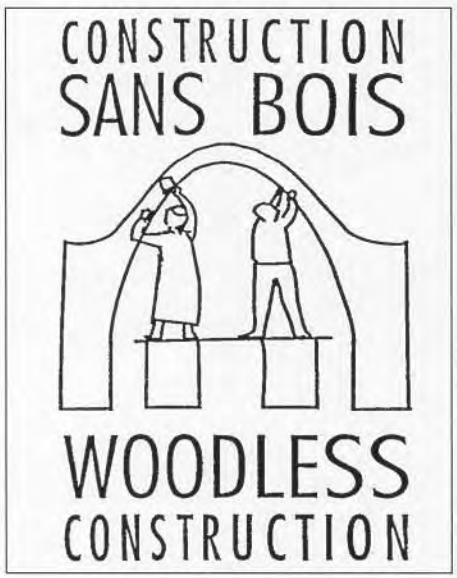
Wall Building

Wall Building
Case Study

BUILDING ADVISORY SERVICE AND INFORMATION NETWORK
gtz
it
SKAT
CRATerre



Woodless Construction – 1
An overview

"Woodless Construction" is the name that has been given in the Sahel countries of West Africa to the construction of vault or dome roofed buildings using ordinary mud bricks. The bricks for the walls and roofs are formed in simple rectangular moulds, smoothed by hand and dried in the open – a method very widely used in the region. Both the vaults and the domes are built using techniques which have their origin in Iran and Egypt. The most important characteristic of these roofs is that they are built without any supporting shuttering. Thus the entire structure – walls, lintels, and roofs – is built with locally available earth, earth buildings already having a rich tradition in the region.

Why Woodless Construction?

The majority of dwellings in the Sahel depend on the use of organic materials for the structure of the roof, and often for the walls as well. Flat-roofed buildings typically use large beams and intermediary battens to provide the support for grass-woven mats and for compacted earth on the roof. Thatched roof structures also use poles, branches and roots to support grass, straw or reed thatch. Surveys in the region show that for almost all such structures the availability and quality of wood or branches has deteriorated markedly in the past twenty years.[1] A common complaint is that finding good wood (species such as the doum

1 On-going surveys and previous work undertaken in Niger and Mali including Uhde, M-L., *Relations entre Habitat Humain et Ressources Naturelles*, CEAA thesis, Grenoble School of Architecture, 1995, 70 pp., illus.; Development Workshop, *Evaluation des bâtiments et des techniques de construction dans le Cercle de Youvarou*, a DW/IUCN report, 1991, 45 pp., illus.; Hammer, D., Tunley P. and Development Workshop, *Iférouane - Habitat en évolution*, a DW/IUCN/WWF report, 1991, 30 pp., illus.

Figure 1 Bricks made using simple wooden moulds and dried in the sun

Figure 2 Round dome structure – a cheap, easily built shelter

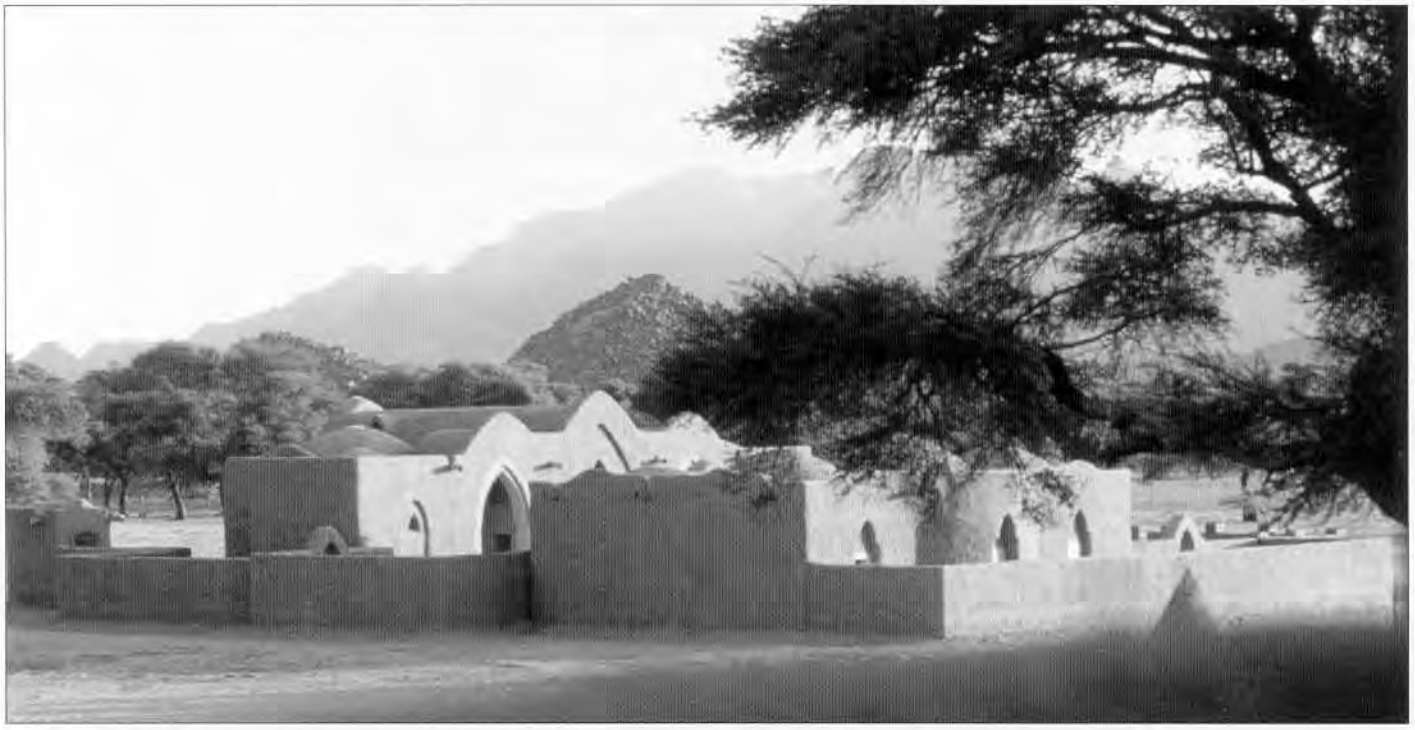


Figure 3 Combinations of vaults and domes for attractive and comfortable facilities

palm or the borassus palm, highly favoured for their ability to resist termite attack and to provide good structural strength and long durability) has become much more difficult. The Sahel has been blighted by years of drought, and there is no doubt that this has in many ways contributed to the disappearance of trees, but the biggest single source of degradation is over-consumption by man. Fuel-wood is one major cause for concern, but wood for building is undoubtedly another.

