EFFECT OF NATURAL RUBBER LATEX ON NORMAL AND HIGH STRENGTH CONCRETE

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ABSTRACT

Nowadays the concrete properties are upgraded regarding the fresh and hardened properties by inclusion of new material other than ingredients of concrete, from reducing porosity by compaction, improves the strength of the concrete. In order to increase the usage of latex modified concrete, greater understand about natural rubber latex modified concrete with locally available materials such as cement, fine aggregate, coarse aggregate is essential. This paper illustrates the effect of natural rubber latex addition to the concrete in small increment in the strength. Also the material available locally is also encourages to investigate the properties of natural rubber latex modified concrete. Natural rubber latex is added in small percentages for both normal strength concrete and high strength concrete. In the normal strength concrete, natural rubber latex effect is linearly increases for the particular percentage that is up to the 0.9%. Mechanical strength of the normal strength concrete such as compression, split tensile, flexural strengths were increases there after decreases at 0.9%. Natural rubber latex of same percentage which is added to the normal strength concrete is added to the high strength concrete, here the Natural Rubber Latex effect is not linear as in the normal strength concrete, it increase the strength of both flexure and split tensile as the percentage of natural rubber latex increases but compression strength is observed to increase at 0.3% and then decrement in further addition.

Keywords: Normal Strength Concrete, High Strength Concrete

I INTRODUCTION

The Para rubber which is the only tree can produce the natural rubber latex. the term latex is nothing but a polymer with water based liquid. The word latex by itself does not refer to natural rubber latex. And the dispersion of organic polymer in the concrete at the time of mixing is also known as latex.

Rubber trees are initially grown in south America, and then kew garden, UK, then in Sri Lanka, Indonesia, and Singapore .In India first it was grown in Kerala. Nowadays the growth of rubber tree are grown in Karnataka also, so it could be interested experimental to study on natural rubber latex with regarding concrete. Since natural rubber latex improves the compression strength of the concrete and also increase the flexural and tensile strength of the concrete when it is added in small percentages. Since natural rubber latex is formed by a simple monomer combines by reaction that reaction is known as polymerization. The natural rubber latex is added as a polymer admixture to the concrete.

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The internal structure of polymer modified cement paste and concrete has been provided by Walters in the year 1990 and pointed out that latex modified cement mortars and concretes are attractive because the latex addition substantially increases the flexural strength and the compressive strength.

II CONCRETE INGREDIENTS

2.1 Cement

Ordinary Portland cement (43grade) with a normal consistency of 31% conforming to IS: 8112-1989 was used. The physical properties of cement are listed out in table.1

2.2 Fine Aggregate

Locally available river sand of fineness modulus 2.59 was used. The fine aggregate was found to be confirming to zone II as per IS: 383-1970. The physical properties of fine aggregate are as in table.2.

2.3 Coarse Aggregate

Natural granite aggregate having fineness modulus of 7.1 was used. The physical properties of fine aggregate are as in table.3.

2.4 Water

Water which is free from all organic impurities is used to develop this concrete mix in the study.

2.5 Natural Rubber Latex

Natural Rubber latex: The Natural Rubber latex is collected from ASSOCIATED LATEX (INDIA) LIMITED having its Administrative Office at P.B. NO.1117, Beach Road, Calicut. Physical properties of natural rubber latex shown in table-4

2.6 Metakaolin

Metakaolin is a mineral admixture obtained by refining the kaolin clay which further going to produce amorphous aluminosilicate that is having good ability of reactiveness towards concrete.. Metakaolin procured from the ASTRA chemicals, Chennai. The specific gravity of Metakaolin is 2.67 shown in table-5

2.7 Conplast Sp-430

Conplast- SP430 is a Super plasticizing slump retaining admixture procured from Fosroc constructive solution was used where a high degree of workability and its retention were required. Properties of Conplast SP430 are tabulated in table -6

