Methods and Designing of Low cost Housing Scheme for Pre-Urban and Rural areas of Pakistan

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Methods and Designing of Low cost Housing Scheme for Pre-Urban and Rural areas of Pakistan

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Contents

No table of contents entries found.

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Keywords:

Natural materials

Low cost techniques

Low income group

Structural component

Zoning

Break even analysis

Abstract:

This project aims to point out the various aspects of predestined building methodologies by highlighting the different available techniques, and the economic advantages achieved by its adoption. The Project is divided into three categories; Zoning for housing scheme, Material and cost effective technologies and the designing of houses. The shelter less population of Pakistan is identified and Map of Pakistan is divided into different zones using GIS in order to provide a suitable and compatible housing scheme for each zone depending upon the accessibility and economy of materials and techniques to be adopted for low cost housing. The different innovative materials like bagasse, bamboo, fly ash, Rice husk ash , straw fibers is used in construction. The techniques like sustainable mud plastering , Bamboo fibers based roofing and floor panels is adopted which is easy, sustainable and cost effective then simple techniques. These materials and adopted techniques reduces the overall cost up to 30% - 35. The houses are designed in for average size and large size families in such a way that it cover less land so land use cost is reduced up to 20% thus providing a complete set of solution for low cost housing and makes it easier for government to achieve the target of 5 million houses in time range of 5 years at possible low cost and maximum efficiency The calculated area required for this project is 18,75,000 kanals and free area of Pakistan is 1257173635 kanals which shows the ease of constructing a housing scheme in Pakistan. . This Project Provide cost effective and ecofriendly houses for middle and lower middle class families in rural and pre urban areas.

1. Introduction:

Housing is a basic need of human kind .Every nation has the inherent responsibility to ensure that its people have housing that is safe, robust, durable and promotes healthy living. It is the responsibility of engineers, architects and policy makers to make these basic needs a reality. But contrary to this, in Pakistan, type and number of homes available is not adequate as per the estimation reported by the Ministry of housing and works, Government of Pakistan. With an annual population growth rate of 2% as

compared to world population growth rate of 1.07% which indicates a great demand to fulfill housing needs. In this context Prime Minister Imran khan started “Naya Pakistan Housing Program” to fulfill housing requirements for shelter less people in Pakistan. The Program seeks to build 5 million housing units for the poor and make Indian cities slum free by the slum rehabilitation projects and affordable housing projects for Economically Weaker Section. This would result in an enormous demand of building materials like steel, cement and wood etc. To reduce this dependence on conventional Building material there is a need to review alternate building materials and formulate guidelines for their application in construction industry. However, with the traditional building technologies it is impossible to solve this menace as we cannot solely depend on the traditional construction materials such as concrete, bricks, wood to cover all housing needs, as they are produced from the natural resources. Low cost house is a new concept which deals with effective budgeting and use of techniques which help in reducing the cost of construction by the use of locally available materials along with improved skills and technology without compromising the strength ,performance and life of the structure and also provide Eco-Friendly structures. There is a huge misconception that low cost housing is suitable for only sub standard works and they are constructed by utilizing cheap building materials of low quality. The fact is that Low cost housing is done by proper management of resources. Seeing the past constructions one can see the use of natural materials like straw, bamboo, fibers (jute, coir), earth etc. These materials apart from being locally available have easy workability and speedy construction hence reducing costs. After analyzing various industrial wastes it had been observed that fly ash and rice husk do possess pozzolonic properties which can act as an excellent substitute material. This paper aims to compile the studies of all these materials keeping in mind their affordability and accessibility.

2. Literature review

Realizing the importance of low cost housing in countries which have varied living standards and huge population to cater along with keeping a check on availability and use of natural resources in construction; the option of low cost housing needs to be explored at the fullest. Several studies have gone under pilot project to estimate the cost reduction. If only walling and roofing to be analyzed alone for low cost solution they saved 26.11% and 22.68% respectively. Using several alternative building materials as discussed in subsequent sections of this paper will also help in saving the cost of construction because if materials are locally available then cost of transportation will be reduced which is approximately 30% of the total construction budge.

2.1. Methods for cost reduction:

In this section, construction method of walling, roofing and lintel are compared. During construction strength and durability of the structure, stability, safety and mental satisfaction are factors that assume top priority during cost reduction. In the case studies for walling and roofing it has been found that about 26.11% and 22.68% of the construction cost can be saved by using low cost housing technologies in comparison with the traditional construction methods respectively. From these results it can be said using low cost housing technologies is a cost effective mode of construction that can be adopted in this industry.

2.2. Technologies

The environmental friendly technologies for low cost housing that can be adopted are as follows:

• Cement -Waste Slag Brick

• Concrete Hollow Block

• Light Weight Concrete Block

• Concrete Paving Block

• Wall Plaster

3. Materials:

The environmental friendly building material for low cost housing that can be used are as follows:

- Natural Fibers
- Pozzolanic materials
- Industrial and Building wastes
- Earth

3. Methodology:

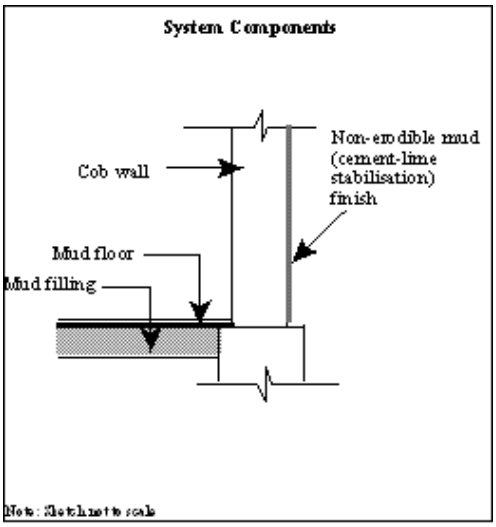
The methods adopted of low cost housing is different for each and every structural member of a house. The changes in certain design required and different cost effective materials are used. Different techniques are adopted for different components of a building to reduce the cost and without compromising the strength of the building. The detailed discussion of methodology is given below,

3.1. In walls:

In the construction of walls, rammed earth, normal bricks, soil cement blocks, hollow clay blocks, dense concrete blocks, small, medium and room size panels etc of different sizes are used. Although bricks continue to be the backbone of the building industry, in actual construction, the number of the bricks or blocks that are broken into different sizes to fit into position at site is very large which results in wastage of material. On increasing the size of wall blocks they will prove economical to an extent due to greater speed and less mortar consumption, which can be achieved by producing low density bigger size wall blocks by the use of industrial wastes like blast furnace slag and fly ash. Several prefabrication techniques have been developed and executed for walls but these medium and large panel techniques have not proved economical for low rise buildings as compared to traditional brick work.

