Bharath
INSTITUTE OF HIGHER EDUCATION AND RESEARCH
(Declared as Deemed-to-be University under section 3 of UGC Act, 1956)
(Vide Notification No. F.9-5/2000 - U.3, Ministry of Human Resource Development, Govt. of India, dated 4th July 2002)
Accredited by NAAC
NATIONAL ASSESSMENT AND ACCREDITATION COUNCIL
Phone : 044-22290742 / 22290125 . Telefax : 044-22293886
Website : www.bharathuniv.ac.in
173, Agaram Road, Selaiyur, Tambaram,
Chennai - 600 073. Tamil Nadu.

Ref No. SMS-2018-O-3

Date : 07/10/2018

TO

Mr.T.P.Meikandan,

Asst Prof/Civil

BIHER

Thro: Concern Head of the Department

BHARATH INSTITUTE OF HIGHER EDUCATION & RESEARCH
(Declared as Deemed to be University U/S 3 of UGC Act 1956)
- 7 OCT 2018
OFFICE OF THE DEAN-RESEARCH
Selaiyur, Chennai-600 073. INDIA

Greetings!!!

We are happy to announce that the Research Advisory Committee has approved your proposal for Seed Money Scheme-2018 which was presented by you. You are requested to complete the proposal and send the progress report to the Dean Research in the prescribed time period.

Title of the Project: Repair and Rehabilitation of R.C. beams

Seed Money Amount: Rs.1,00,000/- (Rupees One Lakh Only)

Approved on : 27/09/2018

Payment details:

Cheque No. 351623 **Dated: 09/10/2018**

Bank Name: Indian Bank, Selaiyur, Chennai.

With Regards

Dean-Research

Received.

इंडियन बैंक
Indian Bank

Branch :- SELAIYUR (TAMBARAM)
PLOT NO.17 AND 18, HASAN COLONY
AGARAM ROAD, SELAIYUR ,TAMBARAM. CHENNAI. T.N.
IFS Code :IDIB000S246

VALID FOR THREE MONTHS ONLY

0	9	1	0	2	0	1	8
D	D	M	M	Y	Y	Y	Y

PAY Mr. T.P. Meikandan. या धारक को OR BEARER

RUPEES रुपये One Lakh Only अदा करें ₹ 1,00,000/-

खा.सं. A/c No.	CA 6670628110

CBS Code: 02505

FOR BIHER RESEARCH AND CONSULTANCY

AUTHORISED SIGNATORY

Please sign above

PAYABLE AT PAR AT ALL OUR BRANCHES

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PROPOSAL SUBMISSION

1. **Details of Principal Investigator**

Name	: Mr.T.P.Meikandaan
Designation	: Associate Professor
Highest Qualifications	: M.E
Department	: Civil Engineering
E-mail	: ganga_meik@yahoo.co.in
Contact no	: 9884967300
Date of Joining	: 02/07/2008

2. **Details of Co - Principal Investigator**

Name	: Dr.R.Venkata Krishnaiah
Designation	: Professor
Highest Qualifications	: Ph.D.
Department	: Civil Engineering
E-mail	: venkatapec@gmail.com
Contact no	: 9840261276

Technical details

1. INTRODUCTION

Reinforced cement concrete is popular construction material used for structural components of a building like beams, columns and slabs etc. One major flaw of RCC is its susceptibility to environmental attack. This can severely decrease the strength and life of the structures. The repair of structurally deteriorated RC Structures become necessary since the structural element ceases to provide satisfactory strength and serviceability. There are considerable numbers of existing concrete structures that do not meet current design standards. They need structural up gradation to meet new seismic design requirements. The reasons may be due to changes in loading, corrosion of reinforcement, construction errors, additional loadings or changes in configuration or accidents such as earth quakes or due to fire etc.

The remedy for insufficient capacity the structures need to be replaced or retrofitted. Different types of strengthening materials include FRP Laminates, Silicon laminates and steel plates. FRPs can be applied to the beams, columns and slabs of the buildings and bridges. Retrofitting is a technical intervention in Structural system of a building that improves resistance to earthquake by optimizing strength and ductility. Depending on the structural deficiencies it is required to prepare and to design the retrofitting approaches. The primary reason for strengthening of structures includes upgrading of its resistance to withstand underestimated loads, increase in the load carrying capacity for higher permit loads etc.

