

“INVESTIGATION ON SOUND AND HEAT INSULATION PROPERTIES OF RUBBERIZED CONCRETE”

Ankit R. Bagul¹, Prof. R.M.Jadhav²

¹PG Student, Department of Civil Engineering, LGN Sapkal College of engg, Nashik 422213, India.

² Assistant Professor, Department of Civil Engineering, LGN Sapkal College of engg, Nashik 422213, India.

ABSTRACT: The waste tyre rubber is one of the issues of environmental problems. Since the amount of automobile in our country had increased it contributed to the increase of waste disposal. In addition to this, more than 300 million tires are currently stockpiled throughout the United States. These stockpiles are dangerous not only from potential environmental threat, but also from fire hazards and provide breeding grounds for mosquitoes. Researches had investigated the application of waste tyre rubber in construction field by using the rubber particle as partial replacement of fine aggregate or coarse aggregate in concrete. This project focused on to construct prototype rooms for experimental study. There will be four rooms constructed of size 3 x 3 x 3 feet each. The first one will have walls of traditional PCC lean mix. The other three will have walls of rubberized concrete in proportion 6%, 12% and 18% by weight of aggregates. The four rooms will be configured at the corners of a square. The sound will be artificially created at the centre of the square. Sound intensity inside each room will be measured. As another part of the study the temperature inside all rooms will be monitored. This will enable to assess the thermal conductivity of the rubberized concrete.

Keywords: stockpiles, tyre rubber, rubberized concrete, PCC lean mix, thermal conductivity.

1. INTRODUCTION

“Energy cannot be created, it cannot be destroyed”; it is the base of all intellectual and spiritual thoughts of human beings. Energy is always subjected to cycles. Thus nothing as such is a waste. The so called waste of one process is in fact a raw material for some other process. Waste is a material that is wrongly placed or is lying unutilized. Hence there is a need to decide the suitable place where a particular waste material may be used or recycled. The present work is concerned with the reuse of tyre waste which is as such a solid waste generated in gigantic proportions.

Globally the tyre production is estimated to be 1 billion per year (Tyre production Wikipedia). India manufacture 11.92 Crore tyres in year 2018 – 19 increase by 22.72% than year 2017 – 18 (ATMA – Automotive Tyre Manufacturer Association)

With the exponential growth in number of automobiles in India during recent years, the demand of tyres as original equipment and as replacement has also increased. The quantity of scrap tyres produced in India is not exactly available but the increasing trend of use of road transportation will

definitely create a problem of disposal in very near future. The total number of registered buses, trucks, cars/jeeps/taxis and two wheelers up to 1997 in India were 0.5 million, 2.25 million, 4.7 million and 26 million, respectively. An annual cumulative growth rate of 8% is expected (Auto man, 1999, Statistical Yearbook, 2000). Considering the average life of the tyres used in these vehicles as 10 years after rethreading twice, the total number of waste disposable tyres will be in the order of 112 million per year.

Tyre recycling or rubber recycling is the process of recycling vehicles tyres (or tires) that are no longer suitable for use on vehicles due to wear or irreparable damage (such as punctures or wear and tear). These tires are among the largest and most problematic sources of waste, due to the large volume produced and their durability. Those same characteristics, which make waste tires such a problem, also make them one of the most re-used waste materials, as the rubber is very resilient and can be reused in other products. Approximately, one tire is discarded per person per year. Tires are also often recycled for use on basketball courts and new shoe products.

Waste-Tire rubber is one of the significant environmental problems worldwide. With the increase in the automobile production, huge amounts of waste tire need to be disposed. Due to the rapid depletion of available sites for waste disposal, many countries banned the disposal of waste tire rubber in landfills. The main objectives of this research were to provide more scientific evidence to support the use of legislation or incentive-based schemes to promote the reuse of accumulated waste tires. This research focused on using crumb tires as a replacement for a percentage of the local fine aggregates used in the concrete mixes in India.

The present work proposes to investigate the impact of tyre waste blending on various parameters of concrete like heat insulation, sound insulation. The tyre waste shall be used as a substitute of coarse as well as fine aggregates in varying proportions. These studies will suggest a safe and environmentally consistent method of disposal of tyre waste material.



Figure1: Generation of Scrap tire.

