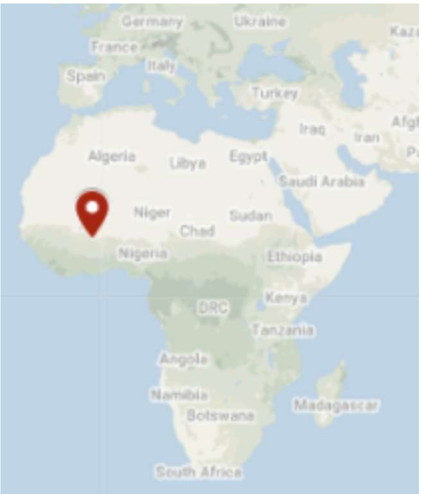
CASE STUDY 2-07: LYCEE SCHORGE | BURKINA FASO



GEOGRAPHICAL AND CLIMATE INFORMATION	
Location	B.P. 322, Koudougou, Burkina Faso
Latitude; Longitude	12.216743389817205, -2.3780847033262478
Climate zone (Köppen–Geiger classification)	BSh: Hot semi-arid steppe
BUILDING INFORMATION	
Building Type	Educational
Project Type	New construction
Completion Date	2016
Number of buildings	1
Number of storeys	1
Covered Area (m²)	1660
Usable area (m²)	83.6 per module / 752.4 in total
Thermally conditioned space area (m²)	**0**
Spaces with Natural Ventilation (with or without Ceiling Fans) Only (m² of usable area)	752.4
Total cost (€)	Unknown
Cost /m² (€/m²)	Unknown
Performance Standards or Certification	None
Awards	None
STAKEHOLDERS	
Building Owner/ Representative	Stern Stewart Institute & Friends
Architect	Kéré Architecture - Diébédo Francis Kéré
Design team	Jin-Gul David Jun, Pedro Montero Gosalbez, Dominique Mayer, Diego Sologuren Martin, Marta Migliorini, Jaime Herraiz Martínez, Adriana Arteaga
Construction management and Supervision	Association Dolai, Diébédo Francis Kéré, Marta Migliorini, Nataniel Sawadogo, Wéneyida Kéré

PROJECT DESCRIPTION

The architecture of the school is based on nine rectangular modules arranged radially around a courtyard, that prevents wind and dust from entering in the central space. The different modules accommodate classrooms and administration rooms. Besides, a series of steps creates a loosely defined amphitheatre, where informal gatherings and assemblies' celebrations for the school and wider community take place.

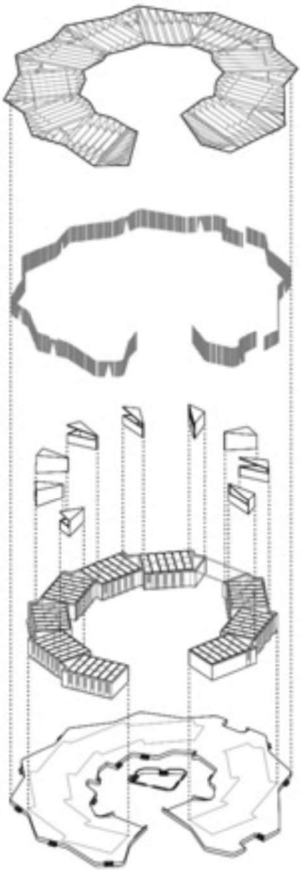


Figure 93 : Exploded axonometry of the ring-shaped Lycée Schorge. © Kéré Architecture