Woodless Construction was developed to provide a viable, affordable and accessible alternative to this dual problem – how to alleviate pressure on the threatened natural resources of the Sahel and at the same time to make building by the population easier.

Time to listen, observe, adapt

Current Woodless Construction activities in Niger, Mali, Mauritania and Burkina Faso have evolved from an initial, "one-off" training course run by Development Workshop in 1980 which introduced the techniques to Niger.[2] There was early recognition that whilst the basic idea of vault and dome building suited the conditions of the Sahel, both the techniques and the way they were introduced and put into use needed to be adapted to suit the habits, experience and preferences of the population, as well as to suit the specifics of local climate and soil conditions. There was also recognition that this would be a long process. In each new locality time has been needed: to demonstrate the Woodless Construction techniques and to allow the population to see that woodless buildings would withstand several seasons of rain; to listen to the population and to react to their ideas; to observe how the buildings behave in the climate of the Sahel; and only then to adapt techniques and forms to suit. One example: the brief but often violent rainstorms which are common in the Sahel during the rainy season require particular care in shaping roofs to ensure quick but controlled rainwater run-off. But because of the high winds that frequently drive the rain almost horizontally, it is very often the *walls* that need protection more than the roofs. Given what are often very localised specific conditions, problems such as the choice of surface finishes or the form of the building is invariably strongly influenced by local practice.

"Tuning-in"

Both training methods and working practices on building sites are the object of constant evaluation and refinement in order to facilitate the way in which the masons learn the techniques. (See *Woodless Construction – 3: Change and adaptation to local needs* in this series of BASIN case studies). This process reflects above all an approach of *adapting to that which exists* rather than trying to impose changes to local practices. Thus Woodless Construction aims to use whatever size local bricks are available for wall building (good quality provided!) rather than insist on special, unfamiliar dimensions for bricks and moulds. In parallel, the unit which determines the dimensions of the building is now the (local) brick, rather than the metre/centimetre, which enormously simplifies laying out and bonding.

Gaining the people's confidence

Confidence in Woodless Construction has come with the passage of time, thanks to the construction of a wide range of buildings, some of them with considerable prestige. Large buildings and complexes and prestigious private houses in Niger, Mali, and more recently Mauritania have helped develop a reputation for high quality which has certainly encouraged emulation by the population. But the greatest emphasis has been to demonstrate small and easily built one, two and three roomed buildings, suited to housing and to small public facilities, all of which are easy to imitate and affordable. These buildings range from cheap, single-domed, round rooms with 20 cm walls through to numerous different combinations of round and rectangular rooms which can be adapted to suit individual tastes and specific functions. Increasingly, the demand for even larger buildings is being met by combinations of two and three roomed structures which can be built quickly by

2 After ten years of experience using these technologies in Iran and Egypt where they have existed for centuries, Development Workshop introduced woodless vaults and domes to Niger in 1980, at the request of a small Canadian NGO, ISAID, in the context of a rural development programme. Over the next 8 years, support from this and other projects, and notably the WWF/IUCN's project for the Conservation and Management of Natural Resources in the Aïr-Ténéré in northern Niger, laid the groundwork for the development of what has now become a major regional activity.

builders after basic training, and can be developed in stages according to the resources of the owner.

The training approach

Early opportunities to learn

During the early 1980's, builders learnt Woodless Construction techniques through 'on the job' experience. The first formally organised training course for builders only took place as late as 1987, at Iférouane (Niger).[3] A survey carried out in Niger and Mali in 1990[4] showed that of over 300 Woodless Construction buildings, some 50% had been paid for by private clients, of which half were local villagers. The survey also showed that the shortage of trained masons was acting as a break on building activity and on the spontaneous spread of the techniques. For Woodless Construction to achieve a significant impact on local building practices, emphasis needed to be put on providing sustained and regular training opportunities, complemented by actions to identify where interest and demand was greatest.

Present activities

A major boost to Woodless Construction came in 1993 when a Development Workshop/IUCN (World Conservation Union) partnership obtained funding from the Danish Government (Danida) for a five year, Woodless Construction Programme of training and awareness-raising in Niger and eastern Mali. In Niger, the United States Peace Corps is also making a major contribution to Woodless Construction through the involvement of their volunteers, as is Lutheran World Relief. In Burkina Faso and Mali, Development Workshop is able to promote Woodless Construction techniques thanks to the Danish Red Cross "Hope in the Desert" environmental programme. In Mauritania, Development Workshop has recently erected some of the first Woodless Construction buildings on behalf of an IUCN sponsored National Park. Through such partnerships and collaborations, of which there are many more, Development Workshop is able to organise, amongst other Woodless Construction activities, several main cycles of training each year in different parts of the Sahel.

Basic training for novice builders lasts about two months, divided into (1) a period of theoretical explanation and practice, followed by (2) work on complete building projects. (For more detailed information on the organisation and content of the training cycles, including training for experienced Woodless Construction masons, see *Woodless Construction – 2: The training of trainers and builders* in this series of BASIN case studies).

Figure 4 "Spontaneous" construction – a vaulted house built by a trained mason with no external help

Local client partnerships

During the second part of these training cycles (work on complete building projects), site work is carried out on a partnership basis with local clients. The local client contributes unskilled labour, building materials, normal site tools, and everything concerned with the finishing of the building, including doors, windows, paint and internal plasters. In return he does not have to pay for a tailor-made plan of his building nor for the cost of Woodless Construction trainees and their experienced supervisors. This partnership relationship represents a major local commitment – some 75% of real costs of putting up the building. It also clearly defines who owns and is responsible for looking after the building. And not least, the client-partnership relationship is an important factor in establishing local market values for Woodless Construction.

Impact and accessibility

In many villages, Woodless Construction is now the predominant roofing method being used for new buildings. Demand is high: after a training cycle, almost all local newly-trained builders go straight on to work on private building contracts.

