

## SHODH SAMAGAM

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# Gandhian Way of Sustainable Construction for Urban Area using Bamboo Composites

**Ankit Bhatnagar**, Research Scholar,  
Chakravarti Rajgopalchari Institute of Management, Barkatullah University, Bhopal, India  
**D. C. Johri**, (Ph.D.)  
Supervisor, Barkatullah University, Bhopal, India

### ORIGINAL ARTICLE



### Corresponding Authors

**Ankit Bhatnagar**, Research Scholar,  
Chakravarti Rajgopalchari Institute of Management, Barkatullah University,  
Bhopal, India

**D. C. Johri**, (Ph.D.)

Supervisor, Barkatullah University,  
Bhopal, India

shodhsamagam1@gmail.com

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GANDHIAN WAY OF SUSTAINABLE CONSTRUCTION FOR URBAN AREA USING BAMBOO COMPOSITES By ANKIT BHATNAGAR, Research Scholar, Chakravarti Rajgopalchari Institute of Management, Barkatullah University, Bhopal Dr. D. C. JOHRI, Former Director, RKDF Institute of Science & Technology, Ex. DGM, BHEL, Bhopal CONTENTS TOPICS PAGE No. List of Figures List of Abbreviations 4 Acknowledgments 5 Abstract 6 Introduction 7 Research to find scope for use of bamboos in building construction 8 Objectives 8 Research Methodology 9 Research Design 9

### ABSTRACT

Bapu, Mahatma Gandhiji is known for non-violence and his contributions to the freedom struggle, but the architecture was also an area of his understanding. Gandhiji did consider building to be an extension of his engagement with different materials, which he began at an early age. His first experiments were with the food, and later, he learned carpentry and to work with leather. He was particularly interested in materiality, the relationship between material, processing, and production with labor and the human body.

Gandhiji said that “all building substances need to be obtained within just 5 kilometers regarding the place regarding construction” and of which “low cost design should not possibly be simply for the very poor, our aim can be to design just simply easier for typically the everyone.

Low-cost housing is most beneficial to middle-class people. It is important to use durable, economical and energy efficient building materials. Gandhi taught us to say no to cement, logging, and expensive materials. He told us not to waste money, materials and energy. Never sit alone on an office desk to design a building. And rely on and learn from the inherited capabilities of the locals to use the best technologies side by side for sustainable development.

‘Bamboo composites’ is a new terminology that people in urban societies know little about, although they follow new trends in environmentally friendly products in their daily routine. Urban societies are following this trend of eco- friendly products, but somewhere they are

far away from the real meaning of eco- friendly techniques. Especially when we see in terms of the use of bamboo composites, which is a sustainable eco- friendly product for all of us. It is mainly the lack of awareness, due to which the use of bamboo composites is deficient in building construction in urban locations like New Delhi (NCR). If given proper awareness, it will help in solving various problems related to the earthquake, building collapse, etc. to some extent in areas of high seismic activities like in Delhi (NCR).

For this issue, secondary research followed by primary research carried out in the descriptive format. That leads us to know various facts other than lack of awareness, which is also playing their role in answering the question of why there is a lack of use of bamboo composites in urban locations like Delhi. The output of this research is to some extent, along with helping in understanding the main reasons for less use of bamboo composites in urban locations, also tries to suggest practical solutions to increase its use in the future.

## KEY WORDS

**Sustainable-Development, Gandhian Thought, Business, Construction, Composites, Bamboo.**

## INTRODUCTION

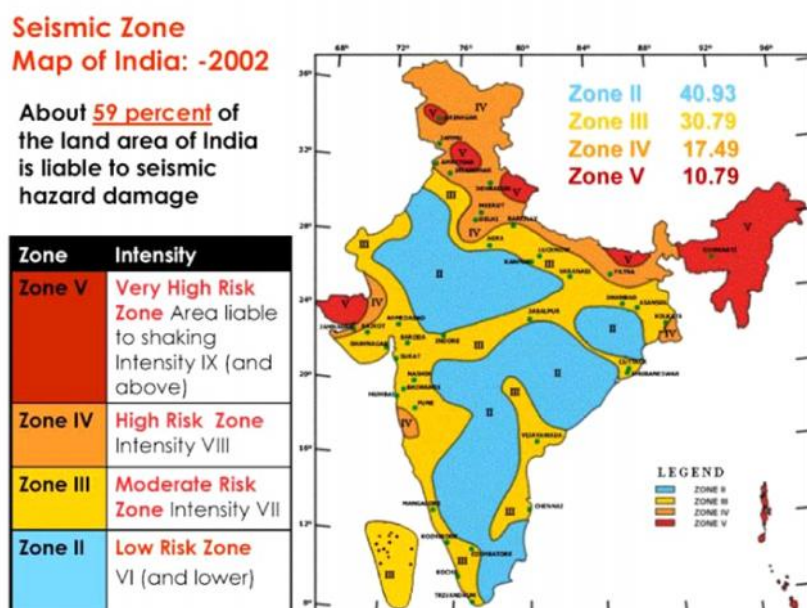
Bamboo, is often called as poor-person's wood, is used generally in the regions where it is grown. In other parts, people seem unaware of numerous qualities hidden in the bamboo and its comparative utility for building construction. Bamboo is a natural material, whose benefits to nature and humankind is unknown to date. Natural material as old as 4,000 years; its usage seems a little less when compared to other natural materials.

