IJIRAE:: International Journal of Innovative Research in Advanced Engineering ISSN: 2349-2163
Volume 11, Issue 05, May 2024 https://www.ijirae.com/archives

Experimental Investigations on Mineral Admixtures and Steel Fibers in High Strength Concrete

Jai Sankar.P
PG Research Scholar, Department of Civil Engineering
Sengunthar Engineering College (Autonomous),
Tiruchengode, TamilNadu, INDIA
Kiruthika N.
Assistant Professor, Department of Civil Engineering
Sengunthar Engineering College (Autonomous),
Tiruchengode, TamilNadu, INDIA

Publication History
Manuscript Reference No: IJIRAE/RS/Vol.11/Issue05/MYAE10086
Research Article | Open Access | Double-Blind Peer-Reviewed | Article ID: IJIRAE/RS/Vol.11/Issue05/MYAE10086
Received: 15, April 2024 | Revised: 21, April 2024 | Accepted: 28, April 2024 | Published Online: 12, May 2024
https://www.ijirae.com/volumes/Vol11/iss-05/07.MYAE10086.pdf
Article Citation: Jai,Kiruthika(2024). Experimental Investigations on Mineral Admixtures and Steel Fibers in High Strength Concrete. IJIRAE:: International Journal of Innovative Research in Advanced Engineering, Volume 11, Issue 05 of 2024 pages 484-491 **Doi:>**https://doi.org/10.26562/ijirae.2024.v1105.07
BibTeX Key Jai@2024Experimental
Academic Editor-Chief: Dr.A.Arul Lawrence Selvakumar, AM Publications, India

Abstract: In the process of manufacturing of concrete sand is the most commonly used fine aggregate. The main sources for the natural sand are river beds. These characteristic assets are getting depleted because of over abuse and defilement by chemicals and waste from nearby industries. The waste generated from the demolition of existing structures for various reasons causes great concern and ecological issues. In this project our main objective is to study the influence of partial replacement of F.A with recycled fine aggregate and to compare it with the compressive strength and workability of high strength M60 concrete. We are also trying to replace the various percentages of recycled fine aggregate to study the tendency of the Characteristic strength of concrete.

Key Words: Cement, Fine aggregate, Coarse aggregate, Recycled Fine aggregate and Fibers.

I. INTRODUCTION

Cement and concrete production expends tremendous measures of natural assets and aggregates, in this way creating considerable energy and ecological misfortunes. Modification and enhancements to the present concrete making routine methods are fundamental to address these ecological and economic issues. The useful impacts of some of these materials on the properties of concrete have further upgraded these endeavors. Because of natural effects connected with total extraction, extensive endeavors have been made towards the usage of indigenous and waste materials in cement. Replacement of cement leads to cost savings; the energy required to process these materials is also much lower than cement. Silica fume is one of the by-item, most preferred cement substitutions, particularly when the building properties and solidness of the hardened concrete were the essential concern. The enormous quantities of demolished concrete are available at various construction sites, which are now posing a serious problem of disposal in urban areas. This can easily be recycled as aggregate and used in concrete. The part of fibers is key to capturing progressing of a split by applying squeezing powers at the break tips, accordingly deferring their spread over the lattice and making a moderate split engendering stage.

II. LITERATURE SURVEY

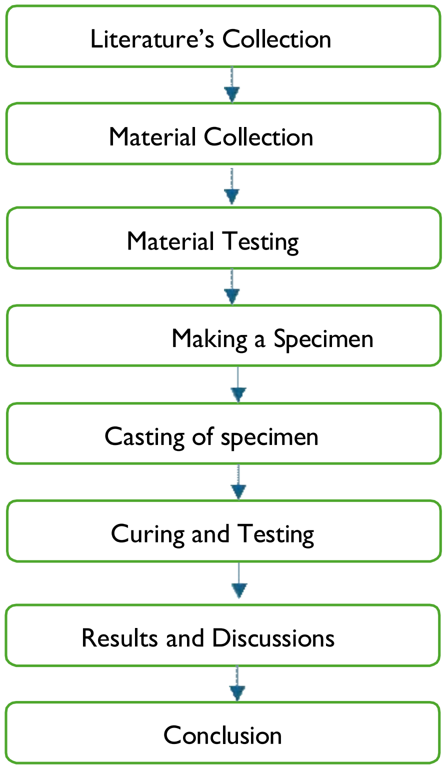
Gonzalez &Etaxeberria (2019) carried out experimental studies on HPC made up of ceramic aggregate in the form of recycled aggregate. HPC was produced using fine ceramic aggregates (FCA) in substitution of 15% and 30% of natural sand, and using 20%, 50% and 100% of coarse mixed aggregates (CMA) on substitution of natural coarse aggregates. The physical, mechanical and durability properties of the recycled aggregate concrete were determined and compared to those of the results of conventional concrete.