TABLE-1: Sieve Analysis and Physical Properties Of Cement

Sl. No	Particulars	Requirement as per IS:8112-1989	Test Results
1	Fineness of the cement	<10	4%
2	Specific Gravity	3.15	3.1
3	Normal Consistency (%)	35>	31
4	Initial Setting Time (min)	Minimum of 30	55min

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5	Final Setting time (min)	<600 min	355min
6	Cube Comprerssive strength 3 days (N/mm^2) 7 days (N/mm^2) 28 days (N/mm^2)	 33 65 100	 14.8 29.6 44.8
7	Soundness	10 mm	6 mm

TABLE 2: Sieve Analysis and Physical Properties Of Fine Aggregate

Properties	Fine Aggregates
Specific Gravity	2.7
Water Absorption (%)	0.1
Fineness Modulus	2.59
Size of aggregates	River Sand confining to Zone-II

TABLE 3: Sieve Analysis and Physical Properties Of Coarse Aggregates

Properties	Coarse aggregates
Specific Gravity	2.67
Water Absorption (%)	0.6
Fineness Modulus	7.1
Size of Aggregates	Passing through 20mm sieve, retained on 12.5 mm 60%, on 12.5-10mm 40%
Elongation Index (%)	10
Flakiness Index (%)	9

TABLE 4: Properties of Natural Rubber Latex

Sl. No	Property	Rubber Latex
1	Colour	White
2	Total Solid Content (% by Weight)	61.5 Max
3	Dry Rubber Content (% by Weight)	60 Min
4	Non Rubber solid Content	1.50 Max
5	KOH Number	0.55 Max
6	Ammonia Number, NH3 (%)	0.70 Max
7	Mechanical Stability time	600 to 1200

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8	Volatile Fatty Acid Number	0.10 Max
9	Magnesium content	8
10	pH	10.4 Min
11	Coagulum Content (% by Mass)	0.01 Max
12	Sludge Content (% by Mass)	0.01 Max
13	Copper Content as PPM	5
14	Iron Content as PPM	8
15	Particle Size of Rubber Latex	0.2 µm
16	Specific Gravity of Rubber Latex	0.94

TABLE 5: Properties of Metakaolin

Specific Gravity	2.4 to 2.6
Physical Form	Powder
Colour	Off white
Specific Surface	8-15 m2/g

TABLE 6: Properties of Conplast SP-430

1	Specific Gravity	1.2 to 1.22 at 300C
2	Chloride Content	Nil as per IS:9103-1999 and BS:5075
3	Specific gravity	Approx. 1% additional air over control

III EXPERIMENTAL PROGRAM

The experimental program consisted of making M30 Grade and M70 Grade concrete. M30 grade concrete designed as per IS: 10262-2009 and its mix ratio were found to be 1:1.67:2.7:0.45. M70 Grade was designed as per ACI method and its mix ratio was found to be 1:0.95:1.25:0.28:2. Then NRL was added at various percentages (0.3%, 0.6%, 0.9%, 1.2%, 1.5%) for the both M30 and M70 Grade concrete at the time of mixing along with the water.

3.1 Test Specimens and Test Procedure

Cube specimens of size 150mm X 150mm X 150mm, cylinder specimen of diameter 100 mm and length 200mm, and prism specimens of size 500mm X 100mm X 100mm were cast. For HSC Cube specimens of size 100mm X 100mm X 100mm, cylinder specimen of diameter 100 mm and length 200mm, and prism specimens of size 500mm X 100mm X 100mm were cast. To obtain an uniform consistency the concrete it has been mixed

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thoroughly in an mixer. Cubes and prisms were well compacted using plate as well as needle vibrators. The specimens were de molded after 24 hours of casting and the specimens were cured for 7, 14 and 28days. In this experimental work total of 324 concrete specimens were casted with 108 cubes, cylinder and prisms. The calculated proportions of a mix are mixed in dry state and then the polymer is added as an admixture along with water.

