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Mixing of Bitumin with Geopolymer Aggregate

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ABSTRACT

Road Transport is known to be one of the most vital infrastructures in the overall socio–economic development of the country. In India, it enables the transportation sector to contribute 4.7% towards country's gross domestic product. Expanding with road network of over 5,603,293 kilometers, India is the 2nd largest in the World. The funds allotted for highways maintenance being insufficient. This represents the demand and need for innovation in the road materials and technologies, in order to preserve andprolong the life of road infrastructural asset.

Keywords: flyash-based geopolymer, coated aggregate, bituminous mixtures.

INTRODUCTION

The performance of road is governed to a great extent by the qualityof aggregates used in the construction, as aggregates form the major component of pavement structure. With the fast pace of infrastructure development in the country, high rate of decline in natural resources has become overburden to the government. This represent scope for new avenues for research and development in road material and construction technologies for future. The total road length in country has found to have significant increase from 3.99 lakh km in 1951 to 54.73 lakh km in 2016.The average highway network in India is 1.66 km length of road per square km is dense than of japan (.91km/sq km) USA (.68 km/ sq km). Considering this, Government of India has taken new initiatives by encouraging feasible utilize of waste materials , by products , etc.

LITERATURE REVIEW

The road network being the backbone of country's economy, its development and maintenance consumes a major part of financial budget. The initial investment of road infrastructure can be controlled by using locally available materials thus reducing the cost of transportation. However, this technique often becomes not practicable because of poor quality of materials. Therefore, innovative ideas are required to enhance the properties of these locally available materials and make them suitable for pavement construction. Oluyemi-Ayibiowu *et al.* (2016) assessed the engineering characteristics of coarse aggregates used for construction works in Akure Township. Aggregates of different sizes where collected from three different quarry sites in Akure, Ondo State, Nigeria. The engineering characteristics of aggregates were determined using laboratory tests. The tests results of Specific Gravity, Aggregate Impact Value (AIV), Aggregate Crushing Value (ACV), Flakiness Index (FI) and Elongation Index (EI) were used to determine the toughness indices. Kavussi & Hicks et. Al, (1997) studied the characterizing role of fillers in bituminous mixtures.Four types of filler (limestone, quartz, fly ash, and kaolin) with different physical properties were examined. It was reported that the dry compacted filler test proved to be good test method for filler characterization. Kumar *et al.* (2008) studied the effect of using flyash as filler materialin the bituminous concrete mixture. Davidovits (1991) demonstrated the technological progress made in the last few years through the development of new materials such as 'geopolymers'. The study reported that with the need for alternate buildingmaterials, new state of-the-art materials designed with the help of geopolymerization reactions have new applications and procedures and transforming ideas granted in inorganic chemistry. The study demonstrated that at low temperature transformation, kaolinite into hydrosodalite tremendous latent energy in the new mineral reaction was observed. The research clearly established the process of formation of geopolymers which reported to be inorganic, hard, stable at temperature upto 1250°C and non flammable. Davidovits (1994) attempted with an expectation of possible way to reduce carbon dioxide emissions by 5 to 10% by reducing the use of fossil fuel and new energy technology.

RESULTS

Results and discussion of this investigation has been presented in thischapter and sequenced in five divisions:

1. Workability properties of flyash based geopolymer pastes (F1G andF2G) prepared with F1 and F2
2. Geopolymerisation of flyash in different concentrations of sodiumalkaline medium through microstructure study.
3. Performance of best resulting bituminous concrete mixture type in thefield.

Physical and mechanical properties of flyash based geopolymer coated aggregates improved with increase in NaOH molarity. It was noted that the results were comparatively better for F2GCA than F1GCA coated aggregates. It may be due to higher calcium oxide in F2. The toughness index of aggregates could be used as a selection parameter for coarse aggregate source (Sharif 2001 and Oluyemi et al. 2016). The toughness index of the F1GCA at 10M was found to be 79 which are 8.21% higher than uncoated aggregates. This may be the effect of partial reaction between surface silica with alkali silicates, in forming additional gel . For F2GCA the toughness index at 15M was found to be 6.33% higher than F1GCA at 10M and 13.51% higher than uncoated aggregates. As many studies reported that the property of flyash based geopolymer is significantly affected by temperature, the physical and mechanicalproperties of the coarse aggregates coated with F1G and F2G geopolymer paste were tested in a range of 140ºC to 170ºC and results are tabulated.