Priyanka & Vyawahare (2022) made studies to compare the strength characteristics between self compacting concrete using silica fume. The trial mixes which satisfy the fresh concrete properties as per EFNARC guidelines and the one which gives the maximum strength has been used in the present work. They found that the mechanical properties of SCC using silica fume and quarry shows the better result in strength properties among other mixes.

Devi (2022) performed the studies to know the influence of polypropylene fiber in enhancing the strength and durability properties of fly ash blended concrete containing quarry dust as fine aggregate.

IJIRAE:: International Journal of Innovative Research in Advanced Engineering ISSN: 2349-2163
Volume 11, Issue 05, May 2024 https://www.ijirae.com/archives

III. METHODOLOGY



MATERIALTESTING

Testing of Cement	
Initial Setting time of Cement	25Min
Normal Consistency of Cement (0%ash)	33%
Testing of Fine Aggregate	
Specific Gravity of Sand	2.617
Fineness Modulus of Sand	2.71
Testing of coarse Aggregate	
Specific Gravity of Aggregate	2.63
Fineness Modulus of Aggregate	6.83
Water absorption test for coarse aggregate	1.0
Testing of Water	
pH Value	6.8
Turbidity presents in Water	1.7ppm
Total dissolved solids	131ppm
Chloride content present in water	1538ppm
Residual chlorine presents in water	0 ppm
Fibers Properties	
Yield Strength	850MPa
Tensile Strength	345 MPa

MIX PROPORTION

SAMPLES	CEMENT	F.A	C.A	WATER
A	1	1.21	2.40	0.28

Results of Partial Replacement of Recycled Fine Aggregate with Fine Aggregate

COMPRESSIVE STRENGTH

Fig. 1 COMPRESSIVE STRENGTH TEST

COMPRESSIVE STRENGTH TEST RESULTS

Mix	Average Split Tensile Strength MPa		
	3rdDay	7thDay	28thDay
CC	32.43	45.33	67.56
RFA 01	32.67	46.20	68.78
RFA 02	33.89	50.67	70.22
RFA 03	34.01	53.16	48.27
RFA 04	31.67	48.27	64.89
RFA 05	28.65	42.31	61.48
RFA 06	26.43	36.18	56.27