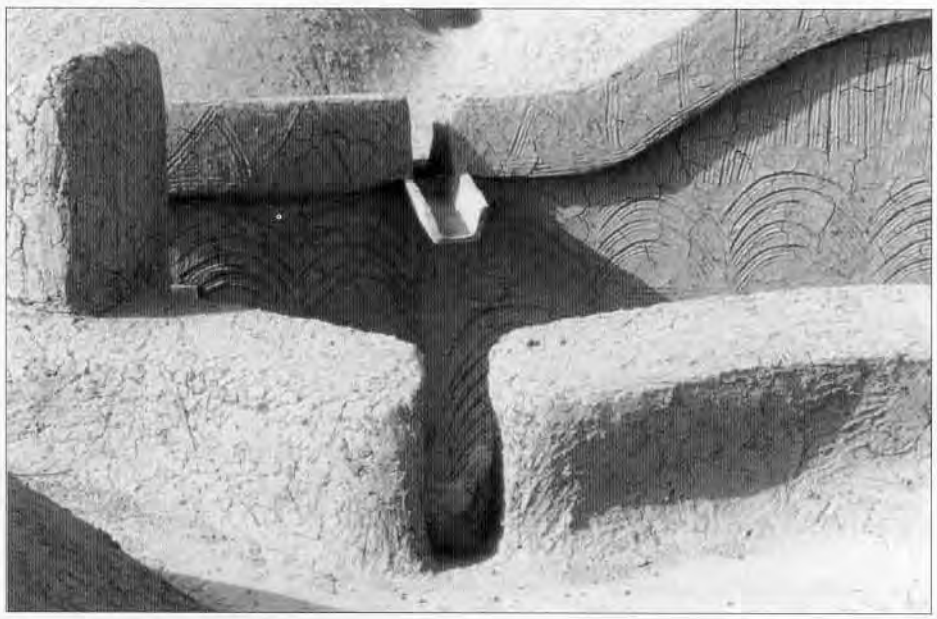
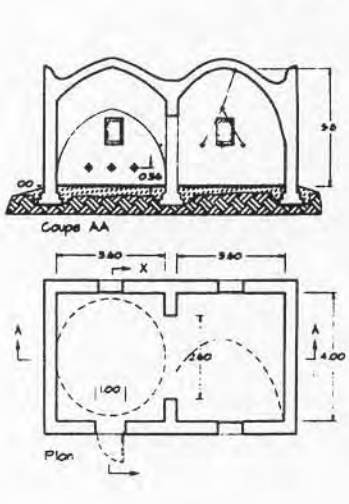


Figure 5 Particular care in shaping roofs to ensure quick but controlled rainwater run-off

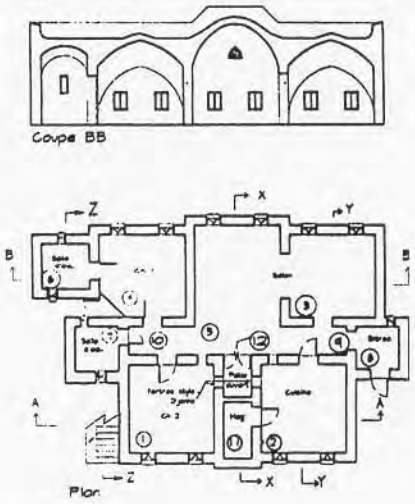
3 Funded by WWF/IUCN – see footnote 2.

4 Development Workshop, *Vulgarisation de la construction de voûtes et coupoles au Sahel*, a DW/IUCN report, 1990, 59 pp., illus.

COSTS
(Buildings commissioned by client-partners in Spring 1994,
ie after the Fcfa devaluation)



Simple, two-room house,
30m² habitable area,
7,200 Fcfa ($ 12) / m²,
excluding finishings.



More complex house,
90m² habitable area,
15,200 Fcfa ($ 25) / m²,
excluding finishings.

A two or three room house costs about 9,000 FCfa/m² (or 15$/m²) to build, not including finishings (see box). This *average* cost is similar to those incurred in the construction of the flat, timber-roofed buildings they are replacing. But a family making its own bricks and providing its own labour will obtain a house for a fraction of this. Clients are attracted to the system because it avoids the difficulty and expense of having to obtain often poor quality wood, needing replacement sometimes within a year, and because the buildings are much cheaper than those built with non-local materials. There are increasing signs, too, that it is considered prestigious to have a Woodless Construction house. And every 30m² dwelling built without wood represents a saving of about 15 wooden beams and some 8 cartloads of smaller wood for battens.

Spreading the word

A variety of activities are undertaken to ensure that the public is aware of the potential of Woodless Construction.

But it is the local builders who play the most important role in spreading the techniques. On-going technical support is provided after training, and initiatives by local builders to form themselves into organised groups with the aim of promoting the techniques are being encouraged. Future focuses include the training of local architects and technicians and a broader range of dissemination tools addressing the various audiences of Woodless Construction, including the local builder.

For more information on Woodless Construction, contact:

John Norton,
DEVELOPMENT WORKSHOP,
B.P. 13, F – 82110 Lauzerte, France
tel: (+ 33) 63 95 82 34
fax: (+ 33) 63 95 82 42,
E-mail: dw @globenet.gn.apc.org

Published by

German Appropriate Technology Exchange
Dag-Hammarskjöld-Weg 1
Postfach 51 80
D - 65726 Eschborn
Federal Republic of Germany
Phone + 49 - 6196 - 79-3190
Fax + 49 - 6196 - 79-7352

(1995)

What is BASIN?

Building materials and construction technologies that are appropriate for developing countries, particularly in the low-income sector, are being developed, applied and documented in many parts of the world. This is an important prerequisite for providing safe, decent and affordable buildings for an ever-growing population.

But such new developments can do little to improve the building situation, as long as the information does not reach potential builders. The types and sources of information on standard and innovative building technologies are numerous and very diverse, making access to them difficult.

Thus, in order to remedy this drawback, GATE, ITDG, SKAT and CRATerre are co-operating in the Building Advisory Service and Information Network, which covers four principal subject areas and co-ordinates the documentation, evaluation and dissemination of information.

All four groups have a co-ordinated database from which information is available on Documents, Technologies, Equipment, Institutions, Consultants as well as on Projects and Programmes. In addition, printed material or individual advice on certain special subjects is provided on request. Research projects, training programmes and other field work can be implemented in co-operation with local organizations, if a distinct need can be identified and the circumstances permit.

BASIN is a service available to all institutions and individuals concerned with housing, building and planning in developing countries, but can only function efficiently if there is a regular feedback. Therefore, any publications, information, personal experiences, etc. that can be made available to BASIN are always welcome and will help BASIN to help others.

Wall Building

WAS / BASIN
GATE - GTZ
P.O.Box 5180
D - 65 726 Eschborn
Germany
Phone + 49 6196 793190
Fax + 49 6196 797352

Cements and Binders

ITDG
Myson House
Railway Terrace
Rugby CV21 3HT
United Kingdom
Phone + 44 1788 560631
Fax + 44 1788 540270

Roofing

SKAT
Vadianstrasse 42
CH - 9000 St. Gallen
Switzerland

Phone + 41 71 237475
Fax + 41 71 237545

Earth Building

CRATerre – EAG
Maison Levrat, Rue du Lac
BP 53
F - 38092 Villefontaine Cedex
France
Phone + 33 74 95 43 91
Fax + 33 74 95 64 21

KM 8/95

Wall Building

Wall Building
Case Study

BUILDING ADVISORY SERVICE AND INFORMATION NETWORK
gate
it
SKAT
CRATerre

CONSTRUCTION SANS BOIS

WOODLESS CONSTRUCTION

Woodless Construction – 3 Change and adaptation to local needs: A case study in Mopti, Mali

"Woodless Construction" is the name that has been given in the Sahel to the construction of buildings, in which all the structural elements, including the vault and dome roofs, are made of ordinary mud bricks.

