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Experimental investigation on strengh properties on pervious concrete pavement

D.Vinothkumar[1], B.Karthiga[2]

[1]P.G. Scholar, Department of Structural Engineering, Paavai Engineering College, Pachal, Namakkal – 637018, India
[2]Assistant Professor, Department of Civil Engineering, Paavai Engineering College, Pachal, Namakkal – 637018,India

ABSTRACT

Concrete production has greatly improved in recent decades. Concrete, on the other hand, has a unique purpose. Water cannot flow through ordinary concrete, but it passes through this concrete. The main motivation for making this type of concrete is to use it on the pavement and in open dreams, where rainwater can pass through and continue to raise low water levels. Due to the decline in cement prices, cost savings were a major factor. In this experimental work made of slag powder was added to a mixture of asphalt, coarse aggregate, and water to form concrete. A small amount of slag powder can be used to improve strength.The use of strong concrete as a solution in the case of large water is desirable. The total strength of the finished concrete is determined by conducting a test of the ability of the material to withstand the strength of the slag powder that removes cement by various percentages of 0%, 10%, 20%, 30%, 40%, and 50%. The results obtained are discussed in the following chapters.

INTRODUCTION

Pervious Concrete

The word "pervious" is used to describe an open, almost zero-slump area made of Portland cement, compact, with little or no compound, admixtures and water. In a simple way, concrete that drains substance. It's a great opportunity. Unlike heavy concrete, it has high strength, has high porosity and allows it to move freely. Concrete equipment. For this reason, it is useful in situations where water forms, ice or other sources are available. Other sources must be exhausted. Absence or very low porosity is found in the absence or very low content of FA. A good level of integration is in between. No-fineness concrete is another name for flexible concrete, corrugated concrete or bare concrete.

Cement, composite, water, and small or poor adhesives make up most of the composite. Good collections often fill the gaps between large aggregates with standard concrete.

Scope of the Project

- ✓ This concrete is a type of concrete with high porosity that helps groundwater to regenerate while reducing storm water flow.
- ✓ The scope of the work is to investigate Pervious concrete by using Steel slag as partial replacement of Cement.
- ✓ The results of research conducted in separate studies have been studied.
- ✓ This asphalt does not strike on wet days and does not glow at night. This enhances the comfort and well-being of the driver.

Objective of the Project

- ✓ To find the physical & chemical properties of various material.
- ✓ Investigate the concrete used in this study using various mixing scales.
- ✓ To find the optimum % of Pervious Concrete.
- ✓ To find the Permeability of Pervious concrete.

Literature collection

YongjieXue et al (2006) Steel slag obtained by hot-sprinkling method is a very suitable aggregate with porous structure for preparing stone mastic asphalt mixtures after 3 years aging. As the restoration of basalt iron ore increases the level of optimal bitumen, all the volume performance of asphalt rock mixtures containing metal slag such as aggregates will meet the appropriate specification criteria. After two years of use, test methods show outstanding results, with a coefficient of 556 abrasion and friction and surface texture depth of 0.8 mm. In summary, the efficient use of steel as a composite in the construction of the paved road will provide a modern and cost-effective solution for composite materials while also reducing the environmental hazards caused by solid debris. However, further research is needed on its recycling process and its widespread use in the future.

Hisham Qasrawi et al (2008) Metal slag is particularly beneficial for low-strength concrete in terms of compression

Author for correspondence:
P.G. Scholar, Department of Structural Engineering, Paavai Engineering College, Pachal, Namakkal – 637018, India

strength and durability, i.e., lower concrete quality, increasing strength. Metal slag is applicable to standard concrete mixes that increase strength in all replacement measurements.

The best results, however, were obtained when the replacement rate was about 50%. Steel slag increases the strength of concrete by 1.4-2.4 times the size of standard concrete as high value is used, depending on the scale used. When good content with 0.15 mm removed, better results can be obtained. In this case, increasing the volume of slag instead of sand increases strength.

