An Experimental Study on Strength of Different Grades of Concrete using Wheat Straw Ash, Mill Scale, & Plastic Granules

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***Abstract*— In this study, the effects of the use of Wheat straw ash, Plastic granules and Mill scale on concrete strength were investigated. Existing natural deposits are being exhausted at a tremendous rate. The arguments are mostly related to protecting river bed against erosion for having natural sand is a filter for groundwater. For this afford to use suitable recycle materials as substitute for concrete aggregate. Due to increase in industrialization and urbanization, disposing and recycling of waste mill scale, wheat straw ash and plastic granules are major issue. So it is very important to come with proper solution such as using these waste materials as a raw material in construction industry which would help us in conserving natural resources, proper utilization of waste material. Cost and environmental considerations play a big role in today's construction projects. The main binding material of concrete is cement that gives the construction strength and longevity. Wheat straw ash (WAS) is found to be an effective pozzolanic material. Mill Scale is a waste product in iron industry. Mill Scale helps in the improvement of concrete's mechanical properties as well as its durability. In general, the use plastic granules with Mill Scale in concrete has been proved to be enhancing the characteristics of concrete i.e. density. Hence, concrete with WSA, plastic granules and mill scale addition can be recommended for the production of economical and environmentally friend concrete**.

Keywords: Strength analysis, Wheat Straw Ash, Rice Husk Ash, Plastic granules, Mill Scale

1. INTRODUCTION

The most common building material worldwide is concrete. This popularity of concrete carries with an immense environmental cost. Globally, over 14 billion tons of concrete is produced every year. Such volume required of natural resources for aggregate and cement production for this billions of tons of concrete. Due to its low tensile strength compared to its compressive strength heavy amount of reinforcement is needed which are again too costly. Also for this humungous amount of concrete natural material are mined and processed each year in concrete, which leaves a unsustainability marks on the environment. The concrete industry can improve its compliance with environment unsustainability by increased reliance on recycle materials. Since aggregate usually account for 80% of the concrete volume and play a significant role in defining properties such as per workability, strength, density and an effective recycle strategy industrial and agriculture waste into concrete will lessen the demand for material. With respect to tensile strength of concrete if it is managed to somehow in case it even by small percentage which is being ignore till now and hence amount of steel is to be used can be reduced with respect to natural fine aggregate i.e. sand. It has become evident that the availability of good quality natural sand is diminishing in last 25 years. Existing natural deposits of fine aggregate are being exhausted at a tremendous rate. Environmental concerns are also raised against uncontrolled extraction of natural sand. The arguments are mostly related to protecting river bed against erosion for having natural sand is a filter for groundwater. With natural sand deposit in word over drying up, there is a direct or indirect needs for a product that can be replace natural sand fully or partially. For this afford to use suitable recycle materials as substitute for concrete aggregate. Approximately 4300 Mt cement was produced in 2021.(www.iea.org) China and India will have significant production of cement. The cement industries are facing challenges such as cost, CO_2 emissions, and the supply of raw materials in sufficient quantities and amounts. Wheat straw ash has

cementitious property which I have replaced with cement. Due to increase in industrialization and urbanization, disposing and recycling of waste mill scale, wheat straw ash and plastic granules are major issue. So it is very important to come with proper solution such as using these waste materials as a raw material in construction industry which would help us in conserving natural resources, proper utilization of waste material.

2. MATERIALS USED

2.1 Cement: OPC cement grade 43 is used for this experimental study various laboratory test were conducted on cement. Cement used in this study was free from any lumps and was in good condition.

2.2 Sand: Locally available artificial sand which is passing through 4.75 mm sieve was used. Specific Gravity of fine aggregates is found to be 2.64. Water Absorption of fine aggregate was found to be 1.20%. The various properties are done by IS 2386-1970.

