ISSN : 2394-2975 (Online)
ISSN : 2394-6814 (Print)
Vol. 3, Issue 1 (Jan. - Mar. 2016)
International Journal of Advanced Research in Education & Technology (IJARET)

Influence of Nano-Silica on Strength Properties of Concrete Containing Rice Husk Ash

[I]Dr. D. V. Prasada Rao, [II]V.Navaneethamma
[I]Associate Professor, [II]PG Student
[I,II]Dept. of Civil Engineering, Sri Venkateswara University, College of Engg., Tirupati, A.P., India

Abstract
In this paper the results of an experimental investigation on the combined application of pulverised Rice Husk Ash (RHA) and Nano-Silica (NS) on various properties of concrete are presented. In the present investigation, RHA 5% and 10% and NS 1%, 2% and 3% of cement replacement by weight is adopted. For structural applications the various properties, such as compressive strength, split tensile strength, modulus of rupture and modulus of elasticity, of M25 grade concrete containing RHA and NS are evaluated and the results are compared with the controlled concrete. Based on the test results, it can be observed that concrete prepared with a combination of 5% RHA and 2% NS has improved strength properties compared to the controlled concrete. Hence, it can be concluded that concrete prepared with 5% RHA and 2% NS combination can be recommended for the structural applications. The increase in the strength properties of concrete is due to the availability of additional binder in the presence of RHA and NS.

Keywords
Rice Husk Ash, Nano-Silica, Cement Replacement, Compressive Strength and Modulus of Elasticity.

I. Introduction

Concrete is the most commonly used construction material. With fast industrialization and rapid infrastructure development, the demand for cement production is increasing leading to the CO2 emission which results negative impact in the environment. To reduce the usage of cement content in the construction there by the production of the cement, alternate materials need to the suggested for the partial replacement of cement. Cement is one of the main constituents of concrete and its main product of hydration i.e. C-S-H is of nano structure. The strength and durability characteristics of concrete depend on the quality of CSH gel. Silica is one of the most important components in concrete's micro-structure quality improvement. Therefore, extensive research is directed towards the performance of pozolana concrete in recent years. The mechanical and durability properties of concrete are mainly dependent on the gradually refining structure of hardened cement paste and the gradually improving the paste–aggregate interface. Nano-Silica belongs to the category of highly pozzolanic materials because it consists essentially of silica in non-crystalline form with a high specific surface and thus exhibits great pozzolanic activity. A new pozzolanic material, Nano-Silica, produced synthetically, in the form of water emulsion of Ultra-Fine Amorphous Colloidal Silica (UFACS), is better than Rice Husk Ash for the higher content of amorphous silica. Impermeability and strength characteristics of concrete can be improved by using Rice Husk Ash.

In the present research work, an attempt has been made to assess the combined application of Rice Husk Ash and Nano-Silica on the performance of concrete and then the results were compared with the controlled concrete. The present research work is focused to understand the combined use of Rice Husk Ash and Nano-Silica on the strength properties of concrete. Cement is replaced by various combinations of Rice Husk Ash and Nano-Silica. Cement is replaced by the various combinations obtained from 5% and 10% of Rice Husk Ash and 1%, 2% and 3% of Nano-Silica. Tests were performed on standard specimens prepared with concrete containing Rice Husk Ash and Nano-Silica to obtain Compressive strength, Split tensile strength, Modulus of rupture and Modulus of elasticity and then the results were compared with the controlled concrete.

II. Experimental Programme

A. Materials

1. Cement

In the present investigation Ordinary Portland Cement (OPC) of 43 Grade confirming to IS specifications was used. The specific gravity of the cement is 3.15

2. Fine Aggregate

Locally available river sand (Zone - II) confirming to IS specifications with fineness modulus of 2.94 was used as the fine aggregate in the concrete mix.

