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Experimental study of construction and demolition waste in flexible pavement

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ABSTRACT

With the steep increase in the population, construction and demolition of buildings around the world has increase with the same pace which has led to the accumulation of C&D waste. Their disposal is one the major problems as huge amount of land is required for landfill. In this research possible use of C&D wastes in semi dense bitumen macadam has been studied, so these C&D waste can be disposed properly furthermore the natural aggregate which is depleting at very fast rate can be saved for the future generation. In this study test are conducted to check the feasibility of C&D waste in the asphalt pavement .various tests such a marshal stability test, tensile strength test is conducted to determine the optimum percentage of construction and demolition waste which can be used in semi dense bitumen macadam. It also helps in saving the material for future. That can be used for bigger construction. The demolition waste with the different percentages as a coarse aggregate has been used in this research and the results has been compared with the conventional mixes. Over 90% of demolition wastes can be filled with the land fillings and due to its toxic nature it will affect the soil and make it useless. Marshal stability and indirect tensile strength tests has been performed which resulted increase in the durability and strength of payments.

Keywords: *Demolition waste, Flexible pavement.*

1. INTRODUCTION

1.1 General

One of the main sources of solid waste production is construction. Large amount of raw material is used in the construction. Construction of buildings consumes about 40% of total energy and about 50% of total resources are used in the construction. About 3.7 % of total buildings are pulled down annually in the world. About 1100000000 tons of materials are generated from the industry. And this construction waste is increasing at rate of 6.8% annually and more trends in developing countries. The construction and demolition waste is increasing at rapid pace while its disposal is one of the major problems. It has become major problem due top less availability of landfills and oversaturation of C&D waste. Furthermore it has resulted in increase in global warming. So the countries are facing environmental as well as economic problems. Use of recycled aggregate is an important both in the view point of environment and sustainable development. The C&D waste can be in the concrete, bricks, tiles, glass etc. The use of these recycled can be used in the asphalt pavements and it has been observed that it has given the satisfactory results. Some problem is associated with the use of C&D wastes are high water absorption, low specific gravity, and low strength.to deal with these anti stripping agents are used to give the satisfactory performance. In USA about 35 % of the waste is used in the renovation works. In California government uses about 15 % RAP. The waste material from buildings can also be used in semi dense bitumen macadam and various tests like Marshall, stability, tensile strength etc. are checked to know if these material can be used in the construction also to determine the optimum content of C&D waste which gives us the satisfactory results. Use of these waste will result in the saving off natural aggregates and can be used by the future generation. The problem of disposal can also be solved by using C&D waste in the semi dense bitumen macadam.

C&DW after crushing

The aggregates which is obtained from C&D waste by crushing them in the size of these aggregates that is required for graduation. The materials used are bricks, concrete, Tiles etc. By mixing them, then they are used as aggregates.

2. LITERATURE REVIEW

A.R. Pasandín et al. (2012)

In this paper use of demolition waste as coarse aggregate in hot mix asphalt was studied and to find the optimum percentage of demolition waste which can be used as coarse aggregate in the asphalt pavements. Different percentages of demolition waste i.e. 0%, 20%, 40%, and 60% were used by the total weight of natural aggregate in this study filler were also used in the form of lime and cement. Marshall stability is found which is within the limits for the low volume roads .The mixture has shown good improvement for the rutting of pavements, the rutting test was done by the wheel tracking test .But it was observed that the durability of the mixture decreased due to the high susceptibility to the moisture which was found out by stripping test.

