Feasibility Study of Physical Properties on Concrete Beam using with & without FRP LAMINATE

Ronny D'scouza[1] Megha Malvi[1], Omkar Naik[2], Shakti Pathak[3], Neha Sharma [4]
(Associate Professor, Department Civil Engineering, [2]Degree Students of Civil Engineering Department of Civil Engineering, St. John College of engineering and management, Palghar).

omkarn@sjcem.edu.in
shaktip@sjcem.edu.in
nehas@sjcem.edu.in

Abstract
Rehabilitation and strengthening of old structures using advanced materials is a contemporary research in the field of Structural Engineering. Over the past decades, much research has been carried out on shear and flexural strengthening of concrete beams using different types of fiber reinforced polymers and adhesives. Strengthening of old structures is necessary to obtain an expected life span. Such a method of strengthening of old structures by the help of new technology is termed as ' retrofitting '. Life span of Concrete structures may be reduced due to many reasons, such as deterioration of concrete and development of surface cracks due to ingress of chemical agents, abrasion and cavitation in hydraulic structures caused by fast moving water, improper design and unexpected external lateral loads such as wind or seismic forces acting on a structure, while are also the reason for failure of structural members. High tensile strength of specific fibers like glass fibers, carbon fibers etc. found it's application in increasing the strength of new Concrete structures as well as strengthening of older and worn out structures.

Keywords : GFRP, Retrofitting, Rehabilitation, Epoxy.

Emails: megham@sjcem.edu.in,

Introduction

Retrofitting is modification of existing structures to improve the performance and durability of the structures. Day to day retrofitting techniques are required for concrete structures which are vulnerable to damage and failures by deterioration by several earthquakes, fire, bomb blasting and chemical attacks. In the past thirty years mode rate and severs earthquakes occurs around the world every years, such events leads to the damages to concrete structures as well as failures. Thus our aim is to focus on a few specific procedure which may improve vulnerability of existing reinforced concrete buildings. It is of outmost importance for historic monuments, area prone to sever earthquake& tall or expensive structures, Repairing and strengthening of old structures using advanced material are a contemporary research in structural engineering field. The traditional method is by steel jacketing, thin layers of heavily reinforced concrete or pre-tensioned steel cables covered with thin layer of concrete. Numerous structures situated in seismically dynamic zones are not equipped for withstanding seismic activity as indicated by current code and arrangements. Besides, ongoing tremors in urban regions have obviously exhibited a criticalness to overhaul and fortify these seismic inadequate structure.

A huge measure of research work has been done lately to create deferent fortifying and recovery systems to enhance the seismic execution of structures. A few fortifying techniques like an expansion of new auxiliary components; outside posttensioning, steel plate holding and so forth has been connected in the past by shifting the level of progress.

Among these techniques, seismic retrofit with FRP materials has increased prominent acknowledgement from the structural building network as of late. Retrofitting with FRP materials is an actual sound and financially effective repair innovation and is currently broadly being utilized as a seismic retrofitting

technique everywhere throughout the world. This paper introduces an agent review of the current condition of utilizing FRP materials as a retrofitting method for the structures not intended to oppose seismic activity. It outline the extensions and employments of FRP materials in the seismic reinforcing and in addition the seismic retrofitting plans for steel structures. The favorable circumstances alongside the plan rules and the confinements of FRP applications for seismic retrofit are additionally incorporated into this. FRP composites are now increasingly used in the construction industry and offer considerable potential for greater use in buildings, including large primary structures. In recent years mores complex have been developed to satisfy the desire for more features in building design. FRP composites have numerous advantages in construction industry such as offsite fabrication, modular, constructions, reduced mass, improved thermal insulation application

METHODOLOGY:

1.1 Methodology 1:

- Design of M30 mix cylindrical beam as per IS CODE
- Testing is done on sample on CTM machine Epoxy is used as an adhesive and the ratio of epoxy and hardener used is 1 : 2 as per specification
- The wrapping if FRP laminate is done at an angle of 0^0
- Heat the sample on maximum temperature to be achieved is around 400^0 o Samples are cooled rapidly by using water and normally in the air
- Two layers of wrapping are provided around the sample and the resulting sample is left for a minimum of 1 day.
- Testing is done on the sample wrapped with FRP laminate on CTM machine.

1.2 Methodology 2:

Design of M30 mix rectangular beam as per IS CODE

- Testing is done on sample on UTM machine Epoxy is used as an adhesive and the ratio of epoxy and hardener used is 1 : 2 as per specification
- The wrapping if FRP laminate is done at an angle of 00 Two layers of wrapping are provided around the sample and the resulting sample is left for a minimum 1 day
- Testing is done on the sample wrapped with FRP laminate on UTM machine.

