DESIGN AND DEVELOPMENT OF LIGHT WEIGHT CLAY WALL FOR LOW COST HOUSING PROJECT

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ABSTRACT: *The Centre government of India will soon roll out the 'Sardar Patel Urban Housing Mission 'or 'Urban sanitation', which will ensure 30 million houses by 2022.On the steps being initiated to replace slums with low cost houses. Under this mission developing the all over infrastructure of the nation in many ways. As a student of a ME infrastructure Engineering ,So we have decide to my contribution in this mission by design and develop the low cost and light weight clay wall. This research paper discusses the, To achieve the aim of this research as design and development of light weight clay wall for low cost housing projects, the objectives of the research methodology adopted for the project endeavours to complete the following: A thorough literature review to establish the level of current thinking and knowledge on historical back-ground of clay as a material of construction, and to provide the intellectual context of the research. Detailed geological survey of Gujarat and then decide the location of clay then Selection or collection of the sample of clay, fly ash and lime. Detailed laboratory experimentation and testing of the key material properties of the raw materials and of the clay cylinder and wall test specimens that are to be used for the development of the light weight clay wall building material for sustainable building construction. The key engineering properties of the end product to be monitored include: density, moisture content, percentage of voids, and rate of water absorption, compressive strength, swelling and freeze-thaw. Establishment of the thermal properties (conductivity and resistance) of the light weight clay wall. The establishment of the durability of the light weight clay cylinder and wall specimens by means of swelling/shrinkage and linear expansion measurements couple repeated freezing/thawing cycles. Establishment of the environment profile of the light weight clay wall. Performs above all steps we have achieved at the aim of research work, to design and development of light weight clay wall for low cost housing projects.*

KEYWORDS: Light Weight Clay Wall, Low Cost Housing Projects, Clay Use A Chief Material Of Construction In A Historical Time.

1. INTRODUCTION: The Centre government of India will soon roll out the 'Sardar Patel Urban Housing Mission 'or 'Urban sanitation', which will ensure 30 million houses by 2022.On the steps being initiated to replace slums with low cost houses. Under this mission develop the all over infrastructure of the our nation in many ways. As a student of an infrastructure Engineering ,So we have decide to apply my contribution in this mission by design and develop the low cost and light weight clay wall.

A wall is a structure that defines an area, carries a load, or provides shelter or security. There are many kinds of walls such as defensive walls in fortification, walls of buildings which are a fundamental part of the superstructure or which separate the spaces in buildings sections sometimes for the purpose of fire safety, walls which hold back earth called retaining walls, offer protection from oceans such as a seawall or river as a levee. Permanent, solid fences are walls, and border barriers between countries are sometimes walls. Building walls purposes are to support roofs, floors and ceilings, enclose a space as part of the building envelope, along with a roof to give buildings form, and to provide shelter and security. Different type of wall masonry use in Conventional Time Concrete wall masonry, Stone wall masonry, Stone wall masonry, Glass Wall masonry.

The shortage of low cost and ecologically friendly housing worldwide has led to many investigations into new building masonry materials. Concrete wall masonry block are conventionally used for mainstream masonry wall construction but suffer from the rising price.

Disadvantages[2]

- Extreme weather combined with the right circumstances can cause degradation of masonry wall surfaces due to frost damage.
- Masonry tends to be heavy and must be built upon a strong foundation, such as reinforced concrete, to avoid settling and cracking.

- Save for concrete, masonry construction does not lend itself well to mechanization, and requires more skilled labour than stick-framing.
- More permeability.
- Shrinkage and swelling problem.
- Weight is high, so the transportation cost is high.
- Cost is high, so the poor people are not able to purchase them.
- All these negative factors in the wall industry encouraged the development of this research work, and other related researches on new masonry materials with improving environmental profile, improving properties of wall and make them light weight, low cost.
- Design and development of light weight clay wall for low costing housing project by using of natural clay, fly ash use for make them light weight, outer surface of clay wall make by water proofing chemicals or pvc coating use for resist the weathering effect of environment also make it hollow wall for decrease the weight of clay wall or resist the thermal effect.

