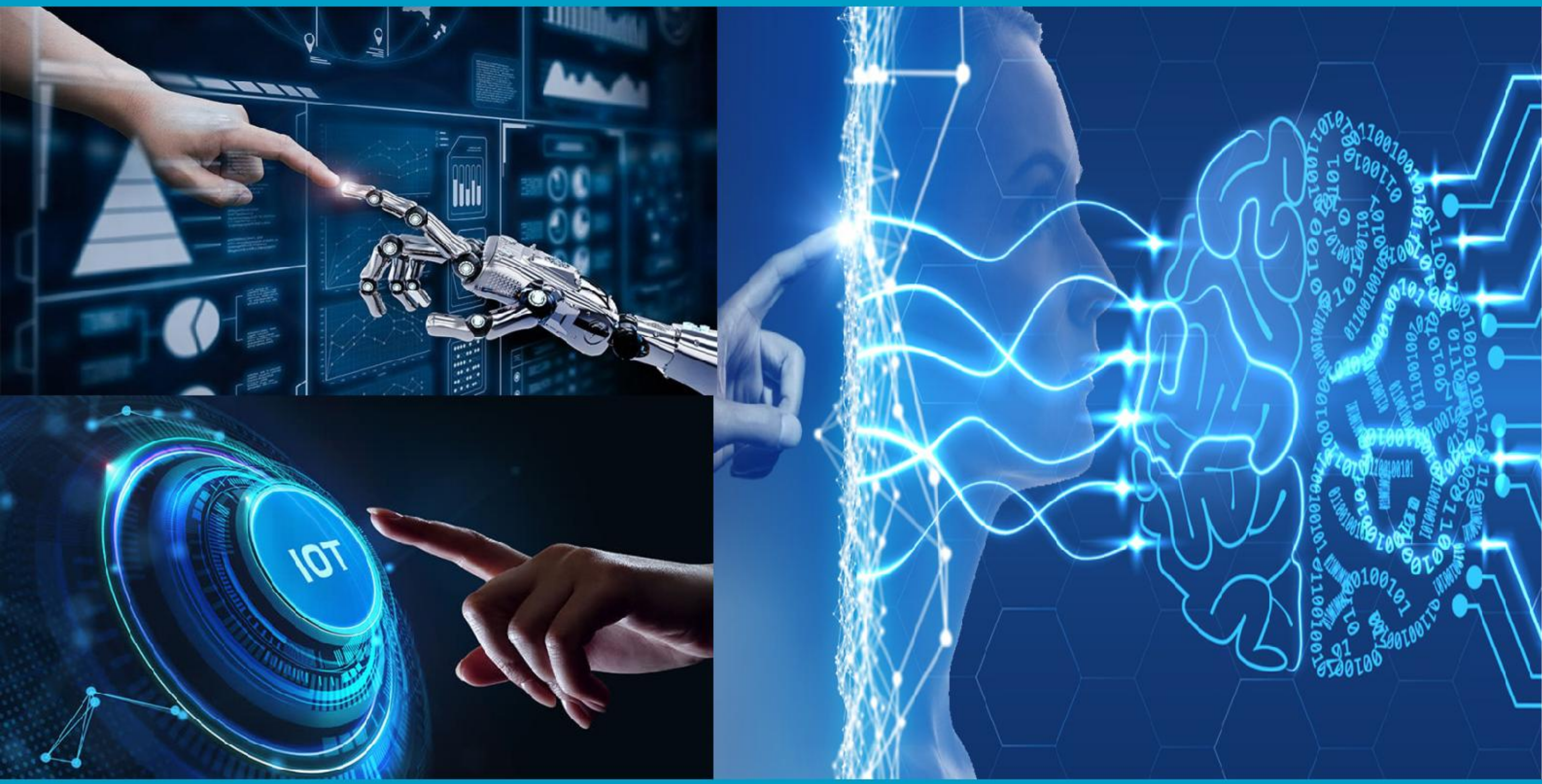
IJMRSETM

e-ISSN: 2395 - 7639



INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING, TECHNOLOGY AND MANAGEMENT

