TECHNOLOGICAL CHALLENGES TO IMPLEMENTING AN AFFORDABLE HOUSING POLICY

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INTRODUCTION

South Asia is home to almost one third of the world's inhabitants, two thirds of whom live in inadequate or makeshift shelters. The failure to address the pressing need for affordable housing, by both public and private institutions, is not only due to neglect but also due to a failure of the engineering community to come up with appropriate engineering solutions and delivery strategies.

In this series of papers the author, who is an architect and a civil engineer, will discuss some of the fundamentals that drive this failure. Rather than deal with the better-known socio-economic factors, that are pertinent and central to affordability, the author will concentrate on the technological and engineering challenges to creating a viable and cost-effective building prototype. The papers will be structured as follows:

- The first paper will summarize the affordable housing strategies available to the world at large and some of the shortcomings of those options.

- The second paper will then define new building materials and delivery options that hold promise but require further research to overcome some of the traditional shortcomings of other and similar building and construction methods.

- The third paper will discuss the pros and cons of the various housing delivery options. It will further discuss sustainable design and eco-friendly solutions, green architecture, and the importance of incorporating sustainable design strategies to any eventual affordable housing solution or solutions.

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PART I - Affordable Housing Strategy for South Asia- The Need for a Radical Approach

PART II - Affordable Housing Strategy for South Asia – Technology Options

PART II - Affordable Housing Strategy for South Asia – Sustainable and Energy Efficient Design Options

Note: This paper was re-written on September, 2006 and incorporates a new proprietary technology, patent pending, developed by the author called Membrane Assisted Seismic-Responsive Structures (MASS).

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PART I - Affordable Housing Strategy for South Asia (SA) The Need for a Radical Approach

Abstract:

This paper focuses on finding an affordable housing solution for the low-income population of South Asian (SA) countries. This group consists of70% of the region's population with limited access to credit, mortgages, etc. for home construction. Since climate and economic conditions vary, this paper avoids regional differences and instead identifies, and proposes solutions to, common impediments to acquiring shelter among the poorest of the SA countries.

Affordable housing in South Asia has been an illusory target at best. Since income disparities are broad in the South Asia – there is only a limited population, only 15% to 25% that qualifies as a group, that can afford minimum and decent shelter. The rest of the population, 75% to 85%, relies on public or private intervention or/and credit in order to afford decent shelter. Since such capital layouts are not possible in the nascent and developing economies of South Asia housing takes a back seat and plays second fiddle to other competing sector such as defense, industrial development, health and primary infrastructure development – and which end up getting a lion share of the national budget. Hence decent housing for most of South Asia's population remains illusory and unachievable.

Part 1 of these series of papers focuses on defining the term " Affordable Housing" and examines, so called, available affordable housing strategies. In the opinion of the author the existing prototypes are not affordable, and hence not truly appropriate, for 70% of the SA population. Hence the author recommends looking at other alternatives. The author makes a case for new strategies that promise to increase the housing stock by better leveraging the sweat equity component of the homebuilder.

Introduction:

As a rule all the so-called affordable housing, or low cost building strategies, have several things in common. The design consists of manipulation of small building units or building blocks held together by a cementing or a bonding agent. Usually, but not always, the building block is a brick or Concrete Masonry Unit (CMU) block. It is either dry stacked, rare but still practiced, or cemented through use of a bonding agent such as cement mortar. Typically the units are geometrical, and rectangular, and are assembled in geometrical and rectangular shapes. The assembly of these building blocks, more often then not, requires a skilled tradesman such as a mason, carpenter, etc. The mortar is the weak link. Poor preparation of mortar is usually the culprit behind failed buildings. The fact that all the known technologies require skilled labor usually precludes participation by the homeowner in the construction process. Currently, in order to execute one of the so called known affordable housing strategies, a homebuilder has to be able to afford the services of a third party, such as a mason or a carpenter. That requires money, either in the form of cash or credit. Hence the only home dwellers, who can afford existing technologies, are the wealthiest top 30% of the population. The fact that 70% of the people in developing countries live hand to mouth, can barely afford to buy food leave alone pay for tradesmen for home building activity, pushes up the bar for affordable housing and hence precludes and mitigates the development of much required housing stock.

