A Review on Cost Effective And Eco-Friendly Use Of Waste Tyre Chips As Coarse Aggregate In Concrete

Pankaj Dayaram Kute[1], Vaishnavi Manohar Tayade[2], Mayuri Shivdas Tayde[3], Pranali Vinayakrao Gurjar[4]
[1]Assistant Professor, Dept of Civil Engineering
[2, 3, 4]Dept of Civil Engineering
[1, 2, 3, 4] MGI-COET, Shegaon, Maharashtra, India.

Abstract- *Due to increase in demand of natural resource aggregate there is need to find alternative material as replacement of aggregate. In the last few years, researcher studied the use of fiber, coir, rise husk, plastic, synthetics etc. to enhancing the properties of concrete using this material. In this study, the main aim is to replace the coarse aggregate by waste tyre to reduce the cost of constructions also preventing natural resource. Day by day there is shortage in availability of natural aggregate that's why there is increase in the rates of coarse aggregate. So by using waste tyre rubber chips as partially replacement of coarse aggregate it may help to reduce cost of construction. Use of waste tyre rubber chips as partially replacement of coarse aggregate in concrete also help to minimize environmental impact because 1.6 billion of new tyres are manufactured per year and out of them 1 billion tyres are generated as waste. However, the recycling industry processed only 100 million tyres per year. Hence, in order to identify potential recycling option in civil engineering the literature study is carried out. From this study, the think is obtained that waste tyre rubber chips are replaced by coarse aggregate by partially with percentage in between 5 and 30% in concrete to use in building constructions. The review on literatures represent that with increase in percentage of replacement there is decrease in strength of hardened concrete. But there is increase in durability as compare to conventional concrete and density reduce with increase in percent of waste tyre rubber chips. From survey of literature reviews is observed that waste tyre rubber chips concrete may be used as light weight concrete and also nonstructural applicant in building construction.*

Keywords- Coarse aggregate, waste tyre rubber chips, light weight concrete, durability, low cost construction, environmental friendly.

I. INTRODUCTION

Now days, cost of construction is increases day by day. In this essence, this literature study aims to utilize waste tyre as construction material in concrete to reduce cost of construction. Due to increase in demand of concrete structures there are increase in cost of construction because lack of availability of natural resources such as fine and coarse aggregate. Due to shortage of this natural resources it is essential to find replacement of that material. The waste rubber as partial replacement of aggregate in concrete has moved toward to enhance the properties of concrete in a wide spectrum. Concrete is the most popular construction materials. So that the construction industry is always trying to increase the use of waste tyres and its applications and improving its properties, while decreasing cost. And it also helps to decrease environmental pollution. Tires are bulky and having 75% void space tyre, so that the land filling of scrap tires faced several difficulties as whole tire requires a large amount of space for landfilling. So that it required high cost due this difficulty. Tyre stores have turned up across the country. The waste tires signify a major environmental, human health, and aesthetic problem. The properties of scrap tires have made waste tire stockpiles difficult.

In every year, near about one billion tyres are manufactured globally, and the same number of tyres are permanently removed as waste from automobile industry. Every year U.S. produce of waste tyres about 290 million, although growths in new automobiles trades in China and India are speedily contributing to waste tyre volumes. Modern tyres are basically rubber products, they are having a complex mixture of natural and synthetic rubbers, and structural strengthening elements. This complexity has been led to stockpiling, dumping and landfill. This causes environmental and health risks and has wasted valuable resources locked up in tyre landfills. Another risks include the still water in tyres that be responsible for breeding grounds for mosquitoes and leaching of toxic elements into soils. Worldwide, in 2011, only 7% of waste tyres were recycled, 11% were burned, 5% were transported for treating. The outstanding 77% were sent to landfills, stored, or illegally dumped; the corresponding of some 765 million tyres a year wasted. India's waste tyres accounted about 6-7% out of the total waste tyre produced globally.The local tyre industry are growing 12% per annum which results in waste volumes are rising. India has been recycling and reusing waste tyres from four decades. And also it estimated that 60% are disposed through illegal dumping. Despite this, the second major producer of reclaimed rubber is

India after China. India was formed 90,000 metric tonnes of reclaimed rubber from waste tyres in 2011. So the use waste tyre rubber chips as partial replacement in concrete is ideal use which reduce not only cost but also eco-friendly. It can be termed as 'green concrete'.