Naturally, Bamboo, due to its inbuilt tilt qualities, has lots of uses. However, now with the increase in scientific knowledge, this material is modified by engineering techniques into various forms called "bamboo composites," which has increased its qualities manifold to suit the demands of urban and rural locations. This innovation paced the demand for bamboo but at a slow rate.

Bamboo, having a tensile strength more than steel, which makes it a perfect material for building houses in urban locations, is a complete replacement of wood. Deforestation, being a significant concern in the present context, the use of wood needs to be discouraged in developmental activities. It takes even up to sixty years for a tree to grow fully and then another sixty years for a replacement. However, there are species of bamboo, which take very little time to mature completely and gain height and width equal to that of a tree, thus making bamboo an excellent resource to be anticipated for building purpose.

In addition to the above, the use of bamboo makes buildings earthquake resistant. It is now scientifically proved that the building made of bamboo are least affected by the earthquake and other similar disasters. We all know that Delhi (NCR) lies in seismic Zone IV and is very prone to the earthquake (Figure-1). Any time a big earthquake may hit the city and cause huge devastation. Therefore, it becomes very important that while constructing residential and other buildings in Delhi NCR, we must keep this aspect into consideration and make building earthquake resistant (in accordance to BIS code, IS:1893- Khan, n. d). By making proper use of bamboo we can make our buildings earthquake resistant. Engineered bamboo has lot of features like it has light weight, high strength, damage resistant, disaster resistant, durable, low cost material, fire resistant and is design flexible too, which makes it a special material in itself making it kind for mankind and nature at the same time. It is not only bamboo qualities, but also its good production in our country make it more

suitable for building construction. India lies at second position in the bamboo producing countries after China and thus there is sufficient bamboo production in the country, which can be utilized at lowest budget. There is need for change in our policies and creating awareness. If people are made well aware of these facts and other uses of bamboo, this can certainly bring a lot of change in the mindset of the people and thus create good scope for bamboo use in building development in urban locations like New Delhi. If the policies are put into action strictly and followed properly, then the use of bamboo composites can be used in across India, not limited to Delhi only and thus coming out with a sustainable solution to many existing problems related not only to housing, but other areas too.



**Figure 1:** Seismic Zones of India (source: <http://www.teluguaspirant.com/wp-content/uploads/2015/02/zones.jpg>)

## Research to Find Scope for use of Bamboo in Building Construction

Keeping in view the multifarious problems related to building construction in Delhi NCR and other issues discussed in the Introduction part above, research was carried out focusing on scope for use of bamboo in building construction in Delhi NCR region. The selection of the topic for research was finalized in consultation with professors/ supervisors of the Institute.

## Objectives

This research paper is to understand the use of Bamboo as construction material as based on the Gandhian Management of Sustainable development by using secondary and primary information gathered through various sources. Principles of this study can be as follows:

- To analyze the problems related to building construction in Delhi NCR,
- Find out the suitability of bamboo composite as building material in the region and its comparative benefits.
- Based on secondary and primary data analysis make recommendations to promote use of bamboo composite in building construction for safety and economy.

## Research Methodology

The present research is mainly focusing on to find out scope of utilization of bamboo composites as a sustainable building material for urban locations in Delhi(NCR) by using qualitative and descriptive pattern of analysis. The required information for the research is collected by using primary and secondary

data collection method technique. It has used qualitative data collection methods, which includes study of books, articles, web sources, etc. in secondary data collection and expert interviews along with visual research for the primary data collection.

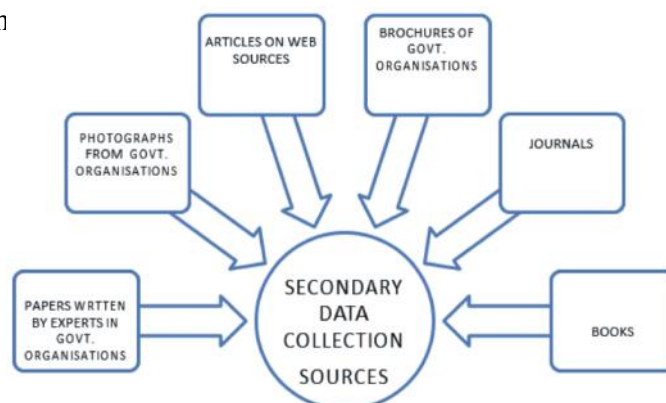
## Research Design

The research uses a mixed method approach (Pragmatic). The combinations of methods, which are best suited to solve the research problem are used in an effective manner. Through this research design, different methods to collect and assemble the qualitative data are utilized, adapting the point and segments to be assessed. Different techniques are used at the same time, one at a time or one after the other as per requirement of the research.

