A Project report on

Utilization of Slag Sand and Granite Powder in Concrete

Submitted in partial fulfillment of the requirements

for the award of the degree of

BACHELOR OF TECHNOLOGY

in

Civil Engineering

by

G.L. Sri Shakthi	**184G1A0176**
C. Sudharshan	**184G1A0178**
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Under the Guidance of

T. Shanthala M. Tech

Assistant Professor

SR IT

Empowering Knowledge

DEPARTMENT OF CIVIL ENGINEERING

SRINIVASA RAMANUJAN INSTITUTE OF TECHNOLOGY
ANANTHAPURAMU

(Affiliated to JNTUA, Approved by AICTE, New Delhi)

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Certificate

This is to certify that the project report entitled UTILIZATION OF SLAG SAND AND GRANITE POWDER IN CONCRETE is the bonafide work carried out by **G L SRI SHAKTHI** bearing Roll Number 184G1A0176, **C SUDHARSHAN** bearing Roll Number 184G1A0178, **BANNELA GOWRI VYSHNAVI** bearing Roll Number 184G1A0189, **G VENKATA SUSHANTH** bearing Roll Number 184G1A0187, **G SALWATH** bearing Roll Number 184G1A0165, and S SASHIDHAR bearing Roll Number 184G1A0166 in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology** in **Department of Civil Engineering** during the academic year 2021-2022.

Guide	**Head of the Department**
Ms. T. Shantala M. Tech,	Dr. Raghu Babu Uppara M.Tech, Ph.D,
Assistant Professor	Associate Professor and HOD

Date:	**EXTERNAL EXAMINER**
Place: Ananthapuramu	

DECLARATION

We G.L. Sri Shakthi bearing reg no : 184G1A0176, C. Sudharshan bearing reg no :184G1A0178, B. Gowri Vyshnavi bearing reg no : 184G1A0189, G. Venkata Sushanth bearing reg no : 184G1A0187, G. Salwath bearing reg no : 184G1A0166, S. Sashidhar bearing reg no : 184G1A0165, students of SRINIVASA RAMANUJAN INSTITUTE OF TECHNOLOGY, Rotarypuram , hereby declare that the dissertation entitled UTILIZATION OF SLAG SAND AND GRANITE POWDER IN CONCRETE embodies the report of our project work carried out by us during IV Year Bachelor of Technology under the guidance of T. SHANTHALA, M. Tech, Department of Civil Engineering and this work has been submitted for the partial fulfillment of the requirements for the award of Bachelor of Technology degree.

The results embodied in this project report have not been submitted to any other Universities of Institute for the award of Degree.

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Project Associates

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1 Introduction

1.1 General

Concrete is the widely used construction material. The principal binder of concrete is cement, which was produced 4.3 billion tonnes in 2014 and global production. The production of cement is a major contributor to greenhouse gas emissions. Thus, concrete industry significantly it impacts the ecology of our planet. Concrete is a composite material which is composed of coarse granular materials called aggregates or filler embedded together in the form of a matrix with the help of the cement or binding material that fills the space between the aggregate’s particles and glues them together. Aggregates are usually obtained from natural rocks, either crushed stones or natural gravels.

According to some estimates after the year 2010, the global concrete industry will require annually 8 to 12 billion metric tons of natural aggregates (U.S.G.S and nationalatlas.gov, accessed Nov 2008). During the past 25 years, the production of crushed stone has increased at an average annual rate of about 3.3 percent. Production of sand and gravel has increased at an annual rate of less than 1 percent. Also, there are problems related to durability characteristics of natural aggregates in addition to their availability. About three quarters of the volume of concrete is composed of aggregate. So, the important properties of concrete like strength, durability and serviceability etc. depend largely upon the property and quality of aggregates used. Thus, introducing suitable alternatives to natural aggregates has always been challenging. Utilizing steel slag in concrete mixes has proved to be useful in solving some of the problems encountered in the concrete industry. Steel slag was used in conventional concrete to improve its mechanical, physical, and chemical properties. Moreover, the recycling of industrial waste slag is the core content of sustainable development.

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Recycling of granite dust will prevent these wastes from ending up in landfills and provides affordable, eco-friendly, solid stone for various uses. If left on its own and is not properly collected and stored, the fine granite powder can be easily airborne and will cause health problems and environmental pollution. Instead of leaving the debris of the granite dust alone, it can be replaced with Cement in concrete. It is a promising material for use in concrete similar to those of Pozzolanic materials such as silica fume, fly ash, slag, and others. These products can be used as a filler material (substituting sand) to reduce the void content in concrete.

