INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 01, January 2025, pp : 870-876
www.ijprems.com
editor@ijprems.com
e-ISSN : 2583-1062
Impact Factor : 7.001

"AN İNVESTIGATION OF THE MECHANICAL PROPERTIES OF MARBLE DUST AND SILICA FUME SUBSTITUTED ORDINARY PORTLAND CEMENT"

Roshan Singh[1], Prof. Kamlesh Kumar Choudhary[2]

[1]PG Student, Department of civil engineering, Saraswati Institute of Engineering & Technology, Jabalpur, India.

[2]Assistant Professor & HOD, Civil engineering Department, Saraswati Institute of Engineering & Technology, Jabalpur, India.

ABSTRACT

The use of Marble powder and silica fume in concrete is abounded with data from mechanical and chemical strengths to assess the material parameters. Studies focusing on material properties with different replacement of cement with Marble powder and silica fume are presented and on structural component with use of multi blend concrete and fiber concrete composites. It has been found the workability of concrete has increased and the amount of cube compressive strength has been decreased and on significant effect has been noted on impact strength of plain concrete. M30 grade of concrete is used in this experiment and O%,5%,10%,15%, 20%,25%, 30%,35% and 40% of Marble powder and silica fume were used as a cement replacement (by weight). The specimens for testing were prepared, the cube, Beams are cured for 7 & 28 days. All the properties were determined by performing different tests like flexural strength and compressive strength and. At last, workability, setting time, compressive strength is investigated. The results of the Compressive Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete 24.22 N/mm2 -26.44 N/mm2 in 9.18 % ,24.27 N/mm2-26.49 N/mm2 in 9.14 %, 24.36 N/mm2-26.76 N/mm2 in 9.83 % at 7 days. The results of the Compressive Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete 38.67 N/mm2- 41.78 N/mm2 in 8.04 %, 38.44 N/mm2- 41.56 N/mm2 in 8.10 %, 38.89 N/mm2- 42.44 N/mm2 in 9.15 % at 28 days. The results of the Flexural Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete 4.83 N/mm2 - 5.29 N/mm2 in 9.27 % ,4.86 N/mm2 -5.27 N/mm2 in 8.46 % ,4.89 N/mm2-5.25 N/mm2 in 7.43 % at 28 days.

Keywords: Marble powder , silica fume, Nominal Concrete , Fiber Concrete, Compressive Strength, Cubes, Splitting Tensile Strength , Cylinders ,Flexural Tensile Strength, Beams.

1. INTRODUCTION

With almost six billion tons produced annually, concrete is arguably the material used in construction most widely in the world. Our country's structural requirements are growing steadily, and as concrete is a vital component of many of the infrastructure projects that support it, it is critical to improve its strength and solidity. The substance concrete is somewhat brittle. When strands are expanded to significant lengths, the material becomes more malleable. Some of the limitations of plain concrete cement are as follows: low elastic, limited pliability, minimal protection against breakage, high fragility, and helpless sturdiness. On the basis of exploratory analyses, strands enhance cement's mechanical qualities, such as its stiffness, sturdiness, flexural strength, compressive strength, and resistance to creep. Among these, steel strands and polymer filaments are particularly common in the cement industry. Only water is consumed per capita more than it is. Concrete is the largest single material element in the built environment. Reduced embodied energy in concrete could have significant positive effects on the environment and the economy without compromising performance or raising costs.

Concrete is a widely used construction material known for its strength and durability. Researchers have been exploring the effects of various additives on concrete properties to enhance its performance. Two common additives studied extensively are marble powder and silica fume.

1.1 Ordinary port land cement (OPC)

Ordinary port land cement (OPC) is the basic Portland cement and is best suited for use in general concrete construction. It is of three types, 33 grades, 43 grades, 53 grades. One of the important benefits is the faster rate of development of strength. Portland slag cement is obtained by mixing Portland cement clinker, gypsum and granulated blast furnace slag in suitable proportion and grinding the mixture to get a thorough and intimate mixture between the constituents.

