Use of Waste Material In Rigid Pavement

Rajesh Sharma[1], Deepak Kumar[2]
[1] Dept of Transportation Engineering
[2]Dept of Soil Engineering

Abstract- *The study aim to enhance the strength of rigid pavement by using sugarcane bagasse ash and of ground granulated blast furnace Slag in cement. Various studies have been conducted across the world which identified the adverse effects of different waste materials in concrete. Consequently, different waste materials were found to be appropriate ranging from 5% to 30% for the highway construction purposes. But, still there is a need to replace the cement partially by introducing another material by considering the chemical composition of cement without changing their binding properties. In the present study, an attempt has been made to aware the researchers and engineers to manufacture inexperienced concrete in order to attain the balance between environment, economical and technical aspects by highlighting different methods of utilizing the discarded materials (i.e. waste).*

Keywords- Cement, waste material (sugarcane bagasse ash and of ground granulated blast furnace Slag), Rigid pavement, Environment

I. INTRODUCTION

A pavement is a durable surface consist of different compacted layer to carried heavy traffic load. Each layer of pavement are consist of selected superior pavement material laid over a soil subgrade. The heavy traffic load on pavement are transfer through different pavement layer to large natural surface area. Therefore each layer are well compacted to resist stresses developed by traffic load. On the base of material used in road pavement, the pavement are classified into two type i.e. flexible pavement and rigid pavement

The cost of the road is depend on the type of pavement used. The flexible pavement are economical then rigid pavement therefore flexible pavement are mostly used. But Now a day, rigid pavement are generally used for carried heavy traffic because they possess high flexural strength and low maintenance cost. In rigid pavement, cement is used as binding material, therefore the initial cost of rigid pavement is higher than flexible pavement. The many waste material like fly ash are used in pavement to reducing the cost of roads without affecting the properties of concrete which used to construct the top layer of pavement. But some other waste material like sugarcane bagasse ash and ground granulated blast furnace slug are also used in pavement by removing the few quantity of cement in pavement. The effect on these material in concrete pavement are determined by compressive strength test and tensile strength test. The various design mix with different proportion of material are prepared for conducting the different test. These material are easily available in India. With the use of waste material in roads, they also help to reduce the various environment problem.

II. OBJECTIVES OF WORK

The work is focused on the use of waste material in different proportion with cement for the construction of rigid pavement. The main objective of the work are:

1. To find out the optimum percentage of sugarcane bagasse ash and ground granulated blast furnace slag in pavement quality concrete.
2. To optimize the cost effectiveness of pavement by using different waste material.
3. The use of waste material without changing their properties of concrete pavement.
4. To set the guideline regarding the use of waste material in pavement construction and make new concrete mix design.
5. To compare chemical composition and phase composition of material used in the construction of rigid pavement.

III. RAW MATERIAL USED

Cement: cement used in this work is ordinary Portland cement of grade 43. Cement used in rigid pavement as binding material.

Sugarcane bagasse ash: Bagasse Ash was burnt for approximately 72 hours in air in an uncontrolled burning process. The temperature was in the range of 700- 6000^{0}C.The ash collected from nearest sugar mill. After collecting, it was sieved through BS standard sieve size 75 μm and the colour of bagasse ash was black. It was then measured by volume to replace the cement at 5%, 10%, 15%, 20%, 25% and 30%. The Specific gravity given of bagasse ash is about 1.84.

Granulated blast furnace slag: It is also used as raw material. Blast furnace slug are collected from iron factory in granular form. After collecting, they are grind into powder form. After grinding they was sieved through BS standard sieve size 75 μm and the colour of blast furnance slug is white. It was then measured by volume to replace the cement at 5%, 10%, 15%, 20%, 25% and 30%.

(e) Water: Potable water was used for mixing and curing of concrete cubes.

IV. TEST USED

A. Fineness test by sieving

In this test, proper grading of cement and material are check. Finer the cement and added material, more surface area of the aggregates will be covered by it. Cement added with material are continuously sieved for a period of 15 minutes on IS sieve No. 9 by holding the sieve in hands, with wrist motion and continuous rotation of the sieve. The fineness of the cement and mixture are less than 10%.

B. Initial and final setting times test

In this test, 200 grams cement mix sieved through IS sieve No. 9 is taken and water is added at the rate of 0.85P by weight of cement.

V. TEST ON CONCRETE SAMPLE

a.Compressive strength test

The 150mm size cubes of various concrete mixtures sample were prepared for test compressive strength. The cubes specimens after molding were stored in curing tanks and on removal of cubes from water the compressive strength were conducted at 7days, 28days by using compressive strength machine. The results of the compressive strength of different mix design are represented in Table. The test results were compared with controlled concrete.

b.Tensile strength of concrete.

