

Collège Amadou Hampaté Bâ: An exemplar school design for the Sahel, combining passive cooling techniques with an innovative use of natural materials



Project Name	Collège Amadou Hampaté Bâ
Location	Niamey, Niger
Climate Zone	Hot semi-arid (BSh)
Latitude/Longitude	13.5128° N, 2.1128° E
Building Type	School
Floor Area [sqm]	≈ 970 m ² (internal + external)
Building Height [m]	Single storey
Number of Storeys	G + 0
Completion Year	2022
Project Team	Client – Collège Amadou Hampaté Bâ Architect – Article 25 Structural Engineer – MHA Structural Design M&E Engineer – Max Fordham Main Contractor – Afrique Univers SARL Site Architect – Gyormbey Kodzo Adaly-Mortty Photographers – Toby Pear, Grant Smith, Souleymane Ag Anara, Nicolas Réméné

1. Project Description

Project Overview

Collège Amadou Hampâté Bâ is a landmark in humanitarian architecture and the first NGO-led project to win a RIBA International Award for Excellence. Designed by Article 25 with Max Fordham and MHA Structural Design, it demonstrates that high-performance, low-energy design can thrive even where resources are scarce.

The school's expansion and refurbishment created eight new classrooms, administration and sanitation blocks for 1,200 students. In Niger's extreme climate – where temperatures regularly exceed 40 °C – the design prioritised passive cooling, using natural ventilation, thermal mass and careful orientation to deliver comfortable learning spaces without mechanical cooling.

At its core is a double-roof system popularised by Francis Kéré: vaulted ceilings made from compressed earth bricks beneath a lightweight steel fly roof. This layered envelope shades the structure and draws air through the roof cavity, reducing internal temperatures by 7–8 °C. Walls of locally quarried laterite stone provide thermal mass and a distinct regional character, challenging the status quo of cement construction in Niger.

The project's achievements extend beyond climate performance: it created jobs, trained local masons and young women, and shifted attitudes toward natural materials and inclusive practice in construction.

2. Climate & Site Context

Basic Climate Conditions		
Temperature	Annual Average	≈ 30 °C
	Annual Range	20 °C (Jan) – 43 °C (May)
Relative Humidity	Annual Average	≈ 35 %
	Annual Range	15 % (Mar) – 70 % (Aug)
Annual Degree-Days (ASHRAE Standard 169-2020)		HDD 18 ° C: ≈ 50 CDD 10 ° C: ≈ 7,500
Climate Analysis		
<p>Niamey's hot semi-arid climate is characterised by intense solar radiation, low rainfall, dust storms and erratic electricity supply. Daytime temperatures regularly reach 45 °C, with large diurnal swings. These conditions demanded a design that could passively regulate heat without mechanical systems. Prevailing north–south winds were harnessed for natural cross-ventilation, and shading was prioritised to minimise solar gain. The lightweight fly-roof creates a ventilated air cavity that removes heat before it enters occupied spaces.</p>		

Site Analysis

The college occupies a flat, dusty site in Niger’s capital Niamey, which has limited vegetation or infrastructure. Orientation and layout were key to achieving comfort – the longitudinal classroom blocks run east-west in order to capture prevailing wind and reduce direct solar exposure. Local materials within 10 km of the site were used to minimise transport impacts and embed the school in its context. Outdoor spaces between classroom blocks provide shaded, naturally ventilated study areas that extend learning beyond the classroom.

3. Passive Cooling Design Details

Passive Cooling Strategies (please tick implemented passive cooling strategies)

- Building Orientation & Form (site orientation, building shape, etc.)
- Envelope Design (insulation, air-tightness, shading, window system, thermal mass, etc.)
- Natural Ventilation (cross ventilation, stack ventilation, night ventilation, etc.)
- Evaporative Cooling (direct/indirect evaporative cooling, etc.)
- Ground Cooling (geothermal, ground-coupled systems, basement/underground space, etc.)
- Radiative Cooling (cool roof, night sky radiation, radiant barriers, reflective surfaces, etc.)
- Nature-based Solutions (green roof/wall, tree shading, etc.)
- Others (human behavior, clothing, semi-passive (fans, etc.)) Human behaviour / semi-passive measures

Description (please describe one strategy per box – you can add more boxes below if needed)

Building Orientation & Form

Buildings are oriented north–south to capture prevailing winds and minimise solar exposure on east and west façades. This simple yet effective orientation works in tandem with the school’s distinctive double-roof form, which was modelled to draw air through the ventilated cavity between the vaulted ceilings and the elevated steel fly roof. As hot air rises, it is expelled through the cavity, pulling cooler air through the classrooms below and maintaining continuous airflow throughout the day.

