FLOATING CONCRETE WITH THERMOCOL: A REVIEW

[1]Sagar R. Kaptan, [2]Dr. Jayeshkumar Pitroda, [3]Dr. Vihangraj Kulkarni
[1]Final Year M. Tech Student, [2]Associate Professor, [3]Associate Professor
[1]Construction Engineering and Management, Civil Engineering Department
[1]BVM Engineering College, Vallabh Vidyanagar, Gujarat, India

Abstract: ***Floating concrete is a composite material composed of cement, water, aggregates and admixtures both physical and chemical. Unlike the traditional Portland cement concrete whose Density is about 2400 kg/m³; floating concrete contains lightweight aggregates and certain admixtures which make the composite lighter. Floating concrete is useful for minimizing the dead load of structure and thus reducing the overall cost of the project. Expanded polystyrene beads can be used with the conventional concrete making materials to produce Floating concrete, having a wide range of performance characteristics. EPS has been used in engineering applications since 1950s. It is as light as that density is nearly a hundredth of that soil. The use of thermocol beads for the production of lightweight concrete weighing between 600 and 1000 kg/m³.Since its density is less than that of water, the concrete in its hardened state can float in water. It has good thermal insulation properties because lighter the concrete, the lower the thermal conductivity.***

Keywords - **Expended Polystyrene Beads, Floating concrete, Light weight concrete, Thermocol, Thermal Insulation Property.**

I. INTRODUCTION

A floating concrete is a solid body made of reinforced concrete and an inward chambers chain loaded up with dense light weight material. Throughout the construction industry faces the challenges and problems. Two-third of the surface of world is covered by water. Therefore it is not surprising that in recent decades there has been a lot of concrete activity in the ocean. The drawback of traditional concrete is high self-weight concrete, where the density ranges from 2200 to 2600 Kg/m^3. In this approach, the concrete's self-weight is reduced to achieve the concrete's efficiency as structural material. The Floating concrete's prime features are its low density and low thermal conductivity. Lighter weight may reduce the construction's overall expense. For low-cost house applications, it is therefore advantageous.

II. CRITICAL LITERATURE REVIEW

The following are the earlier research review based on floating concrete with various lightweight material.

Daneti Saradhi Babua et al. (2018) investigated the impact of polystyrene aggregate size on lightweight concrete's strength and moisture migration properties. The investigation deals with the utilization of expanded polystyrene (EPS) and un-expanded polystyrene (UEPS) beads as a light weight aggregate in concrete containing fly ash as an additional cemented material. Lightweight concrete with broad range of concrete densities was studied primarily for split tension, compression, absorption and migration of moisture. The results show that concrete with UEPS aggregate indicates 70% higher compressive strength than EPS aggregate for aggregate size and concrete density. EPS aggregate concrete with small EPS aggregates showed higher compressive strength and increased in low density concrete compared to high density concrete was pronounced. In addition, the result of absorption and moisture migration show that the EPS concrete with larger size and higher EPS aggregate volumes show higher absorption and moisture migration.**[2]**

Nikhil S. Chavan et al. (2018) examined the mechanical properties of floating concrete by using expended polystyrene as replacement of aggregates. Compression test, split tensile test and density testing were performed on concrete and this concluded. It was Possible to make Concrete floatable by using the EPS Beads as a replacement to Aggregate in concrete. By using EPS beads, floating concrete provides standard workability and can be compacted and finished easily. The compressive strength of Floating concrete was less than traditional concrete. The density of floating Concrete by given Mix Design was less than 1000 kg/m^2. There are issues of leakages and honeycombing, the issue of leakages may be controlled by using water proofing solution. It was also possible to built Boat by the Concrete i.e. Floating Concrete, which gives the more benefit such as Cost saving, Reduces the use of Timber, For Rescue operation. **[8]**