MATERIALS OF RETROFITTING USING FRP LAMINATE

Fiber reinforced polymer (FRP):

FRP is a recently developed materials for strengthening of RC and masonry structure. The main advantage of FRP is the high strength to weight ratio and high corrosion resistance. FRP plates are two to ten times stronger than steel plates while their weight is just 20% of that of steel. FRP composites are formed by embedding continuous fiber matrix in resin matrix. The resin matrix binds fiber together and also provides bond between concrete and FRP.

Epoxy adhesive:

Epoxy is a common used for strong adhesives which are required to be used for bonding – two materials or surface together. Epoxy adhesives are usually two component systems I.e. two compounds (resins) that need to be mixed together and cured either at room temperature or at elevated temperatures. Epoxies are created by polymerizing admixture of two starting compounds, the resin and the hardener. When resin is mixed with a specified catalyst, curing chains react at chemically active sites, resulting in an exothermic reaction. Covalent bond between the epoxy groups of the resin and the amine groups of the hardener (catalyst) that arise from this combination afford for the cross- linkage of the polymer, and thereby dictate the rigidity and strength of the epoxy. Epoxy adhesive generally used for coating; ex- coating of FRP on column or beams, now a day's a wide range of epoxy resins are produced initially. Epoxy provides the use of the strongest bond epoxies are known for their excellent adhesion, chemical and heat resistance and have very good structural insulting properties.

Fine Aggregate :

Ordinary sand available in Bihta, Patna. Having the following characteristics has been used. Specific gravity : 2.66 Fineness modulus : 2. 41 Unit weight : 1. 675gm/cc Water absorption : 0. 43% Bulking : 25%

Sand after sieve analysis confirm to zone- II as per IS 383-1970.

Coarse Aggregate:

Locally available black crushed stone (Pakur stone) in Bihta with maximum nominal size of 20 mm and 10mm have been used as coarse aggregate. The physical properties for the coarse aggregate as found through laboratory test according to IS 2386-1963 is resulted as : Aggregate crushing value = 24% Aggregate impact value = 29% Specific gravity= 2. 64 Water absorption = 0. 94% Unit weight= 1. 60gm/cc Fineness modulus=6.15

Cement :

OPC (Ordinary Portland Cement) is mainly use for retrofitting. Because OPC 53 grade cement is the most preferred building and construction materials for projects that require high tensile strength. The heat of hydration, however is further supported in by higher than that in OPC 43.

Testing:

Slump cone test:

Slump cone test is to determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work. Concrete slump test is carried out from batch to batch to check the uniform quality of concrete during construction . The slump of the concrete is measured by measuring the distance from the top of the slumped concrete to the level of **the top of the slump cone.** The result of the slump test is a measure of the behaviour of

compacted inverted concrete come under the action of gravity. M30 grade of concrete mix design procedure with OPC 53 cement.

It measure the consistency or moisture of the concrete, which gives an idea of the workability of the concrete mixture.

Tensile Strength Test:

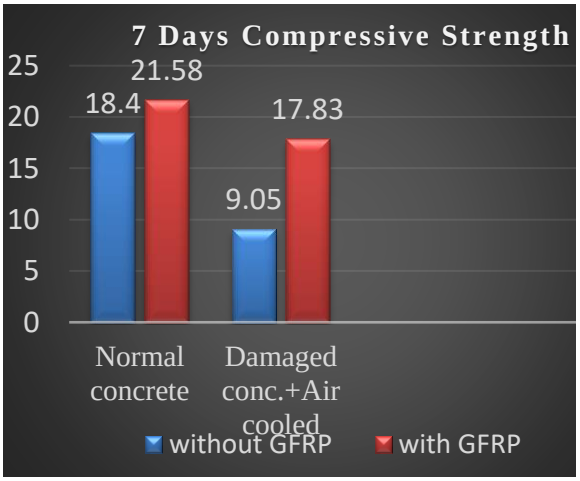
The tensile strength of concrete is the ability of concrete to resist tensile force or stress applied to it. The tensile strength of concrete is measured by the units of force per cross-sectional area. As we know that the concrete performance is compression good, but weak in tension force.