2. **Review of status of Research and Development in the subject**

- **Keertika Sharma et al, This present paper explores the flexural performance of fiber reinforced polymer (FRP) fortified in reinforced concrete (RC) beams.** The RC beams are designed and analyzed for an effective span of 3 m. The linear and non-linear FE analysis of steel reinforcement and FRP bars beams are carried out in finite element method ANSYS software. The finite element (FE) results are verified using Linear analysis method using IS 456-2000 code for steel reinforcement bars and ACI 440-2006 for FRPs bars. The results show that the FRP strengthened beams exhibit increased flexural strength. The non-linear analysis of the beams shows more, Deflection at centre and load point as compared to linear FEM of the RC beams strengthened with FRPs and steel bars

- **Habibur Rahman Sobuz, et al, carried out test which concluded that externally bonded CFRP laminates can be used effectively to strengthen the reinforced concrete beams.** It was found that increase in stiffness and flexural strength is achieved with the increase of CFRP layers significantly. The ductility reduction of the beams after strengthening with CFRP laminate was closely observed in experimental results. The crack pattern at the final loads was observed from the experimental reinforced concrete beams and the observations were recorded for future references. Flexural model based on strain compatibility in the concrete, steel and CFRP reinforcement gave an almost accurate prediction of the experimental results.

- **Jiang Feng Donga, et al (2013), effectively carried out experimental tests on both the flexural and the flexural –shear strengthening capacity of the RC beams using externally bonded of CFRP or GFRP.** From the investigation, which proved that the FRP sheets could not only increase strength and stiffness of the beams strengthened but also control development of cracks and increase ductility of the beams very significantly. For the beams with

flexural–shear strengthening, their load carrying capacity and stiffness can be greatly increased with the higher concrete strength.

- **K. B. Parikh and N. S. Patel**, carried out test for analytical study on strengthening of beam by FRP and concluded that application of FRP on RC beam increases flexure and shear strength significantly. Though the final load/ ultimate load from the FEM are higher than experimental results ,but interestingly , load vs. deflection behaviour is almost similar. Numerical study can be used effectively to predict the behaviour of retrofitted reinforced concrete beams more precisely by assigning appropriate material properties and appropriate connection between concrete and FRP. Toughness and ductility were increased noticeably of RC beam which strengthened with FRP during the test.

- **M.B.S Alferjani, et al, effectively carried out test on the existing research works on reinforced concrete beams strengthened by CFRP**. Strengthening of the beam using CFRP laminate in the strengthening system provides an excellent economical and versatile solution for extending the service life of reinforced concrete structures very significantly. FRP in concrete now increase or decrease margins of safety depending on environmental and stress conditions, generic FRP type and required design life to a greater degree compared to past observations.

