A local alternative to Portland cement in Rwanda

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Pozzolana Cement Project

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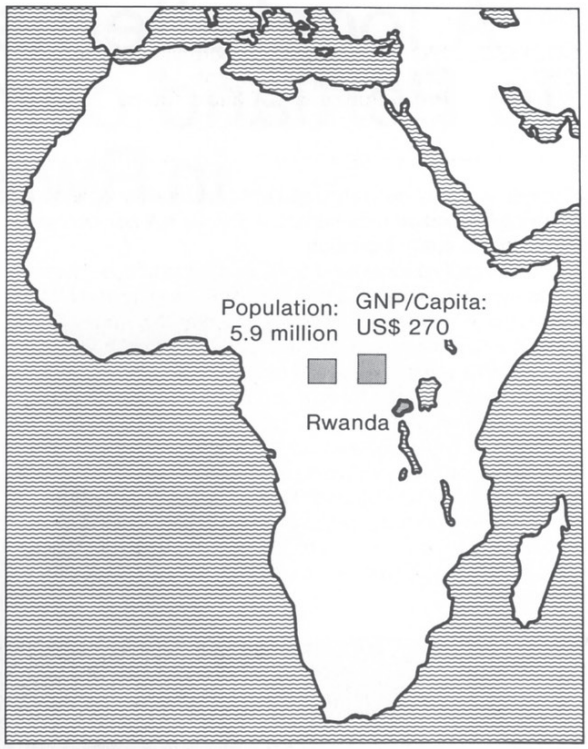
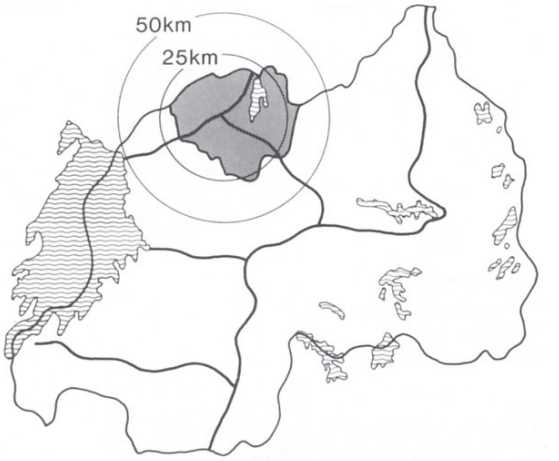
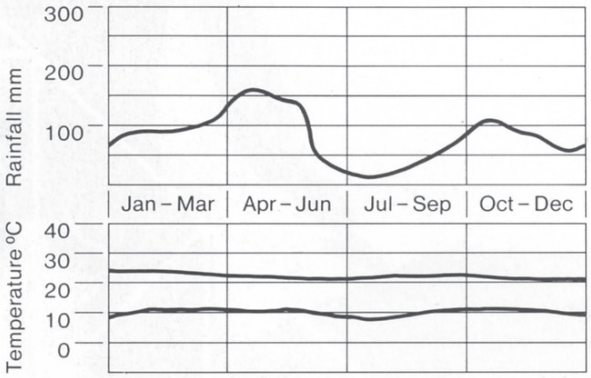
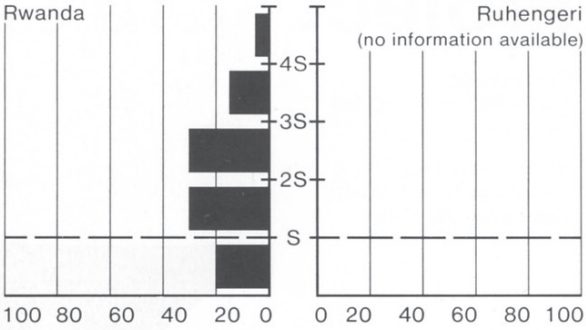


Population Ruhengeri Province: 600,000
Population Kigombe District: 40,000
Population Ruhengeri Town: 15,000





