A Review Paper on Utilization of Waste Foundry Sand and Recycled Aggregate by Partial Replacement in Concrete

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Abstract **- Waste foundry sand are by-products which appears to possess the potential to partially replace regular sand as a fine aggregate in concretes providing a recycling opportunity for them. Low-cost concrete production by replacement of fine sand with Foundry sand is a new trend and makes effectively use of Waste foundry sand as engineering material by reducing disposal and pollution problem. Providing a recycling opportunity for them. With the rapid development of construction industry leading to excessive natural resource consumption and the deterioration of the environment, the contradiction between the sustainable development of construction industry and the shortage of resources will become more and more severe. At the same time, a large amount of solid waste is produced in the process of construction of new buildings every year. Today, the reuse of construction waste has become a common concern issue and deserves deep researches. It can be foreseen that the recycled aggregate concrete as a method of reuse and recycling of the construction waste will bring considerable economic and environmental benefits.**

The paper reviews the utilization of foundry sand and recycled aggregate as the concrete constituent and the noticeable and important findings from the experimental works of various researchers. After a careful study of large number of research papers on the topic it was felt by the authors to integrate all the important results for streamlining the potential of this area of research. The paper summarizes conclusions of experiments conducted for the properties like strength and durability.

Index Terms **- Waste Foundry Sand (WFS), Recycled Aggregate (RA).**

I.INTRODUCTION

Foundry sand used for the centuries as a molding casting material because it is high thermal conductivity. The physical and chemical characteristics of foundry sand will depend in great part on the type of casting process and the industry sector from which it originates. In the casting process, molding sands are recycled and reused multiple times. Eventually, however, the recycled sand degrades to the point that it can no longer be reused in the casting process. At that point, the old sand is displaced from the cycle as by-product, new sand is introduced, and the cycle begins again. The Waste generated from the industries cause environmental problems. Hence the reuse of this Waste material can be emphasized. Foundry sand is high quality silica sand that is a by-product from the production of both ferrous and nonferrous metal casting Industries. The main objective of this experimental work is to compare the effect of foundry sand in PPC concrete with the conventional cement concrete and to see the effect of foundry sand inclusion in PPC concrete. Also, the study is summarize based on compressive strength, split tensile strength and flexural strength of PPC replaced foundry sand with fine aggregate. Foundry sand is high quality silica sand with uniform physical characteristics. It is by-product of ferrous and nonferrous metal casting industries, where sand has been used for centuries as a molding material because of its thermal conductivity. It is a by-product from the production of both ferrous and non-ferrous metal castings. Waste foundry sand is the effluent of the metal cast industries and automobile industries which act as the mould for the preparation of complicated mechanical materials. The raw sand is used for the process for minimum 100 times. Some resins and chemicals are used for the binding of the sand. After a single use it is reused in rotation. After continuous

usage it ejected from the industries. This waste foundry sand consists of highly silica coated with a thin film of burnt carbon, residual binder (Bentonite, Sea coal, resins). Depending upon binder used, WFS classified as green sand and chemically bonded sand. Phenolic urethane as chemical binder mostly used in automobile industries. Recently researchers did work in this waste material utilization, and mostly conclude 10% of WFS of replacement in natural sand in concrete mix behaves same and chemical properties. Also, Chemical composition of WFS mostly depends on casting process and industry type. The utilization of recycled aggregate is particularly very promising as 75 per cent of concrete is made of aggregates. The use of recycled aggregates from construction and demolition wastes is showing prospective application in construction as alternative to primary (natural) aggregates. Research on the usage of waste construction materials is very important since the materials waste is gradually increasing with the increase of population and increasing of urban development. The reasons that many investigations and analysis had been made on recycled aggregate are because recycled aggregate is easy to obtain, and the cost is cheaper than virgin aggregate. The recycling of Construction and Demolition Wastes has long been recognized to have the potential to conserve natural resources and to reduce energy used in production. RCAs fit into present day motto of 'Reducing, Reusing, Recycling and Regenerating'. The use of recycled aggregate weakens the quality of recycled aggregate concrete which limits its application. Concrete is a material which is composed of coarse aggregate, fine aggregate, cement, and water these each material in concrete contributes its strength. So, by partial or percentage replacing of material affects different properties of concrete. By using such waste material which harms the environment can be used for the development of low cost and eco-friendly building materials. In this study an experimental investigation is carried out by varying percentage of fine aggregate with waste foundry sand and coarse aggregate with used recycled coarse aggregate to produce low cost and eco-friendly concrete.

