Sustainable homes

Alternative building technologies for low-carbon affordable housing construction

BACKYARD MATTERS
ENABLING PEOPLE, PLACE & POLICY

ISANDLA
institute

Acknowledgements

Backyard Matters is a partnership initiative between the Development Action Group (DAG) and Isandla Institute. The project recognises that backyard housing is a community-driven response to housing shortages for many who fall through the cracks of state programming and unaffordable private rentals. Backyard housing, however, remains a neglected and sometimes invisible sector. The project is aimed at strengthening the backyard rental market and contributing towards well-managed, quality rental stock that provides affordable, dignified and safe housing solutions in thriving neighbourhoods. The project thus advocates for inclusive policy and programming that embraces the voice, needs and agency of backyard residents and landlords as an integral part of the municipal community. Backyard Matters is funded by Comic Relief.

Cover image: 10 x 10 Sandbag housing, Mitchells Plain, Cape Town. Image courtesy of Wieland Gleich – ARCHIGRAPHY.com

Isandla Institute, 2024

admin@isandla.org.za

www.isandla.org.za

ISANDLA institute

Introduction

With over 2.5 million households – equating to one in seven households – registered on the National Housing Needs Register,[1] South Africa faces a housing crisis. The majority of inadequately housed people live in undignified and unsafe informal structures in informal settlements and backyards that fail to meet basic health and safety standards. These dwellings also disproportionately expose people to risks from climate change impacts and other hazards, due to weak structural integrity and other factors, such as proximity to river banks, density, topography and soil conditions. Thus, new or improved affordable housing needs to offer safety, security and dignity whilst protecting people from the elements and climate change impacts.

However, conventional affordable housing is constructed using energy-intensive building materials and processes to reduce construction time costs. Such housing makes unsustainable use of materials and land and is often uncomfortable to live in due to a lack of insulation and poor solar orientation (Infrahub Africa, n.d). The construction sector is currently the largest emitter of greenhouse gases at 37% of global emissions, with the production and use of materials such as cement, steel and aluminium having a large carbon footprint (UNEP, 2023). Globally, on average as much as 30% of the material delivered to a construction site ends up as waste; in South Africa between 5 million and 8 million tonnes of construction waste are generated annually, with only a small fraction reused or recycled (Fitchett, 2022).

A carbon footprint is the total amount of greenhouse gases (including carbon dioxide and methane) that an activity, product, company or country adds to the atmosphere.

Therefore, in the context of climate change, new or improved housing cannot rely on conventional construction materials and methods. Rather, it needs to improve climate resilience and decrease the lifecycle carbon footprint of the materials and technologies used in its construction. Alternative building technologies (ABTs), also known as innovative building technologies[2] (IBTs), can play an important role in this regard.

Lifecycle carbon footprint is the carbon footprint across the lifespan of the material or technology (i.e. from production to manufacturing, use and disposal).

The South African housing crisis cannot be resolved through public housing provision alone. Incremental self-build housing construction is important; not as per the status quo which is evident in the ubiquitous shacks, but *enabled* to ensure dignified and safe housing. This means that the affordability of ABTs needs to be a central consideration, as limited resources prevent households from building or improving their structures. However, as highlighted in Box 1, affordability is a nuanced concept in the South African housing context.

1 *Reply given by the Minister of Human Settlements to a question in parliament (Question NW535) by Ms M Makesini on 20 March 2023 (www.pmg.org.za/committee-question/21399).*

2 *The National Home Builders Registration Council (NHBRC) has taken the position that the term* innovative building technology (IBT) *is more inclusive of innovation in materials and processes. However, this paper takes the position that traditional building materials and methods (e.g. adobe, mudbricks, straw bale construction etc.), while non-conventional in terms of national building standards, may come from indigenous knowledge systems (IKS) and are not the result of recent technical innovation, and therefore the term* alternative building technology (ABT) *better covers the full spectrum of non-conventional building materials and methods.*

Box 1: The affordable housing 'market'

The affordable housing 'market' is diverse, ranging from households with a monthly income of R3 501 (R1 850 for public rental housing) to households earning up to R22 000. It includes households choosing rental housing, either as a temporary preference or a long-term option, and those seeking to own a house through public housing programmes and/or access to finance (e.g. the First Home Finance subsidy). The majority of poor and low-income households in informal settlements will be considered to qualify for a serviced site, with top structure provided through self-build rather than public housing projects. Therefore, the potential changes needed to enable increased use of ABTs in both public and private sector affordable housing construction will need to consider the diversity of this market and the various ways that housing is constructed by various role players: from large public-funded housing projects constructed by established construction companies to small-scale contractors building units for entrepreneurial landlords, to those wanting to self-build incrementally on a serviced site or extend their existing home. It is also important to recognise that housing affordability can mean vastly different things for different households, depending on their income levels.

In addition to the housing and climate crises, South Africa is also facing a crisis of unemployment, particularly among youth, within a context of low and sluggish economic growth. These housing, climate and economic crises are intersecting and give rise to a nexus of imperatives (see Figure 1). While each crisis adds complexity to the other two, there is also great opportunity in this nexus. The urgency of climate change can be used to tackle the housing and unemployment crises. As such, at the heart of the housing – climate – economy nexus sits **affordable, climate resilient and labour-intensive housing**.

Figure 1: Affordable housing – climate – economy nexus of imperatives

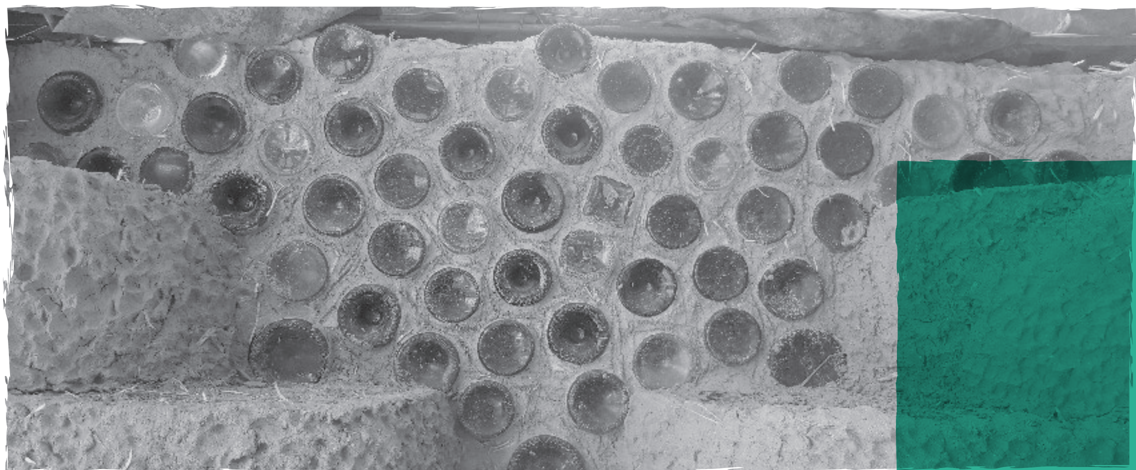
South Africa is currently engaged in a human settlements policy rethink, which includes de-emphasising top structure provision and scaling up serviced site delivery; this rethink should also be a reimagination that includes climate resilience and justice considerations inspired by the Presidential Climate Commission's Just Urban Transition Framework (see Box 2). In other words, we need to envision an alternative future of climate-resilient, low-carbon affordable housing that contributes to jobs and livelihoods and establish the pathways to get there.

Box 2: The Just Urban Transition Framework

Section 3 of the Presidential Climate Commission's *Pathways for a Just Urban Transition in South Africa* (Cartwright et al., 2023), launched in 2023 and referred as the JUT Framework, highlights opportunities for a just urban transition in the energy, mobility, waste management, water and sanitation, spatial and ecological infrastructure functions for which Metros are responsible. It notes that one of the municipal levers that could be applied to scale and accelerate a just urban transition is the regulatory mandate, including by-laws, planning, zoning and building codes that encourage low carbon materials, circular economies and protected ecological buffers, among other tools.

The JUT Framework identifies specific technological opportunities that can be embedded in informal settlement upgrading, and therefore self-build more broadly. This includes combining green technologies (such as insulation, photovoltaic panels and bio digesters) with building materials that are low in carbon, as more sustainable and functional alternatives to zinc panels and concrete foundations, which are currently the norm. The JUT Framework also suggests that the energy efficiency of buildings and labour-intensive methods of installing, maintaining and repairing such components (which should include fire-retardant paints or other materials) can be considered. However, the Framework is unclear regarding the role the state could play in promoting the construction of improved, more resilient homes.

Drawing on extensive interviews, case study analysis and literature review, this paper explains what ABTs are and highlights their benefits over conventional building materials or methods. It proposes a set of criteria to assess the potential of ABTs in contributing to the intersecting affordable housing – climate – economy nexus of imperatives. It then addresses how ABTs have been adopted in South Africa and details case studies where ABTs have been used in affordable housing construction. The paper analyses these case studies against the proposed criteria and distils lessons from this analysis. It identifies barriers to the broader uptake of ABTs, particularly for affordable housing and self-build construction, and concludes with proposed strategies to scale up their use in this regard. This paper is targeted at officials in all three spheres of government, as well as the private sector, civil society and academia, as each has a role to play in promoting and enabling the use of ABTs in affordable housing construction.



Delft Early Childhood Development (ECD) Centre. Image courtesy of City of Cape Town, Architectural Unit.

Defining ABTs

ABTs are defined as non-conventional building materials or methods, i.e. those not covered by national building standards (loosely termed "brick-and-mortar construction"). The National Home Builders Registration Council (NHBRC),[3] an agency of the National Department of Human Settlements (DHS) lists over 25 different ABTs with NHBRC Rational Design Approval[4] / Agrément[5] certification, which are predominantly locally manufactured and with built examples across South Africa. The NHBRC groups ABTs into materials and methods:

Materials

- **Masonry:** Innovative materials and conventional relationships between components (e.g. lightweight concrete blocks; concrete blocks composed of recycled materials)
- **Non-masonry:** Innovative materials and innovative relationships between components (e.g. recyclable aluminium alloy framing with structural insulated panels; sandbag technology; straw / sugarcane bales; adobe; natural / recycled concrete additives; cross-laminated timber)

Methods

- **Masonry:** Conventional materials and innovative relationships between components (e.g.. a moving shuttering system; lightweight plastic formwork mould; or interlocking concrete building blocks)
- **Non-masonry:** Innovative materials using innovative relationships between components (e.g. prefabricated wall panels combined with Nutec board, polystyrene and gypsum board)

3 *The National Home Builders Registration Council (NHBRC) aims to protect the housing consumer and to regulate the home building environment by promoting innovative home building technologies, setting home building standards and improving the capabilities of home builders. (Source: www.nhbrc.org.za)*

4 *Rational design approval requires the assessment of the "fitness-for-purpose" of the elements covered by the design in terms of the performance standards stipulated in the National Building Regulations. Source: NHBRC.*

5 *Agrément South Africa, an entity of the National Department of Public Works and Infrastructure (DPWI), evaluates the fitness for purpose of non- standardised construction products, materials and systems against performance- based criteria. (Source: www.agreement.co.za)*

While recycled content may be used in some ABTs, this is generally not viewed as a separate category of materials and sustainability is not a current criterion in defining ABTs. It is worth noting that re-using existing building materials, a practice gaining in prominence globally, has a long history in South African township building material economies.[6] It is, however, not well-documented and its share of affordable housing construction in South Africa is unknown.

It should also be noted that thermally efficient, low-carbon, structurally sound and inexpensive natural materials and technologies exist, some of which have been used for centuries, including as part of indigenous knowledge systems (IKS). Furthermore, there are a number of potentially more sustainable ABTs that are not being used in affordable housing in South Africa, but show promise. These include cross laminated timber, plastered tyre walls, adobe brick, rammed earth, eco-brick[7] or glass bottle walls, compressed earth blocks and cob construction. Box 3 profiles a South African company whose research and development of alternative technologies align well with the need for low-carbon and sustainable affordable housing construction.

Box 3: Innovation for affordable, sustainable housing

nonCrete, a Cape Town company founded by Stephen Lamb and Andrew Lord, focuses on research, development and use of sustainable, alternative, robust, low-cement building materials and restorative, resource efficient, low-tech, socially inclusive building systems. Emphasis is placed on maximising opportunities for local, gender-neutral job creation, skills development and training, the creation of low-tech building systems, carbon sequestration in the built environment and the restoration of natural eco-systems. nonCrete has developed a new type of biomass-insulated concrete (BIC) that is made with wood chip aggregate sourced from invasive alien plants removed through publicly-funded removal projects involving public employment. The material is affordable, has improved thermal efficiency and acoustic properties and is also fire-proof. nonCrete have developed the *lighthouse* prototype, an alternative to government-subsidised housing, consisting of a single or multi-level house made with BIC. The prototype could create localised job opportunities through the harvesting of invasive alien plants and the development of low-tech, labour-intensive construction practices for local communities (Göswein, V., Silvestre, J.D., Lamb, S. et al. 2021).

nonCrete has also developed the lightweight funicular floor, an alternative method for casting floor and roof slabs. It significantly reduces resource consumption and enables the use of local and sustainable building materials. They also propose an approach to develop a carbon-neutral social housing model, through an inclusive, bottom-up co-design process that directly addresses community needs. The designs can accommodate incremental vertical expansion, allowing homeowners to upgrade their homes when circumstances allow. During the construction phase, emphasis is placed on skills transfer and job creation.

