

Influence of Partial Replacement of Cement with Rice Husk Ash, Silica Fume and Fine Aggregate with Stone Dust on Properties of Concrete

Dr.D.V.Prasada Rao¹, K.Lakshmi Priya²

Professor, Department of Civil Engineering, Sri Venkateswara University College of Engineering, Tirupati,
Andhra Pradesh, India¹

PG Student, Department of Civil Engineering, Sri Venkateswara University College of Engineering, Tirupati,
Andhra Pradesh, India²

ABSTRACT: This paper presents the experimental investigation on the properties of Concrete by partial replacement of cement with Rice Husk Ash (RHA), Silica Fume (SF) and Fine Aggregate with Stone Dust (SD). In the present study, the fine aggregate is partially replaced with 30%, 60% and 100% of Stone Dust by weight. The cement is partially replaced by the combination of 5% and 7.5% Rice Husk Ash and 5%, 10%, and 15% of Silica Fume by weight. The influence of combined application of Stone Dust, Rice Husk Ash 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 Stone Dust, Rice Husk Ash and Silica Fume are compared with that of controlled concrete. Based on the test results, it can be observed that concrete prepared with the combination of 60% Stone Dust, 5% Rice Husk Ash and 10% Silica Fume possesses improved properties compared to the controlled concrete.

KEYWORDS: Stone Dust, Rice Husk Ash, Silica Fume, Partial Replacement, Compressive Strength, Flexural Strength, Split Tensile Strength and Modulus of Elasticity.

I.INTRODUCTION

Concrete is the most widely used material for construction all over the world. Huge quantity of concrete is consumed by construction industry. Concrete is an artificial material in which the aggregates both are fine and coarse are bonded together by the cement when mixed with water. Concrete solidifies and harden after mixing and placements due to chemical process known as hydration. The concrete has become so popular and indispensable because of its inherent properties. Concrete has unlimited and innovative applications in the construction field. The Indian Standard Code of practice for plain and reinforced concrete recommends the minimum cement content to satisfy the strength and durability. It can be noticed that the utilization of cement is increased, but the cement production consumes large amount of energy and emits carbon dioxide results in environmental pollution. Hence, one of the solutions to these problems is to reduce the consumption of cement and utilize Pozzolona materials for the preparation of concrete.

Industrial by-products can be used in concrete as admixtures. Industrial by-products, such as silica fume, blast furnace slag, fly ash, rice husk ash are being used as supplementary cement replacement materials. Optimum use of Rice Husk Ash (RHA), Silica Fume (SF) improves workability, strength and durability of concrete. Rice Husk Ash (RHA) is obtained by burning rice husk in a controlled temperature. When properly burnt it has high SiO_2 content and can be used as a concrete admixture. Rice Husk Ash exhibits high Pozzolanic characteristics and contributes to high strength and high impermeability of concrete.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 1, January 2017

Silica fume, also known as micro-silica, an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm.

Stone Dust or Artificial sand is obtained during the process of crushing of stone to get coarse aggregate and completely passes through the 4.75 mm sieve. The influence of combined application of Stone Dust Rice Husk Ash, Silica Fume is to be investigated.

II. OBJECTIVE

The objective of the present research work is to find the influence of the combined application of Rice Husk Ash (RHA), Silica Fume (SF) and Stone Dust on various strength properties of M30 grade of concrete. Natural fine aggregate is partially replaced with Stone Dust by 30%, 60%, and 100%. The cement is partially replaced by the various combinations of 5% and 7.5% of Rice Husk Ash and 5%, 10% and 15% of Silica Fume by weight. The obtained results of Compressive Strength, Split Tensile Strength, Flexural Strength and Modulus of Elasticity of Concrete are compared with that of Controlled Concrete.

III. EXPERIMENTAL PROGRAMME

A. PROPERTIES OF MATERIALS

i. Cement

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

ii. 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. Properties of Fine Aggregate

S.No	Property	Result
1	Specific Gravity	2.56
2	Fineness Modulus	2.6
3	Grading of Sand	Zone – II

iii. Coarse Aggregate

Coarse aggregate of nominal sizes 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	0.4%

iv. Stone Dust

The stone dust used in the investigation is obtained from the quarry at Chandragiri near Tirupati, Andhra Pradesh. The properties of Stone Dust are shown in Table 3.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 1, January 2017

Table 3. Physical properties of Stone Dust

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

v. Rice Husk Ash:

Rice Husk Ash used in this present experimental study is obtained from ASTRRA chemicals, Chennai. Properties of Rice Husk Ash are shown in Table 4 and Table 5.

