A Study on Mechanical Properties of Polymer Modified Concrete Used with Plastic Crush Replacing Natural Sand

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Abstract
This thesis work is going to compare a non-conventional concrete to conventional concrete in aspects of mechanical properties. This development of efficient concrete mix design plays a very important & vital role in producing economical and modified concrete. This experimental study is aimed to design concrete mixtures with recycled bottles crush as a alternative to fine aggregates. In that research, an effect of Styrene-Butadiene Rubber (SBR) latex on mechanical parameters such as compressive and flexural strength of concrete are studied and also is the best suitable polymer (Nitobond SBR-Latex) content for concrete is calculated. Before the experimental testing the aggregates were saturated in a polymer emulsion of styrene butadiene rubber (SBR).
This project aims to find out the best possible mix to make the conventional concrete light weight and durable as well. Also comparison of mechanical properties of modified and conventional concrete has to be carried out.
In addition to comparing these experimental studies aimed to design modified concrete mixtures with recycled bottles crush as an alternative to fine aggregates that will help in contribute to the construction industries in saving the environment, to encourages the government to finding the solutions regarding the disposal in landfills of waste materials and provide new and improved knowledge to the contractors and developers on how to improve the conventional construction industry methods and services by use recycled bottle crush, and to sustain and attain good performances and meet their recycling goals.

Keywords: Lightweight concrete, mix design, workability, compressive strength, SBR latex, Flexural and Tensile strength

Introduction

1.1 General

Concrete has been widely used in construction industry for about past 170 years and more but nowadays the need of making light weight concrete is the prime focus without affecting its favoring advantages. An aggregates characteristic has great effects on concrete workability and their strength properties. Natural aggregates deposits formed over millions of years and as they work exploited, that are not restore at the same rate as that is used. Environmental pressures and cost and storage of that types of deposit in developed countries are essential in the manufacturing of concrete aggregates. In this experimental work, a venture has been made on studies of the use of recycled aggregates, their strength, weaknesses and the overall potency when the natural aggregate are replaced by recycled aggregate with their particular proportions in constructions purposes.
Concrete used worldwide have some disadvantages like delay in hardening, large drying shrinkage, low tensile strength and low resistant to chemicals. To overcome these problems several attempts are made by modification of cement concretes with addition of polymer additives such as epoxy resins, natural polymers, cellulose, etc. Polymers are preferable in the concrete due to their high performances and attainability as compare to ordinary cement concretes. Various type of polymers such as latex, liquid resins, water soluble powder, etc. is used in modified concretes. To improve the durability of concretes, the internal structures of concretes is significant to be improved by making it impervious. Because of the formation of 3D polymer network of hardened concrete cement based matrices, polymer concrete tend to has high tensile strength, better ductile behavior and very high impact resistance capability and also in this concrete porosity is decreased. Different suitable polymers in fresh concrete are been used, styrene butadiene rubber latex is widely used among them.
Styrene butadiene rubber (SBR) latex are a sort of high-polymer dispersion emulsion collected of butadiene, styrene and water. they can be successfully bonded to other materials. Its major engineering application is good intermiscibilty. It is used to replace cement as binder to enhance the flexure, tensile and compressive strengths of concretes.
This study aims to find out the best possible mix to make the conventional concrete light weight and durable as well. Also comparison of mechanical properties of modified and conventional concrete has to be carried out.

1.2 Polymer Modified Concrete

Polymer has been used in construction from ancient times. Polymer modified concrete has various advantages in term of strengths and durability as compared to conventional concretes. Uses of polymers in cement concretes makes the mortars more workable with low water cement ratio and it

improves the strength of concrete mix.

1.3 Plastic Waste

Disposal of plastic waste from municipal solid waste in environment is hazardous because of its extremely low biodegradability. Its disposal is a very big problem now a day and also a threat to environment. Plastic waste can be used in construction materials and construction cost of buildings can be reduced and also it will also consume the plastic waste.
Research have been undertaken at various institutions and some positive and encouraging results obtained on fresh and hardened property of concretes mixed with plastic waste as fine aggregates where natural sand was partially replaced by waste plastic flakes (chopped in size below 4.75mm) in varying percentage by weight.