Large roof overhangs shade the walls and windows, reducing direct solar gain, while covered verandas create shaded transitional spaces that function as informal outdoor learning areas. The diagonal spans of the roof between classroom blocks form open study courtyards where students often gather to complete homework after school - an indication of how spatial form contributes to comfort and usability. The overall layout balances density with airflow, ensuring that every classroom benefits from shade and cross-ventilation. These strategies not only achieve measurable cooling - up to 8 °C below outdoor temperatures - but also create dynamic, uplifting spaces that connect architecture, climate, and community use.

Envelope Design

The building envelope combines local materials and passive physics to maintain a stable, comfortable internal climate. Laterite stone walls and compressed stabilised earth vaults provide substantial thermal mass, absorbing heat during the day and releasing it slowly at

night to even out diurnal temperature fluctuations. This heavy, breathable envelope limits internal temperature peaks and avoids overheating without insulation or air-tight barriers.

The lightweight steel fly roof above the vaults reflects solar radiation and shades the heavy structure beneath, dramatically reducing heat gain. The air gap between the two layers allows hot air to dissipate naturally, supported by the roof's carefully calculated slope and orientation.

Small window openings and a targeted daylight factor of 1–1.5 % ensure visual comfort without glare or excess solar load, reducing the need for shading devices or artificial cooling. By integrating thermal mass, shading, and reflectivity, the envelope operates as an active environmental system. It requires no mechanical energy, minimal maintenance, and has proven capable of maintaining indoor temperatures up to 8 °C cooler than external conditions - an outcome that far exceeds local building norms in Niger's extreme heat.

Natural Ventilation

Natural ventilation lies at the core of the school's passive design. The classrooms are designed to take full advantage of prevailing north–south winds, with strategically positioned openings that encourage cross-flow. Operable louvres and high-level vents allow occupants to adjust airflow while protecting against dust storms, which are common in Niamey's dry season.

The stack effect generated by the vaulted ceilings and double roof further enhances air movement. As warm air rises through the classroom vaults, it escapes into the roof cavity, where the fly roof geometry accelerates air extraction through pressure differentials. This process continuously draws fresh air in at low level, maintaining ventilation even in still conditions.

Ceiling fans are installed in selected rooms to supplement air movement during the hottest periods, but the design performs effectively without mechanical assistance. This low-tech, climate-responsive approach ensures that air quality and thermal comfort are maintained despite the region's high ambient temperatures and limited electricity infrastructure. The success of this strategy is evident in occupant feedback: classrooms remain comfortable even at 40 °C outside, with students often returning after hours to study because the environment is cooler than at home.

Laterite Stone and Thermal Mass

Locally quarried laterite stone is both a structural and environmental cornerstone of the project. Sourced by hand approximately 10 km from the site, the stone's density and high thermal mass enable it to absorb and store heat during the day, releasing it gradually as night falls. This moderates indoor temperatures and significantly reduces the amplitude of daily thermal swings. The natural breathability of laterite also allows limited air and moisture diffusion, maintaining a comfortable indoor humidity level.

Used as both wall material and permanent formwork for reinforced columns, the stone eliminates the need for additional timber formwork or concrete blockwork, lowering embodied carbon. Its warm red hue and tactile finish express the local landscape, connecting the building visually and culturally to its context. The use of laterite also supported local employment, with experienced masons from Burkina Faso training Nigerien workers in its construction techniques.

The combination of local sourcing, high performance, and cultural resonance makes laterite a vital component of the school's passive cooling strategy. It exemplifies how indigenous materials, when refined through careful design, can deliver both environmental efficiency and architectural beauty in regions facing extreme heat.

4. Active Components

Active (Hybrid) Cooling Strategies

(please describe one strategy per box – you can add more boxes below if needed)

Minimal active systems are used. Electricity is limited to lighting and occasional fans. Four 300 W PV panels on the water tower power a solar pump for the well water supply. Sanitation relies on latrines and soakaways emptied every six years – a low-maintenance, off-grid solution appropriate to local infrastructure.

5. Performance Data

Cooling Energy Use

The new buildings operate entirely without mechanical cooling, achieving **zero operational energy use for cooling**. This success lies in the integration of passive strategies - thermal mass, cross-ventilation, shading, and the innovative double-roof system - which together maintain comfortable internal conditions throughout the year.

