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A Study on the Non Destructive Strength Parameters of High Strength Concrete and Subsequently Formulating an Equation

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Abstract—*Concrete production exists around the globe and is one of the leading construction material, essentially man made stone that has become a most versatile and universally recognised tool to build with. Concrete is a widely used structural material which essentially consists of a binder and a mineral filler. It has the unique distinction of being the only construction material which is manufactured actually on the site, whereas other materials are merely shaped and fabricated and eventually assembled at site. Ever since the time of Romans, there has been a continuous effort by the research workers in the field of cement and concrete technology to produce better quality cement resulting in concretes of overall improved quality. The introduction of reinforced concrete as an alternative to steel construction, in the beginning of 20th century, necessitated the developement and use of low and medium strength concretes. In keeping with the demands of the nuclear age, high density concrete has been successfully used for the radiation shielding of highly active nuclear reactors. Considerable progress has been achieved in the design and use of structural light weight concretes, which have the dual advantage of reduced density coupled with increased thermal insulation. With the present state of knowledge in the field of concrete mix design, it is possible to select and design concrete capable of resisting heat, sea water, frost and chemical attack arising out of industrial effluents.*

Nowadays silica fume is almost invariably used in the production of High Performance Concretes. In future, high range water reducing admixtures (Superplasticizers) will open up new possibilities for the use of such material as partial replacement of cement to produce and develop high strength concrete, as some of them are much finer than cement. The existing literature is rich in information on silica fume concrete and after performing a detail review of the research papers published over the last two decades, the objective of the present study was framed.

Keywords*: High strength concrete, silica fume, water binder ratio, compressive strength, mix proportions etc.*

1. INTRODUCTION

Non-destructive testing is often used to determine/ assess the uniformity and quality of concrete cast both in laboratory and site. Rebound hammer test and ultrasonic pulse velocity measurement are the basic tools adopted by researchers to relate different concrete properties with the said test parameters. In the investigation 16 concrete mixes have been tested for USPV and Rebound hammer values at 28 days age as per IS 13311 (Part I and II). For measuring those values five samples (IS 150 mm cubes) were used for each mixes. The concrete cube specimens are held in a compression testing machine under a fixed load, measurements of rebound number taken and then the compressive strength determined as per IS 516 : 1959. The fixed load required is of the order of 7 N/mm^2 when the impact energy of the hammer is about 2.2 Nm. It is also pertinent to note that samples were dried prior to testing. Average values of those measured parameters are shown in Table.

2. EFFECT OF SILICA FUME REPLACEMENT ON REBOUND INDICES

Fig. 01shows the variation in rebound indices value with respect to silica fume replacement percentages @ 0, 5, 10 and 15%. Maximum and minimum values of rebound indices for control concrete have been obtained as 47 and 33 respectively at 0.30 and 0.42 w/cm values. For silica fume mixes maximum and minimum values are 61 and 37 respectively. In general it is observed that as the silica fume percentage increases rebound values also increases. This trend is similar to that of compressive strength. All the values are exceeding 30 which signify that all concrete mixes conform to good quality as per IS 13311 part II.

Table 1: Rebound Indices and Ultrasonic Pulse Velocity Results at 28 days

Mix ID:	Rebound Value:	USPV (Km/sec)
AE 0	47	5.21
AE 05	55	5.34
AE 10	61	5.39
AE 15	54	5.28
AF 0	40	5.19
AF 05	51	5.21
AF 10	56	5.24

AF 15	52	5.14
AG 0	36	4.95
AG 05	41	4.99
AG 10	47	5.04
AG 15	45	5.01
AH 0	33	4.88
AH 05	35	4.91
AH 10	39	4.97
AH 15	37	4.89