Hence it is worth exploring solutions that help individuals build their own home through their own non-cash capital i.e. their own physical labor or what is popularly know as "Sweat Equity". But effective leveraging is not possible as very few technological solutions exist that will facilitate, in practical terms, participation through "sweat equity". Architects and Engineers do not work out solutions for non-paying clients – such as the poorest of the poor. Hence very few solutions exist.

One approach, engineering wise, to developing a viable solution is to focus on building modules that are lightweight, simple to assemble, and require minimum skilled labor. Since developed countries are not interested in this mode of delivery it is contingent on SA countries to conduct their own research on an urgent basis.

Another approach is to identify technologies that promote sweat equity and tailor them to third world needs.

The fact is there is no magic bullet as far as solutions go for providing shelter. It is a question of evaluating the needs of the target group, assessing the available resources both in terms of capital and building material, and matching the technology that is affordable and offers the best return on investment (ROI).

The first step in identifying such desirable technologies is in measuring their affordability index.

Affordability Index:

The author defines **"Affordability Index"** as the ability of a group to afford a desired piece of shelter. Strategies for providing the shelter are then tailored to suit that individual or families specific needs.

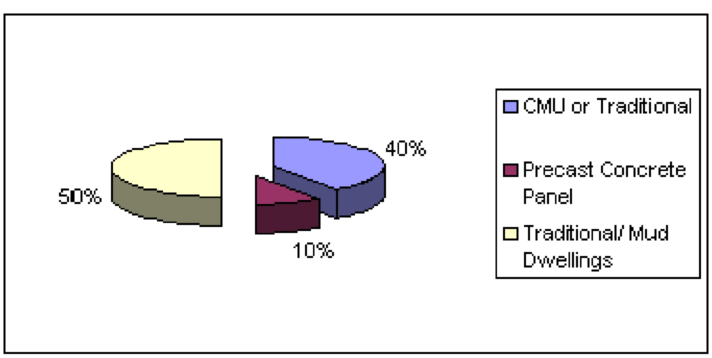
The author suggests that countries develop a country-by-country affordability index.

The author has developed 3 categories of affordability Index –which closely mimic the situation in most South Asian countries today. The last column "Existing Delivery Potential" identifies ways the housing or shelter can be potentially acquired by the target group given the current economics.

Chart 1: Affordability Index

	% of monthly Income available for Housing	% of Total Population	Existing Delivery Practice
Group A	10 %	50-60 % of the Population	• Sweat Equity Investment
Group B	20%	25-35 %	• Mortgage Facility • Subsidy
Group C	30-40%	5-15%	• Mortgage

Chart 2: *Current Building Materials Utilization*

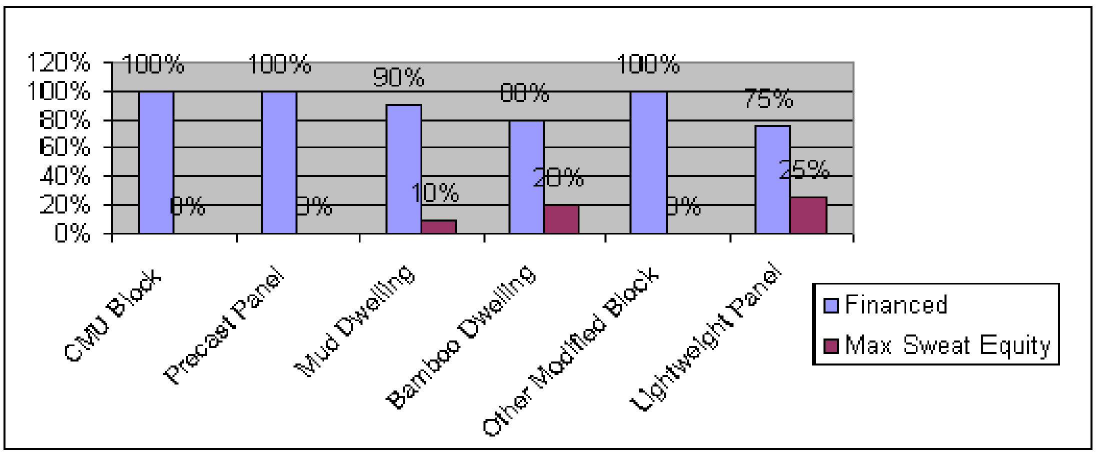


If one were to examine the type of building materials used in South Asia , pre-dominantly in rural areas, the housing stock consists of one of the following, or a combination of: mud, bamboo dwelling, rubble masonry, organic fiber / bamboo used in combination with other building materials. Again the specific choice is contingent on climate and other demographic and regional specifics.

