STUDY OF STRENGTH AND DURABILITY CHARACTERISTICS OF RUBBERIZED CONCRETE

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ABSTRACT
It was need of society to identify areas where tyre rubber can be used without much investment and at mass scale. The use of scrap tyre rubber in the preparation of concrete has been thought as an alternative for disposal of such waste to protect the environment. In this study an attempt has been made to identify the various properties necessary for the design of concrete mix by replacing aggregates with crumb tyre rubber. M20 grade concrete has been chosen as the reference concrete specimen. Scrap tyre rubber powder, has been used as fine aggregate with the replacement of conventional fine aggregate. This will not only allow the sustainable use of aggregates available to us but also provide an effective and mass management of rubber tyre waste. The rubber tyre waste is powdered into fine crumb and then this crumb tyre aggregate is added as 5%, 10%, and 15% to replace the fine aggregate. In this study, workability, homogeneity, compressive and flexural strength of rubberized concrete are evaluated to investigate the optimal use of crumb rubber as fine aggregate in concrete.

INTRODUCTION:

A very large amounts of used rubber tyres cumulate in the world every year out of which 275 million in the India and around 180 million in European Union. One of the most popular methods to get rid of this rubber waste is to pile these tyres in landfills, and since they have low density and poor degradation, we cannot burry them as landfills. These tyres are also placed in a dump, or disposed of by simply piling them in large holes in the ground. And these dumps serve as a great homage to mosquitoes and these mosquitoes spread many diseases, this becomes a serious & dangerous health hazard. However, this rubber waste’s higher amounts can be utilized as fuel, pigment soot, in bitumen, roof and floor covers etc. One of such applications that could use old rubber tyres effectively is rubberized concrete. Concrete can be made cheaper by replacing a fixed percentage of fine aggregate with granulated rubber crumbs from rubber waste. These granulated rubber crumbs can be achieved through a process called continuous shredding, which is done to create crumbs small enough to replace aggregates as fine as sand effectively. Such kind of concrete can be used in manufacturing process of reinforced pavement and bridge structures because this have better resistance to frost and ice thawing.

LITERATIRE REVIEW

century. Some of the peoples research the rubberized concrete: Eldin N.N and Senouci A.B,"Rubber tyre particles as coarse aggregates"examined compressive and tensile strengths of rubberized concrete. He notes that rubberized concrete didnot perform as well as normal concrete under repeated freeze-thaw cycles. It exhibited lower compressive and tensile strength than of normal concrete but unlike normal concrete,rubberized concrete had the ability to absorb a large amount of plastic energy under compressive and tensile loads. It didnot demonstrate the typical brittle failure but rather ductile,plastic failure mode.

Toutanji,H.A "The use of rubber tyre particles in concrete to replace mineral aggregates" Cement concrete investigated the effect of replacement of mineral coarse aggregate by rubber tyre aggregate. Shredded rubber tyres used had a maximum size of 12.7mm and a specific gravity of about 0.61. The incorporation of these rubber tyre chips in concrete exhibited a reduction in compressive and flexural strength. The specimens which contained rubber tyre aggregate exhibited ductile failure and underwent significant displacement before fracture. The toughness of flexural specimens was evaluated for plain and rubber tyre concrete specimens. The test revealed that high toughness was displayed by specimens containing rubber tyre chips as compared to control specimens.

Khatib Z.K and Bayon F.M has developed "Rubberized portland cement concrete" to conduct experimental program in which two types of rubber fine Crumb Rubber and coarse tyre chips were used in Portland cement concrete (PCC) mixtures. Rubberized PCC mixes were developed by partially replacing the aggregate with rubber and tested for compressive and flexural strength in accordance to ASTM standards. Tyre chips were elongated particles that ranged in size from about 10 to 50mm. Results show that rubberized PCC mixes can be made and are workable to a certain degree with the tyre rubber content being as much as 57% of the total aggregate volume. However,strength results show that large reductions in strength would prohibit the use of such high rubber constant. It is suggested that rubber contents should not exceed 20% of the total aggregate volume.