Source: https://noncrete.com

6 *Interview with Kevin Kimwelle, architect, 13 August 2024.*

7 *An ecobrick is a plastic bottle densely packed with unrecyclable waste plastic to create a reusable building block that achieves plastic sequestration.*

Benefits of ABTs

The benefits of using ABTs over conventional building materials or methods can be broadly grouped into three categories: environmental, economic and construction.

Environmental benefits can include:

- Reduced wastage in the construction process;
- Energy efficiency (and other improvements in building performance, which may also increase comfort); and,
- Lower **embodied energy** and related reduced carbon footprint across the whole lifecycle of the material.

Embodied energy is the amount of energy required in extraction, manufacturing and transportation.

Economic benefits can include:

- Lower upfront construction cost;
- Improved long-term feasibility in terms of **lifecycle cost**;
- The potential for localisation of production and value chains (particularly opportunities to strengthen township construction value chains and stimulate job creation); and,
- Potentially improved market value of built structures.

Lifecycle cost is the total cost of constructing, maintaining, and demolishing / dismantling a building over the lifetime of the building.

Construction benefits can include:

- Ease of construction;
- Reduced construction time and labour costs;
- The use of unskilled or semi-skilled labour; and,
- Lower maintenance requirements.

Recent South African research has highlighted that using ABTs such as lightweight concrete blocks and compressed stabilised earth blocks in housing construction offers the potential for an approximately 34–39% energy and carbon emission reduction in comparison to a standard brick and mortar house (Shaw, 2023). The same research noted that ABTs can reduce the quantity of material required to produce the same house typology when compared to brick and mortar. This saving can reduce transportation costs and manufacturing time as less material would be required on site, enhancing sustainability. Therefore, from an environmental perspective alone, ABTs can play an in important role in moving towards low-carbon affordable housing. It is also important to note that the re-use or recycling of existing materials can reduce the carbon footprint of construction, with re-use the best option as the materials are not undergoing an additional industrial, energy consuming process (see the righthand section of Figure 2).

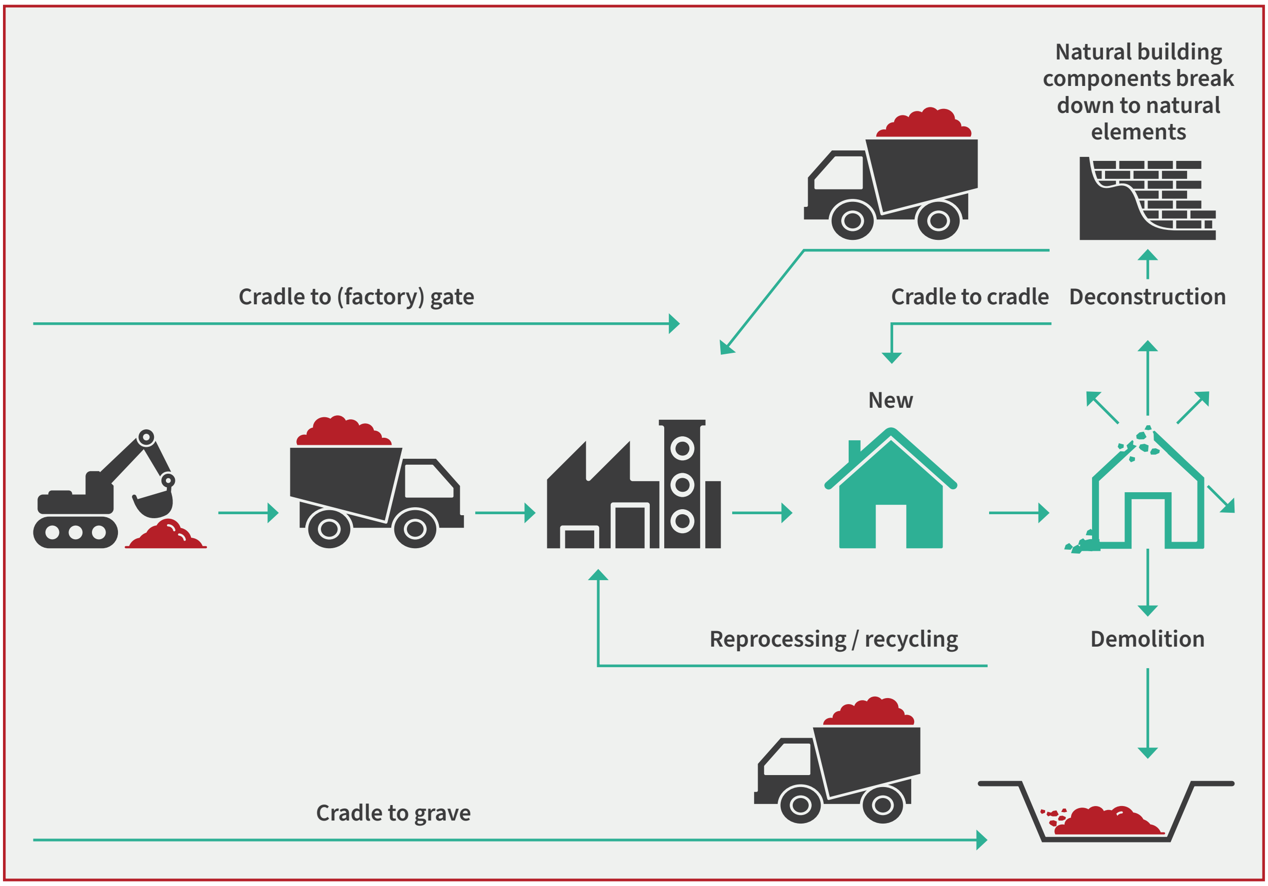


Figure 2: Carbon emissions in the construction material supply chain. (Source: UCL Engineering via Materially Better)

A 2023 UN report highlights the urgent need to decarbonise building materials, proposing the avoidance of extraction and production of raw materials by moving towards a circular economy, shifting to regenerative materials (such as ethically produced low carbon earth- and bio-based building materials whenever possible) and improving methods to radically decarbonise conventional materials (UNEP, 2023, op cit.). Therefore, it is also important to bear in mind the differing carbon footprints of the various ABTs (and categories of ABTs) available, as some may be more or less sustainable than others.

An important point to note is that the relevant South African standards, namely the various Green Building Council of South Africa (GBCSA) guidelines as well as SANS 10400-XA, stipulate building efficiencies at various phases in a building's lifetime, with the focus placed on operational energy consumed; there is, however, a limited set of guidelines regarding the embodied energy in materials and construction systems used in building construction (Shaw, 2023, op. cit.). Figure 3 illustrates the importance of considering both operating and embodied carbon in a structure's life cycle.

A circular economy is a system where materials never become waste and nature is regenerated. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting.

Source: Ellen MacArthur Foundation, undated.

Regenerative materials are made solely from ingredients of biological origin.

To decarbonise is to reduce or eliminate carbon dioxide emissions from a process or in an environment.

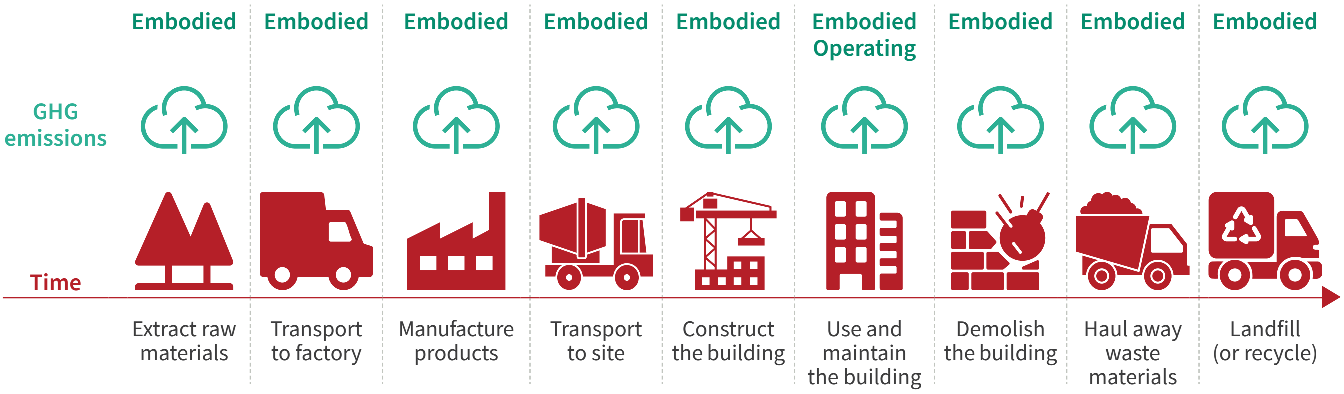


Figure 3: Operating and embodied carbon in a structure's life cycle. (Source: C40 Knowledge Hub)

Only the GBCSA's Excellence in Design for Greater Efficiencies (EDGE) tool begins to address a building's resource inputs and consumption. As this tool has not been applied to ABTs available in South Africa in a systematic way (Ibid.), there is lack of accurate, holistic lifecycle assessment (LCA)[8] of ABTs that could be used to evaluate them for their carbon footprint and thus sustainability, and to provide a basis for incentivisation of those that are more sustainable. Thus, it is currently difficult to identify which ABTs could truly be referred to as sustainable building technologies (SBTs).

In fact, ABTs can lie along a spectrum of sustainability (see Figure 4), from those that are quite similar to conventional building materials (such as concrete products with additives to reduce weight) and generally may still have significant carbon footprints and involve centralised manufacturing, to those ABTs (such as hempcrete, straw bale, adobe construction or the use of waste materials) that may have lower carbon footprints, and potentially allow for more localised material sourcing. It is important to keep this variation in mind when assessing the sustainability factor of ABTs.

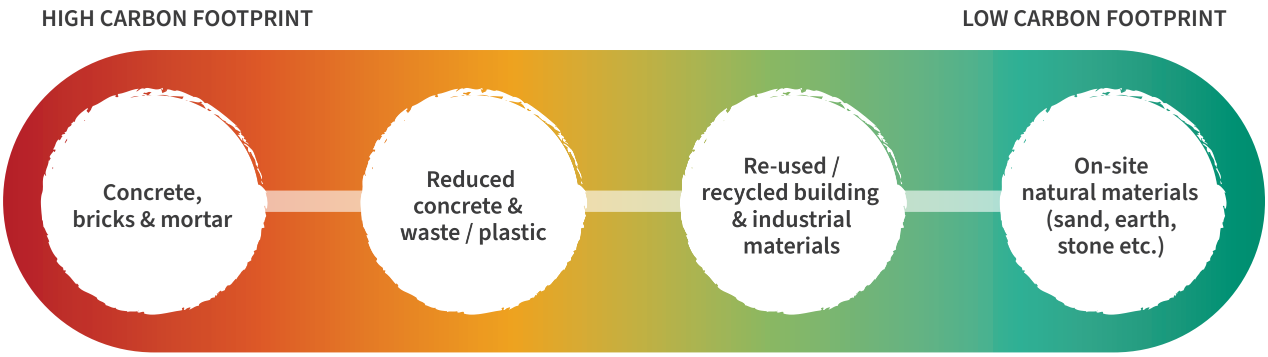


Figure 4: ABT carbon footprint spectrum

8 *The international standards for LCA are dictated by the International Organisation for Standardisation (ISO): ISO 14040-14044:2006. Available: https://www.iso.org/standard/37456.html*

Proposed criteria for low-carbon and sustainable affordable housing construction

It is argued that ABTs can be an effective response to the need for affordable housing, climate change and unemployment. For this to be the case, however, ABTs need to adhere to certain characteristics. The following criteria (partly inspired by the JUT Framework) are proposed for performing a high-level assessment of ABTs to establish which are potentially lower in carbon footprint and more sustainable (and could be referred to as sustainable building technologies or SBTs), have greater socio-economic benefits and are better suited to affordable housing construction – and thus have a larger impact on the affordable housing – climate – economy nexus.

Sustainability:[9] relates to the ABT's assumed lifecycle carbon footprint,[10] its durability, any re-use / recycling of materials and (other) waste reduction (e.g. plastics).

Local environmental suitability: considers local physical factors and environmental conditions to determine whether the ABT is appropriate for that context.

Localisation: refers to whether the ABT consists of locally sourced and / or produced materials.

Job creation: includes both the labour intensity associated with the material sourcing and manufacturing of the ABT and the employment opportunities inherent in local housing construction value chains, specifically through the use of local labour.

Affordability: relates to both the cost to access or purchase the ABT and the maintenance cost.

Accessibility: refers to how easy the ABT is to access or purchase and learn to build with.