Thousif Khan et al. (2018) studied that coarse aggregates replaced by thermocol beads and pumice aggregates in different percentage, such as (100%, 0%), (90%, 10%), (80%, 20%), (70%, 30%), (60%, 40%), (50%, 50%) respectively. compressive strength test, split tensile strength test, Water absorption test and sorptivity test were carried out on concrete. Based on test result he concluded that The mix proportioning based on absolute volume concept used in normal concrete can be successfully employed for achieving a floating concrete keeping the density of the mix less than 1000 kg/m^3. The volume of aggregates can be maintained in the range of 0.7 to 0.75 for achieving floating concrete. Pumice and thermocol beads could be used as an alternative for coarse aggregates. Use of light weight aggregates like thermocol beads and pumice results in reduction of density and thus floating concrete could be easily developed. The ingredients used in floating concrete should be selected in such a way that the specific gravity of the materials chosen should be less than that used in conventional concrete. **[13]**

Malik Mehran Manzoor et al. (2018) used pumice stone and aluminium powder as an air-entraining agent to investigate the development of floating concrete. They had worked on combining the above mentioned types in the investigation. Comparison has been made in this study between plain cement concrete and lightweight concrete with different proportion of aggregate size and fixed quantity of aluminium content (2%) by weight of cement. It was produced with a satisfied strength using five different lightweight concrete mixtures and different pumice proportion. The investigation result showed that aggregate size and proportion had an impact on the concrete's compressive strength and unit weight. Furthermore, the result showed that by using pumice as an aggregate, it is possible to produce a Floating with satisfied strength. This concrete does not meet the load-bearing structural component strength requirement. **[7]**

Rayees Ahmad Ganie (2017) studied the production of floating concrete using pumice stone, foaming agent and thermocol. He also examined the effect of aggregates types and the amount on the concrete's compressive strength. It was produced with satisfied strength using five different lightweight concrete mixtures and different pumice proportion. The research result showed that proportion and aggregate size influenced concrete's compressive strength and the unit weight. In addition, the result showed that a Floating and satisfied foam concrete can be produced using foam and pumice aggregate. The strength requirements for structural load-bearing components are not met by this concrete. For building structures such as barges, slabs, buildings etc., floating concrete can be used effectively. Since the topmost part of earth is covered by water, land use for construction works is minimized and this is an environment friendly method of building boats that replace woods and metals. **[10]**

Roshan Gawale et al. (2016) investigated some of the problem statements currently generating millions of tons of polystyrene waste worldwide. In the end, this will cause pollution and damage to the ecosystem. Increasingly, national and international environmental regulations have become more inflexible, making disposal expensive. The use of waste polystyrene in concrete composition therefore not only solves the problem of disposing of this ultra-light solid waste, but also helps to preserve natural resources. For lower density mixture, the strength of light weight concrete using EPS beads is low. Initial finding showed that light weight concrete using EPS beads has a suitable strength as an alternative building material for footpath construction, partition wall, parapet wall, bed concrete. **[11]**

Roshan Peter et al. (2016) conducted experimental research on the use of light weight aggregate for floating concrete structure. In this experiment, an attempt was made to study the mechanical properties of a structural lightweight concrete grade M20 using the pumice stone as a partial substitute for coarse aggregate and mineral admixture materials such as Silica Fume, together with a control mix, The compressive strength study has been prepared for six sets. Each set consists of 3 cubes. The optimum 7 days' compressive strength have been obtained in the range of 5% silica fume for different replacement of coarse aggregate by pumice stone for 10%, 20%, 30%, 40% and 50%. Thus by comparing the compressive strength he can conclude that any structure can be built with 50% replacement of coarse aggregate with pumice stone with the addition of silica fumes by 5%. **[12]**