2.1 International Status: NIL

2.2 National Status: NIL

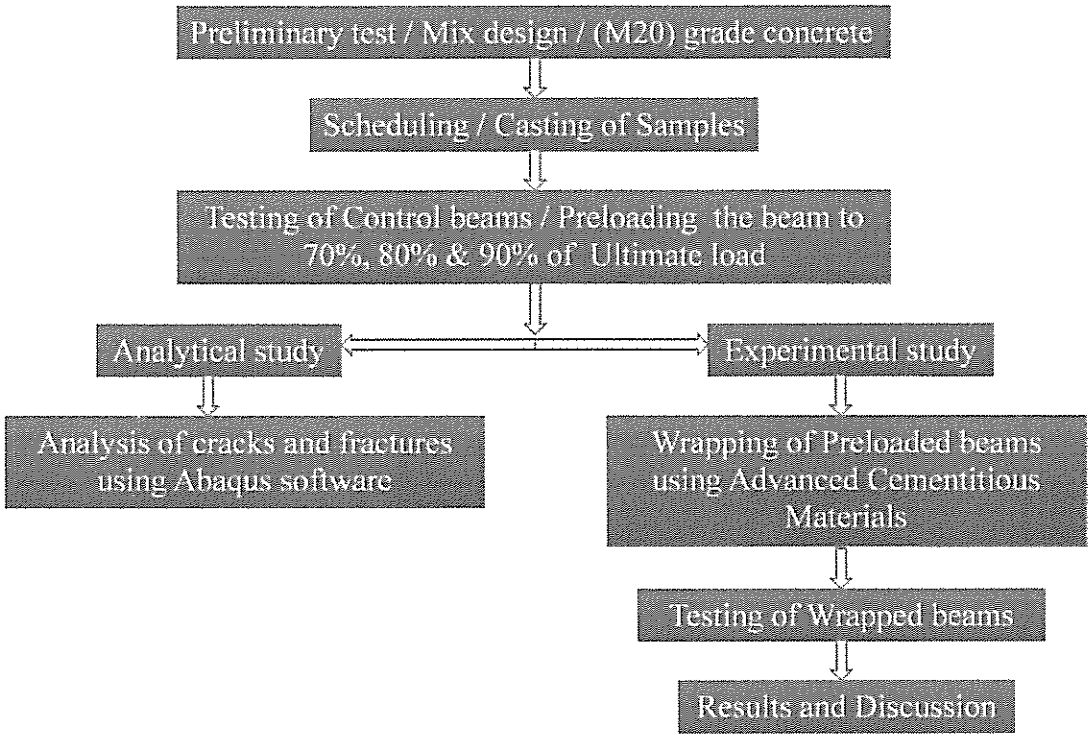
3. Progress/achievement so far,

a) Reference papers were collected.

b) Literatures reviewed. Furthermore literatures to be studied.

c) Proposal work has been started in the Repair and Retrofitting of RC Beams Strengthened with Overlay Made up of Cementitious Materials.

4 Work Plan:

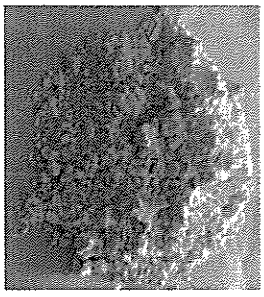


4.1 Methodology:

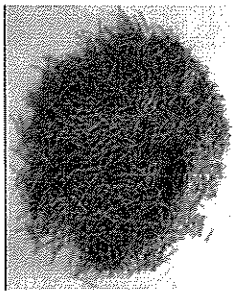
- The main objective of this investigation is to study effectiveness of CFRP and GFRP laminates (FRP) on the flexural and shear strength of concrete beams. The objectives is achieved by conducting the following tasks
- Flexural testing of concrete beams bonded with different layers of FRP laminates.
- Flexural testing of concrete beams, wrapped with different configuration of FRP laminates.
- Calculating the effect of different configuration of FRP sheet and fabric on the flexural and shear strength of concrete beams.
- Comparing the experimental result with analytical calculation, and predicting the uncertainty parameters.

MIX PROPORTIONS FOR ADVANCED CEMENTITIOUS MATERIALS

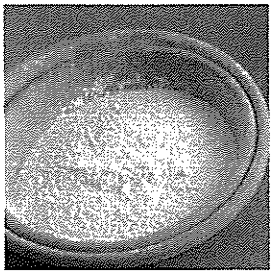
SL. NO.	MATERIAL	PROPORTIONS
1	CEMENT (kg/m^3)	500
2	SILICA FUME (kg/m^3)	125
3	SIEVED SAND (kg/m^3)	550
4	QUARTZ POWDER (kg/m^3)	200
5	STEEL FIBRE (kg/m^3)	157
6	SUPER PLASTICIZER (% Weight of Cement Content in Mix)	3.5%
7	FLY ASH (kg/m^3)	150
8	WATER CEMENT RATIO	0.28