2. METHODOLOGY

2.1 Materials

2.1.1 Natural Aggregate:

Gravels are obtained by crushing natural basalt stone obtain from quarries. They are hard, strong, tough, clear and free from veins, alkali, vegetable matter and other deleterious substances. Aggregates are free from such material, which will reduce strength or durability of concrete.

2.1.2 Sand:

Natural sand free from silt, veins, alkali, vegetable matter and other deleterious substances, obtained from River.

2.1.3 Cement:

BIRLA GOLD A1 GRADE Pozzolona Portland cement is used for all mixes.

2.1.4 ¾” Scrap tyre Aggregate:

Scrap tyre obtained from Scrap tyre section. This cut into pieces of the required size mechanically.

2.1.5 Potable Water:

Water used for drinking purpose is used for mixing and curing.

2.2 Tests on Natural Aggregate

- Specific Gravity and Water absorption of aggregate (IS: 2386 PART 3)-1963
- Crushing strength of aggregate (IS: 2386 PART 4)-1963
- Aggregate impact value (IS 2386 PART 4)-1963
- Flakiness and Elongation index of aggregate (IS 2386 PART 1)-1963

2.3 Tests on Sand

- Sieve Analysis of Sand (IS: 2386 PART 1)-19631.
- Specific Gravity and Water absorption of Sand by Pycnometer method

2.4 Tests on ¾” Scrap Tyre Rubber Aggregate

- Specific Gravity and Water absorption of ¾” Scrap tyre rubber aggregate
- Flakiness and Elongation index of ¾” Scrap tyrerubber aggregate (IS 2386 PART 1)-1963

2.5 Tests on Cement

- Fineness of cement (IS: 4031 PART 1)-1996
- Standard consistency of cement (IS: 4031 PART 4)-1988
- Initial and final setting time of cement (IS: 4031 PART 5)-1988
- Soundness of cement (IS: 4031 PART 3)-1988

2.6 Quantity of Materials

Table 1: Quantity of Materials

Protot ype Room No.	% of Scrap Tyre R.A. Replace ment	½” NA (Kg)	¾” NA (Kg)	¾” Scrap Tyre R.A (Kg)
1	-	63	63	-
2	6	61.11	61	1.48

3	12	59.22	59	2.97
4	18	57.33	57	4.45

2.7 Hand Mixing of Concrete- (IS: 100886-1982)

1. The concrete batch mixed on a water tight, non-absorbent platform with a shovel, trowel.
2. The cement, fine aggregate, scrap tyre rubber coarse aggregate mixed dry until mixture is thoroughly blended and is uniform in color.
3. Then coarse aggregates are added and mixed with the cement, scrap tyre rubber coarse aggregate and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch.
4. Then water added and the entire batch mixed until the concrete appears to be homogeneous and the desired consistency.

2.8 Construction of Prototype room

The project is based on construction of 4 prototype rooms. The 4 prototype rooms of size 1m x 1m x 1m and having wall thickness 0.1m are casted at the corner of a square of size 4m x 4m. As per plan, the centre to centre distance between two adjacent rooms is 3.5m. Then the centre of that square is marked at crossing point of both diagonals of square.

For casting rooms the wooden mould (ferma) is made. The outer size of ferma is 1m x 1m x 1m and inner size 0.8m x 0.8m x 1m. The ferma is supported by battens. The battens are supported to each other in perpendicular direction so as to remove easily after setting of concrete.

The walls of first room are casted by using traditional concrete. The walls of second room are casted by using modified concrete, by replacement of natural aggregate with scrap rubber tyre aggregate in a proportion of 6%. The walls of third room are casted by using modified concrete, by replacement of natural aggregate with scrap rubber tyre aggregate in a proportion of 12%.

The interior surface of the assembled mould is thinly coated with oil to prevent adhesion of the concrete. The walls of the room are filled in layers. Each layer is compacted by using tamping rod and stokes of the rod distributed in a uniform manner over the cross section of all four walls. After the compaction of top layer, the surface of the concrete is to be levelled out at the top of the wall. After the setting of concrete

for 24 hours, the moulds (ferma) are removed and then curing is done for 28 days.

