to no machinery. Earthbags can be filled with local materials, which lowers the embodied carbon associated with manufacturing and transportation. The bags themselves can be recycled grain sacks. Generally, energy-intensive materials that are used in the construction (plastic bags, steel wire and plaster for the outer shell) are used in relatively small quantities.

PRODUCTION IMPACTS

In general, the use of earth as a construction material has relatively little impact on the environment as the raw material can theoretically be extracted locally and easily. It should also be noted that if extraction of the soil is too heavily concentrated on one location, this can cause negative impacts, which vary depending on the ecological value of the location.

Rammed earth: A sturdy and durable construction method, but needs the correct mix of clays and sands to achieve proper density. Due to this, experience is needed and usually increases labour costs. Curing a rammed earth wall takes a long time, so the speed of construction needs to be taken into account.

Depending on how engineered the soil is there may be varying needs for cement content, which increases the environmental impact.

Earthbags: Filling earthbags is laborious and time-consuming but the construction itself requires little time and labour, offering job opportunities to the local community. It is very low cost and requires only a few components during construction, making it an available construction method for more rural areas..

EQUIPMENT & SKILLS REQUIRED

- Formwork & pneumatic compressor.
- Requires training. Skills not readily available.

REUSABILITY & RECYCLABILITY

Rammed earth walls can be broken down and rebuilt to be used multiple times as it does not lose its strength. Limited durability as long as the walls are protected from rain/wind erosion with a roof overhang and plaster the wall.

The filling material used in earthbags can be recycled for new buildings or for garden use after the building is demolished or no longer needed. A house built with rammed earth technology has excellent thermal properties. During the day, it is cool inside, while at night it is warm.

POLICY CONSIDERATIONS

Little local knowledge and/or understanding.

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RECYCLED PLASTIC BLOCKS

MATERIAL SPECIFICATIONS

Recycled plastic blocks can be categorised into interlocking blocks and standard blocks depending on their usage and are made from recycled plastics waste.
This technology can also be used to make beams and columns that are used as the structural framework of a building.

Standard Dimensions - Differs, set by manufacturer.

APPLICATION - WALLING, FLOORING

- Load bearing for single story buildings.

GENERAL DESCRIPTION

In general, this is a viable option as the bricks are made from recycled plastic which reduces plastic waste.

A distinction can be made between factory-made compressed plastic bricks and hand-made 'eco-bricks'.

Factory-made bricks are more durable and their interlocking nature makes them very easy to install with little expertise needed.

Locally-made bricks offer another way of recycling plastic waste, by stuffing mixed flexible plastic waste into bottles, which could be suited to a rural setting.

EMBODIED CARBON

Although virgin plastics have a high carbon footprint, the raw material, in this case, is recycled, which lowers embodied carbon.

Depending on the type of brick, they can be produced locally, however, if factory-made bricks are used in rural areas, transportation has to be taken into consideration. Furthermore, energy used in heating and compressing the plastic should be accounted for.

PRODUCTION IMPACTS

Assembly of the interlocking bricks doesn't require any specialised labour, and only a few labourers are needed, consequently, hiring local workers can boost the local economy.

The production of the bricks from recycled plastic uses fewer resources and does not entail the same toxicity or production of virgin plastic.

The demand for, and the collection of plastic waste, creates an additional local employment stream. It can be argued that the local environment benefits too, by reducing waste plastic that would otherwise end up in the local ecosystem.

The material doesn't undergo chemical treatments that would be harmful to health. It's also a completely thermo-acoustic material, meaning that it has high levels of thermal and acoustic insulation, making it suitable for any climate and is also fire resistant.

EQUIPMENT & SKILLS REQUIRED

Basic masonry skills, which are readily availbale and no equipment, is required since they are purchased from the manufacturers or distributers.

REUSABILITY & RECYCLABILITY

It is possible to reuse interlocking factory-made blocks if the wall is dismantled, and theoretically the locally-made bricks too. Since the bricks need to be clad externally, the plastic is not exposed to UV light which causes material degradation.

