

# **Durability Study of Concrete Using Foundry Waste Sand**

**Ved Dilip Patil<sup>1</sup> and D. P Joshi<sup>2</sup>**

P.G Student Department of Civil Engineering<sup>1</sup>

Professor Department of Civil Engineering<sup>2</sup>

K. C. T. LT. G. N. Sapkal College of Engineering, Nashik, India

vedpatil4375@gmail.com

**Abstract:** *In this paper, a new MPPT technique is proposed which suggests a modified perturb and observe algorithm to reach fast to the MPP compared to the conventional perturb and observe technique. This work explains the PV equivalent circuit, current-voltage, power-voltage characteristics of photovoltaic systems and the operation of the some commonly used MPPT techniques.*

**Keywords:** MPPT techniques

## **I. INTRODUCTION**

Federal and state environmental authorities began to pay for pollution in the 1970s and 1980s, growing focus on waste management, safety, and industrial pollution control. As a result, the foundry sector was forced to reconsider its established procedures for getting rid of used sands. The necessity to cut back on landfill upkeep and disposal costs has been one of the key issues facing the foundry sector. Currently, disposal expenses range from Rs. 10 to Rs. 20 per tonne. Due to new laws, it is anticipated that costs will rise by 5 to 10 times over the following ten years. Also, old landfills are reaching capacity while new landfills will not be coming to market in sufficient numbers as desired by industries. This was mostly due to the nationwide programme that governs and oversees by-product disposal, Public Law 94-580, the Federal Resource Conservation and Recovery Act of 1976.

(Naik, 1987). Used foundry sand has been rejected by landfill operators due to its huge volume and "special waste" categorization due to the global shortage of landfill space. According to Murarka (1987), foundries typically manufacture metal castings at a rate of 227 to 2270 kg of total by-product material per tonne. The states in the east and the midwest have the most foundries per state. In a batch of normal weight concrete, the American Foundrymen's Society advised (33% of the utilised foundry sand should be substituted with fine aggregate; AFS report, 1991) following thorough testing. This research served as the basis for the decision to replace 25 and

Foundry sand was utilised in 35% of the fine aggregates to test the impact of various replacement amounts.

This is because India produces more than 300 million tonnes of industrial trash each year as a result of its agricultural and industrial processes. The problem caused by continuous industrial and technical advancement is waste disposal. Not only can the cost of development be reduced if any of the waste materials are found to be adequate for concrete manufacture, yet it is also possible to dispose of waste fabric safely. Concrete made with excessive energy typically has a high cement content, which frequently causes greater shrinkage and greater disparity in the rate of hydration. with the exception of cost.

### **Objectives:**

1. Determination of compressive strength of concrete for 28days curing period and 56days (i.e., 28days for curing and other 28 days exposed to atmosphere).
2. Effect of accelerated curing on compressive strength (440C, 550C).
3. Determination of porosity and water absorption.
4. Permeability test.
5. Determination of strength after heating and cooling.
6. Determination of strength after alternate wetting and drying.
7. Acid attack test (sulphate attack test).

## **II. LITERATURE REVIEW**

[1] Merve Basar. H and Nuran DeveciAksoy (2012) In order to produce ready mixed concrete (RMC), investigated the potential re-use of waste foundry sand (WFS). Five percentages of WFS by weight and the solidification/stabilization (S/S) procedure were used in place of the normal sand.

was used on each and every concrete mixture. For the WFS-based-RMC's certification, three factors—the mechanical, leaching, and microstructural properties—were examined. The results of this study indicate that WFS can be used to produce high-quality RMC as a partial replacement for fine aggregates without having a negative influence on mechanical, environmental, or microstructural properties; however, the partial replacement shouldn't be more than 20%.

