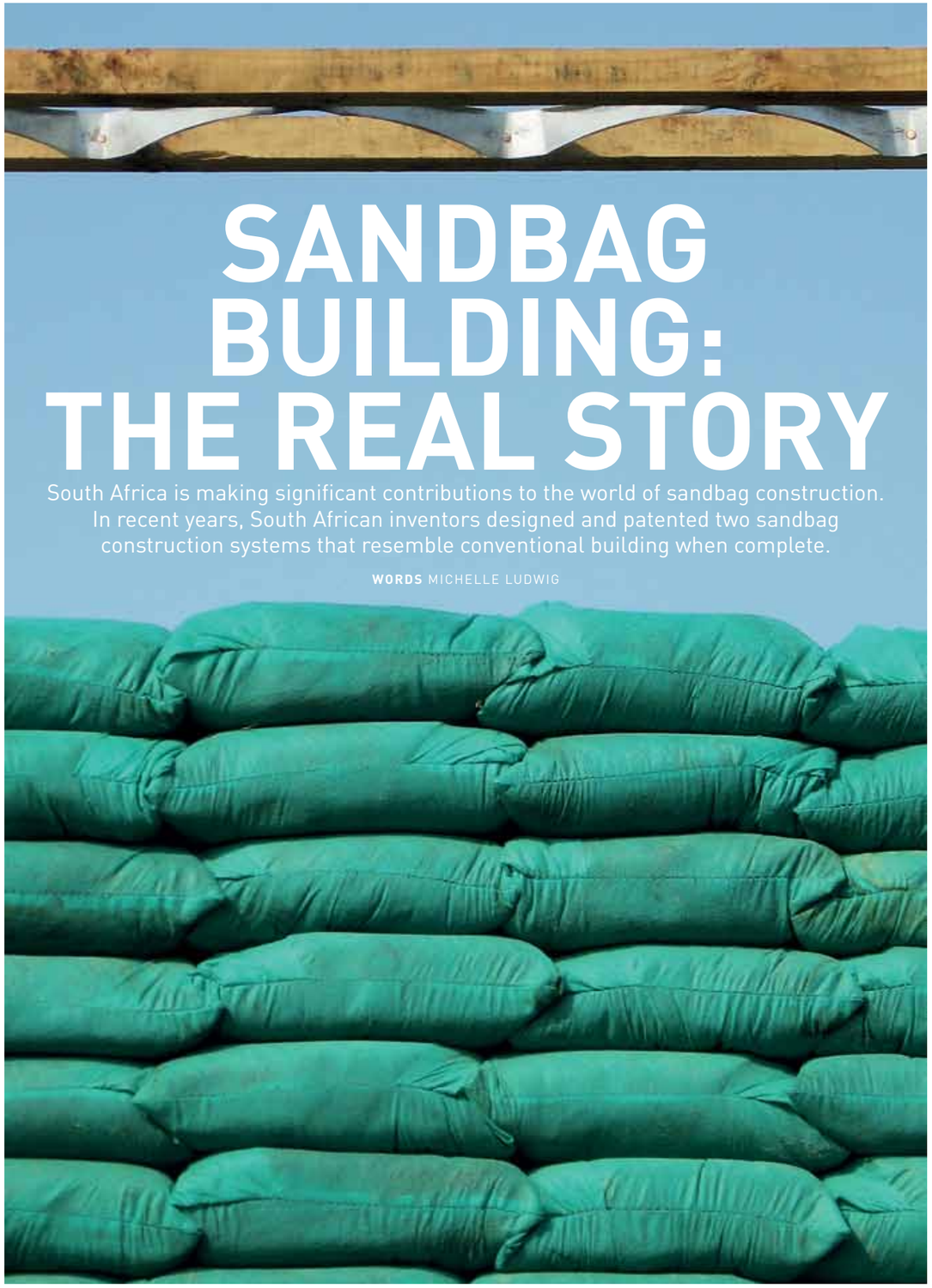

SANDBAG BUILDING: THE REAL STORY

South Africa is making significant contributions to the world of sandbag construction. In recent years, South African inventors designed and patented two sandbag construction systems that resemble conventional building when complete.

