

EFFECT OF WASTE GLASS POWDER AND COAL BOTTOM ASH IN CONCRETE

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INTRODUCTION

- ❑ Throughout history, concrete has emerged as one of the most widely utilized building component.(Yakut 2004).
- ❑ According to Baskaran et al., (2017) after water, it is the substance that is used the most on Earth.
- ❑ The ever-increasing volume of industrial and domestic waste is the root of many environmental problems and burdens. In recent years, waste products such as coal bottom ash, steel slag, copper slag, fly ash, and glass have rapidly increased. These wastes are primarily generated by households and industries, and their possibility to contaminate natural resources such as water, air, and soil is constantly increasing.
- ❑ It is required to help improve concrete's efficiency through the use of waste by-products while also preventing river sand and valuable area from becoming pollution dumpsites.
- ❑ The use of waste glass powder and coal bottom ash (CBA) in the concrete industry is one of the most effective ways to mitigate the environmental difficulties that have arisen as a result of its presence.

PROBLEM STATEMENT

- ❑ Due to the low incomes, a high number of people in underdeveloped and developing countries live in low-quality housing, causing some people to reside in ramshackle housing made of waste materials such as metal, glass, or plywood, resulting in insecure and inhumane living conditions. The affordable shelter would become more available to even the poorest populations if lower-cost construction materials were developed.
- ❑ Perhaps the most expensive materials of concrete is cement, and demand for it is rising globally. Regarding carbon dioxide emissions, the cement industry has an effect on the environment.
- ❑ When cement is produced, carbon dioxide is released during the mobility and fuel consumption processes. (Fayomi et al.2019) Consequently, measures must be taken to reduce carbon dioxide emissions by using greener building materials that have less of an impact on the environment in term of production and transportation

RESEARCH GOAL

- ☐ Evaluation the impact of glass powder and coal bottom ash mostly on characteristics of fresh concrete at various w/b ratios.
- ☐ To ascertain how waste glass powder and coal ash affect the development of fresh and hardened concrete.
- ☐ To quantify the performance of glass powder and coal bottom ash an alternate of cement in concrete mixes using specified proportions.

Mechanical Performance of WGP and CBA modified cementitious composites

❑ Most of the researchers reported that incorporating of WGP/CBA Improved the Mechanical properties of CC.

❑ It may be stated that WGP outperformed CBA against Mechanical Properties by comparing the results of different studies using almost the same specifications.

MT		CC type	Replacement Level (%)	Mechanical Properties	Effect	Optimum Replacement (%)	RF
	WGP	Concrete	20,30 ,40	Compressive Strength	Increased	40	Vijayakumar et al (2013)
	WGP	Concrete	0,10,15,20	Compressive Strength	Increased	20	Kumarappan (2013)
	WGP	Mortar	0,10,20	Compressive Strength	Increased	20	Matos et al (2012)
	WGP	Concrete	10,20,30,40	Flexural Strength	Increased	40	Vijayakumar. G et al 2013
	WGP	Concrete	10,15, 20, 30	Flexural Strength	Increased	10	Vandhiyan R. et al [2013]
	CBA	Concrete	0,10,20	Compressive Strength	Decreased	20	Ramzi, 2016
	CBA	Concrete	10,20,30	Compressive Strength	Increased	30	Raju et al 2014
	CBA	Concrete	10,20,30	Flexural Strength	Decreased	30	Wongkeo et al 2012
	CBA	Concrete	10,20,30	Flexural Strength	Increased	30	Raju et al 2014

MATERIALS AND METHODOLOGY

Waste Glass Powder

- ❑ Waste glass powder with a diameter of less than $90\mu\text{m}$ was used, which was produced from different color bottles, which are commonly known as wine bottles.
- ❑ These bottles were gathered from wine shops, roadside trash bottles, Campus Hostel, and house to house collection in Haspolat, Lefkosa, and Gonyeli, North Cyprus.
- ❑ The bottles was soaked, washed and rinsed to remove any paper labels, dust, or other unwanted materials. They are crushed and grounded by a crushing machine called the Los Angeles Machine after drying. The waste glass powder used had a particle size of $75\mu\text{m}$ to match the particle size range of the binder (cement) to gain a dense matrix with minimal voids.



