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ENGINEERING AND ENVIRONMENTAL ADVANTAGES OF SLAG CEMENT CONCRETE: THE NEED FOR SLAG CEMENT IN NIGERIA

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ABSTRACT

This study review relevant literatures concerning the engineering and Environmental advantages of Slag Cement Concrete over Portland Cement Concrete in the construction industry. Several works were reviewed on the subject matter to ascertain the appropriate mix ratios, assess the setting time, compressive strength, flexural strength,

Introduction

A thorough literature assessment was undertaken to acquire and study the information concerning Slag Cement Concrete features. Concrete characteristics like setting time, compressive strength, flexural strength, permeability and chemical resistance ability of Slag Cement Concrete we're assess. Furthermore, replacement ratios were also review to determine the most suitable replacement ratios.

permeability and it resistance to sulpates and chloride attacks. The review shows that concrete performs better at replacement ratios of 25 to 50%. It also reveals that Slag Cement Concrete has lower setting time than Portland cement. Concrete made with Slag Cement has considerably higher compressive and flexural strength than Portland cement concrete, permeability was observed to be less in Slag Cement than Portland cement, Slag Cement also offers better resistance to chemical attacks than Portland Cement. It was also observed that Slag Cement is more environmental friendly than Portland cement. Hence, Slag Cement should be given more consideration in the construction industry.

Slag concrete use can be followed to the 1700's the point at which the material was joined with lime to make mortars. The originally United States creation was in 1896. Until the 1950's, granulated slag was utilized in the assembling of mixed Portland concretes, or as crude feedstock to make concrete clinker. Nonetheless, in the 1950's, slag concrete opened up in different nations as a different item. The primary granulation office in the U.S. to make a different slag concrete item was Sparrows Point, Maryland, in the mid 1980's. Ongoing years have seen the inventory and acknowledgment of slag concrete develop drastically all through the U.S.

Slag concrete is a water powered concrete framed when granulated impact heater slag (GGBFS) is ground to appropriate fineness and is utilized to supplant a part of Portland concrete. It is a recuperated modern result of an iron impact heater. Liquid slag redirected from the iron impact heater is quickly chilled, creating lustrous granules that yield wanted responsive cementitious attributes when ground into concrete fineness

Finding proper application for slag offers a monetary benefit as well as a chance to discard this high weight troublesome - to - handle strong waste in accordance with the idea of steel creation and ecological best practice for economical turn of events (IISI, 2005). Concrete can be supplanted in part by 20% of EAF slag in block making without forfeiting the strength apparently. • The compressive strength of the squares (E. N. BASSEY et 2011). The compressive qualities of slag concrete commonly improved altogether as the relieving time frame expanded as long as 90 days (E. N. BASSEY et 2011).

Prior examinations (BSP, 1977; Matyas, 1978) have prompted the utilization of BF slag as bases in street development and for upkeep and surfacing of the streets. This training is broad in Europe and India with huge scope BF creation. Report from Germany shows the appropriation of fundamental Oxygen Furnace (BOF) slags for street, track laying and development of channel (Rellermeyer, 1975). Besides BF slag has been effectively utilized in the assembling of concrete and glass (Lee, 1974). Dome slag was additionally answered to have halfway supplanted concrete in mortar blend readiness (Aderibigbe et al, 1982. As the innovation of creating steel by Electric Arc Furnace technique is itself moderately new, work nearby conceivable business utilization of EAF slag has not yet been broad. Anyway examination did so far has shown a decent guarantee for the utilization of EAF slag in the structure business. Contemplating the strength properties of EAF slag, Edoro (1986), found that utilizing coarse EAF slag total instead of stream rock in indistinguishable water/concrete cement blends a higher strength of up to 1.2-1.6 N/mm2 was acquired for the slag totals. Pellingrino (2009), explored the mechanical and strength attributes of cement containing EAF slag total and found that they were acceptable. Concerning the usefulness of the solid blends from OPC and EAF slag, the aftereffects of prior examinations, (Okpala et al, 1987; Diagbonya, 1987), are appeared in Tables 2 and 3. There was an observable expansion in both the droop

and compacting factor esteems. This was because of the presence of the granulated slag in OPC concrete. The expansion saw is as the consequence of the presence of genuinely high level of ferrous oxide (FeO) in the slag. This compound generally doesn't assimilate a lot of water, along these lines makes accessible more blending water than when concrete alone is utilized. The water non-spongy nature makes free blending water that licenses higher droop and compacting factor.

