Scientific Journal of Impact Factor (SJIF): 4.14

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 3, Issue 12, December -2016

STRENGTH PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH SILICA FUME AND FINE AGGREGATE WITH QUARRY DUST

Dr. D. V. Prasada Rao[1] and V. Ravi Kumar[2]

[1]*Professor, Department of Civil Engineering*
Sri Venkateswara University College of Engineering, Tirupati, Andhra Pradesh, India.

[2]*PG Student, Department of Civil Engineering*
Sri Venkateswara University College of Engineering, Tirupati, Andhra Pradesh, India.

ABSTRACT

The main aim of the experimental investigation is to find the combined influence on strength properties of concrete prepared using Silica Fume (SF) and Quarry Dust (QD). Quarry Dust is used as partial replacement of natural sand and Silica Fume as partial replacement of cement. In the present experimental investigation the fine aggregate (Sand) is partially replaced 30%, 60% and 100% by Quarry Dust and the cement is partially replaced by 5%, 10% and 15% of Silica Fume by weight. The combined influence of Quarry Dust and Silica Fume on compressive strength, split tensile strength, flexural strength and modulus of elasticity of M30 grade of concrete is investigated. The test results of concrete prepared using the different combinations of Quarry Dust and Silica Fume are compared with that of controlled concrete. The variation of different strength properties indicates the same trend as that of controlled concrete. Based on the test results, it can be observed that the concrete prepared with a combination of 60% Quarry Dust and 10% Silica Fume possesses improved strength properties compared to the controlled concrete. The increase in the various strength characteristics of concrete containing Quarry Dust and Silica Fume can be attributed to the effective particle packing and also the availability of additional binder in the presence of Silica Fume.

Keywords*: Quarry Dust, Silica Fume, Partial Replacement, Particle Packing and Strength of Concrete.*

1.0 INTRODUCTION

Concrete is the most widely used composite material today. The constituents of concrete are coarse aggregate, fine aggregate, cement and water. Rapid increase in construction activities leads to shortage of conventional construction materials. It is conventional that natural sand is being used as fine aggregate in concrete. The function of the fine aggregate is to assist in producing workability and uniformity in the mixture. The river deposits are the most common source of fine aggregate. Now-a-days the natural river sand has become scarce and very costly. Hence, it is necessary to think of alternative materials. The Quarry Dust may be used in the place of river sand fully or partly. It is proposed to study the possibility of replacing sand with locally available Quarry Dust without sacrificing the strength and workability of concrete by incorporating the Silica Fume as a mineral admixture.

In the present day construction practice along with the strength equal importance is given to the durability of concrete. The Indian Standard Code of practice for plain and reinforced concrete recommends the minimum cement content to satisfy the strength and durability. Hence, the utilization of cement is increased. But, the cement production consumes large amount of energy and emits carbon dioxide, polluting the environment. One of the solutions to these problems is to use Pozzolana materials. Previous studies indicates that the use of Fly Ash, Silica Fume, Metakaoline, Ground Granulated Blast Furnace Slag as partial replacement of cement, reduces the cement consumption and also increases the strength and durability of concrete.

2.0 OBJECTIVE

The main objective of the present research work is to find the influence of the combined application of Quarry Dust and Silica Fume on various strength properties of M30 grade of concrete. 30%, 60% and 100% of Quarry Dust and 5%, 10% and 15% of Silica Fume are adopted as replacement by weight. Compressive strength, split tensile strength flexural strength and modulus of elasticity of concrete with various combinations of Quarry Dust and Silica Fume are to be obtained and the results are to be compared with the controlled concrete.

3.0 EXPERIMENTAL PROGRAMME

3.1 Properties of Materials

3.1.1 Cement

In the present investigation Ordinary Portland Cement (OPC) of 53 Grade confirming to IS specifications was used.

3.1.2 Fine Aggregate

Locally available river sand confirming to IS specifications was used as the fine aggregate in the concrete preparation. The properties of Fine aggregate are shown in Table 1.

Table 1. Physical Properties of Fine Aggregate

S.No	Property	Result
1	Specific Gravity	2.56
2	Fineness Modulus	2.60
3	Zone	Zone – II

3.1.3 Coarse Aggregate

Coarse aggregate of nominal size 20 mm and 12.5 mm, obtained from the local quarry confirming to IS specifications was used. The properties of Coarse aggregate are shown in Table 2.

