



INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK



SPECIAL ISSUE FOR NATIONAL LEVEL CONFERENCE "Technology Enabling Modernization of Rural India (TMRI- 2018)"

SUSTAINABLE CONSTRUCTION FOR RURAL DEVELOPMENT

DR. PUSHPENDRA KUMAR SHARMA¹, DR. CHANDRA NATH TRIPATHI²

1. Assistant Professor, Civil Engineering Department, HCST, Farah, Mathura
2. Associate Professor, Environmental Engineering Department, HCST, Farah, Mathura

Accepted Date: 19/03/2018; Published Date: 01/04/2018

Abstract: This paper stands on rural conditions of constructions, use of non-conventional and low cost materials for the construction of rural houses along with urgent need of proper roads for sustainable rural development. Due to high construction cost of houses and roads in rural areas it is very difficult for villagers to live comfortably and sale their agro and horticultural products in markets without link roads in developing countries like India. The use of agro and horticultural bye products and their wastes in rural housing and road construction has been disserted. It also provides need of low cost housing and roads for the peoples belonging to low income groups covering use of local materials in different parts of buildings and roads so as to make them affordable houses. The paper emphasizes on a very urgent need to pay a little attention towards the use of local resources and home grown skills like masonry, bricks instead of reinforced concrete avoiding hydraulic structures which usually enhance the cost of road construction indirectly in rural areas. The paper advocates the maximum use of green concrete if concrete construction is unavoidable in rural houses and roads both. The green concrete is prepared through recycling and reusing waste materials from various industries and is very popular to control the environmental pollution. The green concrete is not only an efficient and eco-friendly but it can sustain economically longer without any pollution.

Keywords: Chak-roads, agro and horticultural, link roads, dissert, home grown, green concrete

Corresponding Author: DR. PUSHPENDRA KUMAR SHARMA



PAPER-QR CODE

Access Online On:

www.ijpret.com

How to Cite This Article:

Pushpendra Kumar Sharma, IJPRET, 2018; Volume 6 (8): 285-293

INTRODUCTION

Sustainable rural development satisfies the requirements of existing generations without compromising those of next generations to come. All natural resources have their limits within which human well-being depends. So the renewable resources must be used wherever possible and husbanding non-renewable resources to extend their viability for generations to come (Pandit, S. and Sharma, P.K. 2017).

In developing countries like India own house has become a dream for a common man of rural areas. Not only food, clothes and shelter are the fundamental needs but link roads connecting local towns and markets to sale the agro and horticultural products, bye products and wastes is also an additional and today's fundamental need for sustainable rural development. In addition to the construction of low cost affordable houses, road construction also plays a very important role in the development capabilities of a developing country, particularly in rural areas. Many researchers have paid lot of attention on low cost housing and economic construction of roads using non-conventional resources and techniques but none has advocated for the cost affected by unavailability of transport means in rural areas where there is no proper link roads, the transport cost of building materials is too high to afford. A low cost housing is directly related to the availability of transport means in rural areas which is the main feature and innovative idea behind this paper.

RURAL CONDITIONS

In rural areas before we build a house we usually do not calculate the amount of money that will spend on the construction. The process of rural house construction is a complex as we need to consider a number of factors in order to come up with the approximate amount like site condition, materials availability, transport, labor cost and the choice of construction etc. (Cunningham, T. 2013) as explained in later section,

Site Conditions

When we talk of the low cost rural housing we never think about the condition of construction sites that very much affect the cost of construction in rural areas. Some of the important factors that indirectly and seriously affect the cost of rural housing are wet lands, conflicting utilities, poor soil conditions, approach streets, infected materials, overhead electricity transmission lines, natural stream crossings, groundwater table, water quality, buried storage or soak pits, endangered species habitat.

The location of house to be constructed also affects the overall expenses. For example if site of construction is low lying or too elevated or is not properly accessible i.e. narrow approaching streets, obviously the cost of construction will increase through the manual transport of construction materials increasing the labor cost.

Construction Materials

As far as construction materials are concerned, the available literature talks of low cost and locally available raw materials needed in the process of construction of rural housing but the authors opinion here is that it is must to have raw materials of construction in close proximity of rural housing construction sites. If the raw materials to be used in construction are within easy approach to the site of construction, it will surely lower the cost of construction as compared to the farther distances to transport from where one has to spend more money on labor and time as well which indirectly affect the cost of rural construction.