Slag concrete for the most part improves workability, finishability and pumpability of plastic cement. It might give a little lessening in water interest (see SCIC #5). Slag concrete will in general build season of beginning set, which is regularly an advantage in warm climate. In cooler climate, gas pedals, warmed materials or bringing down the level of slag concrete in a blend (as a part of cementitious material) can be utilized to diminish seasons of set (see SCIC #3). Early age qualities (through 7 to 14 days) of slag concrete will in general be lower while later age qualities will be higher (see SCIC #14). Creation of slag concrete makes a worth added item from a material—impact heater slag—that in any case may be bound for removal. Not exclusively does the creation of slag concrete decrease the weight on landfills, however it likewise lessens air discharges at steel plants through the granulation cycle (when contrasted with the conventional air cooling measure).

Engineering Advantages of Slag Cement Over Portland Cement

Workability

Slag concrete improves the workability of cement because of its fine crush and smooth design. Upgraded functionality benefits putting, compaction, and completing of the solid. The subsequent solid components may have less surface voids and improved solidification. Slag concrete has additionally been utilized adequately in the plan of self-merging solid blends.

Setting Time

Setting time is where opposition arrives at determined qualities. To a solid project worker, starting setting time alludes to the time at which a solid surface can bear the heaviness of a person with least space. Initial and final setting time are significant on the grounds that, they give a sign of when the solid can be appropriately positioned, consolidated and wrapped up. The elements affecting the setting time are, cementitious material science, cementitious material fineness, cementitious material substance, water to cement proportion, concrete and encompassing temperatures, admixture type's and so on

How does slag cement affect the setting time?

At temperatures under 85 degrees Fahrenheit, concrete containing slag can have longer season of set, when contrast and 100%Portland Cement concrete. The lower the encompassing or potentially solid temperatures, the more slow the set occasions will be (Figure 1). The level of slag concrete utilized can likewise influence the time of set. Be that as it may, substitution paces of under 30% for the most part will not influence the time of set fundamentally. More slow occasions of set are gainful in sweltering climate in light of the fact that the contractor makes some more extended memories to convey, spot and finish concrete. In the event that seasons of set need tobe diminished, gas pedals, warmed materials or decreased slag concrete content may be utilized.

Improved Compressive and Flexural Strength

Concrete made slag concrete gives higher compressive and flexural strength contrasted and Portland concrete. Improve strength makes it simpler to accomplish determined wellbeing variables of the solid combinations. It gives upgraded material properties permitting makers to streamline solid blend plans.

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How does slag cement improve concrete strength?

Slag concrete increment the compressive and flexural strength of regular solid (Figure 4 and 5) and is frequently an imperative segment in creating high strength concrete. 28 days strength for the most part increment as the level of slag concrete increment, up to about half slag concrete as a level of the cementitious material. At the point when PC responds with water, it structures CSH and Ca(OH)2). CSH is the paste that gives strength and holds concrete together, Ca(OH)2) is a bye result of PC hydration that doesn't add to strength. At the point when slag concrete is utilized, it responds with water and Ca(OH)2) to shape more CSH. The extra CSH densifies the solid network, improving the strength. Concrete made with slag concrete will have higher strength development over the lifetime of the solid component contrasted and PC solid combinations. Slag concrete has an especially critical impact on the flexural strength of cement. Flexural strength or Modulus of Rupture is one of the main elements in concrete pavement design. Expanded flexural strength is clear in figure 5, where 50% slag concrete accomplished a 20% strength improvement. Improved flexural strength are credited to the expanded thickness of the glue and improved glue totals bond.