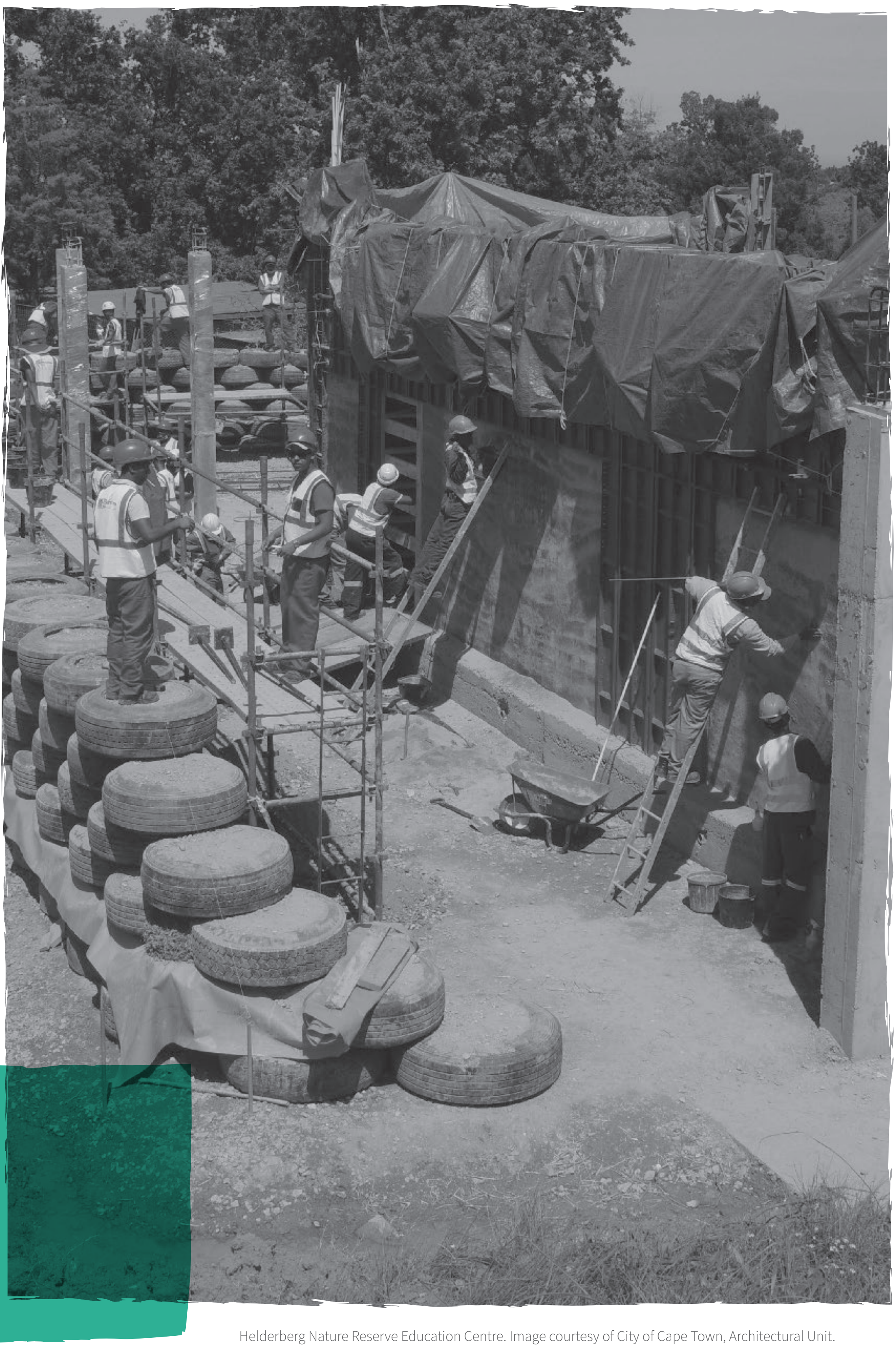
Social acceptability: relates to the level of social acceptance by beneficiaries / community members

Incrementalism / multi-storey construction: considers the extent to which the ABT allows for incremental augmentation of a new/existing structure (whether built with the same ABT, another ABT or bricks and mortar) and how suitable it is for constructing a multi-storey building or adding additional storeys after initial construction.

In the next section, these criteria are applied to evaluate a selection of case studies where ABTs have been used in affordable housing construction, to derive insights with regard to upscaling and the changes required to improve the uptake of low-carbon and sustainable ABTs.

9 The term 'sustainability' is used in this paper as a synonym for embodied energy and life-cycle carbon footprint, as these latter terms are not as well understand by the general public as the former. This criterion only relates to the materials and methods used in construction, not other 'greening' aspects of a structure or project, such as the installation of solar panels, etc.

10 It is important to note that no standardised and widely adopted life-cycle carbon (LC) assessment methodology current exists in South Africa to assess ABTs.



Helderberg Nature Reserve Education Centre. Image courtesy of City of Cape Town, Architectural Unit.

Uptake of ABTs in affordable housing to date

In recent years, ABTs have been used in affordable housing construction in NGO-led projects, state-subisidised housing projects and private sector initiatives. However, many of these have been pilots and/or at a small scale. Despite the benefits and potential of ABTs, broader use in public and private sector affordable housing construction, and particularly incremental self-build housing construction, has been severely limited. In trying to understand why this is the case, this paper reviews a number of case studies, complemented by interviews with a range of stakeholders. Ironically, and because of a number of barriers related to the development and use of ABTs, some ABTs intended for addressing the needs of lower income housing have had limited uptake at this end of the market, with more uptake among higher income households.

While ABTs haven't yet taken centre stage in public housing projects, it is worth emphasising that the public sector is a significant financier and provider of all forms of public infrastructure. In particular, it plays a critical role in social and community infrastructure provision, where it has tried to promote the use of ABTs and their public acceptance. For example, ABTs have been used, albeit at a limited scale, in the construction of new public facilities, such as schools, libraries and other community facilities. Examples of these are the OR Tambo Environmental and Narrative Centre in Ekurhuleni (Holmes, 2013), the Manenberg Housing Contact Centre (Specifile. n.d.), Delft Early Childhood Development (ECD) centre (Roux, 2024b) and Helderberg Nature Reserve Education Centre in Cape Town (Roux, 2024a). While these are not housing projects, such interventions are critical in creating a demonstration effect, sparking innovation and facilitating social acceptance.

The next section summarises nine case studies, including the ABT used, how the project was initiated and the process followed, what the ABT construction materials and/or methods entail and what the benefits of the respective ABT are. Other information relates to the role of communities in choosing, producing or paying for the ABT, how the project/initiative was funded and key challenges encountered and lessons learnt. Each case study is evaluated against the criteria identified earlier.

CASE STUDY 1

Sandbag housing

(1) Design Indaba 10 x 10 Sandbag housing initiative
(2) UBU Sandbag housing

Location

(1) Freedom Park, Mitchells Plain, Cape Town

(2) Philippi, Mshini Wam and Imizamo Yethu, Cape Town

Project date

(1) 2007–2009

(2) 2012–present

ABT utilised

Sandbag and ecobeam

Funding source

(1) Design Indaba

(2) Donor funding, self-funding, public and private funding

Short description

(1) Ten teams of South African architects were paired with international designers to design attractive housing that fitted within the government housing subsidy and complied with building standards. The design by Luyanda Mpahlwa of MMA Architects was used in the construction of 10 houses in Freedom Park. These houses were given to local families who had previously been living in nearby shacks.

(2) In 2014 UBU entered the Better Living Challenge, run by the Western Cape Government and the Craft and Design Institute and won the public vote for their sandbag and ecobeam proposal. Power Construction donated the concrete raft foundation and work started in May 2015 on the incremental "Process" house in Philippi. The intention was to develop the process in conjunction with community members. The project took 2.5 years and lessons were learnt and applied to subsequent projects in Mshini Wam and Imizamo Yethu.

Summary of ABT construction and benefits

The house frame is constructed using ecobeams (composite of a steel lattice and 38mm timber battens) and the walls are built from polypropylene sandbags filled with local sand. The sandbags are covered with chicken wire and then plastered over.

Benefits include thermal and acoustic efficiency; fireproof; bullet proof and not subject to rising damp issues. Agrément certified.

Community engagement / involvement or contribution of money or labour

(1) Recipients contributed labour by filling sandbags

(2) The homeowner can be involved in the design and trained in the building technique to be involved in building on site.

Challenges encountered and lessons learnt

(1) Cost constraints forced a few changes and omissions in the final products, such as the terraces. The provision of serviced, well insulated homes significantly improved the lives of the inhabitants. The double storey (52sqm) design allowed for more people to be accommodated on the 27sqm building footprint and for remaining spaces between houses to be used for food gardens or small enterprises. The cost was less than the government housing subsidy for construction of the top structure.

(2) Clients/beneficiaries, initially unsure about the technology, spend 1 day in training and quickly learn and come to appreciate it. The process and cost to obtain and maintain certification has been an obstacle. Social acceptance of the technology is increasing.

Sources: *UBU. n.d. FAQ. Available at: https://www.ubu.bz/faq; Damons, M. 2022. Innovative double-storey housing project for Khayelitsha. GroundUp. 21 November 2022; Johnson, M. 2014. The Sand Bag House by MMA Architects In Freedom Park, South Africa. Living Spaces; Sustainable Development Network. n.d. Sustainable Neighbourhood Design Manual. Chapter 3; Adetooto et al. 2022. Strategies to promote the acceptance of sandbag building technology for sustainable and affordable housing delivery: the South African case*

Criteria

Sustainability: No bricks or concrete are used and the construction process has a small carbon footprint as it mostly happens on site. Recycled sandbags can be used, diverting waste from landfill. Sand is often available on site. The sandbags provide high thermal insulation, which moderates indoor temperatures and reduces the need for energy-intensive heating or cooling.

Local environmental suitability: The method is suited to many local environmental conditions, and many types of sand can be utilised.

Localisation: Sand is sourced either on site or locally. Ecobeams are produced by UBU in Cape Town; there are no other construction companies currently making use of this technology in South Africa. Localised production of ecobeams would be possible.

Job creation: Sandbags and ecobeam technology is lightweight, labour intensive and requires on-site labour rather than expensive machinery to assemble. This creates multiple opportunities for employment and skills development within the community.

Affordability: The current cost of sandbags and ecobeams is comparatively low (about 40% cheaper than conventional brick building) – single storey home on a level ground roughly between R5,000–R6,000/sqm. Maintenance costs are low and sand can be sourced locally. It offers fast construction speed, saving time and money.

Accessibility: The construction method is provided as a paid service by UBU, an NGO based in Cape Town, which also manufactures the ecobeams and sandbags. There are no other construction companies currently making use of this technology in South Africa.

Social acceptability: Sandbag technology has been used to build various types of structures in South Africa, including low-income residential dwellings, as well as public facilities such as schools. Despite the advantages and benefits of sandbag technology, the level of social acceptance is quite low, but growing.

Incrementalism / multi-storey construction: Sandbag and ecobeam technology involves a framework, can be used to build incrementally and therefore allows for self-build. UBU has introduced concrete ring beams and columns to enable construction of a second storey.

CASE STUDY 2

Urban Think Tank Empower (UTTE) Empower Model (a collaboration with Ikhayalami NPO)

Location

BT Soweto, Site C, Khayelitsha, Cape Town

Project date

2014–present

ABT utilised

The structures are made of hollow-core concrete blocks, timber and corrugated iron sheets

Funding source

90% of project funding came from Swiss Re, a reinsurance company

Short description

UTTE worked closely with community representatives to respond directly to existing community conditions in developing the pilot development design. This first community has now been completed, with 72 informal structures replaced with 72 new homes (resulting in no displacement), a public open space and shared community centre with socio-economic benefits for over 400 beneficiaries. There are 6 distinct housing typologies.

Summary of ABT construction and benefits

The modular design allows for 10 different unit sizes to accommodate a variety of layouts suited to specific resident needs. This approach acknowledges family diversity, future aspirations of residents and alternative spatial requirements, e.g. shops, restaurants or daycare centres. The unit design follows a core and shell principle. The core comprises eight standardised functional components, while the shell demarcates the unit sizes as selected by the residents according to their family size, household income, spatial requirements and general aspirations. This allows the design to accommodate a range of needs, while maintaining unit affordability and a highly efficient site layout. The two-story unit provides both spatial efficiencies through increased site density, but also thermal comfort to the living spaces, as warm air rises to the high ceilings of the second floor and is expelled. Fire risk is addressed via concrete block walls between the units and non-combustible surface finishes in the kitchen area. The units are fireproof and water-resistant.

Community engagement / involvement or contribution of money or labour

Each family pays 10% of the cost, mostly through microfinance loans, with the option to repay between 36 months to 60 months. Monthly instalments range from R300 to R1,300.

Challenges encountered and lessons learnt

The project required community education, professional humility, local authority generosity and NGO facilitation, with co-production with the community and negotiation being integral.

Lessons are that future projects must involve:

- Extensive mapping and community engagement
- Building compliant structures incorporating residential and commercial opportunities
- Increasing density
- Optimising services
- Providing shared community facilities
- Public open space and landscaping to improve the quality of the environment
- Developing renewable energy solutions
- Offering skills development opportunities
- Creating food farms.

Sources: *Low, I. 2018. Family business: Empower Shack in Khayelitsha near Cape Town, South Africa by Urban-Think Tank and ETH Zurich. Architectural Review. 14 May 2018; UTTE. n.d. Building 1000 homes; Interview with Benjamin Kollenberg, UTTE, 26 July 2024*

Criteria

Sustainability: While the structures are constructed from hollow-core concrete blocks, timber and corrugated iron sheets, which have significant embodied carbon, this is less than a conventional brick and mortar BNG house.

Local environmental suitability: The method is suited to different local environmental conditions.

Localisation: The materials can be sourced at local building material suppliers, but may not be produced locally.

Job creation: Provides work opportunities and supports sustainable economic activities through communities. Strengthens existing social cohesion and empowers residents.

Affordability: The total cost (2022) to build the smallest 42.5sqm house model was about R230,000, R350,000 for a middle-sized house and R480,000 for the largest 80 sqm houses.

Accessibility: The construction method is provided as a paid service by UTTE and Ikhayalami, an NPO based in Cape Town. The materials are all easily available via building material suppliers.

Social acceptability: There is a high degree of social acceptance of the construction and design method within the beneficiary community.

Incrementalism / multi-storey construction: The construction method and design allows for flexible adaption of internal spaces, as well incremental augmentation. The model is premised on multi-storey construction.

