# Water Absorption and Sorptivity of Sustainable Mortar Made With Used Foundry Sand and Hypo Sludge

***Keval Mehta[1], Prof. (Mrs) Reshma L. Patel[2], Dr. Jayeshkumar Pitroda[3,*]***

[1]Final year M. Tech. Environmental Engineering, B. V. M. Engineering College, Vallabh Vidyanagar, Gujarat, India

[2]Associate Professor, Civil Engineering Department, B. V. M. Engineering College, Vallabh Vidyanagar, Gujarat, India

[3,*]Associate Professor, Civil Engineering Department, B. V. M. Engineering College, Vallabh Vidyanagar, Gujarat, India

***Abstract***

*Nowadays, the age of development materials is decreasing the standard resources which developed a need to find the new capable and useful materials for the improvement work. This paper exhibits the water absorption and sorptivity of sustainable mortar made with Used Foundry Sand (UFS) and Hypo Sludge. Utilized foundry sand generated from metal giving industry. Hypo sludge generated from paper fabricating industry. Use of used foundry sand and paper waste in mortar can be the best course for the utilization of waste in development movement. Used foundry sand is supplanted with the normal sand and Hypo sludge supplanted with cement. The cube of mortar is seen at 7 and 28 days. An average 96 mortar shapes were made and tested at 7 and 28 days of five mortar mix i.e. A (0%), A1 (25%), A2 (50%), A3 (75%), A4 (100%) of used foundry sand was replaced by weight of natural sand and then optimum replacement was taken based on the compressive strength. With the 25% used foundry sand three mortars mixes i.e. B1 (10%), B2 (20%), B3 (30%) of Hypo sludge was replaced by weight of cement. The results exhibited that union of the utilized foundry sand and hypo sludge regards diminish water absorption and sorptivity quality with the age (28 days) in the examination with the consistent standard mortar. In the wake of extending the measure of utilized foundry sand and hypo sludge in a mortar, the water absorption and sorptivity quality show relentless abatement.*

***Keywords:*** *Used Foundry Sand, Hypo Sludge, Cement, Natural Sand, Water Absorption, Sorptivity*

## INTRODUCTION

In India, solid industrial waste generation rate is particularly high amid the last decades. Nowadays, the development materials are decreased so we are in need to discover the new elective materials for development work. Mortar is a broadly utilized material in development work. Because of the popularity of materials which causes deficiencies of regular materials, these hand over to a noteworthy test for the specialist to use waste as a viable development material. Research to think about the properties of waste materials and finding an ideal approach to use waste is required. Various past examinations embraced got significant outcomes for the use of waste in making concrete, paver piece, and mortar and so on. Use of waste in mortar has expanded impressively finished the earlier years. Some inquire about completed a productive use of foundry sand in substitution of common sand and hypo sludge in substitution of cement. Basic research work has been depicted towards the imperative use of foundry sand as natural sand and hypo sludge set up the bond similar to cement Sand has been the most widely used fine aggregate in Mortar and mishandles of stream sand has prompted particular unsafe outcomes on this huge average natural resource. Hypo sludge is carried on like bond due to lime. Present-day waste such as glass fibre fly ash, and hypo sludge and foundry sand in Sustainable Mortar can handle the issues of their transfer and disposal.

## EXPERIMENTAL PROGRAM

Following are the details and sources of the materials:

### Source of Materials

In this study, Ordinary Portland Cement grade 53, Used Foundry Sand, Natural Sand and Hypo Sludge was used in this test and the sources of materials are given in Table 1

***Table 1:*** *Source of Materials*

| Experimental Materials | Source |
|---|---|
| Used Foundry Sand | Rhino Machines Pvt Ltd., GIDC, V.U. Nagar, Anand |
| Natural Sand | Bodeli, Gujarat |
| Cement | Locally available OPC 53 Grade |
| Hypo Sludge | Saiyed Paper Mills Ltd.,GIDC ,Vapi |

### Used Foundry Sand and Natural Sand

The Used Foundry Sand shall be obtained from Rhino Machines Pvt Ltd., GIDC, V.U. Nagar, Anand and Natural Sand shall be obtained from Bodeli, Gujarat. The Physical properties of the used foundry sand and natural sand given in Table 2

***Table 2:*** *Physical properties of Used Foundry Sand and Natural Sand*

| Constituents | Used Foundry Sand | Natural Sand |
|---|---|---|
| Specific Gravity | 2.18 | 2.68 |
| Fineness Modules (mm) | 1.12 | 2.64 |
| Water absorption (%) | 0.20 | 1.20 |
| Moisture content (%) | 2.00 | 0.16 |