3. Coarse Aggregate

Machine crushed aggregate confirming to IS 383-1970 obtainedfrom the local quarry is used as coarse aggregate. The nominal sizes of coarse aggregate adopted in the present investigation were 20 mm and 12 mm. The properties of Coarse Aggregate and Fine Aggregate used in the present investigation are shown in the Table. 1

Table 1: Properties of Coarse Aggregate and Fine Aggregate

Property	Coarse Aggregate	Fine Aggregate
Specific Gravity	2.64	2.66
Water Absorption (%)	0.25	1.10

4. Rice Husk Ash

Rice Husk Ash is a Pozolonic material containing Silica, and is a by-product of Agricultural waste compounds. Compared to cement, the particle size of Rice Husk Ash is very finer. It acts as an excellent pore-filling material. Rice Husk Ash is usually considered as a supplementary cementitious material. The properties of Rice Husk Ash used in the present investigation are shown in the Table. 2

ISSN : 2394-2975 (Online)
ISSN : 2394-6814 (Print)

Table 2 : Properties of Rice Husk Ash

Sl no	Ingredients	Percentage (%)
1	SiO_2	94%
2	CaO	0.2%
3	Al_2O_3	0.4%
4	Fe_2O_3	1.5%
5	LOI	< 3%
6	Moisture	< 3%
7	Fineness	300 mesh
8	Bulk Density	590
9	Colour	Grey
10	Pozz.Activity Index	110 %
11	Surface Area	18 m^2/gm
12	Bulk Density	590
13	+ 45 Microns	10% Max
14	$Na_2O + K_2O$	<0.65

5. Nano-Silica

Nano-Silica is a new pozzolanic material in the form of water emulsion of colloidal silica. It is available commercially and it appears to be potentially better than RHA for the higher content of amorphous silica (> 99%) and the reduced size of its spherical particles (1-50 nm). In the present experimental investigation cement is replaced by 1%, 2% and 3% of Nano-Silica. The properties of Nano-Silica are shown in the Table.3.

Table 3: Properties of Nano-Silica

S.No	Characteristics	Actual Analysis
1	Active Nano Content(%wt/wt)	30-32
2	PH (20 C)	9-10
3	Specific Gravity	1.20-1.22
4	Texture	White milky liquid
5	Dispersion	Water

6. Water

Potable water is used for casting and curing concrete test specimens, which is free from acids,organic matter, suspended solids and impurities when present can adversely affect the strength of concrete.

B. Concrete Mix Proportions

In the present research work the combined use of RHA and NS as partial replacement of cement in M25 grade of concrete is studied. Concrete specimens were prepared with a combination of 5% and 10% of RHA and 1%, 2% and 3% of NS.

M25 grade of concrete was designed as per the Indian Standard method of mix proportioning. The mix proportion of M25 concrete by weight is shown in Table. 4. In the concrete mix, 12 mm and 20 mm coarse aggregate were used in the ratio of 1:1.5.

Table.4: Concrete Mix Proportions

Cement in kgs	**FA in kgs**	**20 mm CA in kgs**	**12 mm CA in kgs**	**Water in lit**
326	742	800	400	163
1	2.27	2.45	1.23	0.50

C. Preparation of Concrete Test Specimens

Concrete specimens were prepared using Rice Husk Ash and Nano-Silica. Five sets of concrete specimens for different curing periods 3, 7, 28 ,56 and 90 days were prepared.

Concrete specimens consist of 150 mm × 150 mm × 150 mm cubes, 150 mm × 300 mm cylinders, 100 mm × 150 mm cylinders and 150 mm × 150 mm × 700 mm prisms. The cubes were used to find the compressive strength of concrete. The cylinders were used to obtain the Split tensile strength and Modulus of elasticity, The prisms were used to get the modulus of rupture of concrete.

D. Tests on Concrete Specimens

The compressive and split tensile strengths properties of concrete were obtained using a compression testing machine. The rate of loading for the compressive and splitting tensile tests is in accordance with Indian Standard specifications. The compressive strength tests on concrete cubes specimens were carried out at the age of 3, 7, 28, 56 and 90 days. The split tensile strength, modulus of rupture, modulus of elasticity tests were conducted on concrete specimens at the age of 28 days.

