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# USE OF CERAMIC WASTE IN PAVEMENT CONSTRUCTION BY REPLACING FINE AGGREGATE

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***Abstract*—** Ceramic waste is one of the most active research areas that encompass a number of disciplines including civil engineering and construction materials. Ceramic waste powder is settled by sedimentation and then dumped away which results in environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health. The aim of the study is to use ceramic waste as filler material in flexible pavement. Today construction cost is very high with using routine material like bitumen, fine aggregate and coarse aggregate. This study includes use of different waste material as a partial replacement of bitumen or fine aggregate or coarse aggregate. Industries in India produce
lots of waste which may be useful in partial replacement of all raw materials due to their different properties. So here by we studied many useful research papers in this field and trying to improve with locally available waste material so it can be proved economical as well. Research in this field and positive results are crucial so as to continue all developments with least damage to surrounding environment and obtaining all infrastructures for services and convenience which are desired to get.

## 1. INTRODUCTION

Now-a-days disposal of different wastes produced from different industries is a extremely good problem. These materials are environmental pollutants in the nearby locality due to the fact a lot of them are biodegradable. In latest years, applications of industrial wastes had been taken into consideration in street growing countries. The use of those substances in street making is based on technical, financial, ecological standards. The lack of conventional street substances and the safety of the surroundings make it imperative to analyze the feasible use of these substances cautiously. India has a huge network of industries positioned in exceptional components of the united states of America and lots of more are planned for the close to destiny. Numerous million metric heads industrial wastes are produced in those institutions. The Test to be conducted are marshal stability test with or without waste material.

According to different literatures we have seen that waste material have tremendous capacity to improve strength and stability. We will study 3%, 4%and5% of waste material. The waste material is ceramic waste is used. If these materials can be suitably utilized in Highway construction, the pollution and disposal problems may be partly reduced. In the ceramic industry, about 15%- 30% waste material generated from the total production. This waste is not recycled in any form at present. However, the ceramic waste is durable, hard and highly resistant to biological, chemical, and physical degradation forces

## 2. LITERATURE REVIEW

**1. "Partial Replacement of Fine Aggregate with Ceramic and Demolition Waste", Saswat Hota, Vikas Srivastava : Vol. 5, Issue 8, August 2016.**

By methods for utilizing clay and obliteration squander forty % common incredible blend can be put away while making rigid pavement. Up to 20 % decimation waste and 20% earthenware squander compressive vitality is more prominent than that of referral concrete.

Flexural vitality is more noteworthy than that of referral concrete in any regard most all the substitute degrees. Clay and obliteration waste up to 20% each all together might be utilized as incomplete substitution of wonderful blend.

**2. "A Study On Effect Of Waste Cermaic tiles In Flexible Pavement", Bhavin K Vaghadia, Prof. M. R. Bhatt : Vol.3, Issue 10, October 2016.**

Research facility tests had been finished for sketching out the substantial properties of artistic mix and situated to be inside pertinent points of confinement as in accordance with the Indian prerequisites which show that fired waste is conceivable to utilize as aggregate material in adaptable pavement.

**3. "A Study On Effect Of Ceramic Waste In Bituminous Concrete Mixes", Amit Singh, Dr. Mukesh Patel. : Vol 2, Issue 3,March 2015.**

Writing outline recommends that earthenware waste ended up used as filler texture in SDBC and clay squander to some degree update the bond content material in concrete solid work while in blessing study artistic waste will use as filler just as mix in bituminous solid work. Lab tests were finished for plotting the real properties of artistic aggregate and observed to be inside 12 perfect points of confinement as in venture with the Indian gauges which demonstrate that clay waste is possible to use as aggregate texture in bituminous solid work.

**4. "Use of Ceramic Wastes in Road Pavement Design",ÇagdasKara, Murat Karacasu**

Ceramic is a material that has porous structure and high-water absorption, so performance values

getting better compared to control specimens with more bitumen and OBC values increased in the mixture. So, instead of being an environmental pollution, ceramic waste can be used as a construction material in HMA in the context of the sustainable environment.

