

Project Report

A Study on Application of Bamboo as Reinforcement in Construction of Low Cost Building Wall

A project under Unnat Bharat Abhiyan , AICTE

by : Utpal Kumar Das, Dept. of Civil Engineering, Tezpur University

Period : 2 Years (14 October 2016 to 13 October 2018)

This project titled “ A Study on Application of Bamboo as Reinforcement in Construction of Low Cost Building Wall” under Unnat Bharat Abhiyan aims in finding a viable replacement of common burnt clay bricks used in construction of walls with precast bamboo reinforced cement concrete wall panels. The idea was to design and produce portable and reusable wall panels using locally available materials suitable for low cost buildings, particularly in flood prone rural areas of Assam. From the point of view of portability and cost of construction the thickness, consequently the weight, of the wall panels is a key parameter.

The work was planned and carried out with following considerations:

- 1) Reduction of the lateral pressure of the plinth infill soil when the wall panels being used as plinth wall.
- 2) Preparation of light weight precast wall panels using bamboo as reinforcement material using alternate material and /or technology for construction of the panels.

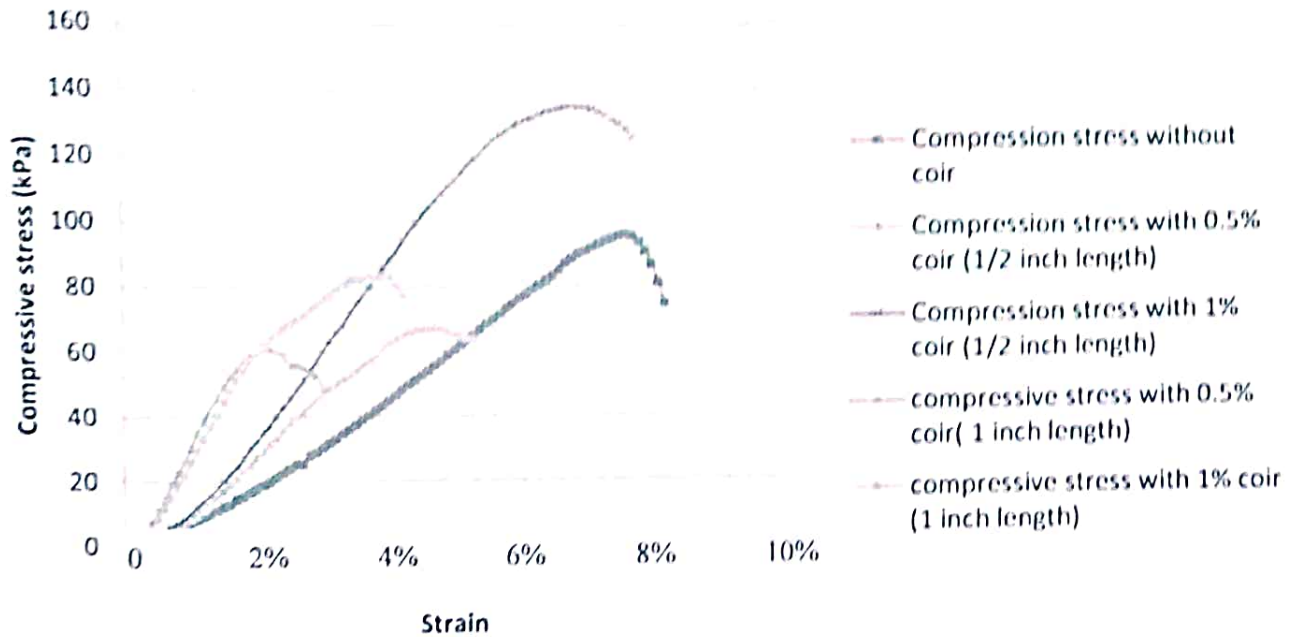
Reduction of the lateral soil pressure of the plinth infill soil on the plinth wall

The proposed precast wall panels when used for plinth protection are subjected to lateral earth pressure of plinth infill soil. A reduction in the lateral pressure of plinth soil consequently reduces the precast wall thickness. Study of this aspect of the work was carried out in the Geotechnical Engineering laboratory of Civil Engineering Dept. , Tezpur University. It was attempted to reduce the lateral pressure of the plinth fill soil by premixing the soil with coir fibres. Coir is one of the abundantly available local natural materials in Assam.