MATERIALS AND METHODOLOGY

Coal Bottom ash

- ❑ Coal Bottom ash employed in this study is a lignite coal, sometimes known as brown coal. This is a flammable soft brown sedimentary rock formed by naturally compressed perlite.
- ❑ This is a combustible soft brown sedimentary rock formed by naturally compacted perlite. It contains between 25 and 35 percent carbon. This coal was collected from Gurdag Trading and Block Industry limited located at Hospolat Sanayi Bolgesi North Cyprus.
- ❑ The used bottom ash in this course of research will be treated as a Dry bottom ash (DBA) which will be obtained by dry ing raw bottom ash at room temperature for 24 hours. The Coal Bottom Ash is used had a particle size of 75 μm to match the particle size range of the binder (cement) to gain a dense matrix with minimal voids.

METHODOLOGY

Nomenclature of mortars

Nomenclature	Cement (%)	WGP (%)	CBA (%)
Control Mix	100	0	0
WGP20- CBA 0	80	20	0
WGP 15- CBA 5	80	15	5
WGP10- CBA10	80	10	10
WGP5- CBA 15	80	5	15
WGP0- CBA20	80	0	20

Figure 4. 1:The Flowability of the mixtures

RESULTS AND DISCUSSION

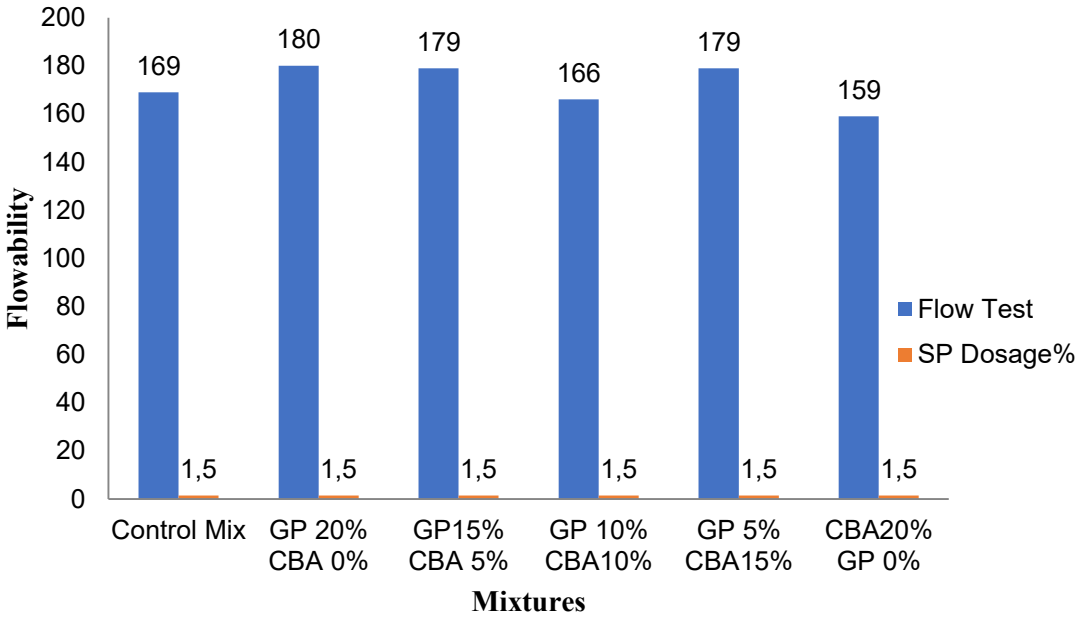
FLOWABILITY

□ The flowability/workability of cement-based composites is a crucial variable since it determines how feasible it is to place and compact newly mixed concrete/mortar while retaining homogeneity.

□ The portion of cement substituted with glass powder and coal bottom ash resulted in a little improvement in mortar flow. As seen in Fig 1 WGP of 20% has the highest flowability of 180mm because of the occurrence of its lightweight surface area which lead to an increase in flow. The increase in mortar flow with the inclusion of Waste glass powder might be the effect of glass material which is cleaner in nature.

□ On the other hand, employing 10% WGP and 10% CBA gives a good improvement in the flowability.