Mohammed Mustafa Al Bakari. A. Syed NuzulFazl S.A, Abu Bakar M. Dand Leong K.W "Comparision of rubber as aggregate and rubber as filler in concrete" this research will attempt to use rubber waste replacement of coarse aggregates to produce early age concrete. It carry out two different type of concrete which are rubberized concrete and rubber filler in concrete. In rubberized concrete, rubbers were used to replace coarse aggregates and river sand as fine aggregate. Coarse aggregate usually gravel or crushed stone and shredded rubber as filler in concrete. The compressive strength was reduced in rubberized concrete for several reasons including the inclusion of the waste tyres rubber aggregate acted like voids in the matrix. This is because of the weak bond between the waste tyres rubber aggregate and concrete matrix. With the increase in void content of the concrete, there will be a corresponding decrease in strength. Portland cement concrete strength is dependent greatly on the coarse aggregate,density,size and hardness. Since the aggregates are partially replaced by the rubber,the reduction in strength is only natural.

Mavroulido.M and Figueiredo.J "Discarded tyre rubber as concrete aggregate: a possible outlet for used tyres" it can be concluded that despite the observed lower values of the mechanical properties of concrete there is a potential large market for concrete products in which inclusion of rubber aggregate would be feasible. These can also include non primary structural applications of the medium to low strength requirements,benefiting from other features of this type of concrete. Even if the rubber tyre aggregate was used at relatively low percentages in concrete,the amount of waste tyre rubber could be greatly reduced due to the very large market for concrete products world wide. Therefore the use of discarded tyre rubber aggregates in concrete shows promise for developing an additional route for used tyres.

OBJECTIVE OF THE PROJECT

The objectives of the work are stated below:
i)To develop mix design methodology for mix 30MPa
ii)To study the effect of adding different percentages (0% - 15%) of crumb rubber(Coarse size 1mm - 60µm) in the preparation of concrete mix.
iii)To determine the workability of freshly prepared concrete by Slump test and Compaction factor test.
iv)To determine the compressive strength of cubes at 7, 14, 28 days.
v)To determine the Flexural strength of beams at 28 days.

EXPERIMENTAL PROGRAM:

Materials Used

The different materials used in the investigation are:

Cement

Cement used in the investigation was found to be Ordinary Portland Cement(53 grade) confirming to IS : 12269 – 1987.

Fine Aggregate

The fine aggregate used was obtained from a near by river course. The fine aggregate confirming to zone – II according to Is 383-1970 was used.

Coarse aggregate

The coarse aggregate used is from a local crushing unit having 20mm nominal size. The coarse aggregate confirming to 20mm well-graded according to IS:383-1970 is used in this investigation.

Crumb Rubber

The coarse size of crumb rubber size of 1 mm - 600 µm was using in this project.

Figure 1 Materials required for rubberized concrete

MATERIAL TESTS

Specific gravity (IS:2386)

Specific gravity of Cement

1. Density bottle is cleaned with distilled water and dried.
2. The weight W1 of the clean, dry density bottle with cap is noted.
3. About one-third of the density bottle is filled with cement. The weight W2 of the density bottle and cement solids is determined.
4. Small quantity of kerosene is poured into the soil and left until all pores are completely filled with water.
5. Additional kerosene is poured into the density bottle to fill it completely upto the top of the cap. The density bottle is dried from outside. The weight W3 of density bottle and its contents is determined.
6. The contents of the density bottle are removed. It is filled completely with kerosene upto the top of the cap. The density bottle is dried from outside and its weight W4 is noted.
7. The specific gravity of the sample is determined by
8. G=(w2-w1)/[redacted]((w2-w1)-(w3-w4)0.79)
9. The procedure is repeated twice, from steps 3 to 6 with other specimens from the same material. The specific gravity is reported as the average of three readings.

TESTING

COMPRESSIVE STRENGTH OF CONCRETE

The compression test was conducted according to IS 516-1959.This test helps us in determining the compressive strength of the concrete cubes. The obtained value of compressive strength can then be used to assess whether the given batch of that concrete cube will meet the required compressive strength requirements or not. For the compression test, the specimen's cubes of 15 cm x 15 cm x 15 cm were prepared by using crumb rubber concrete as explained earlier. These specimens were tested under universal testing machine after 7 days and 28 days of curing. Load was applied gradually at the rate of 140kg/cm2 per minute till the specimens failed. Load at the failure was divided by area of specimen and this gave us the compressive strength of concrete for the given sample.