1.2 Objectives

- To investigate the potential use of slag sand, in conjunction with granite powder as replacement of cement.
- To investigate the compressive strength of concrete made of granite powder and slag sand.
- To evaluate the corrosion resistance of concrete made of granite powder and slag sand**.**

1.3 Scope

In this research work the properties of concrete with partial replacement of granite powder and steel slag sand for M20 grade concrete. By partial replacement of river sand with 0% and 50% of steel slag sand and cement with 0%,10%, and 20% of granite powder. For all the mix proportions fresh concrete properties were determined. Mechanical properties were found out and from that optimum replacement proportion was determined for fine aggregate replacement by fine form of steel slag. For optimum replacement proportions, combination mixes which gives optimum strength were found out to determine the optimum combination mixes in M20 grade concrete. Fresh concrete properties were tested for all the combination mixes. For all the optimum replacement mix proportions, durability properties tests were conducted for both M20 grade concrete in the following proportions:

1. Optimum replacement proportion of coarse aggregate by coarse slag - durability and properties.
2. Optimum replacement proportion of fine aggregate by fine slag - Durability and structural properties.
3. Fresh concrete properties for all the optimum replacement combination mixes were determined

2 Literature Reviews

Y. Yaswanth Kumar. Et.al. [1] examined the usage of granite powder as a partial replacement of cement in concrete. Cement was replaced with granite powder in steps of 0%, 5%, 10%, 15% and 20%. The compressive strength and of the samples were recorded at the curing age of 7 and 28 days. The results indicated that the compressive strength of concrete increased with additional of granite powder up to 10% replaced by weight of cement further addition of granite powder was found that the compressive strength will be decreasing from 10% replacement of cement.

Dr. G. Elangovan [2] In this study, the possibility of using granite dust powder in concrete production was examined by studying the effects of blending of granite dust powder with cement on the performance of fresh and hardened concrete. In this experimental study, granite dust powder was used in concrete as a cementation material as partial replacement of cement. Replacement of cement was made by level of 5%, 10%, 15% and 20% by weight of cement. For each replacement workability, compaction factor and strength test were conducted. Compressive strength after 7- and 28-days curing was obtained. From the test results it was found that concrete at the level of 15% partial replacement of cement with granite dust powder has better workability and high compressive strength of 7 days and 28 days curing. The granite dust powder is free of cost. Hence it seems to be economical.

Anurag Mistra. R. et al (2002) [3] reported that the granite slurry can be used as the building material in the form of granite dust powder, and it has been accepted in the industrially advanced countries.

M. C. Nataraja, A. R. Amrutha et.al.[5] investigated on Ground granulated blast-furnace slag is used as an alternative to cement, two replacement levels namely 30% and 60% for cement is carried out in this experimental investigation. Fresh concrete properties are determined by conducting compaction factor and slump tests, hardened properties namely compressive strength and split tensile strength at 7 days and 28 days are also determined.

Quasrawi et al. [6], the slag is used as fine aggregate replacing the sand in the mixes partially or totally. Ratios of 0, 15, 30, 50, and 100 %are used. Best results are obtained for replacement ratios of 30-50% for tensile strength and 15-30% for compressive strength.

Koneti Vamsi1, Rama Harshitha [7] In this investigation of granite slurry and saw dust was used to partial substitute in proportions varying from 10%, 20%, 30% by weight to cement in concrete and tested from compressive strength, tensile strength, and flexure strength. Concrete cubes measuring. 150 x 150 x 150 mm were cast, and their compressive strength, tensile strength and flexure strength is evaluation at 7, 14, 21, 28 days. It was observed that substitution at 10% of cement by weight with granite powder in concrete was the most effective in increasing compressive and flexural strength compared to other ratios.

Digvijay S. Chouhan, Yash Agrawal et. al [8] It is shown that the granite slurry waste reduces the workability whereas compressive strength of granite concrete is improved when fine aggregate or cement is partially replaced. It has been also shown that the modified concrete performed well when level of F.A. by granite slurry waste is up to 15%.