Woodless Construction was developed to provide a viable, affordable and accessible alternative to a dual problem: how to alleviate pressure on the threatened natural resources of the Sahel and at the same time to make building by the population easier (see *Woodless Construction – 1: An overview* in this series of BASIN case studies).

The bricks for both walls and roofs are formed in rectangular moulds, smoothed by hand and left to dry in the sun for a few days – a method very widely known in the region. During construction, the dried bricks are laid in mud mortar. The vault and dome roofs are built using techniques which originated in Iran and Egypt. The most important characteristic of these roofs is that they are built without any supporting shuttering. Thus the entire structure – walls, lintels, and roofs – is built with locally available earth.

Figure 1 Ordinary mud bricks of local dimensions are used as the unit of measurement in laying out. Increasingly only header courses are used.

In order for the key process of training and dissemination to be effective, the way Woodless Construction techniques are both taught and used in the Sahel has, since the time of their introduction,[1] been the object of an ongoing process of evolution and adaptation to local conditions and training needs. (For more detail on the organisation and content of training cycles, see *Woodless Construction – 2: The training of trainers and builders: a case study in Filingué, Niger* in this series of BASIN case studies). This process of adaptation has naturally drawn upon Development Workshop's earlier experience of building with vaults and domes in Egypt, Iran and Tunisia – all countries which have differing techniques adapted to their own local context. For example, the well-known traditional domes and vaults of Egypt are in an extremely arid region; for them to be viable in the Sahel, which despite low *annual* rainfall is liable to violent rainstorms, much adaptation has been needed, primarily to ensure rainwater run-off. Adaptation has also, however, reflected *observation* of local building techniques in the Sahel and *discussion* with the builders of each locality. The evolution of building techniques and forms is thus inspired by local practice, by a vast range of building techniques and styles, and thus by local solutions to problems and needs. Finding a solution to today's needs is thus a question of mixing existing local ideas with new techniques, the latter being needed where old practice is no longer viable.

In practical terms, adaptation of the traditional vault and dome techniques has focused on two main aspects:

- making the techniques *easier to learn and use* – often for illiterate and sometimes non-numerate builders – and thus safer;
- making the techniques *respond to local needs and expectations* – which includes keeping costs low and providing the shapes and appearance that the public want.

A training cycle run by Development Workshop in 1993 in Mopti (Mali), where there is a rich and diverse tradition of earth building, highlights a number of examples of such adaptations.[2] These adaptations reflect both local conditions and building habits in the Mopti region and the high level of skill amongst local builders. They are therefore described below essentially to illustrate the nature of the *process* of adaptation and not as universally applicable recommendations.

1 Development Workshop introduced woodless vaults and domes to Niger in 1980 at the request of a small Canadian NGO, ISAID, in the context of a rural development programme.

2 This cycle took place in the context of the Woodless Construction training and awareness-raising programme, executed by Development Workshop on behalf of a DW/UICN (World Conservation Union) partnership, and funded by Danida, 1993-1998.

Figure 2 "Alcove" building under construction. Note the use of strings as a guide, the practice of starting the vault from both ends simultaneously, the use of off-centred vaults and open arches to create a spacious interior.

Making Woodless Construction easier to learn and use

A primary objective of any Woodless Construction training cycle is to teach local masons how to build earth walls, as well as earth vaults and domes safely. The experience of training and building in the region of Mopti, however, also confirmed the need to make "good" building practice compatible with pragmatic building methods – methods the builders will really continue to use after training. Buildings with vaults and domes are subjected to greater outward forces than those with flat roofs. It is therefore often the case in the Sahel that local wall building techniques which are adequate for flat roofs would be dangerous for vault and dome roofs.

Brick sizes and laying methods

Over the years emphasis has been placed on the quality of wall building. During the 1980's this meant focusing particularly on brick dimensions, bonding patterns and laying techniques, working to precise plans. It became apparent, however, that such relatively complex and precise practice was acting as a break on the assimilation of the techniques. To take one example, courses with headers and stretchers were used, but these required scaffolding inside and outside the building. Local scaffolding is always makeshift and in short supply. It therefore made sense to build using header courses only. The wall-building taught in Woodless Construction activities, therefore, changed to headers only, but initially still using a special brick dimension ensuring good bonding. This practice gave excellent results and remains popular today. Introducing unfamiliar sized bricks, however, in turn acted as a break on acceptability. Starting to use local bricks whatever their dimensions (provided using the same size brick in any one building) was a logical step, whilst taking great care to ensure good bonding. It was important to eliminate the cutting of bricks to fit measured wall lengths (a trimmed block facilitates corner strength) and this was achieved by stating only approximate wall dimensions on plans and allowing builders to work to the nearest brick when laying out.

These progressive adaptations – "headers only" courses, using local size bricks and using the local size brick as a unit of measurement – took place over some 13 years.

Training structures

Historically, the vault and dome techniques used in Iran or in Egypt were passed from one generation to the next through apprenticeship. In the Sahel this slow process needed to be speeded up, to allow new woodless construction builders to learn these skills in a matter of a few weeks rather than years. In the Mopti training cycle, the use of special training structures on which trainees could practice building arches, vaults and domes, without the constraints of a building site was introduced. These included walls to start off vaults, bases for domes, small structures to practice openings and even small complete rooms.

String guides for vault building

In addition, string guides had been used since early on in the introduction of vault building to the Sahel (1980) to help builders follow a straight line as they built out the courses of bricks from the end supporting wall. But drawing up the correct shape of the vault on the end wall, however, remained a problem.

Drawing the vault shape

Gradually a method has developed using wires or string and small pegs which together with a table of dimensions allows masons to trace correctly any vault in the range of spans he needs. The same piece of string is used again to control the correct angle of bricks as they are laid, by stretching the string across the face of the vault. These simple methods quickly become habit to the trained masons. Almost perfect vaults can be mastered in a matter of days.

Three profiles of vault had been regularly taught, i.e. height to span ratios of 56%,

66% and 75%, but over time such diversity was judged unnecessary. A vault with a height to span ratio of 66% was adopted as a "standard". But in Mopti, it soon became apparent that to offer a locally acceptable building solution it would be necessary to provide flat roofs using secondary vaults and infill. The 66% rise to span was therefore replaced by a new 60% form, easier to "convert" into a flat roof.

