Study on Hardened Properties of Rubber Mix Concrete

Abhilash G S
Lecturer,
Department of Civil Engineering
Government Polytechnic Soraba, Karnataka, India

Abstract: Every year, an enormous amount of rubber is manufactured all over the world. Due to the fact that its decomposition takes a significant amount of time and results in pollution of the environment, it is not possible to discharge it simply into the environment. Rubber that has been reused would be the most appropriate option in this scenario. Rubber wastes were incorporated into concrete as coarse aggregate in order to facilitate their reuse. The various features of the concrete, including its compressive strength, tensile strength, ductility, and other characteristics, were analyzed and compared to those of conventional concrete. As a consequence of this, it was discovered that rubberized concrete is more resistant to cracking, less ductile, and more durable than regular concrete, although it has a lower compressive strength than regular concrete. By incorporating a certain quantity of silica into rubberized concrete, it is possible to further enhance the material's compressive strength. Within the scope of the current inquiry, an effort has been made to create concrete with increased strength through the utilization of rubber. A cube with dimensions of 150 millimeters by 150 millimeters by 150 millimeters was cast in order to investigate the difference in compressive strength. Three different numbers of cubes were produced using different percentages of rubber. Three different percentages of rubber were added to the coarse aggregate: 0%, 5%, 10%, and 15% by weight. Casting the cylindrical specimen with a bottom diameter of 150 millimeters and a height of 300 millimeters was done in order to investigate the variation in the tensile strength of concrete that is spilt. The percentage of rubber in three different numbers of cylindrical specimens was cast for each of the three numbers. By weight of coarse aggregate, the rubber was added at a percentage of 0%, 5%, 10%, and 15% respectively. The compressive strength and split tensile strength of concrete are both reduced as the amount of rubber in the concrete is increased up to a certain limit. The results of the experimental investigation demonstrate how the strength of concrete can change when rubber is incorporated into the mix. During the test that was carried out, concrete of the M20 grade was used for the rebound hammer test. The compressive strength and split tensile strength of the concrete at the age of seven days and twenty-eight days were additionally determined. It has been discovered that with a replacement of 5% rubber by weight of coarse aggregate, values of M20 grade concrete are obtained that are rather close to the original values.

***Index Terms* - Component, formatting, style, styling, insert.**

I. INTRODUCTION

In the building sector, cement, fine aggregate, and coarse aggregate are all products that are absolutely necessary. Fine aggregate is a significant component that is utilized in the production of mortar and concrete, and it is also an essential component in the formulation of mixes. Generally speaking, the consumption of natural fine aggregate is considerable because of the significant amount of concrete and mortar that is used. As a result, the supply of fine aggregate is quite high in developing countries in order to meet the demands of the rapidly expanding infrastructure. India is one of the emerging countries that is experiencing a lack of fine aggregate of a high quality. In particular, fine aggregate deposits in India are being depleted, which poses a significant risk to both the environment and society. Some of the examples include the rapid extraction of fine aggregate from river beds, which causes a multitude of problems, such as the loss of water-retaining soil strata, the deepening of river beds, which can lead to bank slides, the loss of vegetation on the riverbank, the disruption of aquatic life, and the disruption of agriculture due to a decrease in the water table in the well. The intensive exploitation of river fine aggregate for construction purposes in Sri Lanka has resulted in a number of negative consequences. As a result, there are a number of alternatives to river fine aggregate, such as offshore fine aggregate. Additionally, fine aggregate has been produced. Due to the fact that the durability, workability, and strength of concrete are all positively impacted by the physical and chemical qualities of fine aggregate, fine aggregate is considered to be one of the most essential components of both concrete and cement motor. It is common practice to use river fine aggregate or pit fine aggregate as fine aggregate4 bin mortar and concrete. Together, fine and coarse aggregate account for approximately 75–80 percent of the overall volume of concrete. As a result, it is of utmost importance to locate acceptable types of aggregate that are of high quality in the vicinity of the specific location. As a result of the need for natural fine aggregate in the building sector, natural fine aggregate has recently become a very expensive resource. As a result of this circumstance, research has begun to look for alternative materials that are both inexpensive and easily accessible. Alternative materials have already been utilized in some instances. In spite of the fact that shore fine aggregate is utilized in a number of countries, including the United Kingdom, Sri Lanka, continental Europe, India, and Singapore, the majority of records concerning the utilization of this alternative discovered a significantly lower level of practice utilized in the construction industry.

The phrase is being used to describe a landfill that contains waste hazardous elements that have the potential to serve as alternatives for natural fine aggregate. In the construction industry, concrete serves as the foundation for all activities, regardless of the position, location, scale, or type of any project. In point of fact, concrete is the second most widely consumed material after water, with about free tons being consumed yearly by each individual now residing on the planet. The annual consumption of concrete in India is expected to be 450 million cubic meters, which is equivalent to nearly one ton of concrete for each Indian owner. By the standards of world consumption, we still have a long way to go before we reach global consumption levels; yet, do we have sufficient fine aggregate to produce some mortar and concrete? The value of the construction business increased at a staggering rate of fifteen percent each year, even during the period of economic slowdown, and it contributed to seven to eight percent of the countries. GDP

(at current prices) for the past eight years, it is becoming increasingly unsettling for people like common people who talk about greening the sector to have no practical response to his extremely important concern. This is because GDP has been expanding at current prices. In point of fact, we have been accumulating at the landfill a variety of potential alternatives to fine aggregate. Industrial waste by products practically all industries, which have been rising dangerous problem both for the environment and agricultural and for the health of women, and have significant used in construction activity, which may be used full for not only from the point of view of the economy but also took reserve for the environment.
One of the most significant worries for people all around the world is how to properly dispose of leftover tyre rubber. Since a few years ago, there has been a significant rise in the number of automobiles in India, which has led to an increase in the need for tires. As is common knowledge, lightweight concrete is utilized extensively in a wide variety of architectural projects. Between 2007 and 2010, there were around 80 million tyres that were used on roads in India. These tyres were used on two, three, four, and six-wheelers. In India, there are more than 33 million vehicles that use roads. A normal tire is composed of between 24 and 28 percent carbon black, between 40 and 48 percent natural rubber, and between 24 and 36 percent synthetic rubber, which includes styrene butadiene rubbers (SBR) and butyl rubber (BR), both of which are components that are utilized in the production of tires. Every single year, more than 981 million tires are discarded all over the world. Even less than seven percent of these tires are recycled, eleven percent are burned for fuel, and five percent are used for export. The remaining 77% is either disposed of in landfills, heaped up in an illegal manner, or discarded illegally. Every year, approximately 765 million tires that are no longer in use are thrown away all over the world.