Advantages of clay wall over conventional technique[3]

- A comfortable living environment in winter and summer
- Lowest moisture content of all comparable building materials
- High thermal insulation wall save money, Additional insulation is unnecessary.
- Built as a monolithic wall without any artificial insulation is free of harmful biocides.
- Fire Resistance.
- Durability is high and requires less maintenance.
- No Skill labour requires.
- Compare to low cost.
- Aesthetic Appeal.
- Thermal & Acoustic Insulation
- Zero Maintenance Cost
- Flexible in Application
- Empowerment of nation
- It is light weight so transportation cost is comparing to low.
- Compare to less permeability
- Environment friendly
- Using waste product for its production, so reduce in the garbage.
- Water proof

2. LITERATURE REVIEW

Historical Back-Ground of Clay as a Chief Material of Construction

Clay bricks have remained in use as major material of construction since the known history of mankind on the earth. Traditional clay architecture is thousands of years old and even today about one-third of world's population lives in homes constructed from clay. Catal Huyuk (present time Turkey) was the place where glazed tiles were manufactured as early as 6000 B.C. Etruscans are known for their clay statues. In the plains of various parts of the world where the soil is clayey in nature the baked clay bricks were used as early as 3000 B.C. in Moen-jo-Daro and Mesopotamia. The palace of Nebuchadnezzar, the Ishtar gate and the procession street along with the buildings on both its sides were constructed with bricks and adorned with glazed baked clay tile bricks as early as 600 B.C..The hanging Gardens of Babylon, one of the seven wonders of world was made up of clay. European monasteries, castles and mansions were made up with clay and clay was used in the infill panels of traditional timber frame houses. Many of these buildings are hundreds of years old and still standing up proudly today. As building material, clay bricks (baked and as adobe) have been used in construction since earliest times. Kaolin or China clay, is required for the finer grades of ceramic materials; used for paper coating and filler. 13 The earliest remaining examples of soil reinforcement are the Ziggurat of the ancient city of Dur-Kurigatzu, now known as Agar-Quf and the Great Wall of China. The Agar-Quf ziggurat, which stands five kilometres north of Baghdad was constructed of clay bricks varying in the thickness between 130-400 mm, reinforced with woven mats of reed laid horizontally on a layer of sand and gravel at vertical spacing's varying between 0.5 and 2.0 meter. Reeds were also used to form plated ropes approximately 100 mm in diameter which pass through the structure and act as reinforcement. The Agar-Quf structure is now 45 m tall, originally it is believed to have been over 80 m high; it is thought to be over 3000 years old. The great wall of China, parts of which were completed in 200 B.C.contains examples of reinforced soil, in this case it was made of mixtures of clay and gravel reinforced with tamarisk branches. All the religions particularly those with origin from Middle East; the holy lands what western called the Bible lands, Jerusalem, Babylon, Nineveh, Assyria, the land of Pharaohs, are the major testifiers of the virtues of clay as a friend of humanity. New materials like glass fibre and carbon fibre together with special binding materials are being employed to repair the damaged structures. But the people of third world countries can not afford this luxury of using highly expensive and industrially produced materials of construction which would have to be imported at the exorbitant prices. Therefore, these countries must resort to local materials with minimum possible industrial processing for the use of building, the infra-structure and the houses at a relatively lower cost without compromising on the durability, strength and elegance.

Low-cost housing

The sole purpose of the endeavour, the details of which are presented in this thesis is to achieve the goal of low-cost housing for the poor masses in the developing countries particularly in the plain areas like Pakistan, India. Therefore, this chapter would be

incomplete if the account of research being carried out in other likewise countries for low-cost housing are not included here.In Jakarta, Manila, Mexico city and Calcutta millions of squatters camp indefinitely in structures made of cardboard, sheet plastic and flattened cans, on strip of land beside canals and railways, sometimes even in the shadows of high-rise "low-cost" housing. The situation is not very different in the urban areas of Pakistan either. Every intensive process for production of modern construction materials have only added insult to the injury. History of low-cost housing is the history of disappointments worldwide. Two non-monetary factors that play important role in housing for the urban poor are accessibility (to job) and security. The socio-economic and cultural situation plays a vital role in determining the housing and the process and the product which must be taken into consideration. Hassan .F of Egypt has accomplished a commendable job in respect of low-cost housing. It appears that the poor communities in urban areas of developing countries are growing rather than finding economic stability.Low-cost housing materials require reduction of the content of Portland cement in concrete. (a) Intermixing of clay and biomass in blocks. (b) Co-addition of lime with pozzolanic material. Earth shelter houses are becoming increasingly popular. There are long-range economic benefits in terms of reduced fuel cost, insurance rates and maintenance.Nowadays, the process of compressing earth blocks has been mechanized and manual or hydraulic pressing systems or completely integrated plants can be used. Product ranges from accurately solid shape, cellular and hollow bricks, to flooring and paving elements. Rammed earth and compressed earth blocks are the most widespread earth construction techniques used today. These have reached extremely high scientific technological levels, and permit the construction of a wide variety of components and construction system. For example, foundation, floor, pitched and flat roofs, arches, tiles, chimneys, canals, roads, dams and bridges etc.