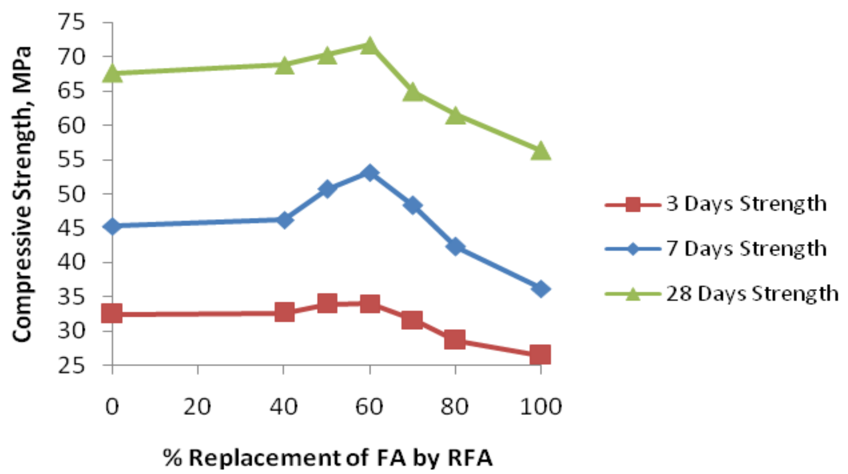


Fig2. COMPARISION OF COMPRESSIVE
STRENGTH RESULTS

From Figure 2, higher compressive strength for concrete was observed for mix RFA 03 at all ages. This optimum combination has been adopted for further studies. Recycled aggregate posses relatively lower bulk density, crushing and impact values and higher water absorption as compared to natural aggregate. The compressive strength of recycled aggregate concrete is relatively higher than natural aggregate concrete. The variation also depends on the original concrete from which the aggregates have been obtained. Initially, the strength may slightly increase and further the decrease in strength could be due to the more quantity of attached matrix to the fine aggregate.

3.2 SPLIT TENSILE STRENGTH TEST RESULTS

Mix	Average Split Tensile Strength MPa		
	3rdDay	7thDay	28thDay
CC	3.12	3.74	4.38
RFA 01	3.15	3.79	4.47

RFA 02	3.29	3.92	4.58
RFA 03	3.34	4.01	4.67
RFA 04	2.93	3.82	4.12
RFA 05	2.63	3.63	3.69
RFA 06	2.41	3.44	3.53

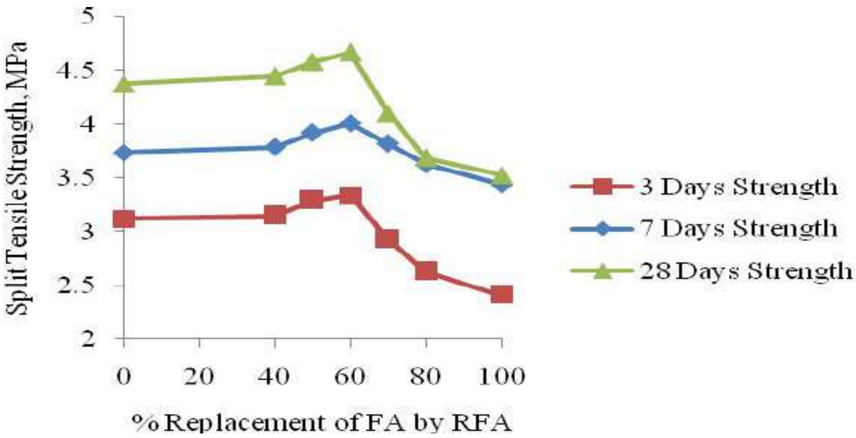


Fig 3. COMPARITSION OF SPLIT TENSILE STRENGTH RESULTS

3.3 FLEXURAL STRENGTH TEST RESULTS

Mix	Average Flexural Strength MPa		
	3rd Day	7th Day	28th Day
CC	4.23	4.93	6.20
RFA 01	4.29	5.01	6.24
RFA 02	4.32	5.23	6.67
RFA 03	4.49	5.41	7.12
RFA 04	4.10	5.12	6.12
RFA 05	3.83	4.83	6.03
RFA 06	3.64	4.54	5.86