3.2 Fresh Properties of NSC

TABLE 7: Compaction Factor Value (NSC)

Ratios of NRL	Compaction Factor of NRL added Concrete
0.0%	0.904
0.3%	0.810
0.6%	0.855
0.9%	0.880
1.2%	0.850
1.5%	0.830

TABLE 8: Vee-Bee Time Sec (NSC)

Ratios of NRL	Vee Bee Time of NRL added Concrete
0.0%	12
0.3%	20
0.6%	18
0.9%	14
1.2%	22
1.5%	24

3.3 Fresh Properties of HSC

TABLE 9: Compaction Factor Value (HSC)

Sl. No	Grade	NRL (%)	Compaction Factor Value
1	M70	0.0	0.95
2		0.3	0.93
3		0.6	0.92
4		0.9	0.90
5		1.2	0.88
6		1.5	0.87

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TABLE 10: VEE BEE TIME IN SEC (HSC)

Sl. No	Grade of Concrete	Ratios of NRL	Vee Bee Time of NRL added concrete in sec
1	M30	0.0%	8
2		0.3%	10
3		0.6%	11
4		0.9%	11
5		1.2%	12
6		1.5%	13

3.4 Hardened Properties of NSC

TABLE 11: Compression Strength of Concrete In N/mm^2 (NSC)

Ratios of NRL	Compressive Strength of NRL added Concrete		
	7 days N/mm^2	14 days N/mm^2	28 days N/mm^2
0.0	22	28.95	35.90
0.3	33.52	36.12	41.90
0.6	36.15	40.15	43.38
0.9	40.60	43.89	50.75
1.2	33.03	36.03	42.24
1.5	30.37	33.56	37.56

TABLE 12: Split Tensile Strength of Concrete IN N/mm^2 (NSC)

Ratios of NRL	Split Tensile Strength		
	7 days N/mm^2	14 days N/mm^2	28 days N/mm^2
0.0	3.04	3.42	4.65
0.3	3.77	4.23	5.21
0.6	4.38	4.46	6.13
0.9	6.23	6.85	7.12
1.2	3.70	4.12	5.13
1.5	2.70	3.73	4.72

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TABLE 13: Flexural Strength Of Concrete IN N/mm^2 (NSC)

Ratios of NRL	Flexural Strength (modulus of rupture) of NRL added concrete		
	7 days N/mm^2	14 days N/mm^2	28 days N/mm^2
0.0	3.51	3.73	3.98
0.3	2.81	4.36	5.31
0.6	3.88	4.14	5.66
0.9	6.11	6.51	7.01
1.2	3.78	4.19	5.16
1.5	3.58	3.93	5.12

3.5 Hardened Properties of HSC

TABLE 14: Compression Strength of Concrete IN N/mm^2 (HSC)

Sl. No	Percentage of NRL	Compression Strength of NRL added concrete		
		7 days N/mm^2	14 days N/mm^2	28 days N/mm^2
1	0.0	43.2	56.34	74.98
2	0.3	65	73.56	82.69
3	0.6	60	68.40	74.34
4	0.9	55.54	60.53	69.34
5	1.2	50.68	57.26	65.36
6	1.5	50.09	55.12	59

TABLE 15: Split Tensile Strength of Concrete IN N/mm^2 (HSC)

SL. NO.	Percentage of NRL	Split Tensile strength of NRL added concrete		
		7days N/mm^2	14days N/mm^2	28days N/mm^2
1	0.0%	3.27	4.95	6.35
2	0.3%	3.65	4.70	5.1
3	0.6%	4.76	4.9	5.5
4	0.9%	5.08	5.75	6.64
5	1.2%	5.73	6.152	7.24
6	1.5%	6.31	7.25	8.55

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TABLE 16: Flexural Strength of Concrete in N/mm^2 (HSC)