FLEXURAL STRENGTH OF CONCRETE (IS:516-1959)

The beam specimens were tested on universal testing machine for two-point loading to create a pure bending. The bearing surface of machine was wiped off clean and sand or other material is removed from the surface of the specimen. The two point bending load applied was increased continuously at a constant rate until the specimen breaks down and no longer can be sustained. The maximum load applied on specimen was recorded. The modulus of rupture depends on where the specimen breaks along the span. Beam dimensions are 500mm×100mm×100mm. if the specimen breaks at the middle third of the span then the modulus of rupture is given by,

Figure 2 Compressive Strength test of cube samples in UTM

Figure 3 Flexural Strength tests of beam samples in UTM

RESULTS AND DISCUSSIONS

As per experimental programme results for different experiments were obtained. They are shown in table format or graph, which is to be presented in this chapter.

SLUMP TEST

The Slump test was performed on the rubberized concrete to check the work ability of it at different replacements viz. 5 %, 10 %, 15% and the following results were obtained, according to which it can be concluded that with the increase in % of rubber from 0 to 15 % , workability decreases. Theoretical maximum value of Slump can be 100 to 175. The results obtained for Slump test are shown below in Table 5.1.

S.No	% of rubber	Slump value (mm)
1	0%	55
2	5%	42
3	10%	34
5	15%	28

Table 1: Results of Slump test

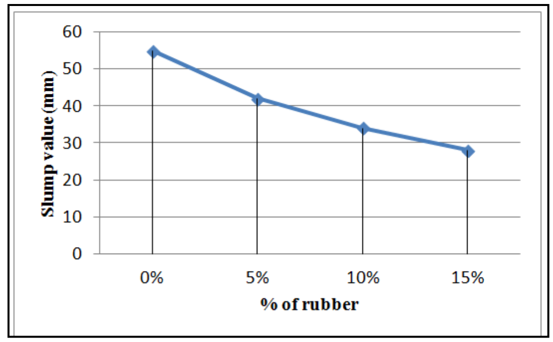

Fig 2 : Slump test results

The above shows the slump results. It was observed that, the slumps decreased as the rubber content were increased in the mix. It was a Low Slump (25 – 50mm). It was suitable for Low Workability mixes used for foundations with light reinforcement. Roads vibrated by hand operated machines.

COMPACTING FACTOR

The compaction factor test was performed on the rubberized concrete to check the work ability of it at different replacements viz. 5 % , 10 % , 15% and the following results were obtained, according to which it can be concluded that with the increase in % of rubber from 0 to 15 % , workability decreases. Theoretical maximum value of compaction factor can be .96 to 1.0. The results obtained for compaction factor test are shown below in Table

S.No	% of rubber	Wt. of partially compacted concrete (kg)	Wt. of fully compacted concrete (kg)	Value of compaction factor(%)
1	0%	9.63	11.83	0.81
2	5%	10.43	12.00	0.87
3	10%	9.52	11.69	0.82
5	15%	8.76	10.92	0.80

Fig 3 Results of compaction factor test

FLEXURAL STRENGTH TEST

The Flexural test was performed on the beams of size 50 x 10 x 10 cm to check the flexural strength of the rubberized concrete and the results obtained while performing the flexural test on UTM are given in Table

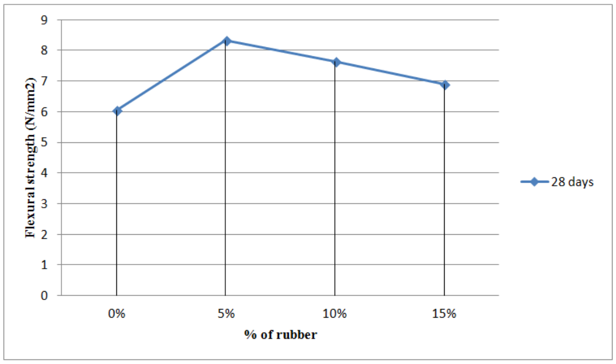

Fig 4: Flexural strength v/s % of rubber

From this study, it can be concluded that a replacement of up to 10% of crumb rubber can be made safely in flexural members. The variation in flexural strength with respect to the given percentage of crumb rubber

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSION

∟Utilization of waste tyres in the study process has been focus to reduce tyrewastes economic ,environmental management.