Table 2. Properties of Coarse Aggregate

S.No	Property	Result
1	Specific Gravity	2.61
2	Water Absorption	0.40 %

3.1.4 Quarry Dust

The Quarry Dust used in this investigation is obtained from the quarry at Chandragiri near Tirupati, Andhra Pradesh. Quarry Dust confirms to zone-I as per the specifications indicated in IS : 383, was used as partial replacement for the concrete preparation. The properties of Quarry Dust are shown in Table 3.

Table 3. Properties of Quarry Dust

S.No	Property	Result
1	Specific Gravity	2.55
2	Fineness Modulus	3.3
3	Zone	Zone – I

3.1.5 Silica Fume

Silica Fume is highly pozzolanic mineral admixture, which is generally used to improve the concrete strength and durability properties. Silica Fume reacts with calcium hydroxide formed during hydration of cement which results in the increase in strength and also the Silica Fume fills the voids between cement particles leads to increase in the durability. Silica Fume is procured from ASTRRA CHEMICALS, Chennai. The properties of Silica Fume are shown in Table 4 and Table 5.

Table 4. Physical Properties of Silica Fume

S.No.	Physical Properties	Results
1	Physical State	Micronised Powder
2	Odour	Odourless
3	Appearance	White Colour Powder
4	Colour	White
5	Pack Density	0.76 Gm/Cc
6	P^h of 5% Solution	6.90
7	Specific Gravity	2.63
8	Moisture	.058%
9	Oil Absorption	55 ml / 100 gms

Table 5. Chemical Properties of Silica Fume

S.No.	Component	Results
1	Silica (SiO_2)	99.9%
2	Alumina (Al_2O_2)	0.043%
3	Ferric Oxide (Fe_2O_3)	0.040%
4	Titanium Oxide (TiO_2)	0.001%
5	Calcium Oxide (CaO)	0.001%
6	Magnesium Oxide (MgO)	0.000%
7	Pottasium Oxide (K_2O)	0.001%
8	Sodium Oxide (Na_2O)	0.003%
9	Loss on Ignition	0.015%

3.1.6 Water

Water used for casting and curing of concrete test specimens is procured from the Structural Engineering Laboratory and is free from impurities which when present can adversely influences the strength of concrete.

3.2 CONCRETE MIX PROPORTION

M30 grade of concrete was designed as per the Indian Standard code of practice. The various ingredients for one cubic meter of concrete for different mixes used in the present investigation are shown in Table 6.

Table 6. Quantities of Ingredients per cum of M30 Grade Concrete

S.No	Cement (%)	Silica Fume (%)	Quarry Dust (%)	Water (lit)	Cement (kg)	Silica Fume (kg)	Fine Aggregate (kg)	Quarry Dust (kg)	Coarse Aggregate (kg)
1	100	0	0	146.25	325	0	710	0	1262
2	100	0	100	146.25	325	0	0	710	1262
3	100	0	60	146.25	325	0	284	426	1262
4	100	0	30	146.25	325	0	496	213	1262
5	95	5	30	146.25	308.75	16.25	496	213	1262
6	90	10	30	146.25	292.5	32.5	496	213	1262
7	85	15	30	146.25	276.25	48.75	496	213	1262
8	95	5	60	146.25	308.75	16.25	284	426	1262
9	90	10	60	146.25	292.5	32.5	284	426	1262
10	85	15	60	146.25	276.25	48.75	284	426	1262

3.3 TEST SPECIMENS

Concrete test specimens consist of 150 mm × 150 mm × 150 mm cubes, cylinders of 150 mm diameter and 300 mm height and 100 mm × 100 mm × 500 mm prisms. Concrete cubes were tested at different curing periods (3, 7, 28, 56 and 90 days) to get the compressive strength. Cylindrical specimens were tested at the age of 28 days to obtain the split tensile strength and the modulus of elasticity of concrete. The prisms were tested to obtain the flexural strength of concrete. The rate of loading is as per the Indian Standard specifications.

4. RESULTS AND DISCUSSION

4.1 Compressive Strength

The variation of the cube compressive strength of M30 grade concrete for various percentages of Quarry Dust for different curing periods is shown in Fig.1. It can be observed that the strength of concrete increased up to 60% of QD and with 100% QD much reduction in strength of concrete can be noticed.