This type of cement can be used for all purposes just like OPC. It has lower heat of evolution and is more durable and can be used in mass concrete production.

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 01, January 2025, pp : 870-876
www.ijprems.com
editor@ijprems.com
e-ISSN : 2583-1062
Impact Factor : 7.001

1.2 Fine Aggregate

Fine aggregate most of which passes through a 4.75 mm. IS sieve and contains only that much coarser material as is permitted by the specifications. Sand is generally considered to have a lower size limit of about 0.07 mm. Material between 0.06 mm and 0.002 mm is classified as silt, and still smaller particles are called clay. The soft deposit consisting of sand, silt and clay in about equal proportions is termed loam.

1.3 Coarse Aggregates

In this study, coarse aggregates of size 40 mm and 20 mm conforming to specifications as given in IS: 383- 1970 is used. Pycnometer test is carried out to find the specific gravity of aggregates. Sieve analysis has been done to find the fineness modulus of aggregate.

1.4 Marble Powder

Marble powder is a fine, white powder obtained from grinding marble. Marble powder obtained from grinding marble has a wide range of uses. Marble powder is also known as limestone and calcium carbonate. In nature, marble powder is mainly found in old rocks and seashells. Marble powder, which is used intensively in industry, can also be used in paint making, ceramic making, and as a filler additive.

1.5 Silica fume

Silica fume is a by-product from the production of elemental silicon or alloys containing silicon in electric arc furnaces. At a temperature of approximately 2000°C the reduction of high-purity quartz to silicon produces silicon dioxide vapor, which oxidizes and condenses at low temperatures to produce silica fume.

1.6 Water

Concrete is a composite material made primarily of four key ingredients: cementitious material, fine aggregates, coarse aggregates, and water. Among these components, water plays a crucial role in the formation and strength of concrete. The following sections will detail the importance of water in concrete, the effects of excess water, and considerations regarding water quality.

Cement (OPC) Fine Aggregate Coarse Agg. Silica fume Marble powder Water

Figure no 1; Ingredients of Mix Concrete

2. OBJECTIVE OF THE STUDY

The main objective of the study is to investigate the change in characteristics strength properties and workability of concrete mixed with different percentage of Marble powder and Silica fume with concrete. Following are objectives of the study.

1. To find out the effect of Marble powder and Silica fume on strength when mixed with concrete sample in partially replacement of cement.
2. To study the workability of concrete on variation in different percentage of Marble powder and Silica fume on strength when mixed with concrete sample in partially replacement of cement.
3. To perform the sieve analysis and specific gravity of Marble powder and Silica fume and Cement used Reduce the maintenance cost.
4. Increase the economy of the construction with using the cheaper material as a replacement of the cement.
5. Compare the result with conventional normal concrete.
6. To find out the compressive strength of hardened concrete after 7 and 28 days of curing, and to compare different concrete cube mixes that substitute some of the cement with a mixture of marble powder and silica fume.
7. To find out the flexural strength of hardened concrete after 7 and 28 days of curing, and to compare different concrete cube mixes that substitute some of the cement with a mixture of marble powder and silica fume.
8. Check the feasibility of Marble powder as a replacement of Cement in the construction of concrete.
9. To provide economical construction cost.

3. METHODOLOGY

Concrete for M30 grade were prepared as per I.S.- 10262: 2009. Water cement ratio to get a characteristic strength of M30 was considered for this study. The exact quantity of materials for each mix was calculated.

In this experimental study Cement, sand, coarse aggregate, water, Marble powder, and silica fume were used

1. Cement :- Ordinary Portland cement of 43 grade From Jabalpur M.P.
2. Sand (Fine Aggregate) :- Locally available river sand From Jabalpur M.P.
3. Coarse Aggregate : Jabalpur M.P.
4. Water :- Potable water was used for the experimentation.
5. Marble powder - Marble powder is available in dry powder form M.P.
6. Silica fume :- Silica fume is available from DCW engineering Jabalpur.

