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# Experimental Investigation of Construction Materials Using $MnSo_4$ Sludge

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***Abstract*—The research work was carried out on experimental investigation of concrete and bricks using $MnSO_4$ sludge. Properties of concrete were checked by testing cubes, cylinder and beams for compressive strength, split tensile strength and flexural strength. The specimens were casted using M25 grade concrete with locally available material. Similarly, bricks were casted and checked for compressive strength, water absorption and efflorescence test for deposits on bricks. The objective of present work was to study effect of $MnSO_4$ sludge in mix design of concrete at optimum percentage (15%) and different proportion such as 10, 20 & 30% in brick. As $MnSO_4$ sludge is available at free of cost. The experimental result showed that addition of $MnSO_4$ sludge in concrete and bricks enhance the properties of concrete and bricks.**

***Index Terms*— Manganese sulphate sludge, Compressive strength, Efflorescence test.**

## I. INTRODUCTION

$MnSO_4$ sludge formed when manganese oxide is reacted with sulphuric acid to form manganese sulphate solution. The aqueous solution is extracted living behind the cake which is non-hazardous in nature. Manganese Sulphate Sludge is a waste generated from Pesticide Company which is in the form cake, and then it is dried. This residual mass is approximately 40%, which needs to be disposed off in proper manner. It has properties similar to cement and can be used for different replacement of construction materials. The materials do not undergo any toxic reaction with air and water. $MnSO_4$ sludge has major quality like corrosion resistance. [2] This technology can offer the reinforcement material in the form of binding material that can be used as construction material and helps successfully decreasing the cost of construction.

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## II. LITERATURE SURVEY

$MnSO_4$ sludge is a new material in infrastructure engineering as compared to other materials like fly ash, rice husk. S. K. Agarwal et al, (2012) have shown that concrete with $MnSO_4$ sludge as replacement of cement by 15% gives better results. He has tested burnt clay bricks of different replacement (10%, 20% & 30%) bricks, there was not much deterioration in the compressive strength of bricks. Nawal Muhammad Dawood (2005) has shown the different corrosion rate values of stainless steel in various aqueous salt solutions are in the order of NaCl >KCL >Na2SO4 >CaCl2 > NaNO3> MgSO4>CaCO3> **$MnSO_4$**> KI> NaHCO3> Pb (NO3)2> KBr for 30 day.[2] This literatures survey reveals that $MnSO_4$ sludge is truly corrosion resistant and environmental friendly. $MnSO_4$ sludge requires less energy in manufacture and raw material is widely available. $MnSO_4$ sludge is available at free of cost. Its physical and chemical properties are impressive, can become beneficial solution in construction. This paper present efficiency of $MnSO_4$ sludge in concrete and burnt clay bricks under compression, flexural, split tensile test on concrete and compression, water absorption, efflorescence test on bricks.

## III. EXPERIMENTAL PROGRAM

The program was conducted for understanding effectiveness of adding 15% $MnSO_4$ sludge as replacement of cement in concrete and10, 20 &30% $MnSO_4$ sludge as clay in burnt clay bricks. The testing carried out on 18 concrete cubes for compressive strength cured for 3, 7 & 28 days, 6 numbers of

cylinders for split tensile test and 4 beams for flexural test cured for 28 days. In case of bricks, 12 bricks for compressive strength cured for 3 days, 12 bricks for water absorption test cured for 24 hours, 12 bricks for efflorescence test cured for 48 hours.

## IV. MATERIAL

1. Cement: OPC of 53 grade cement was used which having specific gravity 3.15. 15% cement is replaced by $MnSO_4$ Sludge.
2. Fine Aggregate: Crushed sand as fine aggregate in concrete mix design. The crushed sand was passing through 4.75mm sieve and retained on 60 micrometer sieve, having specific gravity 2.81and water absorption 2.88%.
3. Coarse Aggregate: Maximum size of aggregate was selected for this mix design 10mm. Specific gravity of aggregate was 2.89 and water absorption 1.63%.
4. $MnSO_4$ Sludge: Different proportion of $MnSO_4$ Sludge were taken for making specimens (0-30%)

5. Water: Water used was potable which satisfied requirements of IS 456:2000 having w/c ratio for this mix design was 0.45.

## V. Testing of Concrete and Bricks With and Without Manganese Sulphate Sludge

### 1. *Testing of concrete*

#### *1.1 Compressive Strength Test as per IS 516:1959*

Compressive strength of concrete was tested with and without $MnSO_4$ Sludge. Concrete cubes were casted (150*150*150) and cured for 28 days. Cubes were tested under compressive testing machine. The load was applied by increasing rate of 140kg/cm$^2$/min until the resistance of specimen to increasing load break down. Maximum load taken by specimen was recorded and failure was noted. Three cubes were tested in each category. Results are shown in Table I and graph is shown in Fig I.

#### *1.2 Split Tensile Strength as per IS 5816:1999*

The cylinder specimen (150*300) was placed horizontally in the center part of assembly by using wooden strips. Specimen loaded by equal distribution of load. The load was applied and increased continuously at the rate of 1.2 to 2.4N/mm$^2$/min until failure of specimen. Maximum load applied was recorded carefully and observe the condition of the specimen. Results are shown in Table I and graph is shown in Fig I.

| % of $MnSO_4$ Sludge | Average Compressive Strength(MPa) after days | | | Average Split Tensile Strength (MPa) After 28 days | Average Flexural Strength(Mpa) After 28 days |
|---|---|---|---|---|---|
| | 3 | 7 | 28 | | |
| 0 | 12.6 | 16.5 | 29 | 4.53 | 5.47 |
| 15 | 12.1 | 15.8 | 27 | 5.72 | 5.68 |

