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Use of Construction Demolition Waste in Pavement

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ABSTRACT: The construction industry has gained very fast growth in recent decades due to the increase in the population, increase in the IT sector and increase in the industrialization and also introduction of new infrastructure projects resulted in the increase of construction industry drastically. Due to which the demand for construction materials is huge for the construction activities which results in the generation of huge amount of construction waste. Construction material wastage resulted in the huge financial setbacks to builders, contractors, regional authorities and also to the country. The objective of the paper is to study the feasibility of the application of Construction Demolition Waste (CDW) for improving the performance of sub grade and sub base layers in the road design. On this mixture, standard tests will be conducted like Aggregate Impact Value Test, Crushing Value Test, Specific Gravity Test, Water Absorption Test, and Loss Angeles Abrasion Test. The results will be analysed and discussed for the application of CDW for improving the performance of sub grade and sub base layers in the highways. In Construction Demolition Waste (CDW) we have mainly focused on the properties of aggregates and bricks which are major waste in CWD, and how to use this in sub grade layer and sub base layer to achieve the strength and economy while considering the environmental factors. The results will be analysed and discussed for the application of CDW for improving the performance of sub grade and sub base layers in the roadways.

KEYWORDS : construction demolition waste, standard tests, sub-grade, sub-base layers, mixture, water absorption.

I. INTRODUCTION

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

The presence of C&D waste and other inert matters makes up almost one third of the total MSW on an average, but so far no notable development has taken place for using this in an organized manner. At present, private contractors remove this waste to privately owned, low-lying land for a price, or more commonly, dump it in an unauthorized manner along roads or other public land.

The fine dust like material (fines) from C&D waste is not currently being used and is thus wasted. In more than 95% cases wastes such as bricks, metal, wood, plastics and glass have some market value and there are contractors who focus solely on dealing in C&D wastes. The use of these materials requires them to be sorted and separated, and is dependent on their condition, although the majority of this material is durable and therefore has a high potential for reuse. It would, however, be desirable to have quality standards for the recycled materials.

In view of the significant role of recycled construction material in the development of urban infrastructure, the Technology Information, Forecasting & Assessment Council (TIFAC) has conducted a techno-market survey on

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'Utilization of Waste from Construction Industry', targeting the house building and road construction industries. The total quantum of waste from the construction industry is estimated to be between 12 million to 14.7 million tones per annum, out of which seven to eight million tones are concrete and brick waste. According to the survey's findings 70% of the respondents said they were "not aware of the recycling techniques" as the reason for not recycling C&D waste, while the remaining 30% have indicated that they are not even aware of recycling possibilities. Furthermore, the Bureau of Indian Standards (BIS) and other codal provisions do not provide specifications for the use of recycled products in construction activities.

II. CONSTRUCTION AND DEMOLITION WASTE

Gurgaon Municipal Corporation near Delhi is planning a C&D waste recycling plant on five acres of land. There is considerable construction activity taking place in Gurgaon, but no place to dump the C&D wastes. The fast pace of the construction and renovation work will continue for at least the next five years. Hence, there is need for a C&D waste processor.

With the three existing landfill sites having exhausted their capacity some time ago, the Municipal Corporation of Delhi (MCD) has given the go-ahead for the establishment of a sanitary landfill facility at Narela-Bawana in northwest Delhi. The Rs 700 million ($15.5 million) integrated solid waste management facility is being developed to meet Delhi's garbage disposal needs for the next 20 years. The site is being developed as the first engineered landfill site in the city and is spread over 150 acres. Approximately 50 acres will be kept aside for disposing of C&D wastes.

The landfill site will take care of refuse from Rohini and Civil Lines zones, and has an initial capacity to handle 1000 tonnes per day, and is planned to expand to handle 4000 tonnes per day. Around 6500 tonnes per day of MSW is generated in Delhi. The Narela-Bawana landfill site has been notified under Master Plan 2021. In addition, the MCD has also carried out a feasibility study on use of C&D waste in road and embankment construction.

Asian countries Asian institute of technology, Thailand had conducted a survey in various Asian countries and prepared a report regarding the construction and demolition waste management in May 2008. The study includes Asian countries like Bhutan, Japan, Hong-Kong SAR, China, Thailand and others including India. The following pie chart shows the status of construction and demolition waste in Asian countries. It shows the status of construction waste in Asian countries, Estimates of C&D Wastes in Some Asian countries (Asian Institute of Technology, 'Report on reduce, reuse and recycle (3R) practices in construction and demolition waste management in Asia', Thailand, May 2008, 81 p.)