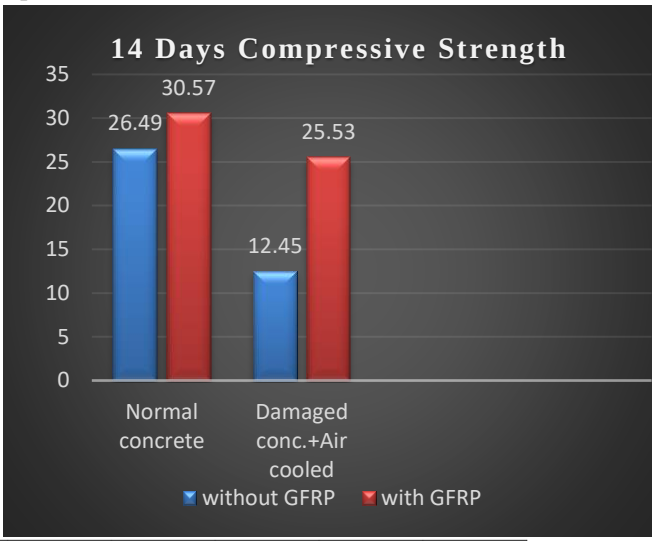
Tensile strength is an important property of concrete structure are highly vulnerable to tensile cracking due to various kinds of effects and applied loading itself. However, tensile strength of concrete is very low in compared to its compressive strength.

Result & Discussion

1. Test results for 7 days

S. No.	Description	Weight of sample (kg)	Density (kg/ m^3)	Load of failure (KN)	Compressive strength (N/ mm^2)
1	Normal concrete	12.908	2482	325	18.4
3	Normal conc. + FRP	13.102	2519.6	380	21.58
4	Damaged conc. + air cooled	12.33	2371.15	160	9.05
5	Damaged conc. + air cooled+ FRP	12.99	2498.07	315	17.83





S. No.	Description	Weight of sample (kg)	Density (kg/ m^3)	Load of failure (KN)	Compressive strength (N/ mm^2)
1	Normal concrete	12.845	2470.19	468	26.49
3	Normal conc. + FRP	13.029	2505.57	540	30.57
4	Damaged conc. + air cooled	12.21	2348.07	220	12.45
5	Damaged conc. + air cooled+ FRP	12.82	2465.38	451	25.53

2. Test results for 14 Days

Fig- Test4: Flammability

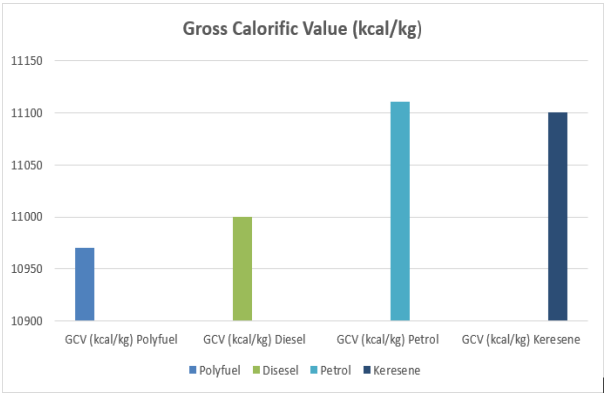
Fig- 5: Extracted Sample

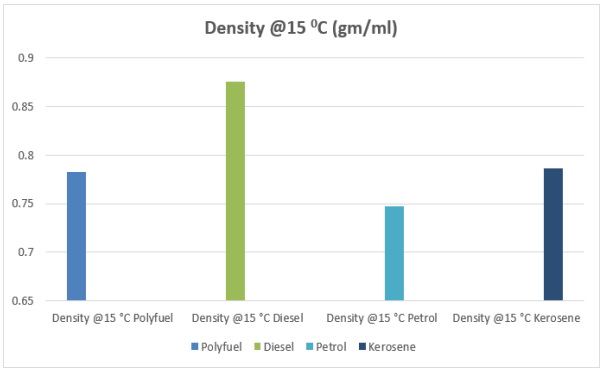
1.1. Analytical Testing

The extracted sample of Polyfuel oil was sent to a testing laboratory for further analysis. From the reports received, we can analyse that result matches the characteristics to Diesel. Hence, we cansay that there is an energy recovery. Considering, 4R's Reduce, Reuse, and Recycle, Recovery [3]

Table 1: Comparing Pyrolysis oil (Polyfuel) to Diesel

Sr. No	Fuel	Gross Calorific Value (kcal/kg)	Density @ 15 ^{O}C (gm/ml)	Flash Point (^{O}C)	Moisture Content (mg/kg) ppm	Price 450 ml (₹)