In this literature review study, researchers investigated feasibility of partial replacement of coarse aggregate by waste tyre chips. Shredded rubber, crumb rubber etc. in concrete and how the concrete is affected by mixture rubber in concrete and there bonding strength also determined. From literature study, Researchers have considered waste tire rubber dimensions of about 15–20 mm and used to replace the coarse aggregates in concrete. 15-20 mm size of rubber chips are used in mix design of concrete at different percentage replacement of coarse aggregate and tested for hardened properties of concrete. On the other hand, and for so many years, material researchers have attempted to create concrete a ductile material. Due to the brittle nature of concrete, the direct and effective approach in creating damage tolerant concrete structures would be to induce basic tensile ductility into concrete. Waste tyre rubber is tough in nature that why it helps to increase split tensile strength of concrete. Also, as per researcher result the partial replacement of coarse aggregate by waste tyre is suitable in between 5-15%. In between there no major change strength of concrete. But increase percentage show decrease in strength of concrete.

And also use of waste tyre chips increase the ductility of concrete, shock resisting, and decrease density of concrete so, it can be used as light weight concrete as non-structural applicant. Also rubberized concrete may be suitable for an architectural application like a stone baking, interior constructions, and in building can be used as an earthquake shock wave absorber. Further it can be used for vibration damping which required at foundation for machinery. And it can also use for railway station such as jersey barrier, railway buffers, bunkers and for trench filling. One of the potential uses of rubcrete may be its use in execution of rooftop surfaces for insulation and waterproofing.

II. LITERATURE REVIEW

From the literature review study, the feasibility of waste tyre as replacement of coarse aggregate in concrete is carried out. Now days increase in demand of concrete structure it cost is increase as well as the material required for concrete their cost is not only increased rapidly but also effect on their availability. In order to reduce the cost of concrete is essential to find out alternate material for coarse aggregate this study is conducted. So the main objectives of this study are to check the performance of concrete by using partial replacement of coarse aggregate by waste tyre rubber chips and effect on the hardened properties is also observed form this review. And whether it is feasible for building construction is also determined.

Eshmaiel Ganjian, Mortezan Khorami, (2009): In this research author investigated that the performance of concrete mixes including 5, 7.5 and 10 % of waste tyre rubber as aggregate and cement. Several projects have been conducted on replacement of aggregates by crumb rubbers. To study characteristics of tyre crumb rubber concrete, two sets were made. In the first set coarse aggregate replaced by waste tyre chips and in second set scrap tyre powder was replaced for cement. For examination mechanical tests were conducted such as compressive strength, tensile strength, flexural strength and modulus of elasticity. The results revealed that with up to 5 percent replacement, in each set, there were no major changes in concrete characteristics but in further increase in replacement ratios significant changes were observed [1].

K. C. Panda, P. S. Parhi and T. Jena, (2012): In this paper author works on causes of decrease in the strength of concrete when waste tyre rubber was used. The causes are as follows. Lack of appropriate bonding among waste tyre rubber particles & the cement paste. Due to replacement of the aggregates by waste tyre rubber, the weight was decreased. High concentration of waste tyre rubber at the upper layer of sample due to lesser specific gravity of the waste tyre rubber particles. Due to non-uniform distribution of rubber particles in the concrete, which in turn results in decrease in concrete strength. The stiffness of rubber is lesser than compare to stiffness of coarse aggregate, the presence of rubber particles in concrete reduces the concrete mass toughness and also decreases load bearing capacity of concrete [2].