A.Anitha, Y.Yeshwanth Kumar et.al [9] In this investigation Granite Slurry (GS) was used as partial substitute in proportions varying from 5% to 20% by weight to cement in concrete and tested for compressive strength, tensile strength and flexure strength. It was observed that substitution of 10% of cement by weight with GS in concrete resulted in an increase in compressive strength to 48 N/mm2 compared to 35 N/mm2 of conventional concrete. Tensile strength too followed a similar pattern with a 10% substitution with GS increasing the tensile strength to 3.6N/mm2 compared with a 2.4 N/mm2 of conventional concrete. However, flexure strength of 10% GS replacement exhibited a good improvement of flexural strength to 4.6 N/mm2 compared to a 3.2 N/mm2 of conventional concrete. Further investigations revealed that to attain the same strength of conventional concrete a 20% substitution with GS is effective.

Amrinder Singh1, Shalika Mehta et.al [10] The point of this paper is to review the chance of utilizing marble dust powder alongside the copper slag as a partially substitution to fine aggregate total in geopolymer concrete. Marble dust powder was utilized in blends containing copper slag as partially substitute to sand in percentage of 10%, 20%, 30%, 40% and 50%. The strength of geo-polymer concrete was checked for 7, 28 days. Blend plans were readied and projected independently and afterward tests were completed and at that point the outcomes were contrasted with deference with customary geo-polymer concrete a lot made by substitution materials.

3 Concrete and it's Components

3.1 Concrete

Concrete is a construction material composed of cement, fine aggregates (sand) and coarse aggregates mixed with water which hardens with time. Portland cement is the commonly used type of cement for production of concrete. Some of the types of cement are Portland Pozzolana Cement (PPC), rapid hardening cement, Sulphate resistant cement etc.

3.2 Cement:

Cement is produced by utilizing an extensive number of raw materials treated and reacted at extreme conditions such as high temperatures. The high-temperature processes are called Pyro processing processes where raw materials are heated at high temperatures for solid-state reactions to take place, which utilize fuel sources such as coal, fuel oil, natural gas, tires, hazardous wastes, petroleum coke, and basically anything combustible. Some cement manufacturing plants utilize the organic waste generated in other industries such as rubber processing industries. There are different types of cement, few of them are,

- Ordinary Portland cement
- Portland pozzolana cement

As such, cement industry contributes to a significant extent of anthropogenic carbon dioxide emissions, which is in the range of 5–7% of total anthropogenic carbon dioxide emissions. The balance of 0.52 tons of raw materials is converted mainly to carbon dioxide by the processes such as $CaCO_3 \rightarrow CaO + CO_2$. This is a serious global environmental problem since increase in carbon dioxide in the atmosphere has direct consequences on global warming. The primary greenhouse gas emitted in the cement industry is carbon dioxide, but in lower quantities, NO_xs and SO_xs are also emitted.

3.3 Aggregates:

Total properties significantly impact the conduct of cement since they possess about 80% of the all-out volume of cement. The aggregates are named

- Fine Aggregate
- Coarse Aggregate

Fine aggregate is material going through an IS sieve that is under 4.75mm measurepast which they are known as coarse aggregate. Coarse aggregate is which retained on 4.75 mm sieve. The most important function of the fine aggregate is to provide workability and uniformity in the mixture.

The fine aggregate also helps the cement paste to hold the coarse aggregate particle in suspension. According to IS 383:1970 the fine aggregate is being classified in to four different zone, that is Zone-I, Zone-II, Zone-III, Zone-IV. Also, in case of coarse aggregate maximum 20 mm coarse aggregate is suitable for concrete work. But where there is no restriction 40 mm or large size may be permitted. In case of close reinforcement 10mm size also used.

Figure 1 Coarse aggregate

Figure 2 Fine Aggregate

Class and size	IS Sieve designation	Percentage passing
Very large,150 to 80mm	160mm 80mm	90to 100 0 to 10
Large,80 to 40mm	80mm 40mm	90 to 100 0 to 10
Medium,40 to 20mm	40mm 20mm	90 to 100 0 to 10
Small,20 to 4.75mm	20mm 4.75mm 2.36mm	90 to 100 0 to 10 0 to 2

Table 1 Sizes of coarse aggregate for mass concrete

3.4 Steel slag:

The solid material which is generated by the interaction of impurities and flux during the making and refining of steels is called steel slag.

Figure 3 Steel Slag Sand

It is obtained by the following ways:

- From conversion of iron to steel in a Basic Oxygen Furnace (BOC)
- By the melting of scrap to make steel in the Electric Arc Furnace (EAF).
- Ladle slag generated during refining process.