2.3 Coarse Aggregate: Angular Coarse aggregate is used with maximum size of 20 mm. Specific Gravity of coarse aggregate was found to be 2.85. Water Absorption of coarse aggregate was found to be 0.50%. The various properties are done by IS 383-1970.

2.4 Plastic Granular: Plastic granules is a black flaky material composed mainly of PVC and is formed on the Plastic Industry. The bulk density is determine by the IS:2386 (Part-III)-1963. Particle size distribution is determine by the IS:2386 (Part-I)-1963.

2.5 Wheat Straw Ash: Wheat Straw ash is dark grey in colour. The small sized particles plays an important role in filling voids in the concrete, hence it produce dense and durable concrete. Wheat straw ash has pozzolanic properties, means it can react with lime to form a cementitious compound. Specific gravity of wheat straw ash is found to be 1.63.

2.6 Mill Scale: Mill scale is a bluish black flaky material composed mainly of iron oxide and is formed on the outer surface of Steel during hot rolling process this scale are usually Less than a millimetre thick. The bulk density is determine by the IS:2386 (Part-III)-1963. Particle size distribution is determine by the IS:2386 (Part-I)-1963.

3. DISCARD MATERIAL

3.1 Aluminium fibre: As we used additional aluminium fibre in concrete with the various percentages. But to uses of aluminium fiber there have very high heat of hydration. After use of aluminium mix concrete cube temperature was very high. We could see the evaporation of water from cubes.

3.2 Wheat Straw: We used Wheat Straw in concrete but there have not any significant strength, so we did not use this material.

3.3 Rice Husk Ash: It's also used in concrete to replace sand but when we compare with wheat straw ash, those results did not signify. After that we used WSA. Uses of wheat straw ash are also depending on availability.

3.4 Rice Husk: We used Rice Husk in concrete but there have not any significant strength, so we did not use this material. After used this material, concrete will segregate, and also did not good binding properties.

4. MIX DESIGN

Mix Design of Concrete, which follows some certain principles, devised by IS:10262-2019. Concrete mix design data is shown in table 1

Table 1

Concrete Grade	Cement (kg.)	Water Cement Ratio	Proportion	Admixture (NABF)
M20	340	0.5	1:2.18:4.53	NA
M25	372	0.5	1:1.88:3.29	NA
M30	400	0.4	1:1.68:3.40	NA
M40	435	0.36	1:1.44:3.05	0.8%

5. RESULTS

5.1 Based upon the results of workability (using slump cone test), compressive strength and flexural strength for M25 grade of concrete for replacement percentages were 40%. 45% 50% by weight of fine aggregate with mill scale. Following are the conclusion-

5.1.1 Increases the percentage of mill scale replace fine aggregate in concrete, workability of concrete decreases. Slump value is decreased by 15.58% for M25 grade of concrete for 45% of replacement of fine

aggregate with mill scale. For rigid pavement when the workability is medium (slump value 68 to 64mm) even replacement of the fine aggregate by mill scale can be done.

5.1.2 Increases the percentage of mill scale replaced with fine aggregate in concrete, density of concrete increases. Density is increased by 13% for M25 grade of concrete for 45% of replacement of fine aggregate with mill scale.

5.1.3 Increases the percentage of mill scale replace fine aggregate in concrete, compressive strength of concrete increases. For rigid pavement when the compressive strength is high even replacement of the fine aggregate by mill scale can be done. The 28 days compressive strength are increased by 14.30% for M25 grade of concrete for 45% of replacement of fine aggregate with mill scale.

5.1.4 Increases the percentage of mill scale replace fine aggregate in concrete, split cylinder strength of concrete increases. For rigid pavement when the split cylinder strength is high even replacement of the fine aggregate by mill scale can be done. The 28 days split cylinder strength are increased by 52% for M25 grade of concrete for 45% of replacement of fine aggregate with mill scale.

