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A Review on Light Weight Concrete Using Vermiculite

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ABSTRACT

Concrete is a major construction material in construction, the vast usage of ingredients of concrete will leads to depleting natural resources. Based on the density concrete it is classified into three groups natural weight, light weight and heavy weight concrete. In specific locations this light weight concrete is used and normally it is prepared either by using lightweight aggregate or by using an air entraining agent. It is used in non-structural members its load carrying capacity is low. Vermiculite is clay substance which is highly porous. In thermal treatment the bulk density of crude vermiculite decreases from 640-1200 to 60-160 kg/m^3. Vermiculite is a clay mineral similar to montmorillonite in structure. Vermiculite is very porous, easily absorbs water ,its a neutral clay with a PH of 7.0-7.5, is a hydrous phyllosilicate mineral which under goes significant expansion when heated.In this paper an attempt is made to gather all the studies made on light weight vermiculite concrete in the recent years and put together at one place

Keywords- cement, fine aggregate, coarse aggregate and vermiculite.

INTRODUCTION

Due to the advancement in the construction industry need of new technology , methods are Much needed to tackle the shortage of raw material, as it is getting depleted due to the over usage in construction minimizing the material usage is only possible by Recycling partial replacement, replacing the materials in few works. The material such as coarse aggregate, fine aggregate can't be replaced where heavy action of loads are occurring. But the replacement is possible in places where less loads are applied, so we can save some materials which are less available by replacing them which is not necessary in few works

Light weight concrete is generally obtained by incorporating light weight aggregate like Pumice, expanded clay, Perlite, Dolamite, Vermiculite. The specific weight of aggregate less than 1120kg/m^3 are generally considered as light weight; in some cases 90 to 900kg/m^3 are also obtained. The bulk weight weight of vermiculite ranges from 60 to 130kg/m^3 . The concrete with weight less than 1800kg/m^3 are considered as light weight concrete. The density of vermiculite concretes are from 400 to 900kg/m^3 . As compared to conventional concrete light weight concrete shows good features like low density, thermal insulation, permeability, sound insulation, reduction in dead weight. Due to their lower density, the demand of light weight concrete is increasing, which makes reduction of cross sections of structural elements.

Vermiculite is a natural occurring material and is composed through the disintegration of mica. It is a micaceous mineral that expands many times when heated to 650-1000^{o}C. Hydrated aluminium and magnesium silica are combined to create a complicated chemical makeup. The expanded vermiculite has a high refractoriness and strong thermal conductivity but a low bulk density. The light weight vermiculite concrete is the greatest choice for gaining strength since it uses vermiculite as a substitute for the coarse and fine aggregates as well as mineral admixtures like fly ash and silica fume.

WORKABILITY

Workability serves as the primary measure of how well new concrete is mixed uniformly and how easily it can be placed and compacted.The workability will effectwhen the concrete is supplemented with additional ingredients. The slump value of self-compacting mortar incorporating raw vermiculite ranges between 40mm to 60mm. The slump will increase when the vermiculite percentage increase.

LIGHT WEIGHT CONCRETE WITH VERMICULITE

T. Subramani, M. Meghnathan, S. Priyanka(2017) They investigated on Fiber Reinforced High Strength Concrete, using recycled aggregate for 20% and 40% replacement of coarse aggregate for M30 grade of concrete with replacement of natural sand with vermiculite mineral with various percentages. And 1% steel fibers is also used and compared with conventional concrete casted using plastic fibers. All the specimens are tested for 28 days using cubes and cylinders and tested the compressive strength,split tensile strength and workability. Investigation resulted that strength of vermiculite concrete although decreased but was increased using super plasticizer and usage of vermiculite had given less density proving to be suitable for light weight structures.

A.V.V. Sairam (2017) (2017) In this study, the mechanical characteristics of M35 grade concrete were investigated using different amounts of vermiculite (5%, 10%, 15%, 20%, 25%, and 30%) in place of some or all of the fine aggregate, as well as various amounts of fly ash (replacing cement in various percentages of 10%, 15%, and 20%) and silica fume (adding 5%, 7.5%, 10%, and 12.5% weight of cement). When the compressive strength reaches its maximum, the W/c ratio is 0.42.

S Syed Abdul Rahman and Gijo K Babu (2016) This paper presents about M30 grade concrete to know diffrences in density of concrete with and without vermiculite. For constant water cement ratio of 0.40 for different variation 0%,5% and 10% of replacement of natural sand with vermiculite powder . It was found that there is a decrease in strength with the increase in vermiculite but decrease in density from 2486 to 2167 kgs/m3 with proves that use of vermiculite decrease the self weight of concrete with slight decrease in compressive strength.

M.R. Divya., Prof. M. Rajalingam and Dr. Sunilaa George(2016) In this study of M30 grade concrete mechanical properties experimental set up were done by replacing fine aggregate with vermiculite passing through 2.36mm sieve by 40%,50%and60%by weight it was found that concrete mix with replacement with 40% vermiculite has given increase in compressive strength, split tensile strength and flexural strength alternately indicates use of high percentage of vermiculite that is beyond 40% as replacement to fine aggregate reduce the strength.