II. LITERATURE REVIEW

T. Sravani, et.al.,

Investigated the mechanical properties of concrete mixtures in which fine aggregates was partially replaced with used foundry sand with three percentages 20%, 40% & 60% by weight. Tests were performed for the properties of fresh concrete, compressive strength, split tensile strength were determined at 7 and 28 days. Test results showed that a maximum compressive strength of 48.94 MPa was obtained with 40% replacement of Waste Foundry Sand for 28 days.

Ankur C. Bhogayata, et.al.,

They studied and reviewed other researcher's work and from that they concluded that all researchers gave their findings with concrete up to 30-40% replacement of fine aggregate with foundry sand in which compressive and tensile strength is increased up to 20% whereas not much change occurs in modulus of elasticity. Also, workability is decreases with the increase of foundry sand content because of very fine particles. However, all researchers noted that concrete made with foundry sand can be suitably used in making structural grade concrete. But very few researchers go up to 100% replacement where strength and durability criteria needed to be studied further effectively in future.

Amitkumar D. Raval, et.al.,

Studied the utilization as partial replacement of fine aggregate for establishing sustainable concrete In this study, effect of foundry sand as fine aggregate replacement with M25 (1:1.10:3.38) mix proportion & w/c ratio (0.48) also the percentage of foundry sand used for replacement were (0%, 10%, 20%, 30%, 40%, 50%) by weight of fine aggregate. Based on the test results they concluded that, the Compressive strength increases up to 30% of replacement & decreases suddenly at 40% replacement when compared to ordinary mix without foundry sand at 28 days. The replacement of natural sand with used foundry sand up to 30% is desirable, as cost effective.

Lalramsanga, et.al.,

They researched under the same mix proportions (M-30), the percentage of recycled aggregate that partially replaced natural aggregate by 30% share same strength value with natural coarse aggregate. Up to 30% replacement, the same strength as conventional concrete is achieved. Beyond 30% replacements of

natural aggregate is not suggested as Specific Gravity, water Absorption and Impact value have almost surpass the permissible limit. 100 % replacement of natural aggregate with recycled aggregate is not suggested as it has low workability, Compressive strength and Split tensile strength of concrete. The amount of reduction in workability increases with further replacement of natural aggregate by recycled aggregate increases. Use of Recycled Aggregate as a replacement of Natural Coarse Aggregate provides environmentally friendly and a promising solution to the problem Construction and Demolition waste management.

Bhagyashree Panda, et.al.,
they studied quarried coarse aggregates, used in both flexible and rigid pavement construction by replacing with recycled concrete aggregate (RCA). Different strength tests such as toughness and hardness test of RCA along with compressive strength test of cube and tensile strength test of cylinder with 0, 25, 50, 75 and 100% RCA replacement have been performed. Their results indicated that 50% RCA replacement with coarse aggregates gives satisfactory mechanical properties of concrete namely, compressive strength and tensile strength which can be used to produce high strength concrete mixes for rigid pavement construction. With increase in % of RCA replacement with less water content results in low workability due to their high-water absorption capacity. So the water content in the concrete mix was continuously monitored.

Ankur Gupta, et.al.,
Their study on the literature survey shown that recycled concrete aggregates may cause a reduction in compressive strength if it is used beyond 40%. It also increases creep and drying shrinkage of the concrete. Absorption of water of recycled aggregate increases from 1.5% to 4.6% causing more water demand but some artificial plasticizers can be used to overcome this loss of water and the strength of such concrete made up of recycled aggregate is not lesser of 90% in contrast to conventional concrete.

A.Naveen Arasu , S. Vivek, J. Robison ,T.Thilak Rahjith,
This experimental investigation was done and found out that with the increase in the WFS ratio. Natural sand was replaced with five percentage (0%, 5%, 10%, 15%, and 20%) of WFS by weight. The sum of five concrete mix proportions (M-1, M-2, M-3, M-4 and M-5) with and without WFS were casted and found out how to reduce the slump and to increase workability of fresh concrete. Compression test has been done to find out the compressive strength of concrete at the age of 7, 14, 21 and 28 days. Test result indicates in increasing compressive strength of plain concrete by inclusion of WFS as a partial replacement of fine aggregate. The results also satisfy the acceptable limits set by the American Concrete Institute (ACI).