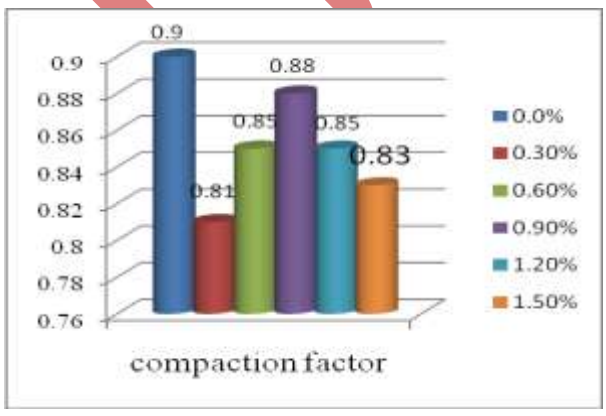
SL. NO.	Ratios of NRL	Flexural strength (modulus of rupture) of NRL added concrete		
		7days N/mm^2	14days N/mm^2	28days N/mm^2
1	0.0%	3.51	4.96	7.12
2	0.3%	3.65	3.93	6.45
3	0.6%	3.81	4.56	6.58
4	0.9%	4.21	5.83	7.86
5	1.2%	4.82	6.97	8.95
6	1.5%	5.32	8.45	10.98

IV RESULTS AND DISCUSIONS

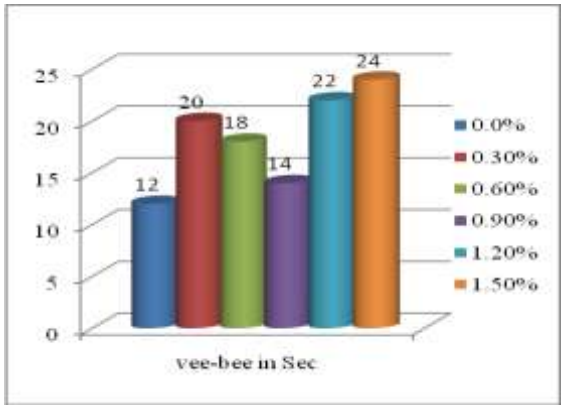
4.1 Fresh Properties of NRL Added Normal Strength Concrete

Usually compaction factor test conducted to find the workability of the concrete, if the compaction value is nearer to1 that concrete has good workability, here Compaction factor value was decreased when the natural rubber latex was added to the concrete at the ratio of 0.9% addition of natural rubber latex by the weight of cement the compaction factor value gives the satisfactory results, since the compaction factor value was nearer to the controlled mix as in Graph 1.

Vee bee is another test for determining the workability of the concrete; here vee bee test conducted for the natural rubber latex added concrete, initially vee bee time is increased for the 0.3% ratio of natural rubber latex added concrete than after the vee bee seconds were decreased up to the 0.9% of natural rubber latex. After words the vee bee time is again increased therefore the optimum percentage is 0.9%. Results of vee bee time is as in Graph 2.