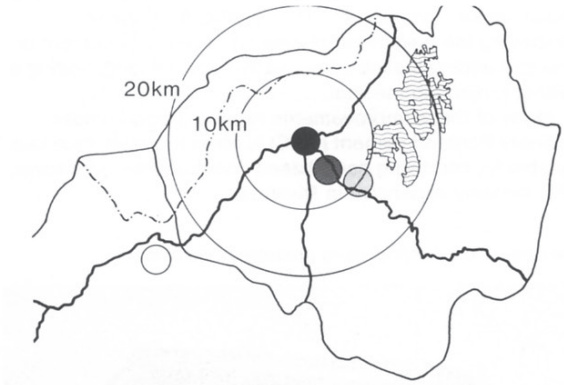
Climate Graph Ruhengeri (1,492m)



Percentage Distributions of Population by Income Level
S=when 85% of household income must be spent on food

Abbreviations:

COOPIBO	IBO Development Corporation Belgium
OPC	Ordinary Portland cement
PPCT	Projet Pouzzolane, Chaux, Tourbe Projet Pozzolana, Lime, Peat



Kigombe District

Ruhengeri
Pozzolana Deposit
Lime Quarry
Production Unit
Main Traffic Routes
National Volcano Park

Rwanda is a very densely populated and mainly agricultural country. Urbanized areas amount to only 6.4 per cent and there are no really big cities.

Traditionally people lived scattered in the hills, each family on its own plot. The houses were bee-hive shaped and built from organic materials. Owing to a scarcity of materials and to foreign influence, they were gradually replaced by round houses with walls of clay and roofs structurally separated from the walls. These houses are still to be found in the countryside, while the original type has almost disappeared.

The house is situated in an enclosure, the rugo, in which are also, at the back, a kitchen, a store-house, and sometimes a latrine. Under a century of foreign influence, the houses have become rectangular, allowing for the use of new materials such as corrugated iron and roofing tiles. These enhance the status of the owner and there are now more

PHOTO : COOPIBO, BELGIUM

A traditional dwelling.

rectangular houses than round ones. The majority of houses are still constructed of wattle-and-daub, but mud bricks are becoming more popular, as wood is scarce and expensive. The better off also use burnt bricks, natural stone, and, occasionally, cement blocks for building. In regions with good clays, burnt roofing tiles are used. The most popular roofing material, however, is corrugated iron, now produced in Rwanda.

Housing in Rwanda is affected by the weather, which is often cold and damp. These conditions cause rapid deterioration, especially in houses made of mud. Common problems are: damage to foundations by ground surface water or splashing rain water; erosion of the walls, mainly by rain; cracks in the walls, providing shelter for vermin; damp earthen floors; cold and noise penetrating beneath sheet-iron roofs which have no other ceiling.

The inhabitants try to solve these problems in several ways: by building a base of natural stone and earth (often after the house is built and is already showing deterioration); firming the foundation with cement; building a concrete drain around the house; plastering the outer walls with cement or mortar of inferior quality, giving priority to the facade of the house, as an indication of the householder's status; concreting the pavement; plastering inside with cement or lime and adding a plinth; lime-washing or painting; adding a ceiling; projecting the roof.

Many of these improvements require a good binder. Ordinary Portland cement (OPC) is often too rigid, thus less suitable for improving earth-based constructions. Moreover, OPC remains expensive in Rwanda.

The new school building, using pozzolana-lime binder.