III. Results and Discussion

A. Compressive Strength

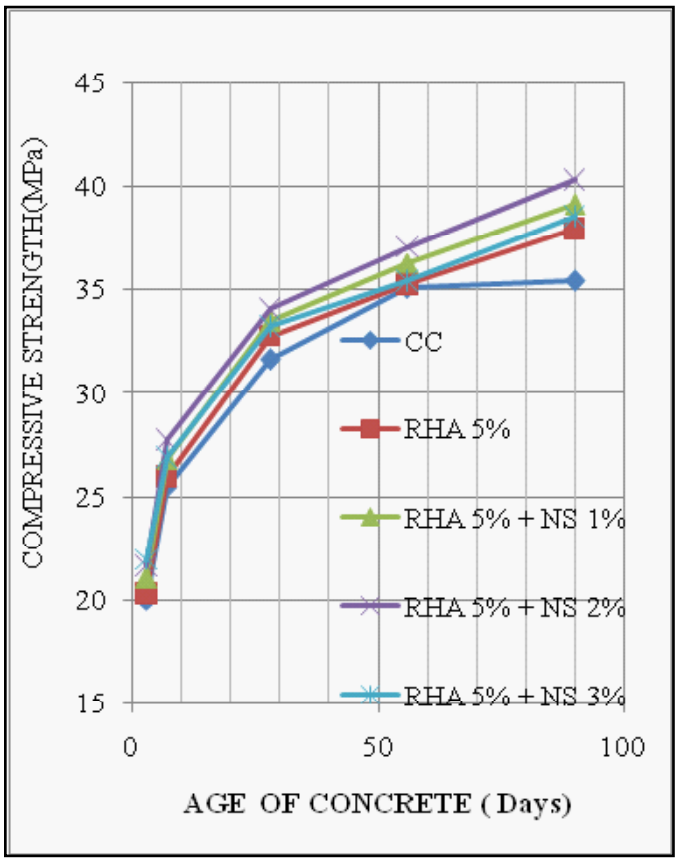

Fig. 1(a): Variation of Cube Compressive Strength with 5% Rice

Husk Ash and 1%,2%, and 3% Nano-Silica
The results of the cube compressive strength of M25 grade concrete for various combinations of Rice Husk Ash and Nano-Silica for different curing periods is shown in Fig.1(a), Fig.1(b).
Each value of the cube compressive strength indicates the average of three test results. It can be observed that as the age of concrete increases, the cube compressive strength of concrete also increases with Rice Husk Ash and Nano-Silica.