Parveen, SachinDass, Ankit Sharma, (2013): In this paper author work on reuse of used waste tyre which is a major ecological problem all over the world. So use of crumb rubber as construction material in concrete to reduce environmental hazards. This study is carried out to achieve the use of rubber waste as partial replacement of fine aggregate to produce rubberize concrete in M30 mix. At 15 and 20% by volume of fine aggregate were cast. And tested for hardened concrete test such as, compressive strength, flexural strength, split tensile strength and stress-strain behavior. The results presented that there was a decrease in strength of concrete for crumb rubber mixture, but slump values rise as increase in crumb rubber from 0% to 20%. It is recommended for more workable concrete, and it also uses as light weight concrete and nonstructural applicant [3].

Kotresh K.M, Mesfin Getahun Belachew, (2014): The author of this paper discovered that, despite the lower compressive strength of rubberized concrete compared to conventional concrete, there is a large market for concrete products that include rubber aggregates, allowing for the reuse of discarded rubber tyres, which is a major source of pollution in the environment. Rubberized concrete's strength can be improved by enhancing the rubber particles' binding characteristics. Tyre recyclers account for roughly 20 of India's 36 tyre manufacturers, with only four or five making a significant contribution. M/S Gujarat Reclaim, for example, has an annual revenue of over Rs.15 crores from its tyre recycling operations in Haridwar (Uttarakhand, India), which produce 20 tonnes of reclaim rubber per day. Quality rubber aggregates in 20-10mm, 10-4.75mm, and 4.75 mm downsizes should be available from tyre recycling plants for use as cement concrete aggregate [4].

S. F. A. Shah, A. Naseer, A. A. Shah, M. Ashraf, (2014): In this paper author investigated that performance of concrete mixtures including 5, 10 and 15% of scrap rubber as replacement for coarse aggregate was investigated. The following test were conducted such as compressive strength, flexural strength, stress-strain behavior, workability, air content, water absorption and unit weight by using standard methods. Thermal behavior for concrete was observed using hotbox technique. No significant variations in concrete properties up to 5% substitution were happened. Further than 5% substitution, concrete properties change considerably. Compressive strength, flexure strength, workability, stiffness and unit weight of rubberized concrete reduced as rubber content increased. And also impact resistance, air content and water absorption of rubber mix concrete increased with increase in rubber content. Thermal performance of concrete containing rubber aggregate was upgraded, and favorable results were obtained. Thus, rubberized concrete could be useful in slabs to improve energy efficiency of building unit [5].

Ali Raza Khalid, M. Haris Hameed, (2015): The author of this paper work on partial replacement of coarse aggregate and fine aggregate by two different types of rubber such as crumb rubber and ground rubber at percentage of 5 to 40% respectively. This paper studies the fresh and hardened properties like workability, unit weight, air content, toughness and strengthening properties of rubber concrete. Adding of rubber reduced slump value and 40 % replacement gave zero slump. The concrete mixtures presented worse compressive strength as compare to normal. These mixtures did not define brittle failure, in any case rather a flexible, plastic failure, and had the ability to integrate a lot of plastic vitality below tensile and compressive loads. Taking this results, it was considered that the 5-10% replacement in concrete could be more suitable option to create light weight concrete without major slump and compressive strength loss [6].

