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A Review Paper on Incorporation of Waste Glass Powder and Hydrated Lime as Cement Partial Replacement to Improve Concrete Mechanical Properties and Increase Service Life

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Abstract *This review paper indicates the utilization of elective material, that can halfway supplant concrete and increment the administration life of solid structures is essential from the natural and mechanical perspective. In this specific circumstance, the halfway replacement of concrete in cement by pozzolanic way and hydrated lime control the autogenous healing. Along these lines examined assessed the consolidation of glass powder and hydrated lime is a secluded and joined manner as halfway substitutes for concrete in cements. The compressive quality and the chloride entrance opposition were assessed by methods of electrical resistivity, chloride porousness, consistent state chloride movement test and dispersion test getting the diffusivity and chloride sullied profundity by the colorimetric strategy. The silica reactivity test was likewise directed due to antacid substances of the waste glass being higher than standard perquisites. It was reasoned that the consolidated utilization of ground glass powder and hydrated lime in concrete permitted, advancing the properties identified with sturdiness and compressive quality effectively accessed at 28 days .Besides, it expanded the assessed administration life up to multiple times, filling is an option for the decrease of concrete use and solid properties improvement.*

Key Words: Sustainable materials, Chloride ion penetration, Durability, Waste glass, Pozzolanic activity.

1. INTRODUCTION

Concrete is one of important and widely used construction material. It is made of a mix of course, fine aggregates and bonded by cement paste. Due to this concrete consume high amount of natural resources like river sand and stones. As human population is growing, need of new infrastructure has increased. Now days environmental problem are important concern in construction industry. Use of natural resources in concrete leads to consumption of natural resources Cost of natural resources also plays a major role in construction related problems. In order to find alternates to natural resources researchers has found other ways which may reduce the use of natural resources. Use of waste materials is one of them, which are now days widely used in construction industry.

Glass powder and Hydrated lime are waste materials generated respectively. These two materials are found to be effective to be used in concrete mix and positive effects on strength characteristics also observed. In this research Glass powder and hydrated lime will be used as partial replacement for cement and sand respectively. Various tests will be conducted to check effective of these two materials together in single mix in concrete to find effects on strength characteristics.

1.1 Materials

1.1.1 Sustainable materials Sustainable materials will be material us utilized all through our customer and modern economy that can be created in required volumes without exhausting non inexhaustible assets and without disturbing the set up consistent state harmony of the earth and key characteristic asses framework. Such material shift colossally and may run from bio based polymers got from polysaccharides, or exceptionally recyclable materials , for example, glass that can be repressed an inconclusive number of times without requiring extra mineral assets. The objective of this middle is to comprehend the basic science behind new types of maintainable material and When promising open doors are recognized, to design new materials required by industry and business to lessen un-favourable ecological and sociological impacts of customary escalated materials.

1.1.2 Chloride ion penetration Chloride entrance alludes to the profundity to which chloride particles from nature infiltrate into the solid. This can promote erosion in RCC structure, and therefore investigation of chloride penetrability is a significant angle that influences the strength of the solid.

1.1.3 Durability Durability might be characterized as the capacity of cement to oppose enduring activity, synthetic assault , and scraped spot while keeping up its ideal building properties. Various cements require various degrees of solidness relying upon the introduction condition and properties wanted.

1.1.4 Waste glass Waste glass is a perfect material for reusing. Contrasted and the assembling of new glass, squander glass reusing helps moderate crude material

assets. Utilizing waste glass additionally decreases vitality necessities (by an option of about 0.2 to 0.3% purpose of waste glass). Therefore reusing waste glass is useful for nature.

1.1.5. Pozzolanic acitivity The pozzolanic activity movement is a measure for the level of response after some times or the response rate between a pozzolan and ca2+ or calcium hydroxide with in the sight of water. The pace of the pozzolanic response is reliant on the inborn qualities of the pozzalan, for example , the particular surface zone the compound organization and the dynamic stage content.

Physical surface adsorption isn't considered as being a place of the pozzolanic movement, in light of the fact that no irreversible atomic bonds are shaped all the while.