**5. "Use of Recycled Materials in Road Construction", M. Abukhettala, May 5 – 6, 2016 PaperNo.138.**

Not with standing all inquiries about on potential utilization of reused material fit as a fiddle, yet there might be hills of issues and expertise holes that require inside and out research and assessment to the enthusiasm of structure better streets and keeping home grown assets.

**3. Experimental Investigations**

**3.1 Aggregates Crushing Test**

The total crushing cost provides a relative measure of the strength of the group to be crushed under pressure of applied pressure gradually. The price of crushing is a measure of the

**3.2 Aggregate Impact Test**

The effects of the cloth are called to resist the durability effect. Because of the movement of engines on the road, aggregates are subject to the effect of decomposition into smaller parts. The aggregates must be sufficiently durable to withstand disintegration due to impact. This function is measured by examining the effect value. The value of the mixing effect is a degree of unexpected or sudden resistance to the effect, which may be different than the applied pressure resistance applied gradually.

**3.3 Los Angeles Abrasion Test**

The aggregates applied in surface path of the interstate pavements are uncovered to wearing because of improvement of visitors. On the factor while automobiles proceed onward the sttreet, the dirt particles gift between the pneumatic tires and avenue surface purpose scraped spot of avenue aggregates. The metallic reamed wheels of creature driven auto mobiles additionally purpose enormous scraped region of the road surface. as a consequence, the street aggregate need to be difficult enough to oppose the scraped place. safety from scraped region of aggregates is managed via a. check system.

**3.4 Specific Gravity &Water Absorption**

Water absorption offers an concept of power of rock. Stones having extra water absorption are extra porous in nature and are normally taken into consideration flawed except they may be found to be suited primarily based on strength, effect and hardness test.

**3.5. Bitumen Penetration Test**

Infiltration well worth is an estimation of hardness or consistency of bituminous material. It's far the vertical separation crossed or entered by using the purpose of a standard needle into the bituminous cloth underneath express states of burden, time and temperature. This separation is expected in one 10th of a millimeter. This check is utilized for assessing consistency of bitumen. It isn't always considered as reasonable for use regarding the testing of avenue tar in view of the high surface strain displayed by using these materials and the way that they incorporate moderately substantial degree of free carbon.

**3.6 Bitumen softening point**

The conditioning reason of bitumen or tar is the temperature at which the substance achieves a specific level of enjoyable. according to IS:334-1982, it's miles the temperature at which a standard ball goes to through an example of bitumen in a form and falls via a stature of 2.5 cm, while warmed submerged or glycerin at determined at indicated states of check. the duvet must have good enough smoothness before its packages in avenue employments. The warranty of mellowing factor realizes the temperature up to which a bituminous fastener ought to be warmed for distinctive street use applications. Mellowing point is managed by ring and ball mechanical meeting.

**3.7 Ductility Test**

Flexibility test gives a percentage of cement assets of bitumen and its ability to increase. In an adaptable pavement shape, it's far vital that fastener have to body a slight malleable movie across the aggregates, so the physical interlocking of the .aggregates is stepped forward. Fastener cloth having lacking malleability receives break up when uncovered to rehashed site visitors burdens and it offers pervious pavement floor. Flexibility of a bituminous material is measured by the separation in centimeters to which it'll lengthen earlier than braking when finishes of well-known briquette instance of the material are pulled separated at a predetermined velocity and at a predefined temperature.

**3.8 MARSHALL TESTS**

**Specific Gravity for Marshall Specimens**

Water ingestion gives a thought of rocks. Stones having more than\ more water ingestion are increasingly permeable in nature and are commonly viewed as unsatisfactory except if they are observed to be adequate dependent on quality, effect and hardness tests.

