Plastic Waste Management with Expanded Polystyrene Beads

Modi Musalaiah, T. Phani Madhavi

Abstract: Plastic waste is the one of the serious environmental issue due to its non-biodegradability nature. The disposing of plastic waste and plastic waste management becomes a major task in developing countries like India due to rapid growth of population and industrialization. Plastic stands in the top most place among variety of solid waste materials, and causes heavy environmental hazards which will affect the future generations and peers. The present study was focused to investigate and understand the attributes of concrete which is made of partial replacement of coarse aggregate with Expanded Polystyrene Beads using M20 mix design. Concrete cubes were casted taking 0%, 5%, 10%, 15% and 20% of Expanded Polystyrene beads as partial replacement of coarse aggregate and tested for 7 days, 14 days and 28 days of compressive strength of concrete.

Keywords: Waste Management, Plastic Waste, Expanded Polystyrene Beads (EPB)

I. INTRODUCTION

Increase in the developmental activities world over, the demand for construction materials is increasing exponentially[4]. Plastic waste is considered as a serious problem to the environment due to inability of plastic to degrade naturally[1]. The demand for building material is increasing and increase in cost of building material is also a matter of concern[2]. The generation of waste plastic was drastically increasing every year due to its usage for various activities and remains on landscape for many years. However, the intensity of plastic can be reduced through recycling. In case, the recycling process was not effective, million tons of plastic waste are disposed into oceans which has a great impact on Marine ecosystem. In the present study, the plastic material Expanded polystyrene was used in construction activity in order to manage the plastic waste and also utilizing the plastic material for several constructional purposes in civil engineering. Expanded Poly Styrene Beads (EPB) is a white foam plastic fabric made from solid beads of polystyrene. Polystyrene is the plastic category that is widely being used as food containers and packaging[6]. The main sources of polystyrene waste was from municipal and industrial solid waste.

It is a closed-cell, inflexible foam material made from Styrene and Pentane. Both styrene and pentane are hydrocarbon compounds and are acquired from petroleum and natural gas as a by-product and it is very light weight with very low thermal conductivity. Its chemical resistance is almost equal to the material upon which it is based polystyrene, and it comprised of 98% air. Concrete is in general, cement-based concrete, which meets special performance requirement with regard to workability, strength and durability, that cannot always be obtained with techniques and materials adopted for producing conventional cement concrete[5]. Light weight aggregate posse’s different salient features such buoyancy which helps the concrete to float and dead load can be reduced[3]. In this, we strive to evaluate the strengthening of concrete with recycled plastic called Expanded Polystyrene Beads as a partial replacement to coarse aggregate by 0%, 5%, 10%, 15% & 20% as an alternative of coarse aggregate and by utilizing this plastic, cubes are prepared and tested at 7 days, 14 days, and 28 days of curing age, the compressive strength of specimens were determined with the w/c ratio of 0.5 and mix proportion of 1:1.5:3.

II. MATERIALS & METHODS

In the present study, concrete preparation was well done by using several materials. The ingredients of concrete were Ordinary Portland Cement 43 Grade - specification IS: 8112, River sand was considered as fine aggregate, Crushed granite stones was taken as coarse aggregate, Water and Expanded Polystyrene beads in the form of spheres.

<table>
<thead>
<tr>
<th>Specific Gravity</th>
<th>Bulk Density</th>
<th>Particle size</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.011</td>
<td>6.86 kg/m³</td>
<td>Spherical (8-9mm dia)</td>
</tr>
</tbody>
</table>
The physical properties of ingredients were evaluated. The mix proportions for M20 conventional concrete mix was derived as per IS: 10262-2009, by including w/c of 0.5, and the partial replacement of coarse aggregates by EPS beads, the concrete was prepared and workability was determined by slump cone and compaction test methods. The Cubes of 150mm×150mm×150mm size were casted for compressive strength evaluation. The specimens were removed from the molds and cured in water for 7 days, 14 days and 28 days and tested. For every mix of expanded polystyrene beads of 0%, 5%, 10%, 15% & 20%, 3 cubes were prepared.