3.1.1. Non erodible mud plaster:

The plaster over mud walls gets eroded during rains, which necessitates costly annual repairs. This can be made non-erodable by the use of bitumen cutback emulsion containing mixture of hot bitumen and kerosene oil. The mixture is pugged along with mud mortar and wheat/ rice straw. This mortar is then applied on mud wall surface in thickness of 12 mm. One or two coats of mud cow dung slurry with cutback are applied after the plaster has dried as shown in Fig. 1 and Fig 2. The maintenance cost gets lowered due to enhanced durability of mud walls.



3.1.2. Solid concrete and stone blocks

This technique is suitable in areas where stones and aggregates for the blocks are available locally at cheaper rates. Innovative techniques of solid blocks with both lean concrete and stones had been developed for walls. The gang-mold is developed for semi-mechanized faster production of the blocks.

3.2. In floor and roof:

3.2.1. Filler slab:

A filler lab material may be termed as a waste material and is used to ensure advantage over RCC slab. As it is known that steel is good in tension and concrete in compression therefore it is difficult to remove concrete from tension zone but on the other side can be replaced by using a filler material. Materials are placed in such a way that strength is not compromised; thereby removing unwanted concrete from below, which leads to decrease in the quantity of material required. These steps act as a cost cutting measures in addition leading to reduction in dead load. To add an extra advantage internal cavity wall can be provided. Different materials had been used as filler material like Mangalore tiles, coconut shells, etc. The advantage of using these materials are that they are cost effective, have improved thermal coefficient, and reduces carbon emission by 20% and better appealing recycled material. Before deciding the design of slab, type of filler material to be used should be decided first because size of filler plays a role in deciding the depth of slab and also the spacing of reinforcement. Filler should be soaked in water so that it does not absorb water from concrete.

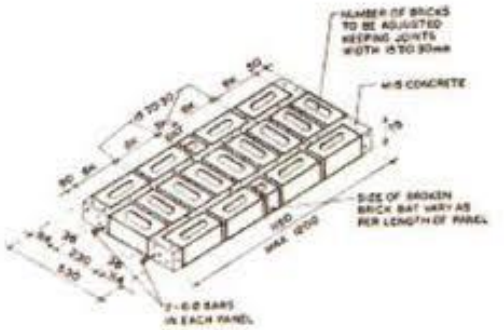
Slab	Item	Cement(kg)	Steel$(^{Kg}/_{m^3})$	Cost$(^{Rs}/_{m^2})$
Two Way Slab	Convectional slab of 120 mm thick	38.4	71	2325.6

	Filler slab 150 mm thick	32	4	577.3
	Saving (%)			24.82%
One way Slab	Convectional slab of 120 mm thick	48	6.5	877.95
	Filler slab 150 mm thick	32	3.5	565.05
	Saving (%)			64%

Table: Comparison between conventional and filler slab

3.2.2. Brick panel roofing:

The concrete used was in high compressive zone whereas bricks were used in less compressive zone. Use of M20 grade or 1:3 grade cement mortar was done for construction. Brick Panel Roofing was made up of first class bricks reinforced with 6 mm MS bars, length was varied between 900 and 1200 mm but width was kept at 530 mm for allowing 36–40 mm gaps between bricks as shown in Fig 3 and 4.In order to increase the length of brick panel, diameter of bars was also increased and is most suitable for rural areas. The different advantages of using these were that they help in saving the quantity of cement, steel, labor. It also saves time and cost, concrete and concreting cost can be saved by 20–25% and 25–35% of complete slab cost respectively. If the production for ensuring availability is to highlighted then in that case a factory can produce approximately 1, 20,000 brick panels/day in an 8 h shift and 24,000 RCC joist in an annum. For all those produced the compressive strength ranges up to 150 kg/cm2. Standard size of brick panel used was of size 1200×530×75 mm and while that of RCC joist was 130× 1200×3600 mm. The numbers of skilled and unskilled labor required are 6 and 20 respectively. Brick panel weighs around 75 kg whereas RCC joist weights 15 kg/m.



View of Brick Panel

3.3. Materials:

Low cost Housing materials can be broadly classified into natural materials and manmade materials according to the source of their availability. Materials like bagasse, rice husk, coconut husk, are naturally available from the remains of agriculture industry. Natural materials such as fibers, earth and fly ash are some of the materials which are easily available and have excellent prospects of being used in the construction industry. Materials like fly ash and ferro cement are an example of man-made materials which can be recycled to make new product that helps in lowering the cost of construction.

3.3.1. Earth:

One of the oldest material available but due to its limitation like erosion, water penetration, termite attack and high maintenance it is less used. But this limitation can be overcome by:

1) Compressed earth block – developed from adobe block or also known as earth block and also consists of cement using manual press.

2) Non-erodible mud plaster – Its constituents are bitumen which is mixed with a specific mud paste and has the ability to resist water.

3.3.2. Bamboo fiber:

Bamboo is also more flexible than steel having low modulus of elasticity of 50 GPa (50,000 N/mm2) than that of steel. Mechanical properties of bamboo vary from specimen to specimen. It can be used mostly as beams rather than in columns as it has a tendency to buckle. One of the major problems with the use of these is that of connection of bamboo culms. It can also be used as bamboo roofing sheet which is strong, durable, light weight and fire resistance.

Availability	Cost
Kasur, Sheikhupura, Gujranwala, Mandi Bahauddin and Sargodha	PKR 5-9 per feet

3.3.3. Straw Fiber

After the removal of chaff and grain, straw is obtained which is one of the byproducts of agriculture industry. This variety is toughest as compared to other straws. One has to be extra careful in disposing it off because if burning is adopted then it will cause breathing problems, therefore, an alternate mode need to be adopted and discovered

Applications

1) Life extended thatch roof – environmental friendly also is fire resistant and water proof.

2) Improved thatch roof – CBRI has designed a technique to make the roof more fire and water resistant and by doing the plaster with the layer of mud makes it more resistant to fire.

Availability	Cost
Punjab, Kpk, Sindh	PKR 100 per kg

3.3.4. Bagasse fiber:

This is obtained from the remains of sugarcane or sorghum stalks. The amount of waste generated is approximately same as the quantity of production. Its physical properties are color pale green to grey yellow, texture and size -non-uniform and bulky. Approximately 50% cellulose and 25% of both lignin and hemi cellulose is present in the remains and if properly modified will show better mechanical properties. To estimate approx. 85% of the material is burnt or deposited on field. The advantages related to this are low energy input required, eco-friendly and reduces the density of product. Disadvantages are because of less impact strength problem of stocking, degradation of fiber etc. In addition, it can be used as bagasse cement board and panels, bagasse PVC boards and in biomass power generation.

