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Use of Municipal Solid Waste Incinerated Bottom Ash and Construction Demolition Waste in Pavement

Md Akrama[2], Mohammad Talha Anwer[3], Ayush Dwivedi[4], Atul Singh[5], Mr. Ayush Kumar[5]
[1, 2, 3, 4]*Research Students, Dept. Of Civil Engineering, KIET Group of Institutions, Ghaziabad*
[5]*Assistant Professor, Dept. Of Civil Engineering, KIET Group of Institutions, Ghaziabad*

Abstract: ***This study focuses on the introduction of a layer of municipal solid waste incinerated bottom ash, sewage sludge and construction and demolition waste and the effect of this layer on the settlement and strength of the pavement. The primary principal of this paper is to deal with the use of MSWI bottom ash in a sustainable manner. This paper investigates the validity of mix layer as an applicable conventional subgrade. The objective of the paper is to study the viability of the utilization of Construction Demolition Waste (CDW) for improving the performance of sub grade and sub-base layers in the road design. On this mixture, certain tests are conducted like Aggregate Impact Value Test, Crushing Value Test, Specific Gravity Test, and Loss Angeles Abrasion Test. The results are analysed and discussed for the use of CDW for enhancing the performance of sub grade and sub-base layers in the pavement.***

Keywords: Construction Demolition Waste, Municipal Solid Waste, Sub-base

I. INTRODUCTION

In India nearly 50% of Construction & Demolition waste is being re-used and recycled, while the residue is mostly land filled. In India its common practice for large Construction and demolition (C&D) projects to stack waste in the road, resulting in traffic obstruction. C&D waste from discrete households finds its way into nearby municipal bins and waste storage depots making the municipal waste heavy and deteriorating its quality for treatments such as composting or energy recovery. The Indian construction industry is highly labour intensive and has accounted for approximately 50% of the country's capital expenses in successive Five-Year Plans, and projected investment continues to show a growing trend. Out of 48 million tons of solid waste generated in India, C&D waste makes up 25% annually.

In the past decades, MSWI bottom ash has been successfully applied in several beneficial application particularly in civil engineering applications. Given that the great demand of construction material MSWI bottom ash, as the reuse of building materials is potential to reducing the production cost of raw materials saving natural resources and solving disposing problems.

Municipal solid waste incinerated bottom ash can be mixed with demolition waste and sewage sludge at different ratios which can be used as road base/subbase or subgrade layer. The geotechnical characteristics of these mixtures such as shear strength, California Bearing capacity are comparable to those of widely used base or subbase or subgrade materials. Various tests have been performed to check the viability of these materials.

II. MATERIALS AND METHODS

A. Bottom Ash

In this paper MSWI bottom ash is obtained from Old NDMC Compost Plant, New Delhi. The MSWI bottom ash is commonly crushed into smaller particles and desired gradation for recycling applications as shown in fig.1.

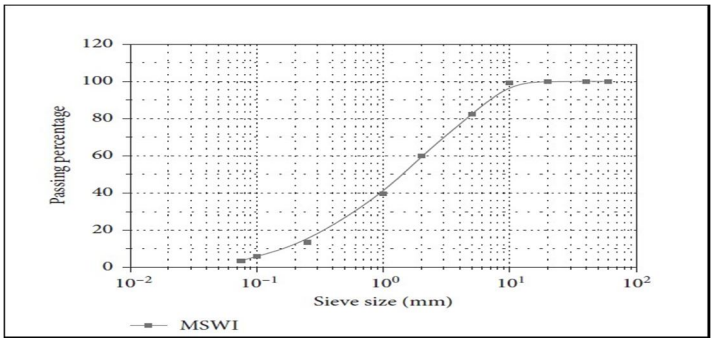


Fig.1 Gradation curve of the MSWI bottom ash

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The particle size distribution is shown in Fig.1. It can be noted that the particle size could be in range from 10^{-1} to 10mm, which is equivalent to natural aggregate size and distribution.
The Cu (coefficient of uniformity) and Cc (coefficient of curvature) are two primitive factors to classify if the soil is well graded or not. The graph shows that the MSWI bottom ash is well graded.

B. Demolition Waste

Waste debris from destruction of buildings, roads, bridges, or other structures are the demolition waste. Debris varies in composition, but the major components, by weight, in the US include concrete, wood products, asphalt shingles, brick and clay tile, steel, and drywall. There is the potential to recycle many elements of demolition waste.
Demolition waste materials are being increasingly used as sustainable alternative to natural aggregates in several geotechnical engineering projects. Recycled concrete aggregate, crushed bricks, waste rock have been considered as demolition material suitable for replacement.