[1]

[2] Pathariya Saraswati C, Ranajay krushnaK(2013) studied the compressive strength of the concrete by replacement of the local sand by foundry waste sand by 0%, 20%, 40% and 60% and they found that for 60% replacement of local sand by waste foundry sand they had obtained maximum compressive strength values.[2]

[3] Sohail Md, Arfath Khan Md, and Abdul Wahab (2013) conducted experimental studies to evaluate the durability and strength of concrete compositions that contain natural sand replaced in part with (WFS). 0%, 15%, and 35% of WFS by weight were substituted for regular M sand, and all of the concrete through the solidification/stabilization (S/S) procedure mixtures. At ages 7, 28, and 56 days, each test was administered. According to test results, waste foundry sand can be used successfully in place of traditional river sand as fine aggregate in concrete. demonstrated an increase in plain concrete's compressive strength of up to 90% before a slight decline.[3]

[4] Siddique, R., and Dhanoa, G. (2014) Experimental studies were conducted to assess the strength and durability of concrete mixtures in which M sand was partially replaced with (WFS). In place of fine aggregate, 0, 5, 10, 15, and 20% of WFS by mass were used. The age and length of each test were both 28 and 365 days. According to test results, (1) replacing fine aggregate with WFS improved concrete's strength characteristics as WFS concentration increased at all ages. (2) By substituting 15% of the fine aggregate with WFS, maximum strength was attained. Although it starts to decline after 15% replacement, it was still greater than control concretes. (3) Waste foundry sand concrete mixes developed compressively and split tensile at a faster rate than control samples.

[5] Rafat Siddique and Ravinder Kaur Sindhu (2015) In order to study resistance, they tested the concrete for sulphate attack and found that the 10% FWS mix had greater strength than the control mix even after submerging the cubes in solution of magnesium sulphate. However, after immersion in the sulphate solution, at all ages, a reduction in strength is seen for both the 15% and 20% replacement levels when compared to the comparable concrete mix's typical 28-day strength.

[6] G. Ganesh Prabhu, Jin Wook Bang, Byung Jae Lee, Jung Hwan Hyun, and Yun Yong Kim(2016) examined the usage of foundry sand as a replacement for natural sand in the manufacturing of concrete using the material's mechanical and durability qualities. The results of the in-depth testing performed on the six mixes led to the following conclusion. The chemical examination of foundry sand revealed that it can be a very good component for making concrete. Although the effect was significant beyond the 30% substitution rate, the fineness and high water absorption of FWS increase the water requirement of the concrete by water absorption, limiting the workability of the concrete.

## **III. METHODOLOGY**

Literature Collection Selection of Material Study the properties of material Mix Design M25 Test on Concrete Results and Discussion Conclusion Future Scope

Experimental Work:

Cement: The choice of cement content is determined by the mix's minimum fine aggregate requirement, exposure classes for durability, and strength needs. In this study, regular Portland cement of grade 43 was used.

Fine Aggregate: The sand is river sand that has been filtered and cleaned to eliminate any possible organic and inorganic materials. Sand is obtained from nearby suppliers of building supplies and sieved using a 4.75mm sieve.

Coarse Aggregate: The coarse aggregates used in concrete have an angular shape and a maximum size of 20 mm.

Foundry Sand: The Badger Mining Corp. supplied both fresh and old foundry sand, and Falk Corporation provided the discarded foundry sand. All of the used sands underwent ASTM C33 testing.

Material Tests:

Properties cement determined by the following tests in Table 3.1

Particulars	Results Obtained	Requirements As Per Is 12269-1970
Fineness of cement (%)	4.3	3-7
Specific gravity	3.1	3.1-3.15
Normal consistency (%)	32	30-35
Initial setting time (min)	31	30
Final setting time (hrs)	8 hours	10 hours

Properties fine aggregate determined by the following tests in Table 3.2

Particulars	Results Obtained	Requirements As Per Is 12269-1970
Specific gravity	2.58	2.60-2.90
Fineness modulus	2.88	2.80-2.90
Water absorption (%)	0.8 %	1%

Properties of fresh concrete Workability by slump test Table 3.3

Replacement level	Value	Degree of Workability
20 %	55	Medium
25 %	50	Medium
30 %	45	Low
35 %	41	Low

Methodology:

Materials which are used to conduct the above tests are Cement (OPC), Locally available sand, Foundry waste sand, Basalt Aggregates and Water.

Casting and Curing:

Cube specimen of size 15cm×15cm×15cm were cast using the mix proportion given in Table 3.4 as per IS:516-1959. The cubes were de-moulded after 24 hours of casting. The cubes were kept for curing under water immersion at laboratory temperature 27±2°C. Water is being changed at regular intervals.