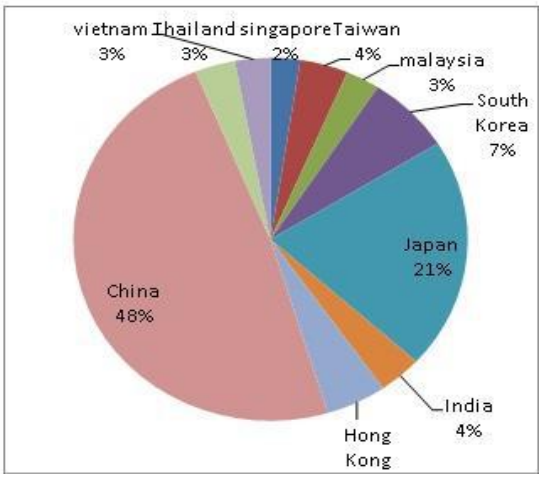

Fig. 2.1 Construction and Demolition Waste Management of Asian countries .

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III. CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT OF INDIA

At the beginning the it is said that there is no adequate or satisfactory data for accessing to this issue. This is because there is no separate regulatory frame work for handling the construction and demolition waste management in India, as it is considered in the municipal solid waste management. Due to which it is getting difficult to access the information or to handle the construction and demolition waste management. As report prepared by the MoEF (Ministry of Environment and Forest) in 2008 estimated that 0.53 million tonnes/day of waste is generated in the country Indian Cities Source (nexusnovus.com). On that basis the 210 million tonnes of MSW is produced annually, it shows the estimate prepared by central government of India. But as per the world bank report says Asian countries produces around about 1000kg per capita per year, it means the figure which stated by the MoEF is very less than the world bank report figure. This show in India is underestimating the construction and demolition waste handling.

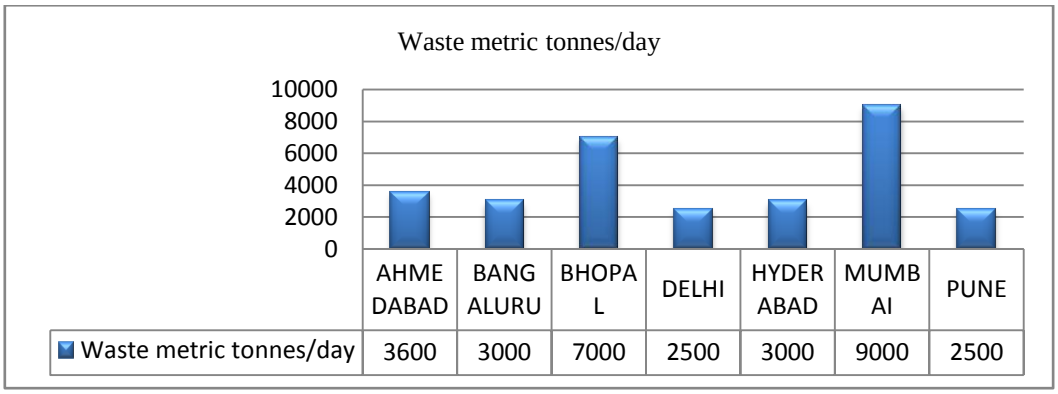

Fig. 3.1 waste produced in metric tonnes per day

Table No. 3.1 Estimate Prepared By Central Government

Year	Authority	Estimation In Million Tones
2000	Ministry of urban development (2000)	10-12
2001	TIAFC(2000)	12-15
2010	MINISTRY OF ENVIRONMENT AND FOREST	10-15
2014	Ministry of urban development (2014)	NO ESTIMATION EXIST

IV. RESEARCH METHODOLOGY

A processed waste material, which is proposed to be used for road construction, is to be assessed for its environment, health and safety hazards, physical, chemical and engineering properties, cost effectiveness, field performance etc. If environment, health and safety assessment results are negative, the candidate material is rejected as a road construction material and is recommended for safe disposal. If the material satisfies the environmental, health and safety criteria, then it is further evaluated for its physical, chemical and engineering properties. If the chemical and physical properties of the candidate material are similar to that of traditional construction materials, then existing testing protocols may be used for evaluation of its engineering properties.