CASE STUDY 3

Diepsloot People's Housing Process (PHP) Housing Project

Location

Diepsloot, Johannesburg

Project date

2012

ABT utilised

Various Saint-Gobain products, combined with traditional methods

Funding source

Housing subsidy grant funding, complemented by private sector funding (Saint-Gobain)

Short description

Habitat for Humanity, the Gauteng Department of Local Government and Housing (PHP Directorate), the City of Johannesburg, and the Diepsloot community came together to build 40 homes (of 51.8 sqm) in the area. Saint-Gobain contributed approximately R4.7 million and 300 contributors worked an average of eight hours per day to complete the project. Saint-Gobain's approach was to identify those households that qualified for a National Department of Human Settlements housing subsidy and those currently living on a serviced site (with access to water, sewage and electricity).

Summary of ABT construction and benefits

Various Saint-Gobain products were combined with traditional methods (bricks and cement for exterior walls and siding). Gyproc plasterboard was used for ceilings and interior walls, Isover glass wool for insulation and Gypframe for metal framing.

Community engagement / involvement or contribution of money or labour

Community members were involved in the project via the People's Housing Process (PHP). They were involved in building or managing the building of their own homes, supported by a support organisation (Habitat for Humanity).

Challenges encountered and lessons learnt

The ABTs used deliver greater safety and better thermal comfort in all seasons than conventional building methods. They can reduce the typical electricity bill for such a home by up to 35 per cent.

Sources: *Saint-Gobain. n.d. Improving housing conditions in South African townships; NHBRC. 2020. IBT Dynamic Database Spreadsheet B*

Criteria

Sustainability: The structures combine bricks and cement, with plasterboard, glass wool and metal framing. So the materials all have significant embodied carbon.

Local environmental suitability: The materials are suited to different local environmental conditions.

Localisation: The materials are not made locally, but in factories in Ekurhuleni (distributed nationwide).

Job creation: The materials are made in factories in Ekurhuleni (distributed nationwide). They have low manufacturing labour intensity. However, they may have some benefits to local housing construction value chains and the use of local labour, as they are widely available and utilised.

Affordability: The materials are comparatively affordable in relation to conventional building materials (currently Gyproc is roughly R120/sqm, Isover is roughly R100/sqm and Gypframe is roughly R25/m).

Accessibility: The materials are available nationwide through building materials suppliers.

Social acceptability: The materials are widely used and have a degree of social acceptance.

Incrementalism / multi-storey construction: The materials are suitable for incremental augmentation, as well as multi-storey construction.

CASE STUDY 4

Greenville Breaking New Ground (BNG) Housing Project

Location

Fisantekraal, Cape Town

Project date

2016–present

ABT utilised

Benex Masonry Building System

Funding source

City of Cape Town

Short description

The project is a collaboration between the City of Cape Town and Garden Cities NPC, a residential development company. With a budget of R163 million, the project aims to provide affordable and eco-friendly housing for over 1,000 families. Beneficiaries are chosen in line with the City's Housing Allocation Policy and Housing Needs Register.

Summary of ABT construction and benefits

Benex, an Agrément Certified product, comprises a modular interlocking building system, laid with a thin bed of mortar. It is an economical and lightweight building material that simplifies the installation procedure, accelerating construction, which enabled Garden Cities to hire both trained and inexperienced labour from the surrounding community. Benex provides thermal efficiency, acoustic performance, fire rating protection and simplified construction.

Walls built using the Benex System are waterproof without having to be plastered, thus reducing costs and building time, particularly in the Western Cape where plastering is often delayed by rain in winter, and it takes time to dry for painting to commence.

Community engagement / involvement or contribution of money or labour

Garden Cities hire both trained and inexperienced labour from the surrounding community.

Challenges encountered and lessons learnt

City of Cape Town building control officers have struggled to stop construction of unapproved additions onto newly handed over homes, resulting in safety concerns. In terms of sustainability, non-recyclable plastic waste collected at rugby matches hosted by the South African Rugby Union was processed by the Centre for Regenerative Design & Collaboration (CRDC) South Africa into RESIN8 (an eco-aggregate that can be added to concrete blocks); this was added to modified Benex building blocks to construct a demonstration house at the Greenville BNG Housing Project. The CRDC model diverts non-recyclable plastic waste from landfill.

Sources: *City of Cape Town. 2023. Innovation and progress at City, partner's R163m Greenville housing project; Garden Cities. 2023. Innovation and Resilience – Trademarks of Garden Cities' Archway Foundation; Benex. n.d. Residential Applications; Green Building Council South Africa (GBCSA). 2023. Edge Green Building Certification – Project Update for Greenville Fisantekraal; Engineering News. 2022. Another "green" milestone for property developer and its supply chain. Engineering News. 16 September 2022; Email correspondence with Tony Marsh, Benex South Africa, August 2024*

Criteria

Sustainability: The blocks are made from concrete and thus have significant embodied carbon. However, the blocks are up to 60% lighter per metre of wall than most other masonry products, which means that less fuel is used in transport. Multiple deliveries of brick or concrete blocks plus additional deliveries of sand and cement are also avoided. The Benex material can be accurately cut with a saw and the waste from the cuttings is returned to the factory for recycling. The disposal of building waste is expensive, so this is a significant saving to the contractor.

Local environmental suitability: The materials are suited to different local environmental conditions.

Localisation: The Benex South Africa factory is in Cape Town.

Job creation: The simplified installation process allows for contractors to hire both trained and inexperienced local labour.

Affordability: The houses are currently priced between R649 000 to R800 000 for two or three bedrooms. The homes fall within the government FLISP (Finance Linked Individual Subsidy Programme).

Accessibility: Benex blocks are only available via the Benex South Africa factory in Cape Town.

Social acceptability: The finished walls are indistinguishable from conventional walls (only lighter), so the social acceptability is high.

Incrementalism / multi-storey construction: As the blocks are similar to conventional concrete blocks, they are suitable for incremental augmentation and multi-storey construction.

CASE STUDY 5

LIFT (Lightweight, Improved, Fire-safe, Timber-frame) technology (part of Iqhaza Lethu project) by Project Preparation Trust

Location

Parkington, Havelock and Ezimbeleni informal settlements, Durban

Project date

2020–present

ABT utilised

Double story, 35sqm lightweight wood frame structure with pile foundations, metal cladding and insulation

Funding source

Co-funded by the European Union, eThekwini Municipality and Project Preparation Trust

Short description

150 units to be built in 3 informal settlements. It is an alternative typology developed in collaboration with HSRC and team of architects and engineers according to rational design principles. In informal settlements, layouts need to be reconfigured to make space for essential services, public space and facilities. Due to the lack of well-located land and to avoid harmful relocations, building upwards can effectively double (or even treble) the available floor space for housing and free up open space. Conventional multi-storey walk-ups are not viable due to high unit costs and, in Durban, the steep terrain of some settlements. The LIFT approach is incremental and driven by the needs, knowledge and practical experience of residents. Allows for low-cost self-build housing construction.

Summary of ABT construction and benefits

The LIFT technology is a low-cost, lightweight, double-story structure consisting of a timber frame with extensive bracing making the units rigid and stable in severe weather events; micro-pile foundations which minimise site disturbance; suspended timber floors; galvanised metal exterior cladding and gypsum board internal cladding with mineral wool insulation in-between; with internal timber stairs. Eight main sub-types of different sizes were developed, ranging from 15sqm to 45sqm, with single and double story variations. The objective is to imbed within communities a different way of building for themselves (either organically or with PHP support). Design criteria include cost, structural integrity on steep slopes, the use of materials familiar to local builders, materials availability from local suppliers, and adequate fire and thermal performance. The house is compliant with timber frame structure building standards (SANS 10082), is engineer- and fire-safety-certified.

Community engagement / involvement or contribution of money or labour

Units are built/assembled on site by local artisans and workers in a PHP-type model.

Challenges encountered and lessons learnt

Reshaping informal settlements is hard without supportive regulations. Incremental upgrading is held back by application of formal building, services and town-planning standards. Consideration should be given to balancing costs with appropriate standards to ensure public safety. Overlay zones could be used to relax national building regulations while encouraging housing investments that follow rational design. Research in Parkington suggests strong community support for trying new approaches to settlement upgrading. Local residents acknowledge the need to spatially reconfigure their settlement and are willing to sacrifice land in the process. Local government could leverage offers to improve tenure and upgrade infrastructure in exchange for local compliance with shared norms and standards, and respect for public property.

Sources: HSRC. 2020. Upgrading dense informal settlements by building upwards? Lessons from Parkington Informal Settlement. Policy Brief; Project Preparation Trust. 2021. Servicing dense, well-located informal settlements and utilising alternative housing typologies - an optimised upgrading approach; Project Preparation Trust. 2022. Innovative servicing, planning and housing solutions for dense, well-located informal settlements.

Criteria

Sustainability: The structures are timber-framed, have timber floors and stairs and make use of galvanised metal exterior cladding and gypsum board internal cladding. Therefore, they have significantly lower embodied carbon than brick and mortar housing.

Local environmental suitability: The method is uniquely (although not exclusively) suited to environmental conditions in Durban.

Localisation: The materials can be sourced at local building material suppliers, but may not be produced locally.

Job creation: The units utilise existing local building skills and are labour intensive, thus creating significant local employment.

Affordability: Approximately R46,000 (excl. labour) for a medium-sized unit (total floor space of 34,4 sqm) in 2020. The costs involved are not out of reach for better-off members of the community, but they would need to be supported with technical expertise and collective planning.

Accessibility: The houses utilise materials which are readily available at local hardware stores.

Social acceptability: The units have been well received by the owners and other residents.

Incrementalism / multi-storey construction: The materials and building methods are generally familiar to residents and local builders making it easier for the units to be replicated in the future by local residents as they improve their own housing over time.

CASE STUDY 6

Bitprop houses constructed using concrete products made with RESIN8

Location

iLitha Park, Khayelitsha and other areas of Cape Town

Project date

2022–present

ABT utilised

Concrete blocks, foundations and floor slabs containing RESIN8 (an eco-aggregate made from non-recyclable plastic waste)

Funding source

Bitprop investor funding

Short description

Bitprop, which partners with township homeowners to develop 4–6 rent-generating flats behind the homeowner's house, started in 2019. In 2022, Bitprop began using concrete products made with RESIN8, which now accounts for around 80% of homes under construction. The construction phase is about 10 to 12 weeks for each project.

Summary of ABT construction and benefits

The Centre for Regenerative Design & Collaboration (CRDC) South Africa processes non-recyclable plastic waste into RESIN8 (an eco-aggregate that can be added to concrete blocks). Concrete manufacturers add RESIN8 to concrete products, and therefore the mix requires less water and sand, reducing strain on natural resources. It also provides superior compression strength, flexibility, fire resilience, thermal resistance and acoustic properties. Bitprop uses concrete blocks containing RESIN8; it is also used in foundations and floor slabs, minimising the consumption of resources during the construction process. Concrete products made with RESIN8 can be up to 15% lighter, with even better insulation properties.

Community engagement / involvement or contribution of money or labour

About 30 to 50 community members are employed in each project.

Challenges encountered and lessons learnt

The township rental market is resilient and the Bitprop model has been successful as 372 rental flats have been constructed with a 15.4% annual return. Strong social relationships among homeowners, tenants and the community have been created. Exclusively local contractors have been employed, and upskilled where needed. CRDC is currently limited by the low demand for RESIN8 for use in concrete products.

Sources: *Daniel, L. 2023. Pollution to solution: Plastic waste put to good use at new Khayelitsha homes. News24. 25 September 2023; Bitprop. 2022. Building greener properties. Available at: https://www.bitprop.com/impact-goals; Interview with Abraham Avenant, CRDC SA, 19 July 2024; Interview with Tashriq Abrahams, Bitprop, 19 July 2024*

Criteria

Sustainability: Non-recyclable plastic waste diverted form landfill is processed into RESIN8, which is then used as an aggregate by concrete product manufacturers as a substitute for quarried and crushed materials. In addition to recycling waste plastic, this process also offsets the environmental impact of quarrying. Bitprop rental flats built with RESIN8 have 64,3% less embodied energy than traditional building methods.

Local environmental suitability: The materials are suited to different local environmental conditions.

Localisation: All materials are locally sourced, keep money circulating in the local township economy.

Job creation: Value and therefore employment is created from non-recyclable plastic waste. Bitprop introduces these materials to township contractors, which is a skill that can be transferred to other construction projects. CRDC collects non-recyclable plastic waste from waste reclaimers, as well as from no-fee schools as part of its "Bag That Builds" plastic recovery programme. The waste collected by pupils is paid for and the schools use the payment towards feeding schemes.[11]

Affordability: The cost (2024) of building Bitprop rental flats with RESIN8 is 3% more than conventional building materials.

Accessibility: Bitprop increases access to well-researched, environmentally responsible materials that aren't typically available to residents of low-income areas. Concrete products with RESIN8 are currently only accessible to order directly from concrete product manufacturers.

Social acceptability: There is a growing degree of social acceptance of the technology among the homeowners and contractors.

Incrementalism / multi-storey construction: The materials are suitable for incremental augmentation, as well as multi-storey construction.

11 This is part of the Western Cape government's iThemba Phakama 4Ps (People, Public, Private, Partnership) project, a collaboration between provincial and national government departments.

CASE STUDY 7

Beira housing project

Location

Beira, Mozambique

Project date

2022

ABT utilised

Hempcrete blocks, airPLAST lime-based plaster and airCOAT lime-based wall coating

Funding source

Funded by the Dutch government in partnership with Empowa, a platform focussing on financial inclusion through the provision of rent-to-own home loans for affordable housing in Africa.

Short description

The houses were designed by a design collective and the Afrimat Hemp team. A local construction company (Casa Real) constructed houses using the Afrimat hempcrete block system and applied airPLAST plastering for finishing. In-situ cast columns were used as the substructure on site, and airCOAT was used as the lime-based paint.