## Secondary data

The research undertaken requires to undergo a thorough study of various sub topics like understanding bamboo plant and its usage through passage of time, bamboo utilization in various aspects of life, scenario in India for bamboo production and utilization, engineered bamboo, benefits of bamboo composites, bamboo composites as a sustainable products, the locations which have utilized bamboo composites in rural and urban areas and the like.

Various sources were looked upon and studied thoroughly to know in detail about bamboo and bamboo composites. The



**Figure 2:** Secondary Data Collection Sources

## Primary data

The research paper required to study the utilization of bamboo composites as sustainable building material for urban locations in Delhi (NCR) and the reason why there is a lack of its utility. It also required to study areas where efforts are already being made to apply bamboo composites in urban locations, availability and marketing of bamboo and bamboo composite in Delhi (NCR). The study made it essential to meet government organizations and people associated with bamboo composites, its production and marketing.

## Expert Interview

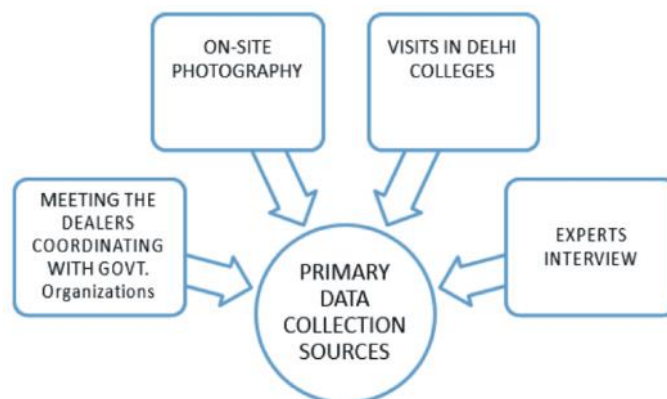
Expert interviews were required to be taken because some information would not be complete if not discussed with the experts. These interviews became a very important part in solving many queries, the answers for which could not be met out by using secondary data only.

These interviews were conducted to gain insight for the topic and the dealers were met and interviewed to understand the availability and demand in the marketplace for the bamboo composites. Interview of the people who had built newly constructed houses and other structures were taken to analyze the awareness about alternate materials used other than wood and concrete for exterior and



interior locations. Visual research through photography was done on site of the structures built with bamboo composites in Delhi (NCR). Experts interviews were conducted in Government Organizations, working for bamboo composites, faculties at Delhi colleges having bamboo composites structures, dealers dealing with bamboo composites, entrepreneurs who have made a name through innovation in bamboo's composite designs.

The primary data



**Figure 3:** Primary data collection Sources.

Thus the use of the secondary data and primary data made to understand the use of bamboo composites in Urban areas in a detailed way.

### Loopholes in the data collection

There were various loopholes, while going through the data. Though very small, yet an important issue, while conducting the primary research was that there was a big difference between the information collected from the primary data, when compared with secondary data. The analysis of the data clearly indicated that primary data at certain places was a better tool than the secondary data, which gave us a clear perspective for better solution of the problem.

Primary data also helped us in enhancing our knowledge and gave much clear insight of the topic and certain points were understood in much deeper context through the primary research.

The secondary data was not very exact in some, cases mainly regarding the usage of bamboo composites in Delhi/NCR, however, the pitfalls were covered by the experts whom we met and interviewed, while collecting our primary research.

### Outcome of Secondary and Primary Data Analysis

The secondary and primary data were analysed in consultation with experts and the outcome of the analysis is discussed in the succeeding text.

### About bamboo

Bamboo is a fast growing tree, like structure grass. These tree like structure grasses are found usually in tropical and subtropical regions. There are 120 species of bamboo which are found all over the world. In general the bamboo plant has a length of 15-20 metres, which reaches up to 40 meters. In India bamboos are found especially in north eastern parts of the country in abundance, the other areas where bamboo grows are Madhya Pradesh, Orissa, Andhra Pradesh and Karnataka..

### Bamboo Properties

Bamboo is having multifunctional properties in it which makes of its varied uses. It is versatile, durable, elastic, low weight, regenerative, fire resistant and thermal insulator.

## **Preservation of bamboo**

Bamboo can be preserved by using two methods, one is the traditional way of preserving bamboo and other is the chemical way. As bamboo gets affected by termites, moulds and fungi, which affects its life span, its preservation is very essential. The life span of bamboo which is not preserved is only 1 to 2 years, and on preservation its life span increases up to 10 years. If a chemical treatment is applied to bamboo then its life increases by 30 to 40 years.

