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### Strength Comparison of Bamboo and Steel Reinforcement in Mud Concrete

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#### Abstract

The authors have designed mud concrete, by replacing cement with Over the past decade the price of construction materials like cement, aggregates, steel etc. have increased many folds, making it difficult for rural people to afford the cost of construction. The biggest problem of reinforced cement concrete (RCC) structures is corrosion of steel, as well as carbon footprint. Locally available Red soil, Fly Ash and achieved an approximate strength 20 MPa meeting the requirements of IS 456:2000 as the minimum grade suggested for RCC structures. This research paper discusses the viability of using bamboo bars as an alternative to steel reinforcement bars in mud concrete. In this research five mix design variations are designed as per IS 10262-2009, control mix (M20), 20%, 30%, 40% and 50% of partially replaced cement. Each variation comprised of locally available Red Soil (mud), and Fly ash in 2:1 ratio and lime as fixed 5%. Bamboo and steel bars of diameter 12 mm are used. Beam (Prism) of size 500 mm x 100 mm x 100 mm were casted with bamboo and steel reinforcement bars in single and double layers. These were cured and tested in flexure at 7 and 28 days as per IS 516-2002. The results between the beams of all variations are compared. It is found that the beam with doubly reinforced bamboo bars of 50% cement replacement gave similar results to M20 doubly reinforced steel bars with the added advantage of elimination of corrosion, decrease in self weight and non brittle breakage.

**Keywords:** Mud concrete, Red soil, Fly Ash, Bamboo, Steel, Reinforcement

#### 1. Introduction

Concrete is an age old construction material in the world, made with the cement, fine aggregate, coarse aggregate and water. Exponential increase in cement production due to its demand in construction industry has led to serious negative environmental impact, specially in rural areas, where the cement factories are usually located. Increase in cost of cement, steel has also led to the increase in cost of construction. Much stress is given to introduce low cost houses which are durable, safe and affordable. Bamboo is naturally fast growing plant, can be grown in any climatic condition and soil type, it also has a good tensile

strength making it suitable to be used as an alternative to steel reinforcement. [1-4]

#### 2. Proposed Solution

In this research work cement is partially replaced by Red Soil (Mud), Fly Ash and Lime. The use of industrial waste helps reduce the environment pollution, making it eco-friendly by reducing the greenhouse effect as well as the cost of construction. The use of bamboo as an alternative reinforcement material would eliminate the damage caused due to corrosion in RCC Structures as well as decrease the self-weight.[3-7].

### 3. Materials

The following sections briefly describe the materials used in this research.

#### 3.1. Cement:

Ordinary Portland Cement (OPC), of 53 grade available in the local market is used.



**Fig.1. OPC Cement**

#### 3.2. Fine Aggregate:

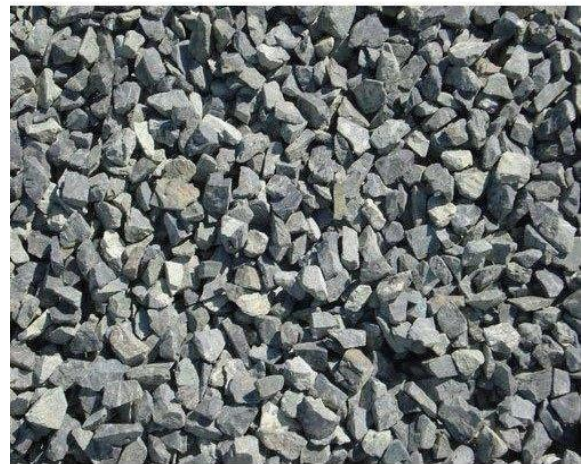
The locally available fine aggregate (river sand) after removing the visible external impurities (clay matter, salt and organic impurities) is used in the research. The normal size of fine aggregate is 4.75 mm and below till 75 micron to be used in Concrete Mix Design in accordance with IS: 10262-2009. Regular required tests as per Indian Standards were carried out to check its conformity and suitability.



**Fig.2. Fine Aggregate**

#### 3.3. Coarse aggregate:

Coarse aggregate is defined as rock particles (gravels) of size more than 4.75 mm to 20 mm. The nominal maximum size used in this research is 20 mm, locally available crushed stone obtained from quarries. Regular required tests as per Indian Standards were carried out to check its conformity and suitability as per IS 10262-2000 to be used in concrete mix design.