Summary of ABT construction and benefits

The Hempcrete system, launched in 2021, is Agrément-certified and the hempcrete blocks are made from hemp shiv (the chopped woody core of the hemp plant) and lime that is cured in the sun and wind. airPLAST is premixed lime plaster, requiring the addition of water on site. hempPLAST is textured plaster consisting of premixed lime plaster with hemp shiv. The blocks are used as infill blocks that tie into a substructure. The system can be used for internal partitioning and external walls. The ability of hempcrete to easily absorb and release moisture assists with regulating internal humidity, thus maintaining a healthy indoor air quality.

Community engagement / involvement or contribution of money or labour

Local construction company Casa Real employed local labourers from Beira.

Challenges encountered and lessons learnt

The main lesson from the Beira project was the transfer of skills from conventional building methods to bricklayers and plasterers. As demand in South Africa is still quite low, some hemp has to be transported across the country to be processed at the factory in Cape Town.

Sources: Afrimat Hemp. 2023. Beira, Mozambique. Available at: https://www.afrimathemp.co.za/beira-mozambique-2/; Afrimat Hemp. 2023. Why use our Hempcrete Block System?; Afrimat Hemp. 2023. Hemp Block and Hempcrete; Interview with Boshoff Muller, Afrimat Hemp, 18 July 2024

Criteria

Sustainability: The hemp plant is one of the fastest-growing plants. This aggregate in hempcrete absorbs so much carbon during its rapid growth that, even after the energy used in the production of the lime binder, more CO^2 is locked up in a hempcrete wall than is used to build it. Hempcrete may therefore have negative net-carbon emissions. Current hemp transport from production sources to the factory has as significant carbon footprint, but there are plans to localise production when demand allows.

Local environmental suitability: The materials are suited to different local environmental conditions.

Localisation: Afrimat's hemp is partly sourced from small traditional growers in the rural Eastern Cape, with initial processing done on site.

Job creation: Afrimat hopes that governments will put policies in place to allow hemp cultivation, as the supply chain of growing, processing hemp and manufacturing hempcrete blocks can create a significant number of jobs. Hemp production provides an opportunity for a more inclusive value chain in comparison to typical commercial sources of construction raw materials. Afrimat's hemp is partly sourced from small traditional growers in the rural Eastern Cape, with initial processing done on site.

Affordability: Hempcrete blocks cost R295–368/sqm and are slightly more expensive than traditional building materials. However, they save money in other ways, such as reducing construction time by up to 30%.

Accessibility: The materials can currently (2024) be sourced from a small number of building material suppliers, in addition to directly from the company.

Social acceptability: There is a degree of social acceptance of the construction and design method within the beneficiary community.

Incrementalism / multi-storey construction: The materials are suitable for incremental augmentation, as well as multi-storey construction.

CASE STUDY 8

Mbekweni stonehouses

Location

Mbekweni, Paarl

Project date

2005

ABT utilised

Recycled bricks and building rubble, natural stone and sand on site, industrial wood pallets, recycled carpet under-felt, local wood off-cuts and recycled glazing

Funding source

National Department of Human Settlements People's Housing Process funding.

Short description

In 2005, Pauline Houniet of the Western Cape Department of Local Government and Housing motivated to have the Mbekweni housing project unblocked by securing additional funding via the PHP (People's Housing Process). She was able to convince the department to revive the project on the condition that unskilled young people would be employed in the construction process (150 were employed). Houniet was referred via word of mouth to Vernon Collis, a Cape Town architect and engineer using recycled building waste and local materials. The project intended to demonstrate construction of a labour-intensive, low-cost, aesthetically pleasing and energy-efficient eco-home using recycled building materials, while providing affordable housing as part of state-subsidised housing programme and within the housing subsidy budget. Inmates from the nearby Allandale Prison were also trained and involved in the construction process. 350 houses were planned, with 13 houses completed by 2008.

Summary of ABT construction and benefits

The prototype was designed by architect Vernon Collis. The inner walls were built with bricks from a local landfill and the outer long walls were built with natural stone found on site. The side walls were constructed from recycled concrete plaster bricks from Cape Brick. Building rubble was used in the foundation trenches to enhance thermal mass. The ceiling consisted of wood pallets, with recycled carpet underfelt for insulation. Window frames were made from local wood off-cuts, with recycled glazing. Broken slate tiles were used for flooring, and damaged kerbstones for foundations. The approach followed requires less fossil fuel for transport of materials, reduces the amount of construction waste sent to landfill, increases labour and keeps costs low. The inclusion of ceiling insulation and positive solar orientation helps to reduce heating and cooling requirements, while energy efficient lighting further reduces electricity demand.

Community engagement / involvement or contribution of money or labour

Beneficiaries were included in decision-making, ensuring homes reflect their needs and preferences. Some homes have second storeys to accommodate additional family members or rental income opportunities. The homes are positioned to maximise backyard space, to allow for food gardening and other outdoor activities.

Challenges encountered and lessons learnt

Grants and support from provincial and national government were vital to success. It was initiated by a provincial government employee, who was able to establish critical links within government and with the private sector to innovate. A diverse array of actors were involved from various levels of government, architects, private sector funders, contractors, NGOs, youth and local beneficiaries, assisting the learning process. However, only 13 of the planned 350 houses were built as the project was halted due to political and institutional issues.

Sources: Robinson, B. 2009. "Resolving urban poverty and ecological sustainability have nothing to do with one another" – a critique; Infrahub Africa. n.d. Mbekweni stonehouses. Available at: https://www.infrahub.africa/case-studies/mbekweni-stone-houses; Sustainable Development Network. n.d. Sustainable Neighbourhood Design Manual. Chapter 3; Email correspondence with Vernon Collis, architect, August 2024

Criteria

Sustainability: It is environmentally beneficial to recover rubble from demolished buildings and reuse this in recycled concrete bricks. Not only are substantial energy savings achieved in the brick-making process, but building rubble, otherwise dumped in landfills, can also be recycled. Waste materials from industrial processes can be used in housing construction, diverting waste from landfill and creating a more circular economy.

Local environmental suitability: The materials are suited to different local environmental conditions.

Localisation: Transportation costs are minimised or eliminated. However, it is time-consuming to collect, clean and reuse materials.

Job creation: 150 unemployed people from the local area were employed in construction, and a training centre was set-up to upskill young people and inmates in construction techniques.

Affordability: By integrating locally sourced materials with passive design, the Mbekweni stonehouse model provided larger, better insulated homes with a lower energy footprint, for a similar cost as conventional state-subsidised housing (the R60 000 per unit housing subsidy quantum at the time). Some materials were available on site, while waste materials were free, and costs to transport were minimal as they were mostly sourced within a 20km radius. However, additional money had to be raised to train contractors, set up waste streams and waste sorting facilities, etc.

Accessibility: Functioning systems were set up to allow local contractors to replicate the sourcing and processing of recycled materials to produce future houses.

Social acceptability: Through consultations with the community, a design language was developed that took their needs and aspirations into account whilst making use of sound ecological design principles. A local take on aspirational homes was used to create an aesthetic in keeping with the surroundings. A prototype house was built at the start of the project, which the community could see, feel and experience, which has aided social acceptance.

Incrementalism / multi-storey construction: The materials are suitable for incremental augmentation, as well as multi-storey construction.

CASE STUDY 9

Selinah Ncanywa House

Location

Gqeberha

Project date

Late 2020 to early 2021

ABT utilised

Recycled and repurposed industrial waste materials sourced from informal recyclers, local businesses, and car industry.

Funding source

Local businesses and a car manufacturer (corporate social responsibility) and self-funding

Short description

Together with a team of builders and with research support from both local and international universities, in partnership with local businesses and a car manufacturer, and with design support from India and the USA, architect Kevin Kimwelle designed a cost-effective two-bedroom house built from recycled wood, metal and repurposed material for Selinah Ncanywa and her granddaughter. The original home from 1946 was retained and connected to the new structure.

Summary of ABT construction and benefits

The house's frame was made from metal used in collapsible shipping containers from the car industry. Large wooden boxes and pallets also from the car industry were used to create walls, laminated beams and columns. Repurposed metal formed the exterior of the house to provide waterproofing, with interior walls lined with recycled chipboard. Crushed recycled glass was used in the concrete foundation and bottles re-used as paving. The house has an atrium to make use of the natural lighting.

Community engagement / involvement or contribution of money or labour

The house was co-designed with the homeowner and Kimwelle sees himself as a community architect co-creating with communities.

Challenges encountered and lessons learnt

The main challenge was creating a two-bedroomed house built from recycled wood, metal, and repurposed waste material. Kimwelle starts by assessing which waste materials or natural resources were available within a specific project area. Thereafter, he assesses the waste materials, and explores how best to use them. In parallel, he engages with the community, and identifies the skill set required to work with these materials.

Sources: The Insider SA. n.d. Upcycling with community architect, Kevin Kimwelle – A dignity restoration project; CAT Footwear. n.d. Do More For Your Community: Kevin Kimwelle. Email correspondence with Kevin Kimwelle, architect, August 2024.

Criteria

Sustainability: The house is made of almost 95% recycled materials. Materials are diverted from landfill and are sourced within the city limits. This construction method creates value for waste, highlights the value of waste in the built environment and creates a more circular value chain and economy.

Local environmental suitability: The materials are suited to different local environmental conditions.

Localisation: Materials are sourced within the city limits.

Job creation: Kimwelle founded an NGO (Indalo World) for the design and construction of his projects. The house was constructed by him together with artisans he trained and employed, who later became part of the team (8–10 people) working on other projects.

Affordability: The cost of the building at the time (2020) was around R450,000. Building with recycled materials makes this mode of construction significantly more affordable, as some materials are free, and just need to be transported to site.

Accessibility: Systems do not currently exist to allow for easy access to building and industrial waste materials.

Social acceptability: The homeowner has expressed satisfaction with the house and the materials used in its construction.

Incrementalism / multi-storey construction: Reliable supply of the same waste materials used in the house would be required for future incremental augmentation. Designs can allow for incremental augmentation as well as multi-storey construction.

Connecting the dots: ABTs for sustainable, affordable housing

In the absence of a standardised metric that can be used to evaluate ABTs for their carbon footprint (and thus sustainability) and their socio-economic value, the proposed criteria for sustainable, affordable housing offer a useful starting point to review the various case studies and to draw out lessons for their enhanced uptake (as well as for the development and use of future ABTs).

Figure 5 shows how the various case studies perform against the criteria, with red for low, orange for medium, and green for high. The assessment is indicative and based on information in the public domain, rather than a comprehensive evaluation.

	Sustainability	Local environmental suitability	Localisation	Job creation	Affordability	Accessibility	Social acceptability	Incrementalism / multi-storey construction
1. Sandbag and ecobeam technology	Green	Orange	Green	Green	Green	Orange	Orange	Orange
2. UTTE Empower: hollow-core concrete blocks, timber and corrugated iron sheets	Red	Green	Orange	Green	Red	Green	Green	Green
3. Saint-Gobain products, combined with traditional methods	Red	Green	Red	Red	Orange	Green	Green	Green
4. Benex Masonry Building System	Red	Green	Red	Orange	Orange	Red	Orange	Green
5. LIFT technology: wood frame structure with metal cladding	Orange	Green	Orange	Green	Green	Green	Green	Green
6. Concrete blocks, foundations and floor slabs containing RESIN8	Orange	Green	Red	Orange	Orange	Orange	Green	Green
7. Hempcrete block, lime-based plaster and wall coating	Green	Green	Orange	Orange	Orange	Red	Orange	Green
8. Mbekweni stonehouses: recycled building and industrial waste materials and on-site natural materials	Green	Orange	Green	Green	Orange	Red	Orange	Orange
9. Selinah Ncanywa House: recycled and repurposed industrial waste materials	Green	Orange	Green	Green	Orange	Red	Orange	Orange

Figure 5: A high level summary of the performance of case studies against criteria for sustainable ABTs for affordable housing

The case studies highlight the following lessons related to the proposed criteria:

Sustainability

ABTs lie on a spectrum of sustainability (as shown in Figure 4). At the one end are those like the Saint-Gobain products or Benex Masonry Building System that are not sustainable as they make use of concrete, bricks and mortar with high carbon footprints, and further along are concrete products made with RESIN8 that may reduce the amount of concrete used and divert plastic from landfill, but still have a significant carbon footprint. Towards the other end of the spectrum are ABTs such as sandbag and ecobeam construction that make use of local materials with lower carbon footprints, hempcrete that makes use of natural materials, and the re-use of building and industrial waste materials and use of on-site natural materials as the most sustainable. The manufacturing and transport of the various materials significantly impacts their lifecycle carbon footprint, which suggests that addressing manufacturing processes and localising material sourcing and production are important. The more sustainable ABTs make positive impacts on material lifecycles by reducing inputs, diverting waste from landfill or reusing / recycling building and industrial materials.

Local environmental suitability

Many of the ABTs are suited to different local environmental conditions. However, some may be more suitable to certain climatic areas or geographic conditions (e.g. the LIFT technology is uniquely suited to the hilly topography of Durban) or cannot simply be implemented in locales with different topographies, soil conditions or weather patterns.

Localisation

Some of the ABTs can be locally sourced or produced (e.g. sandbag and ecobeam, LIFT technology), or can be accessed via local building material suppliers (e.g. concrete blocks, timber and corrugated iron sheeting or the Saint-Gobain products). However, many of the ABTs are sourced and / or manufactured in disparate locations, often far from where they are made available and used. This increases costs, both in terms of price and carbon footprint, and highlights opportunities for localisation of sourcing and / or production, with the resultant socio-economic and environmental benefits that this could bring. Currently, lack of demand prohibits investment in setting up manufacturing in multiple locations.