Srimathi E., Venkatesan M.,
In this study , effect of foundry sand as fine aggregate replacement with M25(1:1.10:3.38) mix proportion & w/c ratio(0.48) also the percentage of foundry sand used for replacement were (0%,10%, 20%, 30%,40%,50%)by weight of fine aggregate Based on the test results they concluded that, the Compressive strength increases up to 30% of replacement & decreases suddenly at40% replacement when compared to ordinary mix without foundry sand at 28 days. The replacement of natural sand with used foundry sand up to 30% is desirable, as cost effective. Kamyad Gull, Amrullah Abdul Rahim Zail

Amanpreet Tangr,
studied on soil stabilization or looked after increasing the load-bearing capacity with some alternative materials or possible waste materials is as an ingredient, that can help soil to improve its bearing capacity strength and mechanical properties of soil. The waste materials for soil stabilization have become popular by considering the environment and economy. In this review paper foundry sand is high-quality size-specific silica sands for use in their molding and casting operations and several million tons foundries sand that can no longer be utilized for the production of metal casting molds and cores. This foundries sand is known as used foundry sand, in most cases, it goes for landfilling which generates anxiety to the environment and also increases cost also because it needs transportation, stuff, and machine. It can be a possible materials to utilizing as an ingredient to stabilized soil and glass fiber is produced from a very fine fiber of glass, glass fiber a superb mechanical properties like a very tensile strength, stiffness, and a flexibility, it is tremendous material for improving soil

bearing capacity or CBR of soil have utilized for soil stabilization in most papers the result determines that foundry sand and glass fiber is superb material improve soil bearing capacity. A possible use for these materials is as an ingredient.

Rvindra N. Patil ,Pravin N. Patil , Kaliash T. Phalak,
Compressive strength of concrete increases with increase in percentage of waste foundry sand as compare to regular concrete in both group of concrete. It was maximum for 15 % replacement. Split tensile strength increases with increase in percentage of waste foundry sand up to 15 % replacement after that it decreases. There was adverse effect on flexural strength of beam model but which was also within the limit as compare to ordinary concrete. Among both group concrete results, second group concrete i.e. concrete containing artificial sand and WFS shows more positive results. Use of waste foundry sand in concrete reduces the production of waste through metal industries i.e. it's an eco-friendly building material. The problems of disposal and maintenance cost of land filling is reduced. Application of this study leads to develop in construction sector and innovative building material. The result of percentage cost change reduces up to 3.5 for 15% replacement of waste foundry sand. This shows that the concrete produced is economical.

Vikas Srivastrava, Avin Harison,
The main objective of this experimental work is to compare the effect of foundry sand in PPC concrete with the conventional cement concrete and to see the effect of foundry sand inclusion in PPC concrete. Also the study is summarize based on compressive strength, split tensile strength and flexural strength of PPC replaced foundry sand with fine aggregate. Workability of concrete made using foundry sand odserved to be increase slightly with replacement level. compressive strength of concrete at 10% replacement level was more than that of referral conventional concrete. At 20% replacement level compressive strength of concrete was comparable to referral conventional concrete. Optimum replacement level of foundry sand as is 10 %.

Pendhari Ankush R.1, Demse Dhananjay G.2, Nikam Madhuri E.3, Karpe Balraj E.4, Khairnar
investigated the performance of fresh and hardened properties of concrete containing discarded foundry sand in place of fine aggregate. They have performed the test on the cubes and cylinders having 20%-100% replacement of foundry sand. They have concluded that the slump of the concrete decrease with increase in the % of foundry sand and the compaction factor increases with increase in the % of foundry sand. The compressive strength of the concrete has increased by 13.42% by the replacement of 20% of foundry sand over normal sand. Their results have concluded that up to the 60% of the replacement of the foundry sand gives rise to the compressive strength of the concrete. The split tensile strength increases up to 60% replacement of foundry sand after that decrease till 100%.