Temperature sensors installed in several classrooms recorded data over a three-month monitoring period. Results showed that internal air temperatures remained consistently **7–8 °C lower** than outdoor readings during the hottest part of the day, even when classrooms were fully occupied by up to 40 students. This performance is particularly notable in Niamey's extreme climate, where outdoor temperatures regularly exceed **40 °C** and relative humidity remains low.

By replacing energy-intensive air conditioning with passive cooling, the design achieves an estimated total operational energy use of **less than 30 kWh/m² per year**, a fraction of the energy demand typical of conventional school buildings in similar climates. The building's performance demonstrates that comfort in hot, arid regions can be achieved through form, material, and airflow alone - without mechanical intervention or ongoing energy costs. These results position Collège Amadou Hampâté Bâ as a benchmark for net-zero operational energy performance in educational architecture across the Sahel.

Indoor Thermal Comfort

Measured data and occupant feedback confirm that the passive cooling strategies have delivered a significant improvement in indoor comfort and well-being. Temperature sensors and qualitative interviews show that the classrooms maintain a **comfortable thermal environment** well within adaptive comfort limits for hot, dry climates. Even during peak afternoon heat, when outdoor temperatures surpass **40 °C**, internal readings remain in the low 30s, creating a tolerable and productive environment for teaching and learning.

Teachers report that lessons continue uninterrupted during hot periods, and students are noticeably more focused and alert than in older, unshaded classrooms on the same campus. The most striking endorsement of the design comes from students themselves: many choose to return after school hours to complete homework in the cooler study areas between classrooms, where shaded airflow provides relief from the heat at home.

The combination of high thermal mass, controlled daylighting, and natural ventilation has proven remarkably effective in maintaining steady, comfortable conditions with no mechanical support. The resulting improvement in concentration, attendance, and engagement demonstrates that passive design is not just a technical solution - it directly enhances educational outcomes and community well-being, making comfort a driver of social as well as environmental sustainability.

6. Financial Data

Cost Benefits

The adoption of passive cooling strategies at Collège Amadou Hampâté Bâ delivers significant financial advantages over the lifetime of the building. By relying entirely on natural ventilation, shading and thermal mass, the school avoids all costs associated with conventional mechanical cooling systems. This includes the initial capital expenditure for air-conditioning units, the ongoing cost of electricity to operate them and the long-term cost of maintenance, replacement parts and specialist servicing.

Although precise figures were not calculated, the avoided expenditure represents a substantial saving both in the short and long term. In a context where electricity supply is unreliable and expensive, eliminating dependence on powered cooling is a decisive economic benefit. The building's passive systems have no moving parts, require minimal upkeep and have proven effective year-round, resulting in negligible operational costs.

By investing in locally sourced materials and simple, durable construction techniques, the project channels resources into the regional economy rather than imported technology. The outcome is a school that achieves enduring thermal comfort with zero energy demand for cooling, ensuring predictable running costs and long-term affordability. This approach demonstrates that passive design is not only environmentally responsible but also the most financially sustainable solution in hot, resource-limited climates.

*Please try to extract passive cooling cost and savings; however, if it is difficult, please annotate the premise. (e.g., the calculation includes the cost for both passive heating and cooling, etc.)

7. Passive Cooling Operation

Maintenance Requirement

Maintenance requirements are intentionally minimal, reflecting the project's goal of long-term resilience with low operational cost. The passive cooling strategies function without mechanical systems, eliminating the need for air-conditioning maintenance or energy inputs. Routine care focuses on simple, locally manageable tasks: periodic inspection of the steel fly

roof and rainwater drainage, cleaning and adjustment of the ventilation louvres, and occasional repointing of laterite joints to maintain airtightness and durability.

The solar-powered water pump requires basic annual servicing, which can be handled by trained local technicians. Because the building fabric itself performs the environmental regulation - through shading, ventilation, and thermal mass - the overall maintenance burden is low, predictable, and affordable for the school. This simplicity ensures that performance is sustained year after year, even in a context where resources and technical support are limited, making the design both robust and self-sufficient.

8. Lesson Learnt / Recommendations

Technical Challenges, Solutions and Achievement

Delivering the project required overcoming multiple technical challenges unique to Niger's climate and construction context. Both the use of laterite stone and the double-roof system were unfamiliar to the local workforce, demanding careful testing and on-site training. The design team conducted material strength and thermal performance tests to ensure the laterite and compressed earth blocks met structural and environmental standards.