Based on the experimental results and analysis of the same, the following conclusions are drawn:

- The unconfined compressive strength of the soil improves due to inclusion of coir fibers.
- The reinforced soil shows ductile behaviour with inclusion of 15mm long coir fiber.
- The coir reinforced soil, when subjected to vertical load less than the unconfined compressive strength of the unreinforced soil, shows increase in stiffness and, thus, indicating lesser settlement.

Comparison of Stress-strain curves



So premixing the plinth infill soil with 1% randomly oriented coir fibre of average length of 15mm is recommended from this study for improvement of the plinth infill soil and reduction of the lateral load on the plinth wall.

Preparation of precast wall panels and use of bamboo as reinforcement material

Bamboo, due to its tensile strength and easy availability, is one of the prospective materials for use as reinforcement in low cost housing. But decomposition of bamboo is one of the major limitations of using bamboo as reinforcement. In order to slow down its natural decomposition under exposure to water, attempts were made in this work to treat the bamboo surface with different locally available material and study the resultant water absorption behaviour of the treated bamboo. The findings are as below:

- Application of Shellac resins provided very satisfactory results as it reduced the water absorption of bamboo samples by more than 10%. Also, due to its easy availability and low cost, application of Shellac resins can be an effective as well as an economic solution for treatment of bamboo.
- Effectiveness of Shellac resin solution layers increased with the increase in the number of coats. It was observed that 10 numbers of coats could reduce the water absorption to less than 10% and 20 coats could further reduce it to less than 5% of weight of dry bamboo. However, complete prevention of water was not possible.

The weight of the wall panels is one of the important aspects of this study for the ease of manual handling of the wall panels in construction sites. The panels of size 30cm x 60cm made of traditional cement concrete were found to be too heavy. In order to reduce the self weight of the panels experiments with alternative aggregate like broken coconut-shell / cut tyre-chips in partial replacement of stone aggregates were carried out in this study. Following are the notable findings of this experimental work:

- 10% reduction in total weight of wall panels can be achieved with the use of waste materials such as rubber tire chips and broken coconut shell as alternate aggregates in partial replacement of coarse stone aggregate in cement concrete wall panels.
- Concrete cubes with 10%, 20% and 30% replacement of coarse aggregate (by weight) by correspondingly equal volume of rubber tyre-chips showed 20%, 35% and 45% reduction in compressive strength respectively.
- Concrete cubes with 10%, 20% and 30% replacement of coarse aggregate (by weight) by broken correspondingly equal volume of coconut-shell showed 15%, 25% and 55% reduction in compressive strength

The 10% reduction of weight achieved with use of alternate aggregate was not sufficient to make the bamboo reinforced concrete slabs light enough for manual handling. It was, therefore, necessary to explore other possibilities for further reduction of weight of the wall panels. With this aim in mind, application of foamed concrete was experimented for making bamboo reinforced wall panels. The following conclusions are drawn from these experimental works:

- Foamed concrete is one of the viable light weight concrete that can be produced without using any specialized equipment.
- Density as low as 0.8 gm/cc of foamed concrete is achievable in laboratory and field condition.
- Although foamed concrete of density 0.6gm/cc could be achieved in laboratory and a slab was concreted at this density it was associated with partial segregation of foam from the water-cement mix.
- With the increase in density of foamed concrete the compressive strength also increases.
- Use of 5% sand in the preparation of the foamed concrete increases both density and compressive strength by about 40%.
- Use of paper mill waste in preparation of foamed concrete enhances the compressive strength but also increases the density. With the addition of 5% and 10% of paper mill waste the compressive

strength gets enhanced by 2.5 times and 4.5 times respectively whereas the density increases by 20% and 75% respectively.