The use of Marble powder and silica fume in concrete is abounded with data from mechanical and chemical strengths to assess the material parameters. Studies focusing on material properties with different replacement of cement with Marble powder and silica fume are presented and on structural component with use of multi blend concrete and fiber concrete composites. It has been found the workability of concrete has increased and the amount of cube compressive strength has been decreased and on significant effect has been noted on impact strength of plain concrete.

M30 grade of concrete is used in this experiment and O%,5%,10%,15%, 20%,25%, 30%,35% and 40% of Marble powder and silica fume were used as a cement replacement (by weight). The specimens for testing were prepared, the cube, Beams are cured for 7 & 28 days. All the properties were determined by performing different tests like flexural strength and compressive strength and. At last, workability, setting time, compressive strength is investigated. The maximum strength for the concrete specimen is obtained when 30% of Marble powder and silica fume are replaced of cement.

4. OBSERVATIONS & RESULT DISCUSSION

Table no.1; Mix proportion by(Saturated surface dry) mass

Cement	Water	Fine aggregate	Coarse aggregate
414	**186**	**711**	**1141**
1	**0.45**	**7.72**	**2.76**

Table no.2; The Final Batches percentages with Silica Fume of Concrete M30 (in kg/m^3)

Mix Code	Cement	Silica Fume	Fine Aggregate	Coarse Aggregate
	kg/m3	kg/m3	kg/m3	kg/m3
M-1	414.00	0.00	697.88	1128.06
M-2	393.30	20.70	697.88	1105.50
M-3	372.60	41.40	697.88	1105.50
M-4	351.90	62.10	697.88	1105.50
M-5	331.20	82.80	697.88	1105.50
M-6	310.50	103.50	697.88	1105.50
M-7	289.80	124.20	697.88	1105.50
M-8	269.10	144.90	697.88	1105.50
M-9	248.40	165.60	697.88	1105.50

Table no.3 ; The Final Trial Batches percentages with Marble Powder of Concrete M30 (in kg/m^3)

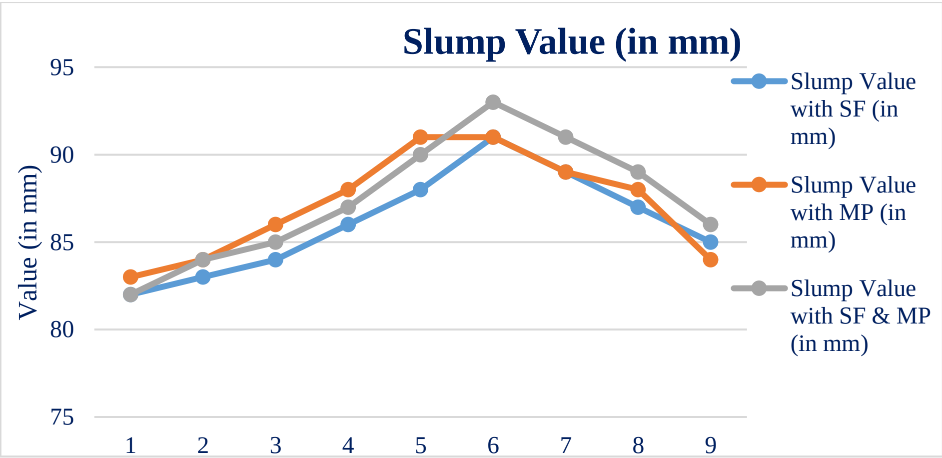
Mix Code	Cement	Marble Powder	Fine Aggregate	Coarse Aggregate
	kg/m3	kg/m3	kg/m3	kg/m3
M-10	414.00	0.00	697.88	1128.06
M-11	393.30	20.70	697.88	1105.50
M-12	372.60	41.40	697.88	1105.50
M-13	351.90	62.10	697.88	1105.50
M-14	331.20	82.80	697.88	1105.50
M-15	310.50	103.50	697.88	1105.50

M-16	289.80	124.20	697.88	1105.50
M-17	269.10	144.90	697.88	1105.50
M-18	248.40	165.60	697.88	1105.50

Table no.4; The Final Trial Batches percentages with Silica Fume and Marble Powder of Concrete M30 (in kg/m^3)