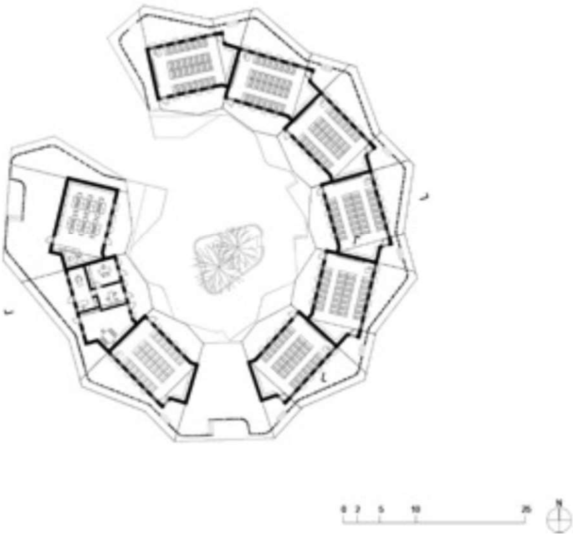


Figure 94 : Floor plan of the Lycée Schorge. The modular structures are arranged radially around a courtyard. © Kéré Architecture

SITE INTEGRATION

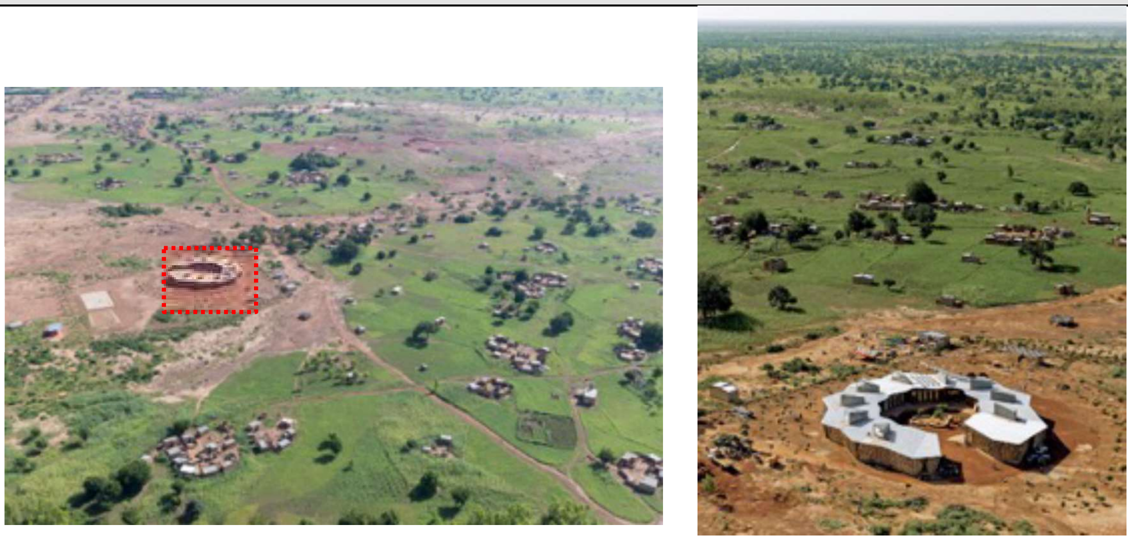


Figure 95 : Bird's-eye views of Lycée Schorge in its surrounding environment. © Iwan Baan

The building is located on a flat swath of semi-arid land and floodplain of the city of Koudougou, in Burkina Faso. The site is characterized by a low building density and sparse vegetation. The choice of the materials, with a mix of wood and stones, allows the building to fit into its natural environment.