WORDS MICHELLE LUDWIG

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Engineer Mike Tremeer, owner of EcoBeam Technologies, introduced the first system in 1998. The EcoBeam system comprises three elements: EcoBeams as a timber frame; geofabric bags filled with sand and stacked as a wall; and conventional cladding (i.e. plaster, fibre cement board).

More recently, Dr Johnny Anderton introduced the EarthBag Building System. This frameless system comprises specially designed and shaped bags that allow horizontal layers to interlock, adding to the stability of the wall and reducing material usage.

The performance and ecological benefits of building with sandbags rather than conventional brick or concrete are significant:

- Improved thermal comfort because walls function as an absorbent mass that stores warmth and re-radiate it into the living space as the mass cools (Hunter, 2004 and Dr. J. Anderton).
- Maximum summer indoor temperatures will be approximately 2°C cooler than that of the standard brick house when insulated ceilings are installed (Agrément Certificate 2012/417[1]).
- Winter energy heating requirements with insulated or un-insulated ceilings would be much less than that of the standard brick house (Agrément Certificate 2012/417).
- Less embodied energy because sand does not require much processing and typically requires less transportation than bricks and cement; the production of the bags is minor (Kracht, 2008 and Stouter, 2010[2]).
- Fewer emissions as the CO_2 of a sandbag wall drop 95% compared to conventional brick (Kracht, 2008).
- The finished structure micro-moves as a monolith and is thus less rigid than brick, which can sustain structural cracks with minor ground movement (Interview[3] and Stouter, 2010)
- Creates job opportunities – unskilled workers can be employed for simple tasks.

01.

© Dr Johnny Anderton

02.

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01. and 02. Sandbags for construction can take different forms.

[1] Anecdotally, sandbag builders report average temperature differences of about 8°C, providing the roof is insulated

[2] "Earthbags when built of 'raw' earth without cement, lime, or gypsum stabiliers use 1/6 or less of the embodied energy of comparable brick construction."

[3] "In an earthquake minor slipping between adjacent surfaces within walls can absorb large amounts of energy. Flexible wall systems can better survive horizontal loading without permanent damage."

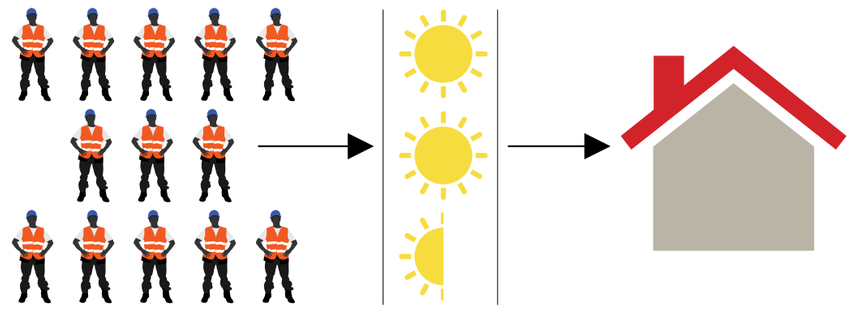
Construction benefits primarily claim cost savings, with a quicker and simpler build. Common perceptions abound that may not fully reflect the reality. Here, builders and owners share their perspectives from the real world of building with sandbags.

Common perception: It's so easy; it can be constructed with no experience and unskilled labour.
Reality: Many clients think this approach is an easy, self-build, DIY project but quickly discover it is not without pitfalls. With any building project, it is important to have at least one person on-site with building experience or enough expertise for both technical aptitude as well as quality control. In particular, according to Rodney Wall of EcoSteps, erecting these walls requires someone who can use a level, pull a building line and understand how to check wall alignment to keep them straight. He relates a common novice mistake: when tamping down the bags into place, it is easy for one's viewing angle perspective to affect alignment – walls can become bowed both inwards and outwards even though they look straight. Some suppliers offer full building services or at minimum will provide three-day on-site training. A best case scenario would be someone on-site familiar with the technology and its characteristics.