According to the findings of the investigations that have been carried out up to this point, the incorporation of waste tyre rubber chips into concrete is particularly recommended for concrete structures that are situated in regions that are prone to experiencing significant earthquakes. Additionally, this material is recommended for applications that are subjected to extreme forceful activities, such as railway sleepers. This material can also be utilized for uses that do not involve weight bearing, such as the construction of noise reduction barriers. The United States of America generates more than 5 billion tons of harmful solid waste products each and every year. Consequently, each year, more than 273 million scrap tyres, which is equivalent to approximately 3.6 million tons, are produced. There are around three billion tires stacked up as a result of this buildup. As a result of the retained automotive tires, fire and health hazards are established. An exploratory study was carried out with the purpose of examining the potential of utilizing tire chips and crumb rubber as an aggregate in Portland cement concrete. This was done in order to find a solution to the problem of disposing of scrap tires. In the process of making concrete blocks, it is presumed that the combination of cement, which functions as a binder, and crumb rubber results in increased flexibility and, thus, a smoother surface. At the same time, it gives the concrete the necessary amount of strength, or at least the minimal amount of strength that is required. It was determined through an investigation into the effects of low and high-volume tire chips on the characteristics of fresh and hardened concrete that tire chips have the potential to be utilized as a replacement for coarse aggregate in concrete pavement mixtures. This was done in order to determine the potential for recycling tire chips as coarse aggregates in pavement concrete. As a potential alternative method of disposing of trash of this kind, the utilization of scrap tyre rubber in the production of concrete has been considered as a means of protecting the environment.

II. RELATED WORK

According to Eldin and Senouci's findings, rubberized concrete exhibited a wide range of desirable aesthetic attributes. The finished surfaces had an appearance that was comparable to that of regular concrete, and there were no issues with the surface finishing. The authors, on the other hand, noted that mixes that contained a high percentage of larger sized rubber aggregate required additional effort in order to get a finishing surface that was smooth. Another thing that they discovered was that the color of rubberized concrete was not significantly different from the color of regular concrete whatsoever.
Khatib and Bayomy [] conducted research on the amount of workability that rubberized concrete displays. Slump was shown to diminish as the percentage of rubber aggregate in the total aggregate volume increased, according to their observations. The findings of their investigation indicate that when the percentage of rubber aggregate in the overall aggregate volume reached forty percent, the slump was very close to zero, and the concrete could not be worked by hand. This type of mixture required the use of a mechanical vibrator in order to be compacted. mixes that contained fine crumb rubber, on the other hand, were more workable than mixes that contained either coarse rubber aggregate or a combination of crumb rubber and tire chips. 3) Siddique and Naik (2004) and Senthil Kumaran et al (2008) offered a summary of some of the research that has been published concerning the utilization of scrap tires in the production of concrete. According to studies, scrap-tire rubber can be used to create concrete mixtures that are both workable and of high quality.

Eldin and Senouci [] noted that, in general, the Rubberized concrete batches demonstrated satisfactory performance in terms of the ease with which they could be handled, placed, and finished. On the other hand, they discovered that increasing the size of the rubber aggregate or the percentage of rubber aggregate resulted in a drop in the workability of the mixture, which in turn led to a fall in the slump values that were obtained. Furthermore, they made the observation that the measured slump was influenced by the size of the rubber aggregate as well as its form (mechanical grinding results in the production of long angular particles). The slump values of mixes that contained long, angular rubber aggregate were found to be lower than the slump values of mixes that contained round rubber aggregate. A decreased surface-to-volume ratio is characteristic of round rubber aggregate. As a result, the amount of mortar required to coat the aggregates will be reduced, leaving more mortar available to offer workability. They hypothesized that the angular rubber granules would form an interlocking structure that would resist the typical flow of concrete under its own weight. As a result, these mixes would exhibit less fluidity on account of this resistance. There is also the possibility that the presence of steel wires that protruded from the tire chips was another factor that contributed to the decrease in the mix's ability to be worked.

In the process of preparing the concrete, Topcu (1995) [] utilized a very small amount of rubber aggregate, but Rostami et al (1993] appeared to make use of a greater quantity of rubber aggregate. As a result of their findings, the densities of the concrete were reduced to 87 and 77 percent of their initial values, respectively, when the maximum amounts of rubber aggregate were utilized in the experiments. It was found by Eldin and Senouci [] that the density of the material decreased by as much as 25 percent when coarse rubber aggregate was used in place of standard aggregate. The researchers Li et al. (1998) discovered that the density of rubberized concrete was decreased by approximately 10% when sand was substituted with crumb rubber in an amount equal to 33% of the volume of the concrete.