Conclusion

Based on the information cited in earlier sections of this chapter an idea of using the most natural material i.e. clay (which is abundantly available almost without cost and requires no industrial processing except baking which is an established form of processing clay).

Buildings must be erected cheaply but for a sufficiently long life and for generations to use them. But the cost must be within the reach of common man. The future of our Off-spring must not be mortgaged for a roof over their heads. Hence this endeavour is devoted to make it possible for every rich and poor to afford a home of his own, which may resist the rigors of climate, environment and catasphrophies and must not cause a hazard to at least the occupants.

The off-spring of Adam shall be best served if clay is used for a roof over their head. Times have changed and this is not the period of adobe structures. This is not the time to use straw as reinforcement. This is not the time for horizontal growth of the buildings because too many people are to be accommodated in a very short space within the urban areas of various countries through the vertical development. The problem is more severe in third world countries like Pakistan, India because in developed countries the growth of population is almost zero; while in countries like India, Pakistan, there is the Population Explosion.

The industrialized countries can afford the luxury of building, the best possible structures at every cost, but the developing countries cannot. However dust is the only solution for erecting multi-storey buildings comparable with those of RCC and Pre-stressing systems. The technology is to be developed to use clay as a replacement of concrete.

Systematic research has therefore been carried out the details of which are presented in this thesis includes design the development of light weight clay wall. Clay together with fly ash to manufacture wall structural panels of baked clay and this has not been done during yester years hundreds of specimens including cubes, cylinders, beams etc are tested to make it possible for Civil Engineers to design buildings using clay and other material available at hand locally.

Based on the information which is given in the earlier section of literature review, clay use as a chief material of construction in historical time, the gap in the clay properties in historical time like water proofing, weight is more, durability, thermal nature, load bearing capacity, restriction in develop multi-storey buildings.

So we have decided to fill the above gap by design and development of light weight clay wall for low cost housing projects by using latest technique to manufacture of clay wall and also using waste material for make them low cost.

3. MATERIALS

The details regarding the materials used in the current work (material source, reasons for using each material, some properties, and the particle/grain size distribution). The materials used consisted of natural clay, fly ash, lime, and domestic waste plastic fibres (Plastic of cement begs). The basic characterization of these materials was carried out in accordance with the Indian Standards and other internationally accepted engineering standards, in line with the IN building regulations.

Clay

An idea of using the most natural material for making low cost wall i.e. clay (which is abundantly available almost without cost and requires no industrial processing except baking which is an established form of processing clay). Clay is a fine-grained natural rock or soil material that combines one or

more clay minerals with traces of metal oxides and organic matter. Clays are plastic due to their water content and become hard, brittle and non–plastic upon drying or firing. Geologic clay deposits are mostly composed of phyllosilicate minerals containing variable amounts of water trapped in the mineral structure. Depending on the content of the soil, clay can appear in various colours, from white to dull gray or brown to a deep orange-red. Clay minerals typically form over long periods of time from the gradual chemical weathering of rocks, usually silicate-bearing, by low concentrations of carbonic acid and other diluted solvents. These solvents, usually acidic, migrate through the weathering rock after leaching through upper weathered layers. In addition to the weathering process, some clay minerals are formed through hydrothermalactivity.There are two types of clay deposits: primary and secondary. Primary clays form as residual deposits in soil and remain at the site of formation. Secondary clays are clays that have been transported from their original location by water erosion and deposited in a new sedimentary deposit. Clay deposits are typically associated with very low energy depositional environments such as large lakes and marine basins. There are three or four main groups of clays: kaolinite, montmorillonite-smectite, illite, and chlorite. Chlorites are not always considered clay. Map of deep black soil in Gujarat. We have to collect sample from the red circle area which is shown in fig. for the testing purpose.

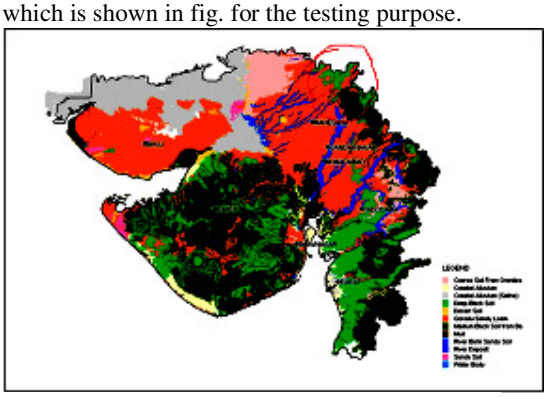

Fig. Sources of deep black clay region in Gujarat.