Supply chain disruptions and regional instability created further obstacles, particularly during the pandemic and periods of border closure. To mitigate this, Article 25 worked closely with contractors and local suppliers to source materials within a 10 km radius, reducing dependency on imports. Despite these constraints, the team successfully demonstrated that passive cooling could deliver measurable comfort and durability. The project has since become a reference point for institutional buildings in extreme climates, proving that well-executed natural design can outperform conventional construction methods.

Financial Challenges, Solutions and Achievement

While the passive design strategies themselves generated long-term cost savings, the project faced several financial challenges during construction. The global pandemic disrupted supply chains and caused a sharp rise in material prices, particularly steel, which increased the cost of the fly-roof structure. This inflation placed pressure on the project budget and required careful coordination between the design and construction teams to ensure essential performance features were retained within available resources.

Despite these challenges, the use of locally available materials - laterite stone and compressed earth blocks - helped offset some of the financial impact by reducing transport costs and reliance on imported products. These materials were inexpensive, durable, and easily sourced near the site, providing stability at a time of global price volatility. Overall, the project demonstrated that even amid economic uncertainty, passive cooling strategies and local sourcing remain financially resilient and deliver long-term value.

Other Challenges, Solutions and Achievement

Beyond technical hurdles, the team faced cultural perceptions that equated earth construction with poverty. Many community members initially preferred concrete and glass as symbols of modernity and progress. Through dialogue, mock-ups, and proof of thermal performance,

trust was built and in most cases attitudes shifted - showing that local materials can create modern, high-quality spaces.

Gender inclusion was another challenge in a male-dominated sector. Working with the contractor, Article 25 introduced on-site training for young women - many former students - covering masonry, formwork, and finishing. Their success became a visible marker of social progress and empowerment.

By linking cultural engagement and skill-building to construction, the project achieved more than environmental innovation: it inspired systemic change and set a precedent for inclusive, locally led architecture. These achievements, alongside technical excellence, earned global recognition through RIBA Awards of Excellence 2024, AIA UK Awards 2024, IStructE Structural Awards 2023, and selection by Architonic and ArchDaily.

9. Free Description

Free Description

Collège Amadou Hampâté Bâ is a benchmark for climate-adaptive design in one of the world's harshest environments. Designed by Article 25 with Max Fordham and MHA Structural Design, it proves that comfort and sustainability can be achieved through passive strategies and local resources rather than energy-intensive systems.

In Niamey, Niger - where summer temperatures exceed 40 °C - the school stays up to 8 °C cooler than outside air without mechanical cooling. A double-roof system combines compressed earth vaults with a steel fly roof that shades and ventilates the structure. Cross-ventilation, thermal mass, and optimal orientation ensure year-round comfort for 1,200 students.

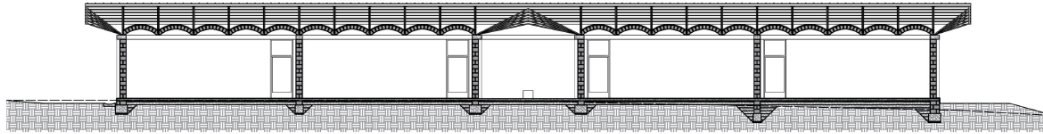
Built from laterite stone and stabilised earth blocks sourced within 10 km, the project minimises embodied carbon while celebrating regional craftsmanship. This approach reduces transport emissions, supports local economies, and challenges reliance on imported cement—showing traditional materials can deliver high-performing, contemporary architecture.

Beyond environmental gains, the project trained local masons and introduced women to construction for the first time in this community, building skills and confidence that now benefit future projects.

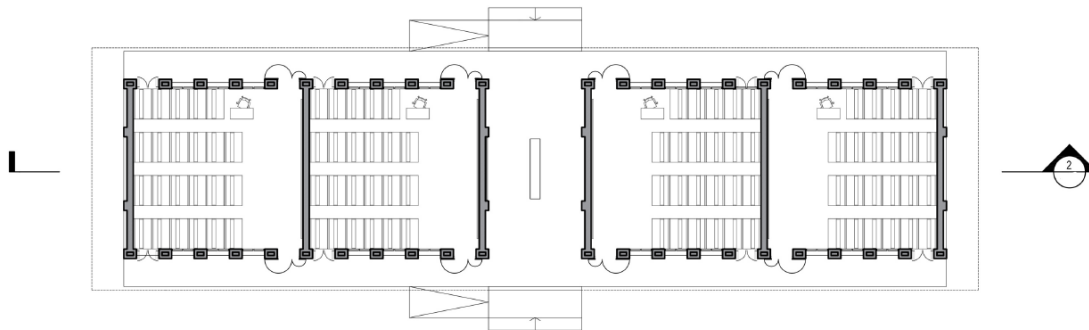
Replicable, low-maintenance, and affordable, the design offers a scalable template for schools, clinics, and community buildings in hot, arid climates worldwide. **Its pioneering approach has earned global recognition, including RIBA Awards of Excellence 2024, AIA UK Awards 2024 for Sustainability, IStructE Structural Awards 2023, and selection as one of Architonic's Projects of the Year.** Collège Amadou Hampâté Bâ demonstrates that passive cooling and context-driven design can transform education, livelihoods, and resilience.