Fedroff et al. and Khatib and Bayomy [] made the observation that the air content of rubberized concrete mixtures increased as the amount of rubber aggregate in the mixtures increased. According to Fedroff et al. (1996), the rubberized concrete mixtures had larger air contents than the control mixtures that were created with an air-entraining agent (AEA). This was the case despite the fact that the AEA was not utilized in the rubberized concrete mixtures. It is possible that the nonpolar nature of rubber aggregates and their capacity to entrap air in their jagged surface texture are the reasons why rubberized concrete mixtures include a higher percentage of air. According to Benazzouk et al. (2007), the presence of air spaces in plain concrete would also result in a decrease in the strength of the concrete. This increase in the amount of air holes it contains would undoubtedly have the same effect. Due to the fact that rubber has a specific gravity of 1.14, it is reasonable to anticipate that it will sink rather than float in the first batch of concrete. On the other hand, if air were to become caught in the jagged surface of the rubber aggregates, it might lead them to float (Nagdi 1993). In actuality, this separation of rubber aggregate particles has been observed to take place. An experimental investigation was carried out by Goulias and colleagues [] that involved the utilization of crumb rubber as fine aggregate in conjunction with Portland cement. The results of the tests revealed that there were variations in the brittle failure of concrete, which suggests that rubber concrete specimens demonstrated a stronger ductility performance than regular concrete. A significant amount of distortion was seen in the concrete, yet it did not completely disintegrate. Chou et al. [] conducted research on rubber as a replacement for concrete in a variety of applications, and their findings have showed some encouraging outcomes. When rubber particles are added to concrete, the concrete's physical properties, particularly its compressive strength, deteriorate. This is especially true when the pressure is increased. When compared to conventional concrete, it is evident that rubber mix concrete, which is produced by utilizing the optimal quantity of rubber, exhibits a considerable increase in compressive strength, split tensile strength, modulus of elasticity, and fracture resistance. This is evident from the experiment that was shown earlier. Therefore, rubber was added in a variety of percentages depending on the weight of the coarse aggregate, including 0%, 5%, 10%, and 15%. Increasing the proportion of rubber results in an increase in both the compressive strength of the cube and the split tensile strength of the cylindrical specimen. The purpose of this study is to investigate the behavior of fiber-reinforced concrete (FRC) in both the fresh and hardened states of concrete. We do this by altering the quantity of steel fiber in the concrete, which ranges from 0% to 15% with 5% increments.

III. METHODOLOGY

Various amounts of steel fiber, including 0 percent, 5 percent, 10 percent, and 15 percent, are added to the ground concrete mixture. It is the OPC 43 grade cement that conforms to IS: 8112 that is utilized, and it comes from a single batch. The characteristics of the cement that was used are presented in table 1. The present operation makes use of river fine aggregate that is readily available in the area and is listed as belonging to zone 2 of IS 383-1970. In table 2, you can find the results of the sieve analysis performed on fine aggregate. The current investigation makes use of crushed ballast stone with dimensions of 12 millimeters and 20 millimeters down, as specified by IS 383 - 1970. Tables 4 and 5 contain tabulations of the outcomes of the sieve analysis as well as the attributes that were examined. For the purpose of this inquiry, both casting and curing are carried out with the use of potable water. There is a range of 6.5 to 8.5 for the pH of the tested water. Super plasticizer that complies with the IS:9103-1999 standard Conplast SP 430 DIS (Sulphonated Naphthalene Formaldehyde) manufactured by FOSROC, with the batch number IN1MF00299416. This study made use of tyre parts that were readily available in the area and ranged in size from 18mm to 20mm. A mix design was developed for concrete of the M20 grade in accordance with the IS 10262-2009 standard. For the purpose of casting the concrete, cube molds measuring 150 millimeters by 150 millimeters by 150 millimeters and cylindrical molds measuring 150 millimeters in diameter and 300 millimeters in length are utilized. In order to prepare the molds for casting, they are first cleaned, and then a greasing agent is applied to all of the interior surfaces. There are three layers of filling in each of the cube molds. Over the whole cross section of the mold, 25 blows are applied with the assistance of a tamping rod. These blows are distributed evenly over the mold's heights, and for each layer, one-third of each layer is applied. Following the process of filling and compacting the mold, the top surface is next smoothed out and allowed to dry for a period of eighteen hours. 1R0, 1R5, 1R10, and 1R15 are the designations given to rubber that contains 0%, 5%, 10%, and 15% of coarse aggregate by weight. For every percentage of steel fibers, there are two-cylinder molds and three cube molds available for casting. A total of twenty molds are cast with a weight-to-cement ratio of 0.4 for 0%, 5%, 10%, and 15% of rubber by weight of coarse aggregates. These molds are then subjected to compression and split tensile tests for seven and twenty-eight days. Plates 3.1 and 3.2 illustrate the process of batching, mixing, and preparing concrete respectively.

For the purpose of curing, the immersion method of curing is utilized. After the specimens have been cast for twenty-four hours, they are removed from the molds and placed in a tank that contains water for seven and twenty-eight days, respectively, to cure. After the curing period has passed, the specimens are taken from the tank. The surface moisture can be removed by wiping the surface with a towel, and it is important to ensure that the specimens are in a dry condition on the surface. On plate 3.3, you can see the specimens that were held for curing.

The following tests on fresh concrete were carried out in the present investigation according to IS 1199-1959 codal provisions.

1. Slump Cone test
2. Compaction factor test
3. Vee Bee Consistometer test

Further, the following tests were carried out on the hardened concrete according to IS 5816:1959 codal provisions.

1. Cube Compression test
2. Split Tensile strength

IV. RESULTS AND DISCUSSIONS

Workability Test:

Methods such as the slump test, the compaction factor test, and the vee-bee Consistometer test are utilized in order to determine the workability of the material in its fresh state. The results of the compaction factor test indicate that the addition of steel fiber to fresh concrete results in a deterioration in the workability of the concrete to a greater extent. It is possible to achieve vee-bee seconds ranging from 7 to 15 and slump values ranging from 12 to 18. Compaction factor values range from 0.85 to 0.91. It is recorded in table 3.8 that the slump, compaction factor, and density values have been recorded.

Compressive strength:

The results of the tests to determine the cube compressive strength of all mixes are recorded in table 5.6. The fluctuation of the cube compressive strength with age is shown in figure F5L. It is possible to observe that when the percentage of steel fiber in concrete increases, there is an increase in compressive strength. Additionally, density values are computed in the state of being toughened. There is a range of 23.04 to 24.11 kN/m3 for the density of concrete. The variation in compressive strength with the percentage of steel fiber for the concrete is shown in the table. According to the results that were observed, there is a rise in compressive strength as the percentage of steel fiber increases. In just 28 days, there was a 33.33% increase in the ratio of 0.4.

Split Tensile Strength:

Additionally, the cylindrical splitting tensile test is often referred to as the "Brazilian Test" on occasion. As may be seen in the image below, the test specimen and the stress pattern in the cylinder demonstrate their respective characteristics. Table 5.8 contains the documented results of the split tensile strength test that was performed. image 5 illustrates how the split tensile strength of the specimen changes over time as can be seen in the image. When the ratio of steel fibers in concrete is increased, there is a corresponding rise in the split tensile strength of the concrete being produced. Additionally, density values are computed in the state of being toughened. There is a range of 21.42 to 23.74 kN/m3 for the density of concrete. Based on the findings presented in the table, which show the relationship between the percentage of steel fibers in the concrete and the split tensile strength of the concrete, it can be concluded that the split tensile strength increases as the percentage of steel fibers increases.