10 x 10 Sandbag housing, Mitchells Plain, Cape Town. Image courtesy of Wieland Gleich – ARCHIGRAPHY.com

Job creation

The various ABTs have differing job creation potential. Generally, those that are less sustainable (i.e. greater embodied energy) are also those that have the lowest labour intensity associated with material sourcing, manufacturing and construction. As such, investment in production and uptake of more sustainable ABTs can have a significant impact on employment, especially among low-skilled workers. In contrast, the picture is more complicated when it comes to economic development benefits to local housing construction value chains and the use of local labour. Those ABTs that are more widely available and utilised and those most similar to conventional materials and methods (e.g. concrete blocks, timber and corrugated iron sheeting or the Saint-Gobain products) currently have more impact in terms of employment as they make use of existing local skills or inexperienced local labour. On the other hand, those ABTs that value waste (e.g. RESIN8) create new value chains, thus creating more potential job opportunities (particularly in the case of informal waste collectors) and those using natural materials (e.g. Hempcrete) support growers / processors or the development of new local skills.

Affordability

In terms of affordability and cost, the case studies disprove the perception that ABTs are generally significantly more expensive than conventional materials and methods. The various ABTs are either cheaper or faster (reduced time cost) to build with than conventional materials and methods, or around the same cost, or are not significantly more expensive. Information on maintenance costs was not accessible, so it can be assumed that those ABTs more similar to conventional materials and methods are more widely available and can rely on existing maintenance skills, and vice versa, with the corresponding relative effects on maintenance costs. This is also a result of market dynamics in relation to supply and demand, as those ABTs with relatively higher demand and corresponding greater supply will therefore be cheaper than the reverse.

Mbekweni stonehouses, Paarl. Image courtesy of Vernon Collis.

Accessibility

Some ABTs (e.g. concrete blocks, timber and corrugated iron sheeting or the Saint-Gobain products) are available nationwide through building material suppliers or hardware stores (and rely on existing skills), while others (such as hempcrete or sandbag and ecobeam technology) are only available from manufacturers that may have limited geographic footprints (and may require upskilling). The current lack of reliable systems for sourcing building and industrial waste materials, coupled with the difficulty in sourcing and assessing of on-site natural materials, make these ABTs less accessible – with implications for cost – and require development of expertise.

Social acceptability

The issue of social acceptability appears to be more nuanced. While members of the public may have initial reservations about ABTs, a number of case studies (e.g. hempcrete blocks, the Mbekweni stonehouses and the Selinah Ncanywa House) highlight that post-construction there is a significant degree of social acceptability of these ABTs among homeowners and local residents. There have been similar observations regarding public sector facilities and infrastructure built using ABTs. This appears to strengthen the promise of the demonstration effect and greater public awareness of ABTs and their benefits in improving uptake. The case studies show that taking the needs and aspirations of future homeowners into account in the design process improves social acceptability of ABTs.

Incrementalism / multi-storey construction

The ABTs (materials and methods) in the case studies are all generally suitable for incremental augmentation, although some may require a reliable supply (e.g. building and industrial waste materials, or natural materials) to allow for this. They are also all suitable for multi-storey construction.

In conclusion, ABTs are a 'mixed bag' and their performance against the proposed criteria varies. As shown in Figure 5, those ABTs that generally score higher on affordability, accessibility, social acceptability and incrementalism tend to score lower on sustainability and job creation, and vice versa. However, while performance against some criteria may currently be low, this is not a reason to discard either the criteria or those specific ABTs. One would need to understand why their performance is suboptimal and what can be done to improve performance. For example, it is clear that weak demand hampers innovation and uptake, which could be a function of awareness and knowledge. Similarly, the absence or poor functioning of certain value chains (e.g. building and industrial waste materials) could be a factor, whilst the job creation and skills development aspects of certain ABTs could be further developed.

The lessons above provide clues with regard to how the use of ABTs, and particular the more sustainable ABTs, could be scaled up going forward. To surface the reasons for the current lack of uptake of ABTs in affordable housing construction, one must begin with the regulatory and policy context.

Regulatory and policy context

The key pieces of legislation affecting (affordable) housing construction (and their national custodian departments) are:

- **The National Building Regulations and Building Standards Act 103 of 1977** (Department of Trade, Industry and Competition (DTIC) via the National Regulator for Compulsory Specifications (NRCS)). New National Building Regulations (NBR) were introduced in 2008.
- **The Housing Consumer Protection Measures Act 95 of 1998** (DHS via NHBRC).
- **South African National Standards, SANS 10400** (2011) Code of Practice for the construction of Dwelling Houses in accordance with the National Building Regulations (DTIC via the NRCS). This code sets out prescriptive provisions that are deemed to satisfy the technical aspects of the NBR. Part X of the SANS 10400 deals with environmental sustainability, and Part XA deals with energy use in buildings.

Agrément is an entity of the National Department of Public Works and Infrastructure (DPWI), set up in terms of the Agrément South Africa Act 11 of 2015. Other role players are the South African Bureau of Standards (SABS), an entity of the DTIC which deals with testing and accreditation of materials and technologies, and the Council for Scientific and Industrial Research (CSIR), falling under the Department of Science and Innovation (DSI), which undertakes research and development to promote the implementation of ABTs.

The NBR do not prescribe how a building should be constructed; rather these stipulate the performance requirements that the building design or construction must satisfy. The NBR are supported by a non-mandatory set of 'deemed-to-satisfy' rules, which are published in SANS 10400. These rules describe design and construction methods, materials and solutions, which if applied, will ensure that the building will satisfy the functional requirements of the NBR.

Thus, the various ways to comply with the requirements of the NBR are:

- **'Deemed to satisfy' SANS 10400 requirements:** A building's design and construction conforms to SANS 10400 requirements.
- **Rational design or assessment:** A professional architect or engineer has certified that a particular design complies with requirements equal to that of SANS 10400.
- **A valid Agrément certificate**: A valid Agrément certificate will comply with the NBR and is accepted by the NHBRC for enrolment. The holder of an Agrément certificate (i.e. the person or company that applied for certification of their material or method) or a licensee can build according to the stipulations of the certificate and must attach a copy of the certificate when submitting building plans for municipal approval. The certificate holder must ensure that any licensee who constructs with the material or method complies with those stipulations and the approved quality management system, which thus also necessitates site inspections.[12]

12 Email correspondence with Agrément South Africa, 14 August 2024.

The role of the NHBRC is to enforce compliance with NBR requirements by homebuilders, which it does through site inspections. It also produces the NHBRC Home Building Manuals, compiled in line with SANS 10400. Any revisions to SANS codes are reflected in the manuals. Therefore, building in line with the manuals ensures that the NBR have been applied.

There are a range of national sector departments and subsidiary entities that impact the regulatory context of ABTs. This makes institutional support for ABTs more difficult due to fragmentation of responsibility. ABTs are not fully covered by existing standards and specifications or codes of practice and/or are not described or referred to in "deemed-to-satisfy" rules (SANS 10400) of the NBR, as these (implicitly) favour traditional 'brick and mortar' construction. This forces those wishing to build with ABTs into providing a copy of an Agrément certificate with their building plans or requiring an engineer to evaluate and approve a rational design in order to comply with the NBR. Requiring an Agrément certificate holder to ensure that licensees comply with certificate stipulations (through site inspections) places a significant burden on certificate holders.

A number of national, provincial and local government policy frameworks and specific policies have relevance. The National Housing Code of 2009 outlines the national norms and standards for the construction of standalone residential dwellings, which apply to all units built through one of the National Housing Programmes. In terms of incremental self-build housing construction, the Consolidated Norms and Standards for Rental Housing (DHS, 2023) are of interest as they articulate the notion of incrementalism in housing construction, with specific attention given to the backyard housing sector. The norms and standards do not specifically address issues related to materials or construction technologies, though.

In 2008, the DHS produced an Innovation and Transformative Technologies for the Human Settlements Sector (I&TT HS) framework, which from 2009 to 2019, laid the basis for various conferences and round table discussions advocating for opening up the sector to the adoption of innovations and technologies (CSIR, DHS & DSI. 2021). The Science, Technology and Innovations for Sustainable Human Settlements (STI4SHS) Roadmap, produced by the CSIR, DHS and DSI in 2021, took this further and serves to guide implementation and scaling up of technologies and innovations in the human settlements sector for the period 2020 to 2029, in support of the I&TT HS framework. It makes specific recommendations for training of building plan examiners on ABTs (by regional architectural institutes) and training of inspectors on ABTs (by the DHS). It further recommends that regional architectural institutes develop online continuing professional development (CPD) content on ABTs for universities and built environment professionals. The DHS is in the process of setting up an Innovation Building Technology Task Team comprising private and public sector players and has advised the private sector to form an Innovative Building Technologies (IBT) Association (PMG, 2023).

Various provinces and municipalities have produced green procurement policies or other policies or design guidelines that promote ABTs in housing and infrastructure construction. Provinces with such policies finalised or in draft form include Kwazulu-Natal, North West, Western Cape and Gauteng, while metros include Cape Town, Johannesburg, Tshwane and Nelson Mandela Bay, with Tshwane having a Green Building Development By-Law in place since 2013. It should be noted that many of the green procurement and green building development policies do not make specific reference to ABTs in terms of building materials and methods.

Barriers to scaling up the use of ABTs in affordable housing construction

As can be seen from the analysis, the regulatory and policy environment does not directly prohibit, and is generally supportive of, the use of ABTs. However, it may not be sufficiently enabling. Institutional fragmentation is also an issue. So what then are the dominant factors preventing widespread uptake of ABTs for affordable housing?

Limited public awareness and social acceptance

A significant obstacle seems to be public awareness and social acceptance of ABTs. Traditional brick and mortar houses are the status quo, are viewed as the "gold standard" by the public and appear to be the aspiration of most houseless residents in informal settlements and backyard housing. In fact, ABT-built houses can have a negative perception among South Africans as being solely for the poor (Adetooto et al., 2022). However, the perception by housing beneficiaries that they are 'guinea pigs' for (untested) ABTs should be contrasted against the number of higher income examples of ABT construction noted previously. Cultural factors also play a role in the preference for brick-and-mortar housing. The "knock test", where a person knocks on a wall and judges the perceived solidity of the structure by the resulting sound, while non-technical and perhaps less important for younger people, still gives conventionally-built structures an advantage over those built with ABTs, that may be lighter in weight or from different materials, and therefore sound less solid. People may not understand the rationale for the use of ABTs or what the benefits for them would be (e.g. better thermal insulation, higher fire rating, lower maintenance costs, etc.). As there are limited public awareness campaigns around the benefits of ABTs, and accessible information in multiple languages is not widely available, the general public do not have a good understanding of ABTs. Poor workmanship resulting in complaints/defects related to ABTs used in certain public housing projects have not helped matters, even resulting in community protest against their use (NHBRC, 2020).

Lack of knowledge and professional expertise

Linked to the lack of public awareness and social acceptance of ABTs is the lack of detailed professional knowledge of the availability, costs (including maintenance), performance and longevity of ABTs, and limited expertise with regard to their use. This lack of knowledge is common across the public and private sectors. Built environment professionals, such as architects and structural engineers, are generally unaware or uncertain about the benefits of ABTs, prefer the familiarity of conventional building materials and methods, or are overwhelmed by the number of ABTs on the market, and the technical details and performance of each. They may also have professional liability concerns. These professionals were not taught about ABTs, their benefits and how to use them at higher education institutions – and mindsets in professional practice are difficult to change.[13] Traditional building materials and methods (e.g. adobe, mudbricks and straw bale construction, etc.) may come from indigenous knowledge systems (IKS), but many of these skills have been lost. As such, these ABTs have the steepest learning curve in terms of upskilling, in comparison to ABTs that are assembled in the same way as conventional materials and may require no additional skills to use (e.g. concrete blocks with additives).

13 Interview with Dr Jan Hugo, University of Pretoria, 15 July 2024.

Contractors and artisans are skilled at using conventional building materials and may not be aware of ABTs or have the opportunity or time to learn how to use them. There is also a reluctance by contractors and specialists to learn about ABTs (Shaw, 2023, op. cit.) due to preference, time and financial costs. Lack of expertise can result in poor workmanship, resulting in defects and public dissatisfaction. While ABTs may be promoted as reducing construction time, in practice this is not always the case as a result of delays due to material shortages and the need for worker training, among others (WCDHS, 2021). In turn, these delays contribute to longer construction times than with conventional materials and methods. Quality management and assurance of ABT construction (and thus consumer protection) is therefore also vital; this requires better ABT knowledge by all role players, which highlights the importance of training.

Issues regarding ABT training

Lack of knowledge and professional expertise with regard to ABTs is not helped by the limited opportunities available for ABT training for architects, engineers and, more importantly, contractors and artisans. As many ABT producers are small companies with limited geographic footprints and intellectual property (IP) is controlled by a few licensed service providers, accessing training on specific ABTs is difficult. The skills gap or learning curve is greater for those ABTs that differ more widely from conventional materials, and therefore require a greater amount of training, perhaps over an extended period of time. Many may not have to the time or be able to afford training, even if they have the interest. As mentioned, traditional building materials and methods may initially require considerable upskilling and may require an architect or engineer to spend a significant amount of on-site time on training, verifying quality of blocks made on site or construction, for example – something which cannot happen under the usual time, cost and funding pressures that projects face.

Costs compared to traditional building materials and methods

While there is a public perception that ABTs are more expensive than traditional building materials and methods, more nuance is required. Some ABTs are cheaper than conventional building materials or methods (e.g. sandbag and ecobeam technology is about 40% cheaper) or only marginally more expensive (e.g. concrete blocks containing RESIN8 are roughly 3% costlier). Also, while ABTs may broadly have higher upfront costs, they may have lower lifecycle costs or carbon footprints, or are cheaper or faster to build with, with less wastage and lower maintenance. Therefore, the true total costs of building materials and methods, including other economic benefits in terms of potential carbon reduction and waste minimisation, should be taken into consideration.