Plastic can only be recycled 2-3 times in general so assuming that constituent plastic is already recycled, there is less scope for further recycling

POLICY CONSIDERATIONS

New in the market. Would require KEBS approval for recognition as a durable building material.

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TIMBER: CROSS LAMINATED

MATERIAL SPECIFICATIONS

A CLT panel consists of several layers of kiln-dried timber boards stacked in alternating directions, bonded with structural adhesives, and pressed to form a solid, straight, rectangular panel. CLT panels are sanded and do not require any additional plastering or finishing.

Standard Dimensions - Differs, set by manufacturer.

APPLICATION - WALLING, FLOORING & CLADDING

- Multistorey / highrise (over 10 floors) as integrate columns or wall panels in structure.

GENERAL DESCRIPTION

Sustainably sourced timber is a very good option environmentally, as it is a natural and carbon-negative material with low production impacts. However, to use timber as a sustainable construction material at commercial scale there is a critical need for improvements in the Kenyan forest management/protection sector. Currently, timber supply in the wider East African region is more viable compared to Kenya.

Design, engineering, and construction knowledge are also key to ensuring robust designs that are durable and require low maintenance.

EMBODIED CARBON

Timber is an excellent material option carbon-wise, as trees naturally sequester more carbon from the atmosphere than they emit, and it is stored when used in durable products.

Carbon emissions are also avoided when using timber compared to concrete or steel. Some carbon is emitted from sawmilling and other processing, but still far better than other materials due to the forest carbon sink effect.

PRODUCTION IMPACTS

If sourced from sustainable, properly managed agroforestry plantations (or smallholder agroforestry lots), then timber is generally a good option for the environment. It may also indirectly alleviate the deforestation of natural forests (though we should be careful not to draw too direct a link here as there are many other complex factors at play).

Timber is a renewable resource as harvested trees can be regrown. It's also circular - waste from the log when sawn can be chipped for other products and the sawdust can be used as a biofuel to power the sawmill, etc.

From a biodiversity perspective, forestry is generally like any other crop - it's a mono-culture and so does not directly promote biodiversity. Treated wood (e.g. CCA - Chromated copper arsenate) is chemically toxic and should be avoided if possible, although sometimes it is necessary for certain applications (e.g. to prevent termites, although other design solutions can also be used here).

Social impacts are strong - any landowner or renter, even smallholder farmers, can plant trees for harvest, making it a very accessible, inclusive, and democratic renewable resource.

EQUIPMENT & SKILLS REQUIRED

High skill requirements needed & high production investment as inputs are not currently available. It is completely new to Kenya and workforce will need to be trained for particular projects.

REUSABILITY & RECYCLABILITY

Wood products can be reused or recycled to create new products like MDF boards. Used wood can also be burned to create clean energy.

If planned properly, CLT panels can also be reused or recycled. If recycled, it can be processed into wood chips or sheet wood products.

POLICY CONSIDERATIONS

Need a sustainable forestry framework so that Kenya can create its own material inputs. Currently only options are to import from Uganda, Tanzania or South Africa

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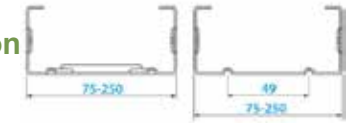
LIGHT GAUGE STEEL (LGS)

MATERIAL SPECIFICATIONS

Light-gauge steel, is where a thin sheet of high grade steel is cold-formed into different sizes and shapes for construction. LGS is less bulky than structural steel and less heavy than concrete. In walls, light gauge steel frames can be infilled with various different panels.

Standard Dimensions - Varies based on use case



APPLICATION - WALLING & FRAMING

- Load bearing for single story buildings.
- As an Infill for multi-story buildings.
- Used both in urban and rural arears.

GENERAL DESCRIPTION

Light gauge steel (LGS) construction is similar to wood-framed construction in principle - the wooden framing members are replaced with galvanised thin cold-formed steel sections.