Chang Jiang Jhy et al (2015) Cooling concrete structures made of electric slag for air-cooled fire as combined are investigated. These tests show that ground-based concrete made of EAFS aggregates has greater mechanical strength and water strength than natural river rock concrete. Apart from this, in the strength test, the coarse concrete made of EAFS aggregates had a lower weight loss than the pulmonary concrete made of natural river stones.

EAFS-reinforced concrete has more waterproofing and compressive strength than broken stone-based concrete. The combined pressure exceeds 21 MPa, and the water availability is less than 0.01 cm / s.

Flora Faleschini et al (2015) studied the shape and the texture of EAF slag significantly improves the tensile strength of EAF-concretes, due to the better bond of these aggregates with the cement-paste. The density of EAF concrete is sensibly higher than conventional concrete, thus leading it to be suitable in high density concrete applications.

Colorimetric methods based on AgNO3 solutions can be used for the determination of chloride ingress into EAF concrete; the dark color of the latter does not preclude the clear visual determination of chloride-free and -affected zones. The use of EAF slag increases the strength of the concrete in the chloride-affected areas, reducing the equilibrium.

Jul Endawati et al (2017) According to the analysis, the high-pressure compounds are derived from the types of air-cooled air, consisting of 56 percent Portland cement, 15 percent ash, 3 percent silk smoke, and 26 percent air slag cooling, with 5 2 MPa. As evidenced by the concept of fly ash conversion, the maximum pressure is 16.2 MPa, with a 6% ash fly binder, 3% silica flame, and 17% granular blast grinding slag - furnace slag.

The study formed a simple concrete mix with the composition of the binding content: 56 percent Portland cement, 15% jet ash, 3% silica fire, and 26 percent air cooled air. Since the installation of cement with fire-cooled blast furnace slag has the same compressive strength combined with cement replacement and grinding granular blast furnace slag, this construction was preferred. UJ.

J. Rosales et al (2017) investigated on Slag Waste (Sw) and Slag Waste -Crushed (Sw-C) present high absorption and density. As the stainless steel slag decomposes, these values decrease; all products have a distribution of the correct particle size, so they can be used as cement substitutes. Chemically, stainless steel slags contain high levels of iron oxide, close to those found in traditional jet ash. These statistics show that waste has a good ability to strengthen cement.However, as the percentage of stainless steel slag in the mortar grows, the mortar's resistance to compression and flexural failure reduces, thus shrinkage increases. As 30% of the cement is substituted with Sw-C, the compressive strength drops by less than 25% relative to the control, but the compressive strength is lower if the stainless-steel slag is not recycled.

Jens Groenniger et al (2016) it does not matter whether LD slag or Gabbro natural composite is used, resistance to asphalt boundary limits is equal. In contrast to Gabbro's integrated natural blends, the use of LD slag in asphalt binder and asphalt base course results in greater fatigue tolerance. Overall, the findings and experiments conducted in this study show that asphalt mixtures made with LD slag are suitable for the construction of asphalt pavement and are effective and even better than traditional asphalt mixtures made with natural blends in most cases.