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Otherwise, new test procedures are to be developed. For standard materials, the testing procedures and acceptance specifications are prescribed by highway agencies or local public works departments. Further, cost evaluation needs to be performed to check the economic feasibility of using the candidate material as replacement of traditional pavement material.

Sometimes life cycle cost evaluation is conducted to study in detail the overall impact of the new material on the total cost of the road project (throughout its service period, including all maintenance activities). Finally, it is important to conduct field trial with the new material to gather information on the short-term and the long-term performance of the road. Performance studies also help to develop acceptance specifications for new road materials.

V. EXPERIMENTAL STUDY AND LABORATORY TESTS

We have collected the demolition construction material of slab, beam and column from WAHE GURU DEVELOPER, AKURDI as per requirement and grading of aggregates given in IS: 383-1970. We have segregated the aggregate according to requirement and we have used the aggregate which retains on 10mm sieve and passes from 12.5mm sieve. Fine aggregate comprises of stone dust with fraction passing 4.75 mm and retained on 0.075mm IS sieve.

We have performed the number of test on aggregate to check their properties and to compare its properties with normal aggregate. After comparison we have concluded the result. Number of test performed is listed below:-

- Aggregate Impact Value Test
- Crushing Value Test
- Specific Gravity Test
- Water Absorption Test
- Loss Angeles Abrasion Test
- Marshal Stability Test

All above mention tests has been conducted as per standard procedures.

Fig. 5.1 Aggregate impact test

Fig. 5.2 Aggregate crushing value test apparatus

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Fig. 5.3 Marshal Stability Test specimens & its testing

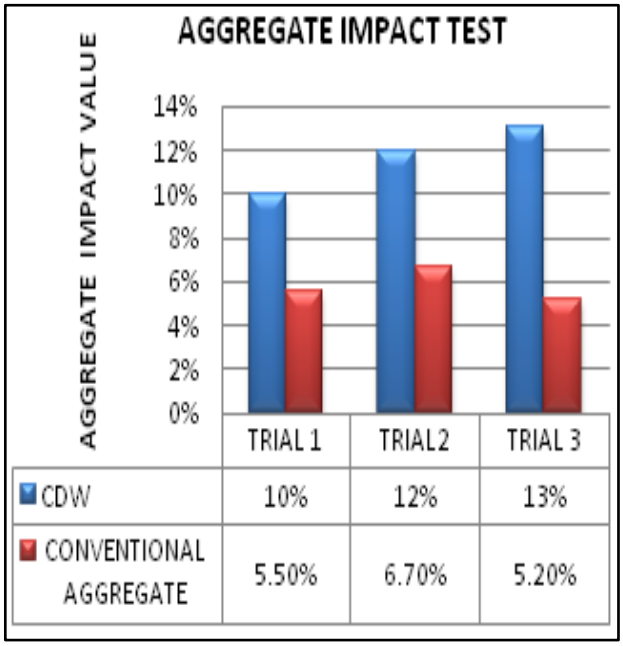

Fig. 5.4 Aggregate Impact Test on aggregate

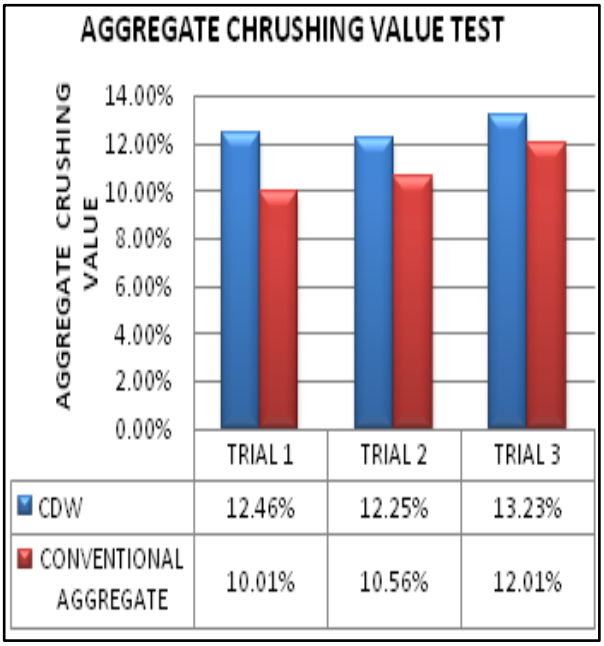

Fig. 5.5 Aggregate crushing value test.