Table 4: Physical Properties of Rice Husk Ash

Property	Results
Colour	Off White
Specific gravity	2.25
Bulk Density	0.39 gm/cc

Table 5: Chemical properties of Rice Husk Ash

S.No.	PROPERTY	RESULTS
Silica	SiO_2	88.90%
Alumina	Al_2O	2.50%
Ferric Oxide	Fe_2O_3	2.19%
Calcium Oxide	CaO	0.22%
Total Alkalies	$Na_2O + K_2O$	0.69%
Loss on Ignition		4.01%

vi. Silica Fume

Silica fume is highly pozzolanic mineral admixture, which is mainly utilized to improve concrete strength and durability of concrete. Silica fume reacts with calcium hydroxide formed during hydration of cement 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 6 and Table 7.

Table 6. Physical Properties of Silica Fume

S.No.	PROPERTY	RESULTS
1	Physical State	Micronized Powder
2	Odor	Odorless
3	Appearance	White Color Powder
4	Color	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 MI / 100 gms

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 1, January 2017

Table 7: Chemical properties of Rice Husk Ash

S.No.	CHEMICAL PROPERTIES	RESULTS
1	Silica (SiO ₂)	99.886%
2	Alumina (Al ₂ O ₂)	0.043%
3	Ferric Oxide (Fe ₂ O ₃)	0.040%
4	Titanium Oxide (TiO ₂)	0.001%
5	Calcium Oxide (CaO)	0.001%
6	Magnesium Oxide (MgO)	0.000%
7	Potassium Oxide (K ₂ O)	0.001%
8	Sodium Oxide (Na ₂ O)	0.003%
9	Loss on Ignition	0.015%

vii. Water

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

viii. Water Reducing Admixture

Super Plasticizer used in this investigation is MYK Save Mix SP200 based on Sulphonated Naphthalene Polymers having a Specific Gravity of 1.25 and is supplied as brown liquid instantly dispersible in water. MYK save mix SP200 has been specially formulated to give water reduction up to 25% without loss of workability or to produce high quality concrete of reduced permeability.

B. CONCRETE MIX PROPORTION

M30 grade of concrete was designed as per the Indian Standard code of practice is shown in Table 8.

Table 8. Quantities of Ingredients per cum of M30 Grade Concrete

S.No	Cement (%)	Stone Dust (%)	Rice Husk Ash (%)	Silica fume (%)	Water (lit)	Cement (kg)	Rice Husk Ash (kg)	Silica fume (kg)	Fine Aggregate (kg)	Stone Dust (kg)	Coarse Aggregate (kg)
1	100	0	0	0	146.25	325	0	0	710	0	1262
2	100	100	0	0	146.25	325	0	0	0	710	1262
3	100	60	0	0	146.25	325	0	0	284	426	1262
4	100	30	0	0	146.25	325	0	0	497	213	1262
5	95	30	5	0	146.25	308.75	16.25	0	497	213	1262
6	92.5	30	7.5	0	146.25	300.63	24.38	0	497	213	1262
7	95	60	5	0	146.25	308.75	16.25	0	284	426	1262
8	92.5	60	7.5	0	146.25	300.63	24.38	0	284	426	1262
9	90	60	5	5	146.25	292.5	16.25	16.25	284	426	1262
10	85	60	5	10	146.25	276.25	16.25	32.5	284	426	1262
11	80	60	5	15	146.25	260	16.25	48.75	284	426	1262

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 1, January 2017

C. 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 also tested at the age of 28 days to obtain the split tensile strength of concrete. The prisms were tested to obtain the flexural strength of concrete. The rate of loading is as per the Indian Standard specifications.

IV. RESULTS AND DISCUSSION

A. COMPRESSIVE STRENGTH

The variation of the cube compressive strength with age of M30 grade concrete for various combinations of Stone Dust, Rice Husk Ash and Silica Fume for various curing periods is shown in Fig.1, Fig. 2 and Fig.3. The cube compressive strength indicates the average of three test results. Results indicate that as the Stone Dust increases more than 60%, the compressive strength decreases. At 60% SD and 5% RHA the compressive strength is maximum. It is also observed that the combination of 5% Rice Husk Ash, 10% of Silica Fume and 60% of Stone Dust maximum cube compressive strength is obtained.

