# INSIDE OUTSIDE

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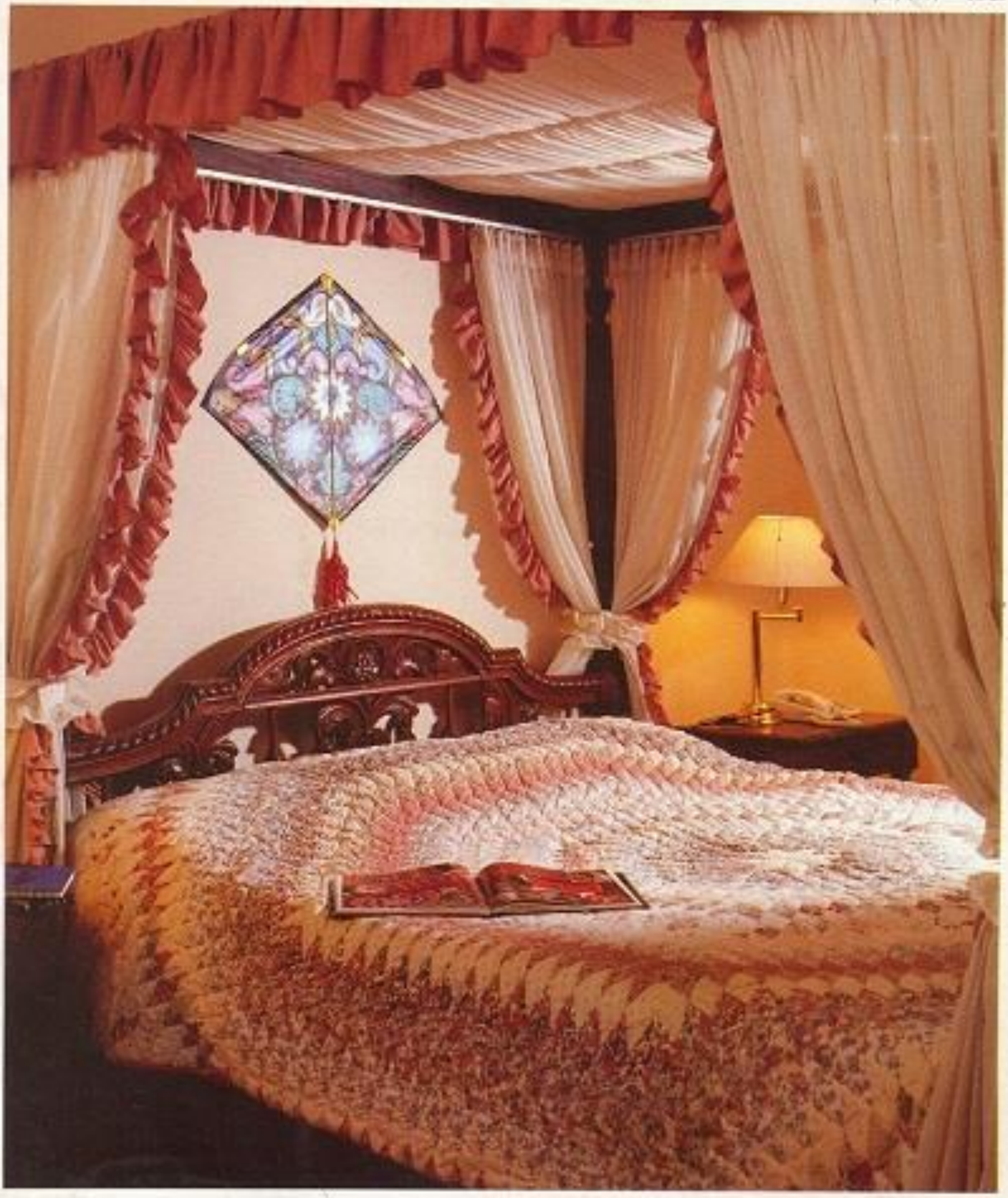
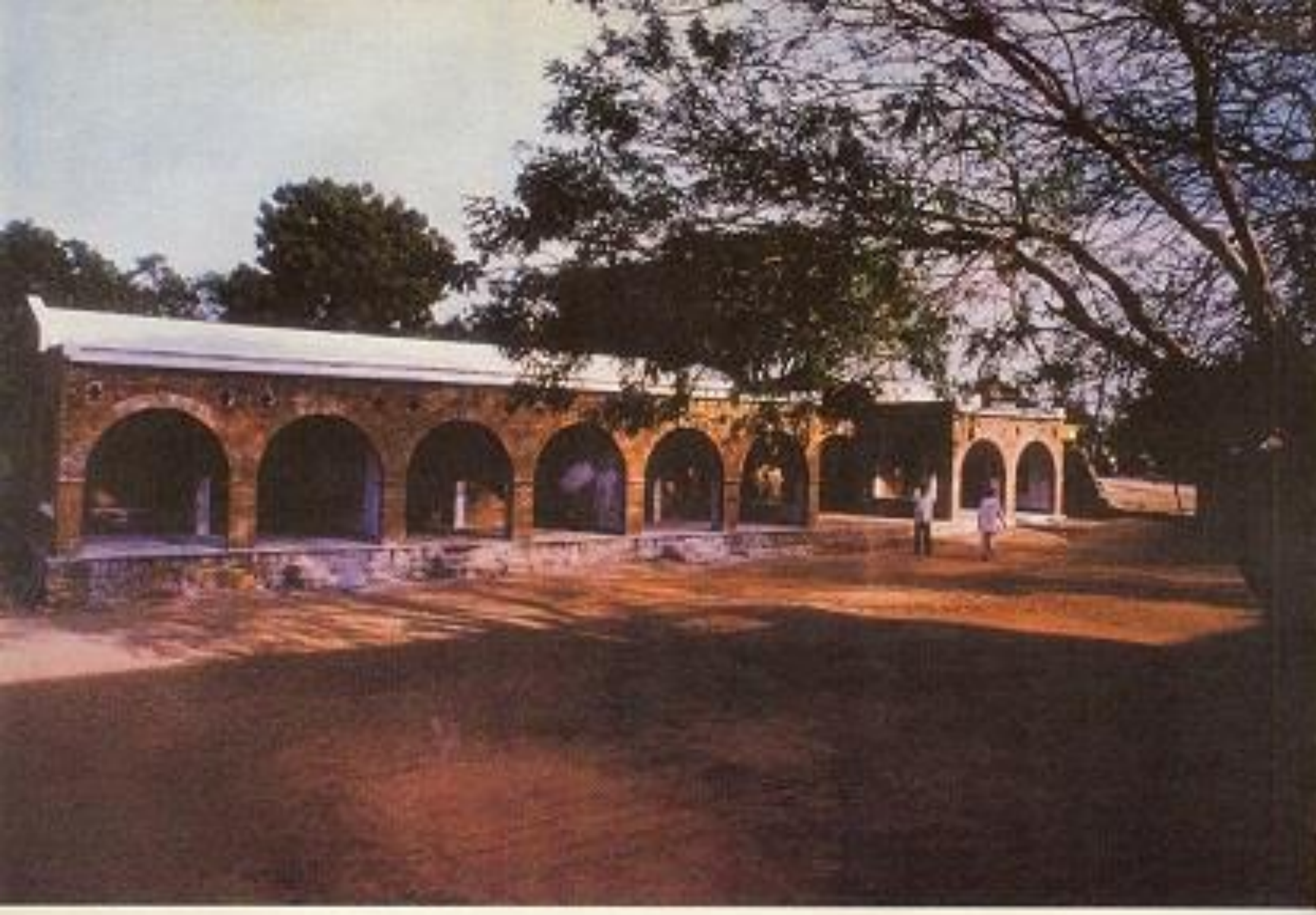