1.4 Polymer (Nitobond SBR)

Mix design of concrete entertains an important role in the concrete and mix design of concrete to give standard design for improved performance and desired strength. At present time the concrete development is based and modifies by using the industrial wastage such as supplementary cementitious material. So to achieve the desired strength some polymers or steel fibers are used in modified concretes.
Nitobond SBR is a modified and enhanced styrene butadiene rubber polymer. The inclusion of Nitobond SBR to concrete reduces permeability and reduces the rate and amount of attack by aggressive chemicals. It provides good bond to concrete and also increase the workability. The idea behind this study is to develop and compare the polymer modified concrete with the same grade of normal concrete. Nitobond SBR is lightweight in nature, and it has practically zero percentage of water absorption and provides complete water tightness.
The main techniques to produce Polymer Concretes is to minimize void volume in the aggregate quantity so as to reduce the quantity of polymer need for binding of the aggregates.

1.5 Advantages of Polymer

These days, most concrete mixture contains Latex polymers to provide the additional strength and workability desired or required. Following are some advantages of Polymer used:

- These latex polymers provide outstanding bond to concrete, masonry, stonework and plaster and block work.
- Improve tensile and flexural properties.
- Improve cohesion and workability.
- These admixtures do not contain chloride.
- Nitobond latex concrete is exceptionally durable and it provides immense protection to embedded steel reinforcement.

1.6 Objective of the Study

- To design a concrete that is light weight as well as durable and at the same time should sustain all its favoring properties.
- To replace the fine aggregate by adding the different percentage of plastic crush.
- The lowest percentage of plastic crush is added to the concrete with respect to the fine aggregates weight.
- SBR latex is added to the concrete in different proportion with respect to the cement weight.
- 0 -10 % at the variation of 2 % of SBR latex is added to the concrete and 0 to 30 % of plastic crush with variation of 10% is taken.
- Mean targeted strength of Polymer modified concrete with plastic crush is found out with different percentage of SBR latex in PMC of M25 and M30.

Results

In this study the concrete mix of M25 and M30 grade were prepared as per IS 10262:2009. The Selected materials are collected and the design mix is performed. Various mixes were prepared using Plastic crush as replacement of fine aggregate at an interval of 10% from 0%-30% and SBR latex polymer by the interval of 2% from 0%-10% by weight of cement. Various tests have been conducted on concrete for compressive strength, flexural strength and splitting tensile strength. In this chapter results of the work were represented in tabulated form.

Compressive Strength

Table 1: Compressive Strength of Cube on Replacement of FA with Plastic Crush (PC) For M25 & M30 Grade Concrete

SN.	Mix Name	M25		M30	
		Load (KN)	Strength (N/mm^2)	Load (KN)	Strength (N/mm^2)
1	FA + PC (100+0)	715.950	31.82	872.100	38.76
2	FA + PC(90 + 10)	678.375	30.15	832.275	36.99
3	FA + PC (80 + 20)	635.850	28.26	787.500	35.00
4	FA + PC (70+30)	587.475	26.11	736.875	32.75

Table 2: Compressive strength of cube on addition of latex polymer in plastic mix concrete for M25&M30 grade

SN.	Mix Name	M25		M30	
		Load (KN)	Strength (N/mm^2)	Load (KN)	Strength (N/mm^2)
1	30%P + 0%SBR	587.475	26.11	736.875	32.75
2	30%P + 2%SBR	630.000	28.00	740.700	32.92
3	30%P +	652.950	29.02	787.950	35.02

	4%SBR				
4	30%P + 6%SBR	686.700	30.52	839.700	37.32
5	30%P + 8%SBR	727.200	32.32	895.050	39.78
6	30%P + 10%SBR	752.400	33.44	953.550	42.38

Flexural Strength

Table 3: Flexural strength of beam on replacement of plastic crush with fine aggregates for m25 grade concrete after 28 days

SN.	Mix Name	Load (KN)	Strength (N/mm^2)	Load (KN)	Strength (N/mm^2)
1	FA+PC (100+0)	19.853	4.84	19.221	5.98
2	FA+PC(90 + 10)	17.714	4.36	17.141	5.33
3	FA+PC(80 + 20)	16.696	4.08	15.661	4.87
4	FA+PC (70+30)	15.104	3.84	14.342	4.46

Table 4: Flexural strength of beam on addition of latex polymer in plastic mix concrete for M25&M30 grade after 28 days