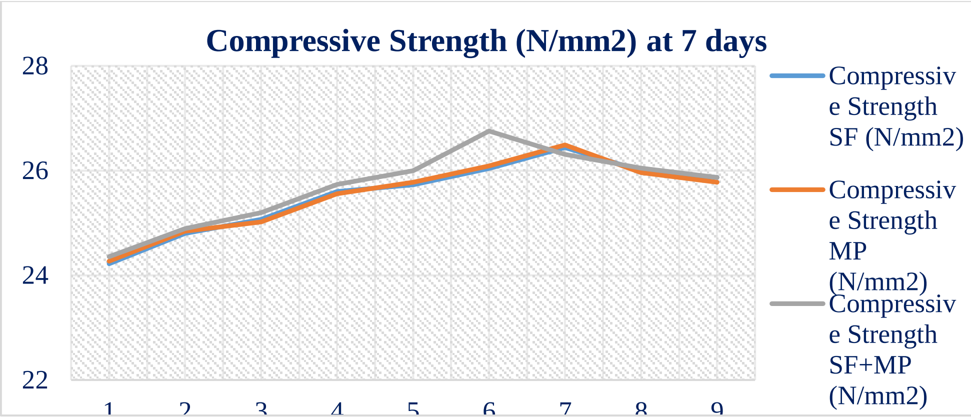
Mix Code	Cement	Silica Fume	Marble Powder	Fine Aggregate	Coarse Aggregate
	kg/m^3	kg/m^3	kg/m^3	kg/m^3	kg/m^3
M-19	414.00	0.00	0.00	697.88	1128.06
M-20	248.40	0.00	165.60	697.88	1105.50
M-21	248.40	20.70	144.90	697.88	1082.94
M-22	248.40	41.40	124.20	697.88	1060.38
M-23	248.40	62.10	103.50	697.88	1037.82
M-24	248.40	82.80	82.80	697.88	1015.26
M-25	248.40	103.50	62.10	697.88	992.70
M-26	248.40	124.20	41.40	697.88	970.14
M-27	248.40	144.90	20.70	697.88	947.58
M-28	248.40	165.60	0.00	697.88	925.02

4.1 Workability of various concrete mixes design for slump cone test

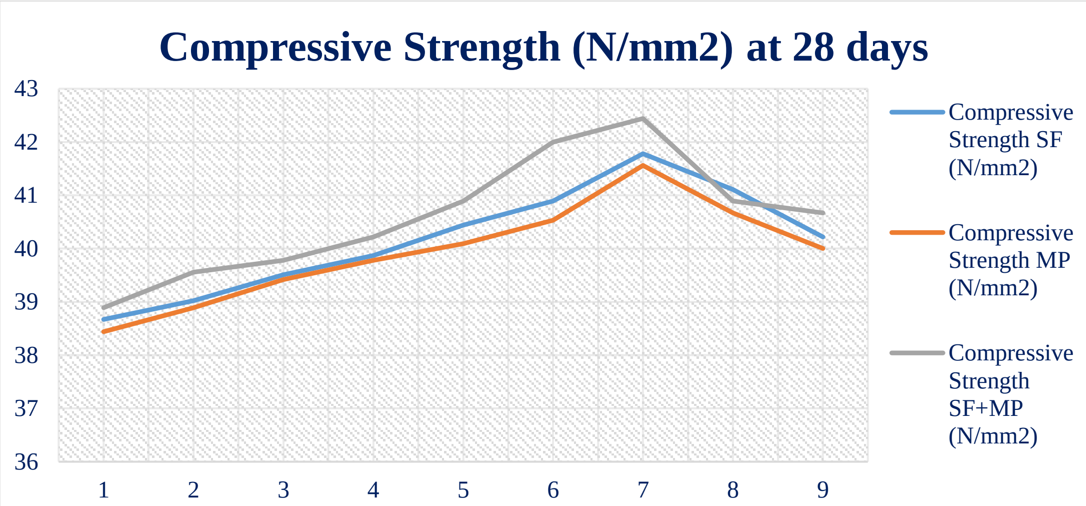


Graph no. 1; The results of the slump cone test show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete.