□ It is indicated that the flowability ranges from 159mm to 180mm for all the different mixes



RESULTS AND DISSCUSSION

Compressive Strength

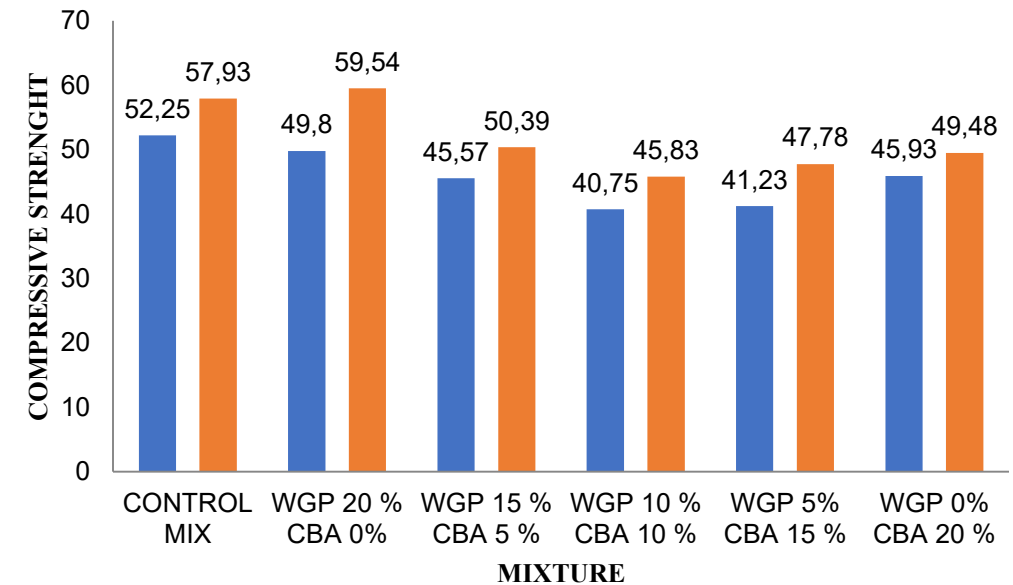
□ The compressive strength of the mixtures containing WGP and CBA with different levels is shown in Figure 2 which represents the average value of 3 specimens of compressive strength for each mixture at the age of 7 and 28days.

The improvement in strength is attributed to the following reasons:

□ As a result, the chemical change of cement particles, Heat was generated, which may have increased the chemical reaction activities (pozzolanic) of GP particles.

□ In mortar/ Concrete, a little proportion of glass powder acted or used as filler, which helps to reduce the total void in the mortar.