1.1.6 Autogenous healing Autogenous healing is the capacity of cement to fix or mend breaks within the sight of dampness. For a fragile material, subject to dimensional changes relying upon the measure of dampness present, oneself mending property of cement is urgent to its application in water holding structures.

2. Scope of Paper

Uses of two materials are completely encouraging or beneficial in concrete because concrete contains large amount of natural resources in form of fine aggregates or course aggregates. To reduce the amount of using natural resources in concrete waste materials can be effective alternates. This study if focused on use of Glass Powder and Hydrated in concrete and to check various effects.

3. Literature Review

SA Barbhuiya, JK Gbagbo, MI Russell, PAM Basheer (2009) this paper presents the results of an experimental investigation on the properties of fly ash concrete incorporating either hydrated lime or silica fume to improve the early strength of concrete. Test results indicated that the addition of lime and silica fume improved the early age compressive strength of fly ash concrete. The inclusion of silica fume was only found to increase the 28 days strength significantly. The air permeability of concrete containing lime and silica fume either decreased or remained almost the same when compared to the concrete without these. The addition of lime and silica fume also improved the sorptivity of concrete. Through the use of differential scanning calorimetry and thermogravimetric analysis (DSC/TG), it was demonstrated that the addition of hydrated lime increased the $Ca(OH)_2$ content in cement paste. The mercury intrusion porosimetry (MIP) data confirmed the beneficaial action of hydrated lime and silica fume, towards decreasing the total pore volume of fly ash cement paste.

Ion Dumitru, Tony Song, Vasile Capar, Philip Brooks, Justin Moss (2010) this paper indicates the examinations were completed to evaluate the capacity of the squashed reused glass as common sand substitution utilizing proportion of 30%, 45%, and 60%. Substitution of cement materials in concrete was likewise viewed as utilizing concrete substitution proportions of 7.5%, 15% and 25% of powder glass. The impact of glass supplanting and cement material supplanting with powder glass on new and solidified solid properties were surveyed. It was reasoned that with the joining of 45% of squashed glass as a characteristic sand substitution, the compressive and flexural qualities have imperceptibly expanded, while the roundabout rigidity barely diminished. The solid with glass as the characteristic sand substitution had lower shrinkage and huge lower chloride dissemination coefficient. Cements with powder glass as a cement materials substitution indicated lower compressive quality and barely higher drying shrinkage than the control blend, yet meeting the solid blend plan prerequisites.

Ana Mafalda Matos, Joana Sousa-Coutinho (2012) this research paper indicates it is well known that Portland cement production is an energy- intensive industry, being responsible for about 5% of the global anthropogenic carbon dioxide emission worldwide. An important contribution to sustainability of concrete and cement industries consists of using pozzolanic additions, especially if obtained from waste such as waste glass. Crushed waste glass was ground (WGP) and used in mortar as a partial cement replacement (0%, 10% and 20%) material to ascertain applicability in concrete. An extensive experimental program was carried out including pozzolanic activity setting time, soundness, specific gravity, chemical analyses, laser particle size distribution, X- ray diffraction and scanning electron microscopy (SEM) on WGP and resistance to alkali silica reaction (ASR), chloride ion penetration resistance, absorption by capillarity, accelerated carbonation and external sulphate resistance on mortar containing WGP. Glass particles well encapsulated into dense and mature gel observed by SEM, may help explaining enhanced durability results and thus confirming that waste glass powder can further contribute to sustainability in construction.

JM Khatib, EM Negim, HS Sohl, N Chileshe (2012) paper researches the exhibition of cement containing glass powder as halfway replacement of concrete. Portland concrete was in part supplanted with 0-40% glass powder. Testing included ultrasonic heartbeat speed, compressive quality and ingestion. Examples were relieved in water at 20^0C. The outcomes show that the most extreme quality of cement happens at around 10% glass powder. Past 10% glass powder the quality of cement decreases and is lower than that of the control.