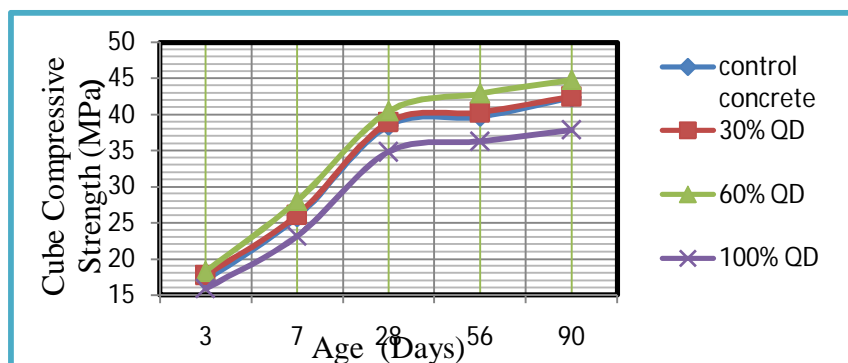


Fig. 1. Variation of Cube Compressive Strength of concrete with Age for Different Percentages of Stone Dust.

Fig.1 represents the variation of cube compressive strength of concrete with different proportions of Stone Dust with Control Concrete. At 60% of Stone Dust the cube compressive strength obtained is maximum.

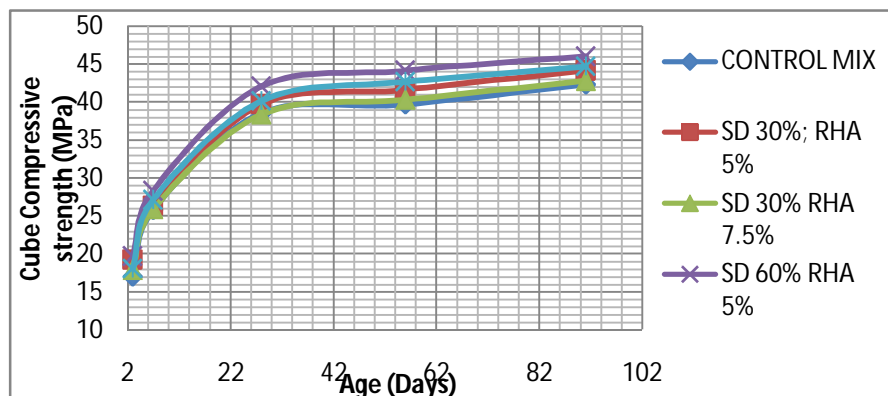


Fig. 2. Variation of Cube Compressive Strength of M30 Grade Concrete with Age for different percentages of Stone Dust and Rice Husk Ash.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 1, January 2017

Fig.2 represents the cube compressive strength of concrete containing Stone Dust and Rice Husk Ash exhibits more strength than the control concrete. At 60% SD and 5% RHA Cube Compressive Strength obtained is maximum

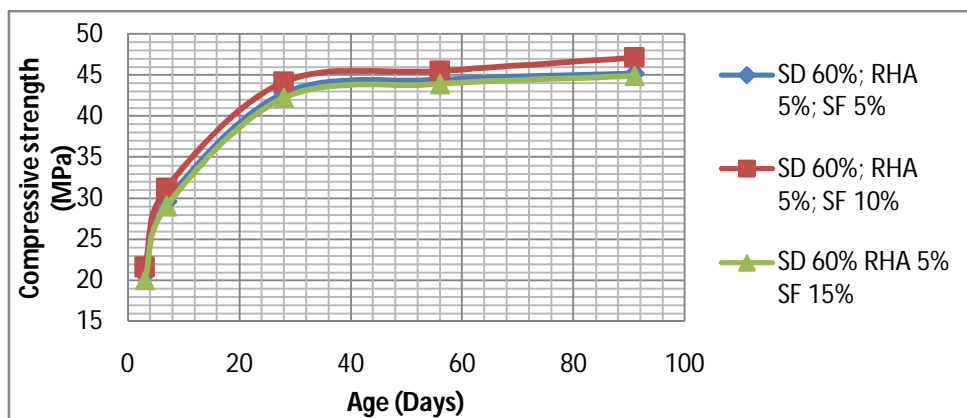


Fig. 3. Variation of Cube Compressive Strength of M30 Grade Concrete with Age for different percentages of Stone Dust, Rice Husk Ash and Silica Fume.

Fig.3 represents the cube compressive strength of concrete containing Stone Dust Rice Husk Ash and Silica Fume exhibits more strength than the conventional control concrete. At 60% SD, 5% RHA, and at 10% SF Cube Compressive Strength obtained is maximum.