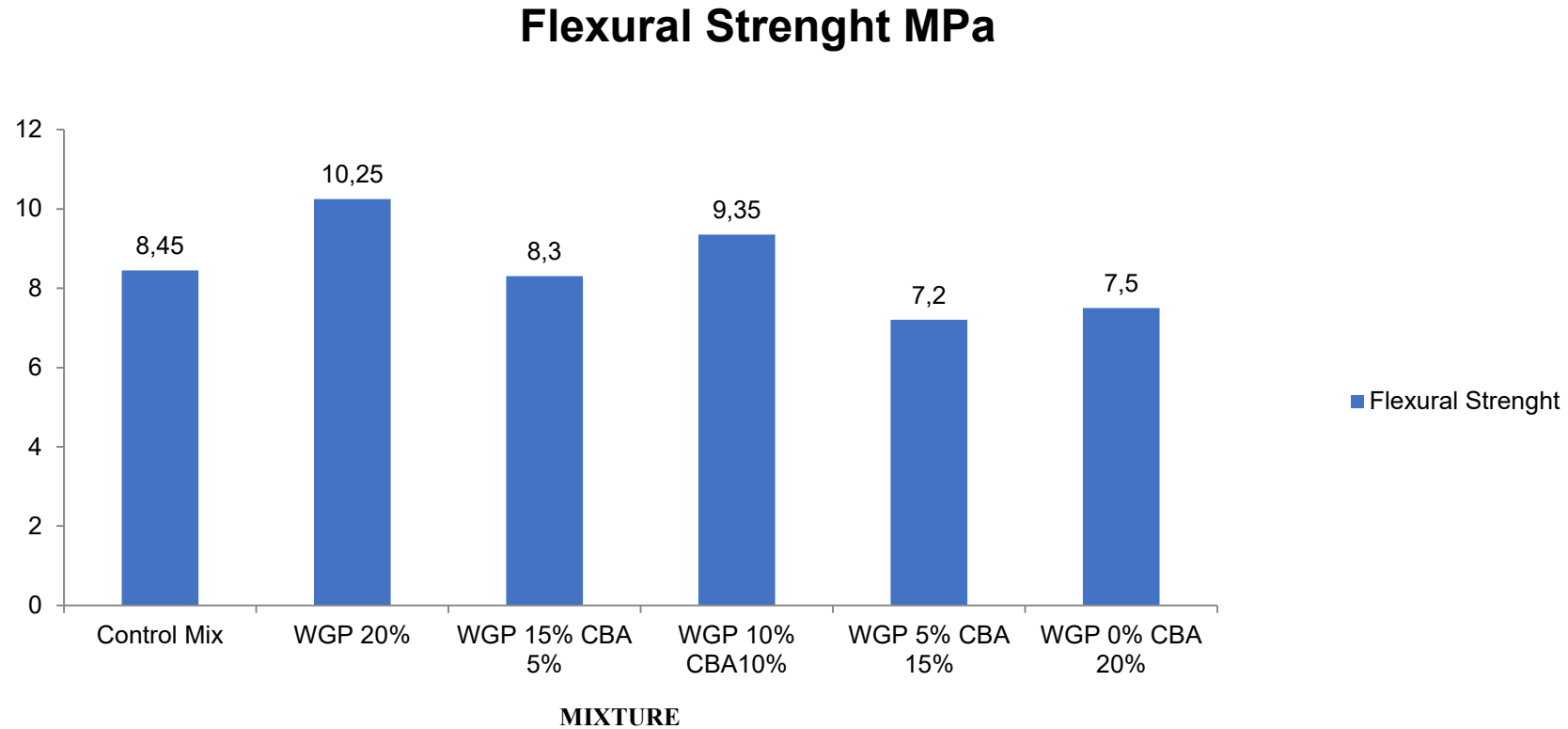
□ Addition of GP to cement composites can promote the early strength (3-7) days age by increasing the hydration reaction due to the high pozzolanic activity



RESULTS AND DISCUSSION

- ❑ WGP at 20% improved flexural strength as compared to the control mix given in Figure. This increase can be explained by various factors. Flexural strength increment is based on the higher pozzolanic activity of WGP and Coal bottom ash and tightened bonding between the particles.
- ❑ Using GP as a part Substitution of cement substitute up to 20% reinforces the flexural strength of concrete because glass powder particles have an angular structure that makes it harder for concrete or mortar to resist bending.
- ❑ Furthermore, when the portion of CBA in the mix increase, the flexural strength of concrete decreased. . It worth noting that 10% WGP and 10% CBA have a higher flexural strength range than that of the control mix.
- ❑ The flexural strength test on the effect of bottom ash in concrete revealed the flexural strength decreases when natural fine aggregate is been substituted with bottom ash concrete. (Raju et al) 2013