PPCT

PHOTOS: COOPIBO, BELGIUM

PPCT- a production unit for pozzolan binder

NGO stimulates innovation in local materials

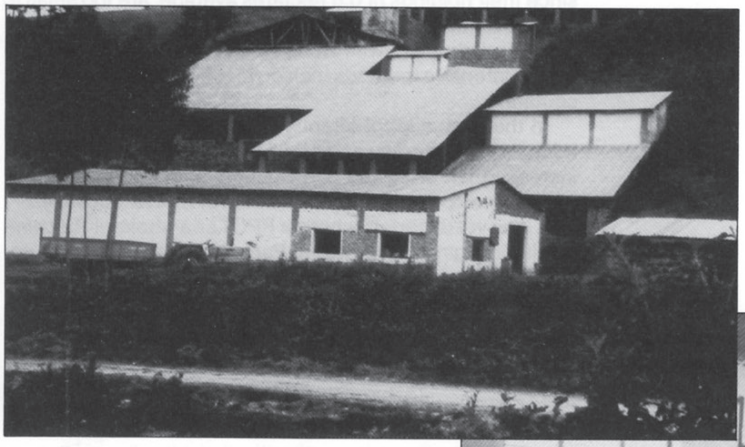
Until 1984 all cement was imported, mainly from Kenya. Erratic supply and difficulties in transport increased its cost, leading Rwanda to produce its own cement. A factory was built, with Chinese assistance, in south-west Rwanda near the largest limestone deposits. Costs remain high owing to the foreign component (fuel); dependence had been shifted rather than diminished.

This development, although important for civil and large construction works, was of little benefit to the small-scale builder. Availability of cement improved, but not its price.

COOPIBO (Development Co-operation IBO), a Belgian NGO, pursued another strategy, based on reliance on local resources. Initially, it stimulated the use of lime and lime-Portland cement mixtures in building, substituting lime for Portland cement to some extent. Later it developed a pozzolanic binder using local resources such as volcanic pozzolanas, limestone and peat.

With the support of the Rwandan authorities, in 1978 in north-west Rwanda, it initiated the Projet Pouzzolane, Chaux (Lime), Tourbe (Peat). PPCT is a research and production centre for an alternative binder, with the aims of: developing a cheaper binder as a partial substitute for Portland cement; using local raw materials, such as volcanic pozzolanas and limestone; promoting peat as an alternative fuel to firewood and imported fuels; creating employment in a region with high un- and under-employment; developing a production centre run on a co-operative basis.

The pilot plant.



The laboratory.

Experiences from the project

An innovative technology

The PPCT project has three phases which partly overlap: research on an alternative binder; development of production technology; installation of a small-scale profitable factory.

Its first two phases have largely been achieved, and a small pilot plant is now producing. Its capacity has yet to be increased in the third phase.

The alternative binder was developed by PPCT, with some assistance from the Post Graduate Centre of University of Leuven, Belgium. It uses two important local materials: volcanic pozzolanas, dried with peat and ground to cement-fineness in a vibrating ball mill; and lime, produced in a vertical kiln, using peat as fuel.

The lime production line.

The binder, however, hardened too slowly and an additive was needed. Tests with various salts showed good strength developments, but presented implementation problems. Ordinary Portland cement emerged as the optimal hardening accelerator. The composition of the binder currently produced is 25 per cent Portland cement, 12.5 per cent hydrated lime and 62.5 per cent pozzolanas, ground to a fineness of 3,5000-4,000 Blaine. Research is still going on with other additives: various ashes, organic products and salts.

Considerable research also went into production technology. The small scale of the intended unit and the use of peat as a fuel made it difficult to rely on conventional solutions used in the cement industry, and the NGO input in this field was essential. A lime kiln and pozzolana dryers were designed to use peat as a fuel. The factory layout made use of gravity as much as possible, by setting up on a hillside. The equipment for grinding and mixing is more conventional and not specific to the cement industry. A small pilot plant is now producing 200 tons per month of this binder, which is much below current demand. A capacity of about 500 tons per month is required, for which funding is awaited.

The pozzolana cement thus produced does not reach the same qualities as a Portland cement, notably with respect to strength, but the product is acceptable for most building, and certainly for housing in Rwanda. It is also much cheaper than Portland cement. To reach satisfactory results, richer mixtures should be used, and much attention paid to curing.

A spirit of co-operation

PPCT provides jobs for 60 full-tme workers and an additional 150 temporary labourers who work in the dry seasons quarrying limestone and cutting peat. The latter are usually subsistence farmers, for whom this extra income is essential, since their holdings of 0.5 hectares average, are too small to provide an adequate living.

To provide them with work, PPCT tries to rely more on labour-intensive methods than on machines for producing its cement.