Steel has the highest strength-to-weight ratio compared to any construction material, which makes it a very durable material with a long lifespan and little to no maintenance. Depending on what steel is used, it usually has a height restriction, but for a single-storey house, it's viable. As steel easily loses its strength in fire, it must be protected with fire rated sheeting. It also has low soundproofing properties.

EMBODIED CARBON

The steel industry is a big carbon emitter, which accounts for the high carbon score of LGS. However, the fact that thin sections of steel are used helps to mitigate this.

Although it has high embodied carbon, LGS allows for faster and cleaner construction as all parts are prefabricated before going on site, minimising material wastage.

Given that LGS sections are lightweight, transportation and installation are easier as no heavy machinery or tools are needed, lowering energy consumption on site.

PRODUCTION IMPACTS

Steel production requires the extraction of iron ore, which is very energy intensive and leads to the production of air and water pollutants, such as heavy metals and acid. Large amounts of coke, are also required, which releases toxic and carcinogenic air pollutants, as well as toxic wastewater.

The impact of the cement production for the fibre cement cladding has been discussed elsewhere with other cement-based materials

EQUIPMENT & SKILLS REQUIRED

High skill level, some uptake in Kenya but workforce needs to be trained for particular projecs as limited trained workers available.

REUSABILITY & RECYCLABILITY

Steel is a very durable material, and corrosion is not likely; modular LGS structures can be viably disassembled and re-used. Wall partitions can be easily altered and repositioned internally to accommodate new uses.

It's also very recyclable after use, as it can be sold as scrap and recycled into more steel products.

POLICY CONSIDERATIONS

New concept - the earlier pricing for the technology has been affected by rising steel prices, so it is currently less affordable than when previously introduced. Consider incentives to support this technology's viability.

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ALUMINIUM FORMWORK POURED CONCRETE

MATERIAL SPECIFICATIONS

Aluminium formwork enables the concrete structure of a building to be cast in place at the building site. Typicaly, the steel reinforcement, concrete panel placement and mechanical and electrical conduits are also integrated into the formwork design.

Standard Dimensions - Manufacturer and Project dependant

APPLICATION - WALLING & ROOFING (SLAB)

- Multistorey / highrise (over 10 floors) as integrated walling structures.

GENERAL DESCRIPTION

Aluminium formwork has the benefit of reducing time and costs on builds, for in-situ poured concrete construction.

The formwork can be produced mainly from recycled aluminium and it can be reused for other projects. It is generally not suitable for smaller buildings - more so for high-rise buildings where speed and quality can be maintained at a high level. It's also associated with high costs, as the upfront investment is big, and the initial setup of the formwork is time-consuming.

EMBODIED CARBON

The raw material for aluminium formwork is recycled aluminum, so there is no need for virgin material extraction, which lowers the carbon footprint. It's also lightweight and doesn't need heavy machinery on site, which lowers emissions.

However, ultimately the construction material being used is concrete, so the same comments apply as for other concrete based products such as hollow concrete blocks or the Kwango Kwaku panels.

PRODUCTION IMPACTS

The process of transforming raw bauxite into aluminum is very energy and water intensive as it is a stable compound.

Furthermore, bauxite is surface quarried, which adds to its ecological impact at the point of extraction. The production of the formwork is highly-skille so can only occur in a factory setting.

Cement is corrosive and generally working in the production of cement products is not a healthy occupation, particularly due to the presence of silica dust.

Concrete buildings have a lower thermally insulative ability than some other materials such as timber and so may not be ideal for thermal comfort but may be suitable in climates where a high thermal mass is required.

Acoustically they generally perform well due to their mass.

EQUIPMENT & SKILLS REQUIRED

High skill level, some uptake in Kenya but workforce needs to be trained for particular projecs as limited trained workers available. Can be purchased in more mature markets, and can also be rented. There is limited formwork available for rent in Kenya.