3.4.1 Steel slag production methods

A. Basic Oxygen Process

In the Basic Oxygen Furnace (BOF), the hot liquid metal from the blast furnace, scrap and fluxes, which contain lime (CaO) and dolomitic lime, are charged to a furnace. A lance is lowered into the converter and then oxygen in injected with high pressure. The oxygen then combines with and removes the impurities.

B. Electric Arc Furnace Process

Electric arc furnace does not use hot metal, but uses cold steel scraps. Charged material is heated to a liquid state by means of an electric current (high-power electric arcs, instead of gaseous fuels, are used to produce the heat necessary to melt recycled steel scrap and to convert it into high quality steel). Meanwhile oxygen is blown into the EAF to purify the steel. This slag which floats on the surface of molten steel is then poured off.

3.5 Granite Powder

Granite industry has grown significantly in the last decades with the privatization trend in the early 1990s as the flourishing construction industry in the World. Accordingly, the amount of mining and processing waste has increased. Granite reserves in India are estimated at 1200 million tons. Granite industries in India produce more than 3500 metric tons of Granite powder slurry per day as waste product. Granite tiles manufacturing industries are also producing tones of granite dust/slurry during the manufacturing process. When dumped on land, these wastes adversely affect the productivity of land due to decreased porosity, water absorption, water percolation etc. They cause serious environmental and dust pollution and require vast area of land for their disposal.

Indian granite stone industry currently produces around 17.8 million tons of solid granite waste, out of which 12.2 million tons are rejected at the industrial sites, 5.2 million tons are the form of cuttings/trimming or undersize material and 0.4 million tons are form of a slurry/powder are at the processing and polishing unit.

Granite is a common type of “felsic intrusive Igneous Rock. Strictly speaking, granite is an igneous rock with similar textures and slight variation in composition and origin. The density of granite is between 2.65 - 2.75 g /cm3. Granite Polishing powder is obtained from granite polishing industries which we have collected locally at Bellary Road, industrial estate area, Anantapur.

Chemical Composition	Constituents in Percentage
SiO_2 (Silica)	58.36
Al_2O_3 (Alumina)	12.63
Fe_2O_3 (Iron Oxide)	21.54
TiO_2 (Titanium Dioxide)	1.40
CaO (Lime)	1.34
MgO (Magnesium Oxide)	1.29
Na_2O (Sodium Oxide)	1.75
K_2O (Potassium Oxide)	0.52
Loss On Ignition (LOI)	1.19

Table 2 Chemical Composition of Granite Powder

Figure 8 Granite cutting machine

4 Methodology

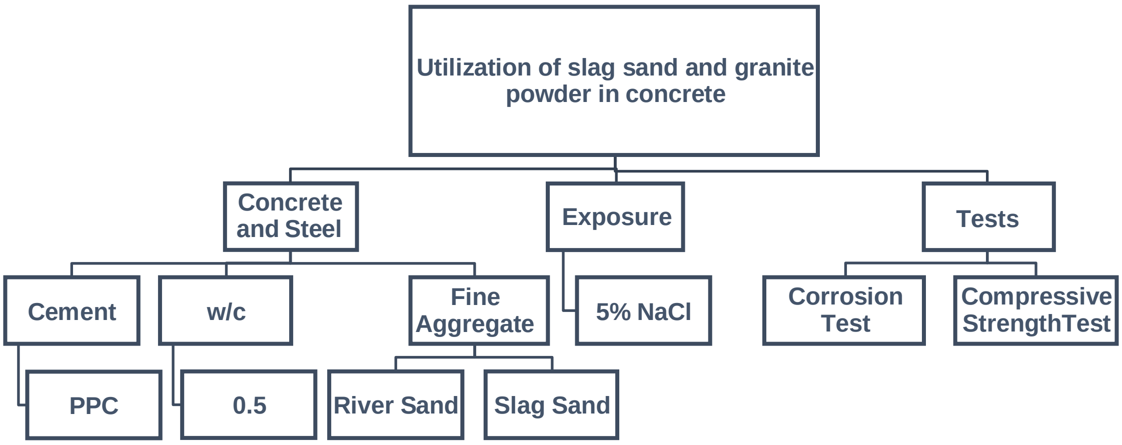


Figure 4 Methodology

4.1 Mix design

Concrete mix design is the process of finding right proportions of cement, sand, and aggregates for concrete to achieve target strength in structures.

Concrete Mix = 1:1.9:2.7

The concrete mix design involves various steps, calculations, and laboratory testing to find right mix proportions.