## **Position of bamboo in India**

Bamboo is found in abundance in India, but its usage is very less. It is used widely in the north eastern part of India because of its abundance there. But when we look into other parts of India where it is not found in abundance, in those places use of bamboo is not more. Government is taking number of steps, especially in rural areas to enhance the use of bamboo. In the Urban locations the use is comparatively very less. Certain Organizations like BMTPC, NMBA, IPIRTI have taken initiative with the help of Government to increase the use of bamboo in a specific manner.

## **Bamboo composites**

Bamboo composites is the engineered bamboo, which has much more features added to it, in comparison to natural bamboo. It is made by mixing two or more chemically distinct material. Composites could be made naturally and artificially as well. Engineered bamboo has more additional properties. These properties are that it is light weight, high strength, durable, disaster resistant, design flexible etc., which makes it good material for constructing building in Urban areas.

## **Government initiatives for bamboo composites**

Number of Organizations in India with the help of Government has done a lot of work regarding bamboo composites. The organisation like NMBA has made various prefabricated structures at various colleges. However, there are still many requirements to be done to ascend the utilization of woods in building construction, especially in urban areas. There are various aspects which need to be looked upon much deeper, by using the primary data. The use of primary data made the understanding about this topic in a better way. The analysis of primary data reveals in Delhi. The organization has made its presence felt from Ladakh to Kerala and from Arunachal Pradesh to Rajasthan, almost all over the country.

That the whole system had lots of loopholes, which are the main hurdles in creating awareness among the people living in urban locations about the ways to utilize bamboo composites in an efficient way and cost effective way. There are certain issues which need to be highlighted by the Government regarding the multifunctional use of bamboo composites.

## **Bamboo composites structures in Delhi at present**

The NMBA, now known as NCATR has developed various structures in Delhi colleges which shows that it will be a success, if government takes certain steps towards awareness generation about the use of bamboo composites.

Brief about the noticeable structures constructed by making use of bamboo composite is given in the succeeding text?



**Figure 4:** Bamboo composites classrooms pictures taken at Deen Dayal College, Delhi  
(Source: Self clicked pictures).

These bamboo composites classrooms were built around four years ago at Deen Dayal College in Delhi. These classrooms were spacious, steady, cooler than the other classrooms during summers and there is no complaints regarding the classroom maintenance or any damage which they have faced. The faculties and students were very satisfied with this bamboo composite structure and they found nothing negative about these rooms.

### **Canteen at Acahrya Narendra College, Near Govindupri, Dehli**



**Figure 5:** Canteen for students in the college. (source: self clicked)



**Figure 6:** Canteen for faculties and furniture made of bamboo composites in the canteen. (Source: self- clicked)

This college is a part of Delhi University. The bamboo composite canteen at this college was built about four years ago and it is a beautiful part of this college, which is running in very good condition. The faculty canteen has also A.C. in it, which also does not causes any problem in the structure. The furniture kept in these canteen are also made of bamboo and are very good. The students and staff are very proud of this structure in their college and so far there is no complaint regarding this structure. It is noteworthy that there was no need to maintain it during the last four years and thus the

maintenance cost was almost nil for this structure, when compared to other structures made in college.

### **Classrooms in Metthew College, Delhi, South Campus**



**Figure.7:** Classrooms at Metthew College in Delhi. (Source: self- clicked)

These classrooms were built about three years ago. The classrooms are very spacious, cool in summers and are strong. They have not faced any complaint regarding its durability and maintenance. By looking at these structures, it is clear that in Urban locations like in bus stop sheds, houses, furniture and sheds at metro stations, offices, exteriors and interior of houses etc. are the options, where bamboo composite can be suitably used because of its low cost maintenance and other benefits mentioned earlier. Keeping the scarcity of land in Urban areas in consideration, two storey buildings can also be made with the help of bamboo composites.

### **Lack of promotional activities**

The analysis of the primary data indicates that there is lack of promotional activities for bamboo composites use and there is urgent need to take necessary steps by Government in this regard.

On comparing bamboo composites with other materials available with dealers in Delhi like plywood, mica etc., there was no promotion tools used in case of bamboo composites. Other materials available with dealers had various promotional tools initiated by the Government agencies or the private companies, which included banners, hoardings, brochures, advertisements etc., whereas in the case of bamboo composite there is hardly any good promotional effort made.

The analysis of collected data suggests that these promotional activities was a basic reason due to which customers preferred to buy wood, sun mica and other materials for building houses, and not bamboo composites, which has numerous benefits. The reason behind which is just the lack of promotional activities for which Government is not taking sufficient steps to spread it at a larger scale among the Urban locations in Delhi (NCR).