Under a skilled person's guidance, there are cost savings to be found by having the majority of the bag filling, stacking and manual labour completed by unskilled labourers, albeit with a little training to show them how. If a smooth plaster finish is desired, a project will still need a skilled plasterer. A structural engineer is a must, preferably having experience with sandbag designs.

Common perception: Alternative building systems struggle to get council approvals or bank financing.
Reality: This is an ongoing challenge to some alternative materials, however the EcoBeam technology has been certified by Agrément SA and approved by the National Home Builders Registration Council (NHBRC[4]) . The EarthBag system has been independently tested

The speed of building depends upon how many persons helping.
EcoSteps built a 42m² bakery in Venda over two and half days with 13 student volunteers. Typically they would employ 6-8 unskilled workers filling bags and 4 persons packing and tamping the wall.



[4] Agrément SA governs and assesses the use of innovative or non-standard construction products. The NHBRC also serves to protect housing consumers by monitoring quality standards in the home-building industry. In order for banks and building societies to grant a bond for any alternative building process, a valid Agrément certificate and NHBRC approval must be obtained.

to Agrément standards and is currently pursuing its certification. Therefore, obtaining council approval should be a reasonable process and in theory banks should evaluate financing decisions in the same way as they do for a conventional building.

In one instance where a council building plan assessor initially rejected plans, according to Andy Strydom of Ecobuilders it was due mostly to resistance from a more rural council officer to evaluate an unfamiliar technology rather than due to official reasons. The NHBRC helped support the application and it was ultimately approved.

With all alternative building systems, certified or not, as long as a rational design is produced and signed off by a structural engineer, it should achieve council approval, although obtaining a bond may still be a challenge.

Common perception: Sandbag construction is only applicable for low-income housing.
Reality: While simple structures are very easy and economical with these systems, they are also used for medium to large residential and institutional projects. Part of this perception can be attributed to the widely-publicised, award-winning 10x10 project by MMA architects in 2008, which successfully designed and implemented a beautiful, high-performing low-income house costing R50 000 while involving unskilled community members in the building process.

Sandbag building can be scaled up with similar benefits to larger projects, and once finished look the same as conventional brick ones. These systems are particularly relevant where project sites are great distances away from typical building material suppliers or lack access to electricity and resources.

> Research shows that the production of earth (especially if it is locally sourced) requires only 1% of the energy needed to produce any other conventional material like concrete or fired bricks.
> - MINKE, 2007

Common perception: If using sandbags, the design must be small, simple and single storey.
Reality: "Most of what you can do with brick can be done with sandbags," says Rodney Wall of EcoSteps, "the only difference is the wall thickness." This includes double storeys, large openings, curved walls, any roof type, and it can still be feasible for future alterations or additions. These aspects feature in Cape Footprints, a double-storey, curved guesthouse in Wilderness where guests can see and experience the thermal performance of a sandbag house first-hand.

Conventional doors and windows can be installed, and electrical and plumbing services are somewhat easier as they do not need to be chased into brick, just encased in the plaster layer. Strydom warns against multiple storeys though, for which he says other methodologies are more suitable.

Common perception: Clients (and building labourers) think a sandbag project will be similar to a conventional build.
Reality: "There is nothing conventional about it," says Glen Saunders, a Cape Town-based experienced sandbag builder who builds all over southern Africa. With a conventional build many practices on-site are taken for granted that could prove problematic with this system.

"They do not need to be problems if there is an awareness of the particular nature of this type of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Jouberton Nursery. This pre-school for 120 children in Klerksdorp, North West was a social architecture project by charity Ediucation Africa. in 2009. It was designed by students from the University of Nottingham, a number of whom also took part in the build along with local community members.


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> An unstabilised 100gsm polypropylene earthbag, the compressive strength was found to be 1.7N/mm^2, hence compressive failure is unlikely to occur in an earthbag structure.
> - VADAGAMA, 2010

system." Saunders provides an example of how a brick wall will be relatively rigid shortly after construction and can support the weight of a ladder leaned against it. In contrast, a sandbag wall with lateral weight applied to it could shift it out of alignment, at least until it is fully finished.