5.2 Based upon the results of workability (using slump cone test), compressive strength and flexural strength for M25 grade of concrete for replacement percentages were 5%, 10%, 15%, 20% by weight of fine aggregate with Plastic granules. Following are the conclusion-

5.2.1 Increases the percentage of plastic granules replaces fine aggregate in concrete, workability of concrete decreases. Slump value is decreased by 10.4% for M25 grade of concrete for 15% of replacement of fine aggregate with plastic granules. For rigid pavement when the workability is medium (slump value 74 to 67mm) even replacement of the fine aggregate by plastic granules can be done.

5.2.2 Increases the percentage of plastic granules replaces fine aggregate in concrete, density of concrete decreases. Density is decreased by 8.8% for M25 grade of concrete for 45% of replacement of fine aggregate with plastic granules.

5.2.3 Increases the percentage of plastic granules replaces fine aggregate in concrete, compressive strength of concrete decreases. For rigid pavement when the compressive strength is low even replacement of the fine aggregate by plastic granules can be done. The 28 days compressive strength are decreased by 17.34% for M25 grade of concrete for 15% of replacement of fine aggregate with plastic granules.

5.2.4 Increases the percentage of plastic granules replace fine aggregate in concrete, split cylinder strength of concrete decreases. For rigid pavement when the split cylinder strength is low even replacement of the fine aggregate by plastic granules can be done. The 28 days split cylinder strength are decreased by 28% for M25 grade of concrete for 15% of replacement of fine aggregate with plastic granules.

5.3 Based upon the results of workability (using slump cone test), compressive strength and flexural strength for M25 grade of concrete for replacement percentages were 5%, 7.5%, 10%, 12.5%, 15%, 20%, 25% by weight of cement with wheat straw ash. Following are the conclusion-

5.3.1 Increases the percentage of wheat straw ash replace cement in concrete, workability of concrete decreases. Slump value is decreased by 11.7% for M25 grade of concrete for 12.5% of replacement of cement with wheat straw ash.. For rigid pavement when the workability is medium (slump value 76 to 58mm) even replacement of the cement by wheat straw ash can be done.

5.3.2 Increases the percentage of wheat straw ash replace cement in concrete, density of concrete decreases. Density is decreased by 0.27% for M25 grade of concrete for 12.5% of replacement of cement with wheat straw ash.

5.3.3 Increases the percentage of wheat straw ash replace cement in concrete, compressive strength of concrete decreases. For rigid pavement when the compressive strength is high even replacement of the cement by wheat straw ash can be done. The 28 days compressive strength are decreased by 13% for M25 grade of concrete for 12.5% of replacement of cement with wheat straw ash.

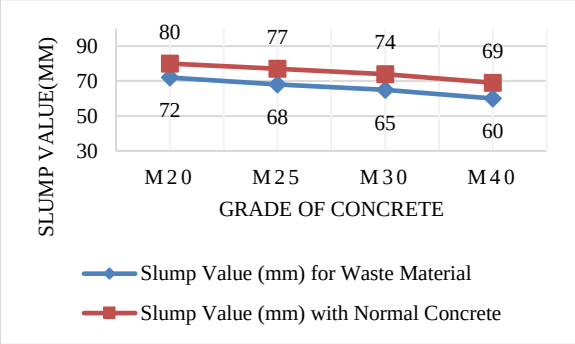
5.3.4 Increases the percentage of wheat straw ash replace cement in concrete, split cylinder strength of concrete decreases. For rigid pavement when the split cylinder strength is low even replacement of the cement by wheat straw ash can be done. The 28 days split cylinder strength are decreased by 5% for M25 grade of concrete for 12.5% of replacement of cement

with wheat straw ash.