B. SPLIT TENSILE STRENGTH

The variation of split tensile strength for different mixes is shown in Fig. 4. Results indicate that as the Stone Dust increases more than 60%, the tensile strength decreases. At 60% SD and 5% RHA content the split tensile strength is maximum. It is also observed that for the combination of 60% Stone Dust, 5% of Rice Husk Ash and 10% Silica Fume content maximum split tensile strength is obtained.

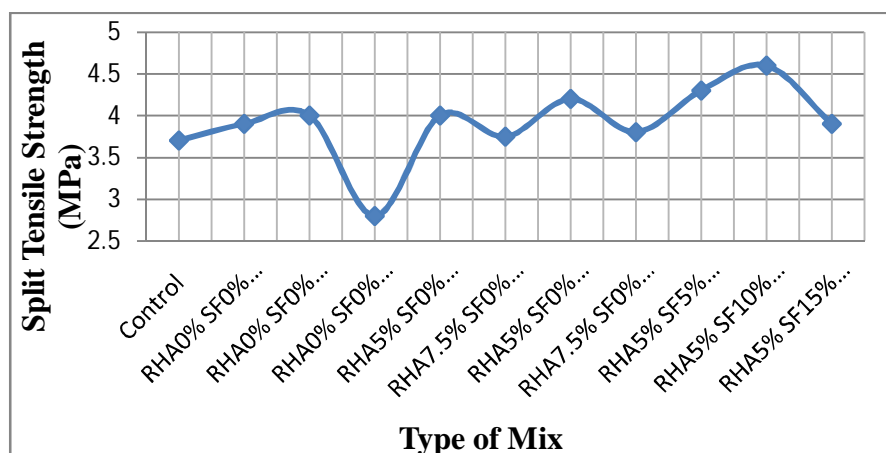


Fig.4. Variation of Split Tensile Strength of M30 Grade of Concrete with different percentages of Rice Husk Ash, Silica Fume and Stone Dust.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 1, January 2017

C. FLEXURAL STRENGTH

The variation of flexural strength for different mixes is as shown in Fig. 5. From the results it can be observed that at 60% of Stone Dust and 5% Rice Husk Ash content the flexural tensile strength is increased. It is also noticed that for the combination of 5% Rice Husk Ash, 10% of Silica Fume and 60% of Stone Dust maximum flexural strength is obtained.

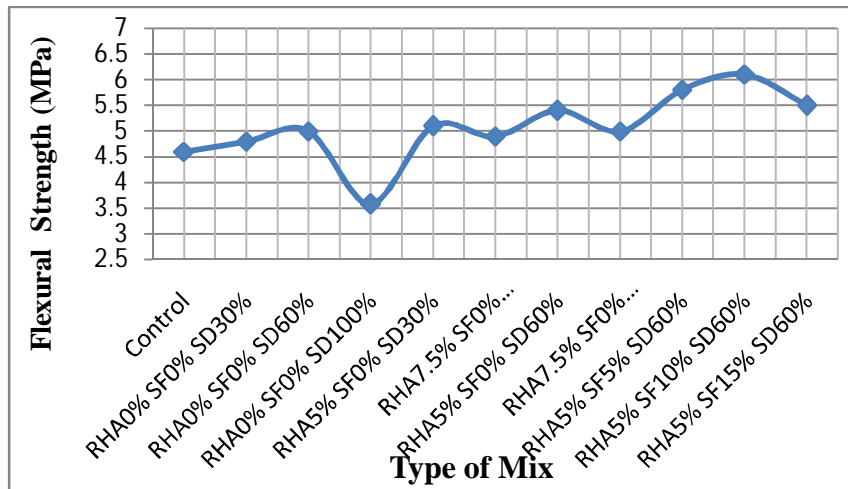


Fig.5.Variation of Flexural Strength of M30 Grade of Concrete with different percentages of Rice Husk Ash Silica Fume and Stone Dust.

D. MODULUS OF ELASTICITY

Fig.6 shows the variation of modulus of elasticity of M30 grade concrete with various percentages of Rice Husk Ash, Silica Fume and Stone Dust. It can be observed that the modulus of elasticity of concrete is maximum with 5% Rice Husk Ash, 10% Silica Fume and 60% of Stone Dust combination and with further increase in percentages of RHA, SF, SD Modulus of Elasticity decreases.