2.9 Plan

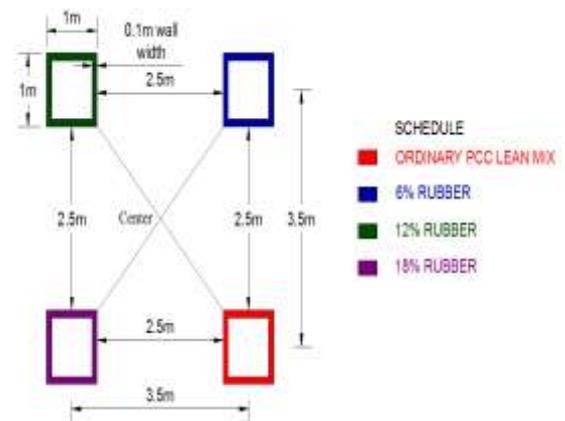


Figure 2: Plan of Prototype Rooms

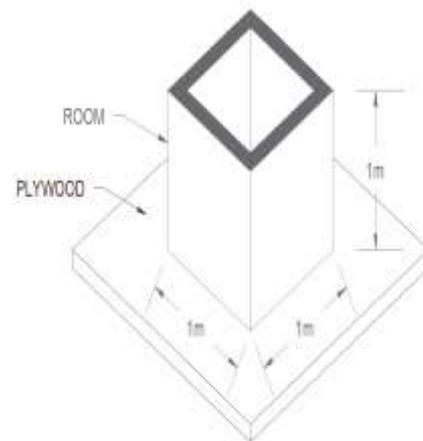


Figure 3: Plan of Single Prototype Room

2.10 Sound Insulation properties of room

To examine the sound insulation properties of rubberized concrete, the digital sound meter is used. Sound level meter is placed at the centre of each room as well as at the centre of all four walls. All rooms are covered with glass sheet. Sound is generated at centre of all rooms. Sound intensity is measured in decibel (dB) at the centre of each room and at centre of all room and comparative study is done.



Figure 4: Testing of Sound Intensity

2.11 Heat Insulation properties of room

To check the heat insulation properties of rubberized concrete, the thermometer of range 0 – 50⁰ is used. The beakers containing water are kept in each room and at the centre of all room. Temperature of water in each beaker is measured after each hour for 24 hours.



Figure 5: Testing of Heat Intensity

3. RESULTS AND DISCUSSION

3.1 Results of test on material

3.1.1 Results of Test on ¾” Aggregate

Table 2: Test carried on ¾” Aggregate

Test	Result
Fineness modulus	2.68
Specific Gravity	2.88
Water absorption	1.393%
Flakiness index	14.73%
Elongation index	14.55%
Crushing strength	22.63%
Impact Value	15.02%

Discussion:-

- As per IS 2386(part3)-1963 the permissible limit of Water absorption is in between 0.5 to 2 %. Therefore the calculated water absorption is within permissible limit.
- As per IS 2386(part1)-1963 the permissible limit of Flakiness index is in between 10 to 15 %. Therefore the calculated Flakiness index is within permissible limit.
- As per IS 2386(part1)-1963 the permissible limit of Elongation index is up to 15%. Therefore the calculated Elongation index is within permissible limit.
- As per IS 1383-1970 permissible limit of Crushing strength is up to 30%. Therefore the calculated Crushing strength is within permissible limit.

3.1.2 Results of test carried on sand.

Table 3: Test carried on sand.

Test	Fineness modulus	Specific Gravity	Water absorption
Result	4.18	2.66	1.878

Discussion:-

1. As per IS 2386(part-3)-1963 the permissible limit of Water absorption is in between 0.5 to 2%. Therefore calculated Water absorption is within permissible limit.

3.1.3 Results of test carried on Scrap Tyre Rubber Coarse aggregate

Table 4: Test carried on Scrap Tyre Rubber Coarse aggregate

Test	Specific Gravity	Water Absorption
Result	1.048	3.64

Discussion:-

- As per IS 2386(part-3)-1963 the permissible limit of Water absorption is in between 0.5 to

2%. Therefore calculated Water absorption is not within permissible limit.