TABLE 5.1.1: Properties of Cement

Sl. No.	Properties	Results
1	Specific gravity	3.14
2	Fineness of cement	6%
3	Normal consistency	28%
4	Initial setting time	30 min
5	Final setting time	551 min

TABLE 5.2.1: Sieve Analysis of Fine Aggregates

Sl. No.	IS sieve size (mm)	Cumulative % passing
1	4.75	92.6
2	2.36	73.5
3	1.18	55.2
4	600	30.8
5	300	28
6	150	9.3

TABLE 5.2.2: Properties of Fine Aggregates

Sl. No.	Properties	Results
1	Bulking of fine aggregate	31%
2	Specific gravity	2.6
3	Bulk density	1.63 kg/ltr

TABLE 5.3.1: Sieve Analysis 20 mm down size coarse aggregates

Sl. No.	IS sieve size (mm)	Cumulative % passing
1	20	80.4
2	12.5	48.33

3	10	9.42
4	4.75	2.01

TABLE 5.3.2: Sieve Analysis 12 mm down size coarse aggregates

Sl.No.	**IS sieve size (mm)**	**Cumulative % passing**
1	12.5	88.3
2	10	42.1
3	4.75	9.71

TABLE 5.3.3: Properties of coarse aggregates

Sl. No.	Properties	Results
1	Specific gravity	2.7
2	Bulk density	1.68 kg/ltr
3	Percentage of voids	39.78%
4	Impact test	18%
5	flakiness	32%
6	Elongation index	29%

TABLE 5.4: Water Test

Sl. No.	Properties	Results
1	pH	6.5
2	Turbidity	5.0 NTU
3	TDS	73 mg/l
4	Alkalinity	170 mg/l
5	Acidity	358 mg/l
6	Hardness	94 mg/l
7	Chloride	21.27 mg/l

TABLE 5.5: For w/c ratio 0.4 mix proportion for different mixes

Rubber (%)		**Cement (kg/m^3)**	**Fine aggregate (kg/m^3)**	**Coarse Aggregate (kg/m^3)**		**Rubber (kg) (% by wt. of CA)**
				12mm	**20mm**	
1R0	Weight (kg)	370	721	488.2	732.6	0
	Proportion	1	1.94	1.32	1.98	
1R5	Weight (kg)	370	721	488.2	732.6	68
	Proportion	1	1.94	1.32	1.98	
1R10	Weight (kg)	370	721	488.2	732.6	136
	Proportion	1	1.94	1.32	1.98	
1R15	Weight (kg)	370	721	488.2	732.6	204
	Proportion	1	1.94	1.32	1.98	

TABLE 5.6: Workability of Fresh Concrete

Designation	Slump* (mm)	Compaction factor*	Vee-bee seconds*
1R0	16	0.85	12
1R5	18	0.88	9
1R10	21	0.90	8
1R15	24	0.91	7

TABLE 5.7: Cube Compressive Strength

Designation	Cube Compressive Strength* (N/mm^2)	
	7 Days	28 Days
1R0	21.85	30.21
1R5	21.48	24.58
1R10	15.11	20.20
1R15	14.21	18.82

TABLE 5.8: NDT Test Results

Designation	Cube compressive Strength (Mpa)		Cylindrical moulds strength (Mpa)	
	7 days	28 days	7 days	28 days
1E0	28	36	28	42
1R5	26	36	28	40
1R10	22	26	22	40
1R15	22	22	22	36

TABLE 5.9: Hardened concrete properties of Cube Specimens

Designation	7-day			28-day		
	Density* (KN/m^3)	Elastic modulus* (N/mm^2)	Flexural Strength (N/mm^2)	Density* (KN/m^3)	Elastic modulus* (N/mm^2)	Flexural Strength (N/mm^2)
1R0	23.76	23371.99	3.27	24.59	27477.26	3.84
1R5	23.05	23173.26	3.24	23.53	24748.73	3.46
1R10	22.37	19435.79	2.72	23.41	22472.20	3.14
1R15	21.96	18848.64	2.63	23.38	21679.48	3.03

TABLE 5.8: Split Tensile Strength

Designation	Split Tensile Strength * (N/mm^2)	
	7 Days	28 Days
1R0	3.995	4.595
1R5	2.69	3.255
1R10	2.05	2.615
1R15	1.49	2.69

TABLE 5.9: Hardened concrete properties of Cylindrical Specimens

Designation	7 day	28 days
	Density* (KN/m^3)	Density* (KN/m^3)
1R0	24.43	24.34
1R5	23.62	23.58
1R10	22.71	23.2
1R15	22.96	23.11

Figure 5.1 to 5.19 are simulated in "Origin" software and in the collected results showed "demo" while generating the graph.