FLY ASH

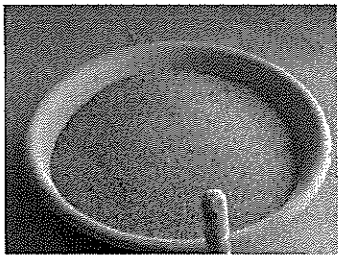


STEEL FIBRE

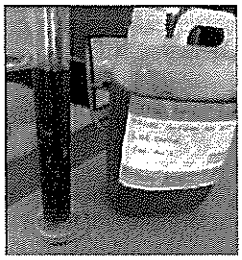


QUARTZ POWDER

SILICA FUME



SIEVED SAND



SUPER PLASTICIZER

INGREDIENTS OF ADVANCED CEMENTITIOUS MATERIAL

FLY ASH

Fly ash (FA) is a fine particle comes from the combustion of pulverized coal in electric power generation plants. During this process, most of the volatile substances and carbon in the coal are burned off. The mineral substance associated with coal crumble and the mineral impurities (such as clay, feldspar, quartz, and shale) are carried off in the form of ash by the exhaust gasses. From these processes, mainly two particle sizes are generated; the first is the coarser particles which contain heavier particles and first fall down to the furnace bottom. It is termed as the bottom ash. While the finer particles are flown together with the flue gasses and discharged to the air using a series of mechanical separators followed by highly efficient electrostatic precipitators or bag filters, so it is called as fly ash (FA).

STEEL FIBRE

Steel fibers are concrete reinforcing material which in combination with concrete provides certain advantages in comparison with traditional reinforcement. Steel fibers are made from different wire materials, designed to provide concrete with temperature and shrinkage crack control, enhanced flexural reinforcement, improved shear strength and increase the crack resistance of concrete. Fibers are sometimes referred to as structural fibers and are intended to carry load and therefore, are used to replace traditional reinforcement in certain non-structural applications as well as minimize and/or eliminate both early and late age cracking. Steel Fibers Reinforced Concrete (SFRC) is generally used to inhibit cracking, improve resistance to impact, to resist dynamic loading and material disintegration. SFRC can be used without any other additional reinforcement in almost all application where flexural stresses are not overwhelming like beams for instance.

SILICA FUME

Condensed silica fume some attention has been given to the silica fume as a possible replacement in cement paste. Silica fume was first used in the USA in 1944. Silica fume in concrete has a more than 60 year history. Silica fume, as a by-product material in the

ferrosilicon industry is a very efficient pozzolanic material, though it has some problems with its use in concrete due to its very fine particles,

QUARTZ POWDER

Since quartz powder is available as a natural material that is made from sawing stones and it is almost useless, and also by product of industries, it could be a good choice for using as filler in concrete. The variable parameter which was quartz powder to silica fume ratio and superplastisizer amount, that replacing condensed silica fume by fine quartz powder particles improved almost all the properties such as compressive strength and flexural strength, with replacing 25% of silica fume by quartz crushed powder, but more than that does not have an efficient effect. The addition of quartz powder with ultra-fine particles improves the concrete properties for various reasons.