Reduced Permeability

Permeability is the proportion of how simple it is for water, air and different substances, for example, chloride particles to enter concrete. A typical method to quantify permeability of cement is the Rapid Chloride Permeability test otherwise called Standard Test Method ASTM C1202 Electrical sign of solid capacity to oppose chloride particle entrance. Low porousness cement can help diminish the decreases hazard for the building up steel to erode when open to chlorides by restricting infiltration of those chlorides into concrete. At the point when the supporting steel interacts with the plastic concrete, a compound

response happens between the steel and the solid that cause a defensive layer (an inactive layer) to create around the building up steel. This detached layer ensures against the erosion of the supporting steel. Over the long haul, concrete in de-icing salts can responds with the building up steel, separate the latent layer and making the steel consume and cause the solid to break. In the wake of breaking, the weakening speeds up as chlorides are permit simple entrance to the building up steel. The crumbling of both the concrete and the steel bargains the structural integrity.

How does slag cement reduces permeability

At the point when Portland Cement (PC) hydrates, it structures calcium silicates hydrates gel (CSH) and Calcium Hydroxide Ca(OH)2). CSH is the paste that give strength and holds the solid together. Porousness is identified with the extent of CSH to Ca(OH)2) in concrete glue. The higher the extent of CSH to Ca(OH)2), the lower the penetrability of the concrete. At the point when slag is utilized as a feature of the cementitious material in a concrete blend, it responds with Ca(OH)2) to shape extra CSH, which thus brings down the permeability of the concrete. By and large, the higher the level of slag in aconcrete, the lower the permeability. Lower permeability cement can be accomplished by subbing between 25 to 50% slag for Portland Cement. Figure 3 shows the capacity of a particular slag cement to diminish the permeability of concrete as measures by quick infiltration test.

Mitigation of Sulfate Attack

Sulfate attacks happens in solidified concrete when sulfates, found in seawater, in certain dirts and in wastewater, respond with the tricalcium aluminate (C 3A) in Portland concrete glue. The response causes a material called ettringite to frame. Ettringite arrangement can bring about concrete extension and untimely deterioration. The higher the C

3A of the concrete, the more noteworthy the potential for sulfate assault. Slag concrete doesn't contain C 3A so the higher the level of slag concrete utilized, the lower the C 3A of the combination and the lower the potential for malicious extension. Moreover, slag concrete decreases the porousness of the concrete and limits the capacity of sulfates to infiltrate into the concrete.

Alkali silica reaction (ASR) Mitigation

Antacid silica response (ASR) happens when the soluble bases in Portland concrete respond with certain receptive totals and water to shape an extensive gel that makes concrete rashly weaken. Slag concrete mitigates ASR by consolidating with the salts in Portland concrete and making them inaccessible for the ASR response. It additionally brings down the porousness of the concrete, restricting the measure of water that is accessible to help the response. Now and again, it will bring down the complete antacid substance of the concrete glue.

Environmental Advantages of Slag Cement Concrete

- Lessening ozone depleting substance emanations by dispensing with roughly one ton of carbon dioxide for every huge load of Portland concrete supplanted.
- Reducing energy utilization, since a huge load of slag concrete requires almost 90% less energy to create than a huge load of Portland concrete.
- Reducing the measure of virgin material removed to make concrete.
- Reducing the "metropolitan warmth island" impact by making concrete lighter in color in this manner mirroring all the more light and cooling constructions and asphalts with uncovered cement.

Applications of Slag Cement

Slag concrete is utilized in practically all solid applications:

- Concrete asphalts
- Structures and establishments
- Mass solid applications, like dams or holding)
- Precast and prestressed concrete (Pipe and Block)
- Concrete exposed to cruel conditions, like wastewater treatment and marine applications
- High-execution/high-strength concrete, for example, skyscraper constructions or 100-year administration life spans

Conclusion

From the review of relevant works on this subject matter, the following conclusions were made

1. Concrete replaced with 25 to 50% Slag was observed to enhance better Engineering properties and as such should be adopted in concrete mix
2. Slag cement lowers the setting time of concrete which is advantageous in hot weather conditions owing to the fact that it gives the engineer longer time to deliver, place and finish concrete.
3. The compressive strength of concrete made with Slag cement is observed to be higher than that of PC which lowers the shrinkage tendencies of the concrete and also lowers the cementitious factors but rather provide better structural integrity.
4. Slag cement provide considerably higher flexural strength than PC making it more suitable in high performance concrete.
5. Permeability of concrete was observed to be considerably less than Portland cement which minimizes the corrosive risk of the steel reinforcement by lowering the penetration effects of

chlorides and sulphates into concrete. Hence, durability and service life is more guarantee.