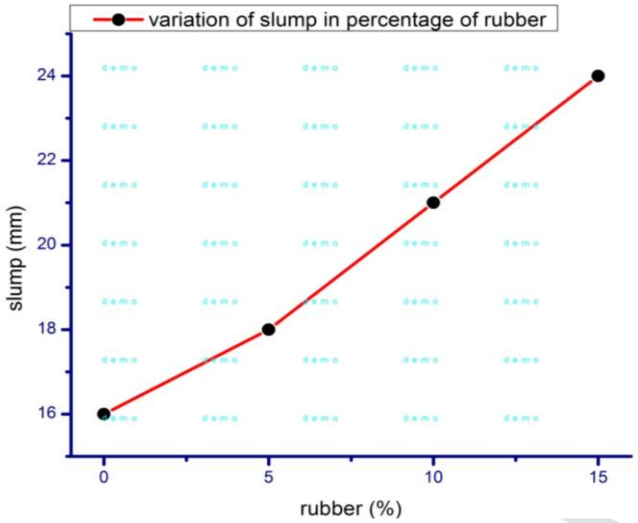

Figure 5.1: Slump v/s Percentage of Rubber

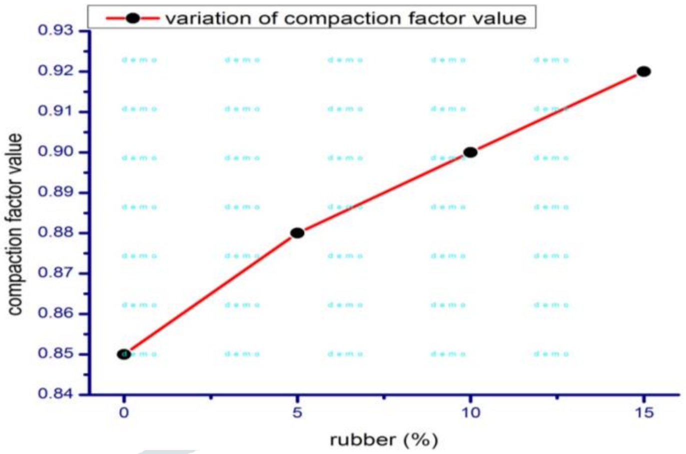

Figure 5.2: Compaction factor v/s Percentage of Rubber

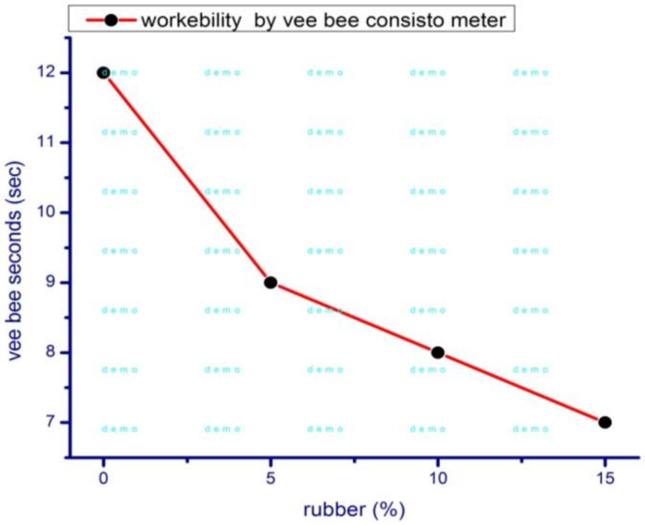

Figure 5.3: Vee-Bee Seconds v/s Percentage of Rubber

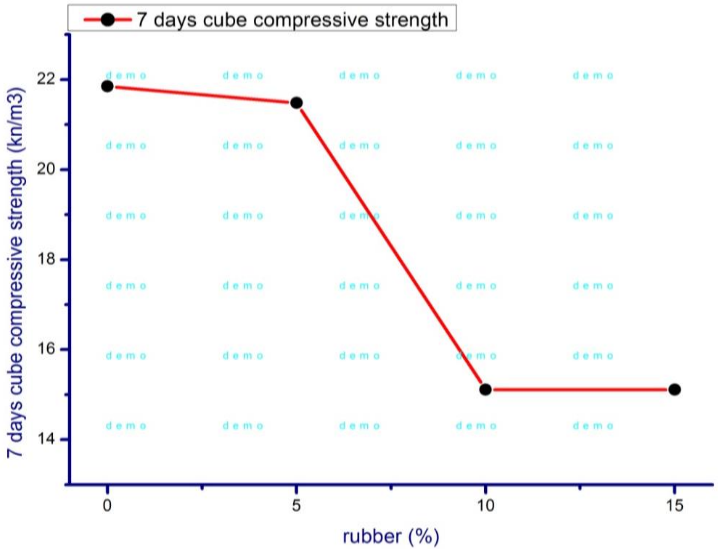

Figure 5.4: 7-day Cube Compressive Strength v/s Percentage

of Rubber

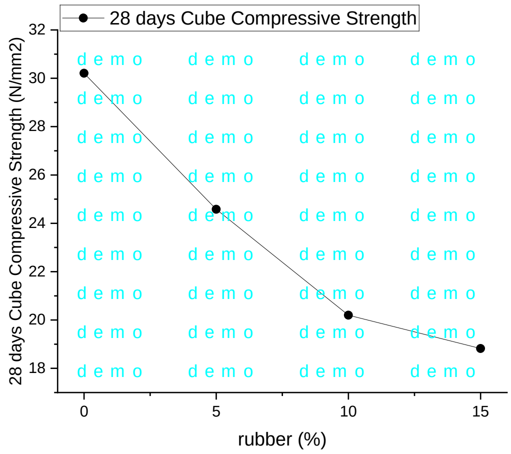

Figure 5.5: 28-day Cube Compressive Strength v/s Percentage of Rubber

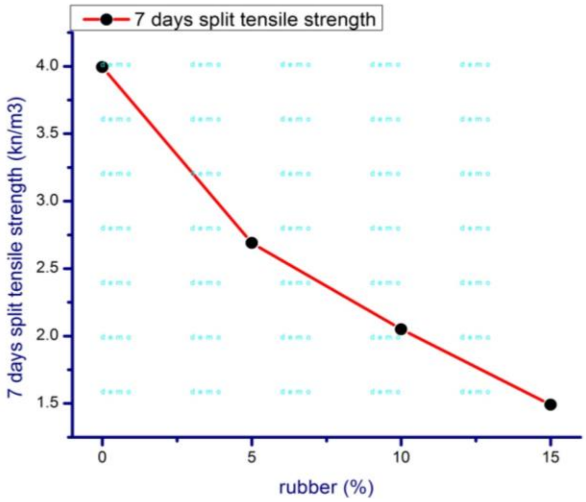