III. RESULTS AND DISCUSSIONS

From the above information, the cured cubes were tested at an age of 7 days, 14 days and 28 days for all the replacement proportions, from 0% to 20% by maintaining 5% interval. The 28 days test results showed in the below table and the results are plotted and discussed.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>% of EPB</th>
<th>28 Days Compressive Strength, N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>27.45</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>24.8</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>23.1</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>21.5</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>18.2</td>
</tr>
</tbody>
</table>

From the above analysis, for no replacement mix, 0% EPB, the strength obtained as 27.45 N/mm², and then it was reduced for every addition of EPB. 24.8 N/mm² was obtained for 5% replacement, for the 10% replacement it was noted that 23.1 N/mm², 21.5 N/mm² is the tested value of 15% replacement and finally for the 20% replacement the obtained compressive strength is 18.2 N/mm²

IV. CONCLUSION

The present study was done for the prediction of compressive strength of M20 mix concrete by partially replacing of coarse aggregate with expanded poly styrene beads as 0%, 5%, 10%, 15% and 20%. The test methods were done according to IS codes and the results were analysed. From the above analysis it was concluded that, the compressive strength of concrete was declined with an increase of % addition of expanded polystyrene beads as a replacement to the coarse aggregate. It is recommended that the further study was needed before using of these EP beads as a concrete material.

REFERENCES


AUTHORS PROFILE

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Prof. Dr. T. Phani Madhavi, Professor of Civil Engineering at Bapatla Engineering College. She received Doctor of Philosophy (Ph.D) in Civil Engineering from Sri Venkateswara University. She obtained Master of Technology (M.Tech) in Civil Engineering with Specialization in Environmental Engineering from Sri Venkateswara University, Tirupati, Andhra Pradesh, India and awarded Bachelor of Technology (B.Tech) in Civil Engineering from Acharya Nagarjuna University, Guntur, Andhra Pradesh, India. Her interested research areas are Civil & Environmental Engineering, Water Quality, Water Treatment, Environmental Pollution, Waste Management, Environmental Impact Assessment, Environmental Studies, Environmental Geotechnology, Construction Management, and Project Management. She published and presented more than 25 research papers and 2 Book Chapters in indexed Journals/Conferences. She is the Editor/Editorial Board Member/Advisory Board Member/International Scientific Committee and Reviewer for more than 20 indexed National and International Journals. She achieved Professional Certifications recognized by Government of India such as Certified Leadership Skills Professional, Certified Environmentalist and Certified Project Management Professional. She has more than a decade of experience in Teaching/Research/Administration/Industry. Prof. Dr. T. Phani Madhavi is the recipient of several awards/honors such as Expert Lecture/Resource Person for the AICTE-ATAL -FDP held on Geoenvironmental Engineering for Solid Waste Management at National Institute of Technology Karnataka, Surathkal ; Keynote Speaker at the International Congress on Phenomenological Aspects of Civil Engineering, Ataturk University, Turkey; Invited Speaker for International Congress of Environmental Research at Kerala; Expert Presentation at Sri Venkateswara University in the Brain Storming Session on Global Warming and Climate Change conducted by Andhra Pradesh State Council of Science & Technology & Sri Venkateswara University; Best Senior Faculty Award, Academic Leadership Award at Bangkok, Rashtriya Gaurav Award,
Research Excellence Award, Best Reviewer Award, Inspiring Educators, Peace Ambassador, Women Researcher Award, Best Teacher Award, Outstanding Researcher Award (handed over by Chief Minister of Pondicherry), Senior Educator and Scholar Award (Medal of Honour), Bharat Ratna Indira Gandhi Gold Medal Award, Best Paper Award (Gold Medal), Young Faculty Award (Bronze Medal), Best Young Scientist Award and Certificate of Appreciations for her contributions in the area of Civil & Environmental Engineering from various National/International organizations. She served as Session Chair/Co-Chair for national and international conferences. She has memberships in several professional bodies.