Jay Bankim Shah et al. (2015) has concluded that the cost, as well as the compressive and tensile strength gradually decrease with the increase of EPS in concrete block. Addition of plastic beads in concrete blocks along with EPS increases the compressive strength but also increases the cost gradually. Use of EPS and plastic beads in sensible quantity results in good compressive strength as well as increase in cost is not major. It can serve as a way of effective use of EPS disposal as well effective use of plastic beads that are waste products of many industries. **[4]**

Lakshmi Kumar Minapu et al. (2014) has presented experimental investigation consisting of casting and testing of 9 sets of cubes, prisms and cylinders consisting of various pumice aggregate proportions used to substitute for hard aggregate. Each set includes 4 cubes, 2 prisms and 2 cylinders to measure compressive, flexural & tensile strength. The pumice aggregate has been used in different proportions as a partial substitution of coarse aggregates along with fly ash and silica fumes. Cubes, prisms and cylinders were casted adopting M30 design mix proportions and then cured for 28 days. After 28 days they were tested for compressive strength, flexural strength and tensile strength. Results showed that lightweight aggregates are by no means less than ground aggregates and can be used for construction.

Hemant k. Sarje et al. (2014) explored the lightweight concrete development technique. Their study concentrates on the test of compression, water absorption & flexural. Low thermal conductivity and low density are the main strengths of lightweight concrete, which minimizes the dead load simultaneously and rises the building price, by mixing fly ash & aerating agents such as kemelite-foaming agent based on protein. **[3]**

Thomas Tamut et al. (2014) investigated the partial replacement of polystyrene beads into concrete, and also examined the properties of lightweight concrete containing EPS beads, such as the compressive strength and tensile strength. Their properties were compared to traditional concrete properties. On 28 days, it has been found that the strength of compression of 5%, 10%, 15%, 20%, 25% and 30% of the EPS-based concrete resistance amounted to 91%, 77%, 57% and 45% respectively compared with normal cement. On this basis, they have been drawn. Increasing the content of EPS beads in concrete mixes reduces the compressive & tensile strength of concrete. Without any fastener, EPS concrete has good working capacity and can easily be compacted, Increased workability by increasing the content of EPS beads. The substitution by EPS has shown a positive application in the construction of non-structural elements as an alternative material and is also the solution for disposal of EPS. The results show EPS concrete has scope for non-structural uses such as partition walls, wall panels and so on. **[14]**

Ganesh Babu et al. (2013) found, depending on strength and density requirements, that light weight concrete can be formed by replacing the normal aggregate with a light weight aggregate in whole or in part. This study deals with the use as a lightweight aggregate of extended polystyrene beads both in concrete and mortars, containing silica as an extra cement material. These mixtures are developed through the use of silica fume efficiency in different proportions. The strength gain rate for these concrete demonstrates that an increase in the proportion of silica fume increases the strength of 7 days. This was shown to be approximately 75%, 85% and 95%, respective of the corresponding strength of 28 days at the level of silica fume replacement of

3%, 5% and 9%. The absorption results show that sand-based EPS mixtures are less absorbed than normal aggregate mixtures. Additionally, with increasing cement content the absorption values were reduced. Even at the level of minimum fume content of silica these concretes have been shown to be very good in terms of their corrosion resistance and chloride permeability. **[5]**

Abhijit Mandlik et al. (2013) used EPS beads to investigate the lightweight concrete. It is suitable for different fields such as bridge decks, low-thermal walls, wooden floor repairs of old buildings, floating quay, and so on. It is therefore observed that the costs of EPS concrete are lower than those of traditional concrete. Increasing the content of EPS beads in concrete mixes lowers the concrete's tensile strength. He noted that the substitution using EPS has been a good use in the construction of nonstructural elements as alternative material and serves as a solution for the disposition of EPS. The EPS concrete is workable without any binding agent and can be easily compacted. **[1]**

The following table 2.1 shows the literature review papers based on various lightweight material used for development of Floating concrete.