III. EXPERIMENTAL STUDY AND LABORATORY TEST

We have collected the demolition construction material of slab, beam, and column from KIET Group of Institutions Ghaziabad, as per necessity and grading of aggregates given in IS: 383-1970. We have separated the aggregate according to requirement and we have used the aggregate which retains on 4.75mm sieve and passes from 6mm sieve. Fine aggregate consists of stone dust with fraction passing 4.75 mm and retained on 0.075mm IS sieve. We have conducted a number of tests on aggregate to check their properties and to compare its properties with normal aggregate. After comparison we have deduced the result. The tests that are performed is listed below: -

1) Aggregate Impact Value Test
2) Aggregate Crushing Value Test
3) Specific Gravity Test
4) Los Angeles Abrasion Test

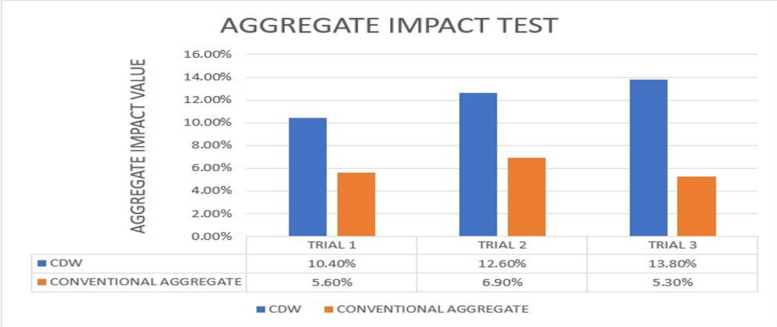


Fig 2. Aggregate Impact Value.

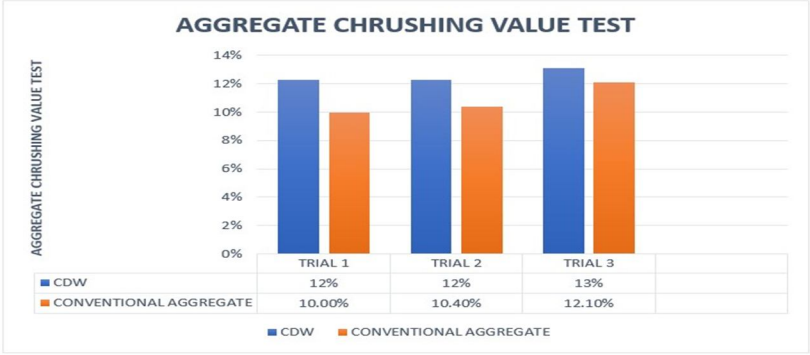


Fig 3. Aggregate Crushing Value.

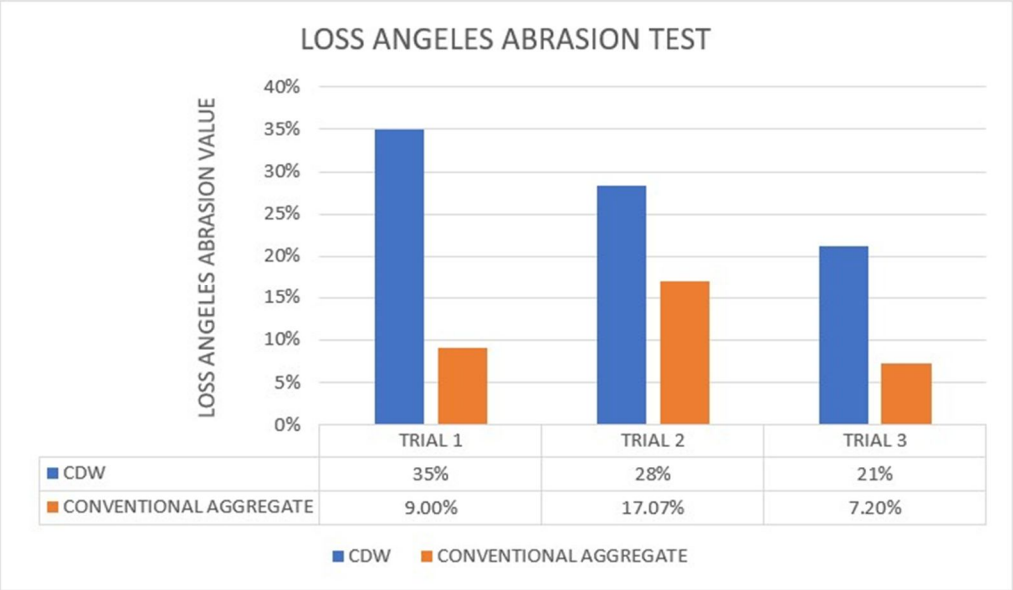


Fig 4. Loss Angeles Abrasion Test.