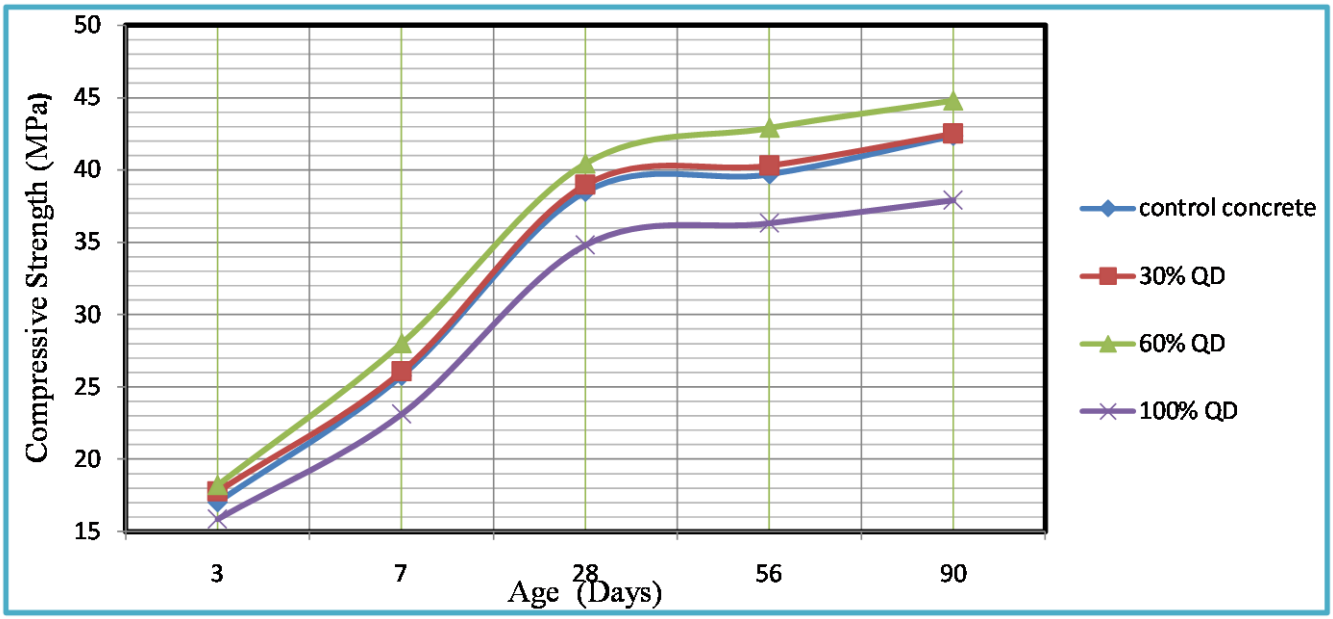
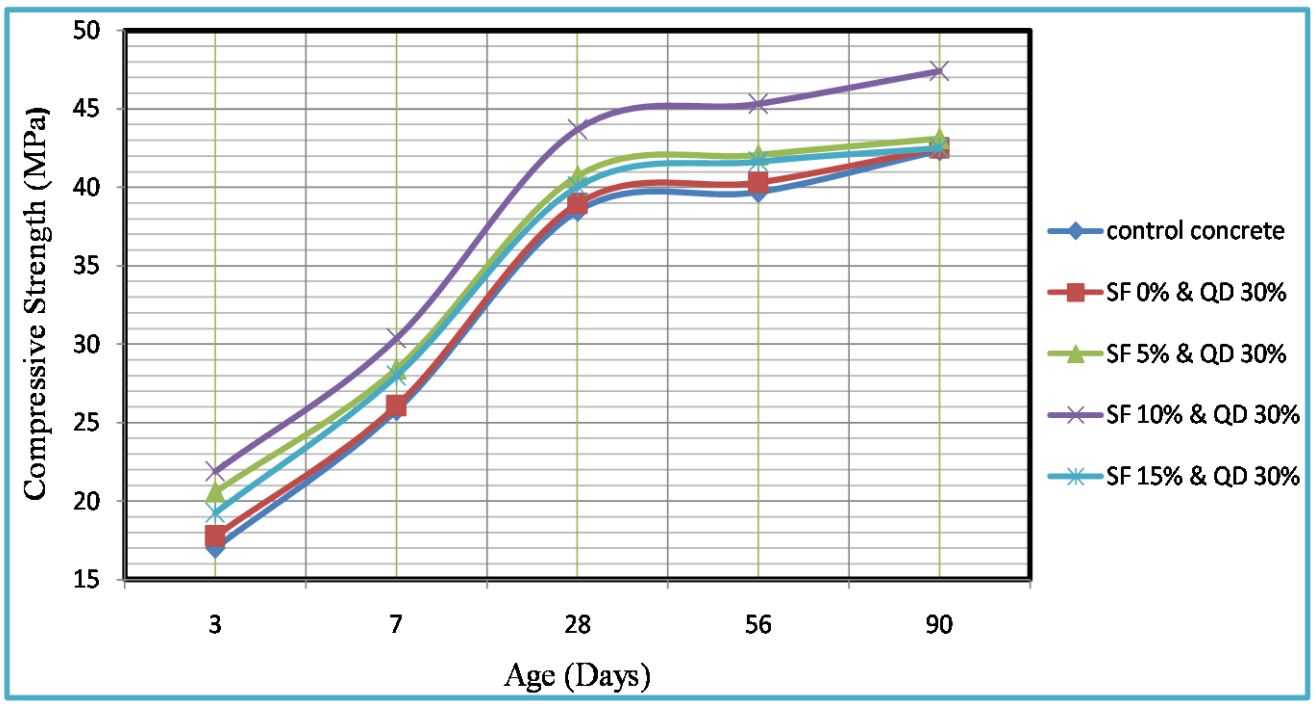
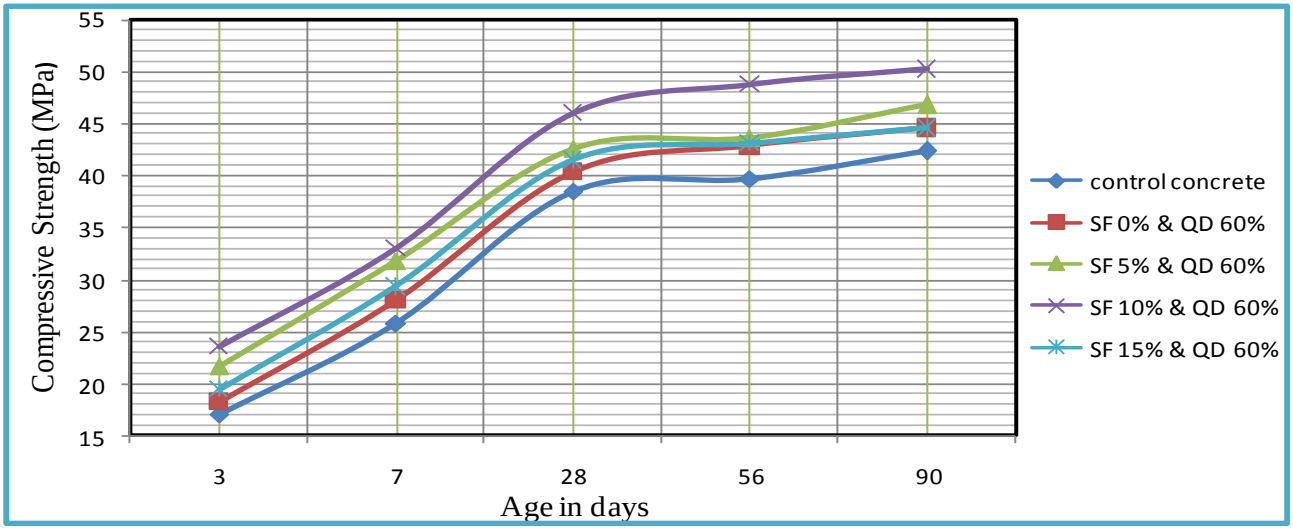