- The foamed concrete gives desired densities if poured within 15 minutes of its preparation. If poured after 20 minutes of preparation the foamed concrete has shown 15-20% increase in density.
- All foamed concrete slabs manufactured in this work have shown high permeability.
- The bamboo weaved in the form of connected cells when used as reinforcement in foamed concrete enhancement in the ductile property of the Foamed Concrete slabs were observed. As the slabs so reinforced with bamboo regained their shape on withdrawal of the load without any segregation of the concrete the bamboo cell reinforcement gives a favorable quality to the slabs during transportation and site handling. But the bamboo cell reinforcement was not found to be effective in increasing the flexural strength of the Foamed Concrete slabs. Providing bamboo cell as reinforcement has decreased the flexural strength of foamed concrete slab to about one-fourth of unreinforced slab

Finally it is concluded from this study that Foamed Concrete is a viable method of preparation of Light Weight Concrete. Since it does not need any specialized equipment it can be used in all these worksites which are capable of preparing normal concrete. Skill of preparation of foamed concrete is important and can be acquired with short term training of people who is already in the trade of concrete. Due to low compressive strength it can be used to make only non-load bearing components of construction. In this project it was attempted to enhance the strength and performance of foamed concrete precast slabs by providing bamboo cell reinforcement. It was found that the bamboo cell does not result in any improvement of strength of the foamed concrete as intended. But it has achieved the desired behavior of the foamed concrete slab from the point of its transportability and field handling by substantially reducing its brittleness. The bamboo cell reinforced foamed concrete slabs can be useful when used with bottom support as flooring material.



(Utpal Kumar Das)

Audited Utilization Certificate

for the financial year : 2016- 2019

Name of the Institute : **Tezpur University**

Name of the Scheme under which Grant was sanctioned : **AICTE Unnat Bharat Abhiyan project.**

AICTE Sanction Order No. & Date under which Grant was sanctioned	Amount Sanction (Rs.)	CERTIFICATE
F.NO.52-7 /RIFD/UBA/POLICY-1 /2016-17 Dated: 22.09.2016	<u>Rs.5,00,000.00</u> [Breakup: Rs.3,00,000 (Non-recurring) Rs.2,00,000 (Recurring)]	Certified that out of the grant-in-aid of <u>Rs. 5 lakh</u> sanctioned by the AICTE during the Financial Year <u>2016-17</u> as per letter mentioned in the margin, <u>Rs.Nil</u> on account of unspent balance of previous year + <u>Rs.14,131.00</u> on account of Interest, a sum of <u>Rs.4,95,871.00</u> has been utilized for the purpose for which it was sanctioned, and the balance of <u>Rs.18,260.00</u> remained unutilized at the end of year <u>2018-19</u> .

Certified that I have satisfied myself that the conditions on which the grant-in-aid was sanctioned have been duly fulfilled and that I have exercised the following checks to see that the money was actually utilized for the purpose for which it was sanctioned.

Kinds of checks exercised:

1. Audited Annual Accounts of the Institute
2. Receipt & Payment Account of the Institute
3. Periodical Progress Report of the Institute

[Signature of Internal Audit Officer / CA
(CA mandatory for self financing Institutes)]

Name: _____
Tezpur University, Assam, Pin-784028
Internal Audit Officer
Tezpur University

[Signature of the Finance Officer]
(Govt./Govt.Aided/University)

Name : _____
Designation : Finance Officer
Tezpur University, Assam, Pin-784028
[with seal] (Finance Officer)
Tezpur University

[Signature of the Head of the Institute]

Name : BIREN DAS
Designation : Registrar
Tezpur University, Assam, Pin-784028
[with seal] Registrar
Tezpur University