Off-centred vaults

For improved economy, strength and use of space, where two or more vaulted rooms were being built side by side, "off-centred" vaults were also introduced. This means that the external side of the vault can be started very low down, with a minimum of outward thrust, whilst the internal side of the vault can be finished much higher up. The resulting rooms have more vertical walls against which furniture can be placed, and opening between adjacent rooms is made easier. Off-centred vaults can only be built where two roof structures provide an opposing thrust.

Responding to local needs and expectations

Adapting the form or appearance of Woodless Construction buildings makes assimilation by the population easier. "Standard" forms and designs are deliberately avoided. Instead, builders are encouraged to see that, taken as a whole, even simple Woodless Construction techniques can quickly be used as a 'kit' which can be adapted to suit many needs.

Flat roofs on vaults and domes

Popular reaction to Woodless Construction in the Niger interior river delta region of Mali in 1991-92 had shown that Woodless Construction rapidly aroused strong local interest in the face of increasing difficulty in finding organic materials or the money to pay for non-local alternatives. People nevertheless wanted *flat* roofs, where they could sit and sleep during the hot season: flat roof terraces with vaults and domes, using secondary vaults in the "voids" between the main roof vault and then infilling with earth, were therefore introduced. Skilful use of off-centred domes and vaults reduces enormously the need for secondary vaults and infill in the roof, an otherwise expensive item.

Reduced wall thickness

Woodless construction is mainly about changing the way that people build roofs, but the paradox is that walls invariably pose the biggest problem. One major concern amongst clients and builders is how much material goes into the walls. In Mali, the programme worked to develop structures which reduce wall thickness and volume, and thus lower costs and building time.

Increasing convenient interior space

Following from this, "alcove" buildings were also demonstrated in Mopti. These exploit the fact that although vaults and domes require either thick walls (or a counter-force from an adjacent roof to contain their outward forces), these thick walls need not be solid. They can therefore contain alcoves which can be both attractive and functional (e.g. to hold a bed, cupboard or toilet) and moreover represent a considerable saving in bricks. Thick walls containing alcoves can be economically built so that they can resist the thrust of much flatter vaults or domes. The advantages here include using less bricks, faster building and a shallow roof, built using just the upper half of the vault profile: the resulting shallow curved vaults lend themselves more easily to infilling for flat roofs.

"Gothic" domes

Creating flat roofs is one issue; making sure that roof forces pass as vertically as possible to the ground is also important – doing so can reduce wall thickness and the number of bricks in the wall. Rather than building hemispherical domes in the traditional Nubian style, "Gothic" (i.e. eccentric) domes have been used. The metal rotating arm which is used for positioning each brick in the dome is set up so that the base of the guiding arm is displaced from

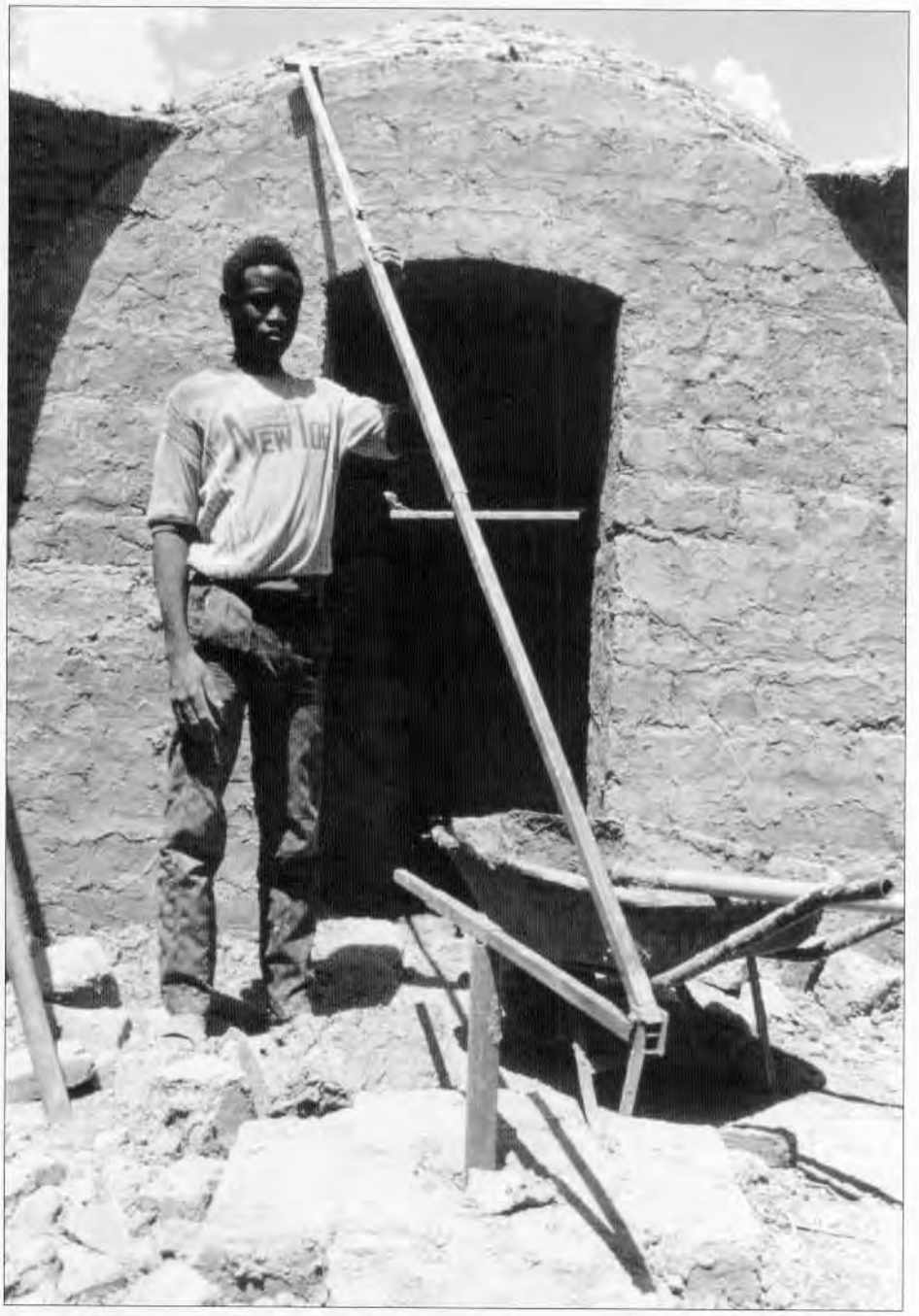


Figure 3 An adjustable radial arm is given to each mason at the end of his basic training, enabling him to build eccentric domes.