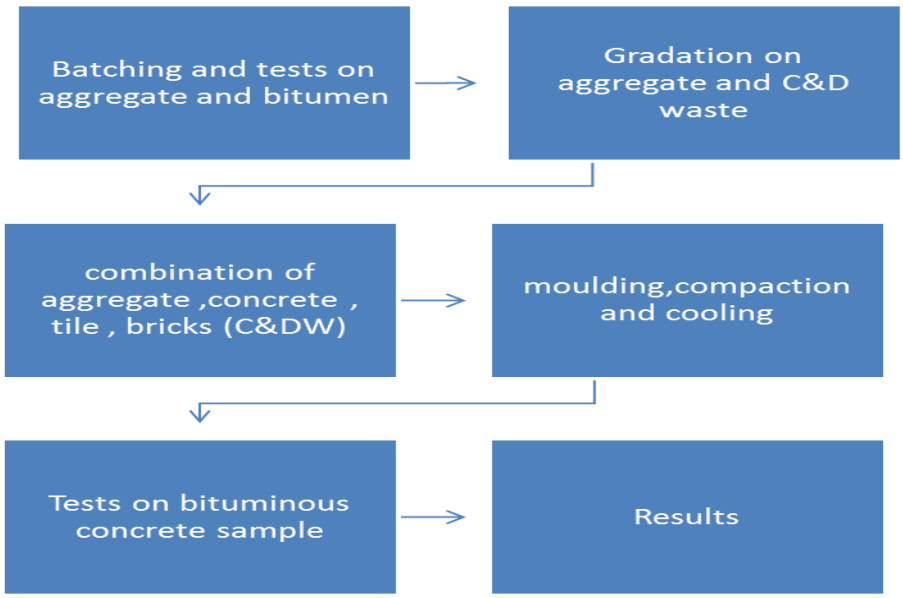
Saeed Fatemi et al. (2016)

Performance evaluation was made on asphalt pavements which used the construction and demolition wastes .construction and demolition wastes were used by 10 %,20%,30%,40% weight of natural aggregate .Different performance tests were conducted like rutting test, creep test, indirect tensile strength to study the performance of pavement .Moisture susceptibility is found using indirect tensile strength ratio .It was found using the construction and demolition waste has resulted in increase in the optimum binder content , there was improvement in the rutting resistance by 30%there is also increase in the increase in the tensile strength which means resistance to the cracking has increased.

Igacio Perez et al:

Conducted research on asphalt mixture made with construction and demolition debris the C&D waste consist of 72% concrete, 20% ,stone , 2% ceramic and 6% asphalt mixture. Marshal test, immersion compression test & wheel tracking test is performed on the mix. Bitumen of 60/70 grade is used in the study. The maximum marshal stability achieved was about 13KN. They were more aid voids in mix than the conventional sample. But the wheel tracking test showed the higher rut depth as compared to conventional sample.

3. RESEARCH METHODOLOGY



- Aggregates were in the study were brought from ACC plant near lovely professional university Jalandhar. The C&D waste were used in ratio of 25%, 30% and 35% by the weight of aggregates. The demolition waste contained concrete, tile and

brick in the proportion of 60:30:10 respectively. Different tests were conducted like impact test, crushing test, abrasion test etc before they were used in the study.

- Gradation of aggregate for demi dense bitumen macadam was done as per the MORTH code revision 5.
- Bitumen of VG 30 grade is used in the study and before using it in the study penetration test, ductility test, softening point test were conducted on the Bitumen.
- On the conventional bituminous mix Marshall Stability test was done and from density void analysis optimum bitumen content was found to be equal to 5.5% by the weight of aggregates.
- C&D modified samples were prepared keeping bitumen percentage constant at 5.5% and changing C&D waste percentage by 25, 30 and 35 %.
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4. RESULTS

Aggregate tests using C&D waste:

Test	C&D % Aggregate	Results
Impact test	0	9.785
	25	11.62
	30	12.53
	35	13.15
Crushing test	0	15.7
	25	20.05
	30	22.49
	35	23.61
Abrasion test	0	14.9
	25	17.9
	30	18.8
	35	20.4

The aggregate test done on the C&D waste were in the limits as set by IRC.

Bitumen tests results for VG 30 grade.

Test	Value
Penetration test	65.73 mm
Softening point test	48.76 C
Ductility test	50.23 mm
Specific Gravity	1.064

Tests on bituminous mix modified with C&D waste

Marshall Stability test

Marshall Stability of C&D modified mix was found to be higher than the conventional mix at same bitumen content. The Marshall stability increased from 11.2 KN at 0% C&D waste to maximum of 12.61 KN at 30% C&D waste. After further increase in C&D waste Marshall Stability start decreasing. Flow value decrease as C&D waste percentage increased as the brick and tiles in C&D waste need more bitumen to gently coated. Bulk specific gravity too decreased as the specific gravity of C&D waste is less than the normal aggregate. Volume of voids increased from 3.215 % to 5.66 % as C&D waste increased from 0% to 35%.