Place : Tezpur

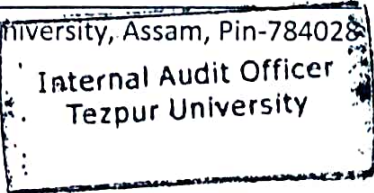
Date : 19/2/2019

RECEIPT & PAYMENT ACCOUNT


Sl. No.	Receipt	Amount (Rs.)	Sl. No.	Payment	Amount (Rs.)	
1.	To Opening Balance	Nil	1	Nil	Nil	FY 2016-17
2.	To Grants Received from AICTE	5,00,000	2	Electronic Balance	16,520	Rs. 1,01,092 in
3.	To Interest	14,131	3	Material (consumable)	10,935	FY 2017-18
			4	Skilled labour	15,050	
			5	Printer	10,200	
			6	Fellowship to D.Baruah	48,387	
			7	Compression Testing m/c, Vicat apparatus, UTM attachment	2,80,132	Rs.3,94,779 in
			8	Consumable, skilled lab., Stationery	44,647	FY 2018-19
			9	Fellowship to M. Das	70,000	
				Closing Balance	18,260	
	Total	5,14,131		Total	5,14,131	

[Signature of  Internal Audit Officer / CA
(CA mandatory for self financing Institutes)]

Name: _____
Tezpur University, Assam, Pin-784028



[Signature of the Finance Officer]
(Govt./Govt.Aided/University)

Name:  _____
Designation: Finance Officer
Tezpur University, Assam, Pin-784028
[with seal] Finance Officer
Tezpur University

[Signature of the Head of the Institute]

Name: BIREN DAS
Designation: Registrar
Tezpur University, Assam, Pin-784028
[with seal] Registrar
Tezpur University

Place : Tezpur

Date : 19/2/2019

FORMAT FOR GENERAL FINANCIAL RULES
(GFR- 19)

Assets acquired wholly or substantially out of Government grants

Register maintained by grantee institution

Block Account maintained by sanctioning Authorities

Name of Sanctioning Authority

1. Serial No. :
2. Name of Grantee Institution : TEZPUR UNIVERSITY
3. No. and date of sanction : F.No. 52-3/RIFD/UBA/POLICY-1/2016-17 Dt. 22.9.16
4. Amount of the Sanctioned grant : Rs. 5,00,000/-
5. Brief purpose of the grant : Project under UMMAT BHARAT ABHINAV Scheme of AICTE
6. Whether any condition regarding the Right of ownership of Government in the property or other assets acquired out of the grant was incorporated in the grant sanction: NO
7. Particulars of assets actually created or acquired :
 1. ELECTRONIC BALANCE CAPACITY 6000 g ± 0.1 gm.
 2. COMPRESSION TESTING M/L, 2000 KN CAPACITY
 3. VICAT APPARATUS
 4. FLEXURE TEST ATTACHMENT OF UTM.
8. Value of the Assets as on : Rs. 2,96,652/-
9. Purpose for which utilized at present: Laboratory Testing of Materials.
10. Encumbered or not : NO
11. Reasons if encumbered : NA
12. Disposed of or not : NO
13. Reasons and authority, if any, for disposal : NA
14. Amount realized on disposal : NA
15. Remarks :



Signature of Chief Coordinator

COMPLETION REPORT

Sanction Order No. & date : F.NO.52-7/RIFD/UBA/POLICY-1/2016-17 Dated: 22.09.2016

1. Name of Chief Coordinator : **UTPAL KUMAR DAS**, Dept. of Civil Engg., Tezpur University, Assam
2. Programme Title: **AICTE Unnat Bharat Abhiyan project.**
3. Date of receipt of Grant : **14-October-2016.**
4. Date of commencement of the Programme : **14-October-2016.**
5. Grant-in-aid sanctioned by AICTE : **Rs.5,00,000/-**
6. Grant released by AICTE : **Rs.5,00,000/-**
7. Details of Expenditure