Pakistan is 5th largest country in sugarcane production having yield area of 759 hectares and produces 35.4 tons per hectare of sugarcane. It yields about 12 million tons of bagasse per year.

Availability	Cost
Punjab : 62 % Sindh : 26 % N.W.F.P :16 %	PKR 9000 per metric ton

Fig 5: Sugarcane Production in Pakistan

3.3.5. Rice husk:

About 220 kg of husk can be produced from 1000 kg of rice and around 55 kg of ash is produced if burnt. It is used in power plants, roofing units, rice husk binder, fibrous building panels, bricks, acid proof cement, production of activated carbon, thermal insulating bricks, production of some acids, production of building materials and low cost sand concrete block.

Area	**Variety type**	**Seed rate/acre**
Punjab	IRRI type Basmati type	6-7 kg 5-6kg
Lower Sindh Upper Sindh	All varieties All varieties	6-7 kg 6-7 kg
KPK (plains) KPK (Swat etc)	All varieties All Varieties	6-7 kg 7-8 kg
Baluchistan	All varieties	6-7 kg

Pakistan is the world's 11th largest producer of rice. Pakistan produced 6.7 million tons of rice per year.

Availability	Cost
Punjab : 55% Kpk : 30% Sindh : 10% Balochistan : 5%	PKR 15,000 per metric ton

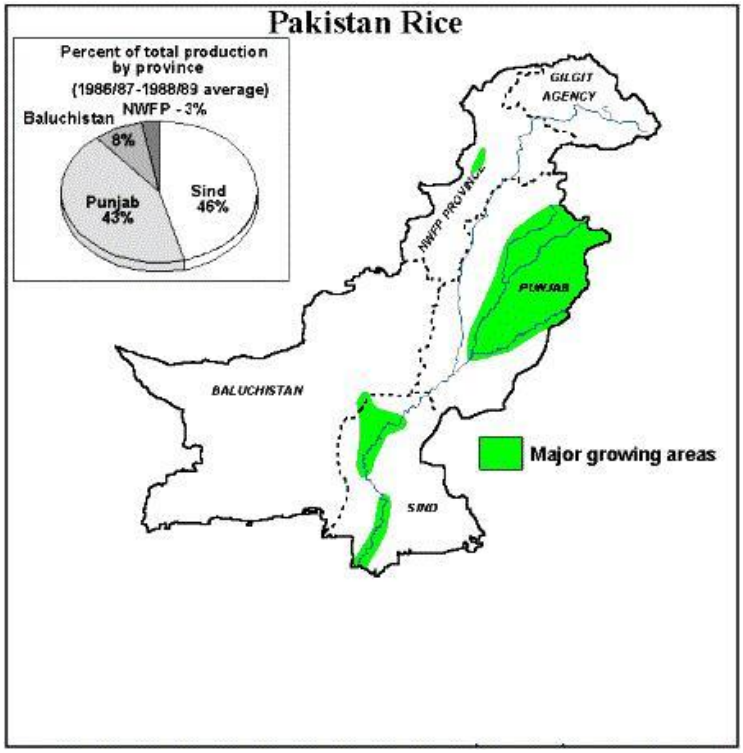


Fig: Rice Production in Pakistan

3.4. Manmade materials:

Industrial revolution created many by products that if not made would have posed a problem of disposing them off. After a deep research into their properties, it was observed that they had best pozzolanic properties therefore these materials were started to be used as an alternative material.

3.4.1. Fly ash:

It is obtained from the burning of coal and is recovered from gasses. Major constituents of fly ash are iron, alumina and silica. .Fly ash can be used in fly ash brick, bulk fill, filler in bituminous mix, artificial aggregate. Its cost is PKR 60,000 per ton.

3.4.2. Aerocon panels:

These are inorganic bonded sandwich type panels consisting of two fiber cement reinforced sheets. It is made up of Portland cement, binders and a mix of micaceous and siliceous aggregates. These panels are eco-friendly, light weight, fire resistance and have sound reduction properties as well.

3.4.3. Ferro cement:

It is a versatile cement product based on the composite material made by cement mortar reinforced with one or more layers of wire mesh. It has a high performance with good strength of material. The only disadvantage is high creep and shrinkage. It had been used for making water tanks; cycle shed etc. They are easy to use and hence can be used in post disaster management activities.

3.4.4. Cement concrete hollow bocks:

These may serve as a cost effective and better alternative to burnt clay bricks. They are resistant to fire and durable as well. The speedier construction can be done while using this. Owing to their larger quantity of mortar required is comparatively less. The strength can be enhanced depending upon the end use of these.

3.4.5. Recycled steel reinforcement

Steel obtained from used up constructions can be used as a recycled scrap iron. It is used in steel reinforced structures like building and bridges. Wastage can be reduced if purchase in standard length, but if different lengths are needed then not more than 5–7% may be wasted. Electrical melting of recycled steel produces 40% of world steel. The advantages are high strength, bond strength, resistant to termite, weathering.

3.4.6. Precast R.C.C

These are door frames with welded reinforcement. They are durable, economical, fire resistant, corrosion free and termite proof. Using them can overcome the problems of cracking, bending and shrinkage. The advantage with them is that they are easy to install at site. It also possesses much stronger strength than other door frames. High strength to weight ratio as compared to RCC and gives 20% savings on cost and material.

4. GIS Zoning (Zones of Pakistan)

QGIS and ArcGIS is used in this project for following purposes:

a. Free Space for Low Cost Housing in Pakistan
b. Zones based on materials availability
c. Zones based on building topography
d. Selection of Free Space/Area in each zone for Low Cost Housing

4.1 Free Space for Low Cost Housing in Pakistan:

For free space first of all area of both man-made and natural features like buildings, roads and rivers are calculated and subtracted from total area of Pakistan.