CLIMATE ANALYSIS

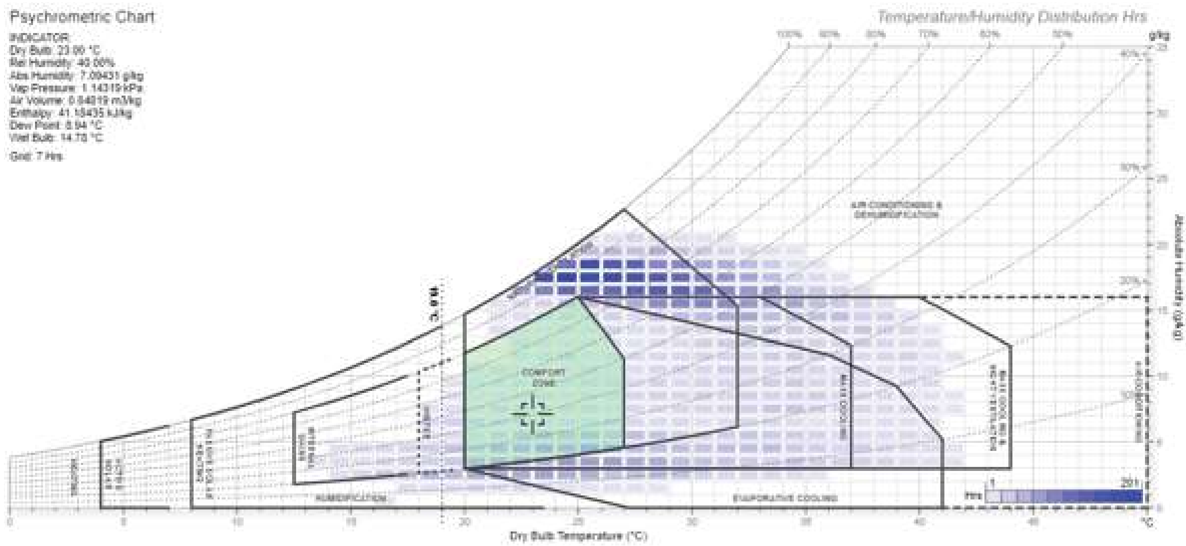


Figure 96: Givoni Bioclimatic chart for the climate of Koudougou using Andrew Marsh online tool [2]. Weather data are extracted from the PVGIS tool of the jrc for the 2007 – 2016 period.

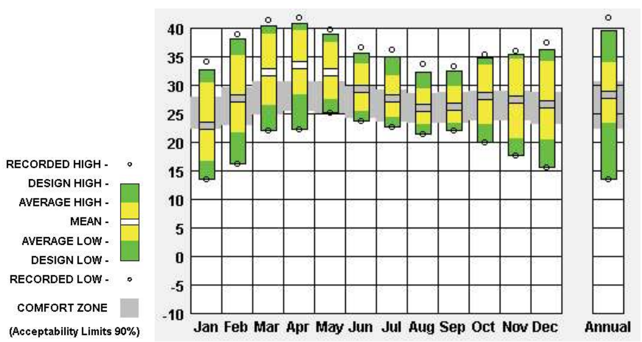


Figure 97: Temperature range by month for Koudougou, Burkina Faso (Source: Climate consultant – Adaptative Comfort model).