Mud dwellings, have been romanticized as the ideal, but in reality mud or adobe construction as practiced now is not practical. Such structures are expensive, time consuming, and require regular maintenance. Mud dwellings do have some pluses, they are more comfortable in terms of thermal insulation, compared to most other building types and freely available – so far less expensive. Bamboo dwellings have a high decay and maintenance factor and a high life cycle cost. However both Mud and Bamboo dwellings allow for higher sweat equity participation.

An examination of the available building technologies reveals that very few permit participation of the desirable resource i.e. human capital.

Chart 3: *Level of "Sweat Equity Participation" with various building types*



Note: Among Current Technologies "Lightweight Panels" or SARID's proprietary "MASS" technology, offer the greatest potential for participation of a home dweller through sweat equity.

The modified earth dwelling – including rammed earth dwellings are complex and require significant effort and startup expenses, such as those being made in USA, and require considerable amount of skilled labor. They generally cost more then buildings made of CMU blocks.

The Rammed earth structures typically do not allow significant sweat equity contribution – due to the highly skilled nature of production.

Most of the mud housing in rural South Asia have a self-help or sweat equity component. However as built today prove to be very expensive, because of the high first cost, and long term maintenance cost, and overall high life cycle cost.

Given the fact that the poor in these countries very often do not have full time jobs, the possibility of contributing equity to housing is a form of wealth creation. It creates employment for the otherwise unemployed and boosts the Gross National Product (GNP).

Hence we need to develop a set of criteria to identify and evaluate the appropriate and desirable technology for Group "A" – the "poorly sheltered" majority of the population in SA countries. Broadly speaking those criteria for the appropriate technology will be as follows:

- ***Sweat Equity:*** *Housing technology that permits sweat equity- emphasis on lightweight building materials, or building blocks, so a husband and wife team can erect the unit*

- ***Ease of Construction:*** *Housing technology that is simple to use, and does not involve skilled labor*

- ***Production Rate:*** *Rapid installation, or volume of material erected, to enable faster rate of production*

- ***Maintenance:*** *Low maintenance, to reduce life cycle cost. Safe and structurally sound*

- ***Material Cost****: Use of inexpensive material resulting in lower building cost*

- ***Capital Investment****: Requires small initial capital investment, such as set up of factory or assembly plant. Usually prefabricated construction requires significant investment and mitigates against light-weight prefab panel construction*

- ***Adaptable:*** *Lends itself to both new and rehabilitation upgrade*

- ***Comfort:*** *Is responsive to climatic needs. Minimizes use of supplementary cooling or heating to provide comfort*

- ***Acceptance:*** *The material would be seen as desirable, upscale, and not seen as a cheap option*
- ***Professional Cost:*** *It is preferred to keep at a minimum, or not to engage and pay for the services of, professionals such as architects and engineers*

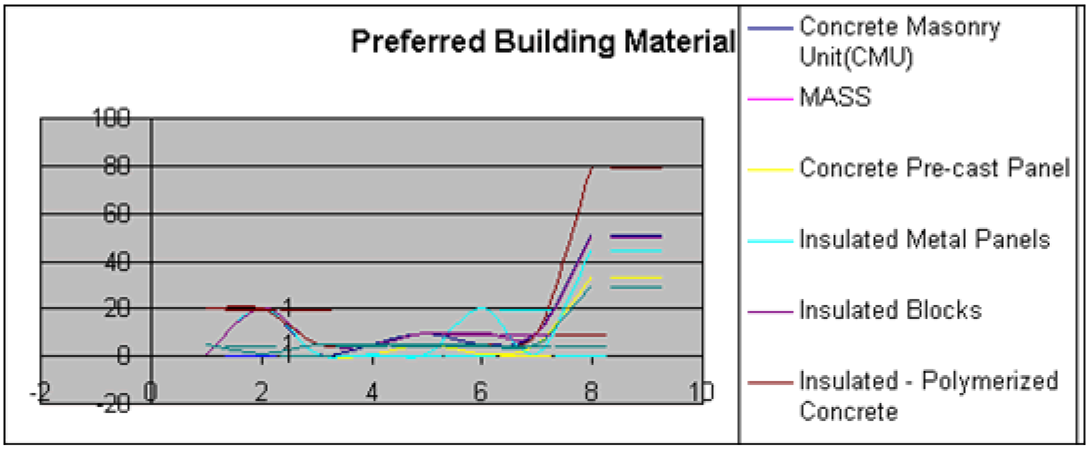
Building Types	***Sweat Equity***	***Life Cycle***	***Material Cost***	***Cap Investment***	***Adaptable***	***Comfort***	***Acceptance***	**Cumulative Score**
Maximum Score	20	20	10	10	10	20	10	**100**
Concrete Masonry Unit(CMU)/MB	1	20	1	5	10	5	10	**52**
Rammed Earth	5	5	5	1	5	20	5	**46**
Concrete Pre-cast Panel	1	20	1	1	5	1	5	**34**
Insulated Metal Panels	1	20	1	1	1	20	1	**45**
Insulated Blocks	1	10	5	5	10	10	10	**51**
Membrane Assisteted Seismic Structures (MASS)	20	20	10	5	10	20	10	**95**
Insulated - Polymerized Concrete	***20***	***20***	***5***	***5***	***5***	***20***	***5***	***80***
Traditional	5	1	5	5	5	5	5	**31**