REUSABILITY & RECYCLABILITY

The formwork is designed to be reused hundreds of times for other projects, and as aluminium is highly recyclable, the raw material can ultimately be recycled, when the formwork is no longer required.

POLICY CONSIDERATIONS

Need to evaluate the carbon factor of concrete materials in Kenya - they may be greener than other countries as 93% of Kenya's energy is made from Green Sources.

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3D PRINTING

MATERIAL SPECIFICATIONS

3D printing manufactures the materials of building elements on site. The most common type is where a robotic arm moves back and forth while extruding concrete, to create the walls of a building.

APPLICATION - WALLING

- Load bearing for single story buildings.

GENERAL DESCRIPTION

3D Printing is faster than traditional concrete-based construction and reduces human error and waste. However, it's more suitable for geometrically complex components, which would be difficult to construct manually and thus allows for more design freedom. High costs are associated with purchasing or renting the equipment and some materials are more expensive to print.

While currently, concrete is the most viable substrate, the use of alternative and more sustainable materials would be a significant advancement in the technology.

EMBODIED CARBON

Although it minimises construction waste and therefore lowers the carbon footprint, it is still a concrete-based construction method and requires the use of large amounts of electrical energy as part of the process.

Transportation and import costs of printers are also very high, not making it feasible and therefore not sustainable for the Kenyan Marke especially for peri-urban and rural areas.

PRODUCTION IMPACTS

3D printing exposes countries and regions especially dependent on low-skill jobs to the reduction of human labour as most of the process is automated. Currently, it's a new technology that is not self-build viable as it requires highly skilled workers which might not be feasible in many parts of the country.

The use of organic printing substrates - for example, wood fibres and bamboo mixed with PLA - can help create more healthy indoor environments.

The sourcing of 3D printers and their parts should also be questioned.

Q: Is the process ethical and what kind of labour is associated with that?

EQUIPMENT & SKILLS REQUIRED

High investment in 3D machinery and required highly skilled workmanship and training.

REUSABILITY & RECYCLABILITY

3D printers can be reused for many years but maintenance is needed and can be costly.

Recycling of the concrete walling is possible by breaking them up and using them as rubble/aggregate, within concrete mixes or as fill material.

POLICY CONSIDERATIONS

Need to evaluate the carbon factor of concrete materials in Kenya as well as the ethical process of using this technology.

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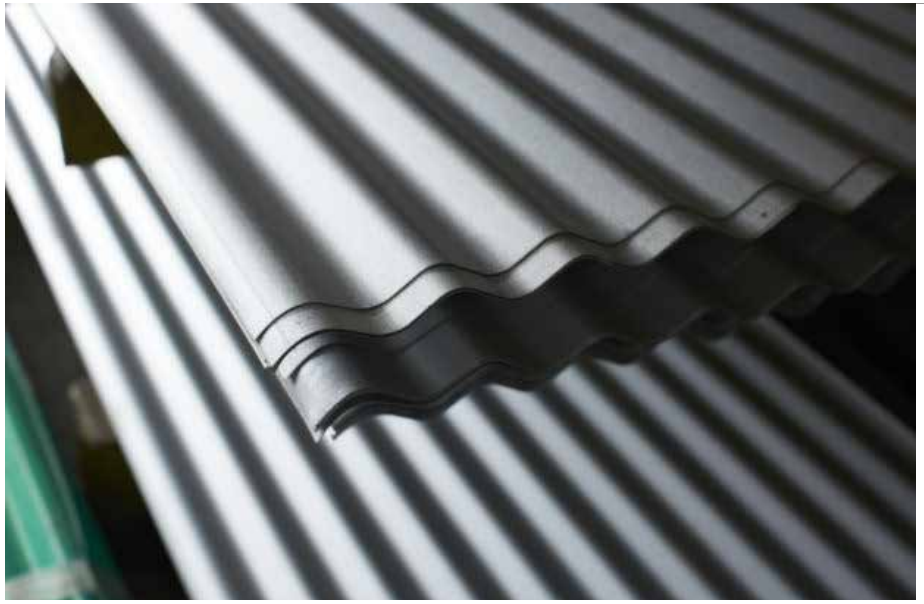
MABATI ROOFING SHEETS



GENERAL DESCRIPTION

Corrugated metal roofing is a metal sheet that is roll formed into metal panels that have a round and wavy appearance.