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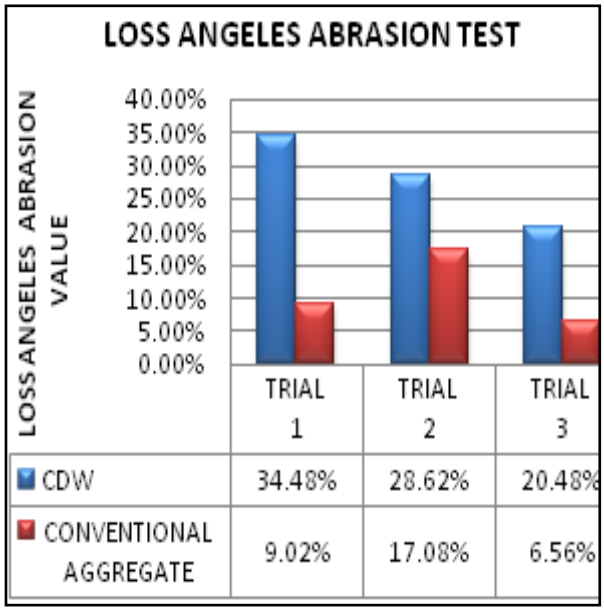

Fig. 5.6 Loss Angeles Abrasion Test on aggregate

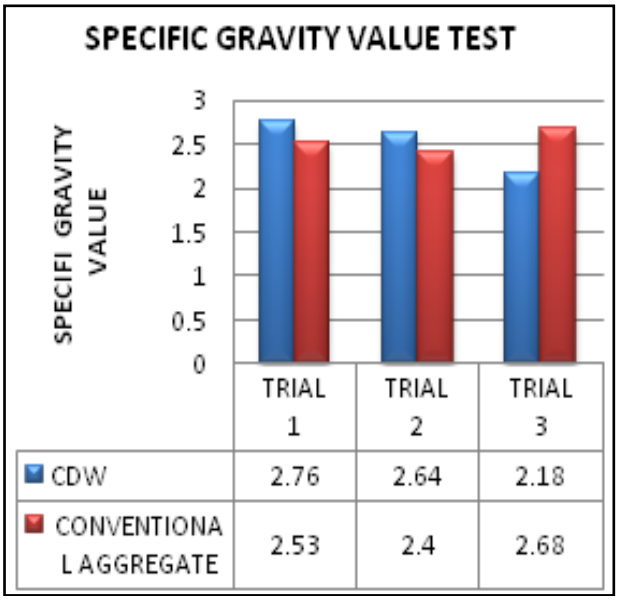

Fig. 5.7 Specific Gravity Test on Aggregate.