If these promotional activities are there and the Government takes necessary steps in this regard, this will create awareness among the community and thus the people will be encouraged to use the bamboo composites for building their houses, keeping its comparative benefits in mind.

### **Organisational and people's initiatives**

When we look at various organizations like NECTAR, BMTPC, CBART, INBAR to name a few, these organisations are doing their best for promoting bamboo composites in urban locations like Delhi, but certain Government policies act as a hindrance which does not let the advertisement of the bamboo composites be there at a full paced motion.

When we look at these organizations, they are the one who have really worked for disseminating knowledge about the benefits of bamboo composites, not only in India but also in foreign countries. In fact the people living in foreign countries are much more aware about bamboo composites and its utility. Some people in the foreign countries have started using bamboo composite for building construction, for which bamboo is being exported from India.



In addition to above mentioned organisations, there are numbers of students/ researchers, who are doing research in bamboo composites as their area of interest and are taking initiatives to promote bamboo composites for business at a small scale. These researchers are also enhancing their knowledge, time to time for making better use of bamboo and develop new types of bamboo composites by carrying out certain experiments on it. These people, who are taking such initiatives are highly educated people from IIT, NID etc. who really want to work for it.

Thus we see that there are already so many initiatives to promote bamboo composites for building construction. The only drawback is just the slow speed at which the Government is working for it and not making much support to such initiatives. There is a need of Government support for these people who are trying their level best to promote bamboo composite use in their own best ways. The poor response from the Government makes them demotivated at certain points leading them to sometimes think to stop working for this. But despite all this, on the other hand it is some people's passion to work for bamboo composites, which is making them to dream big about its awareness and use in future and they still see a hope for it.

### **People mindset**

In addition to the facts mentioned above, the mindset of people in urban area is one other demotivating factor for less use of bamboo composite. In urban areas and especially in the Delhi NCR, people believe in a modern lifestyle. Being eco- friendly is the new modern buzzword which makes them to use environment friendly products, but at the same time they are not much aware of the bamboo composites also being a material available there. It's just a buzzword which keeps on following as a modern concept but no one in urban areas is actually aware about the real meaning of eco- friendly materials. When people look into bamboo composites, they think as if it's just a fashion trend which people follow blindly to show that they are actually using eco-friendly product. People are making their houses and furniture from wood, but when they are provided with bamboo as an option being a low cost material too, they will not buy it because it hurts their self-esteem, because they still consider it as a poor man timber.

Now- a-days even bamboo composites are made having the look very similar to wood and having properties better than wood. So various composites like these new ones are now- a -days providing numerous options to the customers. Some people have certain superstitious beliefs that bamboo is not worth buying because it does not have long life and it will be affected by moulds, fungi etc. They are unaware of the fact that engineered bamboo is earthquake resistant, fire resistant, does not harm the environment and mankind, has tensile strength greater than the iron. In a city like Delhi, which is very much earthquake prone and where we hear in news that the poor construction of buildings leads to loss of lives of people, bamboo composites can play an important place in lessening this damage. In today's time, where customer is the king and today's customer being smart enough having knowledge about best products available in the market, it is surprising that s/he is unaware of such a beneficial material's availability in the market. This is the right time people are made aware of all these facts about the utility and benefits of using bamboo composites and make this to bloom in the market place leaving the other competitive materials behind.

### **Lack of employment opportunity**

The lack of awareness about use of bamboo composite also leads to lack of employment opportunity. There are good opportunity of generating employment in this sector, if proper attention is given. The small industries established for making bamboo composite can create employment for millions of youth. However, as there is major lack of motivation from Government and public sector, the bamboo composite is not taking shape of booming industry.

## CONCLUSION

Utilization of bamboo composites as a sustainable building material for Urban Locations in Delhi (NCR) can be promoted by creating awareness among the people about bamboo composites, its utility and comparative benefits for building construction. This can be only done if proper and good strategies are developed for promoting bamboo composites, with sufficient Government support.

The marketing policies and promotion techniques for bamboo composites also need to be made strong and effective, so as to make this material boom as a building material in urban location like Delhi (NCR). The three P'S of marketing strategy i.e. product, packaging, and publicity are to be used simultaneously and effectively for promoting use of this product in urban areas. There is need to hold workshops, seminars, discussion about promotion strategy of this product and sincere efforts need to be made for creating awareness among people. For creating awareness brochures, banners at shops depicting its usage and options available for bamboo composites need to be developed and disseminated. Use of electronic media can be very effective in making people aware about the comparative benefits and utility of bamboo composites in building construction.