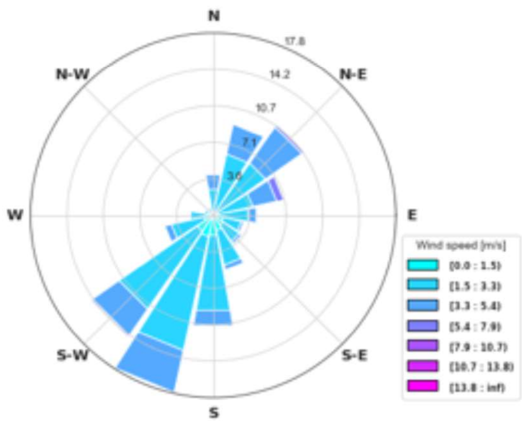
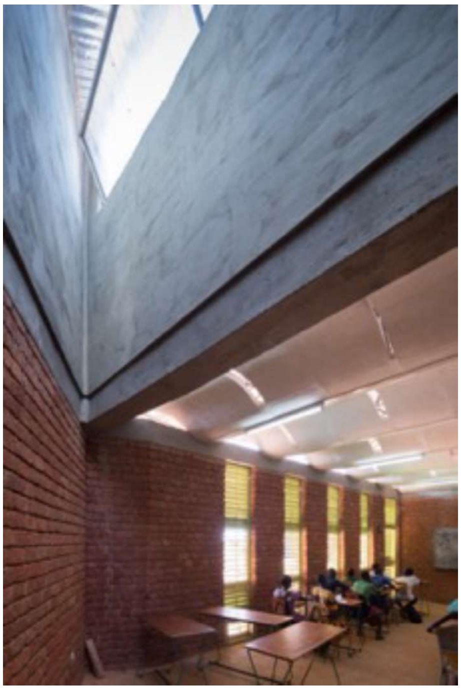
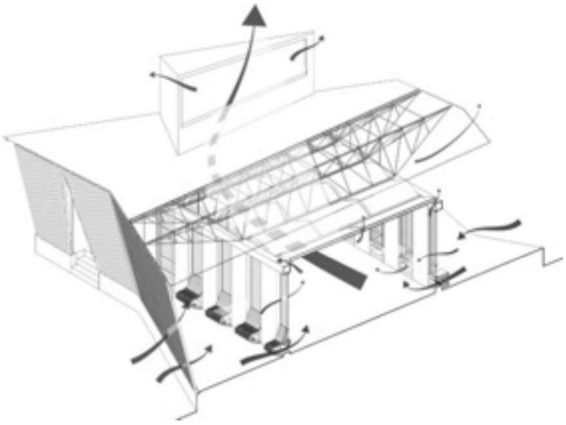
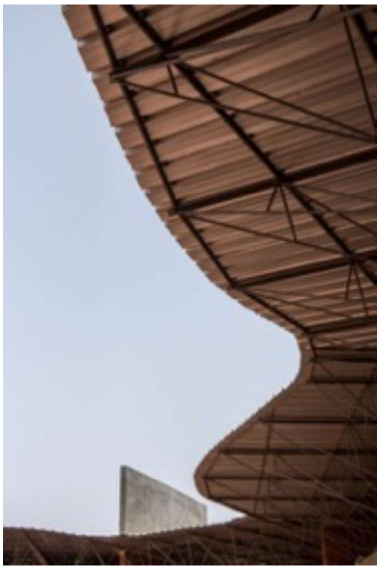


Figure 98: Wind rose for Koudougou, Burkina Faso

Global horizontal radiation (Avg daily total) Min (month) / Max (month)	Min: **5 685** Wh/m² (July) Max: **6 844** Wh/m² (May) Mean: **6 228,2** Wh/m²
Annual Degree-Days for weather classification according to ASHRAE Standard 169-2020	HDD 18°C: **8** CDD 10°C: **6 698**
Annual Degree-Days for the Adaptive Comfort Base Temperature according to the ASHRAE 55-2017	HDD: **72** CDD: **387**
Annual Degree-Days for a static comfort temperature approach	HDD 18.6ºC: **13** CDD 26º: **1 197**

KEY BIOCLIMATIC DESIGN PRINCIPLES	
Passive cooling strategy  *Figure 99: Interior view of the classroom with the wind-catching towers © Iwan Baan.*	Comfort ventilation: Natural cross-ventilation and stack effect. Different passive features have been implemented in order to ensure that the interior spaces would be cooled naturally. Firstly, the louvered shutters installed on opposite facades enhance natural cross ventilation. In addition, wind-catching towers planted on top of the classrooms allow the air to flow in out of the rooms.  *Figure 100: Climate diagram showing the natural ventilation principle © Kéré Architecture*
Passive heating strategy	High thermal mass of the walls, which are composed of laterite stones.
Solar protection  *Figure 101 : Large roof overhangs provide shading spaces. © Andrea Maretto for Kéré Architecture.*	Large roof overhangs protect the louvered shutters and the main facades of the modules. The eucalyptus “screens” form a transparent fabric system all around the classrooms and create intermediary shaded spaces where students can gather. They also protect the classrooms from direct solar radiation, reducing heat gain.  *Figure 102 : Wooden screens protect the building from wind, dust and direct solar radiation. © Iwan Baan*
Building orientation	The modules are differently oriented due to the ring-like arrangement of the building.