Fine aggregate replacement with Steel slag (%)	Cement replacement with Granite Powder (%)	Cement (kg/m^3)	Fine aggregate (kg/m^3)	Coarse aggregate (kg/m^3)		Granite Powder (Kg/m^3)	Steel slag (kg/m^3)	Water (lit/m^3)
				20mm	10mm			
0%	0%	340	896.8029	655.056	436.704	-	-	170
	10%	306	893.3174	652.5101	435.0067	34	-	170
	20%	272	889.8319	649.9642	433.3094	68	-	170
50%	0%	340	448.362	655.056	436.704	-	425.1136	170
	10%	306	448.362	652.5101	435.0067	34	425.1136	170
	20%	272	448.362	649.9642	433.3094	68	425.1136	170

Table 3 Mix proportions of concrete mixes made by replacing fine aggregate with steel slag and granite powder with cement

5 Experimental Investigation

5.1 Objective of testing

The tests were conducted to examine the behaviour of granite powder and steel slag when they were partially replaced with cement and fine aggregates in concrete.

5.2 Experimental setup

Initially, the slag sand and granite powder along with cement, CA and FA were undergone through preliminary tests like specific gravity test and water absorption for CA, Normal consistency of cement, initial and final setting time for cement, CBR test for finding sieve analysis of FA, Fineness test, bulking of sand, slump test etc. to know the physical properties. All the materials used were tested as per Indian standard specifications.

5.2.1 Standard consistency test

The standard consistency of a cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the vicat mould. For finding out initial setting time, final setting time, soundness of cement and compressive strength of cement, it is necessary to fix the quantity of water to be mixed in cement in each case.

Normal consistency of Portland cement = 32%

Figure 9 Standard consistency test

5.2.2 Initial and final setting time

Initial setting time is regarded as the time elapsed between the moments that the water is added to the cement to the time that the paste starts losing its plasticity. The final setting time is the time elapsed between the moment the water is added to the cement and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain definite pressure.

Initial setting time is .... 30 minutes

Final setting time is................... 590 minutes

5.2.3 Soundness of cement

Once of the most important properties of cement is its soundness. Unsoundness in cement is caused by expansion of some of the constituents like free lime produced in the manufacturing process of cement. Another possible case of unsoundness is the presence of too high a magnesia content in the cement and presence of excess of lime than that could be combined with acidic oxide at kiln.

Soundness of cement is 0.79mm

5.2.4 Bulking of sand

Increase in volume of sand due to presence of moisture is known as bulking of sand. Bulking of a sand test depends on the fact that the dry volume of sand and saturated volume of sand has almost the same volume. Bulking depends on the particle size. Sand is employed in concrete for the reduction of segregation and to fill out the pores between cement and coarse aggregates.

Maximum bulking of sand by volume...................20%

Moisture content...3%

Figure 10 Bulking of sand

5.2.5 Determination of fineness modulus of fine aggregate

Weight of fine aggregate sample taken is 1 kg

IS sieve Size in mm	Wt. Retained in grams	% On each sieve	Cumulative %Wt. retained	% Of Cumulative wt. passing
4.75	0.084	8.4	8.4	91.6
2.36	0.042	4.2	12.6	87.4
1.2	0.021	2.1	14.7	85.3
600mm	0.245	24.5	39.2	60.8
425mm	0.135	13.5	52.7	47.3
300mm	0.133	13.3	66	34
150mm	0.137	13.7	79.7	20.3
75mm	0.168	16.8	96.5	3.5
pan	0.035	3.5	100	0
			469.8	

Table 4 Sieve analysis of fine aggregate

Fines modulus of fine aggregate = 469.8/100 = 4.698

5.3 Experimental investigations on Steel slag

5.3.1 Determination of specific gravity of steel slag aggregate

Weight of density bottle = 586 Grams

Weight of density bottle + dry steel slag sand = 901 Grams

Weight of density bottle + dry steel slag sand + water = 1624 Grams

Wight of density bottle + water = 1432 Grams

Specific gravity of steel slag sand = (W2-W1)/(W2-W1) -(W3-W4)

Specific gravity of steel slag aggregate = 2.56

5.3.2 Water absorption of Steel slag

The amount of water absorption by the aggregate is known as water absorption.
Water absorption = ((C-D)/D) Ẋ 100

Water absorption of steel slag sand = 1.01%

5.3.3 Sieve Analysis of Steel slag

Sieve size	Cumulative % of passing
10mm	100
4.75mm	99.8
2.36mm	99.6
1.85mm	85.48
600µm	34.5
300µm	17
150µm	4.6