R Oliveira, J De Brito, R veiga (2013) this paper presents a practically investigation of the utilization of cement renderings with consolidation of fine reused totals with the expectation of improving their exhibition. A test program was accordingly structured with a progression of tests being performed with the goal of describing the conduct of such renderings at a few levels: mechanical quality, water – related conduct, toughness and different properties. Despite the fact that few investigations report utilizing different materials as filler in mortars, glass has only occasionally been concentrated been concentrated in that job. The outcomes were sure, with most properties improving with the joining of up to 20% of fine glass total.

GVijaykumar , H vishaliny, D Govinddarajulu(2013) this paper defines the cement manufacturing industry is one of the carbon dioxide emitting sources besides deforestation and burning of fossil fuels. The global warming is caused by the emission of greenhouse gases such as CO2 to the atmosphere. Among the greenhouse gases CO_2 contribute about 65% of global warming. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. In order to address environmental effects associated with cement manufacturing there is a need to develop alternative binders to make concrete. Consequently extensive research is going into the use of cement replacement using many waste materials and industrial by products. Efforts have been made in the concrete industry to use waste glass as partial replacement of coarse or fine aggregates and cement. In the study finely powdered waste glasses are used as a partial replacement of cement in concrete for new concrete. Glass powder was partially replaced as 10%, 20%, 30%, 40% and tested for its compressive, tensile and flexural strength up to 60 days of age and were compared with those of conventional concrete from the results obtained it is found that glass powder can be used as cement replacement material up to particle size less than 75um to prevent alkali silica reaction

P Ashok, MP Sureshkumar (2014) this paper defines the Bayer process from the creation of alumina from bauxite mineral is portrayed by low vitality productivity and its brings about the creation of noteworthy measures of residue like, high alkalinity bauxite deposits known as red mud. Presently red mud is created nearly at equivalent mass proportion to metallurgical alumina and is arranged into fixed or unlocked fake impoundments (landfills), promoting significant ecological issues. It involves oxides of iron, titanium and silica alongside some other minor constituents. Nearness of Alumina and Iron oxide in red mud repays the lack of similar sediment in limestone which is the essential crude material for concrete creation. Nearness of pop in the red mud which when utilized in clinker creation kills the sulphur content in the pet coke that is utilized for consuming clinker enrooted concrete creation and adds to the concrete setting qualities. In light of financial matters just as ecological related issues, gigantic endeavours have been coordinated worldwide towards red mud the executive gives if use, stockpiling and removal. Various roads of red mud use are pretty much known however none of them have so far end up being monetarily suitable or industrially achievable. Trails have been led under research centre condition to evaluate the quality attributes of the aluminium red mud. The undertaking work centres around the appropriateness of red mud got for development. Five experimental groups were comprised with the substitution rates 0%, 5%, 10%, 15%, 20%, of red mud and 5% of hydrated lime with concrete in every arrangement. To accomplish Pozzolanic property of red mud, hydrated lime was included. This paper brings up another promising bearing for the correct use of material.

P lorca, R Calabuig, J Benlloch, L Soriano, J paya(2014) paper indicates that the decrease in Portland concrete utilization implies lower CO_2 discharge. Incomplete substitution of Portland concrete by pozzolans, for example, fly debris has its confinements because of the amount of calcium hydroxide created in the blend. In this work we have considered the commitment of the expansion of hydrated lime to Portland concrete + fly debris framework. We have likewise examined a few degrees of concrete substitution, running from 15% to 75%.The best mechanical outcomes were acquired supplanting half of Portland concrete by a similar measure of fly debris in addition to the expansion of hydrated lime (20% regard to the measure of fly debris). In these frameworks, a corrosive bases self-balance of the network has happened through a pozzolanic response of fly ash with Portland freed in the hydration of Portland concrete and the additional hydrated lime. It has been distinguished for these blends a lot of hydrated gehlenite, average response item from rich-alumina pozzolans.