6. Slag cement has higher resistance to chemical attacks and as such, it performs better in chemically aggressive areas such as seawater etc.
7. Slag cement as a bye product of steel which is a waste when converted to a usable material eliminates the tendencies of environmental pollution. It also reduces greenhouse effects in concrete construction, hence, it is more environmental friendly than Portland cement.

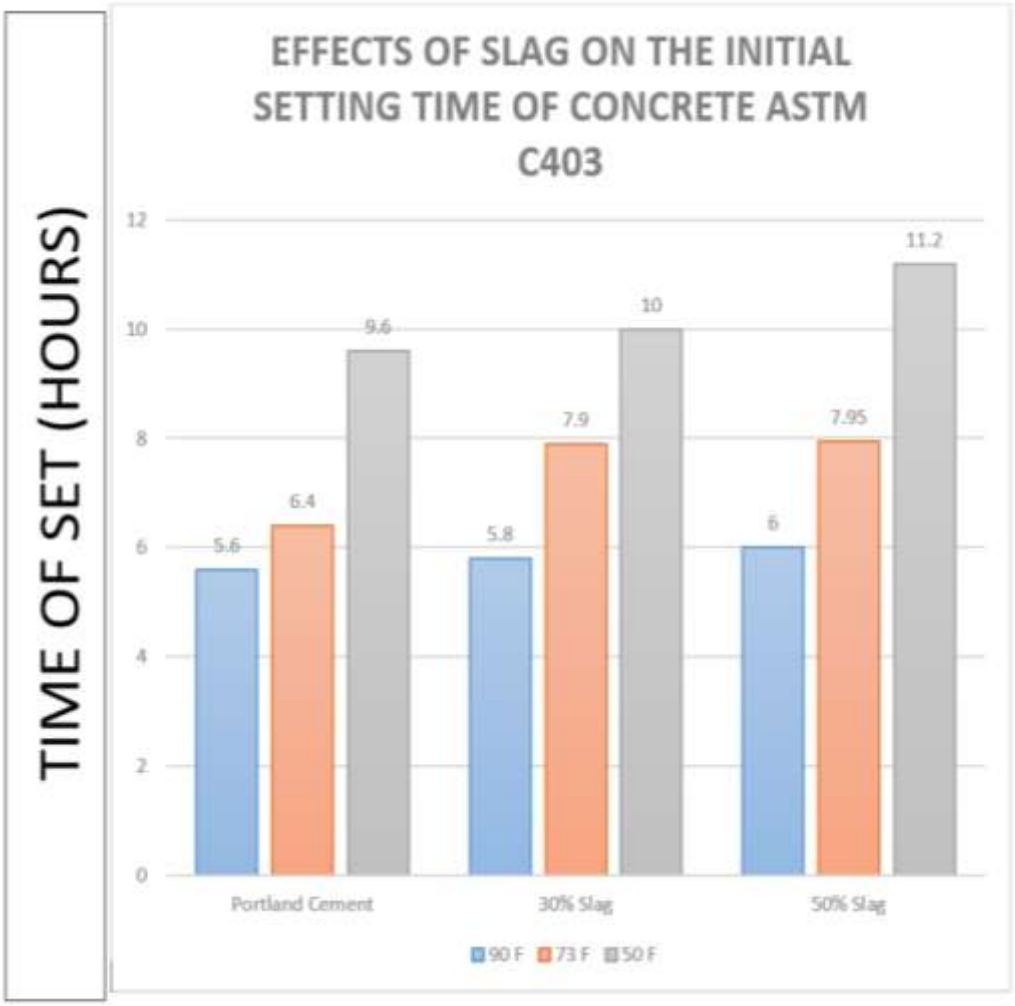


FIGURE 1

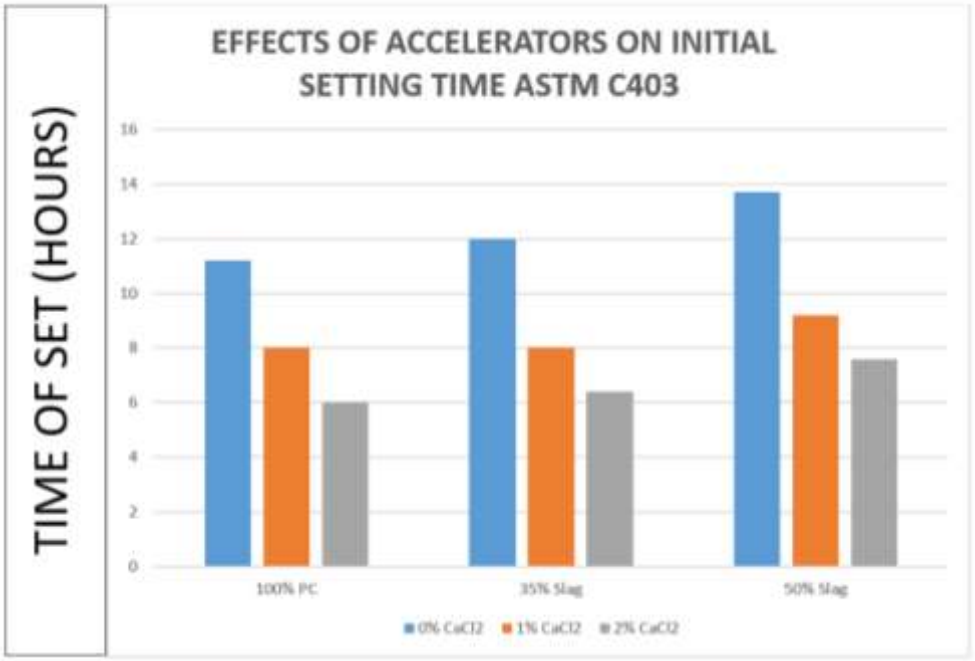


FIGURE 2

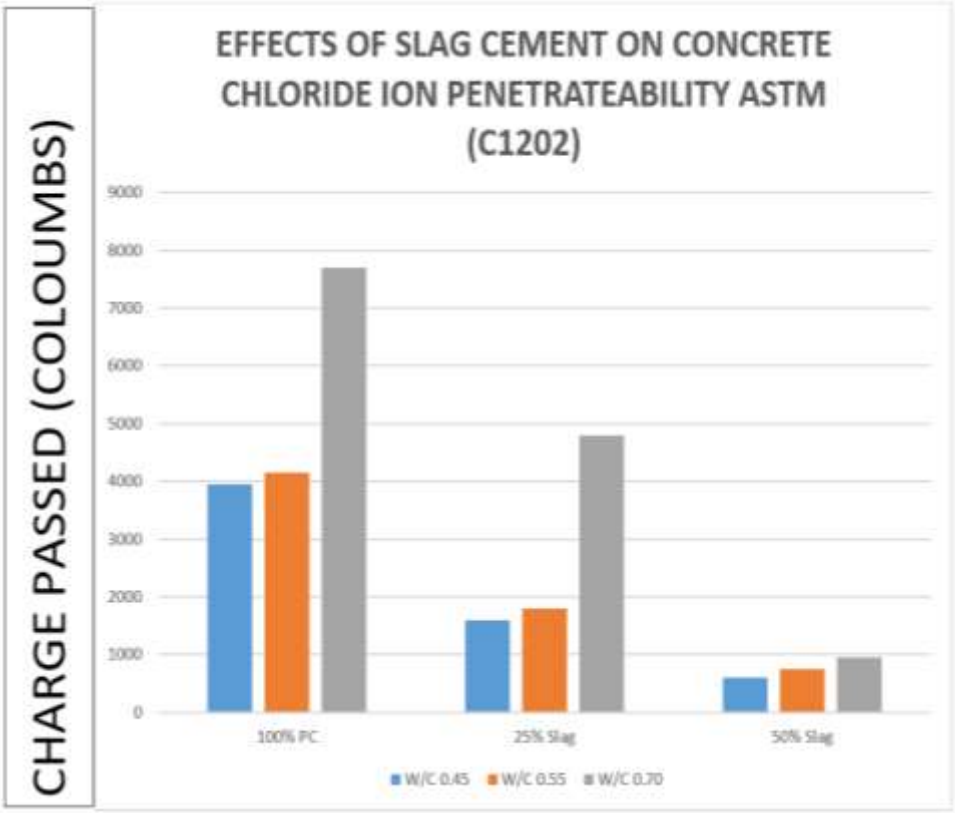
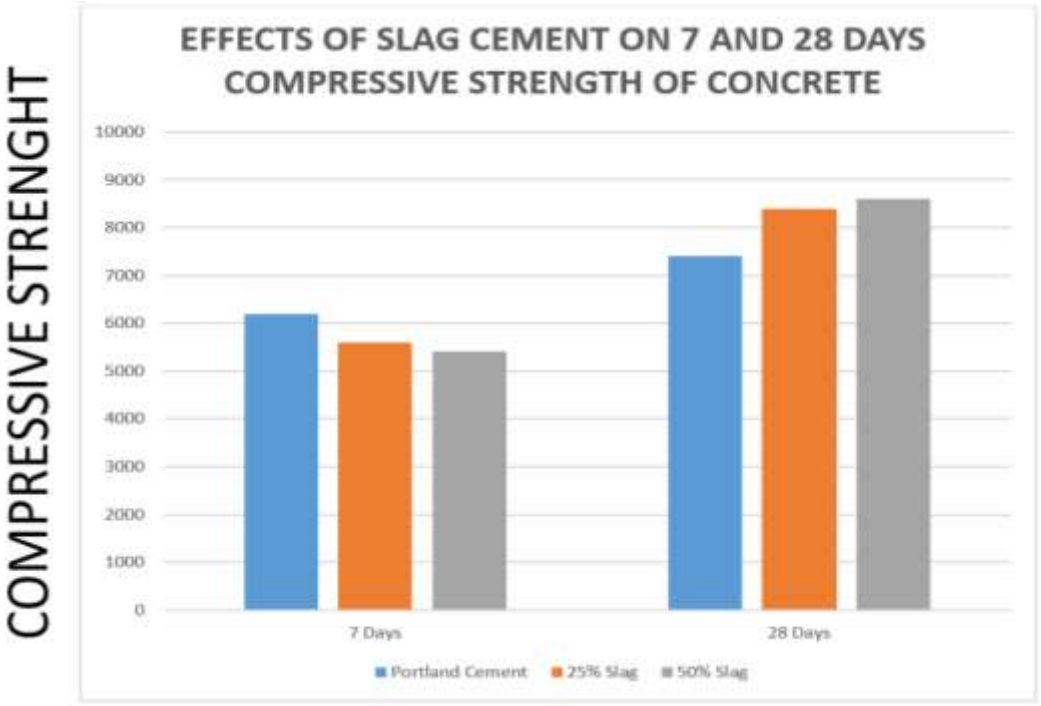