10. Annex

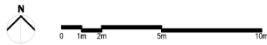
Supporting documentations



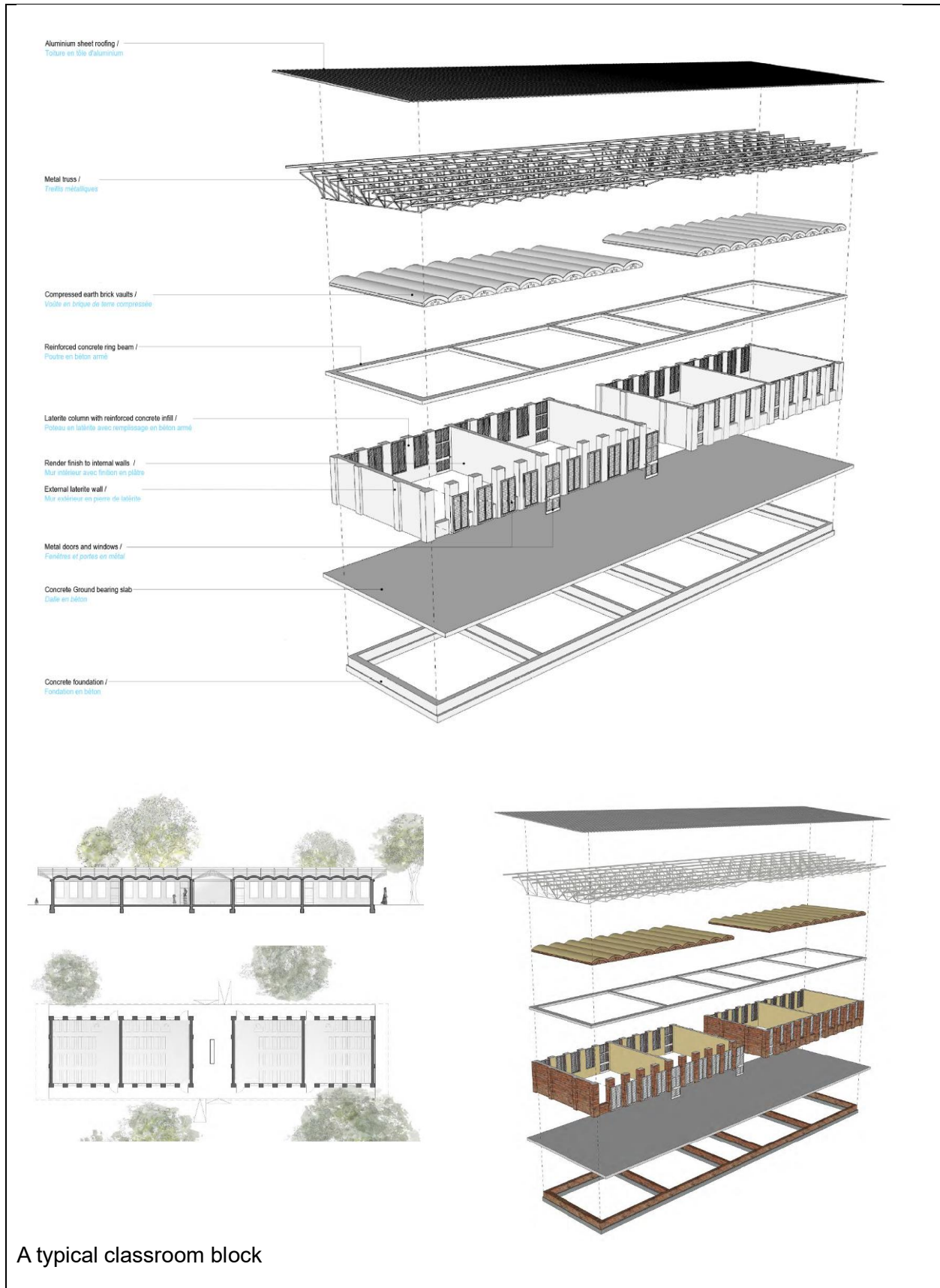
2 Classroom Block A Long Section / Coupe longitudinale du bloc de Classe A