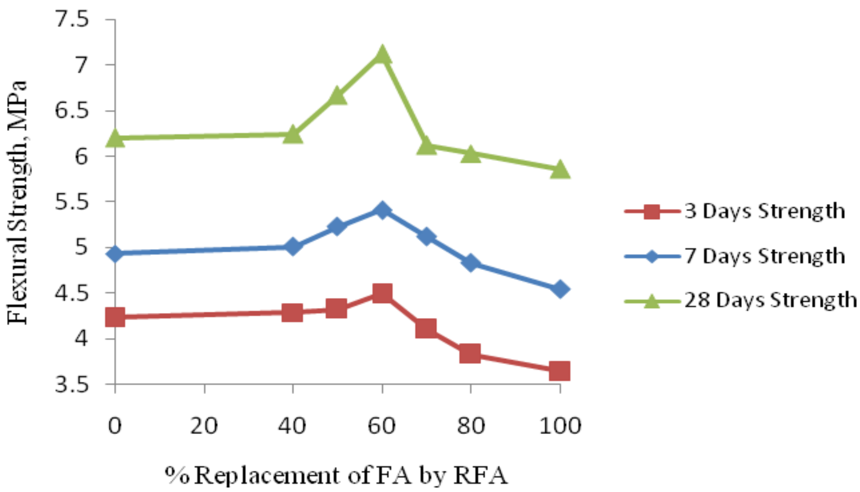


Fig 4. COMPARITSION OF FLEXURAL STRENGTH RESULTS

IV. ROLE OF MINERAL ADMIXTURES

Silica Fume is added with the optimuim mix to a sudy about the factors influencing in Concrete.

4.1 Description of Mixes for Recycled Fine Aggregate based Concrete with Silica Fume

Mix	% RFA	% FA	% of S.F by Cement
RFA 07	60	40	10
RFA 08	60	40	15
RFA 09	60	40	20
RFA 10	60	40	30

IJIRAE:: International Journal of Innovative Research in Advanced Engineering ISSN: 2349-2163
Volume 11, Issue 05, May 2024 https://www.ijirae.com/archives

4.2 Test Results of Silica Fume (Mineral Admixtures)

Mix	Average Cube Compressive Strength MPa			Average Split Tensile Strength MPa			Average Flexural Strength MPa	
	3rd Day	7th Day	28th Day	3rd Day	7th Day	28th Day	7th Day	28th Day
RFA 07	35.87	51.50	75.20	3.62	4.43	5.09	5.36	7.26
RFA 08	36.92	58.67	77.76	3.71	4.63	5.31	5.44	7.33
RFA 09	35.93	53.16	74.40	3.54	4.32	4.81	5.21	7.12
RFA 10	33.65	50.87	71.23	3.46	4.21	4.38	5.02	6.98