# LOWER COST, BETTER DESIGN

AIDED BY THE UK OVERSEAS DEVELOPMENT ADMINISTRATION, THE ANDHRA PRADESH PRIMARY EDUCATION PROJECT BRINGS ARCHITECTURE TO THE VILLAGE. THE ARCHITECT - ROMI KHOSLA OF GRUPINDIA.

TEXT: ANNA KHANNA PHOTOGRAPHS: SANJAY BARNELA & GL MADDOO

Small, standard, box-like structures made of coarsely formed brick with reinforced concrete slab roofs were all that the villager of Andhra Pradesh could look forward to in the way of primary school buildings. These offered neither physical comfort nor mental inspiration. But with the District Primary Education Project taking up 76% of the States education budget, (as ruled by the Government of India in 1993) for much-needed teachers

*Arcaded verandahs provide extra classroom space. The masonry combines wire-cut and country bricks and the roof is in Shahabad stone on pre-cast RCC joists. Agency: DAAT of New Delhi.*

training programmes, that left a mere 24% for the construction of school buildings. The engineers of the state's Panchyati Raj Engineering Department, whose task it was to deliver the goods, faced this budgetary squeeze with a stoic replication of their brick and concrete boxes, that — ostensibly — being all that a small, no-frills budget would permit. And villagers' preferences when they had any, were not going to come in the way of a tried and tested formula.

However, all that was to change radically when, in 1993, the Overseas Development Administration (ODA) of the British Government weighed in — as per a prior agreement in 1986 with the Government of India and the Government of Andhra Pradesh — with a substantial grant of 105 crores of rupees and a three year plan for technical assistance. This was the Andhra Pradesh Primary Education Project which was to ring in the changes in rural places of learning.

The aim was not just the setting up of additional schools out of the extra funding, but the creation of an improved learning environment which, in responding to the imperatives of specific sites in different geographic regions, would be functional, comfortable, convenient, pleasing of aspect and a source of pride and joy to villagers and school teachers alike. Equally important was the legacy the project would leave in the shape of blueprints for future development.

The new, improved school buildings were to be the outcome of an intensive research and development programme costing one crore of rupees. This was launched to identify alternative construction technologies which, in a sustainable fashion, would place the least burden on the state coffers, while providing a basis for top-quality design. Barely five thousand schools had been built in the first construction phase envisaged by the AP Government.

*A bright coat of paint livens up the Assam teak frames and country wood shutters of a classroom and verandah roofed over with corbelled brick pyramids. Agency: PK-PEU DAS of New Delhi.*

Another 35,000 are still required. In a state where, in 1991, the population had already crossed the 66 million mark, literacy was a dismal 43% and spiralling inflation made any kind of budget seem grossly inadequate, there was an urgent need for simple, cost-effective solutions.

At the helm of ODA infrastructural affairs was Mr Roger Bonner of the Education Projects Office in India. Already well-versed in the potential of alternative technologies to benefit disadvantaged peoples — having experimented extensively in Africa with different types of building and microtile roofing— he was determined that whoever was chosen to spearhead this initiative in India would have to be versatile as an architect, completely open-minded on the subject of alternative technologies and, in addition to possessing exceptional organisational abilities, would have to be at one with the ideals of rural upliftment.

He found this combination of qualities in Delhi architect Romi Khosla, who heads Grupindia and ISM. A number of like-minded organisations have then been identified by Mr Khosla in Delhi, Roorkee, Kerala and Andhra Pradesh to participate in the research and construction programme. Under his direction, architects and engineers of his own organisation explored a broad range of technologies, making imaginative use of them in designs which have become the prototypes for the whole of Andhra Pradesh.