If all these points discussed above are taken into consideration and sincere efforts are made to promote use of bamboo composites for building construction in Delhi (NCR) urban area, various problems related to building construction in Delhi(NCR) urban area will be solved to some extent. Promoting the use of this material will not only reduce the risk of death of people by damaging and collapse of poorly constructed buildings, but also will provide the earthquake resistant structures with minimal expenditure. In addition to security from earthquake and building collapse, the bamboo composite constructed building will be more eco-friendly and as these building are less affected by out side temperature, there will be less consumption of electricity. Using bamboo composites can open a lot of scope for development in a sustainable manner, which will not cause any damage to the environment . The sincerer efforts made in this direction will certainly be very useful, not only economically, but environmentally too. The development using such eco- friendly techniques can only be sustainable and safeguard us and our future generation from the threat of deteriorating environmental conditions and also of course from the adverse impact of climate change.

## List of Abbreviations

BMTPC	: Building Materials and Technology Promotion Council
DELHI (NCR)	: Delhi National Capital Region
IIT	: Indian Institute of Technology
IPIRTI	: Indian Plywood Industries Research and Training Institute
NECTAR	: North East Centre For Technology Application and Research
NID	: National Institute of Design
NMBA	: National Mission on Bamboo Application

## REFERENCES

1. Alleviation, Go.I.-M.o.H.a.U.P., 2013. *Affordable Housing in Partnership - Scheme Guidelines*. Report. New Delhi: Ministry of Housing and Urban Poverty Alleviation Ministry of Housing and Urban Poverty Alleviation.
2. Anon., 2011. *Report on Urban Homeless by the National Advisor on Homeless to the Commissioners of the Supreme Court*. report. sccommissioners.
3. Anon., n.d. *encyclopedia britannica*. [Online] Available at: <http://www.britannica.com/EBchecked/topic/51182/bamboo> [Accessed 27 march 2015].

4. Anon., n.d. *keralawebpage*. [Online] Available at: <http://www.keralaagriculture.gov.in/html/bankableagriprojects/fw%5CBamboo.htm> [Accessed 31 march 2015].
5. Anon., n.d. *www.bambootech.org*. [Online] Available at: <http://www.bambootech.org/subsubTOP.asp?subsubid=110&subid=42&sname=USAGE> [Accessed 25 march 2015].
6. Anon., n.d. *www.businessdictionary.com*. [Online] Available at: <http://www.businessdictionary.com/definition/pH-scale.html#ixzz3WX8PFHc1> [Accessed 1 april 2015].
7. Anon., n.d. *www.ipirti.gov.in*. [Online] Available at: <http://www.ipirti.gov.in/bamboo.html> [Accessed 2 april 2015].
8. Anon., n.d. *www.keralaagriculture.gov.in*. [Online] Available at: <http://www.keralaagriculture.gov.in/> [Accessed 2 april 2015].
9. Anon., n.d. *youtube*. [Online] Available at: <https://www.youtube.com/watch?v=mUNqK160KwE> [Accessed march 2015].
10. apil, n.d. *www.apilbambooprefab.com*. [Online] Available at: [http://apilbambooprefab.com/bamboo\\_prefab.htm](http://apilbambooprefab.com/bamboo_prefab.htm) [Accessed 1 april 2015].
11. BIS, n.d. *BIS STANDARDS RELEVANT FOR UTILISATION OF BAMBOO AND BAMBOO COMPOSITE MATERIAL IN STRUCTURAL APPLICATION*. Document. New Delhi: BIS BIS.
12. bmtpc, n.d. *Bamboo - A material for cost effective and disaster resistant housing*. paper. delhi:bmtpc bmtpc.
13. bmtpc, n.d. *TECHNO ECONOMIC FEASIBILITY REPORT ON BAMBOO MAT CORRUGATED ROOFING SHEET*. Delhi: bmtpc bmtpc.
14. Borah Dutta E, P.K.C.D.B.N.D.a.B.K., n.d. *Utilization Aspects of Bamboo and its Market Value*. Paper. Jorhat: Rain Forest Research Institute Rain Forest Research Institute, Jorhat, Assam.
15. Chandra Sabnani, M.P., 2014. The Deliverance The Deliverance The Deliverance System for mass ystem for mass ystem for mass ystem for mass Housing for the Urban ousing for the Urban ousing for the Urban ousing for the Urban ousing for the Urban ousing for the Urban ousing for the Urban. *International Journal of Scientific and Research Publications*, 4(7), p.12.
16. D.kumuda, D., 2014. Homeless Population in India : A Study. *Global Journal for Research Analysis*, 3(8), p.2.
17. Environment, C.f.S.a., 2007. *AFFORDABLE HOUSING*. Report. New Delhi: Centre for Science and Environment Centre for Science and Environment.
18. IPIRTI, 2001. Seminar on Affordable Housing using Bamboo and Bamboo Composites. *IPIRTI NEWS*, 3(1), p.8.
19. Janssen, J.J.A., 2000. *designing and building bamboo*. Technical. Netherlands: INBAR INBAR. M.P., R., 2007. *www.designforindia.blogspot.in*. [Online] Available at: <http://design-for-india.blogspot.in/2007/12/bamboo-mat-boards-from-ipirti-material.html> [Accessed march 2015].
20. Mehra, S.P.M.&.L.K., 2007. *Bamboo Cultivation - Potential and Prospects*. technical paper. NABARD.
21. Murali, S., 2013. *Design of a Climate Adaptive Façade System using Bamboo for Urban India*. Graduation Report. Delft I University of Technology.