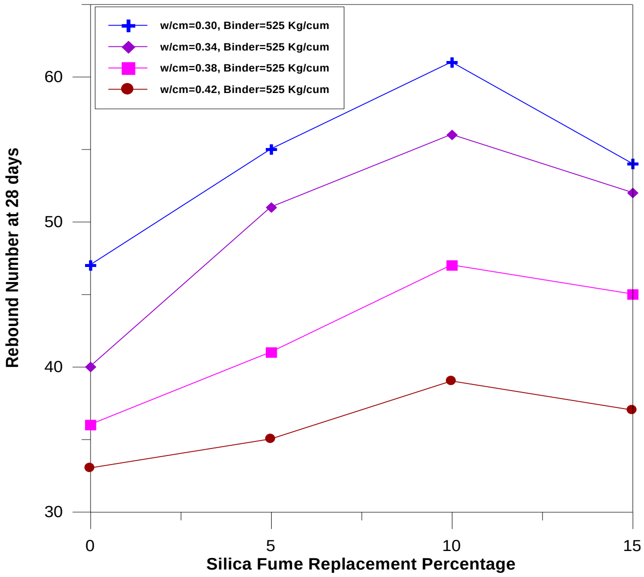

Fig. 1: The relationship between rebound number and silica fume replacement percentages

3. STRENGTH RELATIONSHIP FOR SILICA FUME CONCRETE USING REBOUND INDICES

In order to derive relationship between strength and rebound numbers, regression analysis has been performed using the present data base. After analysis, an exponential expression has been found to be the highly efficient which is as follows:

For control mixes, S_{28}=18.341 x $e^{0.025N}$

For silica fume mixes, S_{28}=25.969 x $e^{0.017N}$

These expressions have been shown in figures 02 and 03.

In the present investigation the value of co relation coefficient (r) is quite high indicating the efficacy of the said models. The value of r for control mixes and silica fume mixes are 0.984 and 0.987 respectively. The accuracy of prediction using the above equations lies ±15% of the actual values. As such, the estimation of strength of concrete by rebound hammer method cannot be held to be very accurate and probable accuracy of prediction of concrete strength in a structure is ± 25 percent (IS 13311 part II).

The expressions for control as well as fly ash mixes are almost identical with some variation. This means that silica fume mixes follows the same trend as that of control while strength needs to be predicted using rebound values.

From the Fig. it is noticed that beyond rebound value of approximately 30-35 strength increases significantly with increase in rebound values. This indicates that strength prediction of high strength concrete is highly sensitive to change in rebound indices.

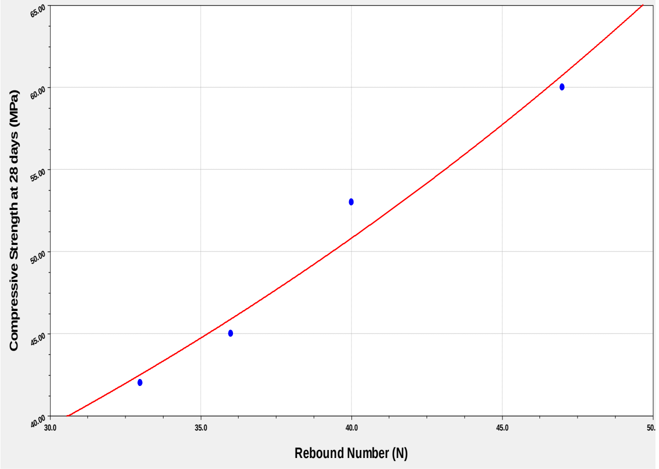

Fig. 2: The Relationship between rebound number and compressive strength for control mixes.

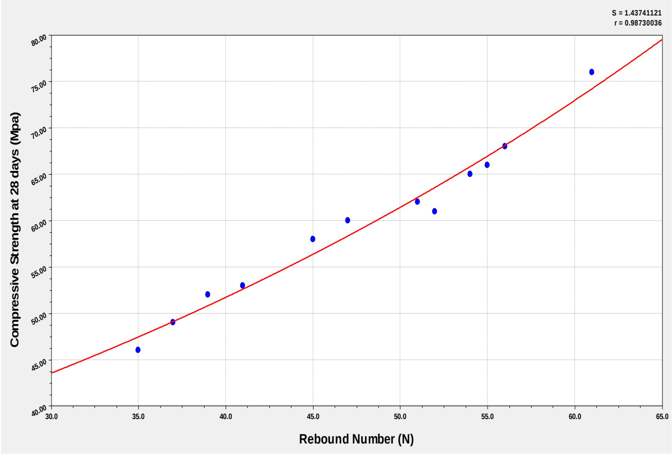

Fig. 3: The Relationship between rebound number and compressive strength for silica fume mixes.

