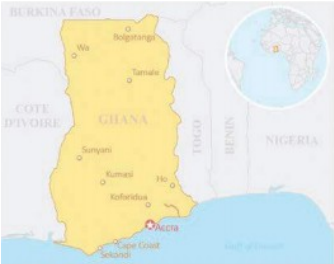
Sustainable design: building from the ground up

Country: Republic of Ghana
Organisations: Sabre Charitable Trust, Arup International Development
Hazards: High winds, earthquakes, extreme temperature



Country and hazard overview
With a rapidly growing population, Ghana's education sector has struggled to keep up with demand. Nearly 30,000 public sector classrooms are in need of major repair and the country has a shortage of nearly 10,000 kindergarten classrooms.

In the country's de-centralised system, the process of constructing schools often begins with a parent-teacher association (PTA) or an elder petitioning the district assembly or district line ministry. The government body will then seek funds for construction, either from their own coffers, or by identifying a development agency willing to fund or even oversee a school construction project.

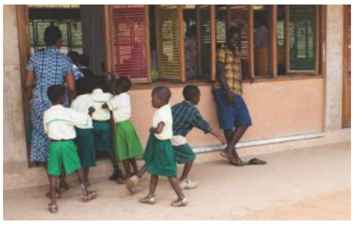
Communities typically contribute to building public schools by providing in-kind labour, materials, or cash to support a hired contractor. Community elders may also attempt to monitor construction to ensure contractors complete their contract, but safety remains a concern given the technical nature of the build.

Contractors failing to properly attach roof trusses to building frames is a common problem in Ghana. Many schools have lost their roofs in high winds, and similar damage can result from seismic tremors in the south of the country.

Incorporating sustainability into design
In 2008, Sabre Charitable Trust teamed up with technical experts from Arup International Development to design and construct safe, affordable, and environmentally sustainable kindergartens to meet the needs of communities living in central and western Ghana.

During design, the first step was in-depth research into local design and construction skills.
The design team ensured the materials were not just local, but also readily available, and even checked local markets to see what was for sale. They also aspired to 'build from the ground up', meaning they were literally attempting to pull resources from the earth and incorporate them into the school building.

When local building practices and conventional materials were not likely to produce a safe building, the team turned to research. They tested local materials, focusing on the strength and durability of local soil-based materials. Some communities used soil to produce bricks, but the quality of the soil and manufacturing processes varied. These and other local practices had to be informed by tested engineering options that increased safety and durability.



An innovative facade made using pivoting bamboo shutters to allow the most natural light and ventilation. Photos: Arup International Development and Sabre Trust.

Challenges: perceptions of local materials
Convincing communities to build with soil and other local materials proved challenging. In Ghana, communities wanted to use concrete and other materials they associated with development. Building school buildings completely out of natural and local materials, and following vernacular practices, put the school at risk of being seen as undesirable. Rather than disregarding the community's notion of progress and pushing local materials for the sake of environmental sustainability, the team had to build trust over time.

The community saw some value in vernacular design but also wanted modern materials. The team opted for a compromise in material choice consisting of a concrete frame, with traditional materials like bamboo and stabilised soil blocks used as infill walls.

At first, the prospect of building with mud seemed unappealing to the community. After training on how to improve manufacturing, which included sifting the soil and mixing it with local stabilising agents like portland cement and pozzalana, community members saw the result as an improvement. The improved soil blocks became more desirable, and proved stronger than the local concrete blocks. In addition, their involvement in the whole process of design and manufacturing gave the community a vital sense of ownership.

By using a concrete structural skeleton designed to resist seismic loads, infill walls could be made from renewable and local materials. This design feature, and the concrete frame's modular form, ensured the design could be scaled up and down, and duplicated. Locals were already erecting concrete frames, but at the time the construction quality was poor. The new designs allowed the community to increase local skills in creating vital structural elements for future infrastructure.

The concrete was made from using locally-sourced pozzolana (a mix of clay and palm kernels) as a 30 per cent substitute for portland cement. Using local materials for the infill walls also increased the building's sustainability and made it easier for communities to contribute to the building process and do routine maintenance. The durable concrete frame is designed to bear the force of shaking, high winds or other hazards. This provided the team with an opportunity to use different or new materials for the works without fear of compromising safety.

Design requirements focused on building for functionality as well as sustainable material choices. The design team created classroom layouts to meet performance criteria for daylight, temperature, and acoustics. This provided a high-quality learning environment without the need for external energy. Every building element had at least two functions so that no materials were wasted and add-ons were unnecessary.

Key lessons:

• Ensure the design team conducts in-depth research into local building materials, processes, and aesthetics.

• Understand the gaps in safety that may exist in traditional building techniques or current practices.

- Develop sufficient trust to show communities they can improve and refine traditional building techniques.

• When appropriate, draw materials from the natural environment. Be sure to use at a sustainable rate.