L .Vijayan (2016)provides a detailed analysis of how exfoliated vermiculite can be utilised in place of fine aggregate. Wherever the ecological temperature is too high, this study was associated. 5%, 10%, and 15% of fine aggregate are used for the replacements. Vermiculite-replaced concrete, as compared to conventional concrete, exhibits a negligible density loss of up to 15%, we can now say. Comparing the split tensile test to conventional concrete, there were little variances in the split tensile strength.

M. Preethi, P. Ashveen Kumar, M. Hamraj(2021) The current study focuses on the partial replacement of fine aggregate with 0% to 25% of vermiculite with an increase of 5% and cement with 0% and 10% of continuous silica fume to prepare M30 grade concrete in order to enhance concrete's performance. In this study, an effort is undertaken to determine how concrete strength and weight are affected by exposure to HCL acid. Different mix proportions of concrete cubes are made and then subjected to hydrochloric acid with a pH of 5. For M30 grade concrete, 100mm x 100mm x 100mm cubes are cast, and they are then cured in water for 28 days. After that, the cubes are submerged for 7 days in a curing drum filled with 4% concentrated hydrochloric acid, maintaining a pH of 5. The weight and compressive strength of the cubes are next examined, and this project also examines the impact of FOSROC CONPLAST SP430, a water-reducing super plasticizer, on the weight and compressive strength of concrete.

S.Sharmila and L.Vijayan (2016) Vermiculite was used in place of fine aggregate for the purposes of this investigation. It is a member of the group of lightweight aggregates. Vermiculite that has been exfoliated is used in place of fine aggregate. The majority of this project's focus is on regions with extremely high ecological temperatures. The Replacements were completed with fine aggregate at 5, 10, and 15%. And eventually draw the conclusion that concrete that has been replaced with vermiculite exhibits a considerable decrease in density of up to 15% when compared to conventional concrete. When compared to regular concrete, there was little fluctuation in split tensile strength during the test.

FuatKoksal (2012) This experiment was conducted to determine whether vermiculite would work well with cement in concrete. Vermiculite replacement research was done on cement to see how it affected concrete's compressive strength. The replacement of the percentages 0%, 5%, and 10% created two experimental groups. The outcomes demonstrated that vermiculite has a noticeable boost in compressive strength on concrete. Which shows that lightweight concrete, when compared to ordinary concrete, is frequently suited to lower an element's self-weight while increasing its strength.

M.V.S.S. Sastry, P. Ashveen Kumq,. K.Jagannadha Rao (2018) In addition to mineral additives like Ultra Fine Fly Ash (UFA) and Micro Silica, which are partially replaced with cement by percentages ranging from 5-15% and 5%,

10%, and 15% by weight of cement, this paper presents an experimental study on the properties of M20 concrete with various percentages from 0-100% at an increment of 20% as partial replacement with vermiculite to the total weight of fine aggregate. Exfoliated Vermiculite (EV) replacement is reducing compressive strength over time, although a cost-effective design was achieved with a 20% sand replacement.

Ramapradheep. G.S, M. Sivaraja(2017) in this Experimental study on self compactingself curing concrete using light weight aggregate for M40 grade using 5%,10% LECA as and 5%,10% replacement to fine aggregate and test was conducted using cubes and cylinders the workability and properties improved for 10% LECA and 10% vermiculate as a partial replacement of fine aggregate.

Yuvraj Chavdaa , Shilpa Kewate(2015) This study examined the use of vermiculite as a light weight concrete and a replacement for nominal aggregate. In accordance with BIS guidelines, a test was performed to see if vermiculite could replace up to 25% of the cement in non-structural and structural applications. The strength requirements for structural applications could not be met by the cement-vermiculite samples. The strength and other characteristics for non-structural materials as wise flooring tiles, solid blocks, pavement blocks, and bricks are framed from Bureau of Indian Standards (BIS) standards. For additional research, an economic feasibility assessment must be conducted.

Rashad Alaa M (2016) he write a review of about the Exfoliated vermiculite (EV) which exhibits different properties like low thermal conductivity, low bulk density, endurance, chemical inertness and comparatively high melting point. Exfoliated vermiculite has effective use in civil engineering, chemical and agriculture fields. In this overview, the author summarized the previous studies using Exfoliated vermiculite as a constructive material in existing cementitious materials, geopolymers and binders.

CONCLUSIONS

From this review study for various experimental investigations conducted for different concrete mixes following conclusions are made.
l. To replace fine aggregate vermiculite is a good option rather than coarse aggregate.
ll. To improve the mechanical properties the fine aggregates may be replaced by vermiculite up to 20%
lll. Vermiculite can be used up to M30 grade concrete as a replacement.by adding super plasticizer vermiculite can also be used as a suitable material for roof and floor insulation.
lV. By replacing fine aggregate with vermiculite and mineral additives like silica fume, fly ash, micro silica GGBFS as replacement to cement they will have the properties of self compacting concrete and self curing concrete with low density.