Prof. Waruldkar A., Mr. Valekar N. S., (2015): According to author study, the rise in automobile industry there were major challenge in front of solid waste management to dispose the automobile waste. The non-degradable nature of the rubber and consequent disposal problem has led to a serious ecological impact in the recent decades. Due to non-degradable nature of waste tyre rubber there were serious impact on environment. To recover this problem much research had been done. The using this discarded material in concrete can be resolved these problems. It is expected that 60 percent discarded tyres are disposed via unfamiliar routes in the city as well rural area. It causes environmental impact, so it can be used as construction material because concrete is widely used material in construction. This certainly led to a constant and increasing demand of natural material used for their production and also to preserve natural resources by using alternative material which are reused waste material. In these research the use of recycled rubber waste tyre as a partial replacement for the coarse aggregate in concrete construction by using locally available waste tyre. The concrete mix design was prepared by using M-20 grade of concrete. The specimens were cast at a percentage replacement of coarse aggregate by waste tyre such as 1%, 2% and 5%. The prepared samples contain of concrete cubes, cylinder, beams. The tests conducted are slump, workability, compressive strength, Tensile strength, Flexural strength. The data collection was based on the tests conducted on specimens in the laboratory [7].

S. Selvakumar, R. Venkatakrishnaiah, (2015): In this paper author investigated that the compressive strength of nominal concrete and replacement of coarse aggregate by crumb rubber in concrete. Crumb rubber concrete with 5% replacement was 38.66 N/mm^2. It is greater than the strength of nominal concrete (36.73N/mm^2) on 28th day. The compressive strength of crumb rubber concrete at 10% replacement that showed satisfactory strength of 3.47 N/mm^2at 7 days. In split tensile strength, the strength of crumb rubber concrete was lesser than the strength of nominal concrete. In the flexural test, it showed a reduction in strength when compared to the strength of normal concrete. The test results show that the crumb rubber had less bonding strength which has affected on the strength of the concrete [8].

I. Rohini, V Arularasi, AC LalithaMutha, (2016): The disposal of waste tyre becomes major problem globally so in this paper author work on use of waste tyre in construction industry. It is expected that 1.2 billion of waste tyre rubber

manufactured worldwide per year and out of them 11% of postconsumer tyres are transferred and 27% are sent to landfill, stored or discarded illegally and only 4% is used for civil engineering projects. Hence, efforts have been taken to identify the potential use of waste tyres in civil engineering industry. In this study waste tyre use as coarse aggregate in concrete mixture. A total 24 cubes and 12 prisms was cast of M25 grade with replacement of waste tyre as coarse aggregate at 10, 20 and 30 % respectively. And compared with nominal M20 grade concrete. Hardened properties of concrete is determined [9].

Zunaithur Rahman. D., Jeyamugesh. S., Sivaranjani. S., and Vijayaraghavan. J.(2016): In this literature the author worked on reuse of waste tyre rubber. Because of growth in automobile production vast amounts of waste tyre essential to be disposed. Due to lack of area of landfilling, many countries banned the disposal of waste rubber tyre in landfills. Hence, to identify the possible use of waste rubber tyre in civil engineering projects. In this essence, study goals to use waste rubber tyre aggregate with replacement of coarse aggregate to make rubberized concrete of M20 grade of mix. At different 0, 10, 20 and 30% partial replacements of rubber aggregate by volume of coarse aggregates were cast and tested for compressive strength in water as well as in acid curing on 14 and 28 days. The results show that at 10% the compressive strength was higher than further replacement of coarse aggregate by waste tyre. It was suggested to use the rubberized concrete for nonstructural uses [10].

Mohammed Mudabheer Ahmed Siddiqui, (2016): The author of this research studied the use of scrap tyre rubber chips as coarse aggregate in place of standard coarse aggregate. Concrete is mostly used construction materials. The construction industry's uses and applications are constantly expanding. As a result, alternative materials must be found to minimize the cost of concrete. Non-biodegradable garbage, such as water bottles, cold drink bottles, disposable glasses, shredded or crumbed rubber, and other non-biodegradable waste, on the other hand, is causing a lot of difficulties in the environment, and its disposal is becoming a major challenge. The purpose of this study is to look at using rubber fragments as coarse aggregate in concrete. Rubber percentages ranging from 0% to 15% of typical particles were tested in concrete. Concrete's compressive strength is measured, and a comparison is made [11].