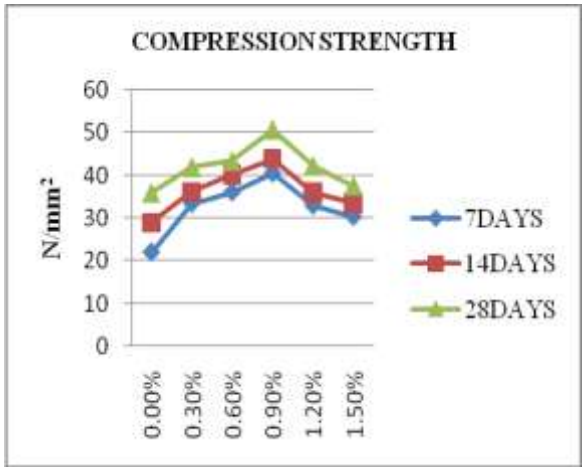


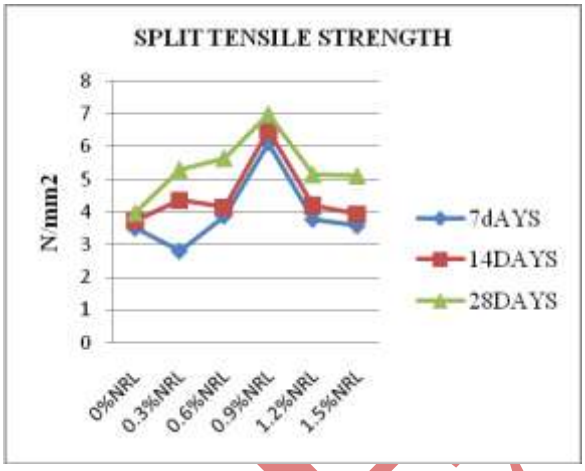
Graph 1: Compaction Factor Values of NRL Added normal strength Concrete



Graph 2: Vee-Bee Time of NRL Added normal strength Concrete in Sec

4.2 Hardened Properties of the NRL Added Normal Strength Concrete



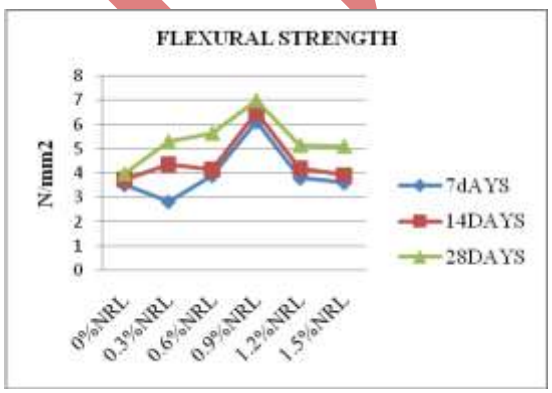


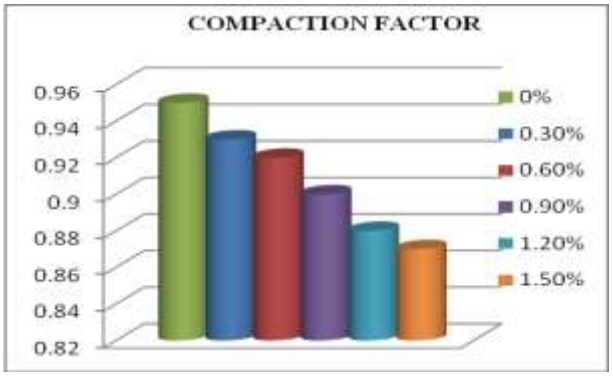
Graph 3: Compression Strength of Natural Rubber Latex added normal strength Concrete in N/mm^2

Graph 4: Split Tensile Strength of Natural Rubber Latex Added Normal Strength Concrete.

For the concrete the compression strength is the main criteria to know the mechanical properties of the concrete, here the compressive strength of concrete is conducted for the various percentages of the natural rubber latex added concrete, compression strength of the natural rubber latex added concrete was increased for the lower percentage of the natural rubber latex, upto the 0.9% of the natural rubber latex compression strength is increased there after compression strength of the natural rubber latex added concrete is decreases therefore the optimum percentage of the natural rubber latex for the compression is 0.9% shown in Graph 3.

The tensile strength of the concrete is difficult to measure directly, so it is measured indirectly by placing the cylinder horizontally and then applying the compressive load which will give the split tensile strength of the concrete. Here the tensile strength of the concrete was observed to increase with 0.9% addition of the natural rubber latex thereafter; it was decreased as in Graph 4. Therefore if the natural rubber latex is added in small percentage to the normal concrete, split tensile strength of the concrete is found to increase to some extent and then decrease linearly. Therefore optimum percentage of NRL is 0.9% for the tensile strength of the NRL added concrete.





