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A STUDY ON EFFECT OF CERAMIC WASTE IN BITUMINOUS CONCRETE MIXES

-A REVIEW PAPER

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Abstract — *Bituminous mixes are most commonly used all over the world in flexible pavement construction. It consists of asphalt or bitumen (used as a binder) and mineral aggregate which are mixed together, laid down in layers and then compacted. Today's bituminous concrete pavements are expected to perform better as they are experiencing increased volume of traffic, increased loads and increased variations in daily or seasonal temperature over what has been experienced in the past. In this paving mix, normally lime is used as filler material. A study has been carried out in work to explore the use of ceramic waste as filler material in different proportion as well as aggregate of 6mm size chips to bituminous concrete mix. Marshall Test has been considered for the purpose of mix design as well as evaluation of paving mixes. The amount of optimum binder content will determined by Marshall Stability test for samples. The mechanical performance will determine for Marshall Stability, deformation behaviour or flow, as well as for density and void characteristics base on prevailing Indian standards specifications.*

Keywords- *bituminous concrete, Marshall Properties (flow value, stability), optimum bitumen content, ceramic waste*

I. INTRODUCTION

Bituminous concrete is the most commonly used pavement material due to its construction procedures.
The ever increasing economic cost and lack of availability of natural material have opened the opportunity to explore locally available waste material.
If industrial waste materials can be suitably used in road construction, the pollution and disposal problems may be partially reduced. As reported, Indian ceramics industry, which is comprised of wall and floor tiles, sanitary ware, bricks and roof tiles, refractory materials and ceramic materials for domestic and others use is producing approximately 15 to 30 MT per annum waste.
The state of Gujarat accounts for around 70% of total ceramic production in India and out of total production 30% goes as waste and dumped in the open spaces.
The advantages of using ceramic waste dust in road construction as mineral filler and as aggregate are:

- The ceramic dust available at zero economic cost.
- Chemical and mechanical properties will be consistent.
- Road construction activity approaches to become green.
- Durable, hard and highly resistant to biological, chemical and physical degradation forces.

Researches show that potential use of the ceramic wastes in the construction industry is beneficial.

Figure 1.1 Ceramic Aggregate

II. BACKGROUND LITERATURE

Practices have been already done with various types of waste material such as Fly ash, Lime, Fibers, Silica fumes, plastic etc. Several studies are made, through which we can conclude:

- Fly ashes along with conventionally used stone dust are used as filler in bituminous concrete and comparison is made between them.
  The results show that all fly ashes are good as filler and can be used in bituminous construction up to 7% and also fly ash group rich in calcium oxide gave better results. **(Vishal Sharma and Satish Chandra, June,2011)**

- Reduction of optimum bitumen content in bituminous mixes using plastic coated aggregates which results in economic in construction of bituminous concrete and also solve disposal problem of plastic waste.
  (Rema devi M, Leni Stephen, 3,March,2013)

- Use of ceramic waste as filler in SDBC and compare with lime as filler in SDBC and results show that ceramic waste containing bituminous concrete perform better than lime containing bituminous concrete.
  (Electricwala Fatima et al. July, 2014)

- Compare the compressive strength and durability properties of concrete by replacing 20% cement with ceramic waste.
  Results show that concrete with ceramic waste powder has minor strength loss also show that despite of this strength loss these concretes possess increase durability performance.
  (Fernando Pacheco-Torgal, 22, july, 2009)

- Study the (OPC) cement has been replaced by ceramic waste in the range of 0%, 10%, 20%, 30% 40%, & 50% by weight for M-30 grade concrete and concrete samples tested and compared in terms of compressive strength to the conventional concrete.
  (Amit kumar D. Raval et al. June, 2013)

- Experimental Investigation on ceramic dust use as a construction material in rigid pavement and concrete specimens were tested at different age for different mechanical properties (For M35 grade concrete) and the results show that with water – cement ratio (0.46), core compressive strength increase by 3.9% to 5.6% by replacing 20% cement content with ceramic dust.
  (Electricwala Fatima et al, 2, august, 2013)

- Use of ceramic wastes in concrete production with the aim of reducing cement and fine aggregate content.
  (O. Zimbili et al. 2014)

- Study is to investigate the effects of using crushed ceramic in the production of interlocking paving units.
  (Dina M. Sadek et al. 14, March, 2013)

III. MATERIALS

Aggregate (Natural+ceramic): Crushed quartzite natural and ceramic aggregate was used as coarse aggregate (10 mm and 6 mm) and also ceramic waste was used as filler in this experimental investigation. The sizes of aggregate and stone dust were used as per specification (MORTH 2013).
Natural and ceramic aggregate material tests were carried out based on Indian standards, in order to ascertain the physical and mechanical properties of the material to be used in the samples of Marshall Stability mixtures. The specific gravity and physical properties of the natural aggregates are shown in the Table 1 and 2 respectively. Physical properties of ceramic waste are shown in table 3.