These panels are then attached to the roof with screws. Corrugated metal is an exposed fastener panel, meaning that each fastener is visible on the panel's surface.

Corrugated roofs are the most economical type of metal roofing. They cost half as much as standing seam metal roofing.

MATERIAL SPECIFICATIONS

These roofing sheets are available in various profiles such as corrugated, box or tile-shaped profiles. They are also available in different colours and thicknesses referred to as gauge. Commonly used gauges are 26-32. G26 for instance refers to a sheet thickness of 0.26mm. Some factories do supply custom cut lengths as per Client's requirements.

Standard Dimensions - W 880mm (760mm EC) x L 2-3m

APPLICATION - WALLING, ROOFING & CLADDING

- Secondary to framing structures, and can be used for both single & multi-story buildings.
- Used both in urban and rural arears.

EMBODIED CARBON

While metal roofing isn't usually considered a "green" option, it could end up saving you money and reducing your carbon footprint in the long term. Metal roofs are increasing in popularity due to their many practical advantages and their ability to lessen an individual's impact on the environment.

Unlike traditional roofing tiles, metal roofing leaves hardly any carbon impact, can last twice as long as tiles, and is more energy efficient.

PRODUCTION IMPACTS

Roofs made of metal are quite energy-intensive to produce. They still look nice and last a long time, and many of them are made in part from recycled materials or can be recycled when they finally reach the end of their useful life.

When talking about eco-friendliness, metal roofing is one of the most sustainable products due to the recycled material content. During first phase production, they have high embodied energies, but once they are installed, they have little carbon footprints, and they can last for long periods of time without replacement. In addition, metal roofs are manufactured with 40% recycled material, and can be 100% recycled when they need to be replaced.

EQUIPMENT & SKILLS REQUIRED

Material is readily available and so is labour.
Estimated 10-30years life span depending on gauge used and location.

REUSABILITY & RECYCLABILITY

Corrugated iron sheets are very durable material, and corrosion is not likely; They can be viably disassembled and re-used.
It's also very recyclable after use, as it can be sold as scrap and recycled into more products. When the time comes to replace the roof, the metals employed in its construction can be recycled again.

POLICY CONSIDERATIONS

Well recognized and approved by authorities.

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RECYCLED PLASTIC ROOFING SHEETS

GENERAL DESCRIPTION

Plastic roofing is generally a strong, durable and lightweight option, saving money on the roofing structure as well as shipping costs.

Because recycled plastic is used and not virgin plastic, the environmental impact is reduced as it uses waste plastic which would otherwise end up in landfill.

MATERIAL SPECIFICATIONS

Recycled plastic roofing sheets transform discarded plastic into durable, sustainable roofing solutions. By upcycling plastic waste, these sheets cut landfill usage, conserve resources, and lower energy consumption. They resonate with circular economy ideals and commitment to sustainable design, curbing plastic pollution while fostering resource efficiency in the community.

Standard Dimensions - W 880mm (760mm EC) x L 2-3m

APPLICATION - WALLING, ROOFING & CLADDING

- Secondary to framing structures, and can be used for both single & multi-story buildings.
- Used both in urban and rural arears.

EMBODIED CARBON

Although virgin plastics have a high carbon footprint, the raw material, in this case, is recycled, which lowers embodied carbon.

The production is still factory-based and does consume energy and resources, but this would be a fraction of the resources needed to create virgin plastic.

PRODUCTION IMPACTS

The production of the sheets from recycled plastic uses fewer resources and does not entail the same toxicity or production of virgin plastic.

