



## **THE ROLE OF CONCRETE IN LOW-COST HOUSING IN AFRICA: A CAUTIONARY NOTE**

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**ABSTRACT:** I am a town planner with 30 years' housing experience, most of it in Africa. I am not an engineer. In this paper, I would like to sound a warning and ask for due thought before specifying concrete as a material in housing. Instead, the local technology should be favoured and, if necessary, adapted for the 21<sup>st</sup> century. I will be concentrating on the Sub-Saharan African context.

## CONTEXET

There is a very high unfulfilled demand for housing but there is a lack of money to pay for it. Overall, urban populations in Africa have grown dramatically in the last decades. Where there were 228 million people in 1990 (UNCHS, 1987), there might be as many as 425 million in 2010 (UN-Habitat, 2003). So, for every 10 people in the cities of Africa in 1990, there might be 18 in 2010 and the recently-peripheral areas are likely to be relatively central and their infrastructure and capital stock will need major additions.

Most African governments have had the resources to meet only a fraction of the demand for new urban housing, let alone catch up with backlogs. Even in relatively prosperous Côte d'Ivoire, in the heady days between 1960 and 1983, output by public housing agencies accounted for only 2,000 dwellings a year (Isaacs, 1983) despite what (Stren 1990:38) describes as a "massive construction orgy, unparalleled in Black Africa". In Nigeria, at the height of the oil boom, only 28,500 out of a planned 202,000 dwellings (about 40,000 per annum) were completed by government agencies. The cost of building this 14 per cent of planned output was estimated to be US\$776 million (23 per cent of the total budgetary allocation of US\$3,374 million) or US\$27,000 each (Okoye, 1990).

Public housing projects account for less than 5 per cent of total housing production in most African countries. In addition, many of these projects yield even less of a share of housing investment by value than their share of housing costs (Malpezzi, 1990). Furthermore, National Housing Authorities are often laden down with inefficiency, corruption, and petty bureaucratic delays so the likelihood of their being able to build thousands of dwellings per year is negligible. It is time for a change of direction. The Habitat Agenda commits countries to scaling up the housing supply process. Agenda 21 commits them to doing it in a sustainable way. In addition, the shift in the balance of incomes in cities, known as the 'urbanisation of poverty' requires that housing is as cheap as possible for the majority of the urban population. In this context, local technologies and labour-intensive building methods operated

by a multitude of small firms provide the most effective way forward.

In Sub-Saharan Africa, most households can afford a room or two built of local materials, even cement blocks, but few can afford a whole dwelling on a plot or a multi-storey flat built of reinforced concrete. The need to lower the cost of housing, as more households live in or close to poverty, is very real and should be embraced by engineers, architects and planners. Multi-habited low-rise housing is the way forward for most households (Tipple, 1994).

Most countries have locally garnered traditional materials, usually based on earth and plants. Materials such as stone, clay for bricks and tiles, earth in various guises, lime, timber, bamboo, sisal and grass all feature in traditional housing. Even animal products such as skins, shells and dung are used in some societies. Most are regarded as unfit for urban use through building regulations introduced in the 1930s, often based on portland cement, and little altered since. However, many very serviceable materials were given a bad name without reason. Now, their use is confined to informal areas, outside building and planning controls, and regarded by policy-makers and members of élites as undesirable.

RCC is almost mythical in its power. Post and slab, cantilevering, and all the other tricks seems to allow almost anything to be done in housing. However, for most housing purposes, the full strength of concrete is unnecessary. Local earth- and timber-based materials can be more appropriate and much more affordable.

## **REASONS TO QUESTION THE FOCUS ON CONCRETE**

### **Employment**

In times when there are unprecedented numbers of young people needing jobs, there is a great need to increase employment and income generation. Housing construction is an excellent sector for absorbing unskilled and semi-skilled labour and providing them

with the means to live. If it is done carefully, it can add to the viability of an economy (Tipple, 1995).