Note: Calculations may have some uncertainty

Area of Pakistan = 881,913 sq. km

Area of waterways with 0.5 km radius = 72924.265815 sq. km

So area of Pakistan without waterways = 881,913 - 72924 = 808989 sq. km

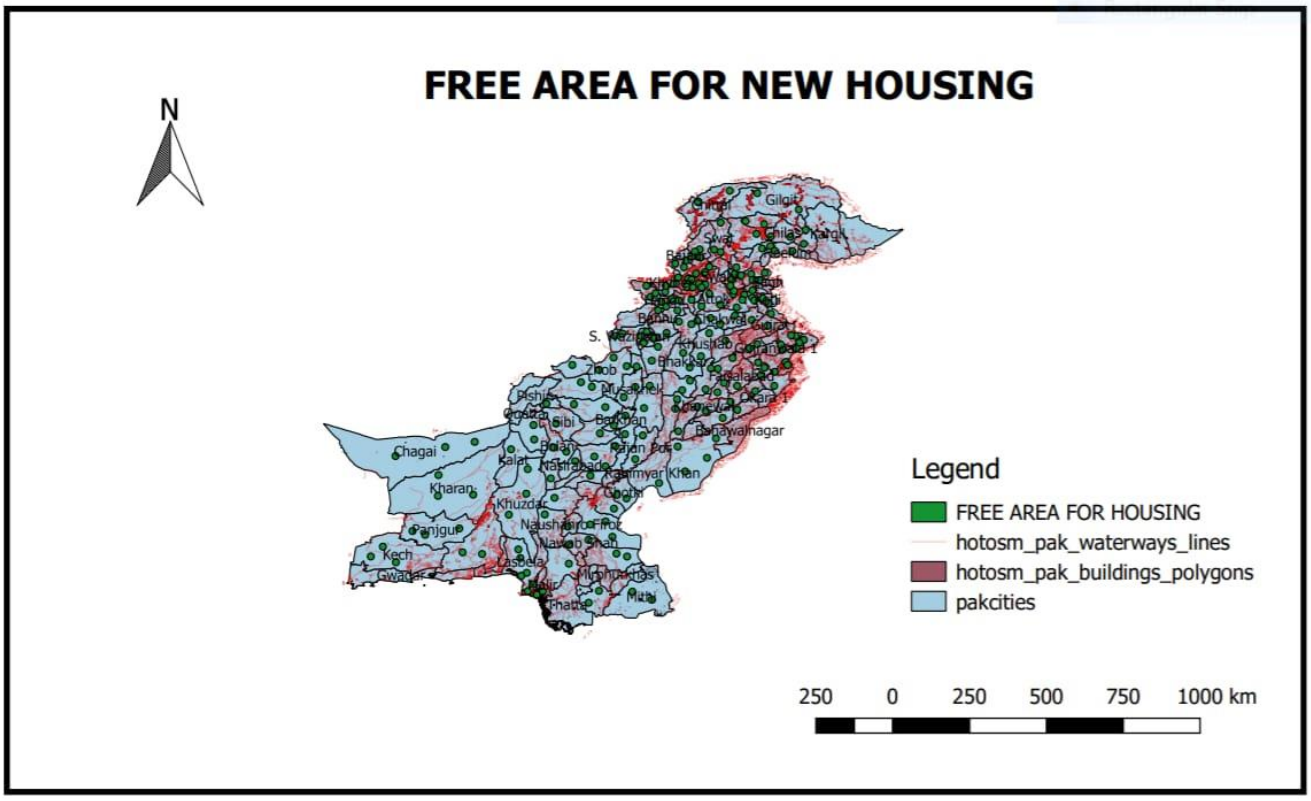


Figure : Free area buffers in Pakistan

4.2 Zones based on materials availability:

Materials are listed and located in different area of Pakistan and different zones are developed in QGIS based on materials availability. These are materials which is used in the design/construction of Low Cost Housing as it reduces the cost of house by reducing the material cost and also transport. This also helps in decreasing the time of construction.

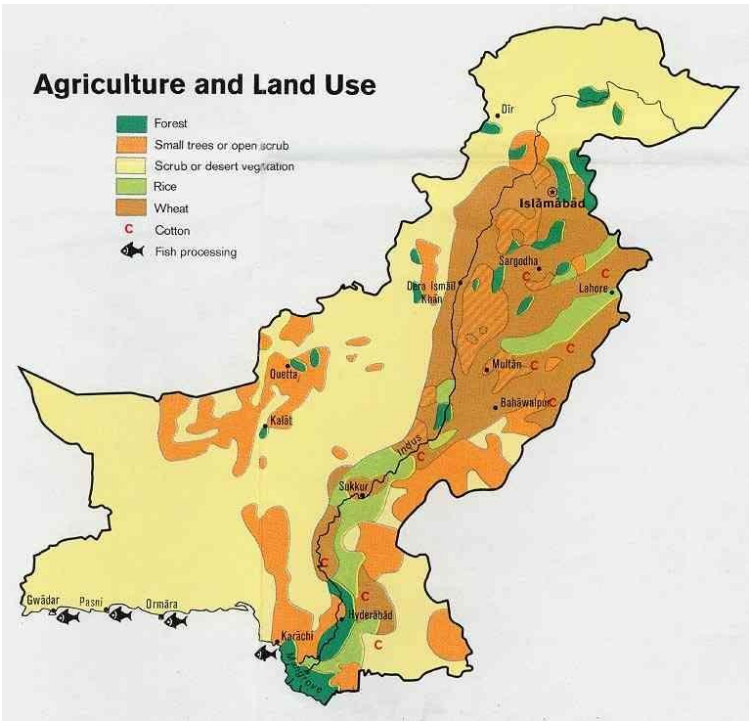


Figure :Map showing agricultural materials availability

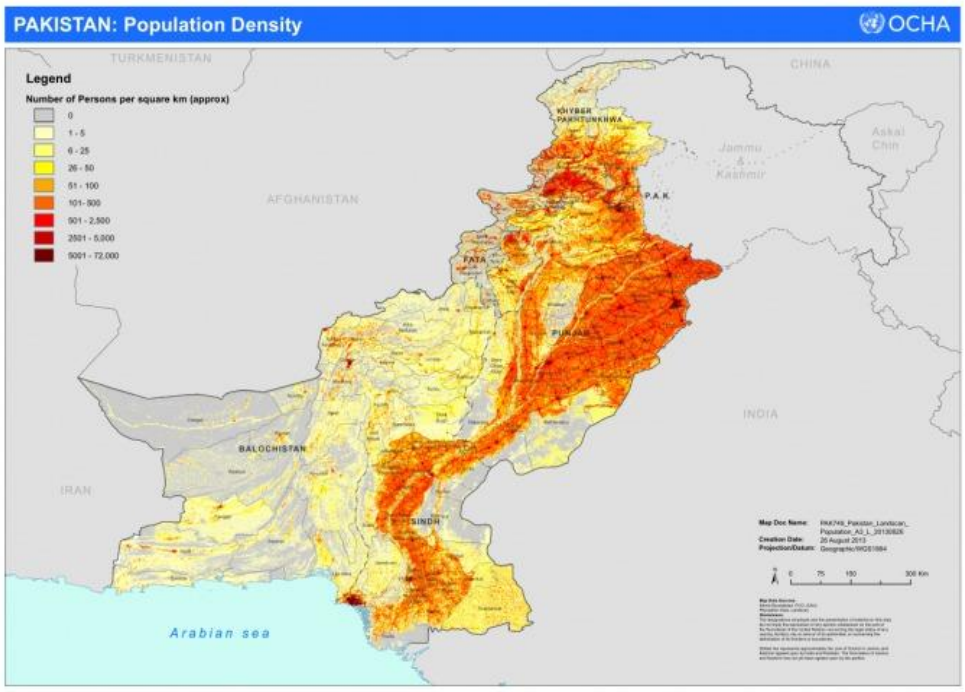


Figure : Map based on Population Density

4.3 Zones based on building topography:

Based on the area and type of building for that specific area different zones are made in QGIS for building topography that is Urban, Rural and Sub Urban. These zones will help in application of type of building for different areas based on the features of area.