5.4 After replacement of Wheat Straw Ash (12.5% with cement), Plastic granules (15% with sand), and Mill Scale (45% with sand)

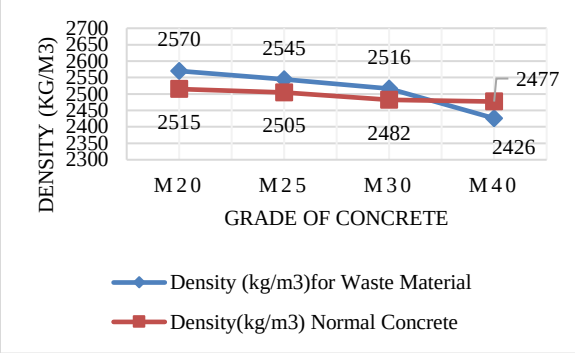
5.4.1 Slump Value: Workability of concrete decreases for all grade of concrete as shown in fig. 1

Figure 1



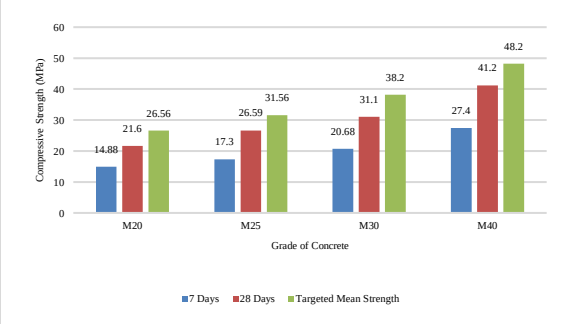
5.4.2 Density: Density of concrete increases for all grade of concrete while decreases for M40 grade of concrete as shown in fig. 2

Figure 2



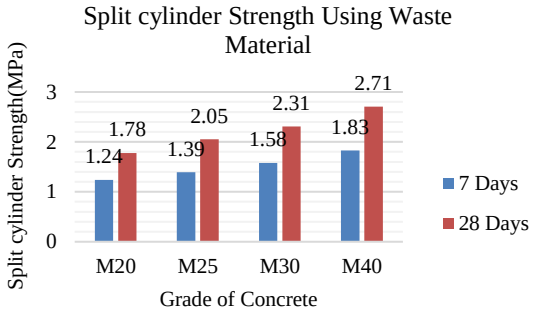
5.4.3 Compressive Strength: Compressive strength of concrete decreases for all grade of concrete as shown in fig.3

Figure 3



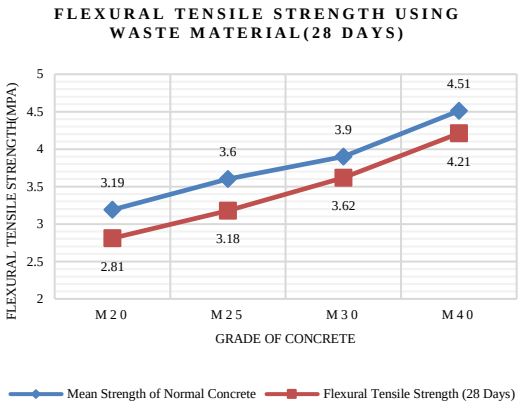
5.4.4 Split Cylinder Tensile Strength: Split cylinder tensile strength is decreases with 8.7 to 16%. Split cylinder Strength Using Waste Material is shown in fig. 4

Figure 4



5.4.5 Flexure Strength: Flexure Strength of concrete decreases for all grade of concrete as shown in fig.5

Figure 5



6. CONCLUSIONS

This research shows that various results on various point of view that in strength, material, workability etc. All the results concluded that point to point as below:

1. Replacement of cement and sand in concrete of any grade workability of concrete decrease. However considered concrete is suitable for slump value decreasing between the 72 to 60 mm at replacement of waste material.
2. Replacement of waste material with cement and sand in concrete of grade M20, M25, M30 density is increase and for grade M40 density is decrease.
3. After uses of waste materials, compressive strength concrete as compared to normal cement is decreased with replacement of waste.

4. Flexural strength of concrete decrease with replacement of waste material.
5. Cost saved per kilometre Road in the range of rupees 31,000Rs(-1%).

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