22. nmba, n.d. *Bamboo Reincarnated*. special supplement. New Delhi: nmba nmba.
23. P. Sharma, K.D.a.S.M., n.d. *Bamboo as a Building Material*. paper. International Journal of Civil Engineering Research.
24. Virdi S. Kuldee, R.D.R., n.d. *Manual on Building Bamboo Houses*. Report. IPIRTI. Ranjan M P, N.I.G.P., 1986. *Bamboo and Cane Crafts of Northeast India*. New Delhi: The Development Commissioner of Handicrafts.
25. Richard, M.J., 2013. *ASSESSING THE PERFORMANCE OF BAMBOO STRUCTURAL COMPONENTS*. dissertation phd. Pittsburgh: University of Pittsburgh University of Pittsburgh.
26. Sabnan Chandrai, L.M.V.r.a.S.U., 2012. *Bamboo -An Alternative Building Material for Modest Houses, to Increase the Stock of Affordable Housing,for the Urban Poor Living Close to Bamboo ProducingRegions in India*. *World Academy of Science, Engineering and Technology*, 6, p.12.
27. Sandra, S., 2000. *www.europa.ue.int*. [Online] Available at: [http://europa.eu.int/comm./dg10/culture/program-2000\\_en.html](http://europa.eu.int/comm./dg10/culture/program-2000_en.html) vom 08.02.2000, 22:00 [Accessed 24 march 2015].
28. SHEE, n.d. *Environmental Friendly Indian Building Material Technology for Cost Effective Housing*. SHEE: SHEE.
29. T, R.T.a.V.D., 2009. *LOW COST HOUSING*. Pilani: Bits Pilani Bits Pilani.
30. Tomar J M S, H.D.K.A.A., 2009. *Bamboo and their Conservation in North East India*. Paper. Indian Forester.
31. *www.design for india.com*, 2012. *design india*. [Online] deign for india Available at: <http://design-for-india.blogspot.in/2007/12/bamboo-mat-boards-from-ipirti-material.html> [Accessed 25 march 2015].
32. *www.e-pao.net*, 2014. *e-pao.net*. [Online] e-pao Available at: [http://e-pao.net/epSubPageExtractor.asp?src=news\\_section.Press\\_Release.Press\\_Release\\_2014.Bamboo\\_Regulation\\_in\\_India\\_The\\_Need\\_for\\_Reforms\\_and\\_Policy\\_Change\\_20140612](http://e-pao.net/epSubPageExtractor.asp?src=news_section.Press_Release.Press_Release_2014.Bamboo_Regulation_in_India_The_Need_for_Reforms_and_Policy_Change_20140612) [Accessed 28 march 2015].

## BIBLIOGRAPHY

33. Ranjan MP, N.I.G.P.,1986.*Bamboo and cane crafts of Northeast India*. New Delhi: The Development Commissioner of Handicrafts.
34. Janssen,J.JA.,2000.*designing and building bamboo. Technical*. Netherlands; INBARINBAR Mehra,S.P.M.&L.K.,2007.*BambooCultivation-Potential and Prospects*. technical paper.
35. NABARD
36. bmtpc, n.d. *TECHNO ECONOMIC FEASIBILITY REPORT ON BAMBOO MAT CORRUGATED ROOFING SHEET*, Delhi : bmtpc bmtpc
37. P. Sharma, K.D.a.S.M.,n.d.*Bamboo as a Building Material*. paper. International journal of Civil Engineering Research
38. SHEE, n.d. *Environmental Friendly Indian Building Material Technology for Cost Effective Housing*. SHEE:SHEE.
39. TomarJMS,H.D.K.A.A.,2009,*Bamboo and their conservation in North East India*. Paper. Indian Forester.