Volume 9, Issue 5, May 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.580

+91 99405 72462 +9163819 07438 ijmrsetm@gmail.com www.ijmrsetm.com

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580|

| Volume 9, Issue 5, May 2022 |

| DOI: 10.15680/IJMRSETM.2022.0905012 |

A REVIEW STUDY ON DURABILITY OF RIGID PAVEMENT BY USING CRYSTALLINE ADMIXTURE CONCRETE

Jeetendra Kumar, Shubender Panwar

CBS Group of Institutions, India

ABSTRACT: The goal of this review paper was to see how crystalline admixtures affected the durability of concrete. Chemical admixtures have lately received a lot of interest as a unique option for overcoming durability difficulties & constructing long-lasting, cost-effective structures. Permeability Reducing Admixtures (PRA) best methods for safeguarding structures exposed to water & waterborne pollutants because permeability of a concrete structure is thought to have a key impact in its longevity. To protect concrete structures against water penetration, several compounds have been developed, & they have been classified into PRA as per their chemistry, performance, & use. Based on the literature evidences, it is said to be that the research activities are carrying out all over the world to identify the suitable alternate to the aggregate to meet the future demands. The industrial by-products and building debris are being considered for the research activities to meet performance of structural concretes.

KEYWORDS: Rigid Pavement, Pavement Quality Concrete, Crystalline Admixture Concrete, CWA

I. INTRODUCTION

In recent years, the durability of concrete constructions has been a hot topic. Building degradation produced a surge in damage in the second part of the twentieth century; repairs of these concrete structures have been escalated in recent years, raising concerns about their long-term stability. Physical & chemical processes that affect the concrete structure's durability are among the factors that influence its durability. Durability is not a material's inherent feature, rather it is linked to how well it performs under particular environmental circumstances. In concrete, around 20-30% of the cement particles are anhydrous, which combines with water or moisture to produce hydration materials, which help to close the fracture owing to self-healing potential. Self-healing materials are utilized to improve structural longevity while lowering maintenance & repair expenses. It also protects the structures from costly maintenance during their lifetime. When watertight conditions are required, crystalline admixtures are offered as a suitable option for waterproofing concrete. Their mode of action is based on their capacity to react with water & cement particles, so increasing the density of the solid matrix in concrete & preventing external water from penetrating the structure. Water absorption tests, chloride penetration tests, & permeability experiments were performed to investigate several aspects of concrete's waterproofing capabilities, including crystalline admixture concrete.

Concrete roads are exposed to extreme weather conditions, resulting in rapid degradation & the need for routine repair. Concrete is a porous material that allows water & waterborne pollutants to infiltrate the matrix, causing it to fracture & spall & perhaps resulting in structural collapse. Carbonation, freeze-thaw cycle damage, corrosion from road salts, & sulphate assault are all prevalent problems with road concrete.

When carbon dioxide (CO_2) in the atmosphere, which is increased by vehicular emissions, dissolves in water, enters porous concrete, & reacts with calcium hydroxide in the cement paste to form calcium carbonate, carbonation occurs ($CaCO_3$). The concrete's pH is decreased to around 9, which causes the embedded reinforcement to deteriorate. The concrete fractures & spalls as a result of the reinforcing corrosion.

Freeze-thaw cycles in porous concrete promote degradation by producing internal pressures in the voids, resulting in fractures & eventually spalling. When the entrapped water in the concrete matrix's cracks, pores, & capillaries freezes, it expands, pushing the voids to open & expand. As the freeze-thaw cycles repeat, the voids get larger & larger, causing the concrete to crack gradually. Another concern that emerges during the winter months is the use of road

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580|

| Volume 9, Issue 5, May 2022 |

| DOI: 10.15680/IJMRSETM.2022.0905012 |

salts to melt or prevent ice from accumulating on highways, making driving safer. These salts dissolve in water & permeate the porous concrete, corroding the imbedded reinforcement & causing concrete to deteriorate.