**(Source: Geo Test House, Vadodara)**

### Hypo Sludge and Cement

The Hypo Sludge shall be obtained from Saiyed Paper Mills Ltd.,GIDC ,Vapi and Ordinary Portland Cement with 53 Grade has taken in this study. The Chemical properties of the Hypo Sludge and Cement given in Table 3

***Table 3:*** *Chemical properties of Hypo Sludge and Cement*

| Constituents | Hypo Sludge (%) | Cement (%) |
|---|---|---|
| Lime (CaO) | 41.5 | 62.00 |
| Silica ($SiO_2$) | 26.90 | 22.00 |
| Calcium sulphate ($Ca_2SO_4$) | 1.16 | 4.00 |
| Aluminum ($Al_2O_3$) | 4.04 | 1.00 |
| Magnesium oxide (MgO) | 4.88 | 5.00 |

(Source: Geo Test House, Vadodara)

## METHODS

Following is the test done on the Mortar:

### Water Absorption Test

The 70.6 mm x 70.6 mm x 70.6 mm size cube after casting were immersed in water for 28 days curing. These specimens were dried in the own for 24 hours at the temperature 85°C until the mass became constant and again weighed. This weight was noted as the dry weight (W1) of the cube. After that the specimen was kept in water at 85°c for 24 hours. Then this weight was noted as the wet weight (W2) of the cube.

% water absorption = [(W2– W1) / W1] x 100

Where,

W1 = Oven dry weight of cubes in grams

W2 = after 24 hours wet weight of cubes in grams.

### Sorptivity Test

The Sorptivity can be determined by the measurement of the capillary suction of water by the bottom surface of the specimen. After casting the cube immersed in water for 28 days curing. The specimen size 70.6 mm x 70.6 mm x 70.6 mm after drying in oven at temperature of 85 °C were drowned in water. The water level should not be more than 5 mm above the bottom of specimen and the flow from the peripheral surface is prevented by sealing it properly with non-absorbent coating. The quantity of water absorbed in time period of 30 minutes was noted by weighting machine... Surface water on the specimen was wiped off with a cloth or tissue and each weighting of specimens was completed within half minute.

Sorptivity (S) is a material property which characterizes the tendency of a porous material to absorb water by capillary suction. The total water retention (per unit region of the inflow surface) increments as the square foundation of elapsed time (T) $I=S.T^{½}$, therefore, $S=I/ T^{½}$

Where;

S= sorptivity in mm,

T= elapsed time in mint.

I= Δw/Ad

Δw= change in weight of cube = W2-W1

W1 = Oven dry weight of cube in grams

W2 = Weight of cube after30 minutes capillary rise of water in grams.

A= surface area of the cube through which water penetrated.

d= density of water.

## EXPERIMENTAL RESULTS AND DISCUSSION

Following are the experimental results and discussion:

### Water Absorption Test

Following Figure 1 shows the results of percentage water content absorbed in mortar mixes for the water absorption test done on mortar batches for conventional mortar and Used foundry sand with replacement of natural sand and hypo sludge with cement in different proportions at 28 days.