Saif Ali, Rajat Saxene, Sumit Yaday, Satyam Bhati, Nitin Kumar
In this review paper we studied the waste foundry sand as the replacement of fine aggregate in concrete mixture in different proportion (10%, 20%, 30%) respectively after which we compare the compressive strength of concrete having different foundry sand proportion. These foundry sand can also be used as an embankment of roads, yards, backfilling of retaining wall, landfill, traction, etc., It was observed that about 20-30% of replacement of fine aggregate to waste foundry sand gave good result for all practical purpose. Foundry sand can be used in concrete to improve strength and other durability factors. It presents the information about the opportunities for sustainable and economical concrete. good result for all practical purpose. Foundry sand can be used in concrete to improve its strength and other durability factors. It presents the information about the opportunities for sustainable and economical concrete. Manikandan A, Anandha Raj L, Aravindh studied the reuse of waste foundry sand in high strength concrete production. The natural fine sand is replaced with waste foundry sand of 0%, 5%, 10% and 15%. The workability of fresh concrete decrease with increase in proportion of waste foundry sand. The freezing and thawing significantly reduces the mechanical and physical properties of the concrete. studied the replacement of waste foundry sand as a replacement for fine aggregate in High strength solid mansory blocks. This study targeted to gives the solutions for making of commercially available solid mansory

blocks to high strength. Design of blocks were made following IS 10262 – 2009 guidelines and testing of blocks were satisfied using the IS 2185- 1979. It was inferred that about 20 to 30 % of replacement of fine aggregate to waste foundry sand to give good results for all practical purposes.

Aniket Abasaheb Bandal, Mr. Laxam Patil, Mr. Rushikesh Ramrao Latpate, Mr. Saurabh Popat Bhand, Prof. Milind Manikrao Darade,
Studied an investigation was carried out on concrete containing waste foundry sand (WFS) in the range of 0%, 10%, 20%, 30%, and 40% by weight for M-40 grade concrete. Concrete was produced, tested and compared with conventional concrete in plastic state as well as in harden state for workability, compressive strength & split tensile strength. These tests were carried out on standard cube, cylinder for 7 , 28 and 91 days to determine the properties of concrete.

Mr.S.S Jadhav, Dr. S.N. Tande Professor, Mr. A.C. Dubal Assistant PProfessor,
This study presents the information about the civil engineering applications of foundry sand, which is technically sound and is environmentally safe. This research was conducted to investigate the performance of fresh and hardened concrete containing discarded foundry sands as a replacement of fine aggregate. A control concrete mix was proportioned to achieve a 28-day compressive strength of 25 MPa. Other concrete mixes were proportioned to replace 25% and 35% of regular concrete sand with clean/new foundry sand and used foundry sand by weight. Concrete performance was evaluated with respect to compressive strength.

Ramniwas,
Researches all over the world today are focusing on ways of utilizing either industrial or agricultural wastes as a source of raw materials for the industry. These wastes utilization would not only be economical, but may also result to foreign exchange earnings and environmental pollution control. The utilization of industrial and agricultural waste produced by industrial process has been the focus of waste reduction research for economical, environmental and technical reasons.

Smit M. Kacha, Abhay V. Nakum,
investigated fresh and hardened properties of concrete containing waste foundry sand (WFS) replaced with 0 to 100% with fine aggregate. The water to cement for all mixes was kept constant. Testing on hardened properties was mainly conducted at 14, 28 and 56 days. The results show that the incorporation of waste foundry sand in concrete causes a systematic decreases in workability, ultrasonic pulse velocity and strength and an increase in water absorption and shrinkage of concrete. They also reported that an acceptable concrete strength can be achieved using foundry sand.

Sarita Chandrakanth,
Investigated fresh and hardened Properties of concrete containing waste foundry sand (WFS) Replaced with 0 to 100% with fine aggregate. The water to Cement for all mixes was kept constant. Testing on hardened Properties was mainly conducted at 14, 28 and 56 days. The Results show that the incorporation of waste foundry sand in Concrete causes a systematic decreases in workability, Ultrasonic pulse velocity and strength and an increase in Water absorption and shrinkage of concrete. They also Reported that an acceptable concrete strength can Achieved using foundry sand.

Md Shakir Ahmed,
conducted an experiment on “Strength evaluation of recycled-aggregate concrete by in-situ tests”. The compressive strength of concrete was determined at various ages up to 90 days using 100mm cubes. Based on the results, they concluded that for a given water cement ratio, the recycled-aggregate concrete showed a lower strength than that for the natural aggregate concrete. The results also showed that the relationship between the strength and water-cement ratio at both ages follows a similar trend for the recycled-aggregate concrete as well as the natural aggregate concrete.