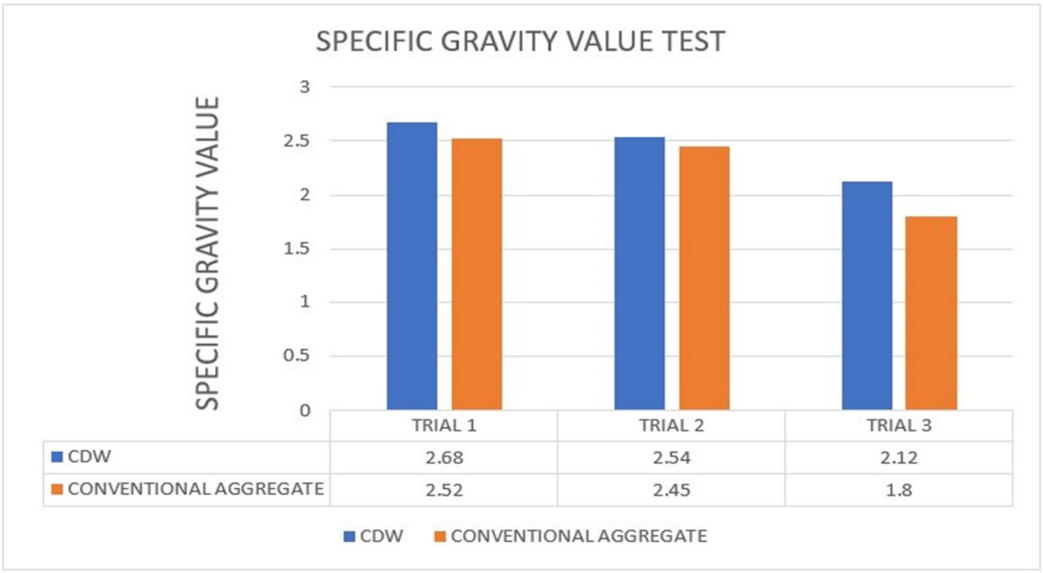


Fig 5. Specific Gravity Test.

IV. RESULTS

The results that are available shows that there is a scope for utilization of waste materials for road construction. However, one should proceed cautiously, because of potential environmental, health and safety concerns related with the India-age of some of the waste materials.

This research is needed before any distinct waste material is finally approved as a substitute road construction material. The accessibility of suitable technology, appropriate legislation and awareness among all stake holders would widen the possibilities of using some of the waste materials for sustainable road construction.

S.N.	Name of Test	CWD	Conventional Aggregate	Range	Remark
1.	Aggregate Crushing Value Test	12.3%	10.83%	<45% (Wearing course); <30% (Concrete pavement)	Hence the values are in optimum range, so we can use it in all the layers except top wearing surface layer of road pavement.
2.	Aggregate Impact Test	12.26%	5.93%	<10% (exceptionally strong); 10-20% (strong)	
3.	Los Angeles Test	28%	11.09%	<40%	
4.	Specific Gravity Test	2.47	2.25	2.3-3.0	

1) The Crushing value of demolition aggregates is found to be 12.3 % which is less than 30 %. So, the aggregates are suitable for the subbase.
2) The Specific Gravity of demolition aggregates is within the specified range. So, the aggregates are suitable for the road subbase.
3) The Loss Angeles Abrasion Value of demolition aggregate is found to be 28%. So, the aggregate is suitable for road pavement design.
4) The aggregate impact test is found to be 12.26% which is less than 10%.

V. CONCLUSION

To study the properties of the construction demolition wastes in pavement design as a DBM Course certain tests were conducted. To study the effect on the properties of road pavement the results of normal aggregate and construction demolition aggregate were compared.