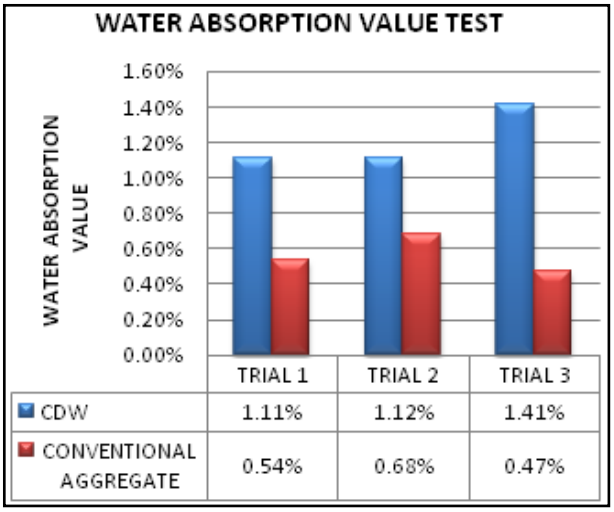

Fig. 5.8 Water Absorption Test on aggregate

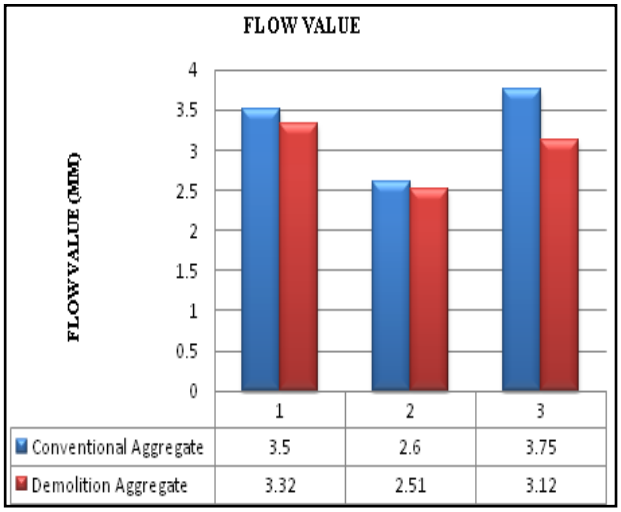

Fig. 5.9 Flow Value test.

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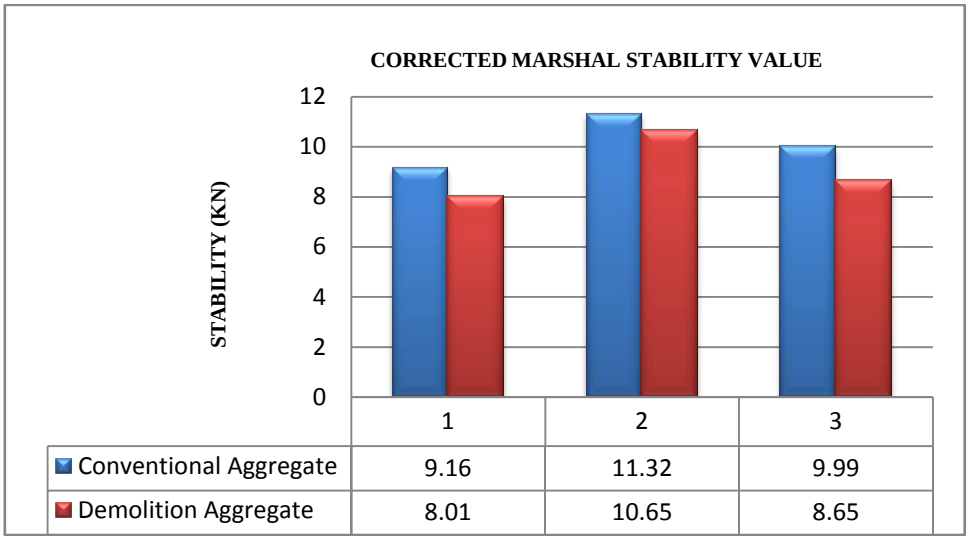

Fig. 5.10 Marshal Stability test.

VI. RESULTS

Result of aggregates test:

Available results points out that there is ample scope for utilization of waste materials for road construction. However, one needs to proceed cautiously, because of possible environmental, health and safety concerns associated with the India-age of some of the waste materials.
This research is needed before any specific waste material is finally approved as an alternative road construction material. It is hoped that availability 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.

Sr. No.	Name of Test	CWD	Conventional Aggregate	Range	Remark
1	Aggregate Impact Test	11.67%	5.8%	<10% (exceptionally strong); 10-20% (strong)	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 crushing value test	12.63%	10.86%	<45% (wearing course); <30% (concrete pavement)	
3	Specific gravity value test	2.52	2.53	2.5-3.0	
4	Water absorption value test	1.21%	1.69%	0.1%-2.0%	
5	Loss angeles abrasion test	27.86%	10.89%	<40%	

- The Impact Value of demolition aggregates is 11.67 %. This indicates that the aggregates are strong.
- The Crushing Value of demolition aggregates is 12.63 % which is less than 30 %. So the aggregates are suitable for the surface course.