Manenberg Housing Contact Centre. Image courtesy of City of Cape Town, Architectural Unit.

ABT pricing is also a function of the currently low market demand. Low demand means that ABT producers have limited production capacity and cannot take advantage of economies of scale to increase supply, thus bringing down prices and enabling use at scale. Accessibility of ABTs, with many only directly available from localised producers rather than at building material supply stores, also affects costs. ABT supply is highly fragmented (many small ABT producers and many products available), which means that producers are competing for a small slice of a small market. The nature of the market as well as the significant costs and lengthy administrative and compliance procedures associated with Agrément certification affect the financial sustainability of ABT producers.[14]

Lack of accessibility

As noted earlier, many ABTs are generally only available directly from producers that may have limited geographic footprints and are therefore not widely available from building material supply stores, where conventional building materials are easy to access. While this lack of availability is partly a result of the weak demand for ABTs, it further hinders their visibility and uptake. Lack of reliable systems and value chains for sourcing building and industrial waste materials, and the difficulty in sourcing and assessing on-site natural materials, make these ABTs even less accessible, and learning to use them may also require a steeper learning curve.

Potential issues with maintenance

ABT use by contractors as well as maintenance is constrained by the dominant ABT franchise model, where intellectual property (IP) is controlled by a few licensed service providers (NHBRC, 2020, op. cit.) and the lack of broad availability of ABTs. While the upfront costs of ABTs may be marginally higher, many have similar maintenance costs to conventional materials and methods (reliant on good workmanship at construction) and may even match or exceed the life expectancy of conventional construction (Shaw, 2023, op. cit.). Generally, only natural methods such as adobe construction require more regular maintenance. In addition to ABT accessibility is the issue of appropriate skills to perform maintenance of houses constructed with ABTs, which may be lacking.

Challenges for incremental augmentation and multi-storey construction

While the case study examples are all suitable for incremental augmentation and multi-storey construction, a 2017 report by the Gauteng Department of Human Settlements examining the state of ABT pilot projects implemented in 2010 indicated that beneficiaries highlighted difficulties in altering or augmenting their houses (NHBRC, 2020, op. cit.). This could be due to the design or makeup of the ABTs used or stem from difficulties in integrating them into other building materials or systems, as well as the lack of broad availability of ABTs. The inability of some ABT systems to integrate well into buildings as a result of their design or material makeup means ABTs should be developed (or adapted) with incremental augmentation and multi-storey construction in mind. A specific barrier is when ABTs have Agrément certification that is limited to single-storey construction, stemming from high certification costs for multi-storey use or the certification panel's limited technical knowledge regarding a particular ABT system (Shaw, 2023, op. cit.).

14 Interview with Barry Lewis, UBU, 25 July 2024; see also Shaw, C. 2023.

Insufficient government / institutional support

While the regulatory and policy context is generally supportive of the use of ABTs, the devil is in the detail. SANS 10400 is not currently accommodative of ABTs, compelling those wishing to build with ABTs into providing an Agrément certificate with their building plans, or requiring the cost of an architect or engineer to evaluate and approve a rational design in compliance with national building regulations. This makes it more difficult and tedious to obtain building plan approval from a local municipality. Municipal officials (e.g. building plan examiners and building inspectors) may not have previously been exposed to ABTs or be knowledgeable on the range of ABTs available and the processes related to their quality assurance. As such, they may be hesitant to approve plans using ABTs, even if they comply with NBR requirements. The requirement that Agrément certificate holders ensure that licensees comply with certificate stipulations (and therefore also conduct site inspections) places a significant burden on certificate holders and limits the broader use of the ABT as the holder may not have the capacity to do nationwide training and inspections. Additionally, this requirement prohibits these ABTs from being made available via building material retailers, as potential buyers (i.e. the retailers) would not automatically be licensees (and would need to be trained and licensed), and the details of the ABT purchased and construction site would have to be captured.

The Agrément and NHBRC IBT databases provide an overview of the ABTs currently certified and available. However, limited data and information (in both accessible and easy to understand, as well as technical forms) is available to the broad range of potential ABT users, suited to their differing needs – from members of the public wanting to learn more about ABTs to those looking for specific technical and performance details. Researchers have also highlighted that the Agrément database may not be adequately up to date with the latest active certificates and contact information for certificate holders. This creates a barrier to ABT exposure (Shaw, 2023, op. cit.).

Provinces and metros are seemingly willing to make use of ABTs. However, it is argued that the comparatively higher costs of ABTs (in relation to conventional materials) exceed the subsidy quantum, which thus precludes them from procurement processes.[15] Policy frameworks at different spheres of government may acknowledge the importance of "green" building, including the use of ABTs, and the public sector has tried to use ABTs (albeit at a limited scale) in the construction of new public facilities, as noted previously. However, unless the use of ABTs is institutionalised and incentivised in public sector practice, it will be limited to a handful of projects. Despite their clear potential, green procurement policies or other policies or design guidelines that promote ABTs in housing and infrastructure construction have been implemented on a limited scale and only comparatively recently, so there are currently limited incentives in place.

Lack of access to finance and housing insurance

Despite Agrément certificates being recognised in principle by mortgage lenders and other finance providers, in practice bank loan applications currently limit or do not allow for construction of buildings using ABT systems, while a high initial capital outlay is required for ABT construction as financial institutions are not willing to provide finance without guarantees (Shaw, 2023, op. cit.). Banks are reluctant to finance these ABT-built projects due to perceived risks and the lack of broad market acceptance.[16] However, it appears that the landscape and appetite for banks to approve loans for ABT construction is slowly changing (UBU. n.d.).

15 Interview with Gilbert Kathi, National Department of Human Settlements, 24 July 2024.

16 Interview with Dominique Geszler, Agrément South Africa, 23 July 2024.

Strategies to improve the uptake of ABTs in affordable housing construction

As highlighted previously, the use of ABTs in affordable housing construction has been limited to pilots and small-scale initiatives. Particularly in the cases where more sustainable ABTs were used, the alignment of a unique set of circumstances was required for these projects to take place, outside the usual cost and time constraints faced by public and private sector projects. Factors included patient[17] private, donor or subsidy funding (or donations of materials), a public sector champion or a private or NGO sector actor looking to demonstrate a different process or their innovative product, and perhaps also a progressive orientation towards clients or intended beneficiaries. These factors highlight why sustainable ABTs, and ABTs more broadly, require a more enabling environment for their increased uptake and institutionalisation.

The current uptake of (sustainable) ABTs is mostly a function of market dynamics related to innovation: demand is low largely due to unfamiliarity, cost and accessibility of the product and/or technology, whereas supply is low and highly concentrated, rather than diffused. The affordable housing – climate – economy nexus and the opportunity that it creates speaks to the need to support the production and use of sustainable ABTs. However, as shown in Box 1, the affordable housing market is diverse, so nuanced responses and strategies are required. The proposed criteria discussed in this paper offer a provisional frame to guide the formulation of strategies to improve the uptake of ABTs, and particularly more sustainable ABTs, in affordable housing construction processes.

The following strategies relate to policy and regulation, knowledge and expertise (among the public and professionals), costs and accessibility of ABTs, technical requirements for incremental and/or multi-storey construction and, lastly, access to finance.

Selinah Ncanywa House, Gqeberha. Image courtesy of Kevin Kimwelle.

17 *Patient capital / funding is when the provider of the capital / funding is willing to make a financial investment with no expectation of a quick return.*

Policy and regulation

- **Include ABTs in SANS10400:** An important step that can be taken in the regulatory environment is for new sub-sections to SANS10400 to be created (similar to how sub-sections were added for timber and lightweight steel construction) that cover the various broad categories of ABTs available in South Africa. This would allow municipal building plan examiners to have a regulatory standard against which to assess building plans using ABTs, which currently effectively require the inclusion of an Agrément certificate or rational design sign-off by an engineer.
- **Streamline Agrément processes and reduce costs:** Agrément certification and administrative and inspection processes can be streamlined and certification costs for applicants below a set annual turnover (e.g. less than R1million) reduced, cross-subsidised by applicants with higher turnover. These steps would serve to reduce barriers to entry for smaller ABT actors and assist with financial sustainability in relation to compliance.
- **Augment and maintain Agrément and NHBRC IBT databases:** The Agrément and NHBRC IBT databases should be improved to include more comprehensive data and information (in both and easy to understand, as well as technical forms) suited to the broad range of potential ABT users and their differing needs. Specifically for built environment professionals, detailed information on the availability, costs (including maintenance), performance and longevity of ABT should be included. Agrément should also take steps to ensure that its database is up to date with the latest active certificates and contact information for certificate holders.
- **Shift responsibility for quality assurance to municipal building inspectors and the NHBRC:** The requirement for Agrément certificate holders to ensure licensees comply with certificate stipulations, which requires them to conduct site inspections, places a significant burden on small ABT producers in particular and skews the market in favour of 'known' products. As municipal building inspectors and the NHBRC already inspect housing construction sites, greater ABT knowledge by these inspectors would enable them to ascertain compliance with Agrément certificate stipulations, as a certificate copy is required with building plan submission. In addition, improved contractor and artisan knowledge of and expertise in using ABTs (via widespread training) would help to address the quality assurance concerns. By following these strategies and removing the need for licensing and compliance monitoring by certificate holders, ABTs could be made available via building material retailers, thus growing the potential market which would ultimately be in the long-term best interest of certificate holders.
- **Adopt appropriate national, provincial and local government policies, regulations, guidelines and incentives**: Mainstreaming ABTs requires new value chains. While there are a number of policies and frameworks at national, provincial and local government levels that are supportive of ABT use, there needs to be a concerted effort by the DHS and provincial departments to ensure that policy guidelines for the use of ABTs and green procurement policies (complemented by specific guidelines for the use of sustainable ABTs) are in place in all provinces. This will not only incentivise the use of (sustainable) ABTs in provincial human settlement and infrastructure projects, but also provide guidance to municipalities in crafting their own policies. In turn, provinces should ensure that all municipalities develop their own ABT policy guidelines, green procurement policies and specific guidelines for the use of sustainable ABTs. This will allow for municipalities to scale up the use of ABTs in their own housing and infrastructure projects, whilst simultaneously incentivising and providing guidance to the public on ABT use. Municipalities could also develop prototypical ABT building designs to support the adoption of ABT construction in incremental self-build housing construction. In the longer term, municipal by-laws, land use incentive tools and other methods could be used to incentivise the use of ABTs. National Treasury could also develop a tax incentive to promote (sustainable) ABT use, similar to the recent tax incentive for solar panel installation, and consider preferential procurement guidelines for ABTs that are labour-intensive and address (youth) unemployment.

- **Develop criteria for low-carbon and sustainable affordable housing construction:** The NHBRC and Agrément, in partnership and with the support of the relevant national departments, can develop criteria for low-carbon and sustainable affordable housing construction, guided by the JUT Framework and similar to those used in this paper, and undertake a transparent and systematic analysis of all ABTs available in South Africa. The GBCSA's EDGE tool is a useful starting point to review existing ABTs in a systematic way to provide a basis for comparison and incentivisation. It can be augmented to take into account other factors, such as the cost of transportation and approximate cost of labour in construction. The ABTs deemed more sustainable could be indicated as such on the NHBRC and Agrément databases, or a specific database made accessible to industry professionals; this will aid designers, architects and construction professionals to make informed decisions in the selection of sustainable building systems.[18] Use of sustainable ABTs could be incentivised by specific provisions included in the suite of policy tools in all three spheres of government identified earlier.
- **Develop supportive policy to promote a more circular economy:** To support a more circular economy, policy must be developed to promote the re-use of building and industrial waste materials, and specific systems and incentives put in place to enable this in practice. Reuse, remanufacturing and recycling needs to be prioritised over disposal and design for disassembly promoted. The use of on-site natural materials and the localisation of sourcing and / or production of ABTs could be promoted and incentivised through green procurement policies and design guidelines, among other tools.

Public awareness and social acceptance

- **Increase public awareness and make information easily accessible and widely available:** There should be increased public awareness campaigns around the benefits of ABTs (e.g. better thermal insulation, higher fire rating, lower maintenance costs, etc.) and easily accessible information in multiple languages made widely available for the general public to get a better understanding of ABTs. Targeting all income bands in terms of promoting ABT use will also allow for ABTs to become aspirational.
- **Lead by example:** Green procurement policies, or other policies or design guidelines that promote ABTs in public housing and infrastructure construction need to be consolidated through practice to scale up the number of ABT-built housing, public facility and infrastructure projects (in accordance with the proposed principles), given that the public sector is the largest builder. As a byproduct of fulfilling public sector mandates in terms of climate change responses, housing and job creation, this will strengthen the demonstration effect, gradually increasing social acceptance. Increased demand for ABTs will also bring down costs, allowing ABTs to fall within the subsidy quantum.
- **Build in an upfront process of community engagement:** Housing projects, and community infrastructure projects, will need to build in an upfront process of community engagement around the benefits and use of the proposed ABT. Such an engagement process needs to be deliberative, providing people with all relevant information so that they can choose solutions that work for them (Isandla Institute, 2024).