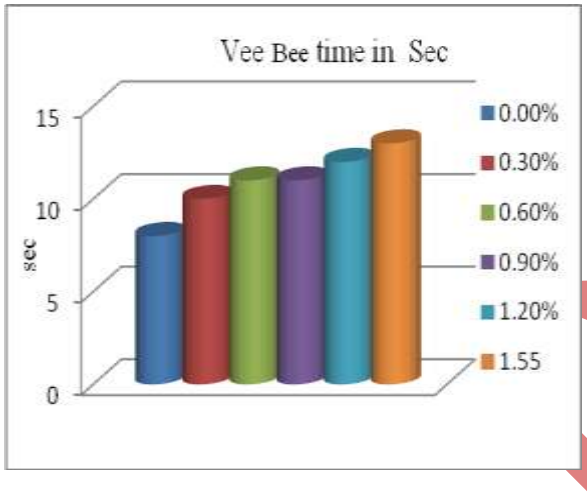
Graph 5: Flexural Strength of Natural Rubber Latex Added normal strength Concrete

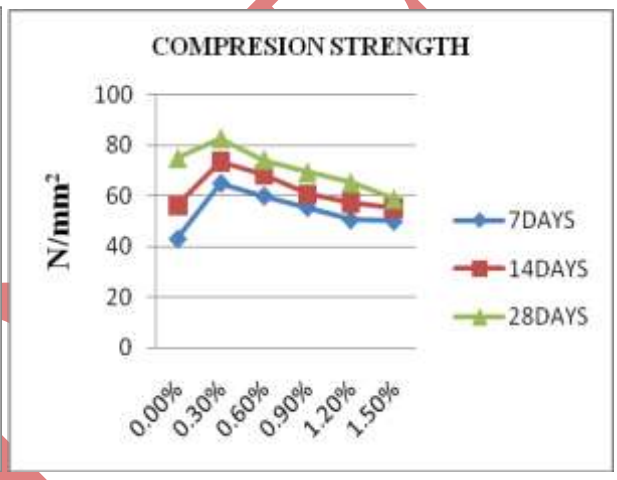
Graph 6: Compaction Factor Values of NRL Added High Strength Concrete

The flexural strength is also one of the main criteria for finding the mechanical properties of the concrete. Here the flexural strength of the concrete was observed that due to the effect of Natural Rubber latex flexural strength of the NRL Added Concrete is increased linearly up to the 0.9% of the natural rubber latex added to the concrete by the weight of cement. There after it was decreased. Shown in Graph 5

4.3 Fresh Properties of Natural Rubber Latex Added High Strength Concrete

Compaction factor test is conducted to find the workability of the concrete, if the compaction value is nearer to 1 that concrete has good workability, here Compaction factor value was decreased when increase the natural rubber latex percentage. Values of compaction factor shows in the Graph 6





Graph 7: Vee-Bee Time of NRL Added High Strength Concrete in Sec

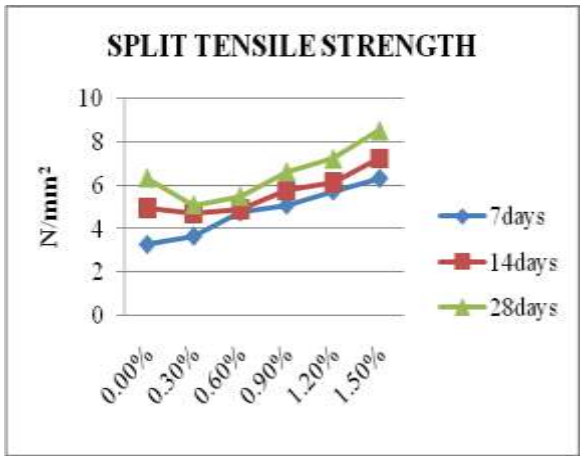
Graph 8: Compression Strength of Natural Rubber Latex Added High Strength Concrete in N/mm^2