Table 5 Sieve Analysis of Steel slag

Figure 11 Sieve Analysis of steel slag

5.4 Experimental investigations on Granite Powder

5.4.1 Specific Gravity:

Specific gravity is the dimensionless unit that defines the ratio between the density of a rock and the density of water. Specific gravity of granite powder obtained is **2.56.**

5.5 Slump Test

Slump test is a laboratory or at site test used to measure the **consistency** of concrete. Slump test shows an indication of the uniformity of concrete in different batches. The shape of the concrete slumps shows the information on the **workability** and quality of concrete. The characteristics of concrete with respect to the tendency of segregation can be also judged by making a few tamping or blows by tapping rod on the base plate.

The slump value of concrete is just a principle of **gravity flow** of surface of the concrete cone that indicates the amount of water added to it, which means how much this concrete mix is in workable condition.

1. **Zero Slump:** This test indicates the very low water-cement ratio, which results in dry mixes. This test is mostly used in road construction works.
2. **True Slump:** This measurement is taken from the top of the concrete when the slump cone has been removed. The true slump is considered more desirable as compared to **the shear slump.**
3. **Shear Slump:** The top portion of the concrete surface slips sideways, and the shear off is a **shear slump**. If shear is achieved in the concrete, then a sample should be taken and repeat this test.
4. **Collapsed slump:** This test indicates the water-cement ratio is too high. It means the concrete is high workability and high concrete mix. This slump test is not appropriate.

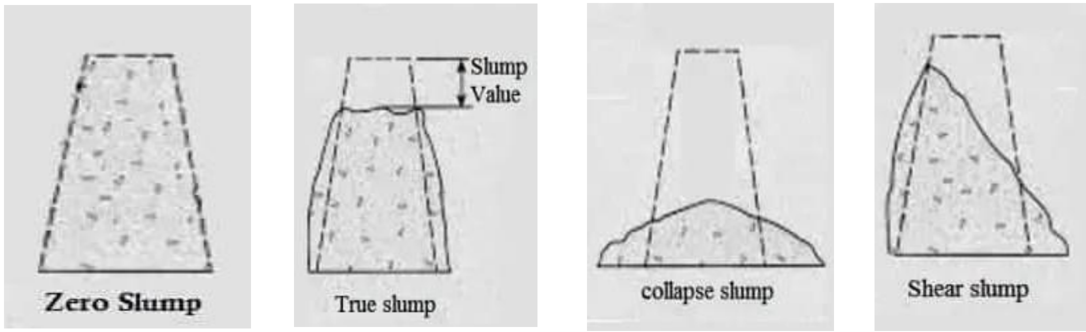


Figure 5 Types of Slump

Concrete having a different mix (M15 or M20 etc.) with a suitable water-cement ratio and can be prepared at the site or casting the six cubes after conducting the slump test.

The sampling and the test are performed under the following rules and laws.

- American Society for Testing and Materials (ASTM) standards are ASTM C 143 or ASTM C143M.
- The American Association of State Highway and Transportation Officials (AASHTO) AASHTO standards AASHTO T119 or AASHTO BS 1881.
- British & European standard BS EN 12350-2.
- Indian standard: IS 1199 – 1959.