Figure 4 Woodless Construction clients often attach great importance to the final appearance of their building. This round, domed building is finished in the manner locally typical of rectangular, flat-roofed buildings.

the centre of the room (usually by one third of the dome's radius). This gives a steeper curve to the profile of the dome, reduces outward thrust, and enables the dome to be started lower down whilst still achieving the same room height. Not only is the result stronger and requires less wall structure, but the annoying echo of hemispherical domes is also reduced. (An adjustable metal guide is given to each mason to keep when he completes his training).

Retro-fitting vault and domes

In the Mopti region, existing earth buildings with thick mud masonry walls also abound. The idea of "retro-fitting" existing (former wood structure roof) buildings with new woodless roofs was successfully tried, always provided of course that the walls were strong enough and the roof concept suitable. In the Mopti region, several buildings were retro-fitted with vaults and/or domes: an office, private houses, and one mosque, the latter proving to be a great source of pride to the local villagers who enthusiastically contributed their labour.

Future directions

Technical changes are making Woodless Construction building easier and more attractive to clients. But just as important is the impact that these changes are having on how local masons and clients are taking decisions into their own hands: laying out bricks to measure the size of a new building on the ground, and then "re-arranging" rooms to suit the client's wishes; or trying out different vault positions by drawing full size on the wall. All increasing opportunities for masons to find viable solutions to local clients' needs unaided.

For more information on Woodless Construction, contact:

John Norton,
DEVELOPMENT WORKSHOP,
B.P. 13, F – 82110 Lauzerte, France
tel: (+ 33) 63 95 82 34
fax: (+ 33) 63 95 82 42,
E-mail: dw @globenet.gn.apc.org

Published by

German Appropriate Technology Exchange
Dag-Hammarskjöld-Weg 1
Postfach 51 80
D - 65726 Eschborn
Federal Republic of Germany
Phone + 49 - 6196 - 79-3190
Fax + 49 - 6196 - 79-7352

(1995)

What is BASIN?

Building materials and construction technologies that are appropriate for developing countries, particularly in the low-income sector, are being developed, applied and documented in many parts of the world. This is an important prerequisite for providing safe, decent and affordable buildings for an ever-growing population.

But such new developments can do little to improve the building situation, as long as the information does not reach potential builders. The types and sources of information on standard and innovative building technologies are numerous and very diverse, making access to them difficult.

Thus, in order to remedy this drawback, GATE, ITDG, SKAT and CRATerre are co-operating in the Building Advisory Service and Information Network, which covers four principal subject areas and co-ordinates the documentation, evaluation and dissemination of information.

All four groups have a co-ordinated database from which information is available on Documents, Technologies, Equipment, Institutions, Consultants as well as on Projects and Programmes. In addition, printed material or individual advice on certain special subjects is provided on request. Research projects, training programmes and other field work can be implemented in co-operation with local organizations, if a distinct need can be identified and the circumstances permit.

BASIN is a service available to all institutions and individuals concerned with housing, building and planning in developing countries, but can only function efficiently if there is a regular feedback. Therefore, any publications, information, personal experiences, etc. that can be made available to BASIN are always welcome and will help BASIN to help others.

Wall Building

WAS / BASIN
GATE - GTZ
P.O.Box 5180
D - 65 726 Eschborn
Germany
Phone + 49 6196 793190
Fax + 49 6196 797352

Cements and Binders

ITDG
Myson House
Railway Terrace
Rugby CV21 3HT
United Kingdom
Phone + 44 1788 560631
Fax + 44 1788 540270

Roofing

SKAT
Vadianstrasse 42
CH - 9000 St. Gallen
Switzerland

Phone + 41 71 237475
Fax + 41 71 237545

Earth Building

CRATerre – EAG
Maison Levrat, Rue du Lac
BP 53
F - 38092 Villefontaine Cedex
France
Phone + 33 74 95 43 91
Fax + 33 74 95 64 21

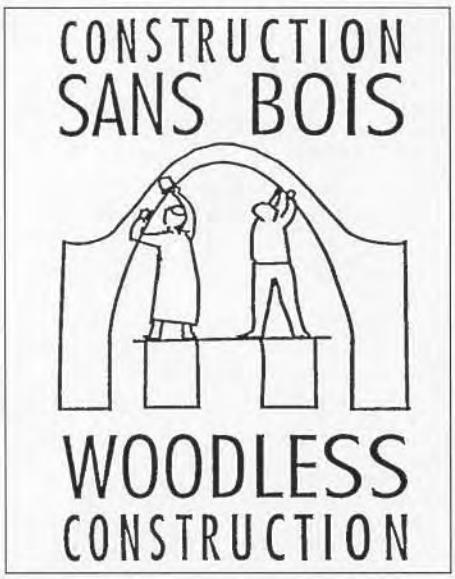
KM 8/95

Wall Building

Wall Building
Case Study

BUILDING ADVISORY SERVICE AND INFORMATION NETWORK

gtz
SKAT
CRATerre



Woodless Construction – 2
The training of trainers and builders: A case study in Filingué, Niger

"Woodless Construction" is the name that has been given in the Sahel to the construction of buildings, in which all the structural elements, including the vault and dome roofs, are made of ordinary mud bricks.

Woodless Construction techniques were developed to provide a viable, affordable and accessible alternative to a dual problem: how to alleviate pressure on the threatened natural resources of the Sahel and at the same time to make building by the population easier (see *Woodless Construction – 1: An overview* in this series of BASIN case studies).

The bricks for both walls and roofs are formed in rectangular moulds, smoothed by hand and left to dry in the sun for a few days – a method very widely known in the region. During construction, the dried bricks are laid in mud mortar. The most important characteristic of Woodless Construction roofs is that they are built without any supporting shuttering. Thus the entire structure – walls, lintels, and roofs – is built with locally available earth.

The immediate aim is to develop within the Sahel a local, i.e. village and town based, capacity to build using these techniques, which does not depend on project funding or outside technical support. The principal means to achieve this aim is the organisation and provision of training at various levels:

- for builders new to the techniques, to enable them to build simple, safe structures without external help after a relatively short period of training;

Figure 1 Trainee masons practice starting off vaults on training structures (phase 2)

- for builders with good experience of the techniques, to enable them to progressively take on the task of training;
- for experienced builders, and in some cases technicians, to enable them to acquire greater skills both in design and building.

Training strategies

Training is based on two key strategies.

Mobility
The training teams "migrate" to the places where the Woodless Construction techniques can be of help and where training is needed. Mobility means constantly having to adapt techniques and processes to local conditions and realities.

Training by local trainers
Local builder-trainers increasingly represent the channel through which these techniques can spread – through running the training sessions of cycles and through local advice and awareness-raising.