**Fig.3. Coarse Aggregate**

#### 3.4. Red Soil (Mud):

Locally available red soil (mud) not widely used in cultivation, rather dumped in back fills was used after proper cleaning (removal of undesirable elements) and sieving through 75 micron sieve so that its particle sizes is similar to that of cement. It is found that this red soil has cohesive properties apart from traces and contents of iron. It is abundantly available in the rural areas of Telangana.



**Fig.4. Red Soil (Mud)**

#### 3.5. Fly Ash

It is an industrial waste product primarily the waste from coal fired thermal power plants using coal. Indian power plants produces huge amount of fly ash waste and it is an environmental concern. Many researchers have used it as a partial replacement of OPC due to its properties and particle size. Fly Ash from a plant near Hyderabad is used in this research; the fly ash is dried and sieved through 75 micron sieve before using in the concrete mix.



**Fig.5. Fly Ash**

**3.6. Lime**

Lime has been used in almost all archeological monuments in India. An attempt has been made to revive this age old construction material as partial replacement if cement. Lime is cleaned from visible impurities sieved and used in hydrated form after adding some amount of the mixing water.



**Fig.6. Hydrated Lime**

**3.7. Bamboo:**

Bamboo is a traditional building material widely used in rural areas. It is used alone as a support to roofing structure, walls, partitions etc... It is a naturally fast growing plant. It is very good in tension and its tensile strength varies from species to species. Only those bamboos are to be used for construction purpose which shows a pronounced Brownish-Greencolour. This will ensure that the plant is at least three years old and is matured.

Various biological studies concluded that bamboo has a high water absorption capacity, the dimensional variations of untreated bamboo due to water absorption can cause micro or even macro cracks in the cured concrete. The node in bamboo naturally prevents the propagation of cracks, damage. Bamboo has the potential to be come an

ideal replacement as reinforcement in place of steel. Bamboo materials of approximate 12 mm diameter is collected from the wholesale market in Hyderabad and used in our research.



**Fig.7. Bamboo**

**3.8. Water**

Potable water (water suitable for drinking) is used in this research. Water is required for hydration of cement.

**4. Methodology**

The research study conducted is laboratory oriented. The above discussed materials red soil, fly ash, lime, cement, fine aggregate, coarse aggregate, bamboo, steel are used in this project. In this project M20 is taken as reference as it is the minimum grade for RCC construction as per IS 456-2000. To design the concrete mix, max nominal size of coarse aggregate size is 20 mm, fine aggregate, water cement ratio 0.50, specific gravities of fine and coarse aggregates and other values and limitations as per IS code 10262:2009. The following Mix design quantities are obtained in kgs for 1.0 m3 of M20 Concrete (reference)

Cement	Fine Agg	Coarse Agg	Water
394	672	1025	197

The partial replacement of cement from 20%-50% in different variations is done by using red soil and fly ash in ratio of 2:1, while lime is kept constant at 5% in all the variations. (These along with cement are termed as cementitious materials). In total five mix variations are designed. Quantities in kgs of each ingredient is calculated based upon its Specific Gravity of each ingredient as prescribed in

IS 10262-2009. The following are the mix design percentages for different variations;

**Table.1. Mix Variations**

Mix Variation	Cementations Materials (100%)				F.A (kg)	C.A (kg)	Water (ltr)
	Cement (%)	Mud (%)	Fly Ash (%)	Lime (%)			
V0 (Ref)	100	0	0	0	100	100	100
V1	20	50.0	25.0	5.0	100	100	100
V2	30	43.4	21.6	5.0	100	100	100
V3	40	36.6	18.4	5.0	100	100	100
V4	50	30.0	15.0	5.0	100	100	100

**5. Casting**

The standard procedure of mixing, casting, curing is followed for all the mixes. Beams (Prism) samples of size 500 mm x 100 mm x 100 mm are casted and tested in flexure at the age of 3,7,28 days. In this research TMT steel reinforcement bars of diameter 12 mm are replaced with bamboo bars of 12 mm (approximately). For proper bonding with the concrete, as the steel reinforcement bars are ribbed in factory similarly the selected bamboo bars are marked with blade, with a care not to lose its base. Both are cut into 400 mm length to fit in the sample beam with sufficient cover. As in conventional methods both steel and bamboo bars are used in single and double layers. To use bamboo in doubly layer, small pieces of bamboos are cut and used with small nails to act as stirrups; doubly beams of steel are tied with stirrups. Bamboos are seasoned (treated) before using. In mix variations except reference, bamboo reinforcement is used as it is the objective of this research.