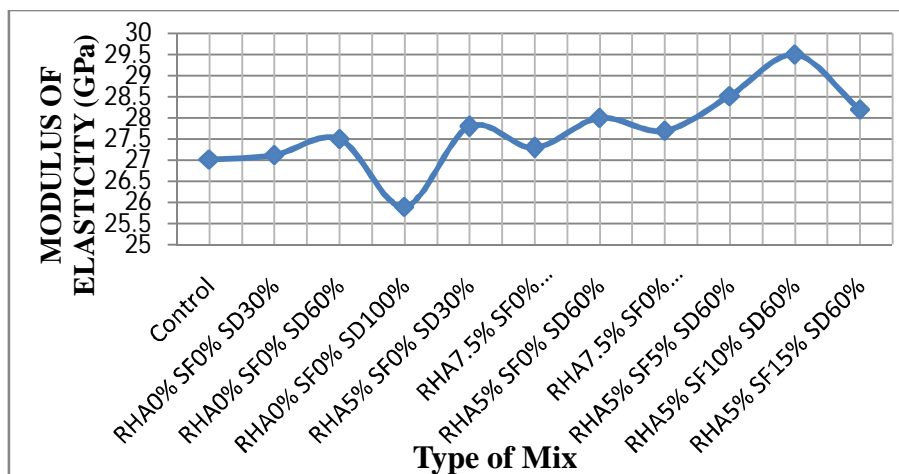


Fig.6.Variation of Modulus of Elasticity of M30 Grade of Concrete with different percentages of Rice Husk Ash Silica Fume and Stone Dust.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 1, January 2017

V. CONCLUSIONS

Based on the experimental investigation, it can be concluded that the strength of concrete is increased by using the combination of Stone Dust, Rice Husk Ash and Silica Fume. Compared to Conventional Control Concrete the Cube Compressive Strength, Split Tensile Strength, Flexure Strength, Modulus of Elasticity is increased at specified percentages. By partial replacement of cement with Rice Husk Ash at 5%, Silica Fume at 10% and fine aggregate is partially replaced with stone dust at 60%, the strength of concrete can be increased. Silica Fume and Rice Husk Ash has high amorphous silicon dioxide content. The RHA and SF react with the calcium hydroxide to form additional binder material. The availability of additional binder leads to increase in the paste-aggregate bond, results improved strength properties of the concrete. The decrease in the strength characteristics of concrete with increase in the RHA content beyond 5% and SF beyond 10% and Stone Dust beyond 60% is due to the poor quality of binder formed in the presence of higher percentages of RHA and SF.

REFERENCES

- [1] Raman,S.N., Zain,M.F.M., and Mahmud, H.B., " Influence of Stone Dust and mineral admixtures", Proceedings of the Seventh International Conference on Concrete Technology, Kulalumpur, Malaysia, pp.33-42, 2004.
- [2] Dr.D.V.Prasada Rao and G. V. Sai Sireesha., "A Study on the Effect of Addition of SilicaFume on Strength Properties of Partially used Recycled Coarse AggregateConcrete",International Journal of Civil Engineering & Technology (IJCIET), Volume 4, Issue 6, 2013,pp,193 - 201, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.
- [3] Rama Rao, G.V., Seshagiri Rao,M.V.,"High Performance Concrete Mix Design using Husk Ash as Mineral Admixture",proceedings of natural conference on materials and structures,Warangal, pp. 65-70, 2004.
- [4] Rama Samy., Dr.Viswa, S.,"Durable To Properties Of RiceHusk Ash Concrete", ICI journal Indian concrete institute pp, 41-50, 2009.
- [5] Madhusudhan,T(2014)., "Utilization of micro silica as partialreplacement of OPC",International Refereed Journal ofEngineering and Science (IRJES), ISSN (Online) 2319-183X,(Print) 2319-182, Volume 3, Issue 3(March 2014), PP.67-73.
- [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] IS456-2000, Plain and Reinforced Concrete code for practice,Bureau of Indian Standards, New Delhi (India).
- [8] Concrete Technology by Shetty,M.S., 1st edition, S.Chand Publications, 1982.
- [9] IS: 10262-2009,"Concrete Mix Proportioning – Guidelines (First Revision)",Bureau of IndianStandards, New Delhi.
- [10] IS 516:1959, "Methods of Tests for Strength of Concrete", Bureau of Indian Standards, NewDelhi, India.
- [11] IS: 8112:1989, "43 Grade Ordinary Portland Cement – Specifications", Bureau of IndianStandards, New Delhi.
- [12] IS: 12269:1987, "53 Grade Ordinary Portland Cement – Specifications", Bureau of Indian Standards, New Delhi.