Construction Choice

The construction in rural areas should be so simple aiming simple and comfortable living without any architectural enchanting which unnecessarily enhances the cost of construction in making extra designs and time consuming as well which usually come from the neighborhood competitions. One should not waste the precious money and other resources by false advisors intending to waste the owner's money in unnecessary show off.

The rural owners should wisely and minutely adopt the construction ensuring everything perfect and aimed to simple comfort. They should not copy the urban construction fashions for swanky purposes. Money wastage for splurging has always been a matter of regret.

Time of Construction

The cost of labor varies site of construction to the other. In fact the sites of construction lying in urban areas are costly with view point of labor cost. But due to migration of rural labor towards urban areas and specially during harvesting time it is very difficult to find labor even in villages and if somehow managed it is very costly. So it is very important factor to keep in mind especially for the construction in rural areas.

Time Bound Commitment

The constructions in rural as well as urban areas both are seriously affected by the delay in completion of the perfect construction. An unwanted delay in project completion greatly affects the cost estimates. The duration within which the construction is scheduled to finish the job greatly affects the house construction cost. An unpredicted delay in project duration dilates the construction costs due to increase in indirect costs in passage of times. To ensure a good and healthy life of a rural construction one should not compromise with the quality of material to be used. If one takes care for above factors it will surely decrease the cost of construction indirectly and this way the rural construction can be made cost effective and affordable as well.

Alternative Materials and Techniques

In India the population growth is very high and the shelter to accommodate such a huge population is becoming day by day short. The people below poverty line are miserably bound for living in slums. This acute shortage of shelter more over due to migration of rural population

from villages to cities it becomes very important to use the alternative materials and techniques in rural areas construction to fulfill their demand which will not only prevent migration from rural areas to urban but also provide conveniences of shelter and employment at door step to the rural population resulting to the overall sustainable rural development. Some of the non-conventional materials and techniques (Jasvi, A. H. and Bera, D.K. 2015) are being discussed here as follows:

Rural Housing Constructions

A rural house can be better understood as assembled by foundation, walls, slab and floor. Taking one by one some use of non-conventional materials and techniques are being discussed here in this section.

Slabs and Floors

As we know that steel is responsible to bear tension whereas concrete bears all compressive stresses, so it is very clear that concrete is of no use in tension zones and its main function is to provide a proper cover to steel. The places other than covering of steel can be made of cavities to be filled by some filler materials. Floors and slabs can be filled by waste materials as filler in tension zones or cavities where from concrete can be replaced reducing dead loads and thereby saving cost, making the members cost effective and reducing the amount of used concrete which indirectly saves almost 20% cement as a result Carbon di Oxide (CO₂) is reduced which a main global warming constituent from cement manufacturing industries. This way we can also control air pollution and global warming sustainably (Sharma, P.K. and Agrawal, P. 2018). Various filler materials reviewed from literature are Mangalore tiles, coconut shells, cow dung cakes, well dried agro and horticultural wastes.

Brick panels designed and developed by CBRI, Roorkee IS14142:1994, IS 14143:1994 can also be used in less compressive zones of slabs and floors. Flat slab technology is also very popular for this purpose (Patil and Rupali 2014).

Construction of Walls

Soil cement stabilized for building blocks can be used for walls construction which produce better compressive strength, thin water resistant walls and eco-friendly (Montgomery and Thomas, 2001). Fly ash sand lime bricks may be used for this purpose which not only reduces the weight on the foundations but also proves to be cheaper as compared to the conventional bricks as these are prepared from the industrial wastes (Sumathi et al 2014).

Natural materials like earth, bamboo fibre, steel girders and lime stone slabs, mud fuska over chhappers, straw fibres, bagasse fibre, jute and coir fibres, banana stem fibres, sisal fibres, rice husk, can also be tried in rural construction as these are ecofriendly, less energy inputs, less density but there is a limited use only in the areas where these natural materials are available in plenty within close proximity (Balaji et al 2014). Fly ash with its optimum percentage may also be used for replacing cement and in bitumen mix for damp proofing purposes. Steels and other

materials obtained from dismantling sites in urban areas can also be reused to minimize the cost of rural housing construction provided transport cost does not affect the cost estimation.