18 *Agrément states on its website that it makes use of an eco-labelling system, known as EcoASA, for building materials and products that meet certain criteria relating to their environmental impact, based on a scoring system. It is voluntary in nature and is based on the Life Cycle Assessment (LCA) methodology. It is unclear which ABTs in its database have this label. Source: Agrément South Africa.*

Improving knowledge and professional expertise

- **Conduct more systematic training on ABTs:** In addition to the improvements in access to ABT information highlighted above, there will need to more systematic training on ABTs for artisans, contractors, architects, building plan examiners and building inspectors. This will need to be done by all the role players, individually and in partnership, namely municipalities (supported by provincial governments), regional architectural institutes, sector training entities, private training providers, higher education institutions, the NHBRC and the DHS.
- **Include ABTs in higher education, continuing professional development and contractor and artisan training:** Higher education institutions need to include ABTs in their built environment curricula, to change the mindsets of new professionals and promote the use of ABTs in practice. Continuing professional development (CPD) as mandated by professional associations also needs to include ABT content. Traditional building materials and methods (e.g. adobe, mudbricks and straw bale construction etc.) and using building and industrial waste materials need to be included in these curricula. In addition, contractor and artisan training in these skills needs to be made more widely available through public sector support for partnering between those with the expertise and construction sector training entities, taking into account the greater amount of training required. Architect or engineers may need to be incentivised or obligated to spend time on site training.
- **Incentivise and support the training of contractors and artisans to use ABTs:** The training of contractors and artisans to use ABTs needs to be incentivised and supported to overcome preference for conventional materials and methods, time and financial costs. The public sector will need to partner with ABT producers / certificate holders and public and private training providers to develop widely available and affordable training programmes, that are convenient for contractors and artisans. This will require ABT producers / certificate holders to make their training freely available (given the public and private benefits) or via a greater number of licensed service providers. Upskilling of contractors and artisans in the use of ABTs will also reduce the instances of poor workmanship.
- **Promote the free sharing of intellectual property:** Traditional building materials and methods and other more sustainable ABTs maximise opportunities for low-tech, labour-intensive work opportunities. Yet, issues related to intellectual property rights can hinder the widespread uptake of ABTs, thereby undermining the employment creating potential of ABTs if standardised and implemented at scale. ABT producers should consider the free sharing of intellectual property; alternatively, government can engage these producers on how best to overcome barriers posed by intellectual property.

Delft Early Childhood Development Centre. Image courtesy of City of Cape Town, Architectural Unit.

ABT costs and accessibility

- **Highlight the total costs of building materials and methods and the relative benefits of ABTs:** Linked to the preceding strategies, there is a need to develop and promote a calculus that is inclusive of all costs and benefits, including externalities, of ABTs. This is essential to enhance both public and professional awareness that ABTs are not necessarily more expensive than traditional building materials and methods, especially when lower lifecycle costs, carbon footprints, speed of construction and reduce wastage aspects of ABTs are brought into the calculation. Beyond monetary cost, the total costs (and benefits) of building materials and methods should be highlighted.
- **Cooperate and partner to improve ABT accessibility:** ABT costs will come down as market demand is stimulated by the other strategies proposed, allowing producers to scale up production capacity (and therefore supply). The accessibility of ABTs can then be improved as they can be made wore widely available from building material supply and hardware stores. This will also require cooperation and partnering between these role players. Market consolidation may be natural as the demand and market for ABTs matures.
- **Incentivise and systematise the re-use of building and industrial waste materials:** The re-use of building materials is already a prevalent informal practice and holds great potential if incentivised and systematised at different scales to create and strengthen value chains. Deconstruction / dismantling of buildings in place of demolition (to preserve building elements and materials for re-use) requires the development of these skills and the incentivisation of this practice. Supportive policy to promote the re-use of building and industrial waste materials, and specific systems and incentives put in place to enable this will also make these more financially feasible construction materials.
- **Promote and incentivise the use of on-site natural materials and localisation:** Promotion of on-site natural materials and the localisation of sourcing and / or production of ABTs will also reduce costs. These practices may need to be incentivised to create new, more localised, value chains and contribute to local employment creation.

10 x 10 Sandbag housing, Mitchells Plain, Cape Town. Image courtesy of Wieland Gleich – ARCHIGRAPHY.com

Maintenance and suitability for incremental augmentation and multi-storey construction

- **Incentivise ease of maintenance, incremental augmentation and integration of ABTs:** The public sector should incentivise ABT producers via policy and regulations (among other methods) to develop products and technologies that allow for ease of maintenance, incremental augmentation and integration of ABTs into other building materials or systems.
- **Highlight potential benefits related to incremental building, maintenance costs and life expectancy of ABTs:** Following the previous point, public awareness campaigns should highlight the benefits of ABTs for incremental self-build and the fact that maintenance costs are similar compared to conventional construction. Other benefits relate to durability and life expectancy of ABTs, which are likely to reduce the need for maintenance.
- **Increase demand for and availability of ABTs to allow for easier maintenance:** Increased demand for and availability of ABTs will allow for easier maintenance and will also allow for increased licensing of service providers or making some intellectual property freely available. Beyond this, removing the need for licensing and currently onerous compliance monitoring by Agrément certificate holders proposed earlier would improve ABT accessibility for maintenance purposes.
- **Reduce Agrément certification costs for multi-storey use and improve technical knowledge:** Agrément certification limited to single-storey construction should be addressed by reducing certification costs for multi-storey use and improving the technical knowledge of certification panels.

Access to finance and housing insurance

- **NHBRC and Agrément to work together with mortgage lenders and other finance providers:** The NHBRC and Agrément should work together with mortgage lenders and other finance providers to achieve greater acceptance of ABTs when trying to access finance and housing insurance. Increased social acceptance and use of ABTs will also allow for greater value to be placed on ABT-built houses, improving their asset value.
- **Source greater funding and investment for ABTs:** As the financial sector is incentivised and obligated to provide more "green" or environmental, social and governance (ESG) funding, greater public sector support for, and social acceptance of, ABTs will unlock greater funding for ABTs. There is also an opportunity for the public sector to source funding for promoting ABTs more widely (for example, from municipal bonds, local and international social impact investment funds, 'green building', climate transition and resilience funding) and by creating incentives to attract corporate funding linked to ESG imperatives. The argument can be made that private sector companies, particularly finance providers and material suppliers can gain direct financial benefit from funding the promotion of ABTs.

LIFT house, eThekwini. Image courtesy of PPT.

The way forward

ABTs can be a game changer for affordable housing that is safe, dignified, climate-resilient and potentially low-carbon. More specifically, ABTs can play an important role in self-build incremental housing construction that responds to people's needs and aspirations and that suits their financial means. ABTs further hold great potential for job creation and local economic development. To realise the multiplier effect ABTs can have on housing, the economy and climate resilience, a fundamental rethink of the housing – climate – economy nexus is required, with significant investment in new systems, markets and value chains.

The criteria for sustainable affordable housing construction proposed in this paper are offered as a starting point for reflections and conversations about the potential of ABTs to respond to these multiple, urgent, societal imperatives. Clearly, further work is to be done to refine and concretise the proposed criteria. For example, an investigation into the lifecycle carbon footprints of ABTs is needed to form a basis for incentivising those that are more sustainable. While one may consider low carbon materials such as sand and rammed earth first prize in terms of sustainability, the important contribution of other materials in reducing building or industrial waste (particularly plastic) should not be overlooked.

Similarly, means to harness the economic potential and job creation possibilities of ABTs need further exploration. For example, how can public employment programmes such as the Expanded Public Works Programme (EPWP) be leveraged for localisation of work opportunities and skills development? How can these temporary jobs be converted to permanent jobs, through skills development and upskilling and, critically, incentives for and investment in the ABT sector? What is needed to develop (localised) reuse and circular economies through which second hand building materials and industrial/plastic waste can be repurposed for affordable ABTs?

A critical test for the value of ABTs lies in the extent to which it results in housing that responds to the realities and aspirations of poor and low-income households, including the potential for self-build. This speaks to issues of affordability, accessibility, social acceptability and the extent to which ABTs enable incremental housing construction (which may include vertical development). In this context, greater efforts will need to focus on how to empower and enable small-scale contractors to use ABTs as part of a broader move towards realising the right to self-build.

If the use (and further development) of ABTs, particularly sustainable ABTs, is to be scaled up in affordable housing construction, an all-of-government and all-of-society response is required. This paper has identified strategies that can be pursued by various stakeholders, including fine-tuning regulation and policy, improving both public and professional awareness and acceptance, reducing costs and improving accessibility, addressing issues related to maintenance and suitability for incremental augmentation and multi-storey construction and, lastly, improving access to finance and housing insurance. Growth in the use of ABTs can, in turn, drive further innovation and funding for greener building technologies, thus better integrating these systems alongside conventional building material and methods. To better understand the limitations, risks and opportunities, there is a need for ongoing sector-wide (and broader) dialogue, engagement and partnership between all role players. This includes the public sector, built environment professionals, ABT producers, researchers, higher education institutions, the private sector and, critically, the end-user: people who currently live in undignified, unsafe informal structures that offer scant protection from the elements, for whom ABTs can be transformative.

References

Adetooto, J., Windapo, A. and Pomponi, F. 2022. The use of alternative building technologies as a sustainable affordable housing solution: perspectives from South Africa

Cartwright, A; Parikh, A; Tucker, A; Pieterse, E; Taylor, A and Ziervogel, G. 2023. Pathways for a Just Urban Transition in South Africa. World Bank

CSIR, DHS & DSI. 2021. Science, Technology and Innovations for Sustainable Human Settlements (STI4SHS) Roadmap

Department of Human Settlements (DHS). 2023. Consolidated Norms and Standards for Rental Housing, GN 2194 GG 47883 of January 2023

Fitchett, A. 2022 Construction waste is costly: what's causing it on SA building sites. University of the Witwatersrand Opinion. 5 October 2022

Göswein, V., Silvestre, J.D., Lamb, S. et al. 2021. Invasive alien plants as an alternative resource for concrete production – multi-scale optimization including carbon compensation, cleared land and saved water runoff in South Africa. Resources, Conservation & Recycling 167 (2021)

Holmes, D. 2013. OR Tambo Environmental and Narrative Centre. World Landscape Architecture. September 24, 2013. Available at: https://worldlandscapearchitect.com/or-tambo-environmental-and-narrative-centre-ekhuruleni-south-africa-newtown-landscape-architects/?v=3a1ed7090bfa

Infrahub Africa. n.d. Mbekweni stonehouses. Available at: https://www.infrahub.africa/case-studies/mbekweni-stone-houses

Isandla Institute. 2024. A just urban transition for and with informal settlements: The art of deliberative engagement. Available at: https://isandla.org.za/en/resources/item/download/380_16cf12f741a8b3963869e347b0fccbe6

NHBRC. 2020. Consumer and stakeholder perceptions and acceptance of building technologies used in residential construction

PMG. 2023. Question NW821 to the Minister of Human Settlements. 17 April 2023. Available at: https://pmg.org.za/committee-question/21843/

Roux, T. 2024a. Helderberg eco edu-centre. Available at: https://www.naturalbuildingcollective.com/helderberg-eco-edu-centre

Roux, T. 2024b. The story of the Delft ECD Training Centre. Available at: https://www.naturalbuildingcollective.com/the-story-of-the-delft-ecd-training-centre/

Shaw, C. 2023. The role of alternative building technologies in sustainable human development in the context of South Africa. M(Prof) Arch dissertation

Specifile. n.d. Manenberg Housing Contact Centre Available at: https://www.specifile.co.za/corobrik-clay-bricks-in-4-star-green-star-sa-manenberg-housing-centre/news/green-building/

UBU. n.d. FAQ. Available at: https://www.ubu.bz/faq

United Nations Environment Programme (UNEP). 2023. Building Materials and the Climate: Constructing a New Future

Western Cape Department of Human Settlements (WCDHS). 2021. Guideline for the use of sustainable building technologies in human settlements

Expert interviews

Many thanks to the following interviewees:

- Abraham Avenant, Chief Executive Officer, CRDC SA
- Ashley Hemraj, Senior Architect, Urban Sustainability Unit, Urban Planning and Design Department, Spatial Planning and Environment Directorate, City of Cape Town
- Barry Lewis, Director, Ubuhle Bakha Ubuhle (UBU)
- Benjamin Kollenberg, Director, Urban Think Tank Empower
- Boshoff Muller, Managing Director, Afrimat Hemp
- Coralie van Reenen, Research Group Leader: Infrastructure Innovation, Council for Scientific and Industrial Research (CSIR)
- Dominique Geszler, Technical Group Leader: Research and Development, Technical Services, Agrément South Africa
- Dorelle Sapere, Senior Project Manager and Urban Designer, Department: Operations Management, Mandela Bay Development Agency, Nelson Mandela Bay Municipality
- Gilbert Khathi, Research Specialist, National Department of Human Settlements
- Heeten Bhagat, Project Manager, Researcher and Lecturer, African Centre for Cities (ACC), University of Cape Town
- Jan Hugo, Lecturer and Course Coordinator Earth Sciences, Architecture Department, University of Pretoria
- Kevin Kimwelle, Architect, Indalo World
- Khalied Jacobs, Director, Jakupa Architects and Urban Designers
- Peggy Mafadza and Lutendo Thanyani, Engineering and Technical Services, NHBRC
- Ronald Mukanya and Amandla Mali, Western Cape Department of Environmental Affairs and Development Planning
- Rudolf Opperman, Specialist Technical Advisor National Building Regulations
- Stephen Lamb, Founder, nonCrete
- Tashriq Abrahams, Architect, Bitprop
- Thiresh Govender, Founder and Director, UrbanWorks Architecture and Urbanism
- Thokozani Norushe, Brian Verwey, Hannalie Prolius and Sandile Gqoboka, Western Cape Department of Infrastructure

Isandla Institute
Email: admin@isandla.org.za
www.isandla.org.za