No.	Author	Material used	Addition/ Replacement	Test	Result
1	Thousif Khan et al. (2018)	Pumice stone, Pumice Powder, Thermocol beads	Replacement of coarse aggregate by pumice stone	Water absorption, Sorptivity, Compressive strength	Water absorption increase with increase in % of pumice stone. Sorptivity value increases from mix. 50 to 70%
2	Roshan peter et al. (2016)	Pumice stone, Silica fume	Replacement of coarse aggregate with pumice stone, Addition of silica fumes	Compressive strength	Floating structure can be built with 50% replacement of coarse aggregate with pumice stone with the addition of silica fumes
3	Roshan Gawale et al. (2016)	Fly ash, EPS, Crush sand stone	Replacement of coarse aggregate with EPS	Compressive strength, Density	Increase in CSS and decrease in EPS causes increase in Compressive strength and Density.
4	Thomas tamut et al. (2014)	EPS beads, Crushed granite stone	Replacement of coarse aggregate with EPS beads	Workability, Compressive strength, Tensile strength	Increase in EPS beads reduces the compressive and tensile strength. Workability increases with increase in EPS.
5	Ganesh Babu et al. (2013)	EPS beads, Silica fumes	Replacement of coarse aggregate by lightweight aggregate, Addition of silica fumes	Compressive strength, Water absorption	Increase in the proportion of silica fumes increase the strength. Sand-based EPS mixture are less observed than normal mixtures.
6	Lakshmi kumar minapu et al. (2014)	Pumice stone, Fly ash, Silica fumes	Replacement of coarse aggregate with pumice stone, Addition of Fly ash & Silica fumes	Compressive strength, Flexural strength, Tensile strength	Light weight Aggregates are by no means less than ground aggregates and can be used for construction.
7	Suhad M Abd et al. (2016)	EPS beads	Replacement of fine aggregate with EPS beads	Workability, Compressive strength,	Compressive strength at 5%, 15%, 20% EPS based concrete compare to control concrete were 41%, 38%, 25% respectively
8	Yuvraj Chavda et al. (2015)	Vermiculite	Replacement of cement with lime, Addition of sodium silicate	Compressive strength,	Max. strength was obtained with 60% replacement of cement with lime and Addition of 15% sodium silicate
9	Tanveer Asif Zardi et al. (2016)	Pumice stone, GGBS	Replacement of cement with GGBS,	Compressive strength,	Avg. density – 925.44 kg/m^3 Avg. strength – 3.1551 N/mm^2
10	Malik Mehran Manzoor et al. (2016)	Pumice stone, Al Powder	-	Compressive strength, Tensile strength, Density	Compressive strength – 8.61 N/mm^2 good for lightweight concrete. Density – 1102.66 kg/m^3
11	Rayees Ahmad Ganie et al. (2017)	Pumice stone, Thermocol	-	Compressive strength, Density, Drying Shrinkage, Thermal Conductivity	Avg. Compressive strength – 11.69 N/mm^2 Avg. density – 1451.62 No shrinkage Thermal conductivity – 0.35
12	Nikhil S Chavan et al. (2018)	EPS	-	Compressive strength, Tensile strength, Density	Avg. Density - 566.22 kg/m^3 Avg. Compressive strength – 4.2 N/mm^2 Avg. Tensile strength – 1.3 N/mm^2

III. CONCLUSION

The following conclusion is drawn based on the critical literature:

1. Partial replacement of aggregate with expanded polystyrene (EPS) beads makes the concrete lighter than the traditional concrete.
2. A positive application as an alternative building material was seen in the replacement of aggregates through using EPS beads.
3. The use of light weight aggregates can minimize the dead load but decrease the strength of concrete in the concrete mixture.
4. It is necessary to choose the ingredients used in the floating concrete so that the specific gravity of the selected materials is lower than that used in conventional concrete.
5. It can also serve as a way of effective use of EPS disposal.