Split tensile test was performed with the help of UTM on cylindrical sample. Load was applied on the horizontal surface at height of cylinder. Two wood strips will applies at top and bottom surface where load was applied so that crushing of concrete does not take place where plane surface of UTM and surface of specimen meets. Size of cylinder sample will be 150 mm diameter and 300mm height.

VI. RESULTS

Table 4.0 Result of different test

S.NO	TEST	RESULT
1.	Consistency Test	28%
2.	Initial setting times test	31 min.
3.	Final setting times test	9 hour approximate
4.	compressive strength test 3 days 7days 28days	 23N/mm2 31n/mm2 43N/mm2
5.	Tensile strength of concrete 3days 7days	 21kg/cm2 27kg/cm2
6.	Specific gravity of sand	2.73
7.	Specific gravity of coarse aggregate	2.65

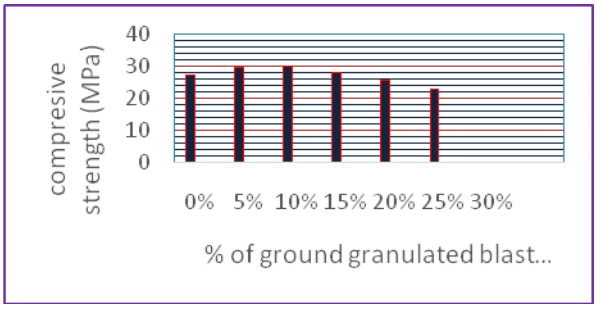

Fig 4.1 Fluctuation in compressive strength with the % of Ground Granulated Blast Furnace Slag after 7 days

Table 4.3 Compressive strength by using sugarcane bagasse ash in cement after 7 Days

Percentage of sugarcane bagasse ash in cement for making concrete block	Sample 1	Sample 2	Sample 3	Average
0%	26.9	27.1	27.2	27.1
5%	27.43	27.5	28.1	27.68
10%	30.2	30.0	29.8	30
15%	30.2	30.5	30.4	30.37
20%	26.4	27.4	26.6	26.8
25%	24.5	23.9	23.7	23.93
30%	20.2	23.1	23.4	22.2

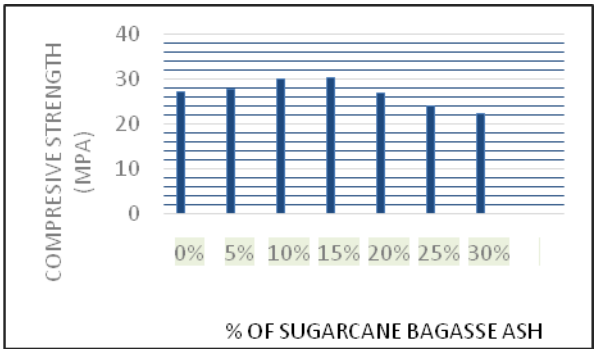

Fig 4.3 Fluctuation in compressive strength with the % of sugarcane bagasse ash after 7 days

Table 4.5 Split tensile strength of concrete block Ground Granulated Blast furnace Slag using after 28 days

Percentage of Ground Granulated Blast furnace Slag in cement for making concrete block	Sample 1	Sample 2	Sample 3	Average
0%	3.1	2.9	2.9	2.97
5	3.1	3.12	3.2	3.14
10	3.25	3.2	3.2	3.22
15	3.2	3.1	3.2	3.17
20	3.3	3.2	3.2	3.23
25	3.2	3.12	3.1	3.13
30	3.1	3.2	3.0	3.1

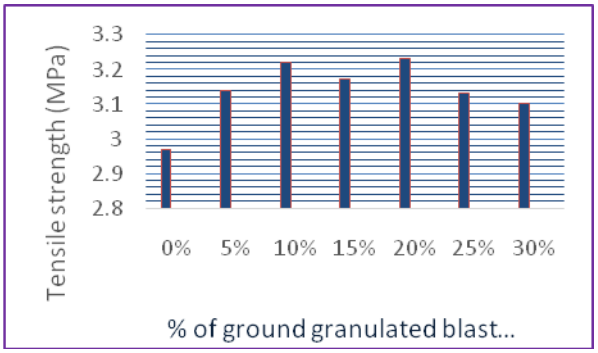

Fig 4.5 Fluctuation in tensile strength with the % of Ground Granulated Blast furnace Slag after 28 days

Table 4.6 tensile strength of concrete block using sugarcane bagasse ash after 28 days

Percentage of sugarcane bagasse ash in cement for making concrete block	Sample 1	Sample 2	Sample 3	Average
0%	3.1	2.9	3.1	3.03
5%	3.12	3.2	3.2	3.17
10%	3.3	3.35	3.27	3.31
15%	3.35	3.4	3.3	3.35
20%	3.2	3.25	3.26	3.24
25%	3.1	3.2	3.15	3.15
30%	3.12	3.1	3.0	3.1