ParthSaika, OwaisMushtaq and A. Arunya, (2016): The author of this research discovered that the disposal of waste tyres is a big concern all over the world because it generates environmental issues. Our major goal was to use leftover tyre rubber chips as a partial replacement for coarse aggregate in concrete. The utilization of leftover tyre rubber chips in concrete is both cost-effective and environmentally benign. The strength of concrete was tested using discarded tyre rubber chips as a partial replacement at varying percentages. Compression and split tensile tests were carried out at different percentages of rubber chips at 7 days curing period. The tests result show that as the percentage of rubber chips rises, lesser will be the strength of the concrete. But in case of 4% replacement of waste tyre rubber chips in concrete it shows the maximum strength compared to the other percentage replacement. The observed strength of control specimens and 4% replacement of waste tyre rubber chips in concrete establish to be nearly identical [12].

Priyanka Asutkar, S.B. Shinde, Rakesh Patel, (2016): In this paper author prepared a modified concrete which made up of mixture containing replacement of coarse aggregate by waste tyre at proportion from 0% to 20% with increase of 5%. Three cubes for each percentage of replacement were cast and tested after 28th days of curing. The mechanical properties like density, compressive strength and elastic properties of modified concrete were determined from testing of concrete cubes and additional stresses and displacement at every 50 mm depth of beams were determined analytically by method of initial functions (MIF). MIF is an analytical method in which elastic properties and theoretical loads were used to analyses the beams without conducting any experimental programed. The analytical results by MIF were compared with bending theory [13].

Sulango Banerjee, Aritra Mandal, Dr. Jessy Robby, (2016): In this paper author investigated that due to the rapid growth in automobile industry, there is increase in production of tyres per year. So disposal of waste tyre causes measure problems in India and globally also. It is projected that 1.2 billion of waste tyre formed worldwide in a year. It is estimated that the waste tyre generated in which 11% of postconsumer tyres are transferred and out of them 27% are sent to landfill, stockpiled or dumped illegally and only 4% is used for civil engineering. Hence, efforts had been taken to recognize use of waste tyres in civil engineering as construction material. In this study, total of 12 prisms were cast and M25 grade was used. And with replacement of coarse aggregate at 5, 10, 15, 20, 25 percent by rubber tyre aggregate and compared with regular M25 grade concrete. Also, properties of hardened concrete also determined such as flexural strength, compressive strength, spilt tensile strength of concrete [14].

Imran Khan, Dr. Sanjay Sharma, Mir Aijaz, (2018): In this paper author investigated that sound absorption behavior of rubberized concrete. Waste tyre disposal is measure issues in

India and worldwide. Because of environmental problem associated with the disposal of waste automobile tires Then this study discovers the opportunity of recycling tire waste in concrete as civil engineering uses through improving the properties of concrete mix as partial replacement with coarse aggregate to produce perfect concrete mixture. And also to make eco-friendly disposal of waste tyre. In this study, percentage replacement of coarse aggregateby tyre aggregatewas 0%, 10%, 20%, and 30% respectively in concrete. Flaked type of waste tyre usually 20mm in size are used as coarse aggregate. Tests were conducted to conclude slump performance, flexural strength, density calculation, water absorption for control and rubberized concrete mix of M25 [15].

ShahidRasool Tarry, (2018): In this paper author investigated that rubber has great ability of becoming an everlasting member of concrete because of its extensive range of decent properties like better flexibility, light weight and easy availability. It can be very eco-friendly to use this discarded material in construction industry. Treated rubberized concrete has more compressive strength as compared to the untreated rubberized concrete. The surface treatment was conducted on the rubber, in which only 92.57% compressive strength of normal conventional concrete was recovered. Flexural strength and split tensile strength of treated rubberized concrete was found more than the normal conventional concrete. After 28 days flexural and split tensile strength was found to be topmost at NTR-5 and NTR-15 respectively. The resolution of this study was to determine if a waste material like worn out tyres enhance the basic propertiesof concrete. It is considered that used tyres would provide much greater opportunities for value adding and cost recovery, as it could be used as a replacement for more expensive material such as rock aggregate. Using rubber aggregates decreases the workability of the resultant mix, but this problem can be dealt with the use of the certain plasticizers [16].