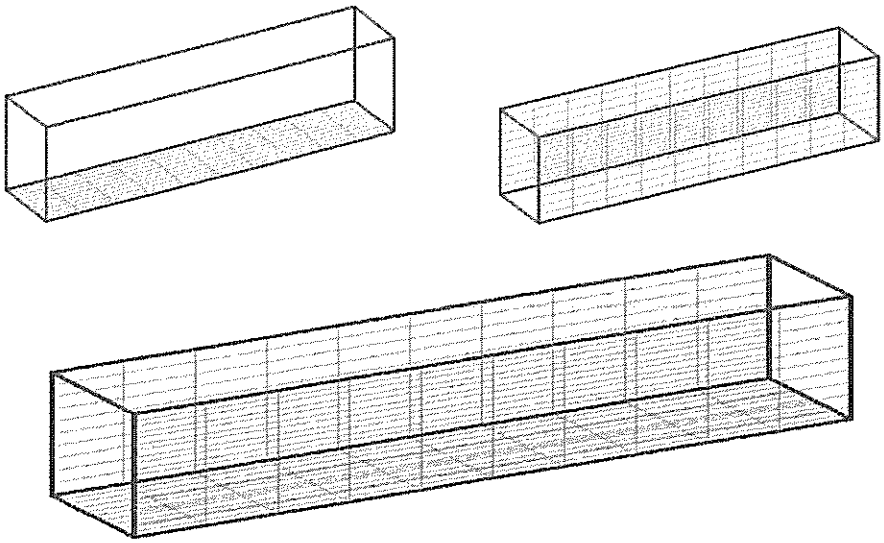
SUPER PLASTICIZER

Superplasticizers, also known as high range water reducers, are chemical admixtures used where well-dispersed particle suspension is required. These polymers are used as dispersants to avoid particle segregation (gravel, coarse and fine sands), and to improve the flow characteristics (rheology) of suspensions such as in concrete applications. Their addition to concrete or mortar allows the reduction of the water to cement ratio, not affecting the workability of the mixture, and enables the production of self-consolidating concrete and high performance concrete.

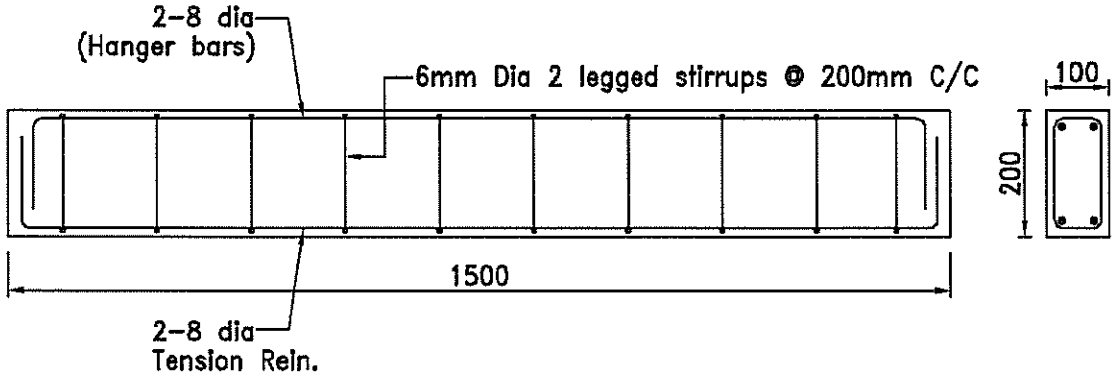
SIEVED SAND

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass.

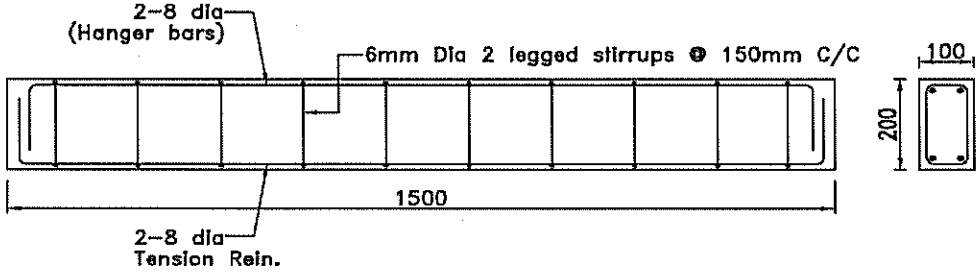
WRAPPING PATTERNS



REINFORCEMENT DETAILS



BEAM FOR SHEAR STRENGTHENING



BEAM FOR FLEXURAL STRENGTHENING

5MIX DESIGN

The mix design for M20 grade concrete as per IS 10262 -2009

MATERIALS PER m^3 OF CONCRETE

Cement	: 413.30 Kg
Water	: 186.00 Kg
Fine Aggregate	: 666.17 Kg
Coarse Aggregate	: 1138.6 Kg