RESULTS AND DISSCUSSION



RESULTS AND DISSCUSSION

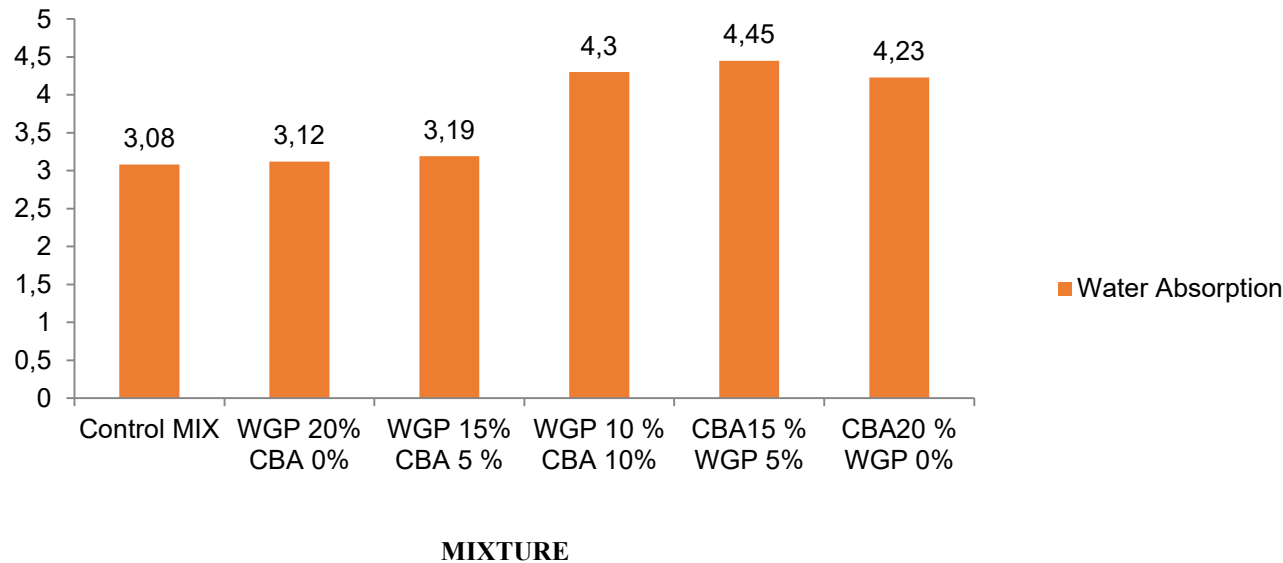
Absorption of water

□ It was found that an addition of 20% of GP has reduced the water absorption of the mixtures containing GP as seen in the Figure which may be ascribed to the filler effect of GP particles that filled the voids and micropores with the additional C-S-H produced by the pozzolanic reaction also, a denser and more compacted

structure was obtained by the addition of GP which blocked the capillary pores and reduce

□ The presence of CBA in the mixture will contribute to higher open pores and porosity due to the consumption of the outer shell of CBA particles through the pozzolanic reaction