Sample No	C&D Waste (%)	Stability Value (KN)	Flow Value (mm)	Bulk Specific Gravity (Gm)	Vv(%)	Vb(%)	VFB(%)
1	0	11.2	3.20	2.348	3.215	11.504	78.157
2	0	11.22	3.28	2.35	3.198	11.521	78.16
3	0	11.19	3.22	2.39	3.150	11.554	78.20
Mean value		11.20	3.233	2.36	3.187	11.526	78.172
1	25	12.29	3.11	2.296	4.293	11.249	72.378
2	25	12.22	3.09	2.299	4.290	11.244	72.368
3	25	12.31	3.083	2.31	4.288	11.240	72.366
Mean value		12.27	3.094	2.30	4.29	11.297	72.370
1	30	12.6	2.96	2.263	5.47	11.0879	66.964
2	30	12.65	2.93	2.266	5.45	11.0799	66.95
3	30	12.58	2.88	2.273	5.41	11.0791	66.911
Mean value		12.61	2.923	2.267	5.443	11.0823	66.941
1	35	12.89	2.75	2.245	5.672	10.999	65.976
2	35	12.93	2.72	2.249	5.668	10.985	65.973
3	35	12.95	2.66	2.255	5.666	10.978	65.966
Mean value		12.923	2.71	2.249	5.668	10.987	65.971