SN.	Mix Name	Load (KN)	Strength (N/mm^2)	Load (KN)	Strength (N/mm^2)
1	30%P + 0%SBR	12.355	3.84	14.342	4.46
2	30%P + 2%SBR	13.471	4.19	17.755	5.52
3	30%P + 4%SBR	14.243	4.43	18.133	5.64
4	30%P + 6%SBR	15.184	4.72	18.714	5.82
5	30%P + 8%SBR	16.272	5.06	19.450	6.05
6	30%P + 10%SBR	17.550	5.46	20.320	6.32

Split Tensile Strength

Table 5: Split tensile strength of cylinder on replacement of fine aggregate with plastic crush for M25 & M30 grade concrete

SN.	Mix Name	Load (KN)	Strength (N/mm^2)	Load (KN)	Strength (N/mm^2)
1	FA+PC(100+0)	190.851	2.70	226.19	3.20
2	FA+PC(90+10)	176.715	2.50	208.52	2.95
3	FA+PC (80 +20)	164.691	2.33	195.09	2.76
4	FA+PC (70+30)	154.105	2.18	183.78	2.60

Table 6: Split tensile strength of cylinder on addition of latex polymer in plastic mix concrete for M25 & M30 grade after 28 days

SN.	Mix Name	Load (KN)	Strength (N/mm^2)	Load (KN)	Strength (N/mm^2)
1	30%P + 0%SBR	154.101	2.18	183.782	2.60
2	30%P + 2%SBR	183.075	2.59	211.352	2.99
3	30%P + 4%SBR	184.502	2.61	214.880	3.04
4	30%P + 6%SBR	188.734	2.67	222.666	3.15
5	30%P + 8%SBR	195.091	2.76	233.266	3.30
6	30%P + 10%SBR	203.583	2.88	245.988	4.48

Conclusions

The strength values of grade M25 and M30 after 28 days was found to be increasing as increase in percentage of Latex polymer in polymer modified concrete with plastic crush as fine aggregate. The compressive strength of conventional concrete is achieved in polymer modified concrete at 8% latex polymer with 30% plastic crush as fine aggregate. The flexural strength of conventional concrete is achieved in polymer modified concrete at 6% - 8% latex polymer with 30% plastic crush as fine aggregate. The Splitting tensile strength of conventional concrete is achieved in polymer modified concrete at 8% latex polymer with 30% plastic crush as fine aggregate. It was observed during experiment that the normal concrete cube splits into two pieces suddenly but the modified concrete was more ductile and shows fractures before complete failure. It was observed that with the incorporation of latex, it improves the mechanical properties of concrete. It was found that with increase in amount of latex the strength of modified concrete after 7 days lacks behind the conventional concrete but after 28 days it was more than the strength of conventional concrete.

References

1. Siva kumar M.V.N.,Effect of Polymer Modification On Mechanical And Structural Properties Of Concrete-An Experimental Investigation, International Journal Of Civil And Structural Engineering
2. Z. A. Siddiqi, R. Hameed, M. Saleem, Q. S. Khan and Jawad A. Qazi, -Determination of compressive strength and water absorption of styrene butadiene rubber latex modified concrete.
3. Batayneh M., Marie I., Asi I., (2006), Use of selected waste materials in concrete mixes, Waste management.
4. Shivani R. Bothra, Yuvraj M. Ghugal - POLYMER-MODIFIED CONCRETE, InternationalJournal of Research in Engineering and Technology
5. R. Wang,R. Lackner and P.M.Wang,Effect Of Styrene Butadiene Rubber Latex On Mechanical Properties Of Cementitious Materials Highlighted By Means Of Nano indentation,International Journal For Experimental Mechanics.
6. Er. Kapil Soni, Dr. Y.P Joshi - Performance Analysis of Styrene Butadiene Rubber-Latex on Cement Concrete Mixes, Journal of Engineering Research and Applications ISSN
7. BS12 – 1991: Specifications for Portland cement (1991)
8. BS 1881-122: Testing concrete. Method for determination of water absorption (2011)
9. Baoshan H., W. Hao, S. Xiang and G. B. Edwin. Laboratory evaluation of permeability and strength of polymer-modified pervious concrete.
10. Chandra S and P. Flodin. Interactions of polymer and organic admixtures on Portland cement hydration.
11. Joao A. R. and V.C.A. Marcos. Mechanical properties of polymer-modified lightweight aggregate concrete.