1 Classroom Block A Plan / Plan du bloc de classe A

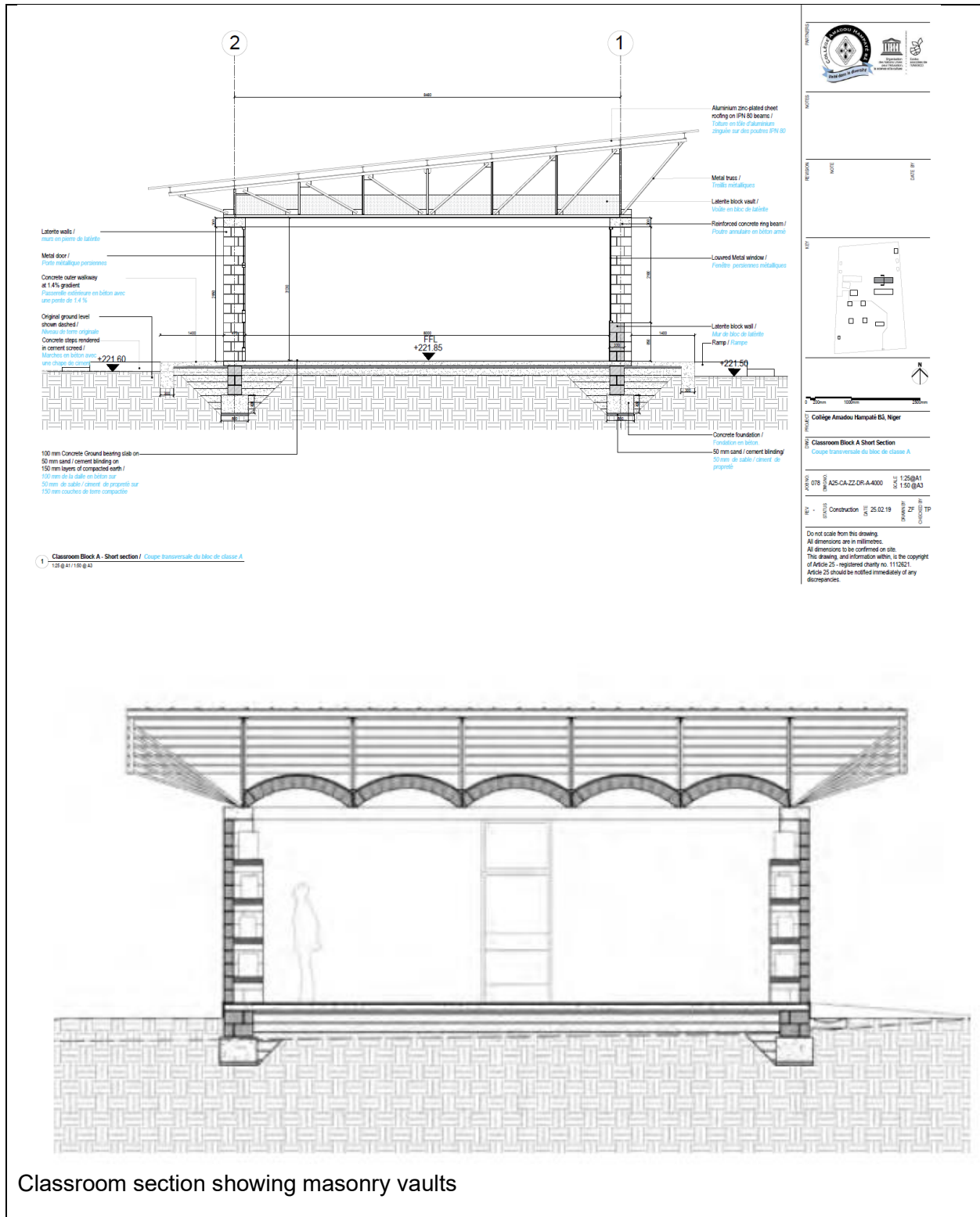


Plan and section of a Classroom Block