Water Absorption



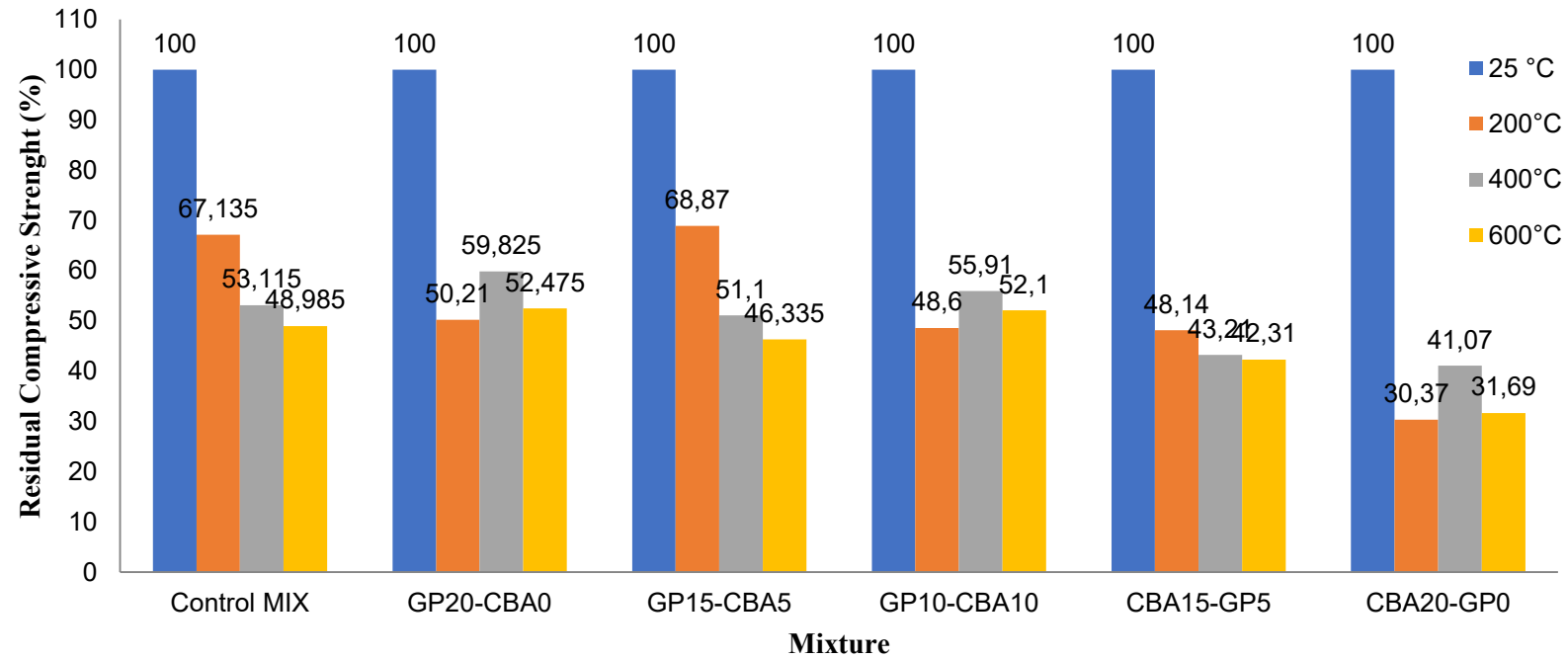
RESULTS AND DISSCUSSION

Fire Resistance

- ❑ The resistance of the examined mortar mixtures incorporated WGP and CBA to High temperatures is shown in Figure, the mixtures were tested against three sets of temperatures (200, 400, and 600°C).
- ❑ At 200 °C, there is an apparent strength development. This high strength development is mainly caused by loss of water of the available free water within the microstructure which increased the friction between failure planes (Khurram et al. 2018)
- ❑ Furthermore, strength growth occurred in some specimen when the temperature was elevated to 400 °C.
- ❑ It was noticed that WGP 15%, CBA 5% start decreasing in strength. However, WGP 20%, WGP10% CBA 10%, CBA 20% gained more strength.
- ❑ All mixes exhibit a significant decrease in residual compressive strength at 600 °C, which was attributed to the breakdown of C-S-H and dehydration of calcium hydroxide. Due to the expansion of dehydrated goods at this temperature, micro cracks occurred, weakening the bonding.

RESULTS AND DISCUSSION

Residual compressive strength (%)



CONCLUSION

Following the extensive experimentation and discussion of the data obtained for different characteristics of the precursors as a partial supplementary cementitious material mortar containing WGP and CBA have been determined to be the best at 20 % replacement level with 1.5 % as an additive admixture at fixed W/B of 0.35. The study was based on the behaviour of WGP and CBA on the flowability, mechanical properties, and durability of the modified mortar, the detailed findings can be drawn.

□ Flowability observation shows workability of the samples enhanced as the glass powder content replacing cement expand. WGP of 20% has the highest flowability because of the occurrence of

its lightweight surface area which lead to an increase in flow. While flowability outcome indicates that the effect of coal bottom ash as a alternate of cement has a good improvement on the flow value of specimens.

□ Compressive strength test explained that the development of the compressive strength continues with age. At a fixed water cement ratio of 0.35, substituting 20% of the cement with WGP enhanced the compressive strength of the mortar.

❑ Flexural strength exhibited a different pattern than compressive strength because flexural strength of CM diminished than that of WGP specimens.

❑ At three different temperatures (200, 400, and 600) °C, mortar modified with GP and CBA showed a significant resistance to fire. At 200 °C, a development in residual compressive strength was observed, which triggered the hydration reaction of unreacted particles of the binders, but this decreased at 400 and 600°C.

❑ In conclusion, based on the analysis and conclusion, it was determined that the inclusion of WGP and CBA plays an advantageous importance in terms of structural and long-term strength characteristics of cement mortar. It should be mentioned that a combination of 10% WGP and 10% CBA can also improve the overall performance of cement-based mortar.

FUTURE RECOMMENDATIONS

❑ Investigating the influence of glass powder or coal bottom ash as a cement substitute on structural steel in attempt to decide the long-term sustainability of glass powder and coal bottom ash use in offshore constructions.

❑ Investigating the impact of combining glass powder with other supplementary cementitious materials as a partial cement substitute on the properties and behaviors of various concrete mixtures.

❑ From an environmental standpoint, bottom ash utilization in cement-based composites should be increased. Recently, it was noted that natural aggregate

supplies are progressively diminishing and that commercially cost effective quarries are getting harder to find in some countries.

❑ Additional research should be conducted along the lines that enhanced utilizing bottom ash in addition to implementing the integration of bottom ash to building structures that might benefit from the unique properties of bottom ash.

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Thank you all for listening