III. DISCUSSION

Eshmaiel Ganjian was tested partial replacement waste tyre rubber feasibility in concrete as coarse aggregate. The results specified that up to 5 percent replacement there were no major changes in concrete physical characteristics. And further increase in replacement ratios showed the changes in strength of concrete. K. C. Panda discussed on causes due which decrease in the strength of concrete when waste tyre rubber was replaced as coarse aggregate. Such as poor bonding strength waste tyre rubber particles & the cement paste and non-uniform distribution of rubber particles in the concrete. Sachin Dass research on reuse of recycled waste tyre which is a major environmental problem all over. So identifying the use waste tyre as fine aggregate in concrete. And they suggest that with use of waste tyre aggregate in concrete as light weight concrete and non-structural applicant. Kotresh K.M discovered that, use of waste tyre rubber gives lower compressive strength of rubberized concrete compared to conventional concrete. S. F. A. Shah tested performance of concrete mixes with 5, 10 and 15% of scrap rubber as replacement for coarse aggregate and Thermal behaviour for concrete was determined using hotbox technique. No significant differences in concrete properties up to 5%. Further than 5% substitution, concrete properties change significantly. He discussed that Compressive strength, flexure strength, workability, stiffness and unit weight of rubberized concrete decreased as rubber content increase. Ali Raza Khalid worked on partial replacement of coarse aggregate and fine aggregate by two altered types of rubber such as crumb rubber and ground rubber at percentage of 5 to 40% respectively in concrete. He concludes that the 5-10% replacement in concrete could more right option to make light weight concrete without major slump and compressive strength loss. Prof.Waruldkar A investigated that the growth in automobile industry the non-degradable waste tyre rubber led to a serious ecological impact in the recent decades. To recover this problem a good deal of research done. The using this discarded material in concrete can be reduced these problems. S. Selvakumar, R. investigated the comparative difference in compressive strength of nominal concrete and replacement of coarse aggregate by crumb rubber in concrete. In which crumb rubber concrete with 5% replacement have compressive strength 38.66 N/mm^2. It is greater than the strength of nominal concrete (36.73N/mm^2) on 28th day. Zunaithur Rahman was discussed to use the rubberized concrete for non-structural uses. Priyanka Asutkar examined a modified concrete which made up of mix which contained replacement of coarse aggregate by waste tyre at percentage from 0% to 20% with increase of 5%. Three cubes for each percentage of replacement were cast. Also tested after 28th days of curing. The hardened concrete properties like density, compressive strength and elastic properties of modified concrete were examined from testing of concrete cubes and extra stresses and displacement at each 50 mm depth of beams were observed by method of initial functions (MIF). Sulango Banerjee discussed that due to the rapid growth in automobile industry, there is increase in problem of disposal of waste tyre. Which causes measure concerns in India and globally. It is estimated that 1.2 billion of waste tyre rubber produced worldwide per year. It is estimated that 11% out of them tyres are exported and 27% are sent to landfill, stockpiled or dumped illegally and only 4% is reused for civil engineering projects. Dr. Sanjay Sharma studied percentage replacement of tire waste as coarse aggregate at 0%, 10%, 20%, and 30% respectively. Crumbled

type of waste tyre commonly 20mm in size used as coarse aggregate. Tests were conducted on slump cone, flexural strength, density and water absorption for rubberized concrete mixture of M25 and nominal concrete. Shahid Rasool Tarry discussed that used of tyres would provide much greater opportunities for value adding and cost recovery in construction by using as replacement for costlier material such as aggregate. Using rubber aggregates reductions in the workability of the resultant mix, but this problem can be rectifying by the use of the plasticizers.