All of the technologies chosen were eco-friendly and based on locally available skills and materials, and where skills were absent, the selected building techniques were easy to teach to unskilled workers. To keep costs low, equipment was confined to different kinds of moulds, hand presses for mud block-making, vibrators and concrete mixers. Bricks from local commercial kilns, found to be inexpensive, were given preference over village-made bricks for the sake of strength, neatness and

*Two flat-roofed classrooms fronted by a large verandah divided to add space for two more classes. Shuttering is in Assam wood set into frameless openings. The roof is in pre-cast RCC planks and joists, and the walls are in stone concrete block masonry. Agency: The A P Panchayati Raj Engineering Department.*

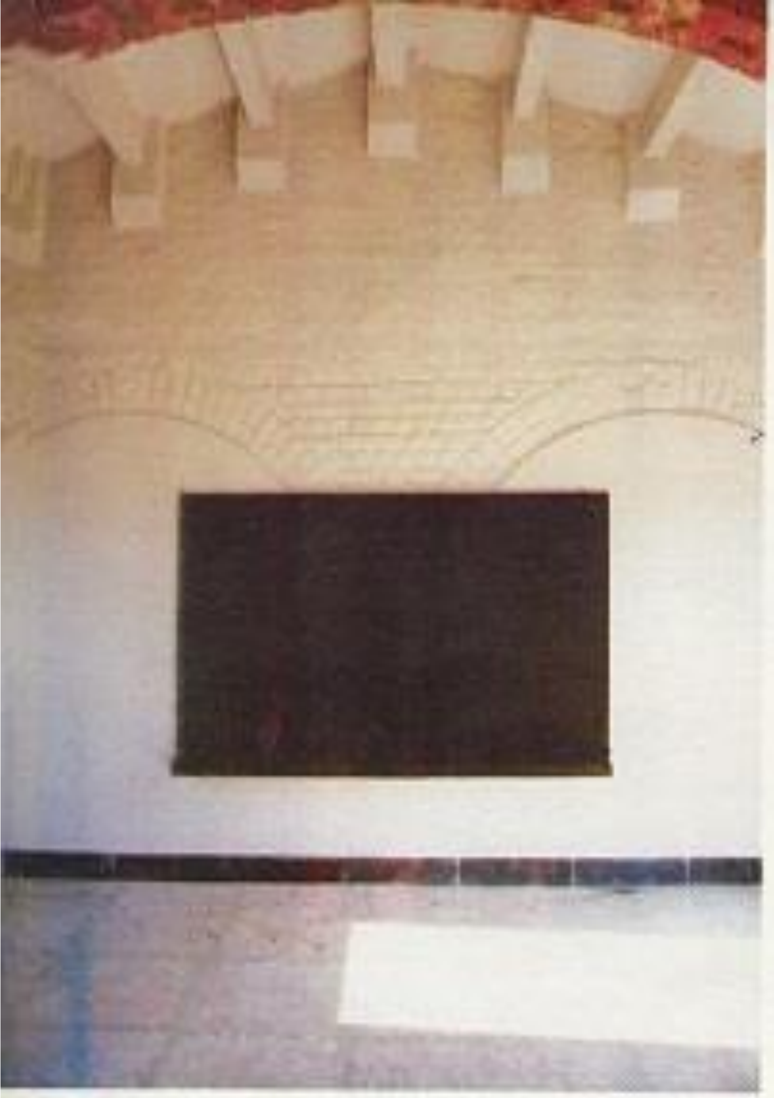
uniformity. Without in any way compromising on standards of safety, the majority of the designs cut down on cement, steel and shuttering by making a more efficient use of these materials. This meant a remarkable overall saving on each building of almost 30%.

Implementation of the programme called for community participation. But since the engineers of the P R E D and the villagers had inhibitions about working together on the site, and there was considerable scepticism in all quarters about the viability of technologies which were to be introduced for the first time, it was found necessary to organise a training course, jointly attended by thirty engineers and thirty primary school teachers representing their different villages. This course, with its hands-on approach stressed the benefits of interaction between villagers and officials, and inspired confidence in the new building techniques and materials by showing how some had already gained ground in other parts of India and foreign countries. It also demonstrated to what degree they had been adapted and updated to suit specific village needs.