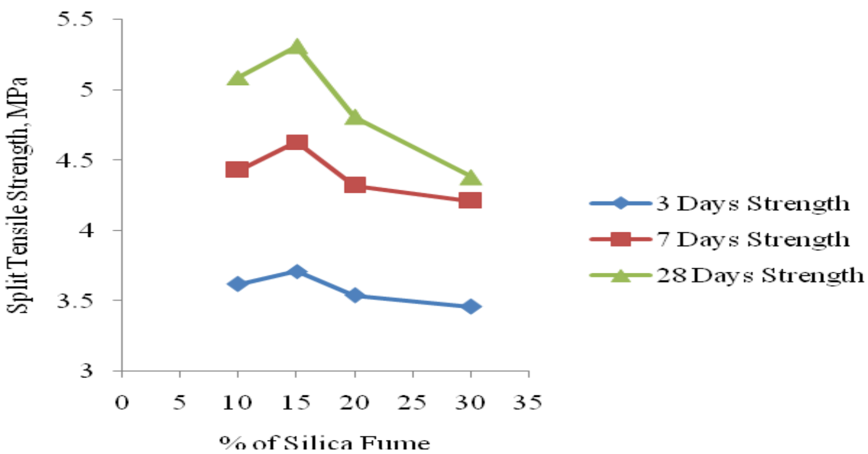


Fig.5A

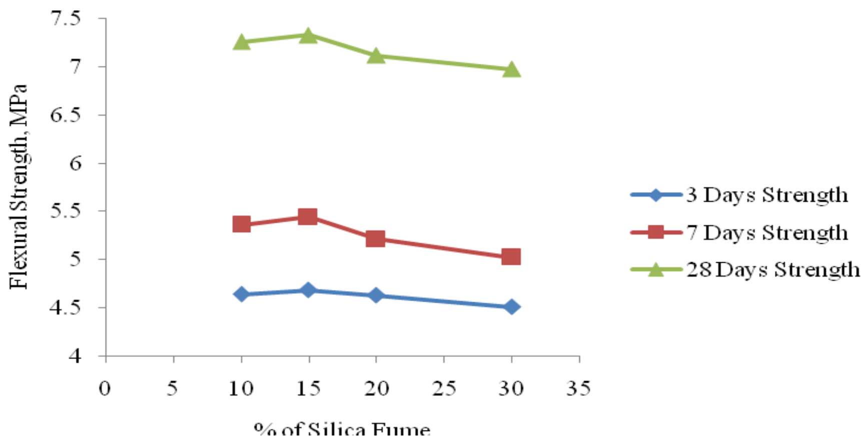


Fig.5B

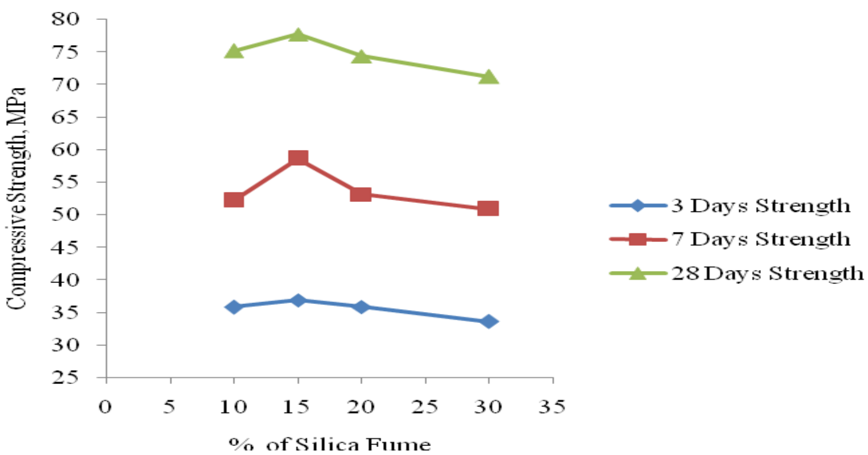


Fig.5C

Fig 5A, B & C COMPARITSION OF STRENGTH RESULTS IN ADDITION OF SILICA FUME

The increment in the quality of cement because of the addition of silica fume can be credited to the enhanced aggregate-matrix bond connected with the development of a less permeable move zone and a superior interlock between the paste and the aggregate. The aggregate-matrix bond change actuated by such pozzolanic materials is likely the consequence of a joined filler and pozzolanic impact. The filler impact prompts decrease in porosity of the moving zone and gives a thick microstructure and consequently builds the quality of the framework. The similar observations can be made for the mix containing up to 30% silica fume, where the addition of 15% silica fume resulted in an average increase in the 28th day compressive strength of 13% relative to the strength of the control mix in both cases. Further addition of silica fume, beyond 15%, resulted in a significant decrease in the 28th day strength of the same mix by about 8%. This may because of the capacity of silica fume performs in cementitious mixes is a physical one. Since silica fume is 100 times tiny than bond molecule it can fill the voids made by free water in the network. This capacity, called molecule pressing, refines the microstructure of solid, making a much denser pore structure.

V. ROLE OF STEEL FIBERS

5.1 Description of Mixes for Recycled Fine Aggregate based Concrete with Silica Fume and Steel Fibers

Mix	% RFA	% FA	% SF of Cement	% STF
RFA 11	60	40	15	0.5
RFA 12	60	40	15	1.0
RFA 13	60	40	15	1.5
RFA 14	60	40	15	2.0

5.2 Test Results of Steel Fibers

Mix	Average Cube Compressive Strength MPa			Average Split Tensile Strength MPa			Average Flexural Strength MPa	
	3rd Day	7th Day	28th Day	3rd Day	7th Day	28th Day	7th Day	28th Day
RFA 11	35.87	55.33	78.20	3.84	5.12	6.30	5.93	5.93
RFA 12	36.54	56.66	78.86	3.91	5.23	6.30	6.12	6.12
RFA 13	35.21	55.20	75.40	4.21	5.31	5.44	6.31	6.31
RFA 14	34.89	53.12	73.21	6.30	6.86	6.99	6.49	6.49