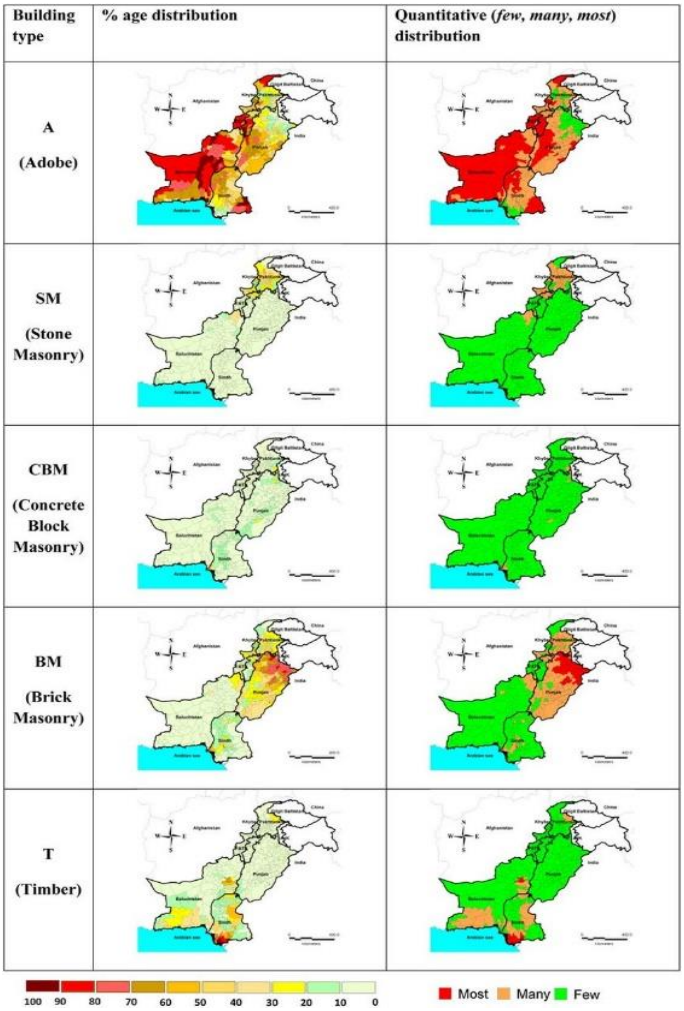


Figure : Map based on topography

4.4 Selection of Free Space/Area in each zone for Low Cost Housing: Each Zone is then specified with calculated free area. Free area is the area which is available for construction of Low Cost Housing. Using this area, it is easy to Because of the unavailability of GIS data, we weren't able to find exact suitable site but using the free available GIS data of Pakistan, we find the area deducting/subtracting area of water bodies and buildings.

If we get all the GIS data of Pakistan we can find the exact suitable site for new constructions which will help in achieving the target of 5 million houses in less time.

4.4.1 KPK

The area recommended in KPK are the district Nowshera, Kohat, Hungu, Dera ismail khan ,Tank, Landikotal.

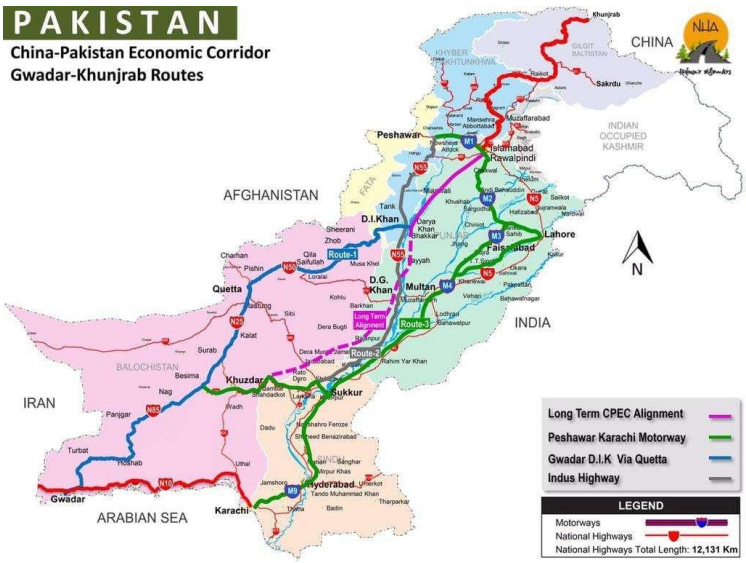
These area lies near the CEPEC route and are near to Indus River.

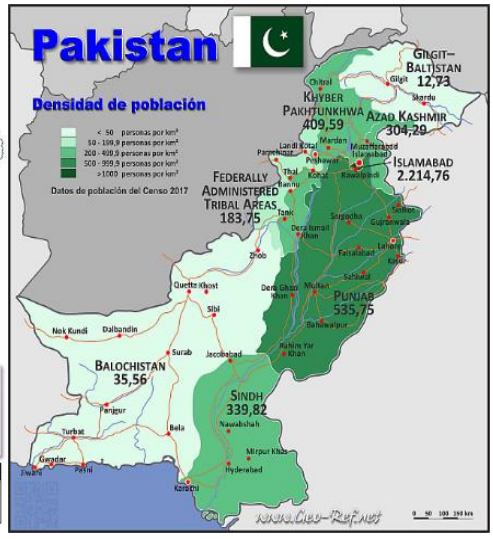
These area lies in seismic zones 2B to 3 having PGA value ranges (1.6 to 3.2)

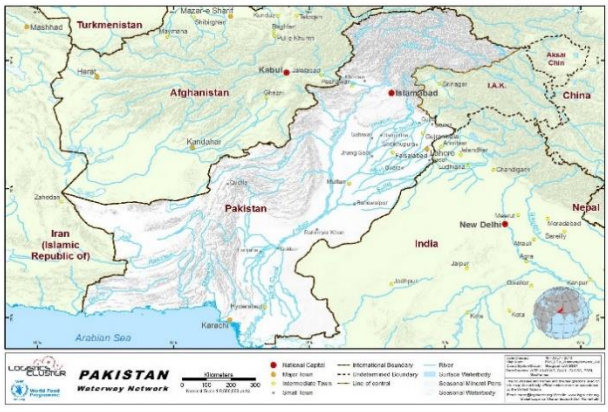
These area is having low population about 50 to 160 persons per square km^2

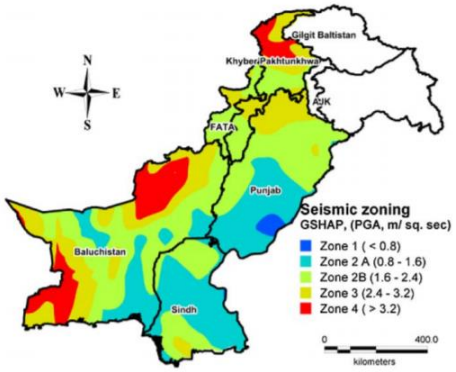
By doing construction in such not only increases the development in these area also raises the standard of living in these types of areas.