MIX PROPORTION FOR M-20

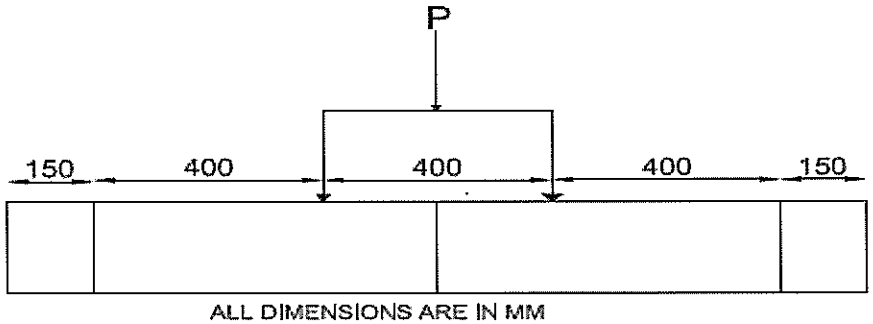
Description	Water	Cement	Fine Aggregate	Coarse Aggregate
Qty	186	413.3 Kg	666.17 Kg	1138.6 Kg
Ratio	0.45	1	1.61	2.755

EXPERIMENTAL SETUP AND TESTING

All the specimens were tested under simply supported conditions in the load frame. The testing was done under two point loading. The loading is transmitted through a load cell. The load was measured using an electrical load cell. Each beam was instrumented with LVDTs for measuring deflection at mid of span.

EXPERIMENTAL SET UP

Each beam was placed on the loading frame in such a way that the centre of the beam and the centre of the loading frame were adjusted and aligned on a line.



ALL DIMENSIONS ARE IN MM

4.2 Time Schedule of activities giving milestones through BAR diagram.

Work plan (including detailed methodology and time schedule)

Sl. No.	Activity / Milestone	1st Year		2nd Year	
1.	Literature review	1-6			
2.	Scheduling / Casting of beams		7-12		
3.	Testing of beams			13-18	
4.	Analytical and experimental study				19-24

4.3 Expected outcome within the time period of Seed Money Scheme

a) Mix design and beam design can be done within the time period of Seed Money Scheme.

b) Scheduling, casting and testing of beams can be done within the time period of Seed Money Scheme.

5 Suggested Plan of action stating the name of funding agency where the project will be communicated for financial support within the time period of project.

Nil

6 Bibliography: Nil

7 List of Projects submitted/impleme7nted by the Investigators (Separate for Pi and Co-PI)

Nil

7.1 Details of Projects submitted to various funding agencies:

Sl. No.	Title	Cost in lakhs	Month of submission	Role as PI/ Co-PI	Agency	Status
	-	-	-	-	-	-

7.2 Details of Projects under implementation

Sl. No.	Title	Cost in lakhs	Duration	Role as PI/ Co-PI	Agency
	-	-	-	-	-

7.3 Details of Projects completed during the last 5 years

Sl. No.	Title	Cost in lakhs	Duration	Role as PI/ Co-PI	Agency
	-	-	-	-	-

8. List of publications published by the Investigator, if any:

a) Principal Investigator

List of National Publications:

Sl no.	Authour	Title	Year	Journal	Volume issue	ISSN	Impact factor
1	T.P. Meikandaan	Study On Accident Prevention In Construction Industry Using Cost Benefit Analysis	2017	Indian Journal Of Civil And Environmental Sciences	Volume 7	2028-3997	2.15
2	T.P. Meikandaan	Effect Of High Range Water Reducers On Sorptivity And Water Permeability Of Concrete	2016	Journal Of Chemical And Pharmaceutical Sciences	Volume 9 Issue 2	0974-2115	1.421
3	T.P. Meikandaan	Study On Properties Of Concrete With	2016	Journal of Chemical and	Volume 9 Issue	0974-2115	1.421

		Partial Replacement Of Cement By Rice Husk Ash		Pharmaceutical Sciences	2		
4	T.P. Meikandaan	A Study On Cat With A Case Study	2015	Indian Journal of Science and Technology	*Vol 8(32),*	*0974-5645*	2.108
5	T.P. Meikandaan	Experimental Study On Workabilty And Strength Characteristic Of Concrete With Chemical Admixture	2015	Journal of Innovative Research and Solutions (JIRAS) A unit of UIIRS	Volume No.1, Issue No.1	2348 3636	6.86
6	T.P. Meikandaan	Experimental Study On Flexural Behaviour Of Rc Beam Strengthened With Cfrp Laminates	2015	Journal of Innovative Research and Solutions (JIRAS)	Volume No.1, Issue No.1	2348 3636	6.86
7	T.P. Meikandaan	Steel Framed Multi Storey Residential Building Analysis And Design	2014	Research gate	Volume No.9, Issue No.22	5527-5529	
8	T.P. Meikandaan	Waste audit for electroplating industries	2006	INDIAN JOURNAL OF ENVIRONMENTAL PROTECTION	Volume No.26, Issue No.7		
9	T.P. Meikandaan	Study of Strength characteristics of recycled aggregate in high strength structural concrete	2016	Journal of Chemical and Pharmaceutical Sciences	Volume 9 Issue 2	0974-2115	