**5.1 Seasoning of Bamboo**

One of the main shortcomings of bamboo is its water absorption when it is used as reinforcement in concrete. It's susceptibility to insects attack tend to adversely affect its bonding characteristics with concrete. To overcome this issue seasoning (treatment) of bamboo is done prior to its use as reinforcement in concrete. Seasoning of the bamboo also increases its service life upto three times than the non-seasoned bamboo. The seasoning method used in this research is ; Borax

boric solution method, this is quite economical and its chemical are easily available .The ratio taken for mixing the solution is 1:1.5.



**Fig.8. Seasoning of Bamboo**

Mechanical Concrete Mixer is used to mix all the mix variations. All the raw materials are homogenously dry mixed before adding the calculated water. It was made sure that the fresh concrete mix has achieved proper consistency before casting the moulds.



**Fig.9. Dry Mix**



**Fig.10. Sample Beam with Bamboo**



**Fig.11. Sample Beam with Steel**



**Fig.12. Casted Sample Beams**

The casted samples are demoulded and sundried for one day and moist cured using jute bags till age of testing.



**Fig.13. Curing of Casted Beams**

### 6. Testing

The beams (prisms) are tested in flexure using three point loading as per IS 516-2002 and flexural strength calculated by the formula  $f_b = \frac{pl}{bd^2}$  ( $p$ =Max Load in N,  $l$ =length between supports,  $b$ =breadth,  $d$ =depth all in mm) as per code. Two sample beams of each variation (i.e. percentage of cement and reinforcement) were tested. In 20% and 30% cement variation it is found that doubly reinforced bamboo is giving better results than singly reinforced. Hence in 40% and 50% doubly reinforced were casted and tested. These results of all mix variations are compared with the reference sample.



**Fig.14. Tested Steel Reinforced sample**



**Fig.15. Tested Bamboo Reinforced sample**

The following table gives the summary of average flexural strength ( $N/mm^2$ ) of all samples tested.

**Table.2. Summary Results**

Mix Variation	Cement (%)	Reinforcement	Age 7 D	Age 28 D
V0 M20 Ref	100	Singly Steel	3.80	5.40
		Doubly Steel	6.72	9.20
		Singly Bamboo	2.60	3.72
		Doubly Bamboo	5.40	7.16
V1	20	Singly Bamboo	1.25	1.50
		Doubly Bamboo	1.50	2.50
V2	30	Singly Bamboo	1.70	2.12
		Doubly Bamboo	1.80	2.25
V3	40	Doubly Bamboo	4.11	5.68
V4	50	Doubly Bamboo	6.00	9.50

### Conclusions

1. It was found that mix variation 4 having 50% cement replacement and doubly reinforced bamboo bars has achieved a flexural strength of  $9.50 N/mm^2$  M20 doubly reinforced steel bars.
2. Combination of 50% cement, locally available red soil (mud), fly ash in 2:1 ratio and 5% lime along with doubly reinforced 12 mm bamboo bars can be used in construction of single storied houses in rural areas.
3. The 50% decrease in cement usage along with use of alternative material red soil (mud), industrial waste fly ash and lime makes this combination environment friendly.
4. Successful usage of bamboo reinforcement bars eliminates the problem of corrosion, as well as decrease the cost of construction.

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### References

- [1] Mohammed Safiuddin and Dr. Ahmed Hussain, (2020). Design of Mud Concrete. Solid State Technology. 63(4), 2691-2697.
- [2] S.Y.Kute, M.R.Wakchaure (2013), Performance Evaluation for Enhancement of Some of the Engineering Properties of Bamboo as Reinforcement in Concrete, Journal of Institution of Engineers (India): Series A, 35, 235-242
- [3] B.B.Paul Mary, Dr. D. Tensing (2013), State of the Art Report on Bamboo Reinforcement, International Journal of Engineering Research and Applications.2 (3).683-686
- [4] Masakazu Terai & Koichi Minami (2012). Research and Development on Bamboo Reinforced Concrete Structure, 15 WCEE, LISBOA.
- [5] Y. Xiao, M.Inoue, S.K. Paudel Editors, "Modern Bamboo Structures", CRC Press, Taylor & Francis Group, London, UK,(2008).
- [6] Abhijeet Dey, Dr. Nayanmoni Chetia, Experimental study of Bamboo Reinforced Concrete Beams having various frictional properties, Proceedings of the Materials Today, Elsevier 5 (2016), pp 436-444.
- [7] K. Ghavami (2007). Bamboo: Low cost and energy saving construction materials. Proceedings of First International Conference on Modern Bamboo Structures (ICBS-2007), Changsha, China, 28-30 October 2007 Page 05-21.