Jobs will also increases in these area and people will not do migration towards big cities like Peshawar, Mardan and Swabi









4.4.2 Balochistan

The area recommended in Balochistan are Zhob, Qila Saifuallah ,Gwadar ,Turbat,Kalat

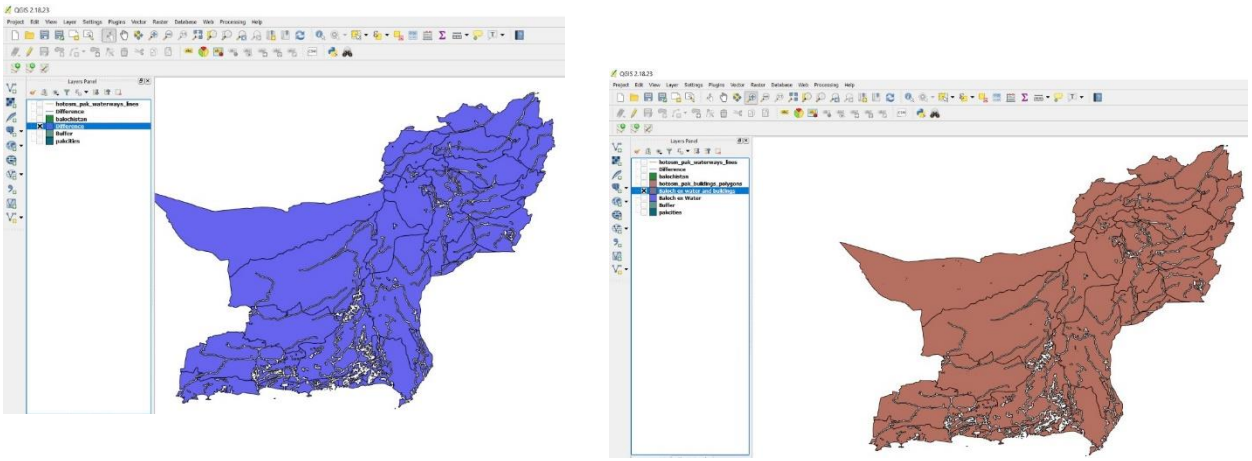
These area are in the route of CPEC

These areas are near to river Zhob,Rakshan

These area is having population less than 50 persons per square km making them least populated zone of Pakistan

These area lie in seismic zone of 2B to 3

By doing construction in these area not only increases the development, also increase the population in these area and people will not move towards big cities like Karachi,Multan etc



estimate the no of houses that can be constructed.

Figure :Map showing free area in Balochistan

4.4.3 Punjab

It is the most densely populated area of Pakistan

The area recommended in Punjab are Bahawalpur , Rahim Yar khan,Sahiwal, Jhelum, Sargodha

These area is less developed by doing construction in these area increases the standard of living

The area lie in seismic zones of zone 1 to 2A

The area is near to river Chenab, Ravi Sutlej and Jhelum

Area is in the route of CPEC

4.4.4 Sindh

The area recommended in Sindh area Sukker, Dadu,Nosheroferoz,Thatta,Mirpur khas,Jamshero

The area is in the route of CPEC

The area lie in seismic zone 2A to 2 B

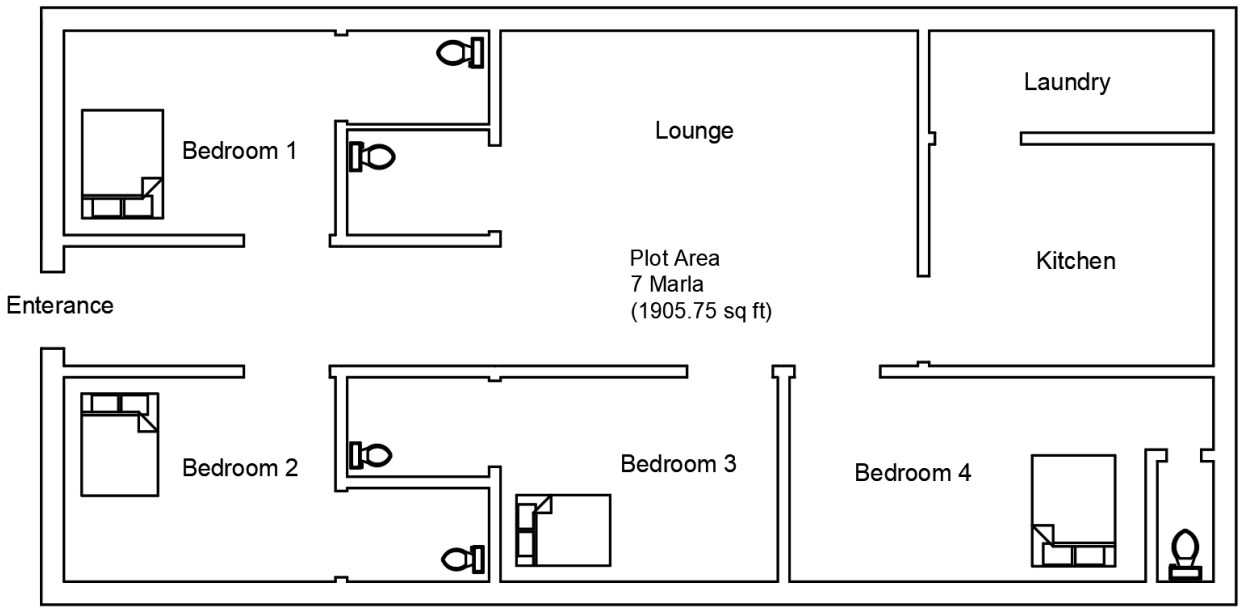
The area is near to River Indus

The area is having moderate population about 200 to 500 persons per square km

The area is highly neglected by doing construction in these area increase the living standard of people and only people will not migrate towards big cities like Karachi, Hyderabad

5.Building Model

The building model for 7 marla house is provided for a housing scheme to get idea of what kind of houses we should construct for low cost housing scheme.