40. T,R.T a.V.D.,2009. *LOW COST HOUSING* .Pilani:Bits Pilani Pilani Bits Pilani.
41. IPIRTI, 2001.Seminar on Affordable Housing using Bamboo and Bamboo Composites .*IPIRTI NEWS*,3(1), P8.
42. Chandra Sabnani, M.P.,2014. The Deliverance The DeliviranceSystem for Mass Housing for the International Journal of Scientific and Research Publications,4(7)p.12
43. Viridi S.Kuldee, R.D.R.,n.d.Manual on Building Bamboo Houses. Report. IPIRTI Anon., n.d. [Online] Available at: <http://www.bambootech.org/subsubtop.asp?subsubid=77&subid=22&sname=BAMBOO&subname=SPECIES> [Accessed 3 april 2015].
44. Anon., n.d. [Online] Available at: [http://tifac.org.in/index.php?option=com\\_content&view=article&id=474&Itemid=190](http://tifac.org.in/index.php?option=com_content&view=article&id=474&Itemid=190) [Accessed 2015 april 2015].
45. Anon., n.d. [Online] Available at: <http://www.bamboonetwork.org/about-bamboo.html>.
46. Anon., n.d. [Online] Available at: <http://www.britannica.com/EBchecked/topic/51182/bamboo> [Accessed 2 april 2015].
47. Anon., n.d. [Online] Available at: <http://homeguides.sfgate.com/climate-bamboo-grow-in-68358.html> [Accessed 4 april 2015].
48. Anon., n.d. [Online] Available at: <http://homeguides.sfgate.com/climate-bamboo-grow-in-68358.html> [Accessed 3 april 2015].
49. Anon., n.d. [Online] Available at: [http://www.academia.edu/3598149/From\\_the\\_Land\\_to\\_the\\_People\\_Bamboo\\_as\\_a\\_Sustainable\\_Resource\\_for\\_India](http://www.academia.edu/3598149/From_the_Land_to_the_People_Bamboo_as_a_Sustainable_Resource_for_India) [Accessed 4 april 2015].
50. Anon., n.d. [Online] Available at: [file:///C:/Users/Tanushree%20Singh/Downloads/Final%20Paper-Bamboo%20review%20\(1\).pdf](file:///C:/Users/Tanushree%20Singh/Downloads/Final%20Paper-Bamboo%20review%20(1).pdf) [Accessed 5 april 2015].
51. Anon., n.d. [Online] Available at: [file:///C:/Users/Tanushree%20Singh/Downloads/Final%20Paper-Bamboo%20review%20\(1\).pdf](file:///C:/Users/Tanushree%20Singh/Downloads/Final%20Paper-Bamboo%20review%20(1).pdf) [Accessed 5 april 2015].
52. Anon., n.d. [Online] Available at: <http://www.bamboogrove.com/general-uses-for-bamboo.html> [Accessed 3 april 2015].
53. Anon., n.d. [Online] Available at: <http://www.guaduabamboo.com/preservation> [Accessed 5 april 2015].
54. Anon., n.d. [Online] Available at: <http://www.greenhomebuilding.com/QandA/bamboo/preservation.htm> [Accessed 4 april 2015].
55. Anon., n.d. [Online] Available at: <http://www.bambootech.org/subsubTOP.asp?subsubid=110&subid=42&sname=> [Accessed 3 april 2015].
56. Anon., n.d. [Online] Available at: <http://www.tn.gov.in/tsunami/digitallibrary/ebooks-> [Accessed 5 april 2015].
57. Anon., n.d. [Online] Available at: [web/36%20Bamboo\\_%20A\\_%20Material\\_%20For\\_%20Cost\\_%20eff.pdf](web/36%20Bamboo_%20A_%20Material_%20For_%20Cost_%20eff.pdf) [Accessed 3 april 2015].
58. Anon., n.d. *bamboo composites*. [Online] Available at: <http://www.ipirti.gov.in/bamboo.html> [Accessed 4 april 2015].
59. Anon., n.d. *Bamboo diversity and conservation in India - Sas Biswas*. [Online] Available at: [http://www.bioversityinternational.org/fileadmin/bioversity/publications/Web\\_version/572/ch25.htm](http://www.bioversityinternational.org/fileadmin/bioversity/publications/Web_version/572/ch25.htm) [Accessed april 2015].
60. Anon., n.d. *Bamboo diversity and conservation in India - Sas Biswas*. [Online] Available at: [http://www.bioversityinternational.org/fileadmin/bioversity/publications/Web\\_version/572/ch25.htm](http://www.bioversityinternational.org/fileadmin/bioversity/publications/Web_version/572/ch25.htm) [Accessed 3 April 2015].

61. Anon., n.d. *Natioanl Mission on Bamboo Application*. [Online] Available at: <http://www.bambootech.org/subsubTOP.asp?subsubid=134&subid=42&sname=USAGE> [Accessed 4 april 2015].
62. Anon., n.d. *National mission on bamboo application*. [Online] Available at: <http://www.bambootech.org/subsubTOP.asp?subsubid=110&subid=42&sname=USAGE> [Accessed 5 april 2015].
63. Anon., n.d. [Online] Available at: <http://www.bambootech.org/tslink.asp?subsubid=68&subid=14&sname=MISSION&subname=P ARTNERS&lid=51> [Accessed 3 april 2015].
64. Anon., n.d. [Online] Available at: [http://web.iitd.ac.in/~chariarv/Synopsis\\_CSVerma\\_2005RDZ8106.pdf](http://web.iitd.ac.in/~chariarv/Synopsis_CSVerma_2005RDZ8106.pdf) [Accessed 3 april 2015].

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