List of International Publications:

Sl no	Authour	Title	Year	Journal	Volume issue	ISSN	Impact factor
1	T.P. Meikandaan	Retrofittng Of Reinforced	2017	International Journal Of Civil	Volume 8, Issue	0976-6316	

		Concrete Beams Using Gfrp Overlays		Engineering And Technology (Ijciet)	2		
2	T.P. Meikandaan	Flexural Behaviour Of Rc Beam Wrapped With Gfrp Sheets	2017	International Journal Of Civil Engineering And Technology (Ijciet)	Volume 8, Issue 2	0976-6316	
3	T.P. Meikandaan	Study Of Damaged Rc Beams Repaired By Bonding Of Cfrp Laminates	2017	International Journal Of Civil Engineering And Technology (Ijciet)	Volume 8, Issue 2	0976-6316	
4	T.P. Meikandaan	Use Of Glass Frp Sheets As External Flexural Reinforcement In Rcc Beam	2017	International Journal Of Civil Engineering And Technology (Ijciet)	Volume 8, Issue 2	0976-6316	
5	T.P. Meikandaan	Properties And Strength Of Glass Fibre Reinforced Geopolymer Concrete	2015	International Journal Of Innovative Research In Science, Engineering And Technology	Vol. 4, Issue 6,	2347-6710	
6	T.P. Meikandaan	Treatability Study Of Tannery Effluent By Enhanced Primary Treatment	2013	International Journal Of Modern Engineering Research (Ijmer)	Vol.3, Issue.1	2249-6645	1.227
7	T.P. Meikandaan	Static And Fatigue Response Of Gfrp Wrapped High Strength Rcc Beam	2012	International Journal Of Biotech Trends And Technology (Ijbtt)	Volume2 Issue 3 Number 1	2249-0183	0.537
8	T.P. Meikandaan	Strength Behaviour Of	2012	International Journal Of	Volume 2 Issue	2249-2593	0.791

		Foundrysand Used In High Strength Concrete		Computer & Organization Trends	4 Number 2		
9	T.P. Meikandaan	The Effect Of Admixture On Permeability Of Concrete	2012	International Journal Of Computer & Organization Trends	Volume 3 Issue 6 Number 2	2231-2803	0.791
10	T.P. Meikandaan	Spatial Distribution Of Ground Water Analysis In Vaniyambadi Town, Vellore District, Tamil Nadu	2011	International Journal Of Engineering Trends And Technology (Ijett)	Volume2 Issue 1 Number 2	2231-5381	2.88

Publications in National/International Journals

b. Co-Principal Investigator

Sl. No.	Title of the Article	Name of the Journal	Page, Volume & Year
1	Experimental Study on Strength of High Volume High Calcium Fly Ash Concrete	IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)	Volume 5, Issue 4 (Jan. - Feb. 2013), PP 48-54
2	Mechanical and Durability Properties of HVHC Fly Ash Concrete	European Journal of Scientific Research	Volume 96 No 4 February, 2013 PP 582-590
3	Effect of Quarry Dust on Waste Plastic Fiber Reinforced Concrete-an Experimental Study	Research in Civil and Environmental Engineering	Volume 1 (04) 2013 PP 234-238
4	Analysis of Risk Management in Construction Sector Using Fault Tree Analysis	Research in Civil and Environmental Engineering	Volume 2 (02) 2014 PP 66-73
5	Strength Properties of Concrete Using Crumb	International journal of innovative research in	Volume 4, Issue 3, March 2015