Drawing Specifications:

Plot Area = 7 Marla (1905.75 sq ft)————————————————4 No of Rooms

4 Attached washrooms and 1 washroom with Lounge

Lounge/Hall

Kitchen

Laundry Area

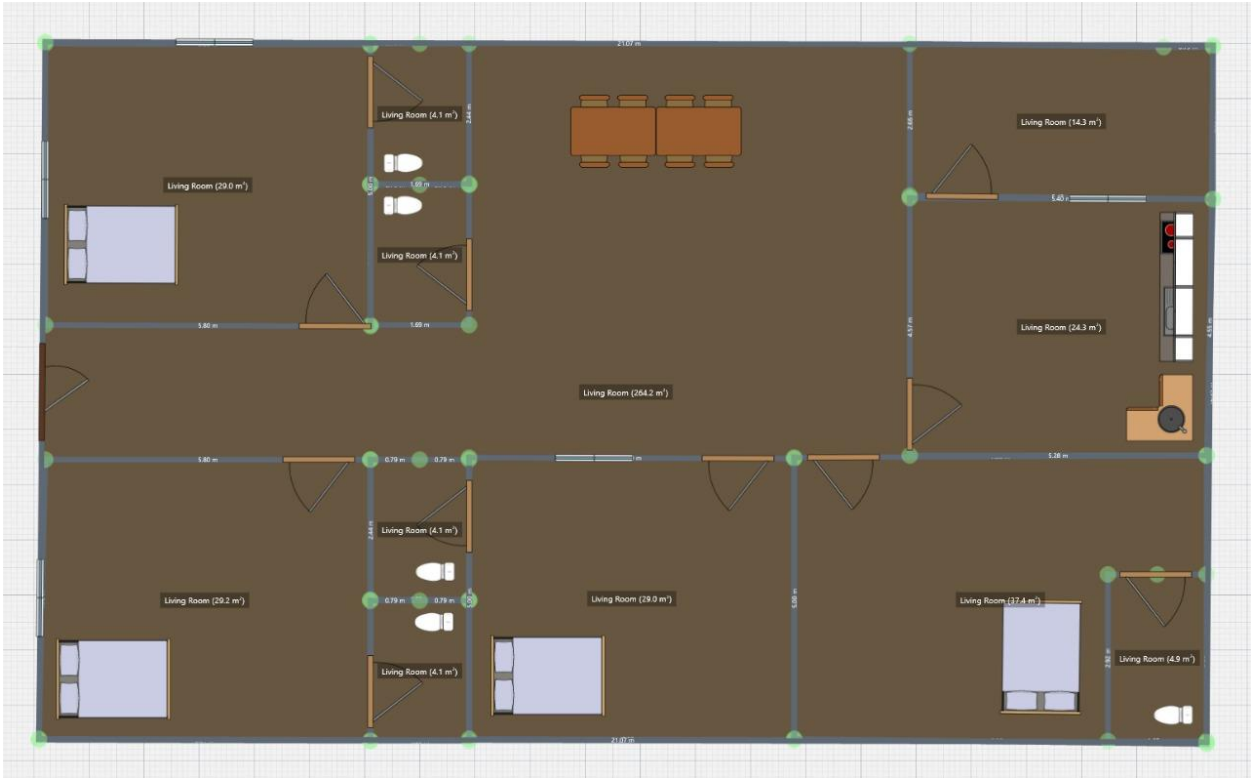


Figure : Plan of a 7 marla house suitable for 8 persons family (minimum)

Arbitary sizes/lengths are taken for 3d modelling of the above map.

Figure : Front view of a house

Figure : 3d model of a house

5. Cost and availability:

For the cost estimation of this housing scheme let us assume a model house in one of a zone in Khyber Pakhtunkhua district swabi in which the cost of a normal middle order 7 marla house is estimated and a cost of same house in which low cost materials and techniques are used is estimated and then both are compared with each other to get the results.

Let model a single story house as of above mentioned plan.

The labor and land cost are same for both types(Normal and low cost) of houses so we are considering the material cost.

The dimensions of house is 21.07m × 4.55m × 3.048m and the parameter of walls are 125.28m

5.1. Normal house:

5.1.1. Specifications:

Wall type : Brick wall

Plaster : Standard 1:3 mortar plastering

Stander RCC is used in floors and roofs

23 pillars in construction

10 wooden doors (1.2m × 3.1m)

6 wooden windows (0.61m × 1.37m)

5 wooden ventilators (0.61m × 0.31m)

1 steel gate (1.828m × 2.44m)

5.1.2. Material estimation:

5.1.2.1 Walls:

3450 kg of cement

11911 kg of sand

20345 standard size class A bricks

5.1.2.2 Plastering of walls, floors and roofs:

9562 kg of cement

20940 kg of sand

5.1.2.3 Pillars:

361.7 kg of cement

678.5 kg of sand

1357 kg of coarse aggregate

5.1.2.3. RCC in floors and roofs(1:2:4):

704 kg of cement

464.05 kg of sand

929.8 kg of coarse aggregate

5.1.2.4. Steel calculations:

We are using one way slab calculations as Ly/Lx > 2 for our roof

- **Given**

Main bars are 12 mm in diameter @ 150 mm center to center spacing
Distribution bars are 8 mm in diameter @ 150 mm center to center spacing. (Main Bar & Distribution Bar Difference)

Top and Bottom Clear Cover is 25 mm
Consider Development length as 40 d
Thickness of Slab – 150 mm
Ly =21070 mm
Lx = 4550 mm

#	Description	No of Bars	Unit Qty	Total Qty	Diameter of Bar	Cutting Length
1	Main Bar	142	1	142	12	5.5 m
2	Distribution Bar	32	1	32	8	21.7m
3	Top Bar	18	1	18	8	21.7m

- **Step 1**

First, find number of rods required for main reinforcement and distribution
Number of Bars Formula = (Length of slab / spacing) + 1
Number of Main Bars = (Ly / spacing) + 1 = (21070/150) + 1 = 142 nos
Number of Distribution Bars = (Lx / spacing) + 1 = (4550 / 150) + 1 = 32 Nos

- **Step 2**

Find cutting length of main bars and distribution bars
Cutting Length of Main Bar,
= Clear Span of Slab (Lx) + (2 X Development Length) +(1 x Inclined length) – (45° bend x 2)
Crank Length = 0.42 D, We have already discussed this on Cutting Length of Main Bar post
= 4550 + (2 x 40 x 12) + (1 x 0.42 x D) – (1d x 2)
= 4550 + 960 + 0.42D – (1x12x2) = 2960 +0.42D – 24
D = Slab thickness – 2 side clear cover – dia of bar = 150 – 50 -12 = 88 mm
Length of Main Bar = 4550 +960+(0.42 x 88) – 24 = 5.5 m

- **Step 3**

Find length of distribution bar
= Clear Span (Ly) + (2 x Development Length (Ld))
= 21070 + (2 x 40 x 8) = 21.7 m
Number of top bars = (Lx/4) / spacing + 1 = (4550/4) / 150 +1 = 9 Nos x 2 sides = 18 Nos
Length of Top Bar (L) = same as distribution bars = 21.7 m

5.1.2.5 Gate, doors and ventilators:

426.75 cubic feet of wood used

0.08 cubic meters of steel used.