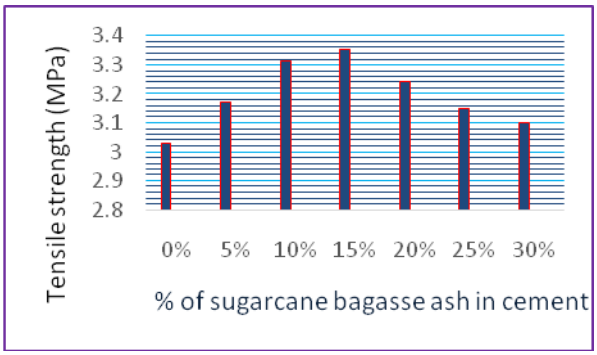

Fig 4.6 Fluctuation in tensile strength with the % of sugarcane bagasse ash after 28 days

VII. CONCLUSIONS

The Compressive strength of concrete block after 28 days by using Ground Granulated Blast Furnace Slag and after 7 days gives optimum results, when cement was replaced up to 15%. At 10 % replacement there was an increment of 12% Compressive strength. . After that sugarcane bagasse was partially replaced up to 30% and it was concluded that, at 15 % it gives the maximum strength after 28days of curing. Different combinations of these two waste materials were prepared during the study. On the basis of the results it was observed that 5% of Ground Granulated Blast Furnace slag and 15% of in the mix exhibit maximum compressive strength. Tensile strength of Ground Granulated Blast Furnace Slag and Sugarcane bagasse ash are slightly higher than the conventional concrete. The Cost of construction of rigid pavement will also reduce due to the reduction of cement in rigid pavement. The setting time of cement are also increase slightly due to the high percentage of silica in bagasse ash.

VIII. FUTURE SCOPE OF THE WORK

These waste material used in the cement are help to improve the properties of concrete. The proposed guidelines of the present study can be implementing in the field in the construction of rigid pavement with the application of reinforcement. Study can be extended by examining the behavior of the green concrete (i.e. made with the waste material) under different loadings and different climatic condition (i.e. to examine different stresses which will take place on green concrete). Beside this, the percent utilization of the waste material proposed in the present study can be increased (i.e. upto 80 or 100 %) by proposing different mix design (i.e. in varying proportion). Furthermore, some other waste materials can also be introduced by analyzing their chemical and physical properties in order to make the green concrete for pavement and sustainable environment.

REFERENCES

[1] Jagadesh, P., Ramachandramurthy, A., &Murugesan, R. (2018) Evaluation of mechanical properties of Sugar Cane Bagasse Ash concrete

[2] Jamsawang, P., Poorahong, H., Yoobanpot, N., Songpiriyakij, S., &Jongpradist, P. (2017) Improvement of soft clay with cement and bagasse ash waste. Construction and Building Materials, 154, 61-71.

[3] Janbuala, S., Eambua, M., Satayavibul, A., &Nethan, W. (2018) "Effect of bagasse and bagasse ash levels on properties of pottery products." Heliyon, 4(9), e00814.

[4] Kazmi, S. M. S., Munir, M. J., Patnaikuni, I., & Wu, Y. F. (2017) Pozzolanic reaction of sugarcane bagasse ash and its role in controlling alkali silica reaction. Construction and Building Materials, 148, 231-240.

[5] Ashish DK., 2018. Feasibility of waste marble powder in concrete as partial substitution of cement and sand amalgam for sustainable growth. Journal of Building Engineering. Jan 31;15:236-42.

[6] Bahurudeen A, Kanraj D, Dev VG, Santhanam M., 2015. Performance evaluation of Sugarcane bagasse ash blended cement in concrete. Cement and Concrete Composites.

[7] Bourtsalas, A.T., Zhang, J., Castaldi, M.J. and Themelis, N.J., 2018. Use of non-recycled plastics and paper as alternative fuel in cement production. Journal of Cleaner Production, 181, pp.8-16.

[8] Das S, Singh G, Ahmed AA, Saha S, Karmakar S., 2015. Ground Granulated Blast Furnace Slag (GGBS) based Concrete Exposed to Artificial Marine Environment (AME) and Sustainable Retrofitting using Glass Fiber Reinforced Polymer (GFRP) sheets. Procedia-Social and Behavioral Sciences.

[9] Deepika S, Anand G, Bahurudeen A, Santhanam M., 2017. Construction Products with Sugarcane Bagasse Ash Binder. Journal of Materials in Civil Engineering. Jul 21;29(10):04017189.

[10] Huda SB, Alam MS. 2014, Mechanical behavior of three generations of 100% repeated recycled coarse aggregate concrete. Construction and building materials.