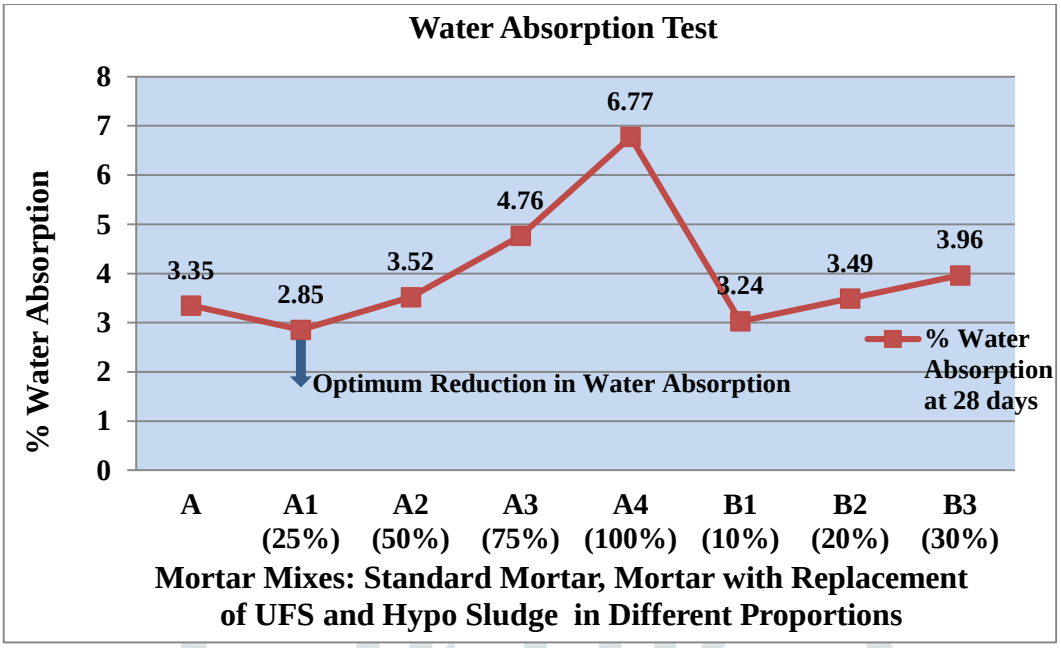


***Fig. 1:*** *Percentage Water Absorption in Mortar Mixes: Standard Mortar, Mortar with Replacement of UFS and Hypo Sludge in Different Proportions at 28 Days*

From the figure 1, it can be said that for mortar mixes percentage water absorbed was gradually increases with increase in replacement of Used Foundry Sand (UFS) with Natural Sand and Hypo Sludge with cement. But after increasing the quantity of UFS to 50%, 75% and 100% and Hypo Sludge to 20% and 30% shows maximum percentage of water absorbed. Optimum batch for minimum water absorption was A1 (25% Used Foundry Sand) and B1 (25% Used Foundry Sand + 10% Hypo Sludge) mix. A1 mix shows 14.92% reduction in percentage water absorption as compare to A (conventional mortar) mix. B1 mix shows 3.28% reduction in percentage water absorption as compare to A mix.

**Sorptivity Test**

Following Figure 2 shows the result of Sorptivity for conventional mortar mix and mortar made with different proportion of UFS and Hypo Sludge.

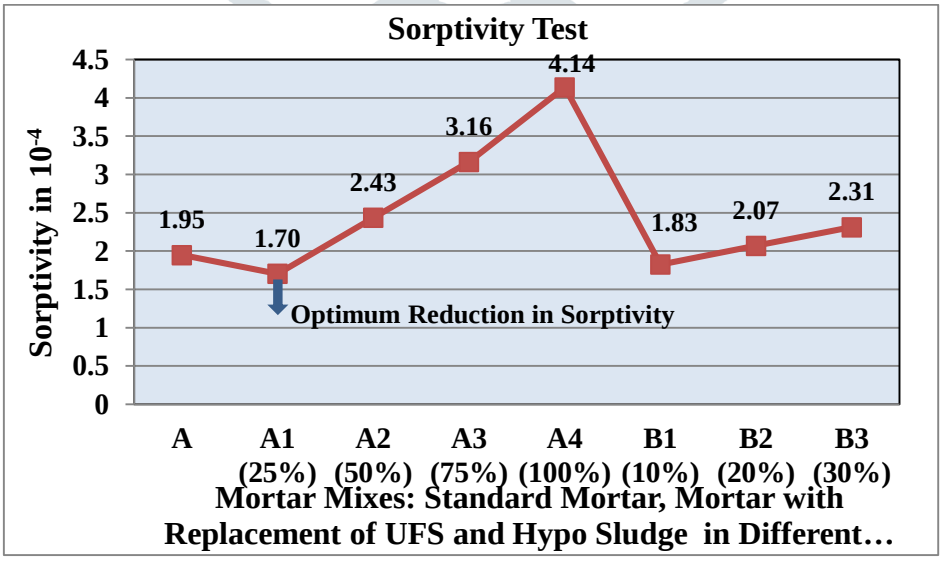


***Fig. 2:*** *Percentage Water Absorbed in Sorptivity Test for Mortar Mixes: Standard Mortar, Mortar with Replacement of UFS and Hypo Sludge in Different Proportions at 28 Days Proportions*

From the figure, it can be said that for A1 (25% Used Foundry Sand) mortar 12.82% reduction in sorptivity compare to the conventional mortar A mixes and B1 (25% Used Foundry Sand + 10% Hypo Sludge) mortar 6.15% reduction in sorptivity compare to conventional mortar A. Then in mortar mixes replaced with UFS and Hypo Sludge sorptivity increase with increase of replacement.