METHODOLOGY

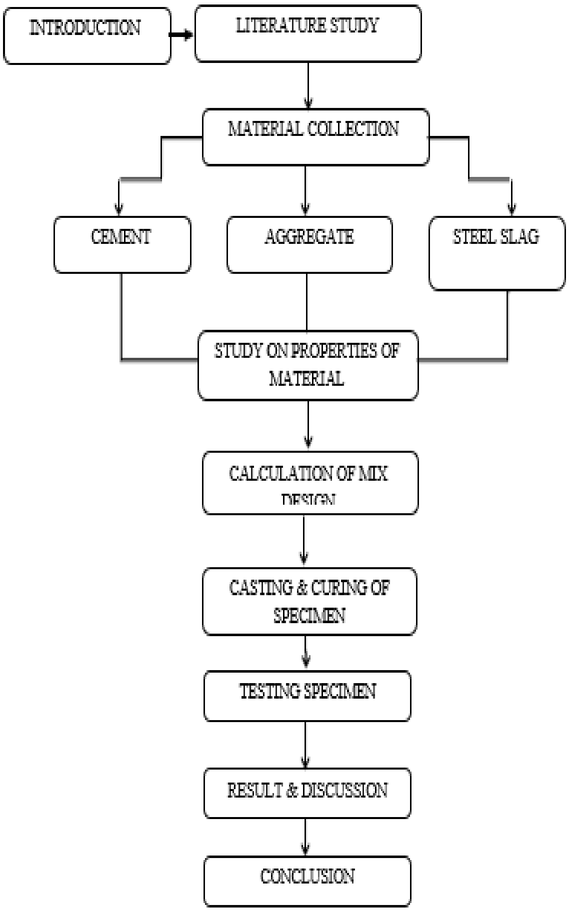

Figure 1

Collection of materials

Cement

It is Concrete's most essential component.Some of the key factors that influence cement assortment include:
Diverse ages, fineness, heat of hydration alkali material, strength premises, C3A, C3S, and so on. **(**Fig 4.1)
There are different types of cement, out of that mostly used two types are:

- Ordinary Portland cement
- Portland Pozzlona cement

Steel Slag

Steel metal slag is a processed product, which is formed when the molten alloy is separated from the impurities in the furnace. Slag is a complex solution of silicates and oxides that solidify when cooled like a soluble liquid. Almost all of the metal is now produced in composite steel plants using alternative oxygen system systems or in special plants (mini-mills) that use the furnace process. Other methods are no longer used. The steel slag powder is obtained from kondalampatty and the size of steel slag powder is 90micron.

Fig 4.1 Steel slag powder

Coarse Aggregate

The coarse aggregate is the strongest and the least porous component in concrete. And it is chemically stable.

Decreased drying and other moisture changes are reduced once there is a compacted area. If the coarse aggregate is well organized and the mixture is well formed, coarse aggregate contributes to the concrete of the pervious origin. As an excessive collection of concrete, standard blue granite crushed by a combination of IS-383: 1970. In most cases, the combined size of approximately 20mm was chosen as the appropriate size.

They usually have all the necessary characteristics of a good building stone, such as high crushing power, low absorption rate, and low porosity, and are available locally.

Water

Water is an important component of concrete because it helps to form a calcium-silicate-hydrate (C-SH) gel by participating in the chemical reaction with cement. The act of binding hydrate cement gel is mainly due to the strength of the cement concrete. The strength of concrete, durability, waterproofing, and other structures will all suffer if the binding water level (w / b) is too high.

Concrete production water should be free of unpleasant salts that could damage the cement. Suspended strings and particles are unacceptable because they disrupt the environment, intensifying binding processes.

MATERIAL PROPERTIES

General

This chapter discusses the properties of materials used in the study of the behavior of concrete forces. The features of the equipment are as follows:

OPC property - 53 grades

It should meet or exceeds IS12269-1987 specified. Made with a combination of high-quality clinker (high C3S content) with high quality gypsum at pre-set prices. Due to its high particle size distribution, high crystalline structure, and moderate phase structure, it is known for its high initial strength and high final strength, so it is widely used and suitable for fast construction, solid concrete, and inexpensive concrete compositions. (Table 5.1)

Table 5.1 Properties of OPC 53

Property	Values	IS code
Fineness of Cement	100 grams	IS:4031-Part 1-1996
Specific Gravity	3.05	IS 2720- Part 3
Initial Setting Time	35 minutes	IS 12269:1987
Final Setting Time	9hours	IS: 4031 (Part 5) – 1988

Properties of steel slag

Physical Properties

The slag has a rough texture and is extremely angular in form. They have low water absorption and high bulk specific gravity (less than 3 percent). The physical characteristics of the steel structure are described in Table 5.2.

Table 5.2 Typical physical properties of steel slag.

Property	Values
Specific Gravity	3.40

Chemical Properties

Slag's chemical composition is usually expressed in terms of basic oxides, measured using basic analysis and x-ray fluorescence. The different types of chemicals found in metal slag in a typical oxygen furnace are described in Table 5.3.

While almost all slags fall under these chemical limits, not all should be used as aggregates. The mineralogical form of slag, which is highly dependent on the degree of cooling in the metal-making process, is very important.