A. NON-RECURRING

Sl. No.	List of approved equipment	List of equipment procured	Major Specification of equipment procured	No. of units	Date of purchase	Expenditure
1	Electronic Weighing Balance	Electronic Weighing Balance	Capacity 6000gx0.1g	01	23.02.2018	16,520
2	Compression Testing Machine	Compression Testing Machine	Capacity 2000KN	01	04.05.2018	2,24,200
3	Vicat Apparatus	Vicat Apparatus	Conforming IS5513-1976	01	04.05.2018	2,832
4	UTM attachment for Tensile testing of bamboo	UTM attachment for flexure testing	HE-SPL, Flexure Test Attachment	01	04.05.2018	53,100
TOTAL						2,96,652

B. RECURRING :

Sl. No.	Particulars of activities	Period	Expenditure in Rs.			
			Laboratory cum field Assistant Fellowship	Material for reinforced slab	Skilled labour for reinforced slab	Contingency
1	Laboratory cum field Assistant Fellowship plus Material and Skilled manpower for bamboo reinforced slab plus Contingency for consumables, accessories etc.	FY 2017-18	48,387	5,500	15,050	15,635
2	Laboratory cum field Assistant Fellowship plus Material and Skilled manpower for bamboo reinforced slab plus Contingency for consumables, accessories etc.	FY 2018-19	70,000	14,479	5,020	25,148
TOTAL			1,99,219			

Gross Total (A + B) = Rs. 4,95,871.00

8. Whether there is any deviation from the purpose for which Grant was released : **No**

9. Give details of activities carried out during the year : **Detailed report in Annexure – I.**


Signature of Chief Coordinator

A. NON-RECURRING :

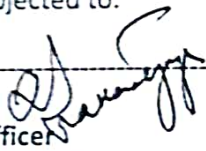
Sl. No.	List of approved equipment	List of equipment procured	Date of purchase	Amount Sanctioned	Amount Utilized	Unspent Balance
1	Electronic Weighing Balance	Electronic Weighing Balance	23.02.2018	Rs. 3,00,000	Rs. 16,520	Rs. 3,348.00
2	Compression Testing Machine	Compression Testing Machine	04.05.2018		2,24,200	
3	Vicat Apparatus	Vicat Apparatus	04.05.2018		2,832	
4	UTM attachment for Tensile testing of bamboo	UTM attachment for flexure testing	04.05.2018		53,100	

B. RECURRING :

Sl. No.	Activities undertaken	Period	Amount Sanctioned	Amount Utilized	Unspent Balance
1	Laboratory cum field Assistant Fellowship	06.10.2017 to 28.02.2018	Rs. 2,00,000	Rs. 48,387	Rs. 781.00
2		16.03.2018 to 15.10.2018		70,000	
3	Material and Skilled manpower for bamboo reinforced slab ; Contingency for consumables, accessories etc.	FY 2017-18		36,185	
4		FY 2018-19		44,647	

Total of A + B = Rs. 4,95,871.00 (amount utilized)


Certified that the grant has been utilized for the purpose for which it was sanctioned in accordance with the "Terms and Conditions" attached to the grant. If, as a result of check and audit objection some irregularity is noticed at a later stage, action will be taken to refund, adjust or regularize the amount objected to.




Finance Officer
 (Signature & Seal)
 Finance Officer
 Tezpur University



Registrar/Principal/Director
 (Signature & Seal)
 Tezpur University
 Napam, Tezpur, Sonitpur, Assam
 Pin-784028 Registrar
 Tezpur University


 [Signature of Internal Audit Officer / CA
 (CA mandatory for self financing Institutes)]

Name: 
 Tezpur University, Assam, Pin-784028
 Tezpur University
 Date: _____

Note: The Registrar/Finance Officer in case of Universities, Principals in the case of Colleges and Executive Heads of other Institutions will sign the Utilization Certificate (UC). The internal auditor may countersign the provisional UC wherever the system of the internal audit exists. In case of the Self Financing/ Private Institutions, UC has to be signed by a Chartered Accountant.

***This is to be submitted for every financial year along with the detailed Receipt and Payment account.**