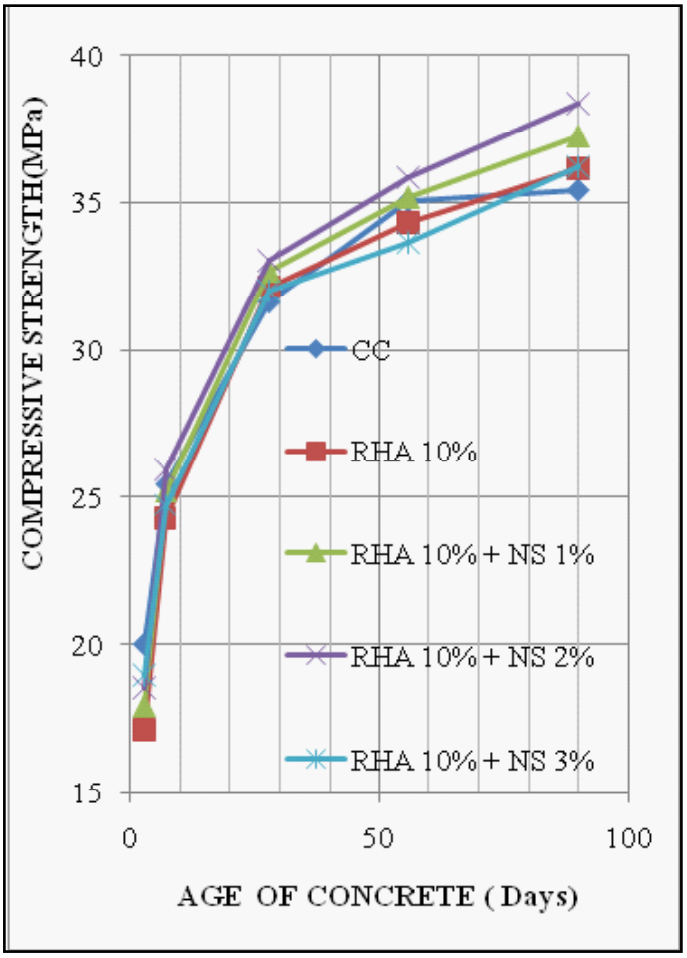

Fig. 1(b): Variation of Cube Compressive Strength with 10% Rice Husk Ash and 1%,2%, and 3% Nano-Silica

With reference to the test results it can be observed that for the compressive strength of concrete with 5% and 10% RHA increases with increase in NS content up to 2% and with further increase in Nano-Silica content the compressive strength decreases.
The variation of 7 days and 28 days cube compressive strength of M25 grade concrete containing 5% and 10% Rice Husk Ash content with increase in the percentage of Nano-Silica is shown in Fig. 2 and Fig. 3 respectively.

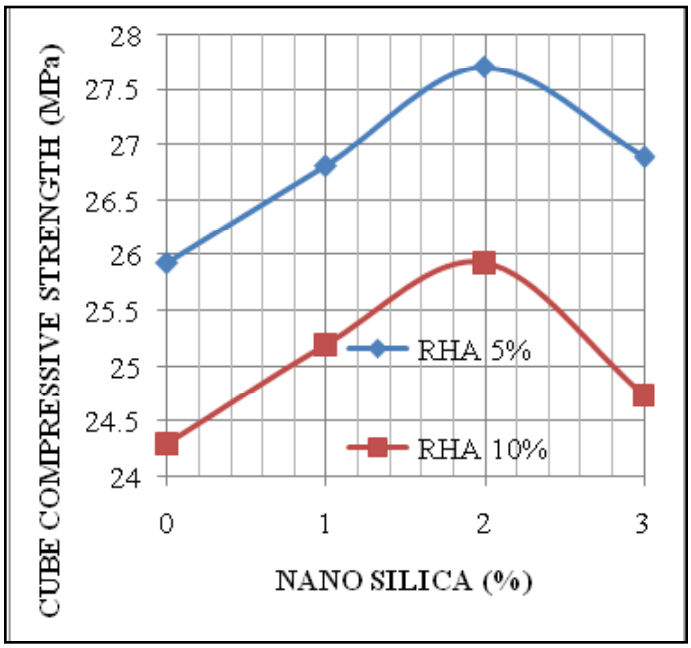

Fig. 2 : Variation of 7 days Cube Compressive Strength of concrete prepared with RHA and NS content.