4. EFFECT OF SILICA FUME REPLACEMENT ON USPV VALUES

Relationship between uspv and fly ash replacement percentages is presented in Fig. 04. From the Fig. it is seen that with increasing silica fume replacement percentages uspv values have increased. Maximum and minimum values of uspv values for control concrete have been obtained as 5.21 and 4.88 km/sec respectively at 0.30 and 0.42 w/cm values. For silica fume mixes maximum and minimum values are 5.39

and 4.89 km/sec respectively. In the present investigation all the values are exceeding 4.5 km/sec satisfying excellent quality grading as per IS 13311 Part I.

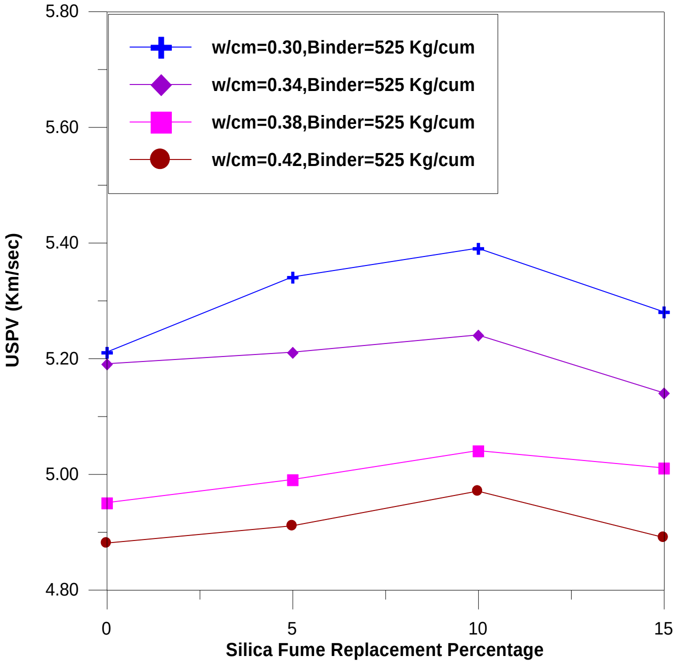

Fig. 4: The relationship between uspv and silica fume replacement percentage

5. STRENGTH RELATIONSHIP FOR SILICA FUME CONCRETE USING USPV VALUES

Fig. 05 and 06 shows the variation in 28 days compressive strength with respect to USPV values at different silica fume replacement percentages @ 0, 5, 10 and 15%. In general it is observed that as USPV increases, Strength increases.

In order to derive relationship between strength and uspv values, regression analysis has been performed using the present data base after analysis, a reciprocal model expression has been found to be the highly efficient which is as follows and the value of co relation coefficient (r) of control and silica fume mixes are 0.956 and 0.935 respectively.

For control mixes: $$S_{28} = \frac{1}{-0.0192x + 0.1173}$$

For silica fume mixes: $$S_{28} = \frac{1}{-0.0127x + 0.0822}$$

The values of co relation coefficient (r) are quite high indicating the efficacy of the said models. The expressions for control as well as fly ash mixes are almost identical with some variations. This means that silica fume concrete mix follows the same trend as that of control while strength needs to be predicted using uspv values.