**4. RESULTS**

Vv, Vb, VMA, VFB results based on bitumen Content Where, Vv-Volume Of Voids, Vb-Volume Of Bitumen, VFB- Percentage of Voids Filled With Bitumen VMA- Percentage of Void in Mineral Aggregate.

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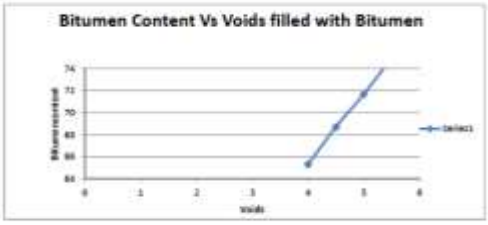
| Sample No | Bitumen Content | height of Sample | Weight in air | Weight in Water | Bulk Density | Vv | Vb | VMA | VFB |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.5 | 63.0 | 1243.0 | 1578.0 | 2.7 | 6.6 | 10.9 | 17.4 | 63.4 |
| 2 | 4.5 | 65.0 | 1240.0 | 1565.0 | 2.6 | 3.8 | 10.5 | 14.3 | 73.7 |
| 3 | 4.5 | 63.0 | 1272.0 | 1589.0 | 2.7 | 7.6 | 10.9 | 18.6 | 58.9 |
| Avg | 4.5 | 63.7 | 1251.7 | 1577.3 | 2.7 | 6.0 | 10.8 | 16.8 | 65.3 |
| 1 | 5 | 64.0 | 1245.0 | 1571.0 | 2.8 | 4.5 | 12.7 | 25.0 | 56.8 |
| 2 | 5 | 66.0 | 1256.0 | 1568.0 | 2.7 | 8.0 | 12.3 | 21.5 | 67.4 |
| 3 | 5 | 66.0 | 1248.0 | 1579.0 | 2.6 | 4.0 | 11.7 | 15.7 | 82.0 |
| Avg | 5 | 65.3 | 1249.7 | 1572.7 | 2.7 | 5.5 | 12.3 | 20.7 | 68.7 |
| 1 | 5.5 | 65.0 | 1255.0 | 1582.0 | 2.7 | 5.3 | 13.6 | 19.4 | 70.1 |
| 2 | 5.5 | 66.0 | 1258.0 | 1584.0 | 2.7 | 4.6 | 13.5 | 18.9 | 71.4 |
| 3 | 5.5 | 65.0 | 1264.0 | 1576.0 | 2.7 | 4.8 | 13.4 | 18.1 | 73.6 |
| Avg | 5.5 | 65.3 | 1259.0 | 1580.7 | 2.7 | 4.9 | 13.5 | 18.8 | 71.7 |
| 1 | 6 | 64.0 | 1248.0 | 1614.0 | 2.7 | 4.1 | 15.5 | 19.6 | 74.0 |
| 2 | 6 | 67.0 | 1276.0 | 1601.0 | 2.7 | 4.0 | 13.0 | 15.0 | 72.7 |
| 3 | 6 | 65.0 | 1252.0 | 1599.0 | 2.7 | 5.4 | 14.0 | 19.6 | 71.6 |
| Avg | 6 | 65.3 | 1258.7 | 1604.7 | 2.7 | 4.5 | 14.2 | 18.1 | 75.0 |

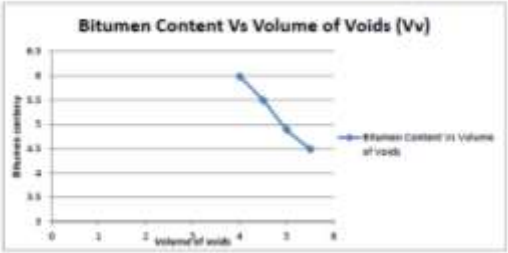
table 1 Marshal Stability Mix Design Values