Table 3.4: Finalized mix proportions for locally available sand (Natural Sand), and Foundry Waste Sand for M20 grade concrete

Sr. No.	Mix Combination	Cement	Fine Aggregate	Course Aggregate 12.5 mm	Course Aggregate 20 mm	W/C Ratio
1	Basalt + Natural Waste	1	2	2	1.32	0.56
2	Basalt + Foundry Waste Sand	1	1.80	2.20	1.36	0.56

Test Procedure

#### Compressive strength test:

The compressive strength test was carried out using IS: 516-1979. At the end of curing period i.e., 28 days and at 56 days (exposed to environment for a period of 28 days after 28 days curing period), compressive strength test was conducted.

The compressive strength results show that the mixtures containing used foundry sands showed lower strengths at all test ages. The compressive strength of concrete containing 25% used foundry sand is 23% lower than control mix at 28-day age. Similarly concrete containing 35% used foundry sand has 30% lower value than that of control mix. However, the decrease in the compressive strength of 25% and 35% as compared to the design strength of 38 Mpa is 11% and 19%, respectively at 28 days. But concrete containing 25% and 35% replacements of regular concrete sand with clean/new foundry sand showed almost the same compressive strength as control mix at all ages

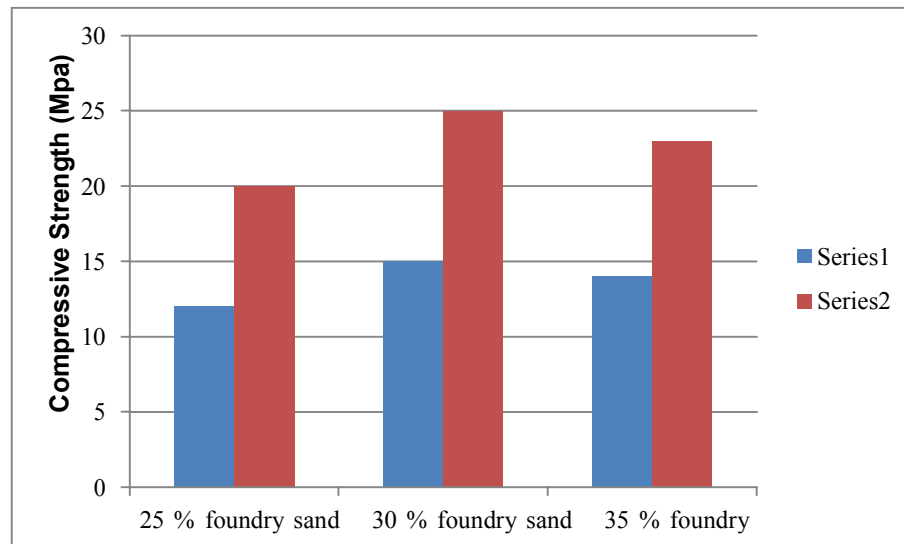


Figure 3.1: Compressive Strength (Mpa) of Concrete with Various Levels of Replacement of Foundry waste  
Accelerated curing method (warm water method):

As per IS 9013-1978 the specimens after casting were kept for drying for a period of 2 and ½ hours and then sealed, after sealing they are kept in accelerated curing tank at a temperature of 55°C for a period of 20 ± ½ hours, after this period they are taken out and wiped and later checked for its compressive strength.

The same procedure is repeated for 44°C (Prevailing temperature in our city).

Water absorption test:

The test was carried out as per ASTM C-640.

% water absorption =  $\frac{(W_w - D_w)}{D_w} \times 100$  Where,  $W_w$  = wet weight of the cube,  $D_w$  = dry weight of the cube.

Porosity

The specimens are cast according to the mix design and cured for 28 days in curing tank. Then it is removed from the curing tank and surface is wiped, then the weight is noted down. Then the samples were oven dried for 24 hours at 65°C temperature and weighed again. Again it is kept in oven for next 24 hours and again the weight is noted down. This process is continued till the weight remains constant. The difference in the weight of the sample gives the porosity.

