Development of Pavement Concrete Tiles using Fly Ash and ETP Lime Sludge

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Abstract

Solid wastes obtained from different industries are heterogeneous, in their composition ranging from organic (in industries producing basic consumer products) to inert organic (such as generated in mining and collieries) and may include even hazardous constituents from pesticide industry. The unsystematic disposal of Effluent Treatment Plants (ETP) sludge retrograde the surface soil and contaminate with surface and ground water became a vital environmental and public health issue. Solid waste (lime sludge) generated from fertilizer industry is being used as the constituent of masonry cement, burning of lime sludge as a raw material for pavement tile production and to make building lime and compounding of fly ash with burnt lime sludge to make lime composite mortars. The idea of this research is to study the application and utilization of these industrial wastes as a pozzolanic material in pavement tile production. At very high pressure the paving stones using sand, lime sludge, fly ash, cement and aggregates are compressed to give a hard faced, strong and durable stone like product with or without bevelled edges. They do not require a solely concrete bed and need just a consolidated sand bed for the support. There is no necessary for bonding or pointing and no requirement of any cement.

Keywords: Abrasion, Concrete Tiles, Durable, Effluent Treatment Plants (ETP) Sludge, Fly Ash

I. INTRODUCTION

Fly ash is a waste material collected from the flue gases extracted through the burning of coal in thermal power generating sectors. About 112 million tonnes of fly ash per annum are produced by about 120 thermal power generating plants in India. Large quantities of lime sludge from water treatment plant are generated in India and across the world and they are disposed of by landfilling. As existing land fill sites have limit of space for disposal and the problem waste stabilization have prompted several researches to find alternatives disposal and recycle techniques for this waste sludge. The finest way for reprocessing these solid wastes is to utilize these wastes in civil engineering construction works, as large quantities of resources are being used recently in civil engineering constructions.

A. Materials Used

Various materials used for making concrete tiles are cement, fine aggregates, coarse aggregates, fly ash & ETP lime sludge from fertilizer industry.

B. Mix Proportion

1) M35 was adopted for making the concrete tiles. All the four tiles made were of different compositions.
2) For the tile named A0, the neither cement nor sand was replaced with any waste products.
3) For the remaining three tiles namely C1, C2 and C3, 50% of sand was replaced with 50% fly ash.
4) For the tile C2, 5% of cement was replaced with ETP lime sludge and for the tiles C3 and C4, cement were replaced by 10% and 15% ETP lime sludge respectively.

C. Wear Determination

The average loss in thickness of the sample gives the wear of the specimen.

\[ t = \frac{(W1 - W2) \times V1}{W1 \times A} \]

Where \( t \) = average thickness loss in mm
\( W1 \) = initial weight of the sample, in gm
\( W2 \) = Final weight of the specimen after abrasion test in gm
V1 = initial volume of the sample, in mm³
And A = Surface area of the sample, in mm²

II. EXPERIMENTAL PROCEDURE

For each composition four tiles of size 200×200×20 mm were casted taking water-cement ratio 0.5. During casting they were vibrated manually by shaking the mold and by tampering it with the trowel. After 24 hours of casting, the tiles were demolded and immersed in water for 28 days. After saturation they were wiped to dry and weighed and then they were put on the hot air chamber maintained at a temperature of 100°C for 24 hours and then cooled at room temperature and reweighed. The percentage water absorption by these tiles was calculated from their saturated weight and oven-dried weight. Then from these six tiles, three tiles of each composition were selected for abrasion resistance test. The test specimen of size 70.6 mm×70.6 mm were sawn off from the central part of each tile. Then they were weighed to the nearest 0.1 gm. After initial weighing the test specimen was placed in the thickness measuring apparatus (dial gauge) and with its wearing surface facing towards up and the dial gauge reading was noted. Aluminum oxide powder of 20 gm was evenly sprinkled on the grinding path of disc of the abrasion testing machine. The test specimen was then fixed in holding device with the wearing surface facing towards the disc and a load of 300 N was loaded at the centre. The grinding disc of the abrasion testing machine was then set on motion of speed 30 rev/min. and aluminum oxide powder was fed back continuously on the grinding path. The grinding disc was stopped after every 22 revolutions and the abraded aluminum oxide powder and remaining abrasive powder were left out from the disc and other 20 gm of aluminum oxide powder was applied in each time. The test specimen was rotated through a right angle in clockwise direction about the vertical axis after every 22 revolutions. This procedure was repeated 15 times there by giving a total number of 352 revolutions. After the test, the test specimen was again reweighed to nearest 0.1 gm and the thickness was measured with the dial gauge in a similar manner done before the test.

III. RESULTS OF ABRASION RESISTANCE TEST

The abrasion resistance value for the tested specimens is given below in table:

<table>
<thead>
<tr>
<th>Concrete Type</th>
<th>Abrasion Resistance in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0</td>
<td>0.131</td>
</tr>
<tr>
<td>C1</td>
<td>0.067</td>
</tr>
<tr>
<td>C2</td>
<td>0.061</td>
</tr>
<tr>
<td>C3</td>
<td>0.085</td>
</tr>
</tbody>
</table>

From the abrasion resistance test of the various fly ash and lime sludge composite tiles it has been demonstrated as follows:
1) The concrete tiles in which 50% sand replacement with fly ash and 5% cement replacement with lime sludge showed 48.85% & 73.2% better wear resistance than the reference concrete tiles and market tile respectively.
2) The concrete tiles with 50% sand substituted with fly ash and 10% cement substituted with lime sludge showed 53.44% & 75.6% better wear resistance than the reference concrete tiles and market tile respectively.
3) The concrete tiles with 50% sand substituted with fly ash and 15% cement substituted with lime sludge showed 35.11% & 66% better wear resistance than the reference concrete tiles and market tile respectively.
IV. Conclusion

The wear resistance of the concrete tiles should not exceed 1mm. All the fly ash and lime sludge composite tiles showed wear resistance less than 1mm. The results obtained from the abrasion resistance showed superior wear resistance than the market tiles. Pavement tiles are widely used as building components and adoptable at low cost. The pavement tiles find their applications for laying hard, durable and to make attractive flooring in the courtyards, walk ways, pavements, car parking and in similar locations.

References