3.1.4 Results of test carried on Cement.

Table 5: Test carried on cement

Test	Result
Standard consistency	34%
Initial setting time	115 minutes
Final setting time	390 minutes
Soundness	19.5 mm
Fineness	14%
Compressive strength	49.3 N/mm ²

Discussion:-

- As per IS 12269 for 53 Grades PPC Initial setting time shall not less than 30 minutes.
- As per IS 12269 for 53 Grade PPC Final setting time is not more than 600 minutes.
- As per IS 12269 for 53 Grade PPC Soundness is up to 10 mm. Soundness is 2mm which is less than 10mm therefore it satisfies IS requirement.
- As per IS 12269 for 53 Grade PPC Compressive strength is 53 N/mm². Compressive strength is 53.1 N/mm² therefore it satisfies IS requirement.

3.2 Results of test for sound insulation

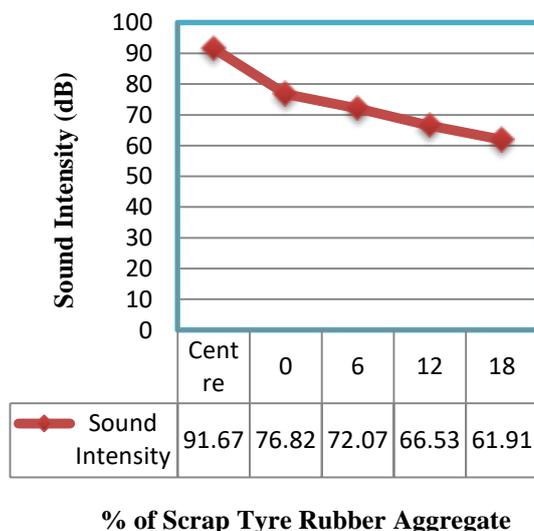


Figure 6: Result of sound insulation of concrete

Discussion: -

- The maximum intensity of sound is 91.67dB which is at centre.
- The sound intensity at 0% replacement of ¾” scrap tyre rubber aggregate is 76.82dB.
- The sound intensity at 6% replacement of ¾” scrap tyre rubber aggregate is 72.07dB i.e. 7% less than that of at 0% replacement.
- The sound intensity at 12% replacement of ¾” scrap tyre rubber aggregate is 66.53 dB i.e. 13.40% less than that of at 0% replacement.
- The sound intensity at 18% replacement of ¾” scrap tyre rubber aggregate is 61.91 dB i.e. 19.50% less than that of at 0% replacement.

3.3 Result of test for heat insulation

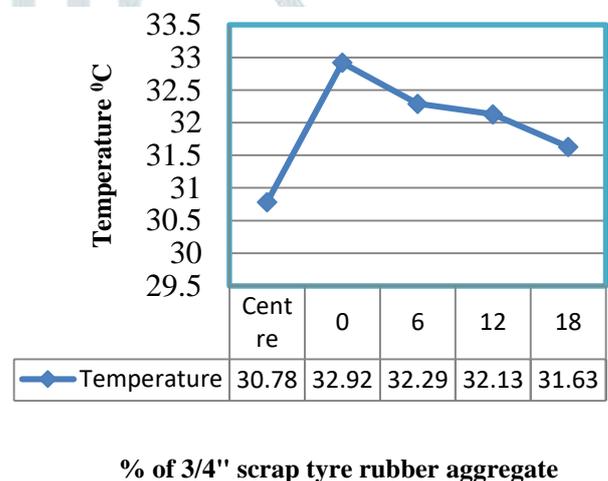


Figure7: Result of heat insulation of concrete

Discussion: -

- The heat intensity measured at center is 30.78⁰C.
- The heat intensity at 0% replacement of ¾” scrap tyre rubber aggregate is 32.92⁰C.
- The heat intensity at 6% replacement of ¾” scrap tyre rubber aggregate is 32.29⁰C i.e. 2% less than that of at 0% replacement.
- The heat intensity at 12% replacement of ¾” scrap tyre rubber aggregate is 32.13⁰C i.e. 3.40% less than that of at 0% replacement.
- The heat intensity at 18% replacement of ¾” scrap tyre rubber aggregate is 31.63⁰C.
- At 18% replacement of ¾” scrap tyre rubber aggregate the heat intensity is decreased by 5% that of at 0% replacement.