Foundation details are neglected because both the houses will have same foundation with same materials used

5.1.2.6 Total materials(Including safety factor):

Cement 14,078 kg of cement

Sand 34,000 kg of sand (758.3 CFT)

Bricks 21,000

Coarse aggregate 3000 kg

Wood 426.75 cubic feet

Steel 1 cubic meter

Steel bars 781 m of 12 mm dia and 1085m of 8mm dia.

5.1.3 Cost estimation:

Cement: Pkr152,042 (10.8 per kg)

Sand : PKR 15,800 (20 Rs per Cubic feet)

Bricks: PKR 210,000 (10 Rs per brick)

Coarse aggregate: PKR 3,400 (50 Rs per CFT)

Wood : PKR 554,775 (Rs 1300 per CFT)

Steel gate : PKR 30,000

Steel bars :

For 12mm diameter bars : PKR 68,000 (Rs 98000 per ton and 2531m per ton)

For 8mm diameter bars : PKR 30,000 (Rs 70,000 per ton and 1126 m per ton)

Total material cost estimated to construct a 7 marla normal house is PKR 1,064,017

5.2 Low cost house:

5.2.1. Specifications:

Wall type : Concrete hollow brick

Plaster : Mud and hot bitumen plastering

Standard RCC is used in floors and roofs

23 pillars in construction

25% cement is replaced by fly ash

10 vinyl doors (1.2m × 3.1m)

6 vinyl windows (0.61m × 1.37m)

5 vinyl ventilators (0.61m × 0.31m)

1 steel gate (1.828m × 2.44m)

5.2.2. Material estimation:

5.2.2.1 Walls:

1125 kg of Rice husk ash

3375 kg of cement

11911 kg of sand

2600 concrete hollow blocks (400x200x200mm)

5.2.2.2 Plastering of walls, floors and roofs:

9562 kg of hot bitumen

20940 kg of mud

5.2.2.3 Pillars:

361.7 kg of cement

678.5 kg of sand

1357 kg of coarse aggregate

5.2.2.4. RCC in floors and roofs(1:2:4):

704 kg of cement

464.05 kg of sand

929.8 kg of coarse aggregate

5.2.2.5 Gate, doors and ventilators:

426.75 cubic feet of vinyl used

0.08 cubic meters of steel used.

Foundation details are neglected because both the houses will have same foundation with same materials used

5.2.2.6 Total materials:

Cement 4500 kg of cement

Sand 13500 kg of sand

Blocks 2600

Coarse aggregate 3000 kg

Vinyl 426.75 cubic feet

Steel 1 cubic meter

1125 kg of Fly ash

5562 kg of hot bitumen

20940 kg of mud

5.2.3 Cost estimation:

Cement: PKR 48600 (10.8 per kg)

Sand : PKR 6,300 (20 Rs per Cubic feet)

Bricks: PKR 70,000(26 Rs per block)

Coarse aggregate: PKR 3,400 (50 Rs per CFT)

Vinyl : PKR 342,400 (Rs 800 per CFT)

Rice husk ash :PKR 16,900

Mud : PKR 8,000

Bitumen : PKR 205,794

Steel gate : PKR 30,000

Steel bars :

For 12mm diameter bars : PKR 68,000 (Rs 98000 per ton and 2531m per ton)

For 8mm diameter bars : PKR 30,000 (Rs 70,000 per ton and 1126 m per ton)

The overall cost of the 7 marla house in PKR 8,30,000 almost.

6. Analysis and discussion:

The material based approach is a very good approach to reduce the cost effectively and not compromising the quality of house. The modeling of a house is performed to analyze and compare the cost of normal house with a material based low cost house.

It can be seen that just a little alteration in materials of construction, the cost can remarkably be reduced as the comparison is shown in following graph.

Graph showing the relation between low cost house and normal house based on materials

The analysis also shows us the use of different materials that will reduce the cost of houses in different percentages

• Filler slab is much more economical than traditional slab as it saves 16%, 44%, 17% of cement, steel and cost in two way slabs and 33%, 46%, 25% in one way slab respectively.

• Brick panel saves 19% per m3 and Rs 418 in cement, 19% per m3 and Rs 21 in sand, 19% per m3 and Rs 127 in aggregate, and 38% per m3 and Rs 536 in steel.

• Soil stabilized bricks are 27.7% cheaper as compared to country fired bricks walls, where country fired bricks use Rs 934 per m2 on contrary soil stabilized bricks use Rs 736 per m2 also they cause less air pollution, energy consumption and carbon emissions.

• Aluminum form work is a comparatively high cost construction but gives high quality and speedy construction which can be used in places where construction is required at a fast pace. For flat slab the total quantity of steel and concrete used are 8.644 m3 and 1294 m3 as compared to conventional building which uses 10,593 m3 of steel and 1505.25 m3 of concrete and the cost saving percentage in flat slab is 15% in B+G+3 building respectively.

• Hollow concrete blocks can be used in those places where the load is not coming directly on wall; the cost is saved by 17.78%.

7. Conclusions:

Adoption of any alternative technology on large scale needs a guaranteed market to function and this cannot be established unless the product is effective and economical. Building houses for low income families as per now poses a great challenge. It involves a great effort to develop new technologies for

using different alternate materials in the construction industry. In this study, low cost housing technologies were studied and the potential for the materials to be used as alternative building materials was discussed. The QGIS is used to achieve the methodology of type of land, material type and area of housing scheme for the project in different zones. The Plan and 3D elevations are designed and cost is estimated to get idea about the use of material to reduce cost. The use of filler slab as replacement to conventional slab is an alternative method to achieve low cost of construction. Similarly more use of fly ash and rice husk ash is another alternative to cement. The use of bamboo as an alternative to steel is an effective material to be used in construction. The essence lies in the systematic approach in building methodology and not necessarily particular construction type or design. The methodology for low cost housing has to be of intermediate type- less sophisticated involving less capital investment. The cooperatives needs to set up which are dedicated to low cost housing so that cost of transportation and import of materials can be avoided which in turn will automatically reduce the overall cost of construction budget by 20–30%.

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