Figure 5.6: 7-day Specimen Split Tensile Strength v/s Percentage of Rubber

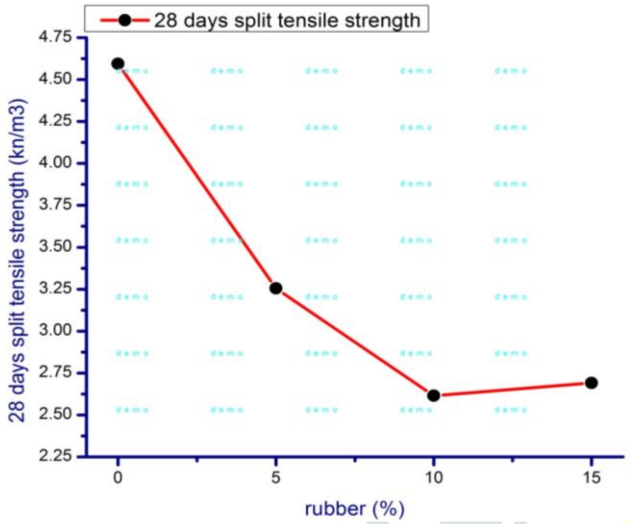

Figure 5.7: 28-day Specimen Split Tensile Strength v/s Percentage of Rubber

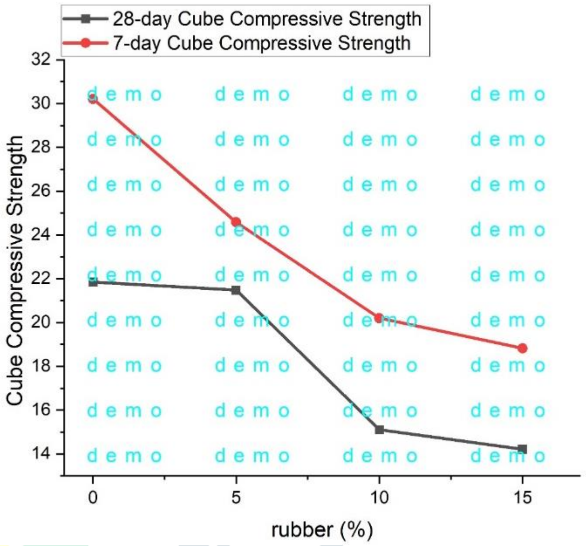

Figure 5.8: Cube Compressive Strength of 7 and 28 day Test Result

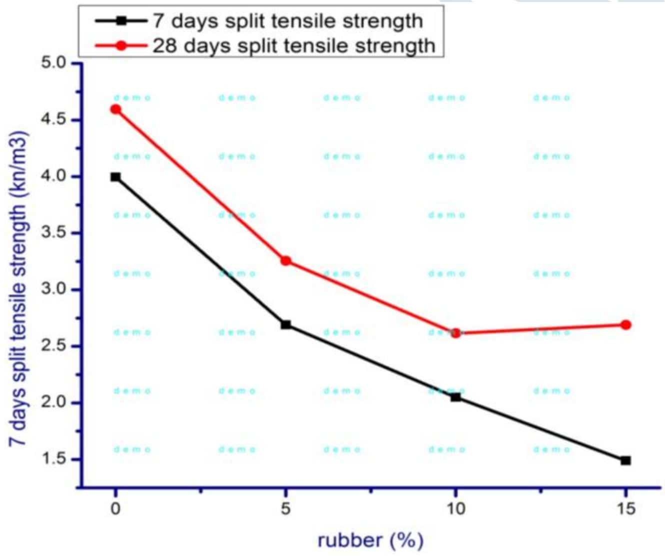

Figure 5.9: Split Tensile Strength of 7 and 28 day Test Result

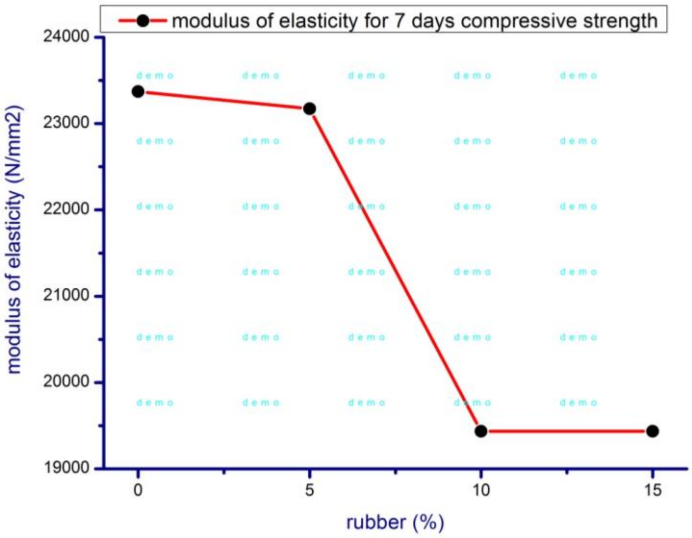

Figure 5.10: Modulus of Elasticity v/s Percentage of Rubber for 7-day Compressive Test