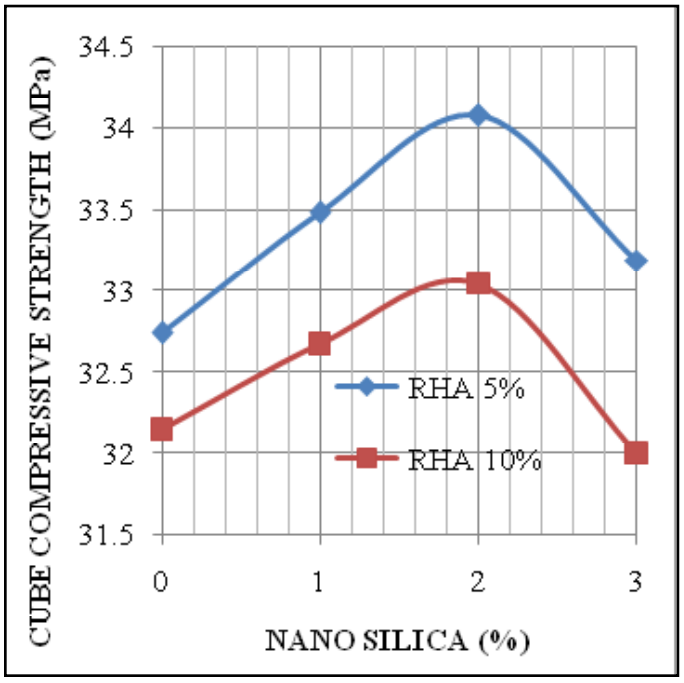

Fig 3. Variation of 28 days Cube Compressive Strength of concrete prepared with RHA and NS content.

The compressive strength of concrete increases with a combination of 5% Rice Husk Ash and 2% Nano-Silica and beyond which the strength decreases with increase in the Rice Husk Ash and Nano-Silica content.

B. Split Tensile Strength

The variation of split tensile strength of M25 grade of concrete containing 5% and 10% Rice Husk Ash content with increase in the Nano-Silica is shown in Fig. 4. The split tensile strength of concrete containing Rice Husk Ash increases up to 2% of Nano-Silica and beyond which the strength decreases with increase in the Nano-Silica content.

ISSN : 2394-2975 (Online)
ISSN : 2394-6814 (Print)