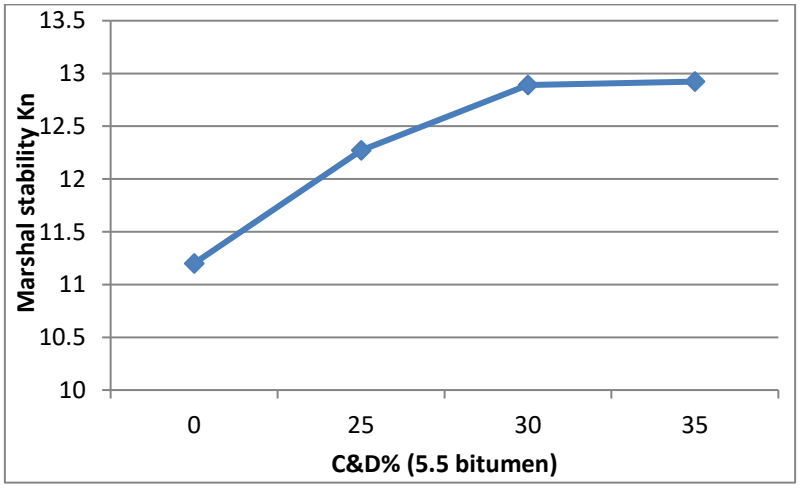


Figure 1 Marshal Stability vs C&D

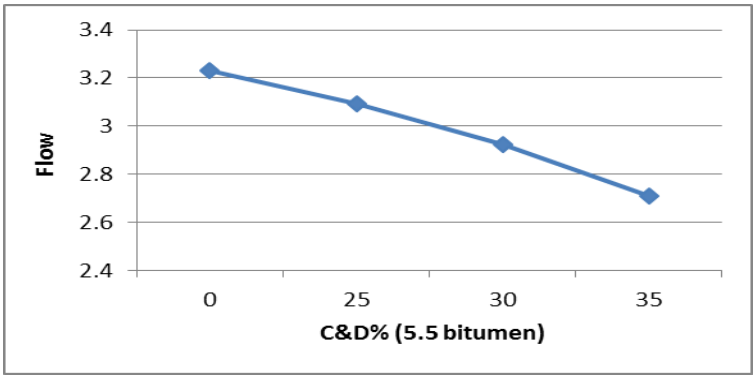


Figure 2 Flow and C&D

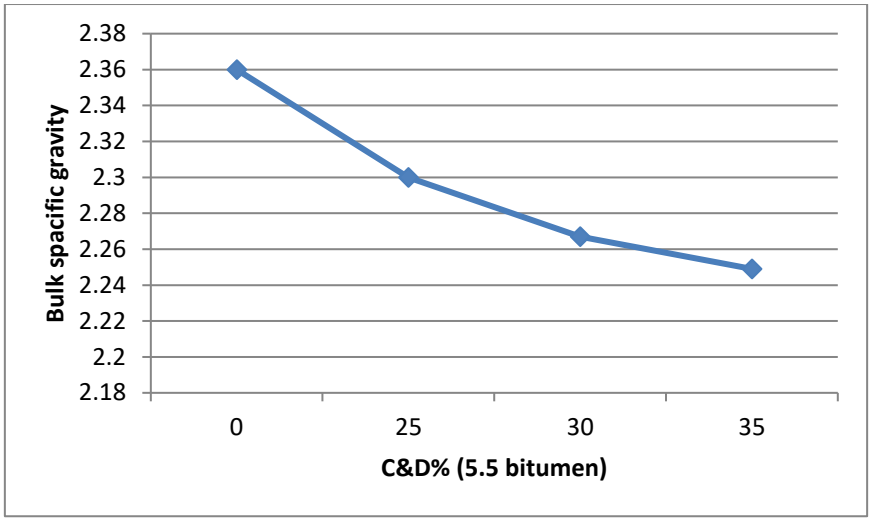


Figure 3 Bulk specific gravity

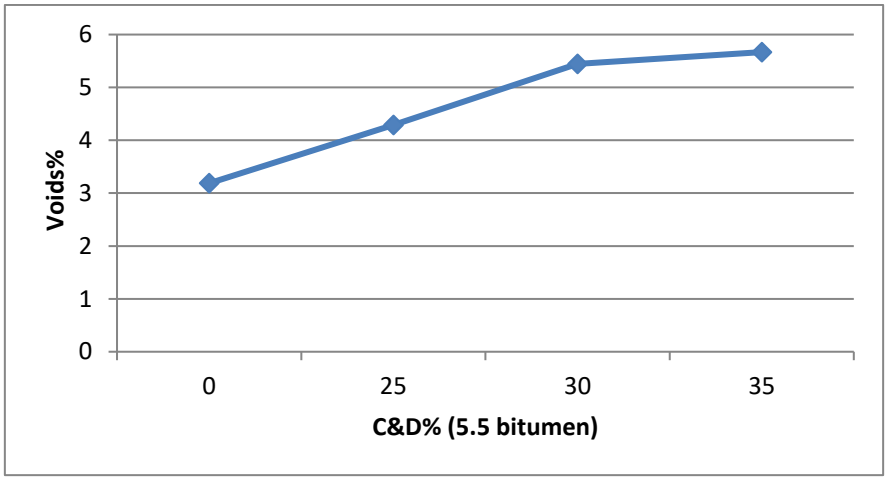


Figure 4 Volume of voids

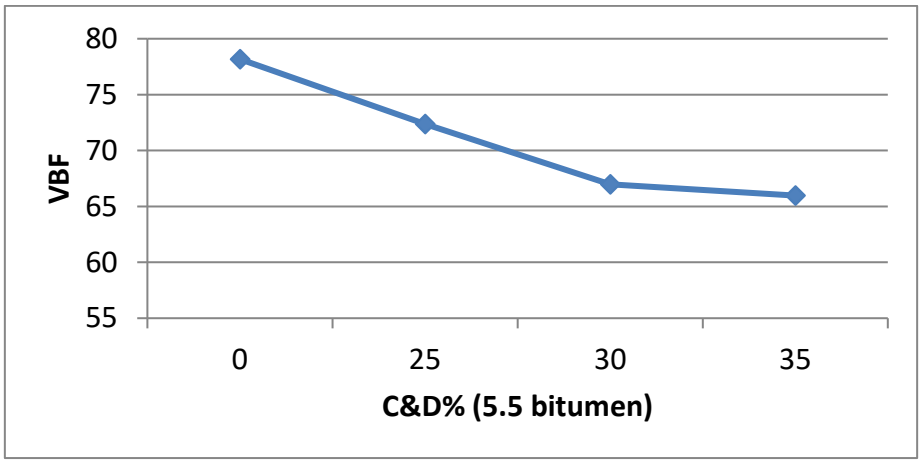
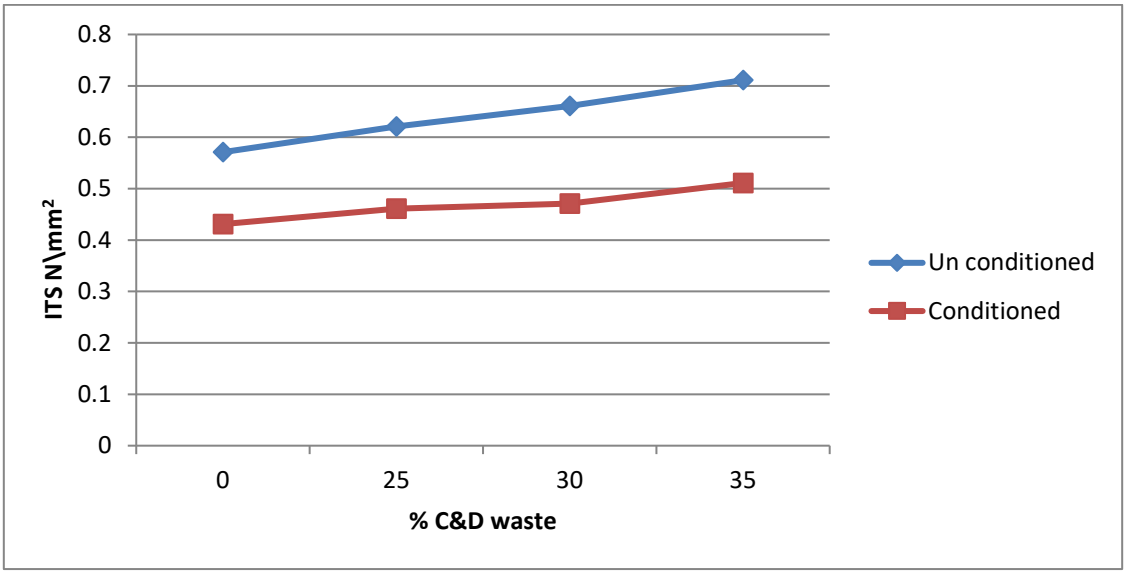


Figure 5 Volume field with C&D

Indirect tensile strength test:

Indirect Tensile strength of C&D modified mix has more tensile strength than the conventional mix sample. Indirect tensile strength increased linearly from 0.571 to 0.711 N/mm^2.However indirect tensile strength ratio decreased with the addition of C&D waste .For 0% C&D waste ITS ratio is 0.754 and for 35% C&D waste replacement ITS ratio is 0.718.hence it can be said C&D modified mix is more susceptible to moisture than the conventional sample.

C&D Waste (%)	Un conditioned (ITS) N\mm^2	Conditioned (ITS) N\mm^2	(ITS) Ratio N\mm^2
0	0.571	0.431	0.754
25	0.621	0.461	0.742
30	0.661	0.471	0.712
35	0.711	0.511	0.718



5. SUMMARY AND CONCLUSIONS

A. The demolition waste from building were used in proportion of 25%, 30%, 35% by the weight of aggregate .the aggregate tests with demolition waste were in limits as per IS codes.

B. It is found that Marshal Stability of C&D modified mix is more than the conational mix .Marshal stability of Maximum 12.22 KN was achieved at 35% replacement of aggregate by C&D waste. Bulk specific gravity also decreased as the brick and tile used have less density than normal aggregate.

C. Indirect tensile strength test results also showed improvement. Indirect tensile strength at 0% C&D waste is found to be 0.571 N/mm^2 & for 35% replacement at is equal to 0.711N/mm^2. However, there is decrease in its ratio which means susceptible to moisture.

D. With the use of C&D waste the overall waste disposal problems can be reduced and the natural aggregate for the future generation can be saved hence will had to sustainable development.

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