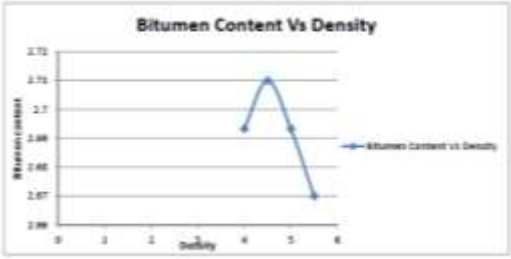
| Bitumen Content | height of Sample | Weight in air | Weight in Water | Bulk Density | Vv | Vb | VMA | VFB |
|---|---|---|---|---|---|---|---|---|
| 4.5 | 63.66 | 1251.66 | 1577.33 | 2.69 | 5.98 | 10.78 | 16.77 | 65.32 |
| 5 | 65.33 | 1249.66 | 1572.66 | 2.71 | 5.49 | 12.25 | 20.73 | 68.71 |
| 5.5 | 65.33 | 1259 | 1580.66 | 2.69 | 4.89 | 13.46 | 18.79 | 71.69 |
| 6 | 65.33 | 1258.66 | 1604.66 | 2.67 | 4.49 | 14.18 | 18.07 | 75 |

table2 Marshal Stability Mix Design Values

MARSHAL STABILITY GRAPHS:(CERAMIC WASTE)




**MARSHAL STABILITY GRAPHS:**

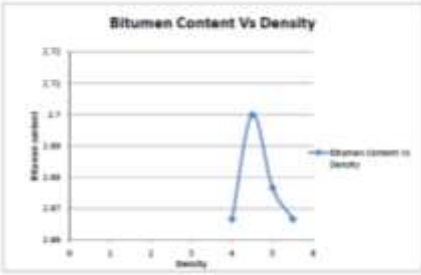
Partial replacement of ceramic dust in VFB Where, Vv-Volume Of Voids Vb-Volume Of Bitumen VMA- Percentage of Void in Mineral Aggregate VFB- Percentage of Voids Filled With Bitumen

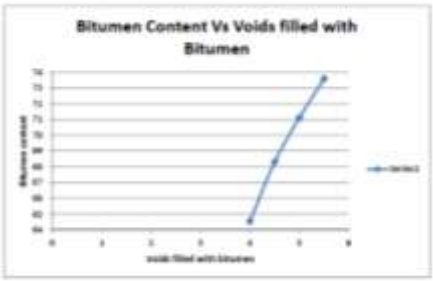
| Sample No | Bitumen Content | height of Sample | Weight in air | Weight in Water | Bulk Density | Vv | Vb | VMA | VFB |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.5 | 63.0 | 1243.0 | 1578.0 | 2.7 | 6.6 | 10.1 | 16.5 | 59.1 |
| 2 | 4.5 | 64.0 | 1270.0 | 1587.0 | 2.6 | 4.9 | 10.8 | 15.9 | 64.4 |
| 3 | 4.5 | 65.0 | 1266.0 | 1586.0 | 2.7 | 5.5 | 10.6 | 14.9 | 72.1 |
| | 4.5 | 63.0 | 1262.0 | 1578.0 | 2.7 | 5.7 | 10.3 | 17.7 | 64.5 |
| 1 | 5 | 65.0 | 1248.0 | 1578.0 | 2.7 | 5.5 | 12.8 | 14.7 | 75.3 |
| 2 | 5 | 63.0 | 1258.0 | 1571.0 | 2.7 | 6.2 | 12.8 | 15.4 | 59.5 |
| 3 | 5 | 65.0 | 1274.0 | 1589.0 | 2.6 | 4.9 | 12.1 | 16.4 | 74.8 |
| | 5 | 64.0 | 1258.0 | 1575.0 | 2.7 | 5.5 | 12.3 | 18.2 | 68.2 |
| 1 | 5.5 | 66.0 | 1270.0 | 1582.0 | 2.6 | 6.2 | 13.9 | 19.7 | 68.2 |
| 2 | 5.5 | 66.0 | 1262.0 | 1591.0 | 2.6 | 5.2 | 13.4 | 19.5 | 70.1 |
| 3 | 5.5 | 65.0 | 1265.0 | 1586.0 | 2.7 | 4.9 | 13.2 | 17.9 | 75.1 |
| | 5.5 | 65.7 | 1267.0 | 1586.3 | 2.7 | 5.5 | 13.4 | 18.3 | 71.2 |
| 1 | 6 | 64.0 | 1277.0 | 1599.0 | 2.6 | 4.3 | 14.4 | 19.3 | 75.5 |
| 2 | 6 | 68.0 | 1284.0 | 1604.0 | 2.7 | 5.6 | 13.5 | 14.8 | 74.9 |
| 3 | 6 | 66.0 | 1296.0 | 1588.0 | 2.7 | 5.5 | 13.6 | 18.8 | 75.6 |
| | 6 | 66.0 | 1278.5 | 1597.5 | 2.7 | 5.2 | 14.1 | 18.5 | 75.6 |