Note: (1)The higher the score the more suitable the building type is for Group A. All criteria have been assigned a minimum value of 1. (2) Maximum Score (Weighted Average): The choices have been weighted – to incorporate an importance value

MASS is a proprietary technology – patent pending – developed by Javed Sultan and as built for the Aga Khan Foundation (AKF) and the city of Karachi. See following website for additional information. www.sarid.net

As the chart shows more then 70% of the population cannot afford to provide themselves with shelter unless the solution incorporates some form of investment in form of sweat equity. The sweat equity contribution should take place at several stages of the shelter production and delivery process.

Given the above very few technologies available today qualify as suitable for group “A” above – the population group most in need of a housing solution. Hence the dearth in housing production is also the result of a lack of a cost effective building technology solution. The few solutions such as lightweight insulated concrete, or structures such as MASS structure developed by Javed Sultan of SARID, Inc. , seem promising but have yet to be accepted by the public at large. Unfortunately what is available is proprietary, not well known, and carry a licensing fee, and the developers want to recover some of the money spent on Research and Development (R&D).



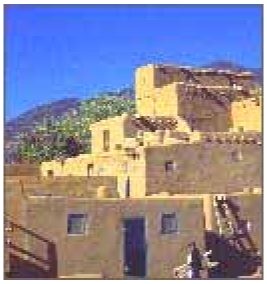
Preferred building type is MASS (score of 95) or lightweight insulated panel -such as a polymerized concrete with a score of 80.

Ideally the sweat equity participation should occur at various stages of the production / implementation/ finishing process. However there are difficulties associated with each stage. For most building materials the following is true.

- ***Sweat Equity*** *participation during the production process i.e. when the building material is being made is very difficult. Usually this stage requires skilled labor, in order to maintain quality control and material integrity during the production process.*

- ***During Implementation****: Such as lifting the panels in place – however this is provided the panels are lightweight and weigh in the vicinity of 75 lbs or so. This will enable a husband and wife team to install the panels*
- ***Panel Size:*** *If the panels are too small, such as the current CMU blocks or brick, the entire wall production process is more time consuming. Large panel sizes are preferable, which utilize mechanical locking as supplemental anchoring. Mechanical interlocking is difficult to achieve – but if achieved reduces the cost associated with mortaring, etc.*

Finishing stage: *Sweat equity participation during the finishing process. The process should be simple to learn and implement. Once the panels or building units are installed a husband and wife team can finish the walls and surfaces.*



Rammed Earth Housing
Taos, New Mexico

Most of the affordable housing solutions available today, rely on large initial capital investment – not only in terms of land and infrastructure development but also purchase of building materials or equipment that would produce the building materials. Since Group A, which is largest group in most South Asian countries, has neither the capital or access to credit, has been left out of the housing market.

Before identifying some of the solutions that offer a greater promise of proliferation of certain building technologies, or housing implementation methodologies, it will be helpful to identify the available technologies and examine their strength and weaknesses.