Once this course was under way, a growing sense of optimism began to dispel the cynicism of traditional attitudes, and things began to go forward at an encouraging pace. As a culmination of the research programme, 29 school building prototypes were successfully built in the District of Rangareddy. This area was chosen for its proximity to Hyderabad, so that daily monitoring by engineers and architects — in the interests of high-precision symmetry — could easily be undertaken. In all, 57 buildings were put up on 29 sites.

Villagers' needs and preferences — at last being shown greater deference — are being increasingly aired through village education committees, which are coming into existence all over the state. Panchayati Raj engineers, now fully trained in the new technolo-

*Five open-sided classrooms on the cruciform plan. The walls are of cement-stabilised mud block masonry reinforced by structural steel tubes. The micro-concrete tiled roof rests on a steel understructure. Agency: DA of New Delhi.*



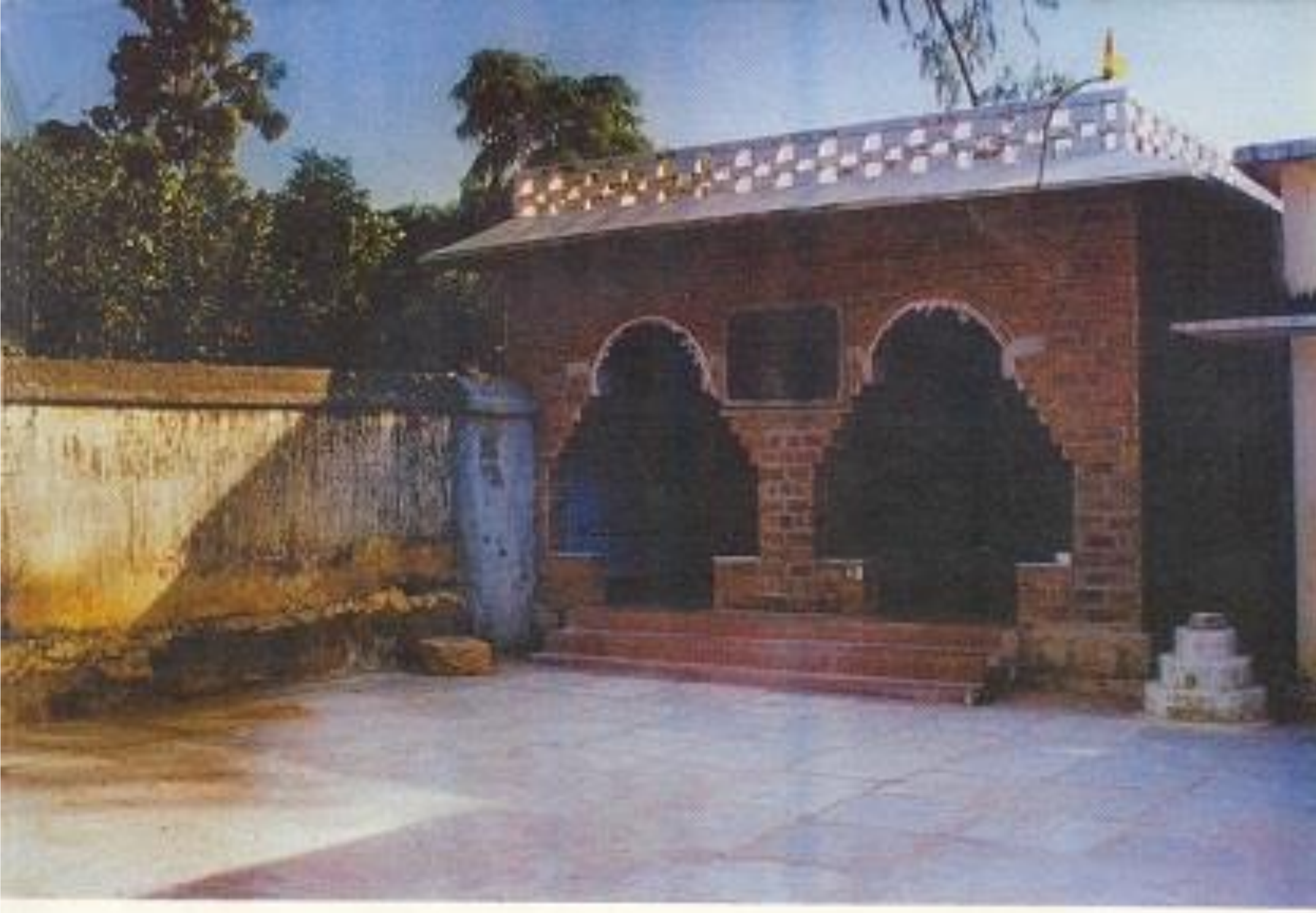
gies, are able to give these committees guidance on how to stretch their construction budgets that bit further, on more or bigger classrooms, on better village homes, or on higher quality replacements of old buildings — things, in fact, which had been previously unaffordable. And now, instead of resigning themselves to the standard brick and concrete box, villagers can refer to a selection of colour photographs of the prototypes suitable for their region and then make considered choices. It is interesting that the possible combinations of roofs, walls, and openings add up to a round 50.