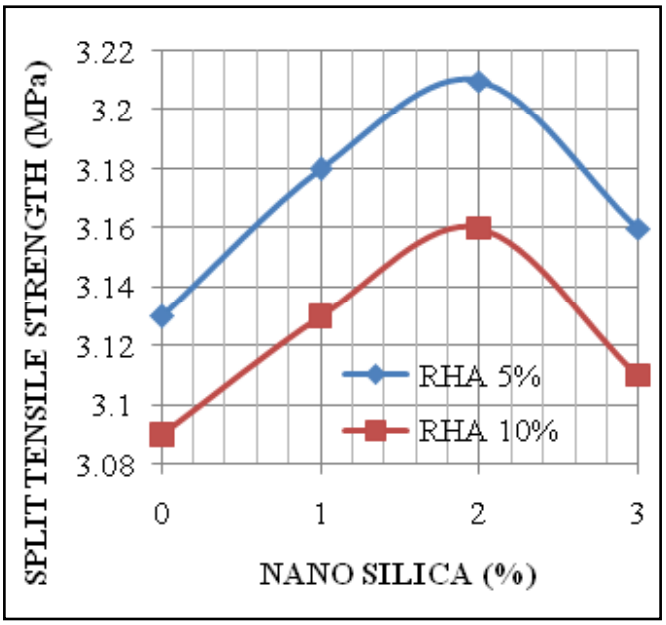

Fig. 4: Variation of Split Tensile Strength of concrete with RHA and NS content

C. Modulus of Rupture

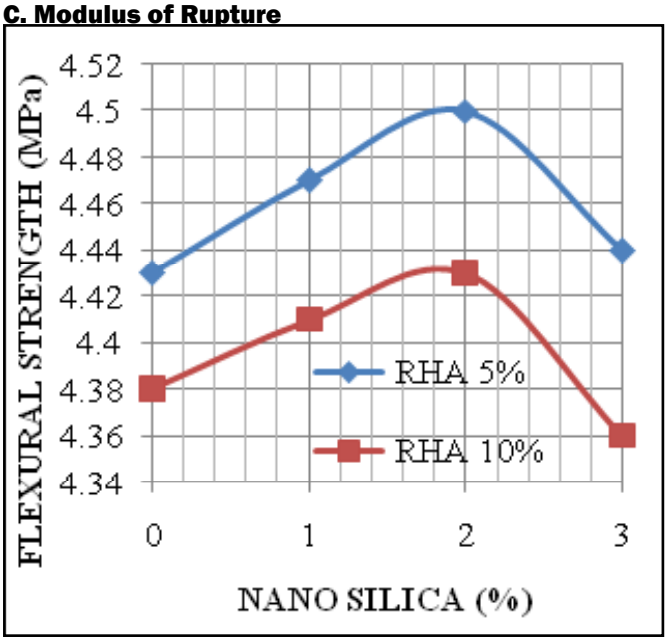

Fig. 5 : Variation of Modulus of Rupture of concrete with RHA and NS content

The variation of modulus of rupture of M25 grade of concrete containing 5% and 10% Rice Husk Ash content with increase in the Nano-Silica is shown in Fig. 5. Modulus of Rupture of concrete containing Rice Husk Ash increases up to 2% of Nano-Silica and beyond which the flexural strength decreases with increase in the Nano-Silica content.

D. Modulus of Elasticity

The variation of modulus of Elasticity of M25 grade of concrete containing 5% and 10% Rice Husk Ash content with increase in the Nano-Silica is shown in Fig. 6. Modulus of Elasticity of concrete containing Rice Husk Ash increases up to 2% of Nano-Silica and beyond which the Modulus of Elasticity of concrete decreases with increase in the Nano-Silica content.

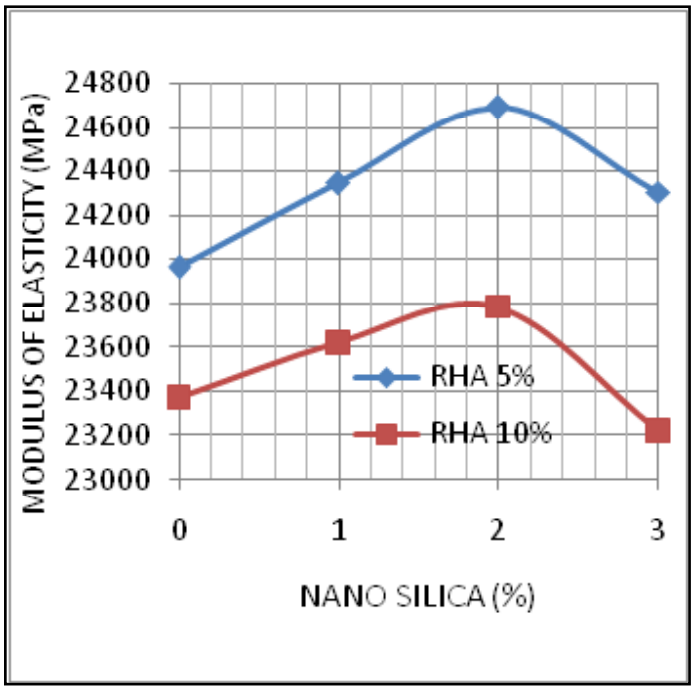

Fig.6 : Variation of Modulus of Elasticity of concrete with RHA and NS content

IV. Conclusions

Various strength tests were conducted on standard concrete specimens prepared with a combination of Rice Husk Ash 5% or 10% and the Nano-Silica content is varied from 1% to 3% with 1% increment. The test results of Nano-Silica Rice Husk Ash Concrete are compared with that of Controlled Concrete. Using the test results, it can be concluded that for a given Rice Husk Ash content, the various strength properties of concrete increases as the percentage of Nano-Silica is up to 2% and then decreases.

The variation of compressive strength, split tensile strength, modulus of rupture, and modulus of elasticity results of M25 grade concrete prepared with various combinations 5% and 10% Rice Husk Ash and 1%, 2% and 3% Nano-Silica content follows the same pattern.