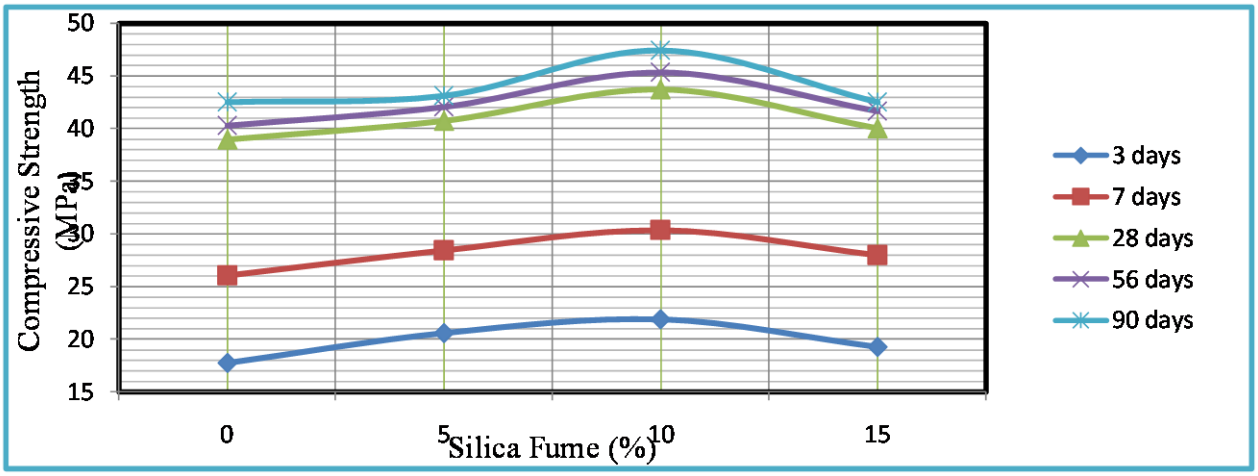
Fig. 1. Variation of Cube Compressive Strength of M30 Grade Concrete with Age for different percentages of Quarry Dust.