For prototype development to focus on specific regional requirements, areas of high or low rainfall, desert, and cyclone and earthquake-prone zones were broadly delimited. In none of these areas has any reliance been placed on the steel, glass and concrete designs which have long been the norm in industrialised countries. Quite apart from their stark incongruity in the village setting, centralised production and long-distance transportation of their building components, plus dependence on mechanical systems of cooling would have sent building costs sky-rocketing.

In the absense of powered cooling systems, (temperatures go as high as 46°C) air, with its low heat conductivity, is valued as an insulator. It is massed in increased volumes under pyramid roofs and is locked in, wall cavities produced by new methods of bricklaying, the most favoured being rat-trap bonding, which also saves on the number of bricks used. Workers were trained in this system by members of Laurie Baker's Kerala-based Centre of Science and Technology for Rural Development (COSTFORD). Air is also sandwiched between pairs of red Mangalore tiles, one inverted upon another and then concreted into the grid pattern of a reinforced concrete roof. The aesthetic bonus here is the striking chequered pattern on ceilings

LEFT: *Using locally available low-cost materials for treating the wall and the roof have reduced construction cost by 30%.*

RIGHT: *Ceiling insulation by red Mangalore tiles and ventilation through brick jali walls. Agency: COSTFORD.*



The aim was not just the setting up of additional schools out of the extra funding, but the creation of an improved learning environment which, in responding to the imperatives of specific sites in different geographic regions, would be functional, comfortable, convenient, pleasing of aspect and a source of pride and joy to villagers and school teachers alike.

formed by the tiles exposed undersides.

Trapping air under long, shallow inverted troughs (channels pre-cast in RCC or ferro-cement) or under jack arch roofs has created another attractive design feature — the scalloped, undulating skyline.

Pre-cast RCC channels, invaluable for their lightness as well as their insulating properties, are moulded in situ, then inverted and marshalled in parallel rows from wall to wall at roof height with reinforcing steel bars concreted in between. Likewise, ferro-cement channels — semi-circular, parabolic, or semi-elleptic in profile, and varying from 10 to 40 millimetres in thickness — are