Low Cost Building Options:

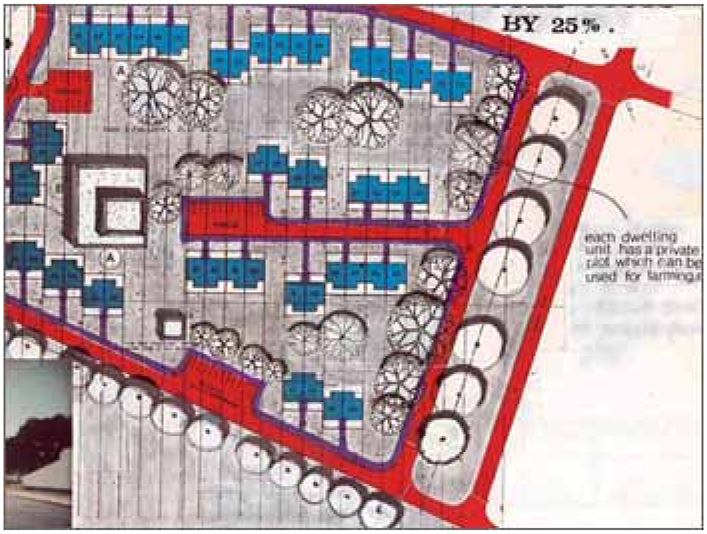
A. Site and Services Approach:

These schemes have more often then not been tried in urban settings and are mostly applicable to new construction as opposed to renovation and upgrading existing communities.

The site and services approach generally speaking is a mechanism by which the basic infrastructure for a housing development is provided by an external body. The facilitating agency may provide a wet core, such as the toilets and kitchen. The actual dweller is responsible for the rest of the superstructure i.e. the building above the foundation level.

The State, the local government or a public or private agency does the initial site development and placement of infrastructure. Usually this approach results in building significant number of housing units 250 housing units or more at the minimum.

Typically the executing agency would buy the plot, grade it, sub-divide the lots, provide for piped sewer, water and roadways as well as surface water drainage infrastructure. Each individual plots, which can be as small as 20 feet by 30 feet, would be given a latrine and a Kitchen or Kitchenette. The household is then expected to come up with the resources to build a shelter – using contemporary construction strategy. The most common construction techniques are using either cement blocks or Concrete Masonry Unit blocks (CMU), or fired bricks. However since the process of construction requires skilled labor, and is time consuming, the participation of the homeowner vis-à-vis sweat equity is minimum. The process very often fails to provide shelter for the poorest as they are not able to build the shelter. A site and services approach with an appropriate technology for building would provide the best option for housing production for Group “A” as far as new housing development goes.



In a site and services project the plots would be provided with basic infrastructure such as water, sewer, roads and a wet core such as kitchen and toilet. The dweller would have to build the rest of the shelter.

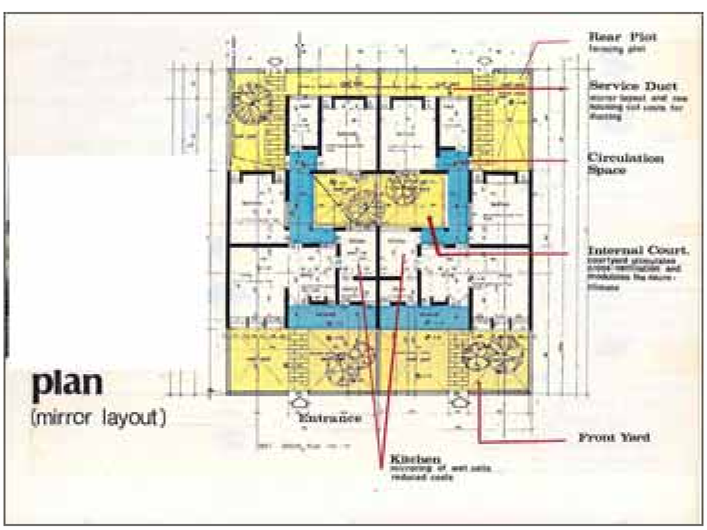
Site layout from low cost housing designed by the author, over 500 units of housing were built, in Kano, Nigeria

In site and services projects the design attempts to group the housing in order to share the party walls, combine sewer for several units into one septic system. The plans mirror each other in order to share plumbing lines and wet cores.