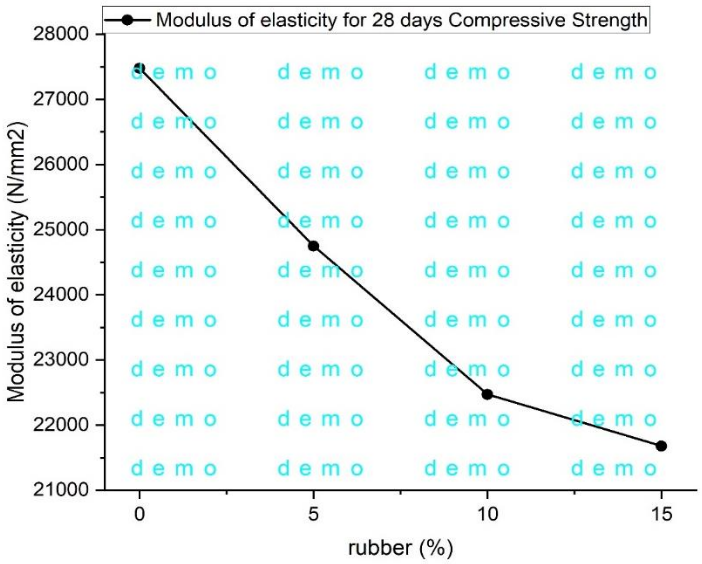

Figure 5.5: 28-day Cube Compressive Strength v/s Percentage of Rubber

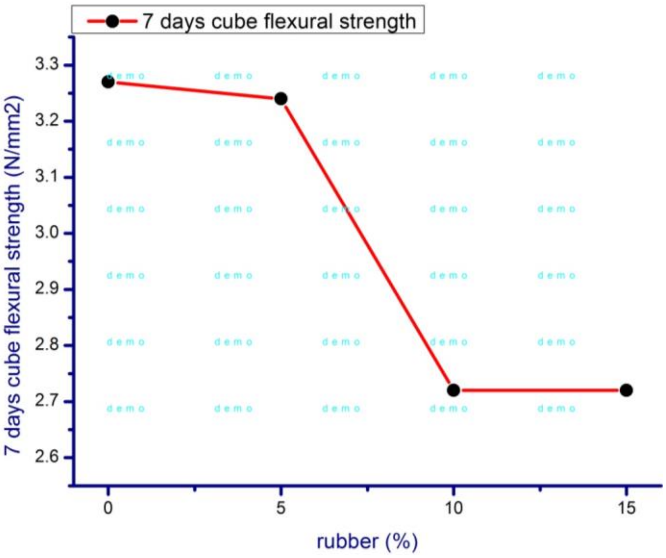

Figure 5.12: 7-day Flexural Strength of Cube v/s Percentage of Rubber

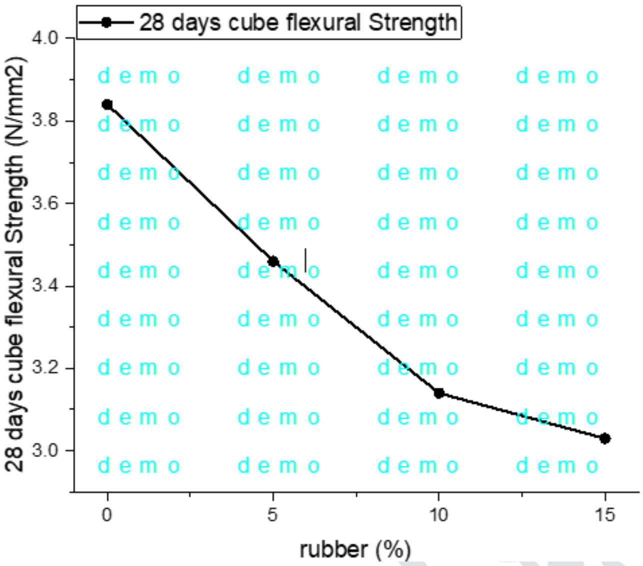

Figure 5.13: 28-day Flexural Strength of Cube v/s percentage of rubber

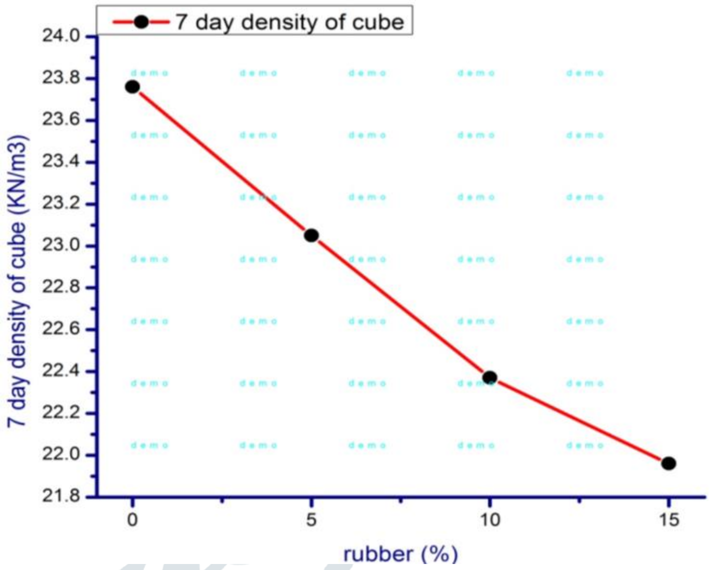

Figure 5.14: 7-day Density of Cubes v/s Percentage of Rubber

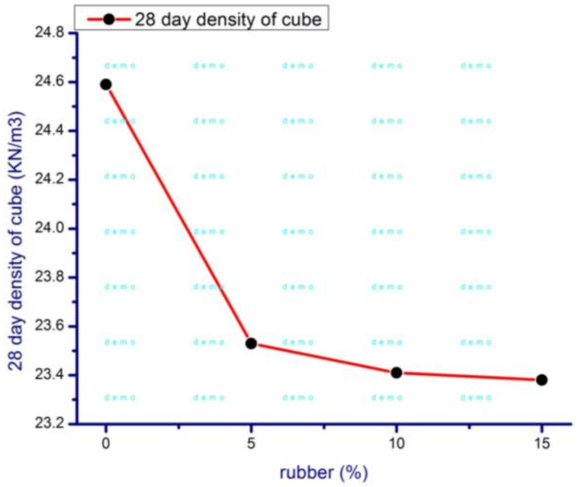

Figure 5.15: 28-day Density of Cubes v/s Percentage of Rubber

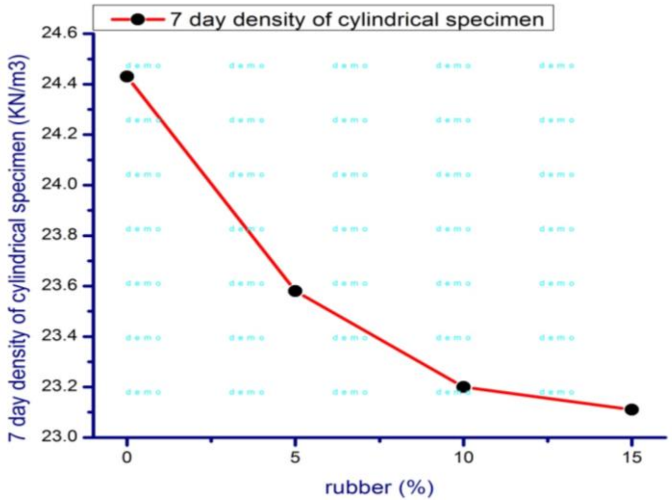

Figure 5.16: 7-day Density of Cylindrical Specimen v/s Rubber

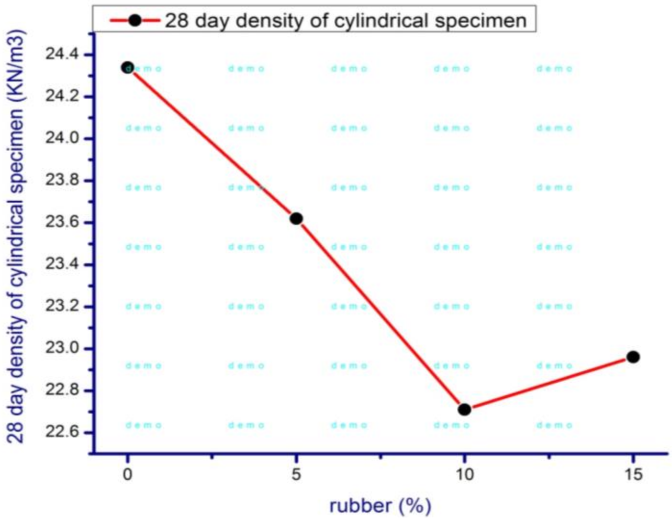

Figure 5.17: 28-day Density of Cylindrical Specimen v/s Percentage of Rubber

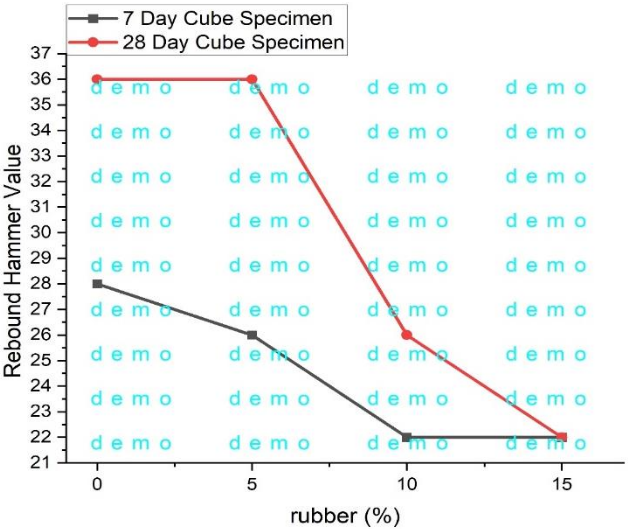

Figure 5.18: Rebound Hammer Value v/s Different Percentage of Rubber for cube specimens

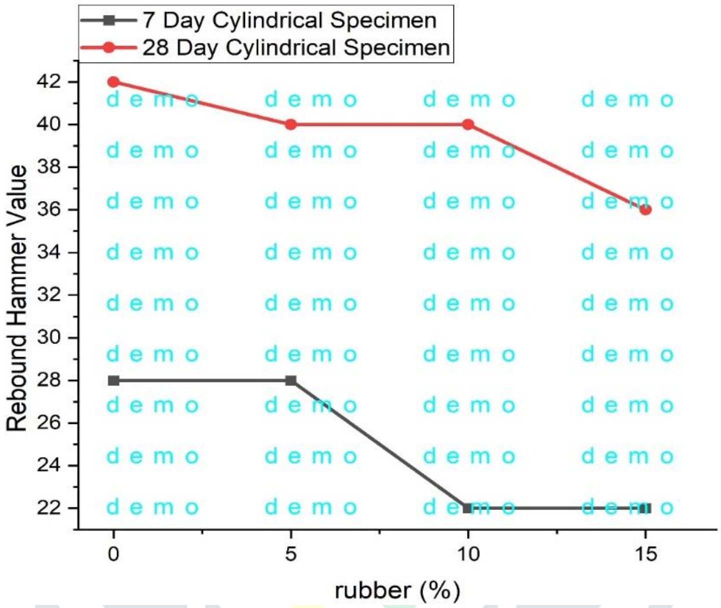

Figure 5.19: Rebound Hammer Value v/s Different Percentage of Rubber for cylindrical specimens

V. CONCLUSIONS

Following conclusion are drawn from limited experimental investigation carried out in this project.

1. Workability of concrete increases with increases in percentage of rubber by the weight of coarse aggregate.
2. Density of conventional concrete varied from 23.29 to 23.97 KN/m².
3. Modulus of elasticity of conventional concrete varied from 23371.99 to 27477.26 N/mm².
4. Flexural strength of conventional concrete varied from 3.27 to 3.84 N/mm²
5. Maximum cube compressive strength of conventional concrete for 7-day and 28-day are 21.85 N/mm² and 30.1 N/mm² respectively.
6. Maximum split tensile strength of conventional concrete for 7-day and 28-day are 3.99 N/mm² and 4.591 N/mm² respectively.
7. Rebound hammer value for cube compressive strength of conventional concrete for 7-day and 28-day are 28N/mm² and 36N/mm² respectively.