Table-1: Specific gravity of aggregates

SIZE OF MATERIAL	SPECIFIC GRAVITY	WATER ABSORPTION %
10mm	2.82	0.76
6mm (natural)	2.79	0.75
6mm (ceramic waste)	2.54	0.94
Stone Dust	2.64	0.825
Ceramic Waste	2.506	0.89

Table-2: Physical properties of aggregate

Sr. No.	Description of Test	Test Method	Test Result Observed	Specification as per MORT&H Table-500-18
1	Aggregate Impact value (%)	IS-2386 (P-IV)	9.69%	Max 24%
2	Aggregate Crushing value (%)	IS-2386 (P-IV)	15.7%	Max 10-25
3	Los Angle Abrasion value (%)	IS-2386 (P-IV)	17.5%	Max 30%
4	Flakiness and elongation Index (%)	IS-2386 (P-I)	23.53%	Max 30%
5	Water absorption (%)	IS-2386 (P-III)	0.76%	Max 2%
6	Specific gravity	IS-2386 (P-III)	2.94	NA
7	Stripping (%)	IS-6241-1971	99.5%	Minimum retained coating 95%

Table-3: Physical properties of ceramic aggregate

Sr. No.	Description of Test	Test Method	Test Result Observed	Specification as per MORT&H Table-500-18
1	Aggregate Impact value (%)	IS-2386 (P-IV)	16.62%	Max 24%
2	Aggregate Crushing value (%)	IS-2386 (P-IV)	20.4%	Max 10-25
3	Los Angle Abrasion value (%)	IS-2386 (P-IV)	20.5%	Max 30%
4	Flakiness and elongation Index (%)	IS-2386 (P-I)	26.5%	Max 30%

5	Water absorption (%)	IS-2386 (P-III)	0.89%	Max 2%
6	Specific gravity	IS-2386 (P-III)	2.506	NA
7	Stripping	IS-6241-1971	99.5%	Minimum retained coating 95%

Ceramic waste dust (Filler): In present study ceramic waste have been utilised as filler material ceramic waste has been collected from himmat nagar, Gujarat. The chemical properties of ceramic waste are shown in table 4.

Table-4: Chemical composition of ceramic waste powder

Sr. No.	Component	Composition
1	Aluminium Oxide, Al2O3	30.14%
2	Calcium Oxide, CaO	2.17%
3	Ferric oxide, Fe2O3	1.18%
4	Magnesium Oxide, MgO	0.24%
5	Potassium Oxide, K2O	0.01%
6	Silicon Oxide, SiO2	61.23%
7	Sodium Oxide, Na2O	0.09%

Bituminous Binder: To prepare bituminous concrete, Bitumen used in the study is penetration grade 60/70. Laboratory tests were performed for defining the physical properties of bitumen and found to be within acceptable limits as per the prevailing standards. Table-5 shows the physical properties of bitumen.

Table-5: Physical Properties of Bitumen

Sr. No.	Description of test	Test Method Standards	Test Results	Spec. Limit as per MORT&H
1	Specific Gravity	IS:1202	1.01	0.99 Min.
2	Penetration	IS:1203	62	50-70
3	Ductility	IS:1208	85	Min. 40cm
4	Softening Point	IS:1205	50	Min.47°c
5	Absolute Viscosity	IS:1206	2725	2400 poise
6	Kinematic Viscosity	IS:1206	454	Min-350 cst

IV. METHODOLOGY

In order to meet the objectives, the following research methodology was adopted:

1. Selection of Material
   i. Bitumen (VG-30)
   ii. Aggregate (Natural+Ceramic waste)
   iii. Filler (Ceramic waste)
2. Experimental Investigation

- Test on Bitumen
  i. Penetration
  ii. Softening point test
  iii. Ductility
  iv. Flash
  v. Specific gravity test
  vi. Viscosity test
- Test on Aggregate (Natural+Ceramic waste)
  i. Elongation Index and Flakiness Index
  ii. Impact
  iii. Los angeles Abrasion
  iv. Water absorption
  v. Specific gravity
- Test on Bituminous Concrete
  i. Marshall Stability

3. Mix design and sample preparation.
4. Result analysis.

- Comparative analysis
- Statistical analysis

V. CONCLUSION

Literature review shows that ceramic waste was utilised as filler material in SDBC and ceramic waste partially replace the cement content in cement concrete work while in present study ceramic waste will utilise as filler as well as aggregate in bituminous concrete work. Laboratory tests were performed for defining the physical properties of ceramic aggregate and found to be within acceptable limits as per the Indian standards which show that ceramic waste is feasible to utilise as aggregate material in bituminous concrete work.

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