Hongjian Du, Kiang Hwee Tan(2014) this paper defines the pozzolanic reactivity of waste glass powder was tentatively learned at concrete substitution levels of 0, 15, 30, 45 and 60% by weight. Results uncovered that the solid compressive quality was not diminished by the concrete replacement following 28 days as a result of the pozzolanic response between glass powders and concrete hydration items if the substitution is beneath 30%. Additionally the protection from the chloride particle and water entrance persistently increments with expanding glass powder content up to 60% concrete substitution. At 60% substitution level the electrical resistivity and water entrance profundity were decreased by 95% and 80% separately while the compressive quality was kept up as 85%. These upgrades in solidness properties are expected to the refined microstructures, especially at the interfacial progress zone. Pore size conveyance was estimated to shows that elite cement (improved quality and

impermeability against chloride and water) could be accomplished by utilizing glass powder as 15% added substances which add to the pozzolanic response as opposed to being inactive fines for minimal pressing.

DP santos, ARG Azevedo, RL Hespanhol, J Alexandre (2016) this paper define the look for reuse produced squander in urban focuses, proposing to protect common assets, has remained genuinely consistent, both in setting of forestalling abuse of assets as the emplacement of waste on nature. Glass squander glass made a genuine natural issue, for the most part on account of irregularity of its streams. Utilization of this item as s mineral added substances, finely ground, concrete substitution and total is a promising heading for reusing. This work plans to consider the impact of glass squander from cutting procedure in cement mortar, supplanting some portion of concrete. Glass powder is utilization supplanting Portland concrete at 10, 15 and 20% by mass. Delivered mortar will be assesses its presentation in new and solidified states through tests actes in lab. Choice include is shown by makers of added substances and specialists to introduce great outcomes when utilized as glue mortar.

Hongjian Du, Kaing Hwee Tan (2017) this paper indicates the mechanically and solidness properties of cement with concrete supplanted by finely grounded glass powder in high volume up to 60% were examined. XRD and TGA examinations demonstrated that the fine glass powder responded with calcium hydroxide to shape calcium- silicate – hydrates. In that capacity the microstructures of cement were high smaller and homogeneous, particularly at the interfacial change zone. Concrete with concrete supplanted by 15% and 30% glass powder showed the most not worthy quality.

Zhu Pan, Zhong Tao, Timothy Murphy, Richard Wuhrer (2017) this review paper indicate that the high temperature performance of cementitious materials containing fine glasses powders (GP) as a partial replacement for ordinary Portland cement. Various mixes were prepared in which cement was replaced by GP in 3 different proportions, i.e. 5wt%, 10% and 20wt%. Compressive strength tests were carried out at various temperatures (20,500 and 800^{0}C) for mortars containing GP. To have a fundamental understanding of the material behaviour at elevated temperatures, x ray diffraction (XRD), scanning electron microscopy (SEM) and thermal strain tests were conducted on the corresponding pastes. Results show two distinct temperature ranges regarding effects of GP on the strength of mortars. At temperature below 500^{0}C, a mortar mix with 20% GP (Type1) showed the best performance with an average strength loss of 15% compared to 33% strength loss in reference samples. The XRD analysis shows a reduction in the calcium hydroxide (CH). Therefore, the low strength loss of mortars with GP is associated with their low CH content. In the temperature range of 500-800^{0}C, the average strength loss was 56% in the GP mortar and 35% in the reference mortar. The thermal shrinkage of GP paste is higher than the reference paste. This can be attributed to softening of glasses. The higher strength loss of GP mortar is due to the higher thermal incompatibility which arises because the paste shrinks while sand particle expand.

Samiha Ramdani, Abdelhamid Guettala, ML Benmalek, Jose B Aguiar (2019) this review paper indicates that the present experimental results about the effect of incorporating waste rubber aggregates in combination with waste glasses powder or silica sand powder obtained from dune natural sand, on the performances of cementitious mixtures. Rubber aggregates (RW) were used to replace crushed sand in concrete mixes with ratios of 10%, 20%, 40% and 60% while glass powder (GP) and natural sand powder (SP) were used to replace 15% of the cement weight. Nine different forms of concrete with the separate wastes forms of concrete with the separate wastes and with the combination of them were designed and prepared. The mixtures were characterized in the fresh and hardened states by means of workability, fresh density, compressive and tensile strengths, propagation of ultrasonic waves and deformability tests. The water/binder ratio and superplasticizer percentage of all mixtures were maintained constant. The results showed that the strength increased with the incorporation of glass powder and rubber aggregates, especially with 10% and 20% RW contents. In addition, the developed rubberized concrete with the incorporation of glass powder presented higher fresh density and deformability, compared to the cementitious rubberized mixtures without GP. Furthermore, the simultaneous incorporation of rubber waste and glass powder enhanced the concretes workability due to the low GP and RW water absorptions.