	Rubber with Partial Replacement of Fine Aggregate	science, engineering and technology	
6.	Bulk Utilization of Flyash in Self Compacting Concrete	KSCE Journal of Civil Engineering (Annexure-1 of Anna university)	Volume 19(7),pp 2116-2120
7.	Management of waste minimization in construction industry using lean technology	International Journal of latest technology in engineering, management and applied science	Volume 4(3),pp53-57 March 2014
8.	Effect of Quarry Dust on Class C Fly Ash Concrete	International Journal of Engineering Development and Research	Volume 4 Issue 1 February 2016 PP 291-297
9.	Optimization of Resourced Demands in Construction of a Residential Building	International Journal of Engineering Research-Online	Volume 4 Issue 3 (May-June)2016 PP 483-487
10.	Use of Ceramic Waste Insulator as a Coarse Aggregate in Concrete	International Journal of Modern Trends in Engineering and Science	Volume 3 Issue 6 2016 PP 45-49
11.	Strength and Durability Characteristics of Concrete Using Metakaolin and Foundry Sand	International Journal of Modern Trends in Engineering and Science	Volume 3 Issue 7 2016 PP 143-146

9. Budget

Sl. No.	Equipment	Quantity	Amount in INR
1	Beam moulds	6	50,000
	Vibrator	1	10,000
2	Consumables (Like fine aggregate, coarse aggregate, cement, laminates for wrapping, etc..)	As per requirement	25,000
3	Travel support for the purpose of research work.	---	5,000
4	Contingency	---	5000
5	Others	---	5000
	Total		1,00,000

10. Name of at least two subject experts from the Institute and one from the outside Institute with their contact details:

a) Dr.M.P.Chockalingam– Professor, Dept of Civil, BIHER, Chennai-600073.

b) Dr.S.Senthil Selvan – Professor, Dept of Civil, SRMIST, Chennai.

CERTIFICATE FROM THE INVESTIGATOR

Project Title: **Repair and Retrofitting of RC Beams Strengthened with Overlay Made up of Cementitious Materials**

It is certified that

1. I do hereby agree to submit a complete proposal for financial support to the external funding agency within the time period of SMS-2018

2. I undertake that spare time on equipment procured in the project will be made available to other users.

3. I agree to submit a certificate from Institutional Biosafety Committee, if the project involves the utilization of genetically engineered organisms. I also declare that while conducting experiments, the Biosafety Guidelines of Department of Biotechnology, Department of Health Research, GOI would be followed in to.

4. I agree to submit ethical clearance certificate from the concerned ethical committee, if the project involves field trails/experiments/exchange of specimens, human & animal materials etc.

5. I agree to abide by the terms and conditions of SMS-2018, BIHER, and Chennai.

Name and signature of
Principal Investigator
(T.P.MEIKANDAAN)

Name and signature of
Co-Principal Investigator
(Dr. R. VENKATA KRISHNAIAH)

Date: 03.10.2018
Place: Chennai - 73

Forwarded by Head of the Department

4/10/18

Signature of the Head

Head of the Department
Department of Civil Engineering
Bharath Institute of Science & Technology
BHARATH UNIVERSITY
(Declared u/s 3 of UGC Act.1956)
Selaiyur, Chennai-600 073.

PROJECT EVALUATION FORMAT

Recommendation Sheet

Name of the Principal Investigator	Mr.T.P.Meikandaan
Name of the Co-Investigator	Dr.R.Venkata Krishnaiah
Name of the Department	Civil Engineering
Title of project	Repair and retrofitting of RC beams strengthened with overlay made up of cementitious materials
Recommendation of the evaluation committee	—Recommended—
Financial allocation recommended	Rs. 1,00,000 -

Sl. No.	Equipment	Quantity	Amount in INR
1	Beam moulds	6	50,000
	Vibrator	1	10,000
2	Consumables (Like fine aggregate, coarse aggregate, cement, laminates for wrapping, etc..)	As per requirement	25,000
3	Travel support for the purpose of research work.	---	5,000
4	Contingency	---	5000
5	Others	---	5000
	Total		1,00,000

Name and Signature of the Research Advisory Committee members with date

Dr. P. Muneenchandran

Internal Quality Assurance Cell IQAC Saveetha Chennai-77 SIHER