Table 5.3 Typical steel slag chemical composition

Type Component	Steel slag
CaO	41.7
SiO2	33.8
T-Fe	0.4
MgO	7.4
Al2O3	13.4
S	0.8
P2O5	<0.1
MnO	0.3

Mechanical Properties

The slag used has good abrasion tolerance, durability characteristics, and bearing strength, making it easy to use in combination.

- IS Code compressive strength for cube and cylinder
- Tensile strength split
- Flexural stiffness

Properties of coarse aggregate

Particle form, bulk weight, and source filter are all used for integrated separation. Particles larger than 4.75 mm are referred to as CA and particles less than 4.75 mm are referred to as fine-grained. With the exception of large concrete, which may have particles of up to 150 mm, fine aggregates have a particle size of 75 m to 4.75 mm and CA with a particle size of 4.75 to about 40 mm.

The quantity of many natural minerals, such as sand and beads, ranges from 1520 to 1680 kg / cum, and produces a standard weight of concrete with a unit weight of approximately 2400 kg / m3. (Table 5.4)

Table 5.4 Properties of Coarse Aggregate

Property	Values	IS Code
Specific Gravity	2.83	IS:2386-Part 3-1963
Water absorption (%)	1%	IS:2386-Part 3-1963
Bulk Density(kg/m3)	8.718	IS:2386 Part 3

Mix design

The Indian Standard recommends the M20 grade concrete design form as the design code IS: 10262-2009.

Grade Designation	=	M20
Type of Cement	=	OPC 53 grade
Nominal Aggregate Size	=	12.5 mm
Type of Aggregate	=	Crushed Angular Aggregate
Sp. Gravity of Cement	=	3.15
Sp. Gravity of 12.5 mm Aggregate	=	2.83
Water Absorption of 12.5 mm Aggregate	=	1%

Table 6.1 Mix proportion of concrete For 1m^3

Cement (kg)/m3	Water (kg)/m3	CA (kg)/m3	W/C ratio
405	202.5	1232	0.50

Experimental work

Compressive strength of pervious concrete

For pressure compression, cubes of 150 x 150 x 150 mm were spread. The strength of the various concrete cubes is measured according to BIS: 516–1959 and was tested using a pressure gauge at 7, 14, and 28 days. The combined strength of the M20 control marks and conceptualized concrete was measured using a cake sample. Three cubes were measured each year in each compound, and the total pressure was calculated.

A sample of the cube was inserted during the pressure test. The full packaging of the types, as well as the appearance of concrete and other unexplained failures, has all been proven. The estimated compressive strength of the specimen is determined by dividing the total applied load during the evaluation of the c/s area. Representing the previous mix combination as an average of three values. The following formula is used to calculate compressive strength. (Fig 7.1)

Compressive strength (MPa) = Maximum load (N) /cross sectional area (mm2)

= P/A

Were,

P - Failure load of the specimen.

A - Area of specimen.

Fig 7.1 Compressive strength testing of cube Specimen

Split tensile strength of mpc concrete

Using 150 mm dia with a length of 300 mm, the tensile force evaluation was determined. Using cylinders, the complete dissipating power was measured at 7 and 28 days. Specimens were measured by UTM according to IS 5816-1970 (1985) by holding the cylinder horizontal between the loading areas and increasing the load firmly until it could not occur near the exact width of the cylinder template.

The cylinder is placed horizontally in the center of the loading machine, and the load is applied to the vertical width before the cylinder fails. Between the specimens and the load plates of the measuring unit, are inserted small packaging strips made of suitable materials such as plywood. The packaging strap is soft enough to allow the load to be distributed in a reasonable position, protecting the wide area of the contact. The load is then applied along the straight edge of the cylinder until it fails, as shown in Figure 7.2

The failure load of tensile strength of cylinder is calculated by using the formula

Tensile strength = 2P / πDL.

Were,

P - Failure of the specimen

D - Diameter of the specimen

L - Length of the specimen

Fig 7.2 Split Tensile Strength Testing of Cylindrical Specimen

RESULTS AND DISCUSSION

Compression strength of concrete

The compressive strength of six concrete mixes was tested in seven different years: seven days, fourteen days, and twenty-eight days. The findings are listed in Table 8.1, and the differences are reflected in Figure 8.1. The findings show that 30 percent metal slag has a higher compression strength than other alloys. At 7, 14, and 28 days, the 30SS combination developed a compressive strength of 12.8, 19.8, and 28.5Mpa greater than the control concrete.