Ranjitham Mariyappan, Bharani Devi Sivalingam, Buvana Ramesh, Deepak Ramkumar,
In this trial study spent foundry sand is utilized rather than fine total. There is a large number of waste foundry sand created each year in India, there is additionally a removal issue and ecological impacts. Additionally in solid, River sand is utilized as a fine total which is exceptionally less in sum. Tragically, We need an approach to lessen the utilization of River sand and increment the utilization of Foundry

Sand. So Foundry Sand is utilized as a swap for the fine total in concrete. Here, Spent Foundry Sand (SFS) is utilized as a halfway swap for the fine total by 15% and 20% in M20 evaluation of cement. At Long last the trial results and diagram were appeared in this examination.

Md. Safiuddina, Ubagaram Johnson Alengaramb, Md. Moshiur Rahmanb,

Research works commenced more than 30 years ago to investigate the properties of RCA and new concrete including RCA (Frondistou-Yannas 1977). Most investigations conducted in the past were largely limited to the manufacture of non-structural grade RCA concrete due to undesirable physical properties of RCA, such as high-water absorption that increases water demand for a given workability. However, structural grade concrete can also be produced using RCA. According to Shayan and Xu (2003), the use of RCA in high-strength and high-performance structural concretes is possible with the addition of silica fume, and through proper mix design and quality control. Levy and Helene (2004), and Poon et al. (2003) have graded RCA as potentially good for use in structural concrete. Moreover, Hendriks and Pieterson (1998), and Tu et al. (2006) reported that RCA can be used to produce durable and sustainable concretes. Whether used in non-structural or structural grade concrete, RCA provides environmental benefits by reducing the disposal load on landfill sites and conserving natural rock resources that are currently being depleted to produce NCA.

III.CONCLUSION

Based upon above literature review following conclusion were made regarding properties of concrete incorporating waste foundry sand and recycled aggregate.

1. It is found that compressive strength of concrete mix is increases with increase in percentage of waste foundry sand and recycled aggregate as compare to normal concrete. It was maximum for 40% replacement after that it reduces.
2. It is also found that split tensile strength increases with increase in percentage of waste foundry sand and recycled aggregate up to 40% replacement after that it reduces.
3. It is also found that flexural strength increases with increase in percentage of waste foundry sand and recycled aggregate up to 40% replacement after that it reduces.
4. The possibility of substituting natural fine aggregate with industrial by-product aggregate such as waste foundry sand and recycled aggregate offers technical, economic and environmental advantages which are of great importance in the present context of sustainability in the construction sector.
5. As waste foundry sand is waste from metal industries and recycled aggregate is waste from construction industries therefore both waste can be effectively use in concrete mix hence an eco-friendly construction material. By using this waste in concrete, problems regarding to safely disposal is reduced.

REFERENCES

[1] Sravani, G. Anusha D. Mallika "Experimental Study on Partial Replacement of Fine Aggregate with Waste Foundry Sand in Concrete" Journal of Civil Engineering and Environmental Technology P-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 5, Issue 8; October-December 2018, pp. 571-575.

[2] Ankur C. Bhogayata, “USE OF USED FOUNDRY SAND IN CONCRETE: A STATE OF ART REVIEW” IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.

[3] Amitkumar D. Raval, Arti Pamnani, Alefiya I. Kachwala, “Foundry Sand: Utilisation as a partial replacement of Fine Aggregate for establishing Sustainable Concrete”, International Journal of Engineering Sciences & Research Technology (IJESRT), PP: 308 – 311, 4(1), January (2015).

[4] Lalramsanga and Laldintluanga H “Study of Partial Replacement of Natural Aggregate by Recycled Aggregate on Concrete" International Journal of Latest Engineering and Management Research (IJLEMR). ISSN: 2455-4847 www.ijlemr.com || Volume 02 - Issue 11 || November 2017 || PP. 01-06.

[5] Bhagyashree Panda, Nazia T. Imran, and Kundan Samal "A Study on Replacement of Coarse Aggregate with Recycled Concrete Aggregate

(RCA) in Road Construction" Springer Nature Singapore Pte Ltd. 2021 B. B. Das et al. (eds.), Recent Developments in Sustainable Infrastructure, Lecture Notes in Civil Engineering 75.

[6] A Gupta, N Gupta, A Shukla, R Goyal and S Kumar "Utilization of recycled aggregate, plastic, glass waste and coconut shells in concrete - a review" International Symposium on Fusion of Science and Technology (ISFT 2020). IOP Conf. Series: Materials Science and Engineering 804 (2020) 012034.

[7] A.Naveen Arasu, S.Vivek, J. Robinson, T. Thilak, Ranjith, "Experimental analysis of waste foundry sand in partial replacement of fine aggregate in concrete" International Journal of ChemTech Research CODEN (USA): IJCRGG, ISSN:0974-4290, ISSN(Online):2455-9555 2017 Vol.10 No.8, pp 605-622.