∟Concrete with higher percentage of crumb rubber possess low workability i.e with increase in percentage of crumbed rubber the concrete workability decreases.

∟Test results of 28 days rubberized concrete shown 5% to 10% replacement of rubber in fine aggregate gives high compressive strength than conventional concrete(0% rubber) specimens.

∟Test results of 28 days rubberized concrete shown 5% to 10% replacement of rubber in fine aggregate gives high Flexural strength than conventional concrete(0% rubber) specimens.

∟With the addition of the crumb rubber, the reduction in strength cannot be avoided. However, these data provides only preliminary guideline for the strength-loss of locally produced modified concrete in comparison with the conventional concrete of 30 MPa targeted strength.

∟Rubberized concrete is also used for insulation work like insulation from noise and heat. So it can be used as an insulating material in walls in residential as well as commercial buildings and as a noise insulator in theatres, cinema halls, noise proof rooms and auditoriums etc.

∟Rubberized concrete is also a Light Weight Concrete. Fast growing world motor vehicle usage is increasing in every year, Promisable future product for replacement of fine aggregates. Alternative to fine aggregate to recycle tyres helping the conservation of the environment. Reduce the natural source utilization ,improve to use modified materials.

REFERENCES

[1] Rubber Manufacturer's Association, NW Suite 900, Washington DC 20005,2000.

[2] Tantala, M.W., Lepore, J.A., and Zandi, I., "Quasi-elastic behavior of rubber included concrete", Proceedings 12th International Conference on Solid Waste Technology and Management, Philadelphia, 1996.

[3] Paul, J., Encyclopedia of polymer science and engineering, Vol. 14, 1985, pp. 787-802.

[4] Takallou, H.B. and Takallou, m.B., Elastomeric, Vol. 123, 1991, pp.9.

[5] O'Keefe, W., Power, Vol. 128, No. 10, October 1984, pp. 115.

[6] Read, J., Dodson, T., and Thomas, J., "Experimental project – use of shredded tyres for lightweight fill, Oregan Department of Transportation, Post Construction report for Project No. DTFH -71-90-501-OR-11, Salem, Oregan, 1991

[7] Heitzman, M., "Design and Construction of Asphalt Paving Materials with Crumb Rubber", Transportation Research Record No. 1339, Transportation Research Board, Washington DC, 1992.

[8] Scrap Tyre Management Council, Scrap Tyres Use, Washington DC, 1995.

[9] Esch, D. C., "Asphalt pavement modified with coarse rubber particles: Design, construction and ice control observations," Alaska Department of Transportation and Public Facilities, 1984.

[10] Adams, C., Lamborn, M., and Shuler, S., "Asphalt-rubber binder laboratoryperformance," Report FHWA/TX-8571, 347-1F, Texas Department of Highways and Public Transportation, 1985.

[11] Estakhri, C., "Use, availability and cost effectiveness of asphalt rubber in Texas, Research Report 1902 –1F, Texas Transportation Institute, Texas A&M University System, 1990

[12] Khosla, N.P. and Trogdon, J. T., "Use of ground rubber in asphalt paving mixtures," Technical Report,

Department of Civil Engineering, North Carolina State University, Raleigh, May 1990.

[13] Raghvan, D., Huynh, H., and Ferraris, C.F., "Workability, mechanical properties and chemical stability of a recycled tyre rubber-filled cementitious composite," Journal of Materials Science, Vol. 33, No. 7, pp. 1745-1752.

[14] Khatib, Z.K. and Bayomy, F.M., "Rubberized Portland cement concrete," Journal of Materials in Civil Engineering, 1999, pp. 206-213.

[15] Fedroff, D., Ahmad, S., and Savas, B. Z., "Mechanical properties of concrete with ground waste tyre rubber," Transportation Research Board, No. 1532, 1996, pp.66-72.