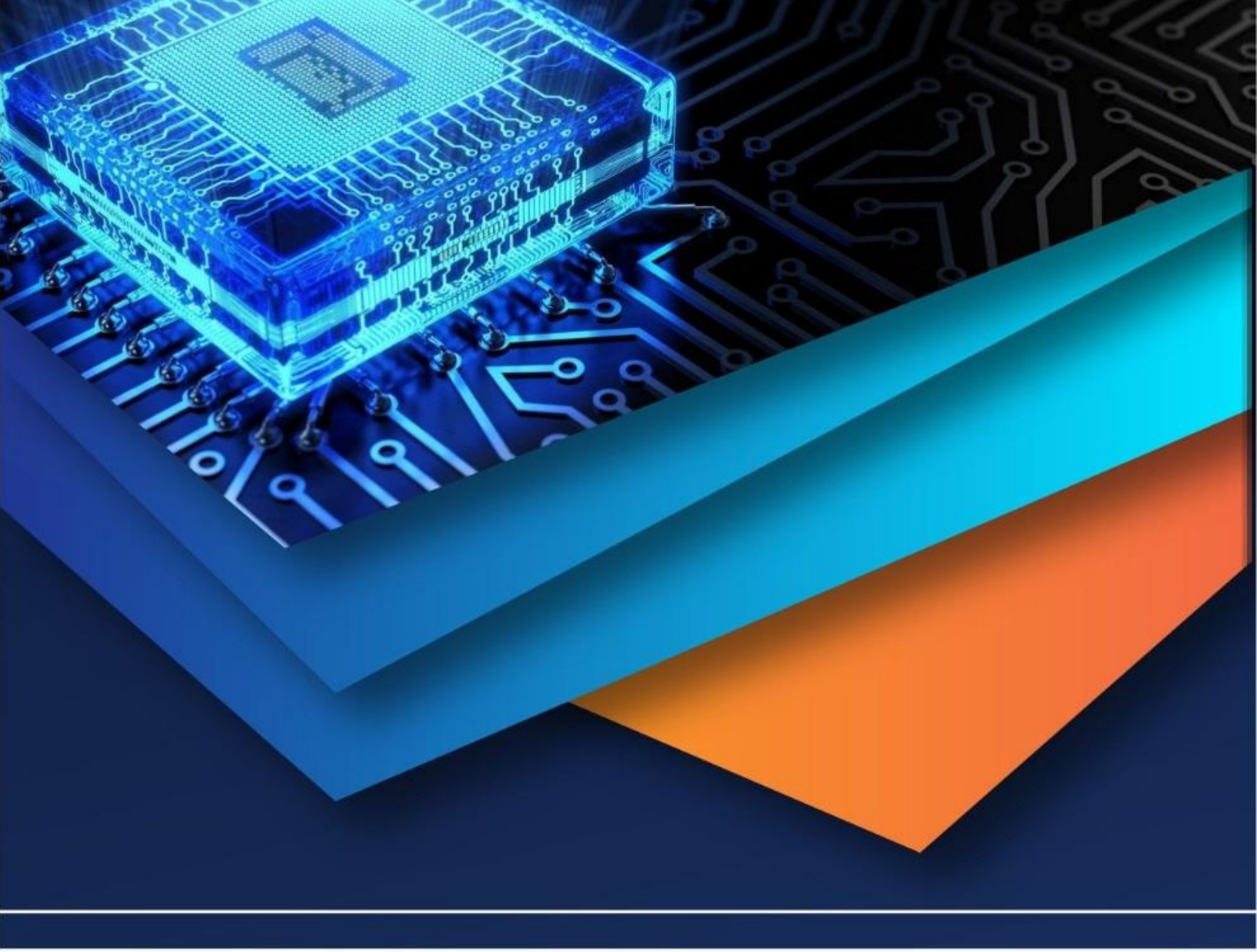
The result shows that construction demolition waste aggregate can be used in pavement design as a DBM course that minimise the requirement of conventional aggregate and could be helpful in controlling the environmental pollution. To use the CDW aggregate in pavement design, we need to separate it from its various components that causes uncontrolled growth of construction sector as to establish a new crusher and segregation plant. With rapid increase in industrialization and infrastructure development which leads to the generation of CDW waste and by disposing it, in a river or use it as a land fill it causes environmental pollution. So, to minimise it we can recycle and reuse the CDW waste as aggregate in road pavement design which will control the land pollution. To use conventional aggregate, we need crushing and segregation plant so in the same manner, to use CDW aggregate we also required recycling plant. The cost difference in both the process seems to be same and other process of road construction is same for both the aggregate. Municipal Solid Waste incinerated bottom ash can be used as filler or binder in pavement design.

Bottom ash can be used with the hydraulic binder as an aggregate instead of primary sand and gravels in concrete because of its particle size distribution similarity to traditional aggregate.

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