Insulation	The laterite stones that composed the walls provide an excellent source of thermal mass, absorbing the heavy daytime heat and radiating it at night. The roof is composed of sheet metal which is separated by an air gap from the concrete ceiling to form a ventilation chamber that7 dissipates solar radiation.
Vegetation	Over 2,000 tree seedlings, such as mango trees, flamboyant trees, orange trees and so on, planted by pupils and students as part of the institution's ecological commitment, will create a forest around the campus in a few years. A bench surrounds each seedling to protect it, and will create a comfortable spot in the shade.
Natural daylighting	The massive undulating ceiling, made of perforated plaster vaults, diffuse indirect sunlight in order to improve daylight levels inside the rooms while avoiding the heat otherwise caused by direct radiation. Besides, the ceilings are painted white to optimize the diffusion of light in the spaces. The louvered shutters provide more natural light.
Use of local and embedded materials	The walls of each module are composed of locally sourced laterite stone. After extraction from the earth, the laterite is cut and shaped into bricks, which are then exposed to the sun to harden. The "screens" that wrap around the modules are made of locally available eucalyptus wood.
Water saving	A watertank of 10m^3 is installed on site. A rainwater catchment basin and a well ensure the campus to be self-sufficient.
Waste management	In order to minimise costs and reduce material waste, the school's furniture is made from local hardwoods and steel offcuts from the roof construction.

Figure 103: View of the courtyard of the Lycée Schorge © Andrea Maretto for Kéré Architecture.

INFRASTRUCTURES and REGULATIONS to enable SUFFICIENCY ACTION	
Dressing code	Informal dressing, adapted to the season, is welcome and promoted (e.g. short trousers and short leaves in hot periods): **Yes**
Protected bike parking and showers	**Yes** Ratio with number of users: **-**
Ceiling fans	In every room, even those conditioned: **In some classrooms only, not in all spaces.**
Lighting system fractioned to allow using light only in zones occupied and where daylighting insufficient	In every room, even those conditioned: **Yes**
Space and facilities for line drying clothes (especially important in residences, hotels, sport facilities…)	In every room, even those conditioned: **No**
Book of instruction for correct use of the passive features (windows, solar protections, water savings) and active (lighting…) in order to promote sufficiency and efficiency actions	Available through leaflets and posters at relevant places, online, etc.: **No**

Figure 104 : Exterior view of the building.

BUILDING FABRIC AND MATERIALS	
Roof	The roof is composed of (from the outside to the inside): ▪ metal sheet ▪ iron structure with air gap ▪ concrete ceiling ▪ perforated plaster vaults
Windows	Unglazed windows Metal louvers
	Window-to-wall ratio (WWR): -
Walls	The **walls** are composed of **20 cm** of local **laterite stones** (*BLT- Le Bloc de Laterite Taillé in French)*

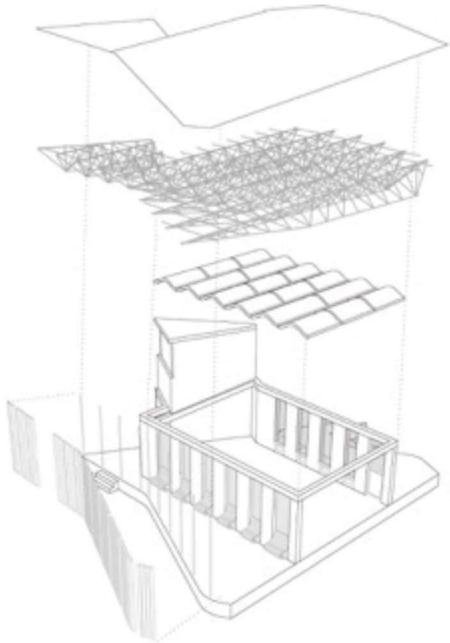


Figure 105: Exploded view of a typical classroom, showing the roof structure. © Kéré Architecture