Table 8.1 Compressive Strength of Concrete

S.No	Mix ID	Compressive Strength (MPa)		
		7 days	14 days	28 days
1	CC	7.5	14.2	20.4
2	10SS	9.6	16.8	22.8
3	20SS	11.20	17.5	24.6
4	30SS	12.8	19.8	28.5
5	40SS	11.50	18.2	25.8
6	50SS	10.4	17.20	23.6

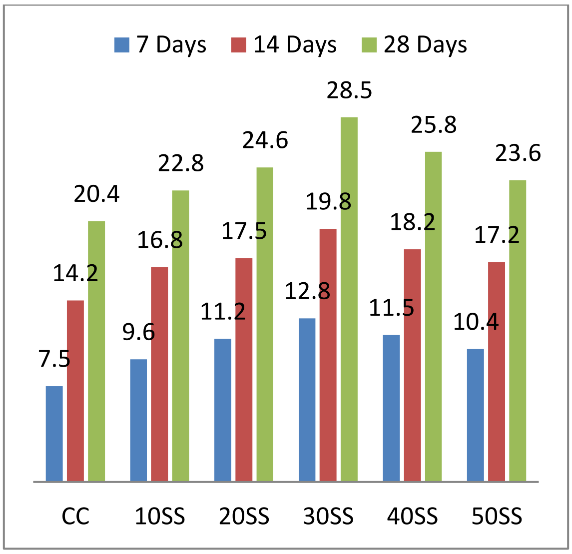

Fig 8.1 Compressive Strength of Concrete

Split tensile strength of concrete

The split strength of the six-mass concrete mix is measured in seven different years: seven, fourteen, and twenty-eight days. The results are presented in Table 8.2, with the differences being shown in Figure 8.2.

The findings show that 30 percent steel slag produces more cracking strength than other compressive strengths comprising almost 30 percent steel. At 7, 14, and 28 years, it was found that the 30SS alloy provided a strength of 1.75, 2.56, and 2.85Mpa over the control concrete.

Table 8.2 Tensile Strength of Concrete

S.No	Mix ID	Split Tensile Strength (MPa)		
		7 days	14 days	28 days
1	CC	1.22	1.72	2.35
2	10SS	1.48	1.95	2.50
3	20SS	1.55	2.18	2.66
4	30SS	1.75	2.56	2.85
5	40SS	1.62	2.42	2.72
6	50SS	1.50	2.06	2.54

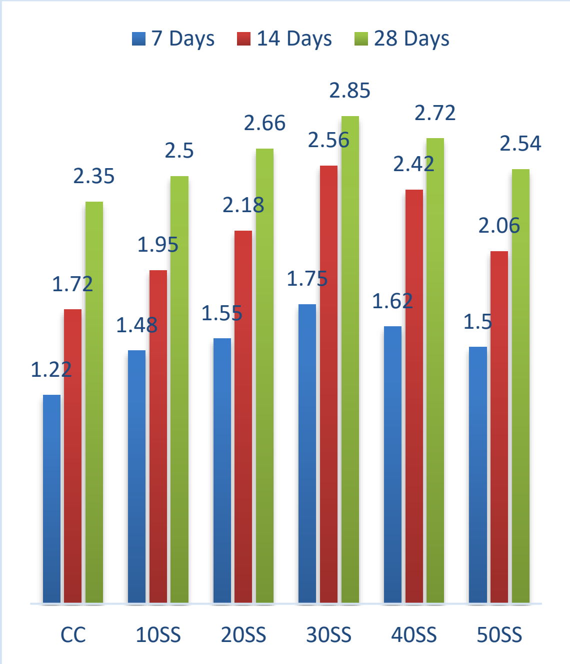

Fig 8.2 Tensile Strength of Concrete

Water absorption test

The water absorption of the six concrete mixes was measured, and the findings are shown in Table 8.3 and their differences in Figure 8.3.