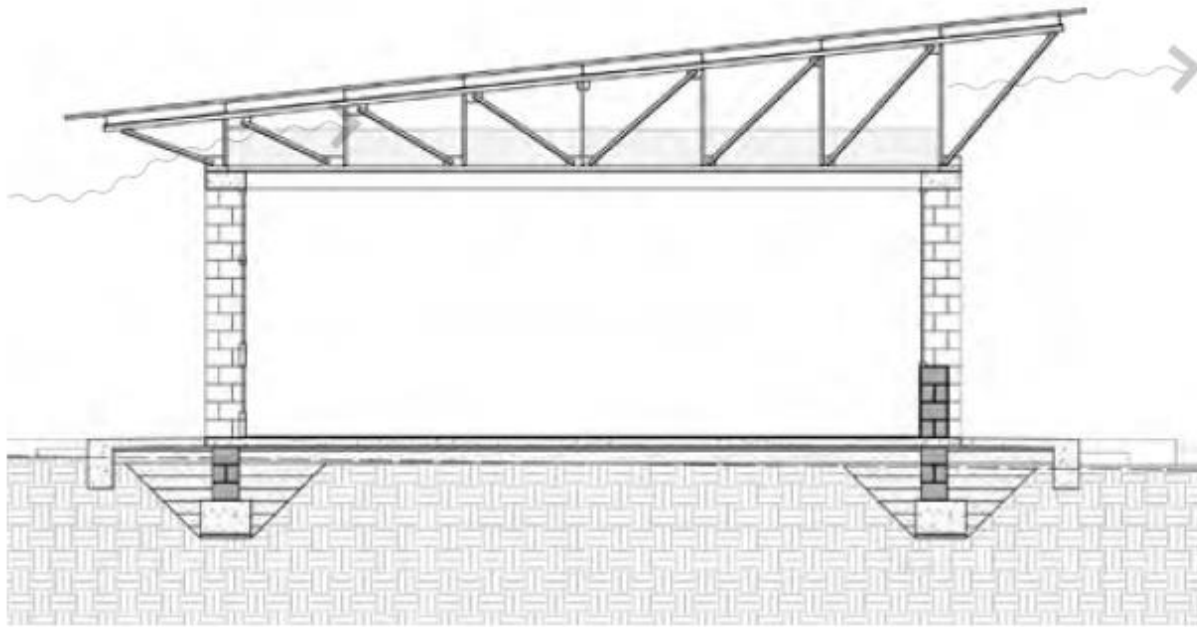




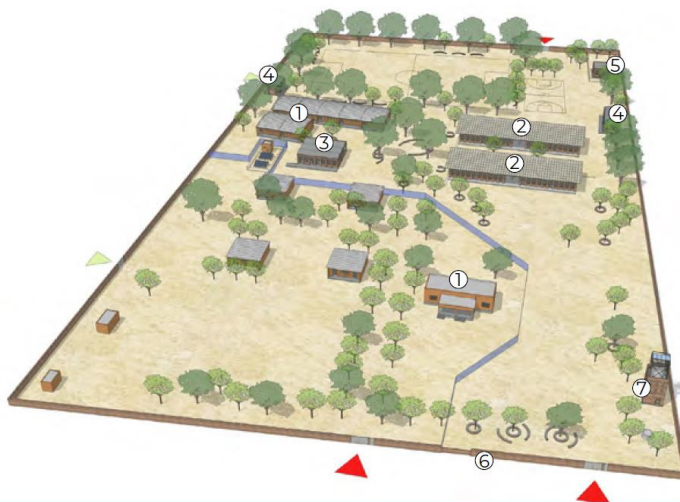
Sectional perspectives of the proposed classrooms