The variation of cube compressive strength of M30 grade of concrete with Silica Fume for different percentages of Quarry Dust is shown in Fig.2 and Fig.3. The compressive strength of concrete initially increases up to 10% of Silica Fume and then the strength decreases with increase in Silica Fume. It can also be observed that at a combination of 10% of Silica Fume and 60% Quarry Dust maximum compressive strength can be obtained. The reduction in strength of concrete due to increase in the percentage of SF can be attributed to the loss of workability of concrete.

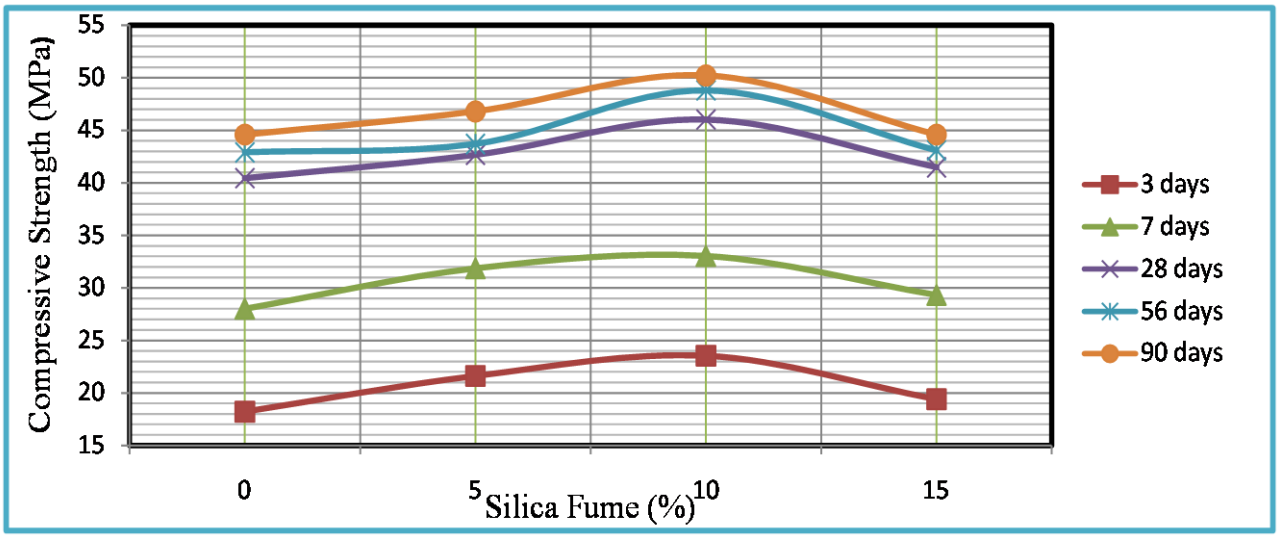


i. 30% Quarry Dust





i. 30% Quarry Dust



ii. 60% Quarry Dust

Fig.3. (i-ii) Variation of Cube Compressive Strength of M30 Grade of Concrete with Silica Fume for Various Percentages of Quarry Dust.