FUTURE SCOPE

Albeit a few works on the impacts of vermiculite are recorded, many explores are as yetrequired:

(1) In the regions where sand is not available vermiculite can be used as a replacement.
(2) The strength is also being achieved up to normal limits, so we ca recommend vermiculite.
(3) As light weight structures are being builtthey are more useful in earthquake regions.

REFERANCES

[1] A.V.V Sairam and K Sailaja " An Experimental Study on Strength Properties of Vermiculite Concrete Using Flyash as Partially Replacement of Cement and Silica Fume as Mineral Admixture", International Research Journal of Engineering and Technology, Vol. 4(2017).

[2] T.Subramani, M.Meganathan, S.Priyanka , " Experimental Study On Strength Properties Of Diaphanous Concrete With Vermiculite " , International Journal of Application or Innovation

[3] Yuvraj Chavdaa ,ShilpaKewate " Use of vermiculite for light weight floating concrete" International Journal of Scientific & Engineering Research, Vol.6, Issue ISSN 2229-5518 (2015)

[4] M.V.S.S.Sastri, P.Ashveen Kumar and K.Jagannadha Rao "Experimental Investigation on Strength Properties of Ultrafine Fly ash and Micro Silica as Mineral Admixtures for Vermiculate Mortar ",(2019) under publication in i-manager"s Journal on Journal on Material Science (JMS)

[5] P.santoshmurugan Dr.M. Devesene Dr.R.Venkatasubramani "An Experimental Study On Strength Properties Of The Diaphanous Concrete With Vermiculite." International Journal Of Applied Engineering Research. Vol.10 (2015)

[6] FuatKoksal "Effect Of High Temperature on Mechanical and Physical Properties of Lightweight Cement Based Refractory Including Expanded Vermiculite", Journal Of Materials Research Innovations, Vol. 16, (2012)

[7] Thangam.D,Geetha.V " Effect Of Vermiculite And GGBFS On Concrete By Self Curing Parameter" International Journal of Advances in Engineering Research(IJAER) Vol.13 (2017)

[8] A. Azad, S.F. Mousavi, H.Karami, S.Farzan "Using Waste Vermiculite and Dolomite as Eco Friendly Additives for Improving the Performance of Porous Concrete", Eng. J., vol. 22, (2018)

[9] Rampradheep.G.S. , M. Sivaraja „Experimental Investigation on Self-Compacting, Self-Curing Concrete Incorporated with the Light Weight Aggregates" Brazilian. Archives. Biology. Technology. ISSN 1678-4324vol.59 (2017).

[10] S.JyothiManjula, G.VijayMano ,J.SundarPrabu, M.Prabanjan,S.Pradeep " Structural And Impact Behaviors Of Light Weight Self-Compacting Concrete. " The Asian Review of Civil Engineering ISSN Vol. 7 (2018).

[11] Chandraseker.G.,Hemanth.Kumar.Ch.,V.Manikantha,M.Simhachalam., "Effect Of Flyash On Mechanical Properties Of Light Weight Vermiculite Concrete." International Journal of Innovative Research in Science, Engineering and Technology.Vol.5 (2016).

[12] Rashad, Alaa M. " Vermiculite as a construction material–A short guide for Civil Engineer. " Construction and Building Materials (2016).

[13] M.Preethi, P.Ashveen Kumar and M.Hamraj "Strength Characteristics of High Strength Concrete (HSC) with and without Coarse Aggregate (2019)", International Journal of Engineering and Advanced Technology, ISSN vol. 9 (2019)

[14] M.Preethi, P. Ashveen Kumar and M. Hamraj "Study On Concrete with Replacement Of Fine Aggregates By Vermiculite And Cement By Silica Fume" (2021), Vidya Bharati International Interdisciplinary Research Journal 2021, Pages 2497 – 2503.

[15] Dharma Prakash R andDr.Sreevidya V (2016) the present study explores the strength and durability properties of light weight vermiculite concrete.

[16] Mr. M. Gunasekaran et al., îˊTŤ6Ò DzStudy on Vermiculite)ncorporate in Mortardz Study on Vermiculite replacing natural sand is investigated. Design mix having the mix proportion 1:3 with the water cement ratio 0.5

[17] Carbajo, J.; Esquerdo-Lloret, T.V.; Ramis, J.; Nadal Gisbert, A.V.; Denia, F.D. (2015) Acoustic properties of porous concrete made from arlite and vermiculite lightweight aggregates. Mater. Construcc. 65 [320], e072 http://dx.doi.org/10.3989/mc.2015.01115

[18] Aliakbarsayadi, Thomas, R.Neitzert, G. Charles Clifton, Min Cheol Han"Assessment of Vermiculite Containing Bio-Polymer Aggregate".

[19] Norman M.P. Low. (2003) "Vermiculite – Apromising material for high temperature", Refractories & industrial Ceramics, Volme44,No.3

[20] Mr. M. Gunasekaran A. Priyalakshmi, C.Anudevi H. Premachandar"Study on Vermiculite Incorporate in Mortar" (IJIRST/ Volume 2 / Issue12/ 007)

[21] Osman Gencel "Properties of gypsum composites containing vermiculite and polypropylene fibers: Numerical and experimental results", Energy and Buildings, 2014; 70: 135–144.