B. Concrete Masonry Unit/Modified Block/ Brick:

These category of solutions include fired brick, sun-dried brick, low strength sun-dried or mechanically dried bricks. The key features of this solution are:

- Unit sizes are small so say 4"x 12" or some dimension thereof so they can be manipulated easily by hand
- Modified Blocks/ Soil cement: Cost is kept down by increasing the amount of locally available material such as on site clay and using a binding material such as cement, or other binders, and creating a low strength brick/ block
- CMU/ Brick/ etc. require a skilled mason to build the structure – which ends up being a significant portion of the building cost.



Plan of low cost- row housing designed by the author in the 70's. Party walls are shared, wet core is mirrored to save on plumbing cost. A central courtyard, facilitates cross ventilation, and keeps the house cool and provides a more private and protected courtyard where small children can play.

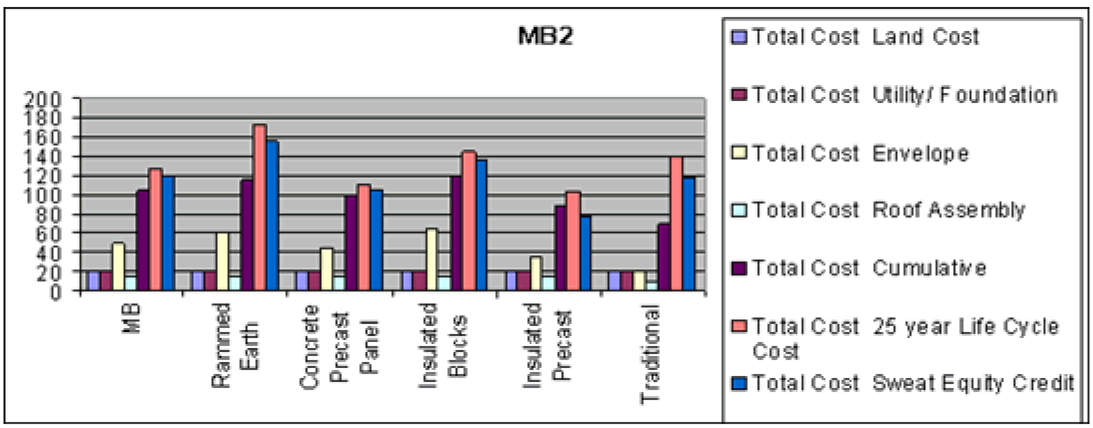
Construction Cost Comparison for Group "A"

Chart IV: *Group "A" – Relative Construction Cost of various Building Options*

	Cost								
	Land (Varies/ assumed 20)	Utility/ Foundation	Envelope	Roof	Cumulative	25 year Life Cycle Cost (Factor)	**Sweat Equity Credit – Cumulative Score**	Life Cycle Cost Factor	Sweat Equity Factor (Group A)
CMU	20	20	50	15	105	126	**120**	120%	-5%
Rammed Earth	20	20	60	15	115	172.5	**155**	150%	-10%
Concrete Precast Panel	20	20	45	15	100	110	**105**	110%	-5%
Insulated Metal Panel	20	20	65	15	120	144	**137**	120%	-5%
Insulated Blocks	20	20	65	15	120	144	**137**	120%	-5%
Insulated Precast* or MASS Technology	20	20	35	15	90	103.5	**78**	115%	-25%
Traditional	20	20	20	10	70	140	**126**	200%	-10%

*(Note: **The lower the score the more desirable the building option. Here polymerized, lightweight, concrete and MASS technology have the lowest score***
*(*) Is the best option. (1) Land cost will vary given location. Here it is given a value of 20. (2). In order to get the 25 year life cycle cost and sweat equity credit the cumulative numbers have been multiplied by the factors shown on the two extreme right columns.*

Chart V: *Cost Comparison of Building Materials*



Note: Insulated precast and MASS technology cost the least and have the best score

Low Cost housing: CMU Block, plastered and painted. Designed by the author in late '70's Kano, Nigeria.