If there a need of concrete construction a green concrete must be promoted for the construction of houses in rural areas to make them affordable. A new construction over the demolition sites, the wastes disposal has always been a very big challenge. This demolition waste disposal acquires lot of land not only decreasing the soil's fertility but also a threat to agricultural fields for next generation (Baikerikar, A. 2014). So the authors recommend and support a maximum use of green concrete to achieve the goal sustainable construction for rural development (Sharma and Agrawal 2018).

Rural Roads Construction

Growth, employment, education and health care are closely linked with rural connectivity. Poor socio-economic conditions prevail where there is a poor connectivity. All weather roads national network in rural areas is an important link for progress.

Roads in remote areas are the life lines for the residents anywhere. Numerous road construction projects and many roads researchers have contributed to provide low cost roads especially in rural areas for the overall and sustainable development of villages in interior parts of developing countries like India. The major cost affecting factor in case of roads construction is crossings over natural streams because the construction cost of hydraulic structures is very high which indirectly increases the cost of rural roads and that is why the planners should at their best avoid these crossings so as to avoid the construction cost of culverts and bridges. Use of local resources and indigenous skills like masonry, bricks, manufactured blocks, and interlocking bricks may be used for the construction of rural roads instead of conventional cement concrete or bitumen which needs a lot of cost and tools along with specialized skills (Paul Larcher MART Working Paper 13).

It is presumed that the Management of Appropriate Road Technology (MART) aims to reduce the cost of constructing, rehabilitating and maintaining road infrastructure along with vehicle operations in emerging and developing countries (EDCs). The MART programme supports sustainable improvements in road construction and maintenance in developing countries. It promotes effective use of locally available resources such as human resources and readily available intermediate equipments especially agricultural tractors and related accessories (Paul Larcher MART Working Paper 13).

Chak-roads like something are better than nothing in rural areas to reach the farms without which the farmers cannot reach their respective fields for doing various field activities. These are the earthen approach ways to access fields. Most of the chak-roads have been encroached by powerful farmers in villages which is very important point to be cared.

Water bound macadam may also be used for long periods with minimum maintenance after monsoons. If gram panchayat is running in fund shortage for pucca pavement it can be paved through PMGSY, a Government of India, initiative for rural development. The pavements may also be constructed by bricks on edge laying, interlocking cement masonry bricks, or by green concrete.

If concrete is used in rural roads then only green concrete must preferred in which recycled ingredients are used in both the rural housing and rural roads with view point of cost effective parameters. A number of waste materials that may be used as the part ingredients of conventional cement without affecting its strength much yet it needs a detailed study of project life analysis with all its affecting parameters considered so as not to compromise with its quality during optimization with respect to environmental factors. Thus the use of waste materials in construction purposes and getting rid of disposal problems is a kind of Sustainable Environmental Management keeping the various needs of future generations to come in mind through saving our natural resources (Sharma, P.K. and Agrawal, P. 2018).

Pradhanmantri Gram Sadak Yojna (PMGSY) is also constructing many link roads and working for the overall development of villagers. The various construction stages and help for maintaining rural roads is also guided by the engineers engaged in the various departmental activities for social awareness. (PMGSY, GOI. <http://pmsgsy.nic.in/pmg111.asp>).

Mostly Chak roads are existing in remote areas to reach the farms of farmers. First earth work is done to prepare the granular sub grade lifting earth from sides to save the expenses on digging the road side drains. Ramming this subgrade and alternate spreading water layer by layer a water bound macadam is made which can also be utilized as a means to transport the goods with a little maintenance if there is fund shortage. Over this water bound macadam, 40 mm grit layer followed by simple bricks, bricks on edge, interlocking bricks, or 40 mm thick green concrete layer or a coat of bitumen is laid. In concrete roads in rural areas the green concrete plays a very cost affecting role as there is a number of recycled materials from the sites of demolitions. This not only solves the problems of disposal but also saves cement and other ingredients reducing the cost of construction by 30 to 40%. With view point of cost it is most important to use the green concrete because the rural roads neither have traffic densities as much as that of urban nor a very heavy loaded vehicles to move over.