Acknowledgment:

I am extremely thankful for their motivation, kind support and valuable research guidance to Prof. (Dr.) I. N. Patel, Principal, BVM Engineering College, Vallabh Vidyanagar, Gujarat, Dr. Jayeshkumar R. Pitroda, Associate Professor, PG Coordinator Construction Engineering and Management, Civil Engineering Department, BVM Engineering College, Vallabh Vidyanagar, Gujarat, Dr. Vihangraj Kulkarni, Associate professor, HOD, Civil Engineering Department, Government Engineering College, Banswara, Rajasthan.

References:

1. Abhijit Mandlik, Tarun Sarthak Sood, Shekhar Karade Sangran Naik, Amruta Kulkarni, (2015), “Lightweight Concrete Using EPS”, International Journal of Science and Research, Volume 4 Issue 3, Page: 2007-2010.
2. Daneti Saradhi Babu, K. Ganesh Babu, Wee Tiong-Huan, “Effect of polystyrene aggregate size on strength and moisture migration characteristics of lightweight concrete”, ELSEVIER, Cement & Concrete Composites 28 (2006) 520-527.
3. Hemant K. Sarje, Amol S. Autade, “Study of Performance of Lightweight Concrete", International Journal of Latest Trends in Engineering and Technology (IJLTET), ISSN: 2278-621X, Vol. 4, Issue 4, November 2014.
4. Jay Bankim Shah, Sagar Patel, “Light Weight Concrete using Expended Polystyrene Beads and Plastic Beads”, International journal of pure and applied research in engineering and technology, ISSN:2319-507X, Volume 3(10): 43-48,2015.
5. K. Ganesh Babu, D. SaradhiBabu, " Behaviour of lightweight expanded polystyrene concrete containing silica fume”, Cement and Concrete Research 33 (2003), 755–762.
6. Lakshmi Kumar Minapu1, M K M V Ratnam, Dr. U Rangaraju, “Experimental Study on Light Weight Aggregate Concrete with Pumice Stone, Silica Fume and Fly Ash as a Partial Replacement of Coarse Aggregate”, International Journal of Innovative Research in Science, Engineering and Technology, 3(12).
7. Malik Mehran Manzoor, Abhishek Gupta, Rukhsana Gani, Ankush Tanta, “Floating Concrete by using Light Weight Aggregates (Pumice Stones) and Air Entraining Agent”, International journal of science and engineering development research, ISSN: 2455-2631, Volume 3, Issue 6, June 2018.
8. Nikhil S. Chavan, Dhiraj Yadav, Shrikant Gadhe, Dnyandeep Bachipale, Shweta Kale, Mahesh V. Tatikonda, “Mechanical Properties of Floating Concrete by using Expended Polystyrene Beads as Replacement of Aggregates”, International Research journal of engineering and technology, e-ISSN:2395-0056, p-ISSN:2395-0072, Volume: 05, Issue: 05, May 2018.
9. N. Sivalinga Rao, Y.Radha Ratna Kumari, V. Bhaskar Desai, B.L.P. Swami, (2013)“Fibre Reinforced Light Weight Aggregate (Natural PumiceStone) Concrete”,International Journal of Scientific & Engineering Research, Vol 4,(5),pp 2229- 5518.
10. Rayees Ahmad Ganie, “Floating Concrete by using Pumice Stone and Foaming Chemical”, International journal of civil engineering, e-ISSN: 1694-2280, p-ISSN: 1694-2396, Volume 4, Issue 2, 2017.
11. Roshan Gawale, Shubham Mishra, Harshal Sambare, Jidhnesh Kothari, Assistant Prof. Monali Patil, "Lightweight concrete by using EPS beads", International journal of innovative research in science and engineering, ISSN:2454-9665, Vol. No.2, Issue 03, March 2016.
12. Roshan Peter, Anantha Kumar, “Experimental Investigation of Floating Concrete Structure using Light Weight (Natural Pumice Stone) Aggregate”, World journal of engineering research and technology, ISSN: 2454-695X, Vol. 2, Issue 2, 118-129, 2016.
13. Thousif Khan, Ibrahim Killedar, Sharu Malik H N, Muhathasheem R F, Jagannatha G M, Dr. Shivakumara B, “An Experimental Study on Floating Concrete Using Light Weight Material”, International Research Journal of Engineering and Technology, e-ISSN: 2395-0056, p-ISSN: 2395-0072, Volume: 05, Issue: 05, May 2018.
14. Tamut, Rajendra Prabhu, Katta Venkataramana and Subhash C Yaragal, “Partial Replacement Of Coarse Aggregates By Expanded Polystyrene Beads In Concrete”, International Journal of Research in Engineering and Technology, Volume 3, Issue 2, Feb 2014, eISSN: 2319-1163, pISSN: 2321-7308.
15. T. Parhizkar, M. Najimi and A.R. Pourkhorshidi, (2012) “(Application of Pumice aggregate in structural lightweight concrete”, Asian journal of civil engineering (building and housing) Vol. 13, No. 1 pp 43-54.
16. Yuvraj Chavda, Shilpa Kewate, “Use of vermiculite for light weight floating concrete” , International journal of Scientific & Engineering Research, ISSN 2229-5518, Volume 6, issue 12, Dec 2015