RESEARCH METHODOLOGY

The research methodology was sketch through extensive literature review to study the properties of locally available broken granite stones as coarse aggregates and its suitability for application in bituminous concrete for road works. Further, methodology included study on flash based geopolymer coated aggregates and, evaluates its effect in the bituminous concrete. In this chapter, sources for collection of required materials, testsperformed on the source materials and process methodology to evaluate the properties of flyash based geopolymer paste, fly ash based geopolymer coated aggregates in bituminous concrete mixture is briefly discussed.

CONCLUSIONS

Based on the investigation, the following conclusions can be made:

- The broken stones collected from the quarry were found to be marginal aggregates. Physical and mechanical properties of flyash based geopolymer coated aggregates improved with increase in NaOH molarity. The results were comparatively better for F2G coated aggregates than F1GCA which are possibly due to higher CaO in F2.
- The toughness index of the F1GCA at 10M was 8.21% higher than uncoated aggregates. Similarly, for F2GCA, the toughness index at 15M was found to be 6.33% higher than F1GCA at 10M and 13.51% higher than uncoated aggregates. This is due to partial reaction between surface silica with alkali silicates, forming gel products surrounding the aggregate particle which leads to increase in strength.
- As a result of rapid polymerisation at higher temperature, maximum increase of 18% and 16% in crushing resistance for F1GCA and F2GCA was recorded at maximum aggregate temperature of 170ºC. The fluidity of the paste decreased with increase in molarity of NaOHas it contained very high OH_2 for both F1G and F2G. The fluidity decreases with increase in sodium silicate to sodium hydroxide ratio. As a result of higher calcium oxide in F2, which reacts with magnesium and silicon for the formation of gel products, reducing thefluidity of the F2G below 15 molarity of NaOH.
- With increase in NaOH molarity, the sample F1G image showed high rate of agglomeration with reduced voids. The morphology of F1G beyond 10M changed from spherical to flakes.
- In SEM image of flyash based geopolymer F2G at 15M, was sticky, but with separated particles with voids, indicating particles needed higher concentration of NaOH for further reaction.
- This indicated that the sodium silicates and sodium hydroxide participates completely in the polymerization process. For the selected gradation of aggregates, at 4% voids, optimum binder content required for CBC10 and F1GBC10 was 5.5%. For F2GBC10 and F2GBC30 mix the optimum binder content of 5.8% and 6.25% was achieved which is higher than other mixes.

REFERENCES

1. Aggregates Business International.2016 Available from: http://www.aggbusiness.com/categories/quarry-products/

2. Aliaa Faleh & Al Ani 2017, 'Effect of fly-ash on the performance of asphalt concrete mixes', Journal of Babylon University/Engineering Sciences, vol. 25, no. 5, pp. 1693-1707.

3. Alvarez-Ayuso, E, Querol, X, Plana, F, Alastuey, A, Moreno, N, Izquierdo,M, Font, O, Moreno, T, Diez, S, Vázquez, E & Barra, M 2008, 'Environmental, physical and structural characterisation of geopolymer matrixes synthesised from coal (co-) combustion fly ashes', Journal of Hazardous Material, vol.154, pp. 175-183.

4. American Society for Testing and Materials (ASTM) D 6926, Published in September 2010, Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus, United States, pp. 1-6.

5. American Society for Testing and Materials (ASTM) D1075, Published in August 2011 Standard Test Method for Effect of Water on Compressive

Strength of Compacted Bituminous Mixtures. United States, pp. 1-3.

6. American Society for Testing and Materials (ASTM) D6927, Published in November 2006Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures.United States, pp. 1-7.
7. American Society for Testing and Materials (ASTM) D6931, Published in February 2012, Indirect Tensile Strength of Bituminous Mixtures, United States. pp. 1-5.
8. Anjan, K& Chatterjee 2010, ‘Indian fly ashes, their characteristics and potential for mechano - chemical activation for enhanced usability’, Main Proceedings, Second International Conference on Sustainable Construction Materials and Technologies, University of Wisconsin Milwaukee Centrefor By-products Utilization.

9. Bakharev, T 2006, ‘Thermal behaviour of geopolymers prepared using class F fly ash and elevated temperature curing’, Cement and Concrete Research,vol. 36, no. 6, pp. 1134-1147.

10. Bayomi, FM 1992, ‘Development and analysis of cement-coated aggregates for asphalt mixtures-effects of aggregates and mineral fillers on asphalt mixture performance’, American Society for Testing and Materials,pp. 19-34.

11. Bouchard, GP 1992, ‘Effects of aggregate absorption and crush percentage on bituminous concrete’, ASTM Special Technical Publication, STP 1147, pp. 35-44.