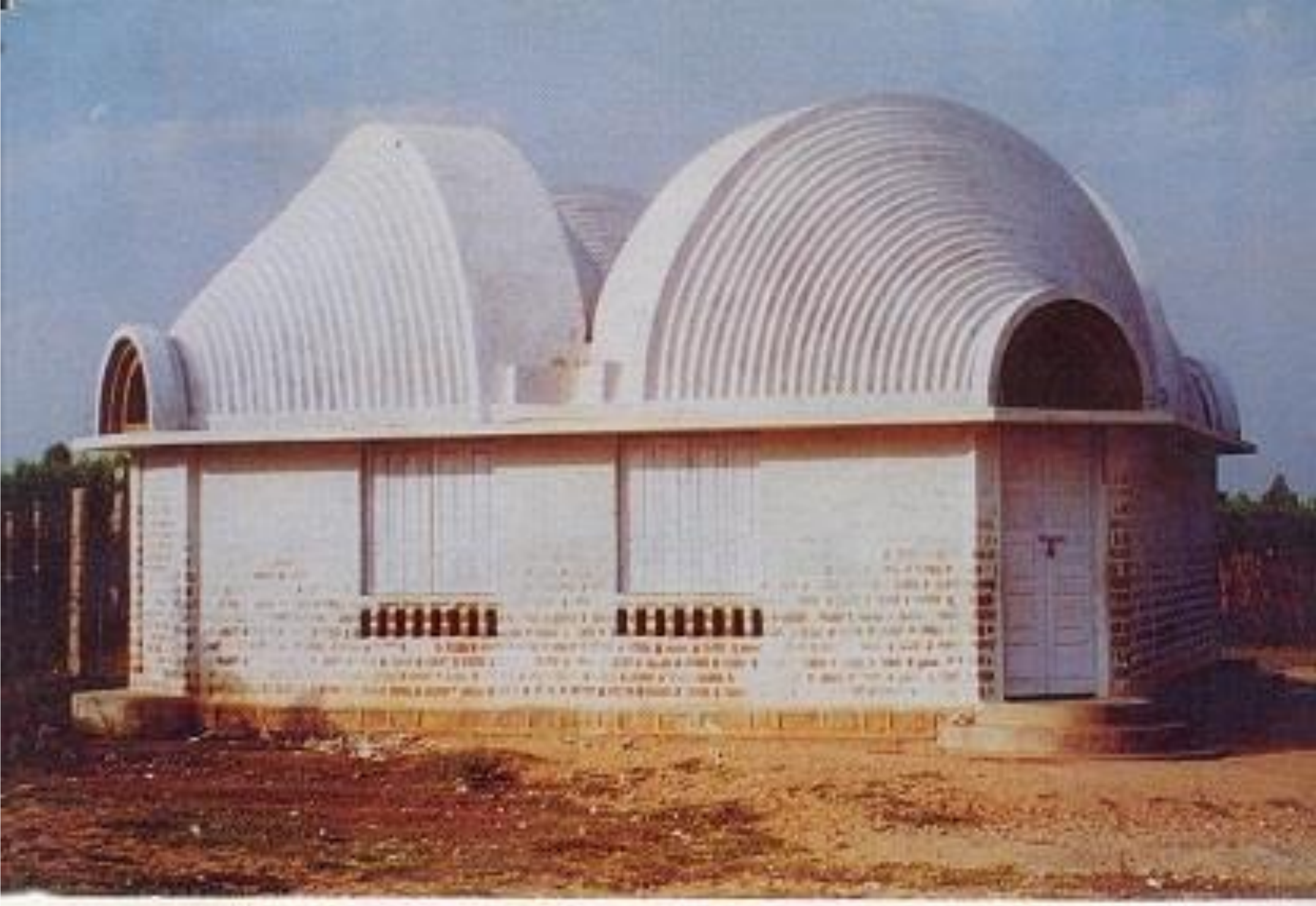
*Air is sandwiched between pairs of red Mangalore tiles, one inverted upon another and then concreted into the grid pattern of reinforced concrete roof. The workers were trained in this method by members of Laurie Baker's Kerala-based Centre of Science and Technology for Rural Development (COSTFORD).*

economical alternatives to RCC roof slabs and lintels. Made by reinforcing high strength, cement sand mortar with steel wire mesh, they have the advantage of using less cement and steel, and need no shuttering or vibrators. Although local artisans can be trained to construct them at the site, the programme researchers advocate their production at building centres for convenience in purchasing them at the time of building. Other elements in improved roof insulation are brick infills in RCC grids or Shahbad stone slabs, which are readily available and easily dealt with by semi-skilled workers using unsophisticated equipment. The RCC beams, joists and planks used in roof construction can also be precast by local artisans after only short periods of training.