Concrete highways are exposed to sulfate-rich soils, which are utilized to build the road's foundations & pavement structures. Sulfates dissolved in water infiltrate the concrete matrix, causing the concrete to deteriorate.

If we can prevent water & waterborne pollutants from entering the concrete, it will be more durable & require less maintenance. Concrete that is impermeable is more durable.

II. LITERATURE REVIEW

Various literature are reviewed to find out the benefits of crystalline waterproofing chemical compare to other waterproofing system. Contract specification of various underground metro project is also reviewed & observed that they are specified crystalline waterproofing system for their project considering the cost benefits & durability of structure.

- **ACI-212.3R-10 (Report on chemical admixture) – American Concrete Institute -** While it is often assumed that correctly proportioned & cured concrete At w / cm low will provide a finished product with high durability & low penetration, a completely waterless concrete structure or "solid bottle" (Perkins 1986). Water can seep into small holes in concrete by capillary absorption (also known as wicking) or hydrostatic pressure as it is a porous material. The extra interaction between the water & the wall of the holes enables the water to flow through very small holes in the concrete where no external working head is installed outside. The flow of water due to pressure differences, such as water contact with an underground concrete structure, is called concrete maturation. External variables such as stiffness & treatment can impair the strength in some cases, causing a decrease in stiffness.

  The primary purpose of PRAs is to concrete to slow down or stop the flow of water. These mixtures, however, can have many secondary effects on plastic & solid concrete. Some PRAs can be used as low-level water reducers, ventilation, or to change the curing time of concrete. These items can contribute to complementing the features, similarities, & editing when you are on the plastic stage. In the case of stiffness, changes in the pressure force, resistance to cold & melting, as well as shrinkage often result. Test kits are recommended to ensure that plastic & solid concrete structures meet expectations.

- **Basumajumdar, A.K Das, N.Bandyopadhyay&S.Maitra (2004). "Some studies on Fly-ash & Lime." Indian Academy of Sciences, 28 (2), 131-136 [5] -** A total of four distinct types of class F fly ashes were gathered. The combinations were compacted by combining several sources from West Bengal (India) with lime in a 9:1 weight ratio. The compacts were steam-cured to achieve the best strength possible from the interaction of fly ash & lime. We assesed, the free-lime content, compressive-strength, & tendency of the steam cured compacts at a acutely high temperature, & analyzed the final outcome of FTIR spectrum changes as a function of the heating temperatures. To determine the sequence of dehydration & the related activation energy, thermos gravimetric measurements under non-isothermal conditions were used to study the kinetics of thermal dehydration of the compacts.

- **Saurabh Borle, A. N Ghadge "Comparative Study of Conventional & Modern Waterproofing Techniques" [3] -** Leakage causes moisture, metal corrosion, & fungal development, as well as affecting the structural characteristics of concrete & detracting from the structure's attractiveness. It also causes discomfort, which has a harmful influence on human health. Water leakage may be avoided, & about 80% of construction faults can be avoided. In construction, the structure may be waterproofed by using membranes & coatings to shield contents in addition to protective structural integrity.. Waterproofing techniques are classified into two major categories: ie. conventional (tarfelt, brick bat coba) & advanced (coatings, hinged). The goal of this study is to analyze various waterproofing answers by way of considering standards such as cost, durability, & comfort of use. Traditional techniques are straightforward to use, but they are uneconomical & readily disintegrate owing to changes in atmospheric conditions, according to the findings of this study. Modern waterproofing techniques, including as coating & membrane systems, are more costly & complicated to install, but they perform better. The

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580|

| Volume 9, Issue 5, May 2022 |

| DOI: 10.15680/IJMRSETM.2022.0905012 |

coating procedure necessitates extra care during surface preparation, which necessitates excellent craftsmanship. On the other hand, the crystalline technique has the benefit of preventing fissures from emerging over time as a result of water interacting with crystals, & hence gives better stability.