FIGURE 3



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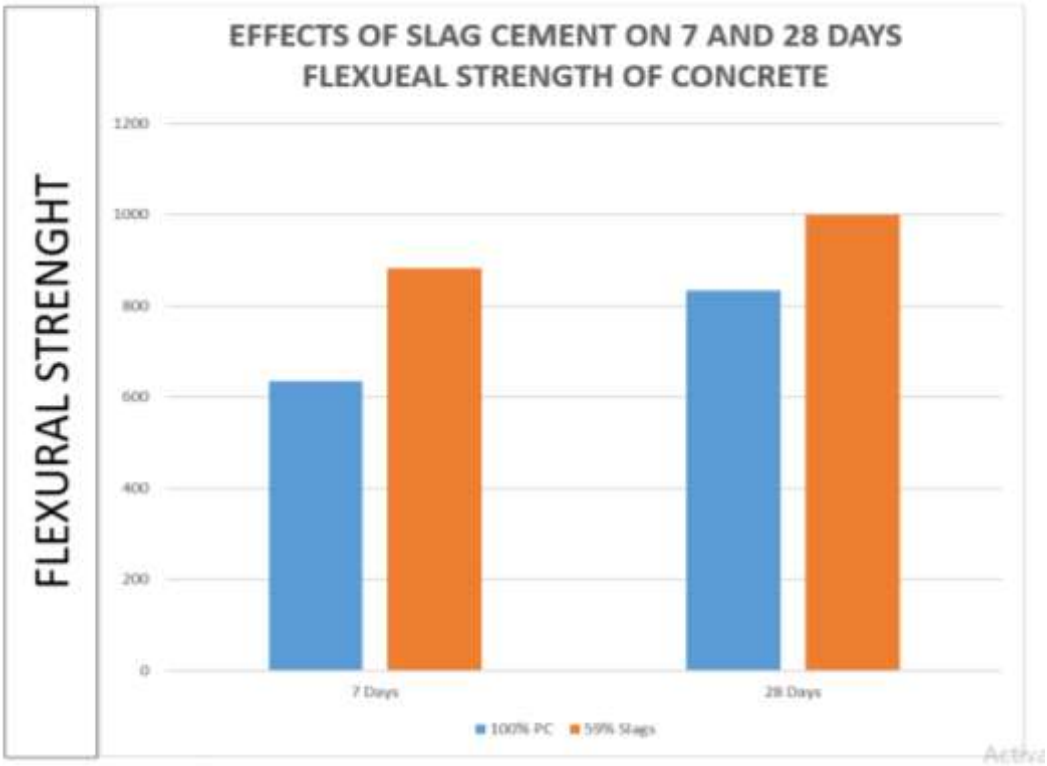

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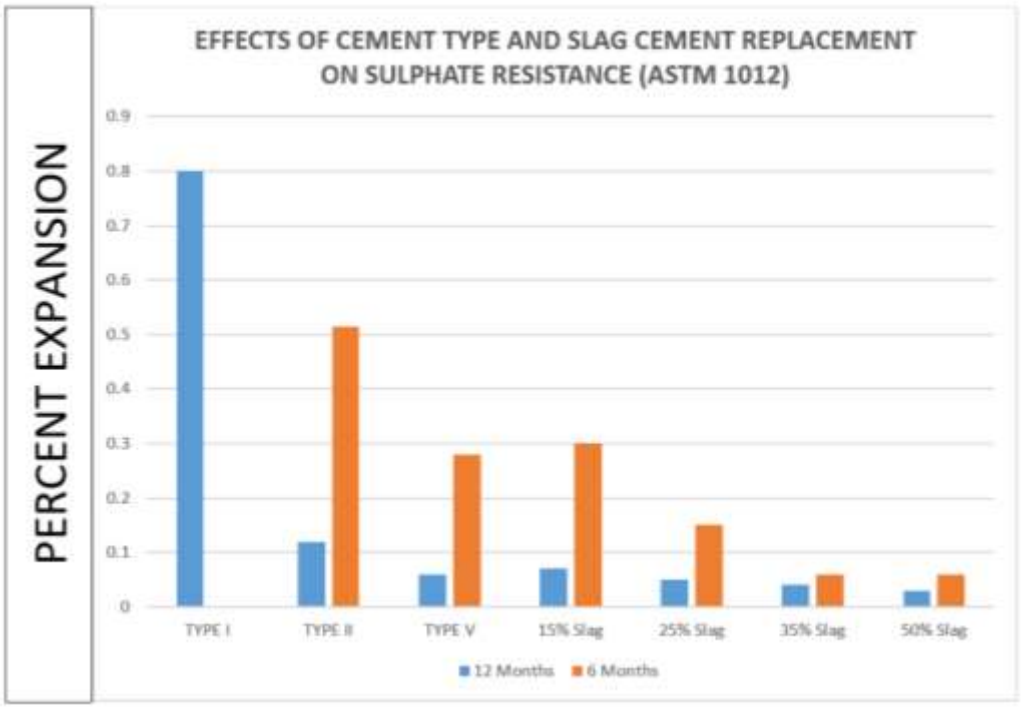

CEMENT TYPE AND SLAG CEMENT REPLACEMENT

FIGURE 6

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