The demand for, and the collection of plastic waste creates an additional local employment stream. It can be argued that the local environment benefits too, by reducing waste plastic that would otherwise end up in the local ecosystem.

The sheets can resist weather extremes even though it's a lightweight material. They offer better acoustic properties - in the rain for example - than comparable metal sheeting. They are also more insulating than metal (although due to the thinness of the sheet, other solutions would be needed to offer substantial levels of thermal and acoustic comfort).

Clear sheets allow for light to be transmitted through the roof, which can be important for daylighting and thermal comfort.

EQUIPMENT & SKILLS REQUIRED

No equipment is required as this product is manufactured by specific upcycling plants. The skills required to use this material will not differ from traditional corrugated roofing sheets as they would be handled with similar experience.

REUSABILITY & RECYCLABILITY

It is possible to reuse the sheets if the roof is dismantled, as it is a durable material.

Plastic can only be recycled 2-3 times in general, so assuming that constituent plastic is already recycled, there is less scope for further recycling.

POLICY CONSIDERATIONS

New in the market..

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Advancing Affordable Housing

The Kenyan National Government has undertaken a proactive approach to mitigate the challenges of housing affordability through the establishment of Appropriate Building Materials and Technologies (ABMT) Centres across the country. These centers serve as hubs for disseminating and training on various construction technologies that enhance housing affordability. Additionally, the Ministry actively evaluates and shares promising international technologies with stakeholders and users, as outlined in the National Housing Policy (Sessional Paper No. 3 of 2016).

The State Department for Housing and Urban Development (SDHUD), under the Government's leadership, has been championing the adoption of Interlocking Stabilised Soil Blocks (ISSBs) technology as a locally appropriate building material. This technology leverages the abundance of local soils and materials, making it suitable for small-scale applications and labor-intensive use. By endorsing ISSBs, the Government aims to bolster confidence among building professionals, practitioners, and homeowners while addressing poverty and housing affordability challenges faced by many Kenyans.

The journey towards this goal began in the mid-1980s and culminated in the early 2000s, involving collaborations between the Housing and Building Research Institute (HABRI) of the University of Nairobi, private sector entities, and other industry stakeholders. The Government's direct involvement in 2004 marked a significant milestone, leading to the implementation of the National Housing Policy for Kenya. This policy embraced ABMT promotion, particularly the adoption of ISSBs, with the aim of improving housing quality and conditions in rural areas.

Key objectives driving the promotion of ABMTs in Kenya, including the adoption of ISSB technology, encompass:

- Reducing construction costs for enhanced economic viability.
- Elevating housing quality to benefit the populace.
- Accelerating construction timelines and delivery.
- Nurturing environmentally friendly construction practices.
- Empowering community members, especially youths and women participating in Hydraform-ISSBS activities, by generating income and fostering social inclusion.

These initiatives reflect the Kenyan Government's commitment to fostering affordable housing solutions while simultaneously addressing socio-economic challenges within local communities.

“These initiatives reflect the Kenyan Government’s commitment to fostering affordable housing solutions while simultaneously addressing socio-economic challenges withing local communities.”

greenthumb Kenya

by

KENYA GREEN BUILDING SOCIETY

BUILD GREEN, SAVE KENYA

Efficient resource management is essential for introducing Appropriate Building Materials and Technologies (ABMTs) (like Interlocking Stabilised Soil Blocks) to local communities. By optimizing resources—financial, labor, and local materials—we can accelerate ABMT implementation across Kenya.

The Kenya Green Building Society (KGBS) plays a vital part in this endeavor. Through advocacy and partnerships, KGBS can raise awareness about ABMT benefits among stakeholders, securing funds and incentives for projects. Additionally, through our knowledge sharing excercises, KGBS will begin training initiatives to empower local builders with ABMT skills, ensuring successful integration into housing projects.

Resource management fuels ABMT adoption, with the Kenya Green Building Society driving progress by promoting awareness and providing essential training for sustainable community development.

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KENYA GREEN BUILDING SOCIETY

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