Table I: Comparison of concrete with/without $MnSO_4$ sludge

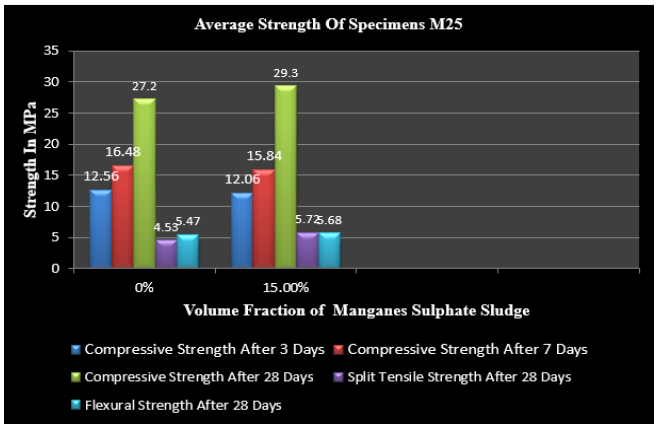


Fig I: Chart showing average strengths of specimens

#### *1.3 Flexural Strength as per IS 516:1959*

The beams were casted for this test having dimension (150*150*700). The specimen was placed in machine for uniform loading. The load was applied to uppermost part of mould along with two loading points. For applying loads two steel rollers were used in the assembly. Load continuously applied 180kg/min until failure occurs. Results are noted carefully. Results are shown in Table I and graph is shown in Fig I.

### 2. *Testing of bricks*

#### *2.1 Compressive Strength Test as per IS 3495.1-4:1992*

Compressive strength of bricks was tested with and without $MnSO_4$ Sludge. Bricks were casted (190*90*90) and cured for 3 days. Bricks were tested under compressive testing machine. The load was applied by increasing rate of 140kg/cm$^2$/min until the resistance of specimen to increasing load break down. Maximum load taken by specimen was recorded and failure was noted. Three bricks were tested in each category. Results are shown in Table II and graph is shown in Fig II.

Table II: Comparison of brick specimens with/without $MnSO_4$ sludge

| Sr. No. | % of $MnSO_4$ Sludge | Average Compressive Strength (MPa) | Water Absorption (%) | Efflorescence (deposits) |
|---|---|---|---|---|
| 1 | 0 | 5.27 | 23 | Nil |
| 2 | 10 | 4.78 | 22 | |
| 3 | 20 | 4.45 | 24 | |
| 4 | 30 | 4.32 | 24 | |

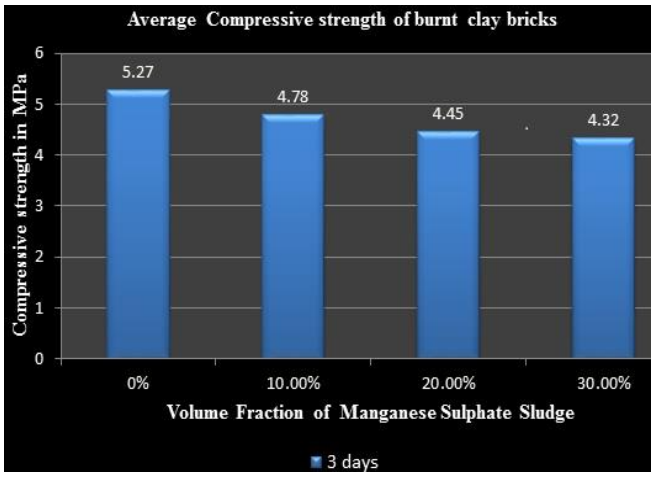


Fig II: Chart showing compressive strengths of bricks

#### *2.2 Water absorption Test as per IS 3495.1-4:1992*

Water absorption of bricks was tested with and without $MnSO_4$ Sludge. Bricks were casted (190*90*90) and cured for 24 hours, initial and final weights were taken. Then water absorption is found. Three bricks were tested in each category. Results are shown in Table II and graph is shown in Fig III.

#### *2.3 Efflorescence Test as per IS 3495.1-4:1992*

Efflorescence of bricks was tested with and without $MnSO_4$ Sludge. Bricks were casted (190*90*90) and cured for 2 days. Bricks were deepening into water at 15mm depth, after 24

hours and 48 hours, whether deposits were present or not. Results are shown in Table II.

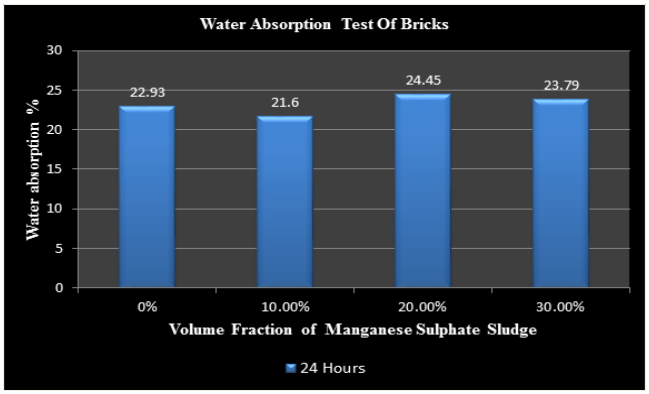


Fig III: Chart showing water absorption strength of bricks

## VI. CONCLUSION

This paper shows effectiveness of $MnSO_4$ sludge when it is used at its optimum percentage (15%) in concrete and varying percentage (10, 20 & 30%) in bricks. $MnSO_4$ sludge can replace cement in concrete and burnt clay in bricks. As it is available at free of cost, so it helps to reduce cost of construction. Use of $MnSO_4$ sludge in concrete and bricks is an effective technique to enhance performance of construction materials

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