MT Marvila, J Alexandre, ARG Azevedo, EB Zanelato, GC Xavier, SN Monteiro (2019) review paper indicates that mortars are cement- based material used mainly to coat and settle construction blocks. In addition to cement, their composition usually includes hydrated lime, sand, and water. The hydrated lime is important to improve the mortar workability. However, lime has a high commercial cost, and its production causes emission of $C0_2$, a major responsible for global warming. Therefore, the purpose of this work was to investigate the possibility of total or partial replacements of hydrated lime in mortars by Kaolinitic clay with ideal plasticity parameters. Clay amounts of 0, 25, 50, 75, and 100wt% were used as replacement of hydrated lime in mortars. The results showed that with up to 50wt % of hydrated lime replacements, it is perfectly feasible to fulfil with technological parameters of standards.

Peter A Adesina, Festus A Olutoge (2019) this review paper indicates that sustainability in construction encourages the incorporation of rice husk ash in concrete. While the properties of such concrete have, been

sufficiently establishment in the literature, the properties of concrete incorporating blended rice husk ash lime as partial replacement for concrete has not been reported. This study seeks to fill the identified research gap. In this study, RHA and lime were blended and used to replace conventional cement at different percentages to form RHA- lime concrete. Results from strengths test showed that RHA- lime concrete exhibited higher early strength development was impaired by lime leaching. Also RHA lime cement mixes were found suitable for use in structure concrete and can replace conventional cement up to 25%. The inclusion of lime enhanced pozzolanic reaction, here the strength properties of RHA- Concrete. RHA- lime mixes can therefore serve a viable alternative to conventional cement in concrete.

Xin Deng, Jun Li, Zhongyuan Lu, Jun Chen, Kai Luo, Yunhui Niu (2020) this paper indicate that lime –based mortar is one of the most widely used decorative materials due to its environment- friendly and healthy nature since ancient times. In this study, decorative rendering mortar was prepared through partially replacing white cement by hydrated lime. Effects of hydrated lime on mechanical properties, microstructure and efflorescence behaviour of decorative rendering mortar were investigated. Results showed that the decorative rendering mortar with required physical properties could be obtained when less than 50% of white cement replaced by hydrated lime. Newly generated $Ca(OH)_2$ from cement hydration was easy to be carbonated in- situ due to looser structure of cement- hydrated lime system with high porosity. Rapid carbonation of newly generated $Ca(OH)_2$ would also promote the cement hydration. Carbonation and the in-situ formed carbonation products decreased the soluble $Ca(OH)_2$ and blocked the migration channel in the early stage, hence refined large pores into small pores and imhibited the efflorescence.

4. CONCLUSIONS

From the study it can be observed that Glass powder and Hydrated lime have positive effects on various properties on concrete when replaced at a specific quantity. From study it was observed that there is very less findings on use of quartzite in concrete. Conclusion of the following study can be explained for glass powder and hydrated lime as

- Upto 15% replacement of cement with Glass Powder in concrete shows positive effects on strength of concrete.
- To improves the workability and water retention of cement.
- The main purpose of glass powder is use in concrete make the structure denser, this results reduction in water absorption and improves the durability of concrete.
- More we increase hydrated lime with helps to autogenous healing.
- Hydrated lime helps to maintain PH levels in the concrete.