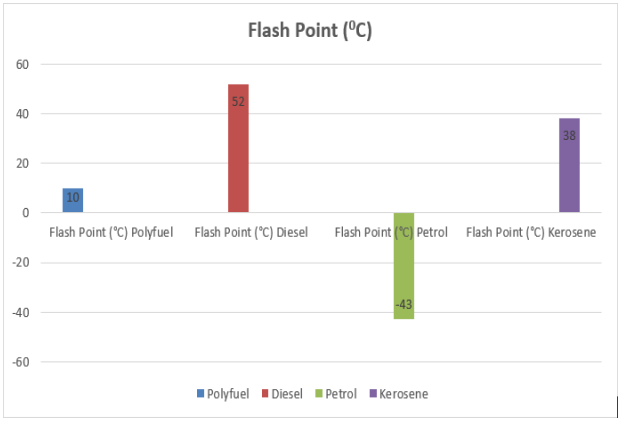


Table 2: Chemical Analysis Parameters

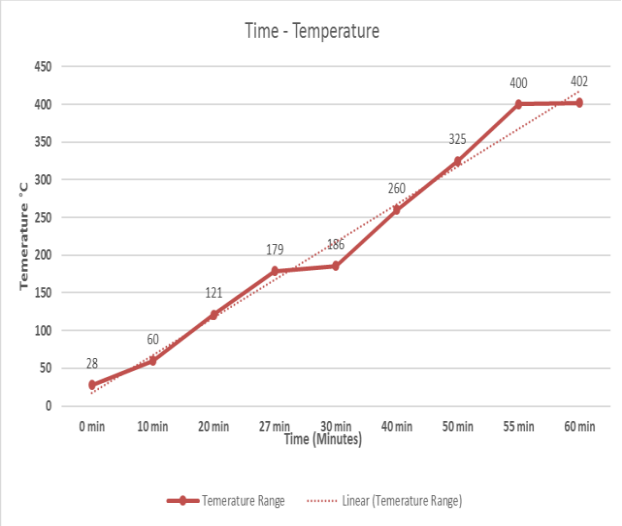
Sr. No	Test	Method/ Technique	Result	Unit of Mesure
1	Gross Calorific Value	ASTM D-4809- 18	10970	Kcal/kg
2	Flash Point	IP – 170- 13	<10	OC
3	Desnity @15 ^{0}C	ASTM D-4052- 18	0.7825	gm/ml
4	Moisture	ASTM E 203- 16	200	Mg/kg (ppm)

1	Polyfuel	10970	0.7825	<10	200	34.46
2	Diesel	11000	0.8750	52	100-150	47.20
3	Petrol	11110	0.7236	-43	N.R	54.98
4	Kerosene	11100	0.8875	38	N.R	23.5

1.2. Time - Temperature Behavior

At the time-temperature behavior of reactor which respects to time as shown in the following Figure 6,

Fig-6: Time temperature graph for pyrolysis process



It is observed that the initial temperature reading is 28 °C after that at the time of 20 minutes, the reactor temperature shows 121 °C and the waste recycled HDPE present in the reactor started to melt. At 179 °C and above the temperature waste recycle HDPE melt completely. When the temperature reaches around 380~430 °C waste recycle HDPE start de-polymerization, 400 °C during which the hydrocarbon vapor and synthetic gas are produced [3]

1.3. Residue Generation

At the end of this process, 5-7 % Char residue (we called as Black Char). These Black Char can be used in road construction activity, because it has a good amount of strength & Bonding. This Black Char residue is used in both rigid payment & flexible payment also. In rigid pavement this residue use for crack & gap filling. Also, the syngas are combustible and can be used as a fuel of internal combustion engines, for boilers, it can also use as an

industrial feedstock in several catalytic processes [3]

2. Conclusion

Conversion of waste plastics into Polyfuel can solve the problem of plastic waste recycling and the shortage of liquid fuel in developing countries like India, Brazil, Argentina, and Guyana etc. pyrolysis by using HDPE waste plastics can be done easily with economic means. The yield of the product can be increased by varying the process parameters like temperature, pressure, good investment etc. The fuel produced in this study was found to be comparable to the regular diesel fuel used in automobiles. So it can be concluded that the "Polyfuel" may bean alternative fuel of the future which can solve many issues thereafter. This process can be called as zero discharge process as no wastage is found in this technique [2]

3. References

1. Sonawane YB, Shindikar MR and Khaladkar M Y, High density polyethylene waste treatment by using catalytic pyrolysis to recover liquid fuel, International Journal of Science, Environment ISSN 2278-3687 (O) and Technology, Vol. 5, No 3, 2016, 1421 – 1425
2. Y. P. Chauhan, O. R. Jadhav, U. B. Chougule, S. D. Patil, O. J. Kadam, Polyfuel- A fuel from waste plastics International Congress on Environmental Research (ICER-18),February 08-10, 2018
3. Y.P. Chauhan (AM093927-5), G. H. More, C. R. Mane, T. Y. Salunkhe, D. D. Shinde, Polyfuel - "Thermolysis of waste plastic to produce liquid fuel"