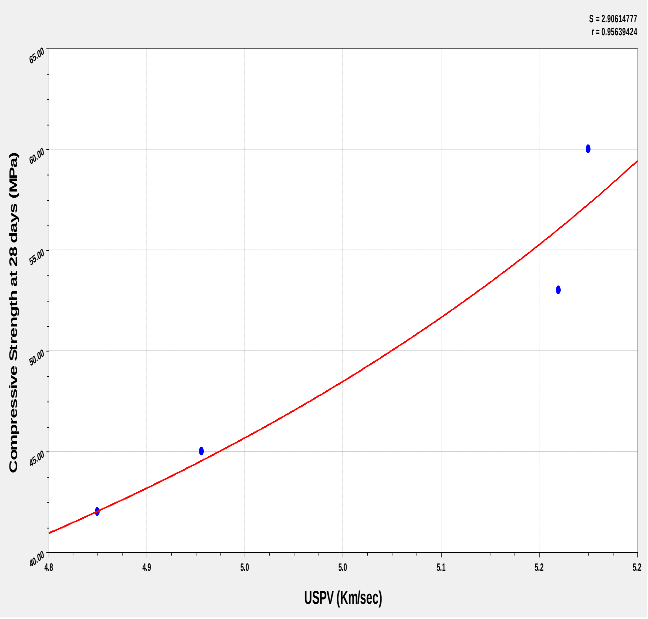

Fig. 5: The relationship between compressive strength and uspv for control mixes.

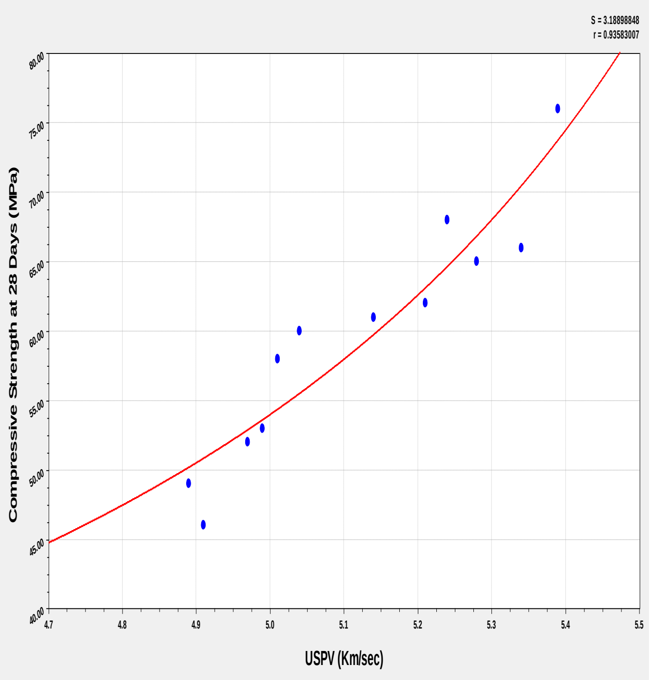

Fig. 6: The relationship between compressive strength and uspv for silica fume mixes:

6. CONCLUSION

From the results of the present investigation, the following conclusions may be drawn –

- As the strength increases, rebound value also increases.

- For silica fume mixes, rebound hammer number varied from 37 to 61 at 28 days for strength varying between 49 and 76 Mpa.
- As the silica fume percentage increases rebound values increases. However at 15% replacement level, the rebound value decreases marginally due to reduction in strength.
- An exponential equation between compressive strength and rebound number has been obtained for silica fume mixes.
- The USPV values varied from 4.89 to 5.39 km/sec at 28 day for silica fume concretes.
- As silica fume content increases, uspv values increases up to 10% silica fume replacement percentage. However at 15% level, the corrresponding uspv value decreases marginally.
- It is observed that as USPV increases, strength increases.
- For silica fume mixes a reciprocal equation between strength and uspv values has been achieved.

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REFERENCES

[1] N.K.Amudhavalli et.al; "Effect of silica fume on strength and durability parameters of concrete", International Journal Of Engineering Science And Emerging Technologies, August 2012.

[2] V. Bhikshma et al.,"Investigations on mechanical properties of high strength silica fume concrete", Asian Journal Of Civil Engineering, 2009).

[3] P. Ratish Kumar; "High performance silica fume mortars"; Architecture and civil engineering Vol-8,2010.

[4] K.C.Biswal et al.;"Effect of superplasticizer and silica fume on the properties of concrete", Conference Trivandrum Kerala, March 16th 2011.

[5] Mohammad Panjehpour et al.; "A Review for characterization of silica fume and its effect on concrete properties"; Sadhana; International journal of Sustainable Construction Engineering And Technology,Dec 2011.