Fly Ash[4,5]

Using the fly ash in this research because mainly large amount of production in Gujarat and its properties light weight which is considering. During 2005-06 about 112 million tonnes of ash has been generated in 125 such power stations. With the present growth in power sector, it is expected that ash generation will reach to 175 million tones per annum by 2013-14. To increase the use of fly ash, and to improve the properties of concrete, many investigations on high-volume fly-ash concrete have been made but for using low quality fly ash very less research is done. Fly ash, also known as flue-ash, is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the furnace is in this case jointly known as coal ash. Fly ash is produced when coal is consumed by power plants. Fly ash can be used beneficially in numerous applications. The high- est. value application is replacing cement in production of concrete. Fly ash use improves concrete quality and creates significant environmental benefits. The analysis on fly ash production from coal based thermal power stations indicates that 82 power stations, as of today, produce about 175 million tons per year by 2013-14 A.D. with 20% annual rise in the thermal power generation slated for the decade. In India, it is estimated that 130-145 million tons of fly ash is generated by 70 major thermal power plants of which only 6-10 % is utilized by cement, construction and road industries. In map Shown the geographical location of various thermal power plant in Gujarat. In Gujarat total nos. power plant is 8. .We have collected fly ash from the Gandhinagar power plant.

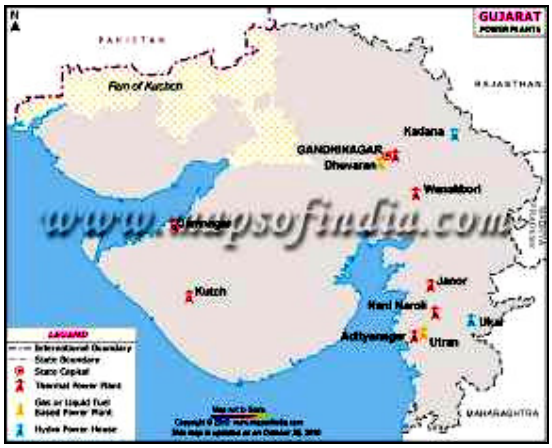

Fig. Gujarat thermal power plant

Lime

Using lime in this research work because its own desire properties with mixing other materials, which is describes below. Lime has many, complex qualities as a building product including workability which includes cohesion, adhesion, air content, water content, crystal shape, board-life, spread ability, flow ability; bond strength; comprehensive strength; setting time; sand carrying capacity; hydrolocity; free lime content; vapour permeability; flexibility; and resistance to sulphates. Lime is calcium containing inorganic material which carbonates, oxides and hydroxides predominates. Lime is a calcium oxides or calcium hydroxide. These materials are still used in large quantities as building and engineering materials (including limestone products, concrete and mortar) and as chemical feedstock's, and sugar refining, among

other uses. We have using locally available lime from the market.

Waste material use as a Reinforcement

Using waste material like cement begs fibers in this research work as reinforcement of a wall. For achieve the desire properties of wall. It is increase the tensile strength of wall. In below showing the figure of cement begs fibers.

Fig. Cement begs fibers

4. THE DESIGN

PRE MIX DESIGN RESULT

Clay Test Result before Design[7]:

This all test performed under the Indian Standard codes.

Table: Preliminary test result

Sr.No	Description	Result
1	Grain size distribution	**99% Silt and Clay present in sample**
2	Liqvid limit	**65%**
3	Plastic limit	**27**
4	shrinkage limit	**17.1**
5	Standard Proctor test	**1.69 gm/cc dry density And 20.7 % moisture content**
6	Free swell index	**47.5 %**
7	Permeability test	**10^-7 cm/sec**

MIXING:

Clay mix with fly ash and lime. Fly ash making the light weight wall, also provide more strength compare to the only clay. Fly ash making the surface very smooth and lime reduce cracking and binding the layer. So, Liquid limit and plastic limit reduce. Take unique proportion then do liquid limit, plastic limit test after 24 hours mixing with water.

Table Mix Proportion

Clay%	Lime %	Fly ash%	LL	PL	PI
88	2	10	56	33	23
86	4	10	56.5	34	22.5
78	2	20	53	32	21
76	4	20	53	30	23
40	10	50	45	25	20
30	20	50	47	26	19
30	10	60	44	28	16
20	20	60	47	29	18
20	10	70	39.5	24	15
10	20	70	41	23	18
25	**5**	**70**	**36**	**27**	**9**

Above mixing Proportion got liquid limit, plastic limit Moderate. Liquid limit range should be 30 to 40 % .So mix the proportion is unique. Take Proportion 25% clay,5% lime,70% fly ash for develop the clay wall.