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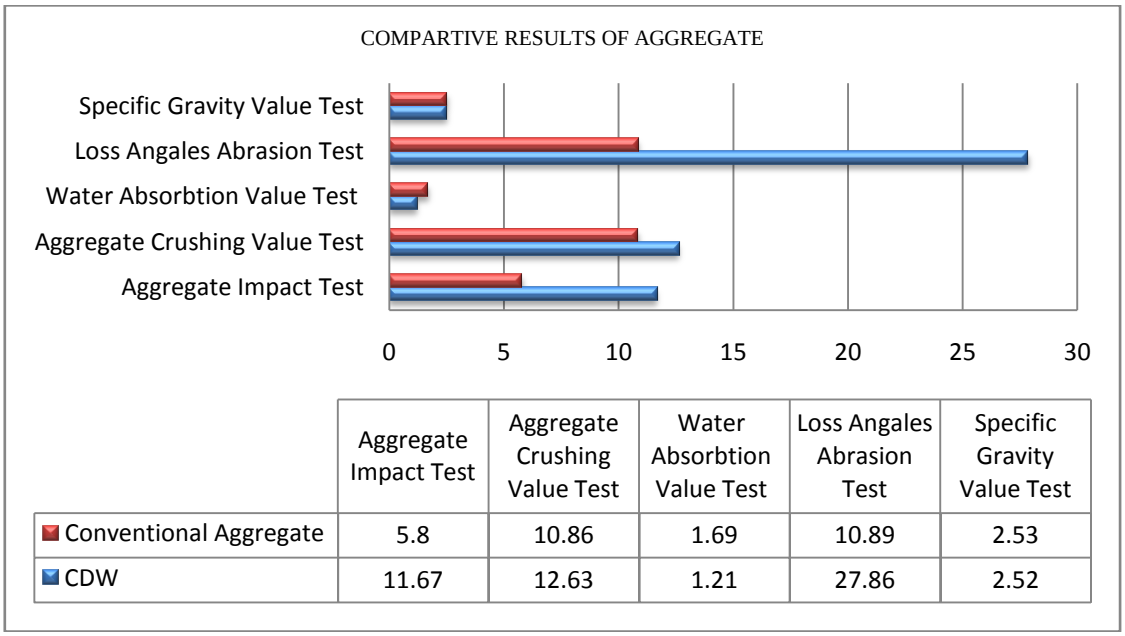
- The Specific Gravity of demolition aggregates is within the specified range. So the aggregates are suitable for the road surface.
- The Water Absorption of demolition aggregates is greater than 1.21 %. So the aggregates are suitable for the study.
- The Loss Angeles Abrasion Value of demolition aggregate is 27.86%. So the aggregate are suitable for road pavement design.

Thus, all the tests on demolition aggregates were successful and the aggregates are best suited for the design of road pavement.



	Aggregate Impact Test	Aggregate Crushing Value Test	Water Absorbtion Value Test	Loss Angales Abrasion Test	Specific Gravity Value Test
Conventional Aggregate	5.8	10.86	1.69	10.89	2.53
CDW	11.67	12.63	1.21	27.86	2.52

Fig. 6.1 Comparative Test Results Of Aggregate

Result of marshal stability test :

Sr. no.	Name of test	CDW	Conventional aggregate	Range	Remark
1	FLOW VALUE (mm)	2.96	3.29	2-4	Hence the values are in optimum range, so we can use in DBM course.
2	CORRECTED MARSHAL STABILITY VALUE (KN)	9.10	10.15	8.2 minimum	

- The Flow Value of demolition aggregates is 2.96 mm. So the aggregates are suitable for the DBM course in pavement.
- The Corrected Marshal Stability Value of demolition aggregate is 9.10KN. So the aggregate are suitable for road pavement design as a DBM course.

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VII. CONCLUSION

Tests were conducted to study the properties of the construction demolition wastes in pavement design as a DBM course. The results of normal aggregate and construction demolition aggregate compared to study the effect on the properties of road pavement.

- Marshall Stability of conventional aggregate was found to be 10.15 KN.
- Average Flow of the conventional aggregate was found to be 3.29 mm.
- Marshall Stability of CDW aggregate was found to be 9.10 KN.
- Average Flow of CDW aggregate was found to be 2.96 mm.

Thus the Marshall Stability of construction demolition wastes was found10.15 KN which satisfies the requirement criteria for DBM course as per given in MORTH specification.

The above result shows that CDW aggregate can be used in pavement design as a DBM course which minimise the requirement of conventional aggregate and can be helpful in controlling the environmental pollution.

To use the CDW aggregate in pavement design, we need to segregate it from its various constituents that causes rampant 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.

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