III. THEORETICAL DEVELOPMENT

Concrete's capacity to facilitate water flow is harmed by crystalline additives. It contains unique active compounds that react with moisture in the concrete as well as other cement hydration products. Insoluble crystalline compounds are formed throughout the capillary system as a result of this reaction. The size of the capillary holes shrinks over time as crystalline forms grow, until they are totally blocked & water flow ceases.

CHEMISTRY IMPROVING CONCRETE DURABILITY WITH CRYSTALLINE ADMIXTURES

Chemical admixtures are another option for improving concrete's qualities & capabilities. They are an integral solution that has been utilized for a long period of time to improve the performance of concrete in a numerous of ways & is often considered as a superior strategy. Their initial & most common application was to increase the temp. range where concrete mix can be poured without being freezed. Plasticizers that permitted less water in the mix while still maintaining enough slump were popular ways to increase the workability of concrete (formability). Building on this track record of success, it is now possible to combine careful attention to the mix of concrete ingredients with the use of appropriate chemical admixtures to produce solutions to deterioration issues. This is especially true when using additives that produce impressive results using crystallization techniques.

When it is mixed with the moisture in green concrete & thru the by-product of cement hydration. Such a kind of chemical reaction leads to un-soluble crystalline structure in the capillary-tracts. Even in adverse environmental circumstances, this preserves concrete from disintegration.

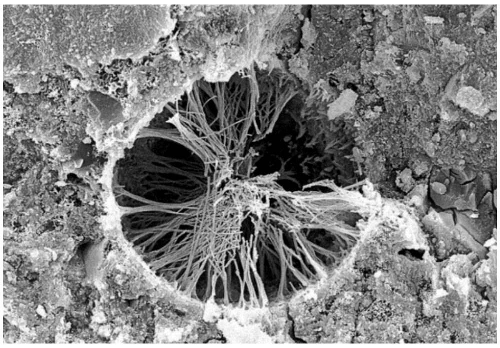


Fig 1: Scanning electron microscope image of crystalline formation

DEFINING & WORKING OF CRYSTALLINE TECHNOLOGY

The inherent & porous features of concrete are used by crystalline technology. Specific chemicals react with natural by-products of cement hydration when water is utilized as the catalyst (calcium hydroxide, mineral based salts, mineral oxides, & un-hydrated & partially hydrated cement particles). Within the linked pores & other gaps in concrete, this reaction produces a non-soluble crystal that develops to form a web-like crystalline structure. The crystalline structure becomes a permanent, essential component of the concrete as a result of this process. Because it is non-soluble, it fills gaps, fissures, capillaries, pores, & other holes in the concrete to make it impermeable, preventing water & other liquids from infiltrating even under high hydrostatic pressure. This means protecting against liquid-based chemicals that can attack concrete & corrode rebar, even in harsh & aggressive environments.

The interaction between water & cement leads a cement particle to hydrate, resulting in a hard, solid, rock-like mass. Chemical by-products are also produced, which remain latent in the concrete. Crystalline technology involves the addition of a new group of chemicals to the mix. When these two groups, cement hydration by-products & crystalline

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580|

| Volume 9, Issue 5, May 2022 |

| DOI: 10.15680/IJMRSETM.2022.0905012 |

chemicals, are combined in the presence of moisture, a chemical reaction occurs, resulting in the formation of a new non-soluble structure in capillaries, micro-cracks, & shrinkage cracks in concrete. The porosity of the concrete is sealed by the crystalline reaction, which prevents water or water-borne compounds from penetrating the substrate.

Integral crystalline technology products are made from a dry powder mixture of Portland cement, extremely finely processed silica sand, & a variety of additives. The non-soluble crystalline formation is created by chemicals reacting with the by-products of cement hydration. Specific formulas are created for use as a coating material, additive in concrete, or dry shake product. It can be included into a building during construction or used as a maintenance material later in its life cycle to increase its longevity.