In the past, a lot of attention was paid to workers' education via literacy and other courses. These helped to increase their skills and participation, but had to be discontinued, mainly due to the lack of further subsidies.

It is as yet uncertain whether PPCT as a whole will become a self-managing co-operative. Parts of it might work on a co-operative basis, but the overall project requires managerial and technical skills beyond the level of the average worker. A more conventional organizational structure may be required.

A struggle for financial support

After some initial research in another project, PPCT was started by the Belgian-based NGO COOPIBO, with the support of the Rwandan authorities, and the financial backing of the Appropriate Technology Fund of Belgium. These funds covered only the initial research phase.

In October 1984, Belgium and Rwanda agreed to implement a second, much larger phase. It would include an in-depth feasibility study, followed by investment in a profitable production unit. So far, Belgian funds have not been forthcoming, despite the facts that real progress has been made and the project is running relatively well. External interests seem to prohibit its expansion.

Faced with such a situation, a small NGO is relatively powerless. Since October 1984, COOPIBO has continued its

research and feasibility study and increased production from about 350 (1984) to 2,100 (1986) tons a year, using its limited resources, and with some assistance from other NGOs such as Oxfam. The Rwandan authorities are backing the project, but have so far have failed to unblock the situation.

Towards the application of pozzolan binder

Patterns of use
The cement is produced for a variety of uses: in public buildings; development projects; and in the private sector, mainly for housing. Most often it is used for plastering, but also for pavements, masonry and joints.

Setting formal standards
Establishing norms and standards for materials is usually a requirement of the authorities. PPCT carried out testing and experimental applications on nearby building sites, as well as negotiations with public authorities. Thus a set of realistic standards proposed by PPCT were accepted. These are comparable to those for masonry cements elsewhere, and thus far below the strength level of a Portland cement, yet acceptable for most building in Rwanda. Establishing the level of standards to be attained posed fewer problems in Rwanda, where authorities take a realistic attitude, than with the official funders who often insist on a higher quality product.

Housing improvement in the private sector
Local builders and ordinary people build most of the houses in the private sector and not to strict, established standards. Scarcity of funds and the resultant economizing lead to poor safety levels and high risks. It is more difficult to introduce a new product here, as failure will give rise to bad publicity and rejection of the product. Thus PPCT made a special effort to research and popularize its product. The first step was a technical study (including an analysis of application methods, mixtures, etc.) on the use of other house-building binders in north-west Rwanda, notably Portland cement and lime.

Testing followed within PPCT, substituting pozzolan cement for the original products in their various uses, and in identical quantities. These tests indicated the potential uses and disadvantages of the new product.

Recently the methods thus established have been circulated among people building or improving their houses. The aim was to see whether similar results would be obtained under less controlled conditions.

The conclusions were that pozzolan cement fits in well with housing construction habits and that it can replace other binders in masonry, jointing, pavement, bricks, stones, drains and plastering.

Although improvements are still possible, the research has helped PPCT to establish criteria and utilization techniques for its binder and to increase its use among builders.

Improved finishing with pozzolana-lime rendering.

Application to stairs and base course.

PHOTOS: COOPIBO, BELGIUM

PPCT

Lessons to be learned

To develop PPCT was beyond local capacities and not in the interests of the conventional cement industry. This gap was successfully filled by an NGO.

Some unique and innovative technology has been developed within PPCT. Yet it was impossible not to rely on imported technology for some elements, notably grinding and mixing. This influences the scale and complexity of production, and probably puts the management beyond the capacities of a workers' co-operative.

It has proved to be difficult to continue research while simultaneously developing a production unit.

Safety margins with pozzolan cement are narrower than with Portland cement, which is the binder people know best. Correct building techniques and curing of the new product must be disseminated to its users, as well as information on its shortcomings.

In Rwanda, it proved acceptable to develop a local binder of substantially lower quality than Portland cement. Though adequate for most building, project funders prefer to maintain higher standards and this is inhibiting progress.

A small NGO finds itself in a weak negotiating position vis-á-vis public authorities when applying for funds.