REFERENCES

[1] Eshmaiel Ganjian, Mortezan Khorami*, "Scrap tyre-rubber replacement for aggregate and filler in concrete"*, Construction and Building Materials, Volume 23(5): 1828-1836, 2009.

[2] P. S. Parhi, K. C. Panda, T. Jena, *"Scrap Tyre-Rubber Replacement for Aggregate in Cement Concrete: Experimental Study"*, International Journal of Earth Sciences and Engineering, ISSN 0974-5904, 2012.

[3] Parveen, SachinDass, Ankit Sharma, *"Rubberized Concrete: Need of good environment (overview)"*, International Journal of Emerging Technology and Advanced Engineering (ISSN2250-2459), volume 3, Issue,2013.

[4] Kotresh K.M, MesfinGetahunBelachew, *"Study On Waste Tyre Rubber as Concrete Aggregates"* International Journal of Scientific Engineering and Technology, volume 3, Issue No. 4, 433-436, 2014.

[5] A. Naseer, A. A. Shah,M. Ashraf, S. F. A. Shah,*"Evaluation of Thermal and Structural Behavior of Concrete Containing Rubber Aggregate",* Arabian Journal for Science and Engineering, 2014.

[6] M. Haris Hameed, Ali Raza Khalid, *"Rubberized Concrete (Rubcrete)",* 1st International Multi-Disciplinary Conference, 2015.

[7] Prof. Waruldkar A., Mr. Valekar N. S., *"A Technical and Economical Assessment of Replacement of Coarse Aggregate by Waste Tyre Rubber in Construction"*, International Journal of Engineering Research and General Science, VOLUME 3, 2015.

[8] S. Selvakumar, R. Venkatakrishnaiah, *"Strength Properties of Concrete Using Crumb Rubber with Partial Replacement of Fine Aggregate"*, International Journal of Innovation Research Science, Engineering and Technology, (ISSN 2319-8753), 2015.

[9] I. Rohini, V Arularasi, AC LalithaMutha, *"A Present Study Investigation Based on Partial Replacement of Coarse Aggregate with Waste Tyre Rubber in Concrete"*, International Journal of Emerging Technology (IJLRET), 2016.

[10] Zunaithur Rahman D., Jeyamugesh S., Sivaranjani S., and Vijayaraghavan J., *"Study on Waste Rubber Tyre in Concrete for Eco-friendly Environment",* Innovative Construction Techniques and Ecological Development, ISSN 2472-8640, 1:5 December 2016.

[11] Mohammed Mudabheer Ahmed Siddiqui, *"Study of Rubber Aggregates in Concrete an Experimental Investigation",* International Journal of latest research in Engineering and Technology (IJLRET), ISSN: 2454-5031, 2016.

[12] Parth Saika, Owais Mushtaq and A. Arunya, *"Experimental Study of Replacement of Coarse Aggregate by Rubber Chips in Concrete"*, International Journal of Chemical Sciences, ISSN: 0972-768, 2016.

[13] S.B. Shinde, Priyanka Asutkar, Rakesh Patel, *"Study on the behavior of rubber aggregates concrete beams using analytical approach"*, Engineering Science and Technology on International Journal, (2016).

[14] Sulango Banerjee, Aritra Mandal, Dr. Jessy Robby, *"Studies on Mechanical Propet of Tyre Rubber Concrete"*, SSRG International Journal of Civil Engineering, (2016).

[15] Imran Khan, Dr. Sanjay Sharma, Mir Aijaz, *"Effect of Recycled Waste Tire Rubber as Coarse Aggregate on the Performance of Concrete"* IJET – VOLUME 4 Issue Journal of Engineering and Technology, (2018).

[16] ShahidRasool Tarry, *"Effect of partial replacement of coarse aggregates in concrete by untreated and treated tyre rubber aggregates"*, International Journal of Advanced Science and Research, ISSN 2455-4227, (2018).