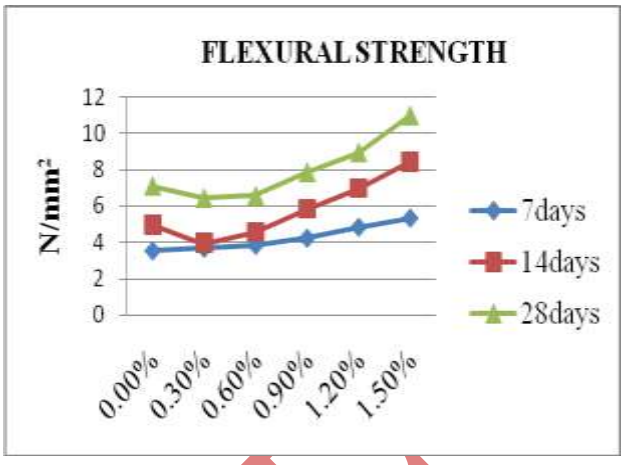
Vee bee is another test for determining the workability of the concrete, here vee bee test conducted for the natural rubber latex added high strength concrete, vee bee time is increased as the percentages of natural rubber latex is increased. Values of Vee Bee time is shown in Graph 7.

4.4 Hardened Properties of Natural Rubber Latex Added High Strength Concrete

For the concrete the compression strength is the main criteria to know the mechanical properties of the concrete, here the compressive strength of concrete is conducted for the various percentages of the natural rubber latex added concrete, compression strength of the natural rubber latex added concrete was increased for the lower percentage of the natural rubber latex, at the 0.3% of the natural rubber latex compression strength is increased there after compression strength of the natural rubber latex added high strength concrete is decreases therefore the optimum percentage of the natural rubber latex for the compression is 0.3%. results are shown in Graph 8.

The tensile strength of the concrete is difficult to measure directly, so it is measured indirectly by placing the cylinder horizontally and then applying the compressive load which will give the split tensile strength of the concrete. Here the tensile strength of the concrete was observed that the tensile strength of the concrete increases as the percentages of the natural rubber latex increases as in Graph 4.9





Graph 9: Split Tensile Strength of Natural Rubber. Latex Added High Strength Concrete

Graph 10: Flexural Strength of Natural Rubber Latex Added High Strength Concrete

The flexural strength is also one of the main criteria for finding the mechanical properties of the concrete. Here the flexural strength of the concrete was observed that due to the effect of Natural Rubber latex flexural strength of the NRL added high strength Concrete is increased as increase the percentages of natural rubber latex. shown in Graph 4.10

V CONCLUSIONS

Following conclusions were drawn from this experimental work.

- Experimental work has various percentages of natural rubber latex added to the control mix at the time of mixing along with water which gives the optimum percentage of natural rubber latex as 0.9% by the weight of cement for the normal strength concrete.
- When the natural rubber latex added to the normal strength concrete Split Tensile strength is increased up to 0.9% and then decreases as the increase in natural rubber latex.
- Due to the addition of NRL to the normal strength concrete flexural strength is increased up to 0.9% then decreases as increase the increase in natural rubber latex.
- Experimental work conducted on high strength concrete also by adding natural rubber latex of same percentages as the normal strength concrete which gives the optimum percentage of natural rubber latex is 0.3% by the weight of cement for compression in the high strength concrete.
- When the natural rubber latex added to the high strength concrete the Split Tensile Strength of the concrete is increases with the increase in percentages of natural rubber latex.
- Due to addition of the natural rubber latex added to high strength concrete the Flexural Strength of the concrete is increased as increase the percentages of natural rubber latex.
- As observed in the above experimental work the natural rubber latex increases the strength of normal strength concrete linearly up to 0.9% for compression, tension, and flexure then after decreases as increasing the NRL. But in high strength concrete compression strength increases at 0.3% then

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decreased for the increased percentage of NRL. Flexure and tension were increases as the percentage of the NRL increases.

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