## CONCLUSION

Based on the experimental research following conclusions are drawn:

1. The incorporation of Used Foundry Sand and Hypo Sludge in mortar improved water absorption and sorptivity quality comparison to that conventional mortar.
2. When compared to the water absorption of conventional mortar, Used Foundry Sand and Hypo Sludge based mortar exhibits more reduction in water absorption. When 25% of Used Foundry Sand was replaced by Natural Sand and 10% Hypo Sludge was replaced cement.
3. As test results show that the in A batch mixes A1 mix (25% UFS) shows 14.92% reduction as well as in B batch mixes B1 mix (25% UFS + 10% Hypo Sludge) shows 3.28% reduction in percentage water absorption as compare to A (conventional mortar) mix.
4. As test results show that the in A batch mixes A1(25% UFS) shows 12.82% reduction as well as B batch mixes B1(25% UFS + 10% Hypo Sludge) shows 6.15% reduction in sorptivity compare to conventional mortar A.

## REFERENCES


1. Ahmad Sajad, Malik M. Iqbal, Wani Muzaffar Bashir, Rafiq Ahmed, ( 2013) "Study Of Concrete Involving Use of Waste Paper Sludge Ash as Partial Replacement of Cement", *Indian Organization of Scientific Research*, Vol.3, PP:06-15
2. Bhimani Dushyant Rameshbhai, Pitroda Jayeshkumar, Bhavsar Jaydevbhai J., (2013) "Used Foundry Sand: opportunities for Development of Eco-Friendly Low Cost Concrete" *International Journal of Advanced Engineering Technology* (IJAET) E-ISSN 0976-3945, Volume 4, PP:63-66
3. Chakraborty S, Mahmud T, Islam M. M. and Islam M S, (2014) "Use of Paper Industry Waste in Making Low Cost Concrete", *2nd International Conference on Advances in Civil Engineering 2014* (ICACE-2014)
4. Jagtap Minakshi B., Gadade Vikram B. , Salunke Ganesh B., (2015) "A Review on Utilization of Waste Foundry Sand for Producing Economical and Sustainable Concrete" *International Journal of Advance Engineering and Research Development* Volume 2, Issue 4, e-ISSN(O): 2348-4470, p-ISSN(P): 2348-6406, PP:580-587
5. Kaur Manmeet, Singh Jaspal, Kaur Manpreet, (2016) "Hypo Sludge – An Innovative and Sustainable Approach" *International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development* (IJCSEIERD) ISSN(P): 2249-6866; ISSN(E): 2249-7978, Vol. 6, PP:1-8
6. Khan Abdullah shahbaz, Panth Ram, Gagan Krishna R., Patil Suresh G., (2014) "Structural Performance of Concrete by Partial Replacement of Cement with Hypo Sludge (paper waste)" *International Journal of Emerging Technologies and Engineering* (IJETE),Volume 1 Issue 7, ISSN 2348 – 8050, PP:175-181
7. Kumar M.Sathees, M.Prabu, S.Suganya, (2017) "Influence of Foundry Sand and Hypo Sludge in Concrete" *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 6, Issue 3, ISSN(Online) : 2319-8753,ISSN (Print) : 2347-6710, PP:4261-4268
8. Mehta Keval, Patel Reshma, Pitroda Jayeshkumar, (2018) "Utilization of Used Foundry sand and Hypo sludge in Sustainable Mortar: A Review" *International Journal of Creative Research Thoughts* (IJCRT),Volume 6, Issue 1,ISSN:2320-2882, PP:1121-1127

9. Pitroda Jayeshkumar, (2015) "Gainful Utilization of Fly Ash and Hypo Sludge in Concrete" International Journal of Constructive Research in Civil Engineering (IJCRCE), Volume 1, PP: 1-7
10. Pitroda Jayeshkumar, L. B. Zala, F. S. Umrigar, (2013) "Durability of concrete with Partial Replacement of Cement by Paper Industry Waste (Hypo Sludge)" *International Journal of Innovative Technology and Exploring Engineering* (IJITEE) ISSN: 2278-3075, Volume-2, Issue-3, PP: 101-104
11. Pitroda Jayeshkumar, L. B. Zala, F. S. Umrigar, (2013) "Innovative Use of Paper Industry Waste (Hypo Sludge) in Design Mix Concrete", *International Journal of Advanced Engineering Technology*, Vol. IV, Issue I, PP: 31-35
12. Solanki Jayraj Vinodsinh, Pitroda Jayeshkumar, (2013) "Investigation of Low Cost Concrete Using Industrial Waste as Supplementary Cementitious Materials" *International Journal of Engineering Science and Innovative Technology* (IJESIT), Volume 2, Issue 1, ISSN: 2319-5967 ISO 9001:2008 Certified, PP: 81-88