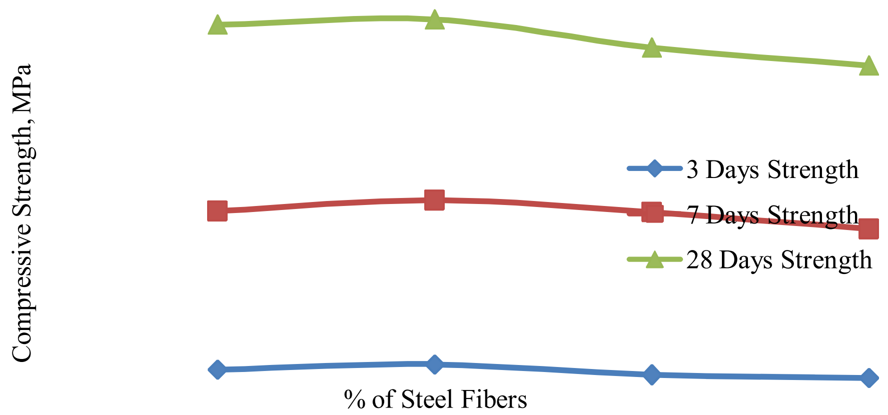


Fig 6.Variation of Compressive Strength with % Addition of STF in RFA Mixes Containing SF

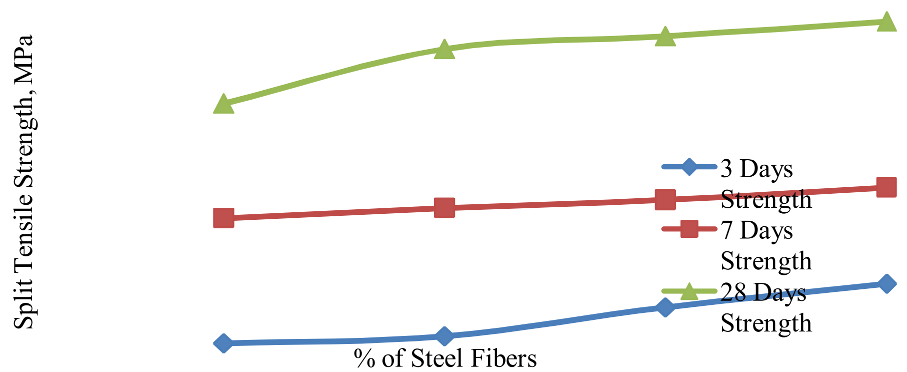


Fig 7.Variation of Tensile Strength with % Addition of STF in RFA Mixes Containing SF

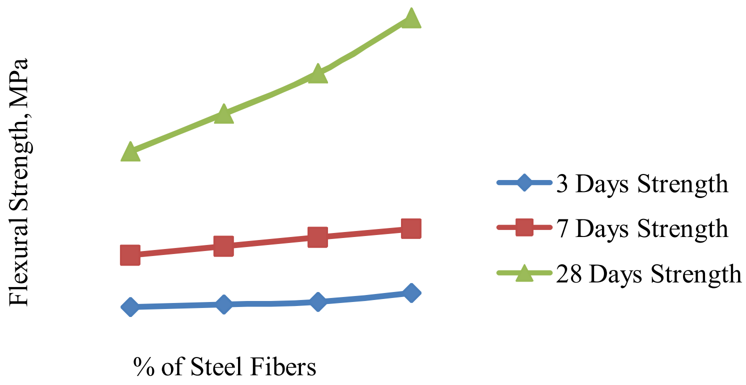


Fig8. Variation of Flexural Strength with % Addition of STF in RFA Mixes Containing SF

At the split tip, steel fibers can control the expansion of the break, diminish the degree of anxiety focus at the tip of break, alter the course of break development, and postponement the development rate of the crack. On the other hand, it was still important to enhance advance the interfacial qualities by consolidating silica fume into the HPC network with a specific end goal to bring the reinforcing, toughening and crack opposing impacts of the steel fibers into full play. It is observed that the split tensile strength goes on increases by adding of steel fibers. It is very well known that split tensile strength will increase when steel fibers are added. Due to the presence of steel fibers in recycled fine aggregate increase in 19% to 35% when compared with optimum mix RFA 08. Nominal increases remain for all dosage of fibers compared to normal mixes. The upgrade in flexural strength is accomplished because of the change in mechanical bond between the cement paste and fiber. As a measure of fiber increments in mixes, it significantly serves to decrease the cracks adequately, thus resulting in an increase in flexural strength.