4.2 Compressive Strength

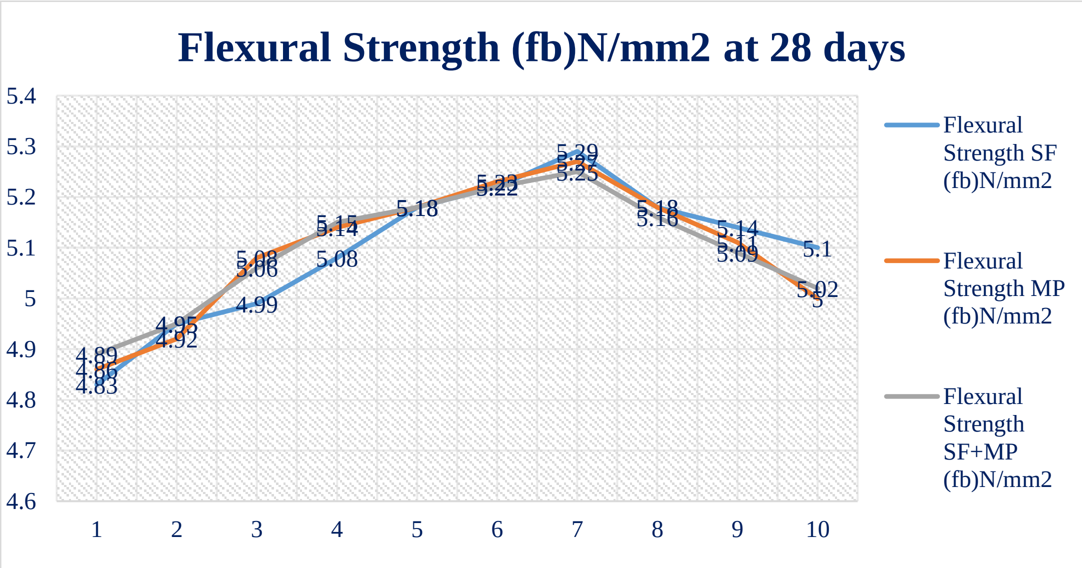


Graph no. 2; The results of the Compressive Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete at 7 days



Graph no. 3; The results of the Compressive Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete at 28 days

4.3 Flexural Strength(fb)N/mm2



Graph no. 4; The results of the Flexural Strength (N/mm2) show the replacement of silica fume and marble powder separately and the mixing of both for cement in the concrete at 28 days

5. CONCLUSION

The following conclusions could be drawn from the present investigation.

1. The flexural & compressive strength of Marble powder and silica fume based multi blended concrete were improved when compared with conventional concrete mix design M30.
2. Super plasticizer agent is required to produce workable mix.
3. Slump Cone test results workability of

- fresh M30 grade concrete with Silica Fume M-24 Slump value 91mm.
- fresh M30 grade concrete with Marble Powder M-15 Slump value 91mm.
- fresh M30 grade concrete with Silica Fume and Marble Powder M-24 Slump value 91mm.

4. The results of Compressive strength for cube (N/mm2) show the partial replacement with Silica Fume for cement in the concrete at 7 Days

Mix design	loads	strength (N/mm2)	% Increase in strength
M-1	545.00 KN	24.22 N/mm^2	0.00 %
M-7	595.00 KN	26.44 N/mm^2	9.18 %

5. The results of Compressive strength for cube (N/mm2) show the partial replacement with Marble Powder for cement in the concrete at 7 Days

Mix design loads strength (N/mm2)% Increase in strength

M-10	546.00 KN	24.27 N/mm^2	0.00 %
M-16	596.00 KN	26.49 N/mm^2	9.14 %

6. The results of Compressive strength for cube (N/mm2) show the partial replacement with Silica Fume and Marble Powder for cement in the concrete at 7 Days