4.2 Split Tensile Strength

The variation of split tensile strength of M30 grade of concrete with Silica Fume for various percentages of Quarry Dust is shown in Fig. 4. The split tensile strength of concrete initially increased up to 10% of Silica Fume for any given percentage of Quarry Dust and beyond which the strength decreases with increase in the Silica Fume. It can also be observed that at a combination of 10% of Silica Fume and 60% Quarry Dust maximum split tensile strength can be obtained.

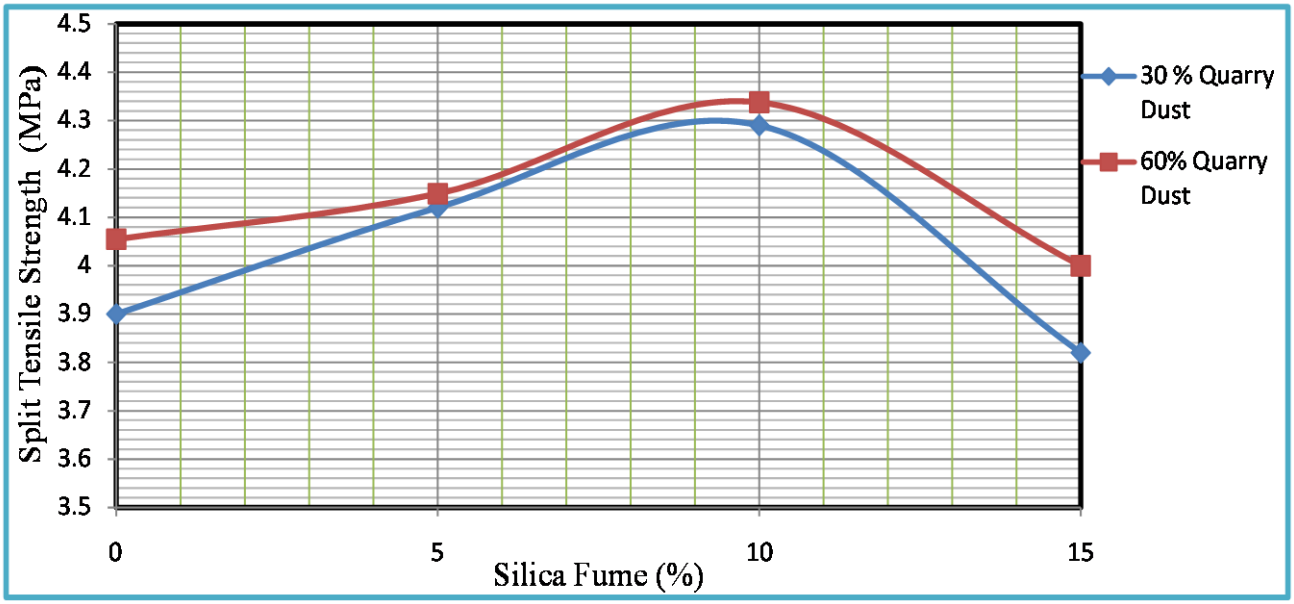


Fig.4.Variation of Split Tensile Strength of M30 Grade of Concrete with different percentages of Silica Fume and Quarry Dust.

4.3 Flexural Strength

The variation of flexural strength of M30 grade of concrete containing various percentages of Quarry Dust and Silica Fume is shown in Fig.5. The flexural strength of concrete initially increases up to 10% of Silica Fume for different