C. Rammed Earth including Slip form:

The rammed earth solution relies on using local soil or clay mixed with a binder such as cement. The soil cement mixture is rammed between a formwork made of either metal or wood or even plastic. Usually a mechanical device does the ramming. Ramming can be done manually as well, but is quite time consuming and labor intensive. Either smaller blocks are made and then the walls are made similar to using regular masonry construction. The other option is making entire wall – in situ- as one wall panel using sometimes a slip-form construction. Once the slurry dries the formwork is removed resulting in the walls. Placing the formwork within the walls, prior to pouring the soil cement mixture, traditionally forms door and window openings. Subsequently the doors and windows are attached to the frames that were earlier set in place. The process is quite involved, time consuming as one has to wait for each layer to dry prior to moving to the next layer and requires a certain level of skill set. Also if metal forms are used the cost of renting metal forms, cleaning, stripping etc. can be significant as it involves the use of skilled labor. The cost savings, through manual ramming, does not translate into excessive cost savings.

Adobe home form New Mexico

D. Precast Panels:

There are many types of precast panels available in the market place for shelter. Essentially the process of delivery and erection are two fold.

1. The pre-cast panels are typically produced off-site, in a controlled environment to ensure qualitative control, and then delivered to the site by truck, etc.

2. The panel is then erected at site using mechanical equipment such as cranes or sometimes by human manpower. Again if the intent is to use manpower it defines the type of panels to use and also the size of panels.

Different type of panelsare available:

- Panels can be sandwiched panels, which are panels consisting of an external skin with some insulation infill which increases the insulating capacity of the panels. The panel edges either interlock or require some sealant, usually silicone, to make them watertight.

- The other type of panels is a monolithic panel, such as pre-cast concrete panels, which are typically heavier and require mechanical equipment for erection. The edges need caulking and some degree of repair and regular maintenance.

- A third type of panel that is available is the polymerized concrete panel. These panels offer the greatest promise in terms of cost and affordability. They require a binder such as cement and use re-cyclables such as paper and Styrofoam as infills. They have high insulation value and are lightweight and offer an opportunity for permanent construction as well participation of sweat equity for erection. However they require private or public investment to set up the initial production plants.

Precast – Concrete Panel Home

Membrane Assisted Seiscmic-Responsive Structures (MASS):

Light Weight Concrete Panel (Polymerized Concrete) Arizona, USA

The author has developed a new proprietary building technology, patent pending, which allows a greater contribution of sweat equity by a homebuilder. In the summer of 2006 the author built two homes in Pakistan. One was built in an earthquake-affected area in Garthama, Azad Jammu Kashmir (AJK), Pakistan, for the Aga Khan Foundation. The other structure was built in Karachi, Pakistan. Both the buildings were completed over a period of 5 weeks or so. The cost of the building is anticipated at well below the cost associated, anywhere from 40% to 50% lower, then known technologies. Since this technology is proprietary and still under development only time will tell if this will be accepted as a viable and practical solution.

Garthama, AJK, Pakistan
(MASS Technology)

Built by the author in 2006 for the Aga Khan Foundation, this 3 room structure, plus kitchen and toilet, uses MASS technology and was built over a 5 week period. Cost is approximately half of what is possible with hereto known technologies.

Conclusion:

The right response to the crises of housing in South Asia, requires matching the building construction technology to the target income group. The most pressing need is being faced by the poorest 70% of the population – identified as Group “A” above. Hence any technology utilized must be able to leverage human capital and promote contribution of sweat equity. The following steps would be a good first move to stimulate a housing growth in the region.

Taiser Town, Karachi, Pakistan
(MASS Technology)

Built by the author over a 5 week period, for the city of Karachi, this affordable housing model utilizes MASS technology.

- ***Group “A” (50% of the population):*** *Group has meager resources, and cannot depend on public or private intervention. The correct strategy is to identify a technology that will maximize the sweat equity component of the building process. The sweat equity participation can take place at the building material production level and/or installation or erection level and/or finishing/ finalization stage . Public programs that offer free land, subsidies, grants, tax incentives would stimulate housing for this sector. Currently the product that holds the greatest promise are lightweight concrete panels, such as polymerized concrete panels and technologies that utilize local soil based technologies such as MASS technology. They are robust, energy efficient, lightweight for a husband and wife team to install, and do not require complex skill sets. They are environmentally friendly, structurally sound, require low maintenance and are seismically responsive. They allow for sweat equity participation at various stages of production and delivery process.*

- ***Group “B”*** *which has some financial leverage, will benefit from Government programs that help provide low interest loans or help individuals qualify for mortgage, etc. This group has a large selection of building types to choose from.*

- ***Group “C”*** *is financially the most well off and could require little or no public support.*

- ***Group “D”*** *can help stimulate growth in housing for group A and B through cross subsidies.*

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