Mix design	loads	strength (N/mm2)	% Increase in strength
M-19	548.00 KN	24.36 N/mm2	0.00 %
M-24	602.00 KN	26.76 N/mm2	9.83 %

7. The results of Compressive strength for cube (N/mm2) show the partial replacement with Silica Fume for cement in the concrete at 28 Days

Mix design	loads	strength (N/mm2)	% Increase in strength
M-29	870.00 KN	38.67 N/mm^2	0.00 %
M-35	940.00 KN	41.78 N/mm^2	8.04 %

8. The results of Compressive strength for cube (N/mm2) show the partial replacement with Marble Powder for cement in the concrete at 28 Days

Mix design	loads	strength (N/mm2)	% Increase in strength
M-38	865.00 KN	38.44 N/mm2	0.00 %
M-44	935.00 KN	41.56 N/mm2	8.10 %

9. The results of Compressive strength for cube (N/mm2) show the partial replacement with Silica Fume and Marble Powder for cement in the concrete at 28 Days

Mix design	loads	strength (N/mm2)	% Increase in strength
M-47	875.00 KN	38.89 N/mm^2	0.00 %
M-53	955.00 KN	42.44 N/mm^2	9.15 %

10. The results of Flexural strength for Beams (N/mm2) show the partial replacement with Silica Fume for cement in the concrete at 28 Days

Mix design	Strength (N/mm2)	% Increase in strength
Mix-B1	4.83 N/mm^2	0.00 %
Mix-B7	5.29 N/mm^2	9.27 %

11. The results of Flexural strength for Beams (N/mm2) show the partial replacement with Marble Powder for cement in the concrete at 28 Days

Mix design	Strength (N/mm2)	% Increase in strength
Mix-B17	4.86 N/mm^2	0.00 %
Mix-B11	5.27 N/mm^2	8.46 %

12. The results of Flexural strength for Beams (N/mm2) show the partial replacement with Silica Fume and Marble Powder for cement in the concrete at 28 Days

Mix design	Strength (N/mm2)	% Increase in strength
Mix-B27	4.89 N/mm^2	0.00 %
Mix-B21	5.25 N/mm^2	7.43 %

6. REFERENCES

[1] Specification for 33,43,53 Grade ordinary Portland cement IS 269 – 2015.
[2] Specification for coarse and fine aggregate IS 383-2016.
[3] Methods of test for aggregate for concrete particle size and shape IS 2386 (Part I) 1963
[4] Methods of test for aggregate for concrete estimation of deleterious materials and organic impurities. IS 2386 (Part II) 1963.
[5] IS: 456 – code of practice for plain and reinforced concrete.
[6] IS: 383 – specifications for fine and coarse aggregate from natural sources for concrete.
[7] IS: 2386 – methods of tests for aggregate for concrete. (nine parts)
[8] Babar Ali , Erol Yilmaz , Ahmad Raza Tahir,Fehmi Gamaoun, Mohamed Hechmi El Ouni, Nd Syed Muhammad Murtaza Rizvi1(November 2021) “The durability of high-strength concrete containing waste tire steel fiber and coal fly ash” hindawi advances in materials science and engineering volume 2021, article id 7329685, 19 pages https://doi.org/10.1155/2021/7329685
[9] G.H.L.S.Sai Kumar, M.Jugal Kishore (2021) “experimental study of fly ash based steel fiber reinforced self compacting concrete” the authors. Production and hosting by elsevier b.v. on behalf of king saud university. this is an open access article under the cc by-nc-nd license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

[10] Hemn Qader Ahmed , Dilshad Kakasor Jaf, And Sinan Abdulkhaleq Yaseen (January 2020) "Comparison Of The Flexural Performance And Behaviour Of Fly-Ash-Based Geopolymer Concrete Beams Reinforced With Cfrp And Gfrp Bars" hindawi advances in materials science and engineering volume 2020, article id 3495276, 15 pages https://doi.org/10.1155/2020/3495276 department of civil engineering, salahaddin university-erbil, erbil, Iraq correspondence should be addressed to hemn qader ahmed; hemn.ahmed@su.edu.krd received 4 april 2019; revised 25 november 2019; accepted 26 december 2019; published 11 january 2020