CONCLUSION

- The Engineering properties of the cement, sand, aggregate is determined by IS methods are well within acceptable range.
- The modified concrete mix using scrap tyre rubber coarse aggregate performs satisfactorily on various tests, with acknowledgement to the proportional relationship between its rates of strength-loss and contain of the rubber in the mix. Mixing, casting and compacting of the concrete mix using ¾” scrap tyre rubber coarse aggregate with local materials can be carried out in a similar fashion to that of traditional concrete mix.
- Modified concrete casted using ¾” scrap tyre rubber aggregate as a partial replacement to coarse aggregate shows reduction in density of concrete compare to traditional concrete.
- As density of concrete reduces, self-weight (Dead load) of the structure reduces. Therefore design becomes economical.
- At the 6% replacement of ¾” scrap tyre rubber aggregate, the sound transmittance & heat conductance are respectively 7% & 2% less compared to the plain concrete.
- At the 12% replacement of ¾” scrap tyre rubber aggregate, the sound transmittance & heat conductance are respectively 13.40% & 3.40% less than that of at 0% replacement of ¾” scrap tyre rubber aggregate.
- At the 18% replacement of ¾” scrap tyre rubber aggregate, the sound transmittance & heat conductance are respectively 19.50% & 5% less than that of at 0% replacement of ¾” scrap tyre rubber aggregate.
- The sound intensity is getting reduced with increase in % of scrap tyre rubber aggregate. Therefore it can be very useful in the areas such as hospitals, schools & no honker’s zone.
- 9. As such a concrete have effective heat conductance, it can be useful in the cold weather areas, hilly areas.
- 10. Such concrete maintains the temperature; therefore it can be useful in hot weather areas like deserts.
- 11. The amount of scrap tyre being accumulated in 21th centuries has created a big challenge for their disposal, thus obliging the authorities to

invest in felicitating the use of ¾” scrap tyre rubber aggregate in concrete as the use of concrete is fundamental to the booming construction industry.

REFERENCES

1. Aan E.Richardson, K. A. (2012). Freeze/thaw Protection of Concrete with optimum rubber crumb content. cleaner production , 96-103.
2. Anh Cuong Ho, A. T. (2011). Effect of ribber aggregate from grinded used tyres on the concrete resistance to cracking. Cleaner Production , 209-215.
3. B.Kardon, J. (1997). polymer-Modified Concrete. Materials in Civil Engineering , 85-92.
4. Bala Muhammad, Mohammad Ismail, Zaiton Haron , Abduirahman Ali Yussuf. (2011). Elastomeric effect of natural rubber latex on compressive strength of concrete at high temperature. Material of civil engineering . Materials in Civil Engineering , 1697-1702.
5. Bala Muhammad, M. I. (2012). Influence of non-hydrocarbons on the compressive strength of natural rubber latex-modified concrete. Construction and Building Materials , 241-246.
6. Bala Muhammad, M. I. (2012). performance of Natural rubber latex modified concrete in acidic and sulfated environments. Construction and Building Materials , 129-134.
7. Baoshan Huang, G.-S. P. (2004). Investigation into Waste tyre rubber-filled Concrete. Materials in Civil Engineering , 287-194.
8. Bashar S.Mohammed, K. M. (2011). Properties of Crumb rubber hollow concrete blocks. Cleaner Production , 57-67.
9. C.Vipulanandan. (1993). Characterization Of Polyster Polymer and Polymer Concrete. J.Mater.Civil Engineering , 62-82.
10. Caijun Shi,Dehui Wang, A. B. (2012). Review of Thaumasite Sulphate Attact on Cement Morar and Concrete. Materials in Civil Engineering , 1450-1460.
11. Chao wang, Y. z. (2011). 20. Chao wang, Yamei zhang , Investigation into the fatigue damage Process of Rubberised Concrete and

- Plain Concrete by AE Analysis. . 20. Chao wang, Yamei zhang , Aibin Ma. (2011). Investigation into the Material in Civil Engineering , 953-960.
12. Clay Naito, J. S. (2013). 21. Clay Naito ,Joe States, C Assessment of Crumb rubber concrete for flexural structure member. Materials in Civil Engineering .
13. Concrete, D. o. (2007). iiker Bekir Topcu. Materials in civil Engineering , 173-178.
14. F.Pacheco, Y. D. (2012). Properties and durability of concrete containg polymeric wastes(tyre rubber and polythylene terephthalate bottles) An overview . . Construction and Building Materials , 714-724.
15. Felix udoeyo, H. I. (2006). Potential of wood waste ash as an additive in concrete. Materials in Civil Engineering , 605-611.