8. Rebound hammer value for cylindrical specimens for conventional concrete for 7-day and 28-day are 28 N/mm² and 42 N/mm² respectively.
9. For addition 5 percent of rubber by the weight of coarse aggregates Density of concrete varied from 23.58 to 23.62 KN/m².
10. For addition 5 percent of rubber by the weight of coarse aggregates Modulus of elasticity of concrete varied from 23173.26 to 24748.73 N/mm².
11. For addition 5 percent of rubber by the weight of coarse aggregates Flexural strength of concrete varied from 3.24 to 3.46 N/mm².

12. For addition 5 percent of rubber by the weight of coarse aggregates Maximum cube compressive strength of concrete for 7-day and 28-day are 21.48 N/mm² and 24.58 N/mm² respectively.
13. For addition 5 percent of rubber by the weight of coarse aggregates Maximum split tensile strength of concrete for 7-day and 28-day are 2.69 N/mm² and 3.255 N/mm² respectively.
14. For addition 5 percent of rubber by the weight of coarse aggregates Rebound hammer value for cube compressive strength of concrete for 7-day and 28-day are 26 N/mm² and 36 N/mm² respectively.
15. For addition 5 percent of rubber by the weight of coarse aggregates Rebound hammer value for cylindrical moulds of concrete for 7-day and 28-day are 28N/mm² and 40N/mm² respectively.

By observing above tabulated test results we can conclude that, there will be decrease in the compressive strength, split tensile strength and Density of Concrete as increase in percentage of the rubber in replacing of the coarse aggregates in different percentages. For economy 5 percent replacement of rubber can be adopted. Rubberized concrete can be used in non-load bearing members i.e. lightweight concrete walls, other light architectural units, thus rubberized concrete mixes could give a viable alternative to where the requirements of normal loads, low unit weight, medium strength, high toughness etc.,

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