6 Results and Discussions

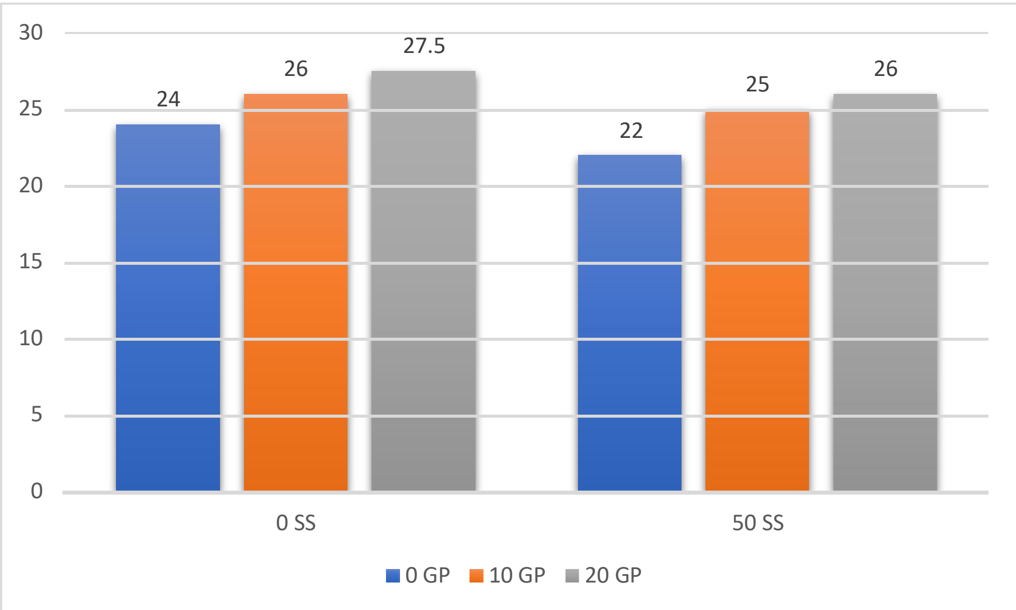
6.1 Tests on fresh concrete

Workability is a property of raw or fresh concrete mixture.

Slump cone test is to determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work. Concrete slump test is carried out from batch to batch to check the uniform quality of concrete during construction. The slump is carried out as per procedures mentioned in **ASTM C143 in the United States, IS: 1199 – 1959 in India and EN 12350-2 in Europe.**

6.1.1 Slump Cone Test

Concrete is compacted in a slump cone into three layers each layer being compacted for 25 blows with tamping rod and top of surface is leveled and slump value is measured by lifting the slump cone vertically.



Graph 1 Slump Cone Test

Separate test, known as the flow table, or slump-flow test is used for concrete that is too fluid (non-workable) to be measured using the standard slump test, because the concrete will not retain its shape when the cone is removed.

Figure 12 Slump cone test

6.2 Tests on hardened concrete

6.2.1 Compressive strength test

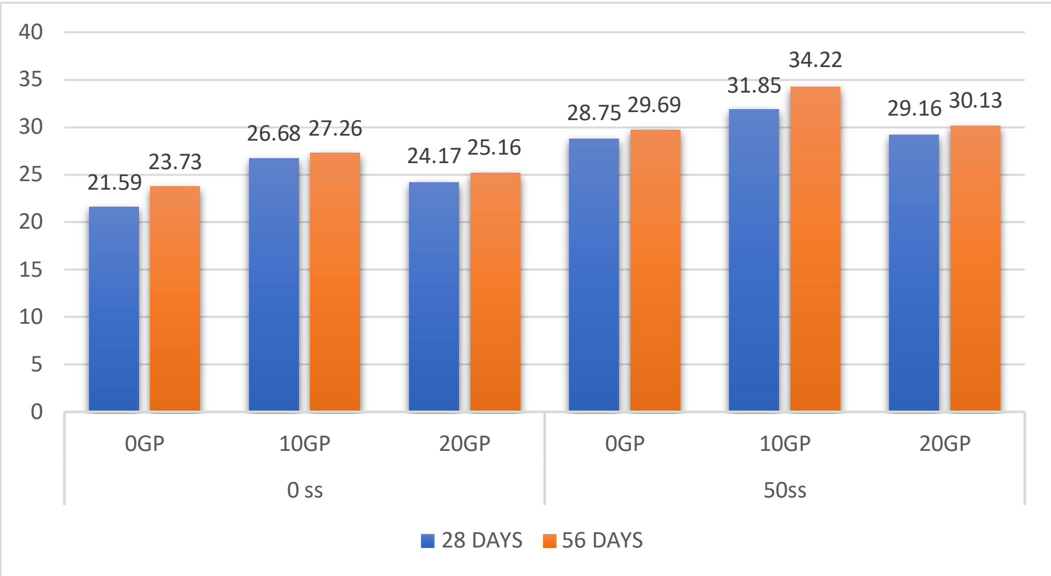
The Compression test is the most common test conducted on concrete. The test is easy to perform and gets most of the desirable characteristics properties of concrete which is related to its compressive strength. The compression test is carried out in the cube of the size 150 x 150 x 150 mm. The cubes are filled with 0%, 10% & 20% with Granite Powder and 0% and 50% of steel slag sand. Each layer is compacted by hand compaction. After the top layer has been compacted the surface of the concrete is brought to the finished level with the top of the mold, using a trowel. After 24 hours the cubes are remolded and are shifted to a curing tank wherein, they are allowed to cure for 28 days and 56 days. After 28 days of curing, the cubes are tested on a digital compression testing machine as per I.S. 5161959. The failure load is noted.