The various construction stages of village roads to make them cost effective, have been depicted in following pictures



Earth Work



Village Chak Road



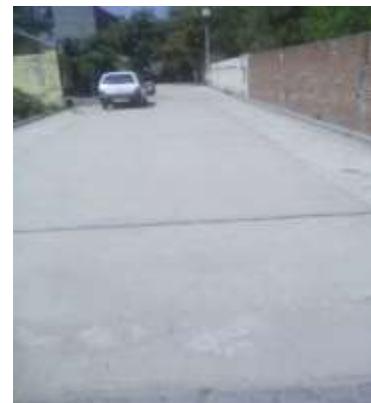
Interlocking Street



Bituminous Coated Link Road



Brick on Edge Street



CC Village CC Road



Interlocking Street Over Granular Sub Base



Water Bound Macadam Base

CONCLUSIONS AND RECOMMENDATIONS

The paper concludes that though there are number of suitable and sustainable ideas, materials and technologies available in literature for the cost effective construction in rural areas yet there is an urgent need of laboratory testing and analysis at pilot scales studies. The authors would not like to recommend the rural owners to compromise with the quality of materials because house construction is a dream which hardly comes true only once in single life span.

In case concrete construction, the green concrete may be used as much as possible in foundations and roads construction works to reduce the cost of rural constructions. The authors do not recommend taking risk of using green concrete in reinforced concrete beams and slabs of large spans.

Though, the construction cost is a very important factor yet life is more precious. So the authors recommend small and simple constructions to make the rural house affordable and not to go for a very large accommodation and unnecessary architectural designs.

The orientation of rural houses should be such that it should fetch maximum renewable energy. Simple living with balanced use of conventional energy along with a wise use of natural resources considering future generations will ensure our goal of sustainable construction for rural development.

REFERENCES

1. Baikerikar, A. (2014) "A Review on Green Concrete Baikerikar". *JETIR1406019*, Nov 2014 Volume 1, Issue 6 PP472-474.
2. Balaji, A., Karthikeyan, B., Sundar Raj, C. (2014) "Bagasse Fibre – The Future Bio composite Material: A Review", *International Journal of ChemTech Research*, Volume: 7, Issue: 01, 2014 pp 223 - 233.
3. Cunningham, T. (2013) "Factors Affecting the Cost of Building Work - An Overview." *Dublin Institute of Technology*, 2013.
4. <http://pmsgsy.nic.in/pmg111.asp>
5. Jasvi, A. H. and Bera, D.K. (2015) "Sustainable use of low cost building materials in the rural areas" *International Journal of Research in Engineering and Technology*, eISSN: 2319-1163 | pISSN: 2321-7308, Volume: 04 Special Issue: 13 | ICISE-2015 | Dec-2015, PP 534-547.
6. Montgomery, D.E. and Thomas, T.H. (2001) "Stabilised Soil Research Progress Report SSRPR8", *School of Engineering University of Warwick*, March 2001.
7. Pandit, S. and Sharma, P.K. (2017) "Sustainable Environmental Management: A Social Responsibility for clean, green and smart India" *Proceedings 3rd International conference on Advances in Management & Decision Sciences*, Gautam Buddha University, Greater NOIDA, ISBN: 978-93-86238-40-5, December 30 & 31, 2017, pp 249-255.
8. Patil, S.S. and Rupali A. Sigi (2014) "Flat Slab Construction in India", *IJEIT*, Volume: 3, Issue: 10, April 2014.
9. Paul Larcher "Low cost structures for rural roads: A review of existing books, manuals and design guides" *MART Working paper No. 13*. ISBN 1 900930 17 X. © Institute of Development Engineering, Loughborough University, Leicestershire, LE11 3TU. Indian Roads Congress (IRC): Jamnagar House, Shahjahan Rd, New Delhi 110001, India.
10. Sharma, P.K. and Agrawal, P. (2018) "Green Concrete: A Sustainable Solution." *International Journal of Computational Engineering Research (IJCER)*, ISSN (e) 2250-3005, vol.

08, no. 01, January-2018, pp. 40–43.
http://www.ijceronline.com/papers/Vol8_issue1/E0801014043.pdf

11. Sumathi, A., Saravana Raja Mohan, K. (2014) "Compressive Strength of Fly Ash Brick with Addition of Lime, Gypsum and Quarry Dust", *International Journal of ChemTech Research*, Volume: 7, Issue: 1,2014, pp 28-36.