The distinctive shape taken by each school building is largely determined by its roof design. Twelve differently structured roofs have been developed to guarantee extended durability, better insulation and minimal maintenance. The most eye-catching of these is the corbelled pyramid roof. The pyramid shape is arrived at by projecting every ring of brick course inwards from the preceding one. The brickwork, laid over a square, rectangle or regular polygon, can easily cover a span of ten metres. The top opening, covered by a stone or ferro-cement slab, may be developed into a skylight or a ventilating system.

Variations on this roof are the spiral pyramid, in which the bricks spiral inwards from the perimeter, and the diagonally corbelled dome, in which bricks are projected inwards and upwards from two small arches facing each other from diagonally opposite corners. The large inner volume they produce makes them suitable for both hot dry and hot humid areas, and they are excellent in cyclone-prone zones, where a sloped roof helps to lessen the impact of gale-force winds. Their only disadvantage is that they do

*Corbelled brick pyramids surmount two classrooms interlinked criss-cross with two equally spacious verandahs. Agency: PK-PEU DAS of New Delhi.*



not allow for the addition of extra floors.

The use of bricks in such roofs has the advantage of eco-friendliness, for in Andhra Pradesh, brick manufacturing is fuelled by rice husk, an otherwise waste product. This economises on conventional fuels, and even the ashes can be recycled into the manufacturing process. Then the method of building not only eliminates shuttering and work platforms, but also calls for very low inputs of cement and steel. The maintenance is also just a matter of scrubbing and re-painting every two or three years.

Yet another pleasing feature is the sloping tiled roof. The conventionally used red Mangalore tiles have to some extent been discarded in favour of micro-concrete tiles. The latter are attractive from above and below, their S-shapes aligning to create a smoothly rippled effect across the roofspan. Made in plain cement concrete with an admixture of small stone chips, they are only 8 millimetres thick and economical on cement. Althought low in thermal insulation and not as strong as an RCC slab, they do have the edge in being easy to produce and use as building components. They are considered good replacements for both Mangalore tiles and asbestos roofing, because the former are heavy on fuel in the manufacturing process and the latter can pose considerable health hazards. There are, of course, no tiled roofs of any description in cyclone-prone areas.

The greater precision in building practices resulting from dedicated instruction and tight monitoring, coupled with the use of better produced materials — burnt brick, stone concrete blocks and cement stabilised mud blocks of the plain and interlocking varieties — has produced walls which are not only stronger and cheaper (it takes only 5 to 10 % cement to stabilise a mud block) but also much easier on the eye.

Doorways have been enhanced

*Distinctive roofing in corbelled brick arches. Agency: PK-PEU DAS of New Delhi.*

by archways with bricks corbelled above abutments, while other openings, meant for the inflow of light and air, feature attractive patterning in brick jali. Some designs even provide for rectangular openings under window sills, so that fresh air may reach children sitting on the floor. Window spaces have been left open or fitted with shutters instead of glazing.

Verandahs, as well as being the airiest parts of the building, provide extra classroom spaces. Sometimes larger in floor area than the classrooms, they are interestingly shaped — octagonal, hexagonal, etc — and so well integrated with the layout as to have the feel and appearance of classrooms without walls.

All the buildings are steadily built up to plinth level in coarse rubble stone and cement to obviate the annual repairs which, with more friable materials, would be necessary after each heavy monsoon.

This judicious mix of appropriate technologies, community participation and inventive designing has made villagers economically, culturally and technically independent of the more costly, standardised, industrial systems of building, while ruling out any return to more primitive, unsustainable methods. And it has been the physical demonstration of the success of this mix — rather than the propounding of theories — which has alerted architects, engineers, educationists and villagers to the very broad range of possibilities available to them in the future designing and building of community and private structures — what ever their intended use. Sixty three of the new buildings are at present under construction. ●

*A two-classroom school protected by a jack arch roof and a running verandah on three sides roofed in micro-concrete tiles.*