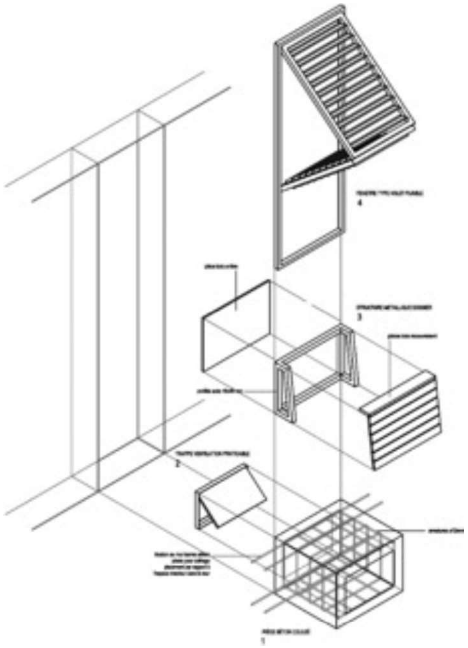


Figure 106: Details of the louvered shutter systems installed in Lycee Schorge © Kéré Architecture

ENERGY EFFICIENT BUILDING SYSTEMS	
Low-energy cooling systems	None
Low-energy heating systems	None
Ceiling fans	None
Mechanical ventilation / air renewal	None
Domestic Hot Water	None
Artificial lighting	Fluorescent tubes
Control and energy management	None

Figure 107: Interior view of a classroom. The undulating ceiling pattern allows to diffuse natural light. © Andrea Maretto for Kéré Architecture

Figure 108 : View of the wind catcher at the top of the building ©

RENEWABLE ENERGY	
PV	None
Solar thermal	None
Wind	None
Geothermal	None
Biomass	None

BUILDING ANALYSIS AND KEY PERFORMANCE INDICATORS	
Thermal comfort indicators	1. Percentage of time outside an operative temperature range (Adaptive)
	2. Percentage of time outside an operative temperature range (Fanger)
	3. Degree-hours (Adaptive)
	4. Degree-hours (Fanger)
	5. Percentage of time inside the Givoni comfort zone of 1m/s
	6. Percentage of time inside the Givoni comfort zone of 0m/s
	7. Number of hours within a certain temperature range
Energy performance indicators	1. Energy needs for heating (kWh/y/m2)
	2. Energy needs for cooling (kWh/y/m2)
	3. Energy use for lighting (kWh/y/m2)
	4. Energy needs for Sanitary Hot water (kWh/y/m2)
	5. Total Primary energy use (kWh/y/m2)
	6. Renewable Primary energy generated on-site = **0** [kWh/m^2/year]
	7. Renewable Primary energy generated on-site and self-consumed = **0** [kWh/m^2/year]
	8. Renewable Primary energy exported to the grid = **0** [kWh/m^2/year]
	9. Ratio of renewable primary energy over the total primary energy use (with and without compensation) = **0 %**
	10. Delivered energy (from electricity bills) = **-** [kWh/m^2/year]
Acoustic comfort indicators	1. Airborne sound insulation
	2. Equivalent continuous sound Level
	3. HVAC noise level
	4. Reverberation time
	5. Masking/barriers
Visual comfort indicators	1. Light level (illuminance)
	2. Useful Daylight Illuminance (UDI)
	3. Glare control
	4. Quality view
	5. Zoning control
Indoor Air Quality indicators	1. Organic compound
	2. VOCs
	3. Inorganic gases
	4. Particulates (filtration)
	5. Minimum outdoor air provision
	6. Moisture (humidity, leaks)

	7. Hazard material
Users' feedback	-

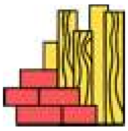
LESSONS LEARNED AND RECOMMENDATIONS

Lessons learned	The architect showed that local materials can be successfully used within contemporary structures.
Recommendations	-

BUILDING STRENGTHS AND WEAKNESSES

Strengths

Passive Design



Local Materials

Replicability

Affordability

The Lycée Schorge was designed with bioclimatic considerations in terms of cooling, ventilation, daylighting and the use of locally available materials.

Weaknesses

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REFERENCES

1. https://www.kerearchitecture.com/work/building/burkina-institute-of-technology-bit
2. https://arquitecturaviva.com/works/escuela-secundaria-lycee-schorge-1