Classroom section showing masonry vaults



Classroom section -showing lightweight roof pitch

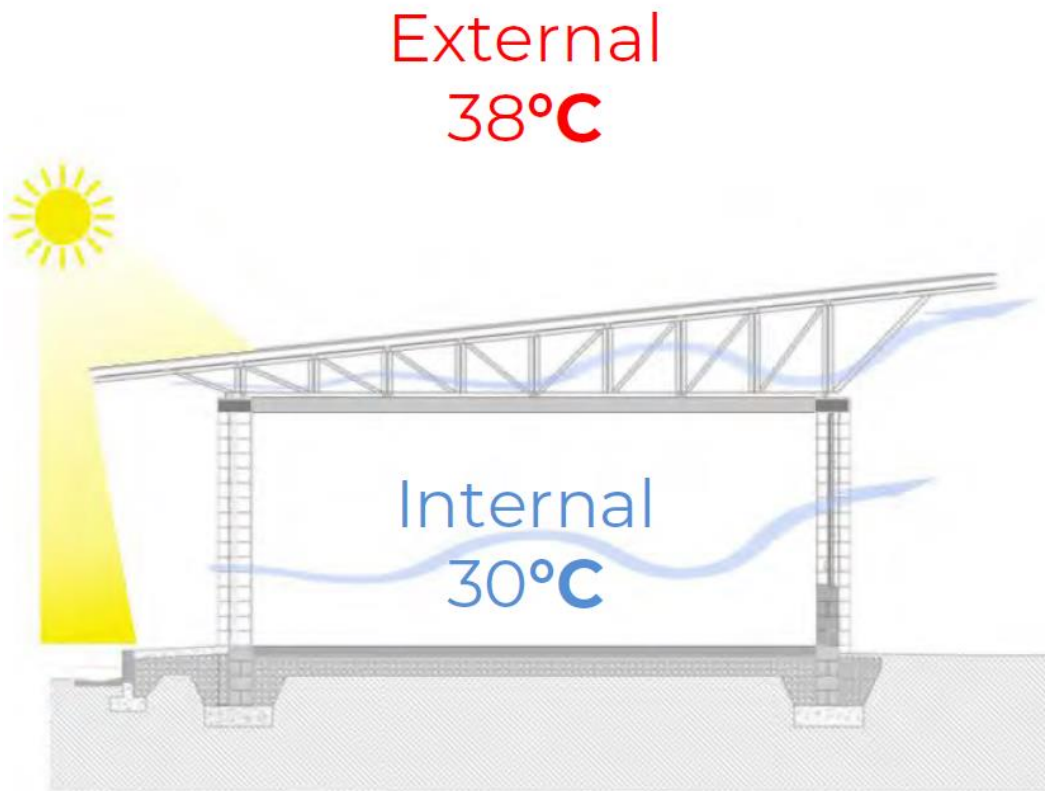


- ① Existing Classrooms and Admin Block refurbished
- ② New Secondary School Classrooms
- ③ New Admin Block
- ④ New Latrines
- ⑤ New Guard's House
- ⑥ Repair of boundary wall
- ⑦ New Water Tower and landscaping

Scope of Phase 2 development



Niger and the Sahel



Passive design and climatic performance



CSEB
0.42 MJ/kg



Fired Brick
2.5 MJ/kg

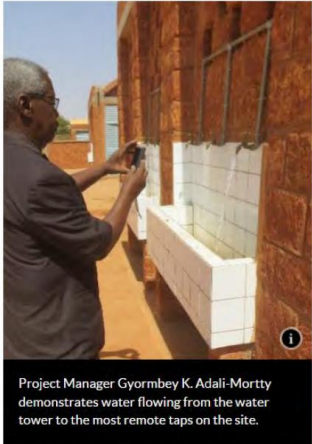


Cement Block
0.94 MJ/kg



Laterite
0.0 MJ/kg (negligible)

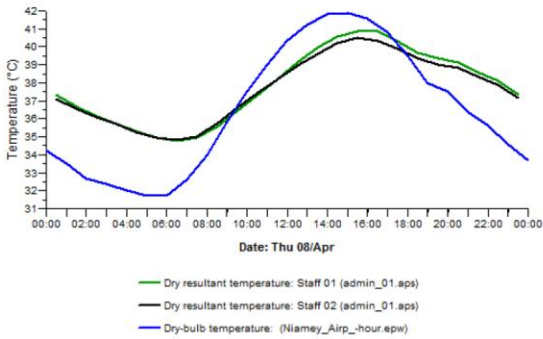
Embodied energy of commonly used bricks/blocks.



Project Manager Gyormbey K. Adali-Mortty demonstrates water flowing from the water tower to the most remote taps on the site.



New latrines



Example temperature variation in administrative block

Supporting photography.



Laterite stone building block. Credit: Grant Smith



Digging up laterite from the ground in local quarry. Credit: Grant Smith



Construction using laterite stone blocks. Credit: Grant Smith



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Construction of a classroom block. Credit: Nicolas Réméné



Completion of on-site construction training for young women. Credit: Grant Smith



Students in one of the classrooms. Credit: Toby Pear



Classroom block facade. Credit: Toby Pear



Shaded study place of classroom block. Credit: Toby Pear



Students walking in between classes. Credit: Souleymane Ag Anara



Student drawing on the blackboard. Credit: Toby Pear.



Students in one of the classrooms. Credit: Toby Pear



Students in classroom, plus the exposed laterite brick ceiling. Credit: Souleymane Ag Anara





Aerial views of school buildings. Credit: Souleymane Ag Anara

11. Citation

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12. Contact

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