The compressive strength is calculated as follows:

Compressive strength (MPa) = Failure load /cross-sectional area.

Slag sand (%)	Granite Powder (%)	Compressive Strength(N/mm^2) (28 Days)	Compressive Strength(N/mm^2) (56 Days)
0%	0%	21.595	23.73
	10%	24.175	25.185
	20%	26.685	27.260
50%	0%	28.750	29.690
	10%	30.160	32.240
	20%	31.850	34.220

Table 6 Compressive Strength Test



Graph 2 Compressive Strength Test

From the figure we can know that the compressive strength of concrete increases with addition of steel slag from 0% to 50%. Beyond this, amount of strength of concrete is decreased.

6.2.2 Accelerated corrosion technique

The short-term accelerated corrosion technique named as impressed voltage technique is adopted to evaluate the optimum replacement level of cement with SS&GP. The system was prepared with the rebar embedded in concrete as an anode, externally placed SS rod as a cathode, and the electrolyte is 2.5% NaCl solution. The diagram of the test setup is shown in Figs. 1. By using an external DC source, a constant voltage of 12 V is applied between rebar and SS rod up to the cracking of the specimen. The anodic current was noted for every two hours and the time to initiate a first crack on the concrete was observed (see Fig. 2), and the corresponding anodic current was noted. This short-term accelerated technique was adopted on only the specimens made with SS & GP concrete replacement levels of 0 and 50% & 0, 10, and 20%. The cylindrical specimens after completion of water curing were kept in the laboratory condition for two months, after that they were subjected to the accelerated corrosion test.

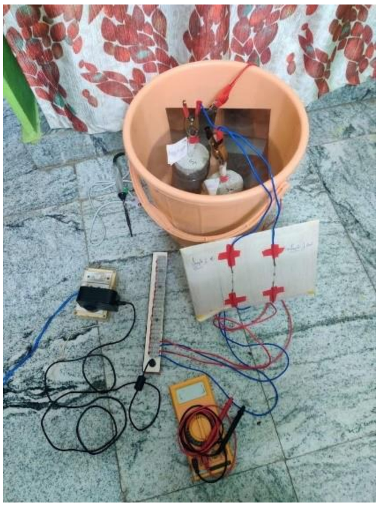


Figure 6 Test setup for accelerated corrosion test

Figure 7 Typical cracked specimen

Systems	Time to Crack(hrs)	Current(mA)
Reference mix	**90-95**	**30-32**
0%SS-10%GP mix	79-80	25-29
0%SS-20%GP mix	77-83	27-32
50%SS-0%GP mix	76-83	35-41
50%SS-10%GP mix	**98-104**	**19-22**
50%SS-20%GP mix	85-92	20-24

Table 7 Impressed Voltage data for PPC, SS and GP admixed systems

The variation of corrosion current response with time for SS & GP replacement levels of 0 and 50% of SS and 0, 10, and 20% of GP. it is observed that the reinforcement embedded in the concrete mix made with PPC, 0%SS-10%GP, 0%SS-20%GP, 50%SS-0%GP, and 50%SS-20%GP exhibited a rapid increase of current as compared to the concrete with 50%SS-10%GP.

From this, the SS & GP addition beyond 50% & 10% is less resistive to corrosion and the service life of this concrete will be less. The results of the impressed voltage technique for plain and blended concretes are reported in Table 1. The anodic current of the concrete blended with 50%SS-10%GP is less than the plain concrete, 0%SS-10%GP, 0%SS-20%GP, 50%SS-0%GP, and 50%SS-20%GP blended concrete. This rise in the corrosion resistance of specimens prepared with 50% of SS-10% of GP is due to the pore structure refinement and stronger paste matrix of pozzolanic reactivity of.

7 Conclusion

From the present experimental investigation, the following conclusions were drawn:

- When the fine aggregate is partially replaced with slag sand with 0% and 50%. It is observed that the compressive strength of the cubes increased gradually at 50% replacement of fine aggregate with slag sand.
- It is also evidenced that the replacement of cement with granite powder at 10% is beneficial for modern construction works.
- The replacement of natural river sand with steel slag up to 50% increases the corrosion performance of rebar.
- Specific gravity of steel slag sand is higher than that of normal sand and hence the density of the steel slag aggregate concrete show slightly higher values whencompared with conventional concrete.
- So, 50% replacement of steel slag and 10% of granite with fine aggregate and cement are advisable to use in construction works.

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