Training cycles

Each year, at the core of Woodless Construction activities is the organisation of 3-month training cycles, two or more of which may take place at the same time in different locations. *The training process is constantly reviewed and revised after each cycle,* but the Filingué (Niger) cycle in 1993, in the context of DW/UICN's Danida-funded programme, can be regarded as fairly typical. In this case training was divided into three phases.

Figure 2 Principal trainers preparing each training module beforehand; here, building a scale model to use as a training tool (phase 2)

Phase 1: Advanced training of trainers and experienced woodless construction builders

An 3-week period of advanced technical and "teacher" training –
- for experienced builders, to improve their skills in working on more complex buildings;
- for future trainers (builders with good communication ability), to take them as "trainee-trainers" through all the elements of a basic builders' training programme, including methods for explaining or demonstrating techniques, and for checking that the information has been understood.

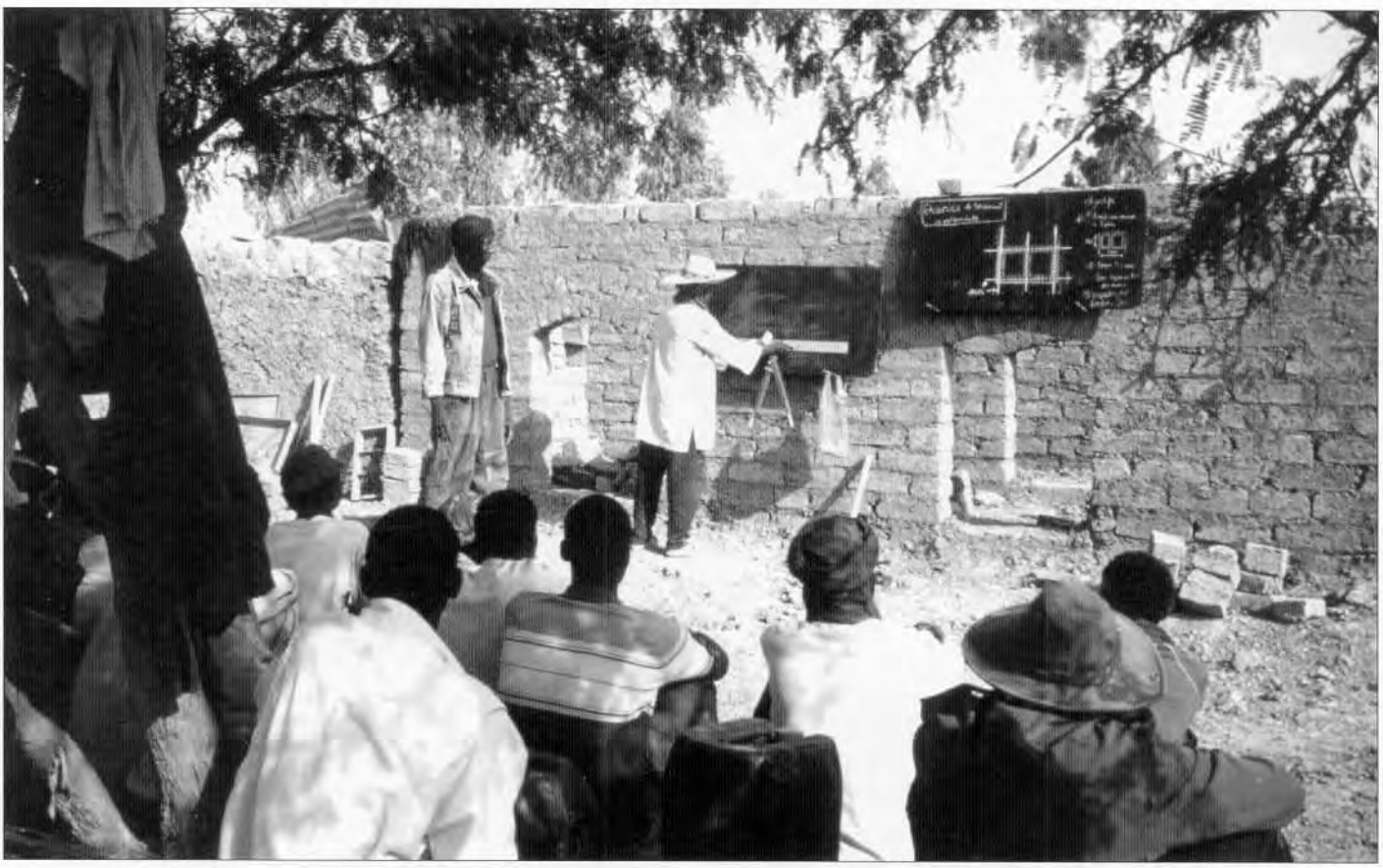


Figure 3 Future trainers practise blackboard skills (phase 1)

Participation and assessment
12 experienced masons participated in this first phase. After joint evaluation it was agreed that:

- 4 were of a high enough standard to become *principal trainers* for Phase 2 (see below);
- the remaining 8, as *assistant trainers*, would each be assigned (according to their language and/or village of origin) their "own" group of four new masons to supervise.

Phase 2: Basic training for new builders

Following on immediately from Phase 1, a 3-week period, for builders new to the techniques, intended to –

- explain the principles of Woodless Construction, and
- enable training structures to be built to practice key skills without the pressure of a real building site.

Training by local trainers
During this phase:

- the 4 principal trainers (trained in phase 1) were responsible for preparing and teaching each training session, under the overall supervision and guidance of the core training team;
- the 8 assistant trainers (also trained in phase 1) were responsible for supervising and assisting the four trainees assigned to each of them.

Participation
32 trainee builders participated, the majority (22) from Filingué, in order to develop a significant builder capacity that the population could choose from. The languages used were Haussa and Zarma, with certain trainers and trainees also speaking some French and Arabic.

A detailed curriculum
Each training session was based on a detailed curriculum, which had been prepared in the form of a *Guide des formateurs* (guide for trainers). The *Guide* was used for the first time, and thus "tested", during phase 1, the training of trainers –

- to ensure that phase 1 trainees had a sound understanding of the *principles* underlying the techniques they were already familiar with and
- to suggest methods they could use for communicating these (including models, diagrams, etc.)

A local language (Haussa) version was quickly prepared and used by the trainers –

- to provide a structured, time-tabled approach ensuring that all key points were covered and enough time allowed for each;
- as a tool enabling the trainers to prepare each training session beforehand; and
- as an *aide-mémoire* during each training session itself.

It is important to realise that the *Guide* is not regarded as a finalised "publication". Drawing from a base of teaching notes and modules, the specific curriculum is prepared in the light of an evaluation of the preceding training sessions and the specific needs of the locality where the training session will be taking place. In the case of Filingué, the curriculum covered 36 training modules, and dealt with each stage in the construction of the building, from laying out through to each basic type of roof building.