[8] Srimati E, Venkatesan M, "Experimental Investigation of Foundry Sand in Concrete" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERTV8IS040360 Vol. 8 Issue 04, April-2019.

[9] Amrullah Abdul Rahim Zai, "Efficiency of Waste Foundry Sand and Glass Fiber on Stabilization of Clay Soil" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERTV9IS010189 Vol. 9 Issue 01, January-2020.

[10] Ravindra N. Patil,Pravin R. Mehetre, Kailash.T.Phalak, "Development of Concrete with Partial Replacement of Fine Aggregate by Waste Foundry Sand" International Journal of Modern Trends in Engineering And Research. e-ISSN No.:2349-9745, Date: 2-4 July 2015.

[11] Alvin Harison, Vikas Srivastava, "Utilization of Waste Foundry Sand as Partial Replacement of Fine Aggregate for Low-Cost Concrete" International Journal of Current Engineering and Technology, E-ISSN 2277 – 4106, P-ISSN 2347 – 5161 Vol.5, No.6 (Dec 2015).

[12] Pendhari Ankush R, "Partial replacement of sand by waste foundry Sand" International Research Journal of Engineering and Technology (IRJET) e-ISSN:2395-0056e-ISSN:2395-0072Volume:04 Issue: 05 may- 2017.

[13] Saif ali, Rajat Saxena, Sumit yadav, Satyam Bhati, Nitin Kumar," A Review Study on of Waste Foundry Sand" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 04 Issue: 04 Apr - 2017p-ISSN: 2395-0072.

[14] Manikandan A, Anandha Raj L, Aravindh P, "Experimental investigation on waste foundry sand for effective utilization in building construction" Research Journal of Chemistry and Environment Vol. 24 (Special Issue I), (2020).

[15] Mr. Aniket Abasaheb Bandal, Mr. Suraj Laxman Patil,Mr .Rushikesh Ramrao Latpate, Mr. Saurabh Popat Bhand,Prof. Milind Manikrao Darade, "UTILIZATION OF WASTE FOUNDRY SAND IN CONVENTIONAL CONCRETE"ISSN: a2455-2631 September 2020 IJSDR | Volume 5, Issue 9.

[16] Mr.S.S.Jadhav, Dr.S.N. Tande, Mr.A.C.Dubal, "Beneficial reuse of Waste Foundry Sand in concrete" International Journal of Scientific and Research Publications, Volume 7, Issue 3, March 2017 74, ISSN 2250-3153.

[17] Ramniwas, "A literature Review on Foundry Sand concrete" International Journal of All Research Education and Scientific Methods (IJARESM) ISSN: 2455-6211, Volume 6, Issue 8, August- 2018, Impact Factor: 2.287.

[18] Smit M. Kacha, Abhay V. Nakum,Ankur C. Bhogayata, "USE OF USED FOUNDRY SAND IN CONCRETE: A STATE OF ART REVIEW" IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.

[19] Sarita Chandrakanth, Asst.Prof.Ajay.A.Haman, "Partial replacement of waste foundry sand and recycled aggregate in concrete" International Journel of Modern Trends In Engineering and Research (IJMTER) ISSN(ONLINE) : 2349 - 9745 ISSN(PRINT) : 2393 – 8161.

[20] Md Shakir Ahmed, H.S. Vidyadhara," Experimental study on strength behaviour of recycled aggregate concrete" International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 10, October - 2013ISSN: 2278-0181.

[21] Ranjitham Mariyappan, Bharani Devi Sivalingam, Buvana Ramesh, Deepak Ramkumar, "Development of Concrete with Partial Replacement of Fine Aggregate by Waste Foundry Sand" FIC-SISTEEM-2020 IOP Conf.

Series: Materials Science and Engineering 955 (2020) 012042.
[22] Md. Safiuddina, Ubagaram Johnson Alengaramb, Md. Moshiur Rahmanb, Md. Abdus Salamb, Mohd. Zamin Jumaatb, "Use of recycled concrete aggregate in concrete: A review" Journal of Civil Engineering and Management · December 2013.
[23] IS: 2386 Part lll, 386, 516, 10262, 456.
[24] IS: 12269 – 1987 (For Portland Pozzolona Cement).
[25] IS: 383 – 1970 (For Coarse Aggregate)