Test Result of Selected Proportion:

Table: Test Result

Sr. No	Description	Result
1	Grain size distribution	**99% Silt and Clay present in sample**
2	Liqvid limit	**36%**
3	Plastic limit	**27**
4	shrinkage limit	**18.1**
5	Standard Proctor test	**1.41 gm/cc dry density And 20.7% moisture content**
6	Free swell index	**38.5 %**
7	Permeability test	**8*10^-7 cm/sec**

TEST SPECIMEN:

- Prepare the laboratory scale test specimens using wooden material.
- It's Dimensions (2'*2'*10cm)=(L*B*H).
- Provide two inner and outer 2 inch Grooves for interlocking between two walls.

Fig:-Dimension of test specimens

Selection the size of cube depends upon considering two factor:-

1. One person carry the wall(one person carry up to 48 kg weight)
2. Standered size of low cost housing and it's sanitation size.

CASTING

For the laboratory specimens, it was not practically possible to compact each individual system at its particular MDD and OMC, and thus specimens of different composition may have deviated slightly from their optimal compaction conditions. However, equal weights of initial materials were used and the test specimens were therefore expected, within experimental error, to be of the same bulk density and volume for all the material compositions in a given stabilizer system. By keeping these experimental procedures the same for all the different mixtures and despite the minor variations in MDD and OMC already mentioned, the tested cured specimens were expected to show the effects of the varied parameters such as intended changes in compaction moisture content, comp active effect or changes in mix composition.

According to the MDD and OMC practically possible 95% density fill up in the cube. So the total vol. of mould is 36000gm.Multiply with 95% density of mix proportion , we got 48222 gm total weight of wall. We taking different materials based on proportion, And casting the mould.Taking water according to the OMC

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Figure: - Mortar casting

TESTING

After the drying of mould we will perform below tests on the wall.

- Moisture content at the time of testing
- Percentages of voids
- Water absorption

- Swelling/shrinkage
- Unconfined compressive strength
- Freezing and thawing
- Thermal properties
- Performance evaluation and environmental profiling

After the getting test result then we will compare with the other type of wall using in current time.
And then recommended for the future work.

CONCLUSION

The following conclusions are therefore drawn from this research**:**

In this research paper I have introduce the techniques of design and development of low cost and light weight clay wall. By using this light weight clay wall on the steps being initiated to replace slums with low cost houses. Everyone get roof over their heads, also a safe and healthy environment. By manufacturing this wall increase the employment and empowerment of nation. Using the waste materials it's give adverse effect to the environment and reduce the waste. All over develop the infrastructure of nation in many ways.

There are certain groups that are likely to benefit from the current research, these include:

- Light weight clay wall manufacturers, who will be able to manufacture low-cost, socio-economic and environmental friendly building products.
- Fly ash manufacturers, materials blenders and processers and outlets/agents, as the formulated product will consume and provide more outlets for these materials. No need of skill laboured and equipments. Other building materials outlets, as they will have an added product on their shelves, a product that will have been developed by way of detailed research and commercial/full-scale trials, in line with modern global trends and advances, quality and standards criteria.
- Building and housing providers (Local Authorities, Housing Associations, Institutions, private companies and individuals), as they will have a product(s) scientifically produced as stated above.
- The high cost of building wall, is currently being transferred to the consumer, thus indirectly affecting the Indian building industry and hence economy, but light weight clay wall are also added environmental advantages of utilizing industrial.
- Waste and/or by-products that are sourced locally. Thus the possible benefits of this research in terms of technology, economy and care for the environment are high.

REFERENCES:

1. http://en.wikipedia.org/wiki/Masonry
2. http://www.masonryplanet.com/brick-masonry-thin-bricks.html
3. https://www.google.co.in/?gws_rd=ssl#q=Advantages+of+clay+wall
4. G.Murali, C.M.Vivek Vardhan, R.Prabu, Z.Mohammed Sadaquath Ali Khan, T.Aarif Mohamed, T.Suresh / International Journal of Engineering Research and Applications.
5. A Study on Low Quality Fly Ash as an Opportunity for Sustainable and Economical Concrete(Volume : 2 | Issue : 2 | Feb 2013 • ISSN No 2277 - 8179)
6. http://mycourse.solent.ac.uk/mod/book/view.php?id=2744&chapterid=1282
7. Bureau of Indian Standards (1985)Methods of tests for soil IS:**2720**.Part**/5**.
8. Bureau of Indian Standards (1985)/plastic-limit-test-of-soil-is-**2720**-**part**-**5**-1985