REFERENCES

1. Mewes, Heinz, Wilhelm Nachtigall, and Micheal Wienand. “Appartus for the incorpartion of glass fibres into thermoplastic synthesis resins.” U.S Patent NO. 4,616,989. 14 oct 1986.
2. Barnhuiya, S.A., et al. “Properties of fly ash concrete modified with hydrated lime and silica fume.” Construction and Building Materials 23.10 (2009)
3. Dumitru, Ion, et al. “ Incoporation of recycled glass for durable concrete. “ 2nd International Conference on Sustainable Construction Materials and Technolgies.2010.
4. Matos, Ana Mafalda, and Joana Sousa- Coutinho. “Durabilty of mortar using glass powder powder as cement replacement.” Construction and Building Materials (2012)
5. Khatib, J.M , et al. “Glass powder utilisation in concrete production .” European Journal of Applied Sciences 4.4 (2012): 173-176
6. Vijayakumar, G, H. Vishaliny and D. Govindarajulu. “Studies on glass powder as partial replacement of cement in concrete production.”International journal of Emerging Technology and Advanced Engineering 3.2 (2013): 153-157.
7. Oliveria, R.J. De Brito, and R. Veiga. “Incorporation of fine glass aggregates in rendering.” Construction and Building Material 44 (2013): 329-341.
8. Ashok, P, and M.P Sureshkumar. “ Experimental studies on concrete utilising red mud as a partial replacement of cement with hydrated lime.” J.Mech . Civil Eng(2014): 1-10.
9. Du, H., & Tan, K.H (2014). Waste glass powder as cement replacement in concrete. Journal of Advanced Concrete Technology , 12(11), 468-477.
10. Lorca,P., et al. “Microconcrete with partial replacement of Portland cement by fly ash and hydrated lime addition.” Materials& Design 64(2014):2014
11. Yildirim, G., Sahmaran, M., & Ahmed, H.U (2015). Influence of hydrated lime addition on the self-healing capability of high- volume fly ash incorporated cementitious composites. Journal of Materials in Civil Engineering, 27(6), 04014187.
12. Santos, D.P., et al “ Characterization of incorporation the glass waste powder in adhesive mortar”. Characterization of Minerals, Metals, and Materials 2016. Springer, Cham, (2016).539-545.

13. Du, Honigjian, and Kaing Hwee Tan . " Properties of high volume glass powder concrete." Cement and Concrete Composites 75(2017): 22-29.
14. Dumitru, Ion,et al. "Incorporation of recycled glass for durable concrete." 2nd International Conference on Sustainable Construction Materials and Technologies. 2010.
15. Pan, Zhu, et al. "High temperature performance of mortars containing fine glass powder". Journal of cleaner Production 162(2017): 16-26.
16. Ramdani, Samiha, et al. "Physical and mechanical performance of concrete made with waste rubber aggregates, glass powder and silica sand powder." Journal of Building Engineering 21(2019): 302-311.
17. Marvilla, M.T, et al. " Study on the replacemens of the hydratd lime by Kaolinitic clay in mortars." Advanced in Applied Ceramics 118.7(2019): 373-380.
18. Marvila, Markssuel Teixeria, et al. " Evaluation of the use of marble waste in hydrated lime cement mortar based." Journal of Materila Cucle and Waste Management 21.5 (2019): 1250-1261.
19. Sposito, Felipe A.,et al. " Incorporation of PET wastes in rendering mortars based on hydrated lime." Journal of Building Engineering 32 (2020); 101506.
20. Pahroraji, Mohammed Ezad Hafez Mohd, et al. " Properties of coal ash foamed brick stabilised with hydrated lime- activated ground granulated blast furnace slag." Construction and Building Materials 235(2020): 117568.
21. Marvila, Markssuel Teixeria, et al. " Evaluation of the use of marble waste in hydrated lime cement mortar based." Journal of Materila Cucle and Waste Management 21.5 (2019): 1250-1261.
22. Adesina, Peter A., and Festus A. Olutoge. "Structural properties of sustainable concrete developed using rice husk ash and hydrated lime." Journal of Building Engineering (2019).
23. Deng, Xin , et al. " Effect of hydrated lime on structure and properties of decorative rendering mortar." Construction and Building Material (2020).