The increase in the strength of concrete containing Rice Husk Ash and Nano-Silica can be attributed to the availability of additional binder in the presence of Rice Husk Ash .Rice Husk Ash has high amorphous silicon dioxide content and is a very reactive pozzalanic material. As the Portland cement in concrete begins to react chemically, it releases calcium hydroxide. The Rice Husk Ash and Nano-Silica reacts with the calcium hydroxide to form additional binder material. The availability of additional binder enhances the paste-aggregate bond which results in the improved strength properties of concrete prepared with Rice Husk Ash and Nano-Silica.

The decrease in the various strength characteristics of concrete with increase in the Nano-Silica and RHA is due to the fact that the concrete becomes dry, for a given W/C ratio, in the presence of high content of RHA and NS. This results in incomplete hydration leading to lower strength of concrete. Hence, the strength properties of concrete can be improved by the addition of a specified percentage of Rice Husk Ash (5%) and of Nano–Silica (2%) content.

The experimental investigation indicated that improved strength characteristics of concrete can be obtained with the combined use of Rice Husk Ash and Nano-Silica. The influence of varying

percentages of Rice Husk Ash and Nano-Silica on M 25 grade of concrete is studied and a combination of 5% of Rice Husk Ash and 2% of Nano-Silica is recommended for improved strength characteristics of concrete.

References

[1]. *Godwin A. Akeke, Maurice E.Ephraim, Akobo, I.Z.S and Joseph O. Ukpata, Structural "Properties of Rice Husk Ash Concrete", Department of Civil Engineering, Cross River university of Technology, Calabar, Nigeria, International Journal of Engineering and Applied Sciences, Vol. 3, No. 3 ISSN2305-8269.*

[2]. *G.Reddy Babu, "Effect of Nano-Silica on properties of blended cement", Department of Civil Engineering, Narasaraopeta Engineering College, Narasaraopet, Guntur-522601, A.P, India, International Journal of Computational Engineering Research Vol 03 - Issue 5*

[3]. *Farah Alwani Wan Chik, Badorul Hisham Abu Bakar, "Properties of Concrete Block Containing Rice Husk Ash Subjected to Girha", Megat Azmi Megat Johari & Ramadhansyah Putra Jaya School of Civil Engineering, Universiti Sains Malaysia, Engineering Campus, 14300 Nibong Tebal, IJRRAS 8 July 2011.*

[4]. *R.N. Krishna, "Our World in Concrete & Structures", Singapore, Indian Concrete Institute, #532 TTK Road Alwarpet Chennai-600018 India. Article 37th Conference.*

[5]. *A.A. Ramezanianpour, M. Mahdi khani and Gh. Ahmadibeni, "The Effect of Rice Husk Ash on Mechanical Properties and Durability of Sustainable Concretes", Received: October 2007; Revised: May 2008; Accepted: March 2009.*

[6]. *Nguyen Thi Xuan Huynh, Vo Van Hoang and Hoang Zung, "Structural Properties Of Amorphous Sio2 Nanoparticles", College of Natural Sciences of HochiMinh City-Vietnam, 227 Nguyen Van Cu Str., Distr. 5, HochiMinh City-Vietnam and Polytechnic Institute of HochiMinh City-Vietnam.*

[7]. *Mauro M. Tashima, Carlos A. R. da Silva, Jorge L. Akasaki, Michele Beniti Barbosa, "The Possibility of adding the Rice Husk Ash (RHA) to the Concrete", Civil Engineering Department, FEIS/UNESP, Brazil.*

[8]. *Sudisht Mishra, S. V. Deodhar, "Effect of Rice Husk Ash on Cement Mortar and Concrete". Civil Engineer. Dept. NERIST, Itanagar and SSVPS BSD College of Engineering, Dhule.*

[9]. *Sayed Abd El- Aky, Sameh Yehia and Ibrahim S. Khalil, "Influence of Nano-Silica addition on properties of fresh and hardened cement mortar", Housing & Building National Research Centre, Cairo, Egypt and Shorouk Academy, Cairo, Egypt. Brno, Czech Republic, EU.*