Permeability Test:

The test was carried out according to German Standard DIN 1048 on concrete specimens of size 150x150x150 mm, and the depth of penetration in specimen is noted down by breaking them equally under UTM.

Alternate heating and cooling:

The specimens are cast and cured for 28 days, after curing the specimens are subjected to heating and cooling for a period of 20 days (20 cycles) to check the durability. The specimens are heated at normal atmospheric temperature in day time and cooled during the night time. This process is continued for 20 days and after that strength of the specimens is checked.

Alternate wetting and drying:

The specimens are cast and cured for 28 days, after curing the specimens are subjected to alternate wetting and drying for a period of 20 days to check the durability. The specimens are kept for wetting in curing tank for 1 day and next day it is allowed to dry, again the procedure is repeated, after 20 days cycle the strength of specimens are tested to check the effect of alternate heating and cooling on concrete.

Acid attack test:

Sulphate attack test was carried out as per Leonardo journal of science ISSN 1583-0233. Magnesium sulphate solution of 50g/l is used to evaluate sulphate resistance of concrete.

#### **IV. FUTURE WORK**

Corrosion of reinforcement embedded in RCC member using foundry waste sand is to be carried out

#### **V. CONCLUSION**

The compressive strength values for concrete with 25% and 35% regular sand replacements with used foundry sand are almost same as the concrete with no replacement. The concrete produced from 25% and 35% replacement of sand by foundry sand waste, shows higher flexural strength as compared to other replacement. It is observed from the test results that modulus of elasticity increases with age.

Water absorption of weathered sand is more as compared to foundry sand waste and locally available sand hence workability is reduced.

Higher workability is recorded for concrete containing locally available sand compared to concrete containing weathered sand and foundry sand waste.

Porosity of concrete decreases in the order of concrete containing weathered sand (17.9%), concrete containing foundry sand waste (16%) and control mix (13.6%). Similarly decreasing trend is observed for water absorption i.e., concrete containing weathered sand (2.2%), concrete containing foundry sand waste (1.9%) and control mix (1.6%).

Concrete containing weathered sand and concrete containing foundry sand waste has resulted in lower strength at 28 days of curing i.e., 27.76 N/mm<sup>2</sup> and 28.05 N/mm<sup>2</sup> respectively compared to control mix of strength 42.292 N/mm<sup>2</sup>, this is due to higher water absorption of foundry waste sand. At 56 days age of concrete (moist cured for 28 days and exposed to ambient temperature for 28 days) control concrete (40 N/mm<sup>2</sup>) and concrete containing foundry sand waste (39.385 N/mm<sup>2</sup>) has recorded nearly the same strength but concrete containing weathered sand has recorded lower strength (31.68 N/mm<sup>2</sup>). All the three concrete for both the ages have satisfied the requirement of M20 grade concrete.

To study the effect of heat curing warm water method (55°C) is used, compressive strength of control mix and concrete containing foundry sand waste registered nearly the same strength i.e., 42.292 N/mm<sup>2</sup> and 40.380 N/mm<sup>2</sup> respectively but concrete containing weathered sand has recorded lower strength of 33.94 N/mm<sup>2</sup> compared to control mix, this is due to higher water absorption of weathered sand.

Permeability is measured in terms of depth of penetration of water in concrete, concrete containing weathered sand, control mix and concrete containing foundry sand waste recorded depth of penetration 4.38 cm, 2.86 cm, 1.85 cm respectively. Concrete containing weathered sand is more permeable which is clear from higher porosity result in 4th conclusion and lower compressive strength in 5th conclusion.

Heating and cooling effect has not much influence on concrete using locally available sand and foundry sand waste, but increase in strength was observed for concrete containing weathered sand (17.31%) compared to control mix, this is due to enhanced hydration.

Effect of alternate wetting and drying is marginal for concrete using locally available sand and weathered sand. But concrete using black sand has resulted in higher strength (27.47%), it is due to enhanced hydration.

Decrease in strength is observed due to sulphate attack on concrete using locally available sand and weathered sand but for concrete containing foundry sand waste increase in strength was observed (25.19%), it may be due to formation of ettringite (tri calcium alumina sulphate).

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