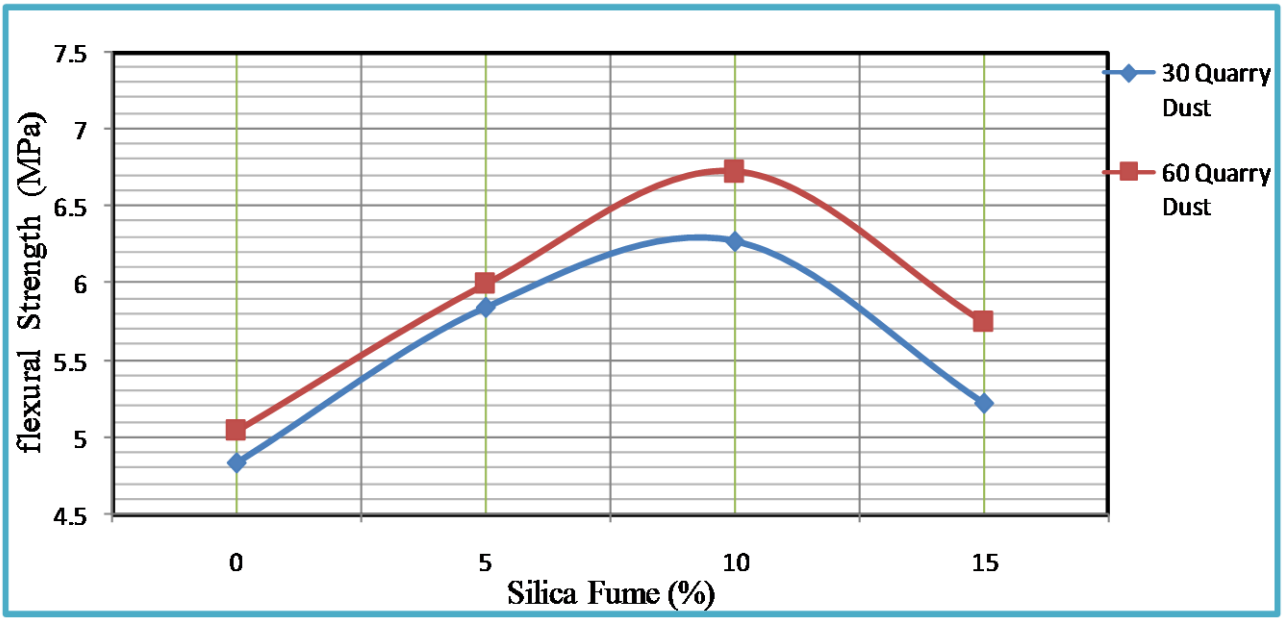


Fig. 5.Variation of Flexural Strength of M30 Grade of Concrete with different percentages of Silica Fume and Quarry Dust.

percentage of Quarry Dust and then with further increase in the Silica Fume the flexural strength decreases. The recommended combination for maximum flexural strength is 10% of Silica Fume and 60% Quarry Dust.

4.4. Modulus of Elasticity

Fig.6 shows the variation of modulus of elasticity of M30 grade concrete with various percentages of Silica Fume and Quarry Dust. It can be observed that the modulus of elasticity of concrete increases with Silica Fume for the given content of Quarry Dust. The maximum value is obtained at 10% Silica Fume for the given content Quarry Dust.

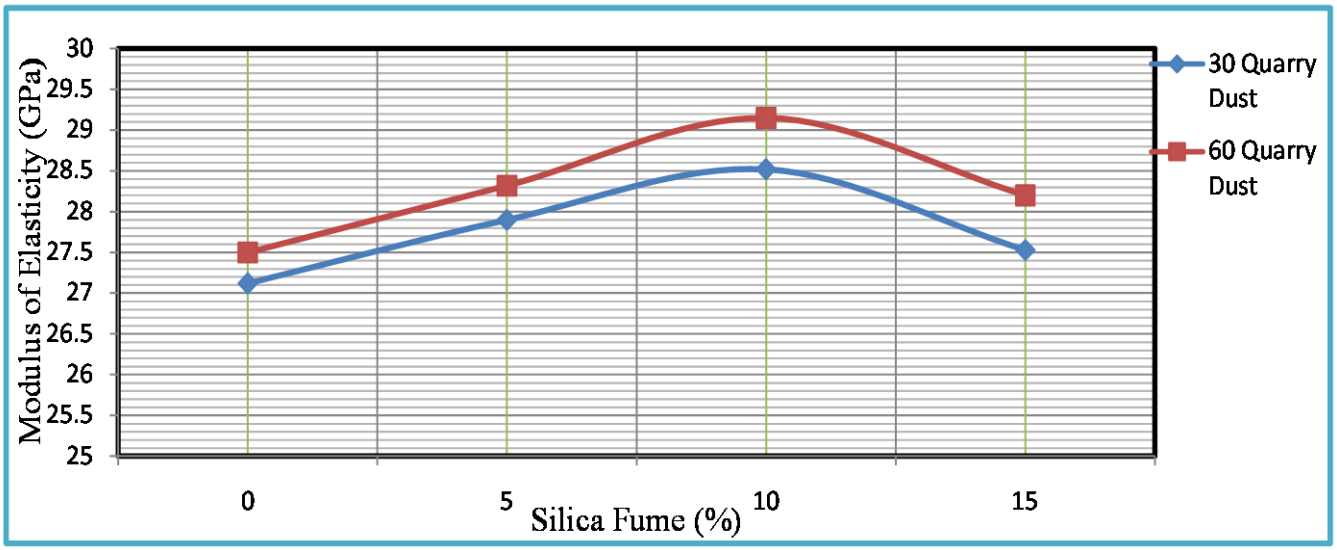


Fig.6. Variation of Modulus of Elasticity of M30 Grade of Concrete with Silica Fume for different percentages Quarry Dust.