In countries where labour is abundant, increased construction activity would be one sure way to increase employment. Ironically, however, the benefits for development are highest from housing built by the informal sector in areas uncontrolled by building and planning authorities. Low-income housing developments in the formal sector tend to be in the middle range of benefit for development, and high-income housing is the least favourable. Strassmann's (1970) study in Mexico suggests that the cheaper the conventional housing, the greater is the proportion of total construction cost that goes to labour. A more elaborate study of low-income housing in Kenya also confirms that less expensive forms of housing generate more employment (Hughes, 1976). So, we should encourage self-help or low-income housing which tends to be built by the informal sector with its greater labour-intensity, use of indigenous techniques, unskilled labour, and small firms.

The informal sector is particularly efficient in this because its construction is simpler than in the formal sector and appears to consume less labour per unit cost. Investment of a given amount in informal housing tends to generate about one in five more jobs than in formal housing besides contributing six times as many (lower standard) dwelling units (Ziss and Schiller, 1982; Sethuraman, 1985).

RCC building can be labour-intensive (as in the Kumasi picture where there is little capital equipment) but it is usually not. Thus, if it replaces a labour-intensive technology, it will have great negative effects on employment for the low-skilled and for those with indigenous skills.

### **Multipliers and Linkages**

Income and employment generated by housing construction are amplified by income multipliers and backward and forward links in the economy. Multipliers measure the effect of adding one dollar

into the economy, linkages measure the extra economic activity established because of the construction of housing.

When a construction worker is paid, the money will be re-spent in the local economy over and over again until it is saved, used to pay taxes, or exported by buying something from outside like a Japanese radio. Because low-income people tend to buy locally produced goods, save little, and pay few taxes, the income multiplier on construction work is relatively high. Thus, construction which uses many labourers per unit of expenditure will generate more local multipliers than that which uses more skilled, well-paid, and non-local workers. RCC tends to fall into the latter category with more skilled and well-paid workers and a higher supervisory content in the workforce.

### **Potential for employment in manufacturing building materials**

Building low-cost housing can be very beneficial in employment and income for the local area. If materials are won or made locally, the direct employment can be augmented by local jobs in materials industries. Also, the profits and income multipliers from local industries benefit the local people. Cement tends to be made in large plants so the economic benefits are rarely close to the building site. Large cement plants have little employment potential per unit of production. A modern industrial plant generates only about 15 per cent by value in income for workers (Ganesan, 1975). Furthermore, transporting cement 100 km can double its cost, a significant problem in large countries with long distances between urban agglomerations. Steel reinforcing bars are also usually heavy in foreign exchange costs.

By contrast, making bricks in small local production units can provide 77 per cent of their value in employment. They generate about 50 times as many jobs as the large cement works and five times as many jobs as medium-scale cement products manufacture. Cement blocks can be made in labour-intensive methods, close to the site. This creates work to about 20 per cent of the value of the products (Ganesan, 1975), but quality issues may become

insuperable (see below). Aggregates production can be labour-intensive but usually is not. Where it is, such rock breaking work is very strenuous and unfulfilling. The women who break bricks for aggregate on Bangladeshi streets cut a very sorry figure.

### **Balance of payments issues**

In many countries, concrete contains basic materials for which foreign exchange must be paid. In Ghana, for example, the clinker is imported to a factory driven by hydro-electric power from the Volta River Dam at Akosombo. Though the final processing is done in country, the power used by the factory cannot be exported to purchase foreign exchange so even it has an external cost. Use of foreign exchange is usually a sign of higher cost and, certainly, a harbinger of uncertainty as relative exchange rates fluctuate.

### **Quality issues**

Potential for low quality is high in concrete and is particularly high in low-cost housing development as it is often built in scattered sites. It is difficult to regulate and there is a lack of good site supervision. Cement is easy to adulterate with flour, rock dust, etc., and the surplus finds a ready market. The products made from such cement will be inferior. Such concrete may withstand initial loads but is likely to collapse over time and under unusual loads, especially during hurricanes, typhoons, tsunamis, floods, etc.

Poorly consolidated concrete is common in columns and slabs. It leaves voids and exposes reinforcement bars, leading to water penetration and invisible but potentially disastrous corrosion. Entrapped air, often the result of poor mixture and/or lack of effort in consolidating a mixture, also weakens the structure. Beam and column joints are prone to poor detailing and faulty casting leading to poor coverage of the reinforcing steel. Al-Mansoori (1997) found that *in-situ* cast roofs on government-built low-cost housing in the UAE collapsed within ten years because of poor casting and the salinity of both the atmospheric moisture and the materials used in the concrete. Their repair is beyond the capabilities and

willingness to pay of the residents who tended to abandon the collapsed portions and live in their extensions where roofing was more traditional.