There are advantages as well; if a bag breaks, it can simply be patched with duct tape or used as a 'half-brick' resulting in very little wastage. Storage and transportation of bags is simplified – 1500 will fit in a car boot, the equivalent of 3000 bricks. Electricity and power tools are not required, making for a quieter construction site.

Common perception: All of the sand and fill for the bags will come from the site and therefore will provide cost savings.
Reality: There are variables to consider in sourcing sand or fill, and it is often not the case that the site will provide enough or suitable sand. If the only excavation on-site is for foundations, the soil displaced will only provide for about a third of the wall needs. If the soil has clay, it is unsuitable as fill. According to Strydom, KwaZulu-Natal has a lot of clay soil and typically sand must be brought in, which impacts on cost savings.

Site-available fill may need to be assessed to ensure it does not contain organic matter. EcoSteps' Rodney Wall says a variety of sand types can be used and even certain dry soils. His company is experimenting with using recycled glass, which would be useful when not near big cities and material suppliers.

Common perception: A sandbag project will be dirt-cheap.
Reality: There are definitely cost savings to be had, but also many variables to consider that impact on the final cost. Foundations and roofs are typically conventional, so would cost the same. If sand or fill is readily or cheaply available, the wall structure materials could be significantly less than a conventional brick wall. However, if the walling component is about 25% (or less) of a project's total cost, with 40% savings, this translates to about 10% overall project savings.

A sandbag wall has an irregular surface, so if plaster were the final finish it would add cost. Other claddings, such as fibre cement, magnesium board or gypsum board can also be used that are less expensive and quicker.

Cost of labour is typically where there are savings to be found as unskilled labour can be utilised. Speed of construction can also provide savings if there are enough hands on deck.

Saunders always initially asks clients why they are choosing this building method and if the first and foremost reason given is that it is cheaper, he cautions them with reality. "Ideally, the main reason to choose sandbags should be for its superior performance and ecological benefits. Generally it does come in cheaper, but that shouldn't be the main motivation."

Cost is always largely dependent upon size, complexity and the finishes of a project. Saunders says a simple to moderate project could be constructed for about R3000–R5000/m^2, where as the same with brick cavity would start at R5500/m^2.

Owner-builder Susan Botha blogs about her experience of self-building a 160m^2 house in Jeffrey's

PROJECTS

The unplastered versions (01. and 03.) versus the finished versions (02. and 04.) of two homes by Ecobuilders.

01.

© Andy Strydom

02.

© Andy Strydom

03.

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04.

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The 10x10 project by MMA architects in 2008 was one of the first sandbag building projects in South Africa to attract widespread attention.

© Andy Strydom

Bay. She notes the cost as being approximately R3500/m^2, however that cost incorporates much resourcefulness and some volunteer man-hours. On a different scale, the e-Khaya house, a 14m^2 modular design built with the EarthBag system, costs only R8000 (excluding labour) and is designed to replace shack-dwellings, improving thermal comfort, fire resistance and expandability.

Common Perception: Self-building with sandbags is long, hard work.
Reality: Being an owner-builder and contributing to the physical labour could be a daunting task. Most do it by choice – either to save costs or for the hands-on satisfaction – and engage family, friends, the community or casual labourers in the process. Sharon Verwoerd, who built her house in Lynedoch EcoVillage, says they loved the idea of being involved in the building of the house. "With the help of our neighbours – mostly the kids having fun – we filled enough bags (6000) for half of the house in a few weeks during the school holidays."

The Jeffrey's Bay house had help from volunteers who were willing to trade hours for the learning experience. The Cape Footprints house employed local women from Smutsville and four men to fill the bags as the core team of labourers. In addition, they occasionally hired men and women who came from the Eastern Cape, Zimbabwe and Malawi in search of work. ✪

> Ecobeam dwellings without insulated ceiling perform better than the standard brick house and much better with insulated ceilings and meet Agrément South Africa's requirements in all areas of South Africa including the Southern Coastal Condensation Problem (SCCP) areas.
> - Agrément Certificate 2011/398

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