Compared to other concrete mixes, with the exception of traditional blends, the 30SS blends produced 2.89 percent, which is much higher.

Table 8.3 Water Absorption of Concrete

S.No	Mix Id	Initial weight (Kg)	Oven Dry Weight W1(Kg)	Weight After Immersion W2(Kg)	% of Water Absorption
1	CC	8.30	8.25	8.58	4.0
2	10SS	8.35	8.30	8.52	2.65
3	20SS	8.32	8.27	8.48	2.53
4	30SS	8.34	8.29	8.53	2.89
5	40SS	8.30	8.26	8.47	2.54
6	50SS	8.32	8.27	8.49	2.66

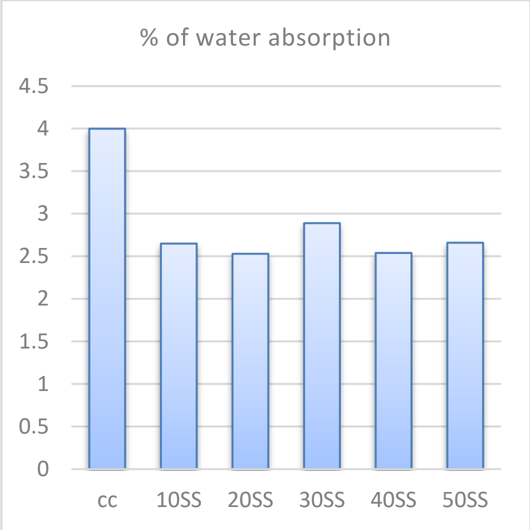

Fig 8.3 Water Absorption of concrete

Permeability test

The coefficients of permeability obtained by the cylindrical mold made of a mixture of different PCCs with different sizes of steel and water are allowed using a sample with the help of a tri axial test placed under a different pressure head set in Table 8.4.

Table 8.4Permeability Coefficient

S.No	Mix ID	Co efficient of permeability cm/sec
1	CC	0.96
2	10SS	0.92
3	20SS	0.90
4	30SS	0.88
5	40SS	0.94
6	50SS	0.95

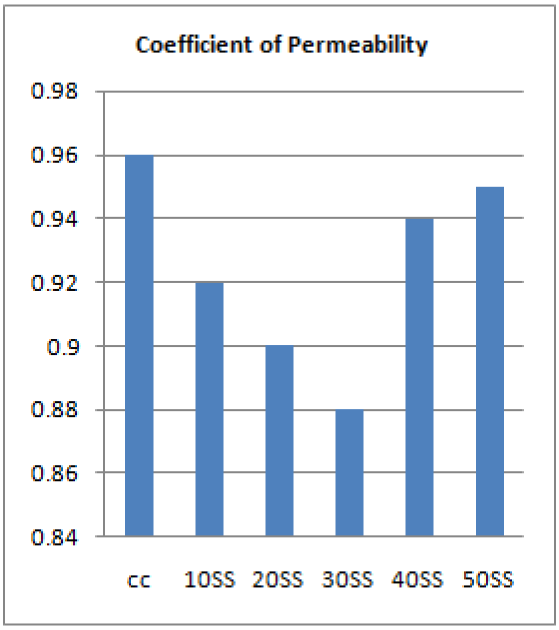

Fig 8.4 Permeability of Pervious concrete

CONCLUSION

The purpose of this analysis is to investigate the efficiency of the slag steel concrete. The appendix properties were investigated, and it was found that they all met the prescribed requirements. M20 quality concrete has been used in the construction of control concrete mixing. Broken, solid, and water-absorbent areas have been identified. The following statement is obtained based on the strength structures of the slag steel concrete.

1. At the age of 28, a 30% stainless steel concrete mix has a maximum compression strength of 28.5MPa for all metal slag mixes.
2. Break strong strength and flexural strength in steel slag concrete both see a related pattern. The 30SS has a split power of 2.85 MPa, which is higher than most concrete mixes.
3. As a result, the excellent slag content in traditional concrete is found to be 30%.

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