Discussion of collapses in earthquakes in Turkey have highlighted similar problems. Kandilli Observatory & Earthquake Research Institute (no date) cite poor concrete quality and poor detailing of the reinforcement (including lack of concrete confinement in the columns and at the beam-column joints, and inadequate splice length) as the technical causes of building damage or collapses there. Owing to poor workmanship in design, application and materials, the actual strength of concrete in the completed structures was found to be  $100 \text{ kg/cm}^2$  at best and only  $60\text{-}70 \text{ kg/cm}^2$  in buildings which collapsed totally in the earthquakes. In comparison to the design strength of  $160 \text{ kg/cm}^2$ , this is very poor indeed (Bayulke, no date). In addition to the frame strength, the filler walls made from lightweight concrete blocks were also found to have compressive strengths lower than they should have been, failing in shear with horizontal cracks (Bayulke, no date).

Salazar (1999) tells how modern concrete technology led to a weakening of traditional skills in building in Maharashtra, India, and destroyed the reputation of houses built that way, preparing the ground for disaster. The traditional masonry housing, developed in its full form, is earthquake resistant as it has a wooden frame holding up the roof. This not only protects the masonry walls from buckling under earthquake loads but also give a good chance that the roof will not fall and kill the occupants. With the growth of modernity, however, the traditional building system and division of labour had begun to break down and poor construction was becoming the rule. Thus, the seeds of the disaster were sown by increasing the vulnerability of the house form through policy changes and the regard the people had for the more 'modern' concrete technology.

When the earthquake struck, many recently-built traditional houses fell down but the mason's houses remained standing! The poor quality was more influential in the stand-or-fall dichotomy than the

traditional technology. The government's relief teams concentrated on concrete and steel construction after the earthquake, despite advice on how effective local traditional construction could be if well built. This further destroyed the traditions of building and imposed alien built forms and land subdivision patterns. The new housing is much smaller than the old because of the more expensive technologies. This led the occupants to add rudimentary extensions and use space in their (now dangerously weakened) pre-disaster homes. In addition, the built form and land subdivision interventions damaged the social structure of villages, increasing their vulnerability. Thus, vulnerability has been increased by the higher technology (Salazar, 1999).

### **Climatic issues**

Mass concrete has a good thermal capacity but not as good as earth building and masonry. Hollow concrete blocks often used in residential construction have poor thermal capacity especially in comparison to what they replace – bricks, stone, earth. This can have severe health implications (especially for the very young and very old) and increase demand for energy. The lack of protection from the cold indirectly encourages the use of charcoal stoves for heating, in countries such as Zambia, with problems of deaths through CO poisoning.

### **Cultural issues**

As we discussed above, a decline in demand for local skills and the standing of those with traditional craft skills can seriously affect the social structure of villages and towns. Local technologies and the ability to utilise them should not to be extinguished lightly. Multi-storey housing, which is often introduced with the use of concrete in mind, can be incongruent with local culture and cause significant problems, especially for newly arriving rural people whose integration into city life is made more difficult by discontinuities in how they can use the home. Some cultural practices do not suit high-rise living. The keeping and slaughtering of animals in the home is made very difficult. In Ghana, the pounding of *fufu*, the

local starchy staple, is capable of breaking concrete structures with sessions of rhythmic pounding before each meal time.

## **CONCLUSIONS**

Cement-based materials are predominant at present in the minds of urban housing professionals, particularly contractors and building technologists. However, the continuation of this should be exposed to scrutiny. While concrete may be necessary for large buildings and can be the most appropriate material for some components, e.g., floor slabs, there is much to gain in most residential building jobs from promoting local materials, assembled according to local technologies, by local workers.

The uncritical assumption that concrete is best should be laid aside in favour of a more open-minded approach to technologies viewed for their own merits and their ability to be improved and adapted for modern urban life. A palette of materials including rammed earth, brick, stone, wood, bamboo, and many other indigenous materials should be added to by developing new cement-based materials and major improvements in the finished quality of concrete through better quality control.

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