Organisation of training sessions
Each training module is studied by the trainers several days in advance, to give them time to prepare for teaching the subject – which invariably includes both theory and demonstration. They also collect soil samples from the region to make test samples and explain differences in brick quality.

Phase 3: Practical training on start-to-finish buildings for local clients

During this follow-on 5 week phase, the phase 2 trainee builders went on to undertake the construction of small and medium sized buildings for local clients.

Organisation of site work
The average building consisted of two or three rooms, and responsibility for the construction of each room was given to one pair of builders. Each pair thus had the chance to work on each stage of construction, from laying out and building the foundations, through to building the roof structure and ensuring proper rainwater run-off. For example, a small two room building was constructed by two pairs of masons, under the direct supervision of one assistant trainer, and supported by labourers provided by the client.

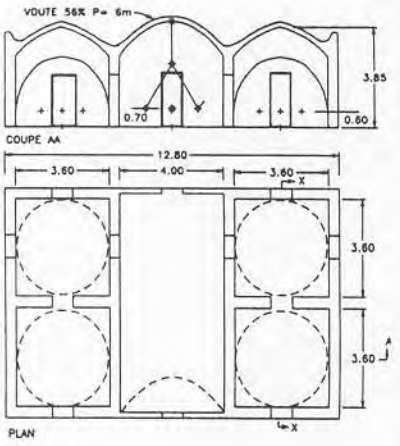
The client-partner relationship
All the buildings constructed during this phase of the training cycle were commissioned by local clients, in the framework of a "client-partner" relationship: the client is provided with a tailor-made design for the building and with the skilled labour input i.e. Woodless Construction trainee builders and supervisors. In return, the client agrees to cover all other construction costs bricks, water, soil for mortar and any renders; finishing – doors, windows, paint, internal fixtures; manual labour to assist the builders on site; and "normal" site tools – scaffolding, ladders, wheelbarrows, etc.

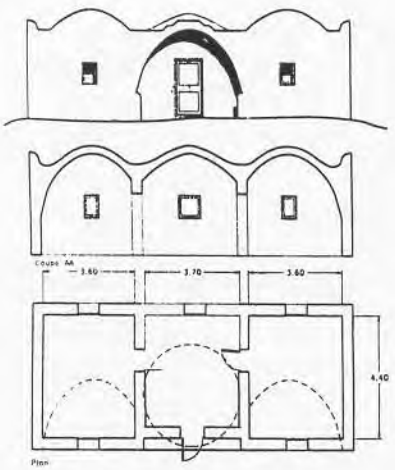
The benefits of the client-partnership relationship are numerous and diverse.

- In addition to gaining practical skills on the building site, the trainee builders also start to acquire experience in dealing with the needs of the client.
- The involvement of "real" clients minimises discrepancies with normal construction costs that would undoubtedly exist were the programme to fully subsidise buildings during training.
- Involving clients in this major commitment (some 75% of the real costs of the building) helps to ensure their responsibility in the future care and maintenance of the building.

Figure 4 Each building commissioned by a client-partner provides "start-to-finish" building practice for trainee builders (phase 3)

COMBINATIONS OF SIMPLE VAULTS AND DOMES
easily mastered by masons who have received basic training





• Responding to the clients' needs encourages the Programme to promote diversity amongst the examples that are built. In turn, future clients have a greater range of examples to choose from, although in no case are these buildings considered as inflexible prototypes.

In the case of Filingué, eight clients commissioned ten buildings, ranging from small, single-room, round, domed houses through to large, multiple-room buildings with a combination of vaults and domes for the roofing.

Performance assessment
All 32 trainees were considered capable, as a minimum, of building one or two-roomed structures using vaults and/or domes for the roofs without assistance and were issued with a certificate. Many of them, however, were also clearly capable of undertaking more sophisticated combinations of rooms (see box).

After training

Versions of all the types of buildings constructed during phase 3 of the training cycle have subsequently been built in the Filingué region by the newly trained builders for local clients. Three months after the end of the cycle, ten new woodless construction buildings were complete or nearing completion, and these included buildings designed by local masons, and a new mosque.

For more information on Woodless Construction, contact :

John Norton,
DEVELOPMENT WORKSHOP,
B.P. 13, F – 82110 Lauzerte, France
tel: (+ 33) 63 95 82 34
fax: (+ 33) 63 95 82 42,
E-mail: dw @globenet.gn.apc.org

Published by

German Appropriate Technology Exchange
Dag-Hammarskjöld-Weg 1
Postfach 51 80
D - 65726 Eschborn
Federal Republic of Germany
Phone + 49 - 6196 - 79-3190
Fax + 49 - 6196 - 79-7352

(1995)

What is BASIN?

Building materials and construction technologies that are appropriate for developing countries, particularly in the low-income sector, are being developed, applied and documented in many parts of the world. This is an important prerequisite for providing safe, decent and affordable buildings for an ever-growing population.

But such new developments can do little to improve the building situation, as long as the information does not reach potential builders. The types and sources of information on standard and innovative building technologies are numerous and very diverse, making access to them difficult.

Thus, in order to remedy this drawback, GATE, ITDG, SKAT and CRATerre are co-operating in the Building Advisory Service and Information Network, which covers four principal subject areas and co-ordinates the documentation, evaluation and dissemination of information.

All four groups have a co-ordinated database from which information is available on Documents, Technologies, Equipment, Institutions, Consultants as well as on Projects and Programmes. In addition, printed material or individual advice on certain special subjects is provided on request. Research projects, training programmes and other field work can be implemented in co-operation with local organizations, if a distinct need can be identified and the circumstances permit.

BASIN is a service available to all institutions and individuals concerned with housing, building and planning in developing countries, but can only function efficiently if there is a regular feedback. Therefore, any publications, information, personal experiences, etc. that can be made available to BASIN are always welcome and will help BASIN to help others.

Wall Building

WAS / BASIN
GATE - GTZ
P.O.Box 5180
D - 65 726 Eschborn
Germany
Phone + 49 6196 793190
Fax + 49 6196 797352

Cements and Binders

ITDG
Myson House
Railway Terrace
Rugby CV21 3HT
United Kingdom
Phone + 44 1788 560631
Fax + 44 1788 540270

Roofing

SKAT
Vadianstrasse 42
CH - 9000 St. Gallen
Switzerland

Phone + 41 71 237475
Fax + 41 71 237545

Earth Building

CRATerre – EAG
Maison Levrat, Rue du Lac
BP 53
F - 38092 Villefontaine Cedex
France
Phone + 33 74 95 43 91
Fax + 33 74 95 64 21

KM 8/95