Table 3 Partial replacement of ceramic dust in VFB

| Bitumen Content | height of Sample | Weight in air | Weight in Water | Bulk Density | Vv | Vb | VMA | VFB |
|---|---|---|---|---|---|---|---|---|
| 4.5 | 63 | 1262 | 1578.33 | 2.66 | 7.7 | 10.5 | 17.68 | 64.54 |
| 5 | 64.33 | 1270.33 | 1573 | 2.7 | 7.3 | 12.2 | 18.22 | 68.32 |
| 5.5 | 65.66 | 1267 | 1586.33 | 2.67 | 7.3 | 12.9 | 18.21 | 71.11 |
| 6 | 66 | 1278.33 | 1597.33 | 2.66 | 7.2 | 14.1 | 18.34 | 75.6 |

Table 4 Marshal stability of ceramic dust values



## 5. CONCLUSION

1) We can see that all the test results of the aggregates come under the permissible limits for each test.
2) It can be observed that VG-30 grade bitumen is used and all the results are within the permissible limits.
3) Cement are found to be inferior to ceramic waste.
4) Marshall Stability value is found to be decreased with the increase in content of recycled aggregates.
5) With the increase in ceramic waste content, air voids are found to be increased.
6) From the above graphs, it can be observed that regardless of mix, characteristics and behavior of materials with increase in bitumen content and ceramic waste shows uniform curve and comes under the Marshall plot
7) Ceramic waste can be used effectively up to 4% by replacing coarse aggregate. However it is also found that replacement by 5% can also be done up to certain extent as there is no decrease in Marshall Stability value.
8) By replacing ceramic waste with fine aggregates, the amount of construction and demolition wastes being dumped and crushing of natural rocks for normal aggregates can be reduced.
9) Cost of construction will reduced by the replacement and is economic and feasible. We can aim for sustainable development with the existing woes of solid waste management system and by paying more attention towards environmental issues.
10) The marshal stability test values obtain for these filler material reveals that with the optimum binder content 4.75% and 2% of ceramic waste in replacement of fine aggregates in marshal stability test, the specimen is found to exhibit higher stability value is( 1635Kg). We can see that all the test results of the aggregates come under the permissible limits for each test. 56
11) Marshall Stability value is found to be decreased with the increase in content of recycled aggregates. Recycled aggregates are found to be inferior to natural aggregates.
12) With the increase in recycled aggregate content, air voids are found to be increased.
13) From the above graphs, it can be observed that regardless of mix, characteristics and behavior of materials with increase in bitumen content and recycled aggregates shows uniform curve and comes under the Marshall plot
14) Recycled aggregates can be used effectively up to 5% by replacing natural aggregates. However it is also found that replacement by 4% can also be done up to certain extent as there is no decrease in Marshall Stability value.
15) By replacing recycled aggregates with natural aggregates, the amount of construction and demolition wastes being dumped and crushing of natural rocks for normal aggregates can be reduced.

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