[11] Esakkiraj. P, Sreesha. S, Sreevidya. V, Antony Jeyendran. S (July 2020) "Development of high volume fly ash concrete incorporating steel fibre" international journal of recent technology and engineering (ijrte) issn: 2277-3878 (online), volume-9 issue-2, july 2020 426 published by: blue eyes intelligence engineering & sciences publication retrieval number: b3567079220/2020©beiesp doi:10.35940/ijrte.b3567.07922 journal website: www.ijrte.org

[12] Anil Kumar, Mr. Rohit Kumar, Dr.Partima Kumar (September-2018) "A review paper about steel fiber and fly ash based concrete" international journal for technological research in engineering volume 6, issue 1, september-2018 issn (online): 2347 - 4718 www.ijtre.com copyright 2018.all rights reserved. 4754

[13] Shyam, A. Anwar, Syed Aqeel Ahmad (March 2017) "A Literature Review on Study of Silica fume as Partial Replacement of Cement in Concrete" DOI:10.24001/IJAEMS.3.3.18Corpus ID: 55118118 Published 1 March 2017 Materials Science, Engineering International Journal of Advanced engineering, Management and Science

[14] K.Sateesh Kumar, Rounak Hussain, K.Bhargavi (July-2016) "strength and durability properties of steel fiber reinforced concrete by partial replacement of cement using fly ash" .ijsetr.com issn 2319-8885 vol.05,issue.19 july-2016, pages:3804-3811 copyright @ 2016 ijsetr. all rights reserved.

[15] Rooban Chakravarthy, Srikanth Venkatesan, And Indubhushan Patnaikuni (November 2016) "Mechanical properties of high volume fly ash concrete reinforced with hybrid fibers" school of engineering, rmit university, melbourne, vic, Australia correspondence should be addressed to srikanth venkatesan; srikanth.venkatesan@rmit.edu.au received 19 june 2016; revised 10 october 2016; accepted 9 november 2016

[16] Irfaz Ur Rahman Najar , Jagdish Chand Kambooj (2016) "Combine effect of silica-fume, fly-ash and steel fibre on reinforced concrete, a review" hindawi publishing corporation advances in materials science and engineering volume 2016, article id 1638419, 7 pages http://dx.doi.org/10.1155/2016/1638419

[17] Khadake S.N., Konapure C.G. (Nov-Dec. 2012), "an investigation of steel fiber reinforced concrete with fly ash" iosr journal of mechanical and civil engineering (iosr-jmce) issn: 2278-1684 volume 4, issue 5 (nov-dec. 2012), pp 01-05 www.iosrjournals.org www.iosrjournals.org 1 | page

[18] B.R. Phanikumar, A. Sofi (November 2014) "Effect of pond ash and steel fibre on engineering properties of concrete" received 1 july 2014; revised 26 november 2014; accepted 12 march 2015 available online 20 april 2015 the cc by-nc-nd license (http://creativecommons.org/licenses/by-nc-nd/4.0/). ain shams engineering journal (2016) 7, 89–99

[19] Muthuswamy, K.R. and Thirugnanam, G.S. Flexural Behaviour of High Performance Hybrid Fiber Reinforced Concrete Beams, Proceedings of the Seventh Structural Engineering Convention (SEC 2010), Annamalai University, Tamil Nadu, India, 08-10 December, 2010, pp. 1192-1201.

[20] B. Krishna Rao, V. Ravindra (2010), "Steel Fiber Reinforced Self compacting Concrete Incorporating Journal of Engineering Science and Technology Vol. 2(9), 4936-4943.

[21] Falah A. Almottiri (2011), " Physical Properties of Steel Fiber Reinforced Cement Composites Made with Fly Ash", Jordan Journal of Civil Engineering, Volume 5, No. 2.