VI. CONCLUSION

The primary objective is to evaluate the effect of mechanical properties of various proportions of alternate materials in concrete. The following conclusions are made from the above experimental investigations

Compressive Strength

From the test results obtained the compressive strength increases with the replacement of fine aggregate by recycled fine aggregates up to 60% thereafter starts decreasing. This observation is valid for 3rd day, 7th day and 28th day strength. This addition of quality is owing to the quickening of the concrete hydration at right on time ages because of the effect of the stone dust. At later ages, no negative impacts were observed. Similarly for concrete partially replaced with 60% recycled fine aggregate gives better strength performance at all ages. Initially, the strength may slightly increase and further the decrease in strength could be due to the more quantity of attached matrix to the fine aggregate. From the test results, it was found that the optimum replacement level of cement by silica fume is 15% on both the cases with the above optimum mix. The increase in the strength of concretes due to the addition of silica fume can be attributed to the improved aggregate-matrix bond associated with the formation of a less porous transition zone and a better interlock between the paste and the aggregate. It was observed that the concrete made with 1% addition of steel fibers gives better performance on all the ages compared to other addition percentage of steel fibers on both quarry dust and recycled fine aggregate.

Split Tensile Strength

The optimum split tensile strength at all the ages of specimens was found on 60% replacement of fine aggregate with recycled fine aggregate. The strength gain percentage may vary from 2% to 6% in case of recycled fine aggregate when compared to CC. The split tensile strength of replacement of fine aggregate with recycled fine aggregate is 6% larger compared to CC on 28th day. It was observed that the split tensile strength goes on increases by adding of steel fibers due to the strength characteristics of steel fibers.

Flexural Strength

The optimum strength of concrete made with replacement levels of fine aggregate with recycled fine aggregate was found to be 60:40 (recycled fine aggregate: M-Sand) at all the ages of concrete. The strength gain percentage may vary 1% to 15% in case of recycled fine aggregate compared to control mix at 28 days. The flexural strength increases with the replacement of fine aggregate by recycled fine aggregate up to 60% (15% more compared to CC on 28th day) thereafter starts decreasing. .It was observed that the flexural strength of concrete goes on increases by adding of steel fibers on recycled fine aggregate cases due to the strength characteristics of steel fibers.

REFERENCES

[1]. Devi 2022, 'Influence of Polypropylene Fiber in Enhancing the Strength and Ddurability Properties of Fly ash Blended Concrete Containing Quarry Dust as Fine Aggregate', International Journal of Civil and Structural Engineering, vol. 5, no. 3, pp. 206-215

[2]. Gonzalez & Etaxeberria 2019, 'Properties of High Performance Concrete made with Recycled Fine Ceramic and Coarse Mixed Aggregates', Construction and Building Materials, vol.68, pp. 618-626

[3]. Marios N. Soutsos, Kangkang Tang and Stephen G. Millard et al 2011, 'Use of Recycled Demolition Aggregate in Precast Products, Phase II: Concrete Paving Blocks', Construction and Building Materials, vol. 25, no. 7, pp. 3131-3143.

[4]. Priyanka, P Naik&Vyawahare, MR 2022, 'Strength and Durability Investigations On Self Consolidated Concrete with Pozzolanic Filler and Inert Filler', International Journal of Engineering Research and Technology', vol. 2, no. 6, pp.3144-3150.

[5]. VenkateshBabu, DL &Krishnamoorthy, R 2021, 'Studies on Strength and Durability Characteristics of High Performance silica fume concrete', The Master Builder, pp. 73-75

[6]. Zhan Baojian, Chi Sun poon and Shi Cai Jun 2013, 'CO_2 curing for Improving the Properties of Concrete Blocks Containing Recycled Aggregates', Cement and Concrete Composites, vol. 42, pp. 1-8.