5.0 CONCLUSIONS

Using the test results, it can be concluded that with the increase in the percentage of Silica Fume the various strength characteristics of concrete increased up to 10%, with further increase in the Silica Fume the strength characteristics of concrete are decreased for various percentages of Quarry Dust.

The increase in various strength characteristics of concrete containing Quarry Dust with increase in the Silica Fume content can be due to the availability of additional binder in the presence of Silica Fume. Silica Fume has high silicon dioxide content. The Portland cement in concrete releases calcium hydroxide during the hydration process. The Silica Fume reacts with the calcium hydroxide to form additional binder material. The availability of additional binder leads to increase in the paste-aggregate bond, resulting improved strength properties of the concrete prepared with Silica Fume. The decrease in the various strength characteristics of concrete with increase in the Silica Fume content beyond 10% is due to the over generation of binder which increases the brittleness of concrete in the presence of high content of Silica Fume. Hence, the various strength characteristics of concrete can be improved by the addition of 10% of Silica Fume and 60% of Quarry Dust content.

The results of the experimental investigation indicate that the Quarry Dust and Silica Fume can be adopted as partial replacement for the preparation of concrete used in the structural applications.

REFERENCES

1. IS: 10262-2009. Concrete Mix Proportioning – Guidelines (First Revision). Bureau of Indian Standards, New Delhi.

2. IS 516:1959. Methods of Tests for Strength of Concrete, Bureau of Indian Standards, New Delhi, India.

3. IS: 8112:1989. 43 Grade Ordinary Portland Cement–Specifications. Bureau of Indian Standards, New Delhi.

4. IS: 383:1970 (Reaffirmed 1997) Specification for Coarse and Fine Aggregates from Natural Sources for Concrete. Bureau of Indian Standards, New Delhi

5. Sanchez, F. and Sobolev, K."Nanotechnology in concrete – A review", Construction and Building Materials 24 (2010), pp. 2060-2071.

6. Nagabhushana and Bai, H. S., (2011) "Use of crushed rock powder as replacement of fine aggregate in mortar and concrete". Indian Journal of Science and Technology, Volume 4, No. 8: 917-922.

7. Kazim Turk et.al.(2012)," studied the effect of fly ash and silica fume on Compressive Strength". Construction and Building Materials, Vol 37,pp.326-334.

8. Lohani, T.K., Padhi, M., Dash, K.P. and Jena, S. (2012) "Optimum utilization of Quarry Dust as partial replacement of sand in Concrete". Int. Journal of Applied Sciences and Engineering Research, Vol. 1, No. 2, 2012 ISSN 2277 – 9442.

9. Kujur, F. E., Vikas, S, Anjelo, F. D., Ehsan, A., and Agarwal, V.C., (2104) Stone Dust as Partial Replacement of Fine Aggregate in Concrete" Journal of Academia and Industrial Research (JAIR) Volume 3, Issue 5: 229-232.

10. Xianyu Jin, and Zongjin Li (2003) "Effects of Mineral Admixture on Properties of Young Concrete". ASCE Mat. J(15) 435-442.

11. Cement Admixed with Wollastonite and Microsilica. ASCE Mat. J(22)305313.

12. Arnon Bentur and Ariel Goldman, (1989). " Curing Effects, Strength and Physical Properties of High Strength Silica Fume Concretes". ASCE Mat. J.(1). 46-58

13. Detwiler, R., and Mehta, K. (1989). "Chemical and physical effects of Silica Fume on the mechanical behavior of concrete."ACI Mat. J., 86(6), 609-614.

14. Dr. D. V. Prasada Rao and G. V. Sai Sireesha, "A Study on the Effect of Addition of Silica Fume on Strength Properties of Partially used Recycled Coarse Aggregate Concrete", International Journal of Civil Engineering & Technology (IJCIET), Volume 4, Issue 6, 2013, pp. 193 - 201, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.