Authors Biography:

Sagar Kaptan received his Bachelor of Engineering Degree in Civil Engineering from Government Engineering College Bharuch, Gujarat Technological University in 2017. At present he is pursuing his Master's degree in Construction Engineering and Management (Final year) from Birla Vishvakarma Mahavidyalaya Engineering College, Vallabh Vidyanagar, Anand, Gujarat. He is also working on Parametric studies on floating concrete with using thermocol.

Dr. Jayeshkumar Pitroda received his Bachelor of Engineering Degree in Civil Engineering from Birla Vishvakarma Mahavidyalaya Engineering College, Sardar Patel University (Vallabh Vidyanagar, Gujarat-India) in 2000. In 2009 he received his master's degree in Construction Engineering and Management from Birla Vishvakarma Mahavidyalaya Sardar Patel University (Vallabh Vidyanagar, Gujarat-India). In 2015 he received his Doctor of Philosophy (Ph.D.) Degree in Civil Engineering from Sardar Patel University (Vallabh Vidyanagar, Gujarat-India). He has joined Birla Vishvakarma Mahavidyalaya Engineering College as a faculty in 2009, where he is a lecturer of Civil Engineering Department and at present working as Associate Professor from February 2018having a total experience of 19 years in the field of Research, Designing and Education. At present holding charge of PG Coordinator Construction Engineering and Management. He is guiding M.E. / M. Tech (Construction Engineering and Management/ Construction Project Management/ Environmental Engineering) thesis work in the field of Civil / Construction Engineering/ Environmental Engineering. He is also guiding Ph.D. students (Civil Engineering). He has published many papers in National / International Conferences and Journals. He has published nine Research Books in the field of Civil Engineering, Rural Road Construction, National Highways Construction, Utilization of Industrial Waste, Fly Ash Bricks, Construction Engineering and Management, Eco-friendly Construction.

Dr. Vihangraj V. Kulkarni received his Bachelor of Engineering Degree in Civil Engineering from Government College of Engineering, Aurangabad in 2009. In 2012 he received his master's degree in Environmental Engineering from Indian Institute of Technology Guwahati, India. In 2018 he received his Doctor of Philosophy (Ph.D.) Degree in Civil Engineering from Indian Institute of Technology Guwahati, India. He has joined Civil Engineering Department at Government Engineering College Banswara, Rajasthan. He is guiding M. Tech. thesis work in the field of Civil / Construction Engineering/ Environmental Engineering. He has published 17 papers in National / International Conferences and Journals. He has published one Research Books in the field of Civil Engineering, "Utilization of Fly ash in construction industries: The way forward".