Images taken using a scanning electron microscope show how newly created crystalline structures bridge & seal capillary tracts & fissures in concrete. This considerably increases the life of the building by reducing the penetration of liquids & hostile compounds into the concrete.

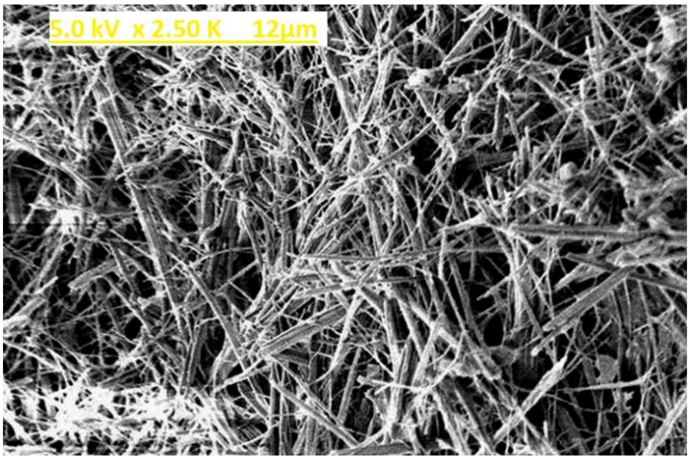


Fig 2: Concrete structure due to crystalline technology

As a result, crystalline technology has been demonstrated to have the following benefits:

- **Integral Waterproofing of Concrete:** Concrete permeability may be reduced using crystalline technology. It prevents the holes, apertures, & other routes or channels that characterize the normal porosity of concrete when it combines with the by-products of cement hydration to form a non-soluble crystalline structure. The diffusion of liquids & gases is considerably lowered by blocking pores, capillary tracts, & micro-cracks with a crystalline formation, safeguarding concrete buildings against water penetration effects such as freeze-thaw cycles & water-borne chemical assaults. Furthermore, because all causes of degradation require these pathways & channels to permeate into the concrete, blocking them protects against subsequent assaults.

- **Resists acid attacks:** As we've seen, concrete may be harmed by acidic or caustic chemicals. Acids in liquid form eat away at concrete by penetrating it through capillary porosity & macro-cracks. When acid reacts with calcium hydroxide in concrete, a calcium salt is produced, which is easily washed away from the cement, resulting in a weaker paste structure. Following the consumption of the calcium hydroxide, the acid will attack the calcium silicate hydrate, which is the true cementing mechanism that binds all of the particles together, causing major structural damage to concrete. These acidic chemical reactions & concrete degradations are considerably decreased when crystalline technology is used to plug the capillaries &pores of the concrete in the first place.

- **Resists sulphate attacks:** Similarly, employing crystalline technology to waterproof the concrete & reduce its permeability reduces the quantity of sulphate ions that can seep into the concrete pores. When sulphates are barred from entering the concrete, sulphate attack is lowered, while the concrete's resistance & durability are

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580|

| Volume 9, Issue 5, May 2022 |

| DOI: 10.15680/IJMRSETM.2022.0905012 |

increased. It's also worth noting that with crystalline technology, the reactive chemicals interact with different calcium compounds in the concrete. These calcium compounds are a fundamental building block for sulphate corrosion & are released as by-products of cement hydration. By reacting with calcium hydroxide & turning it into a non-soluble complex, the crystalline method lowers the amount of free CH available for the initial sulphate reaction. This has a direct impact on the rest of the sulphate corrosion process being slowed.

- **Inhibits the effects of Carbonation:** It has been verified that crystalline development in the capillary tracts reduces not only the flow of water but also the flow of gases into concrete. Because carbonation is dependent on CO & CO2 permeating the surface of the concrete, crystalline technology considerably slows down the carbonation process, especially in humid environments.

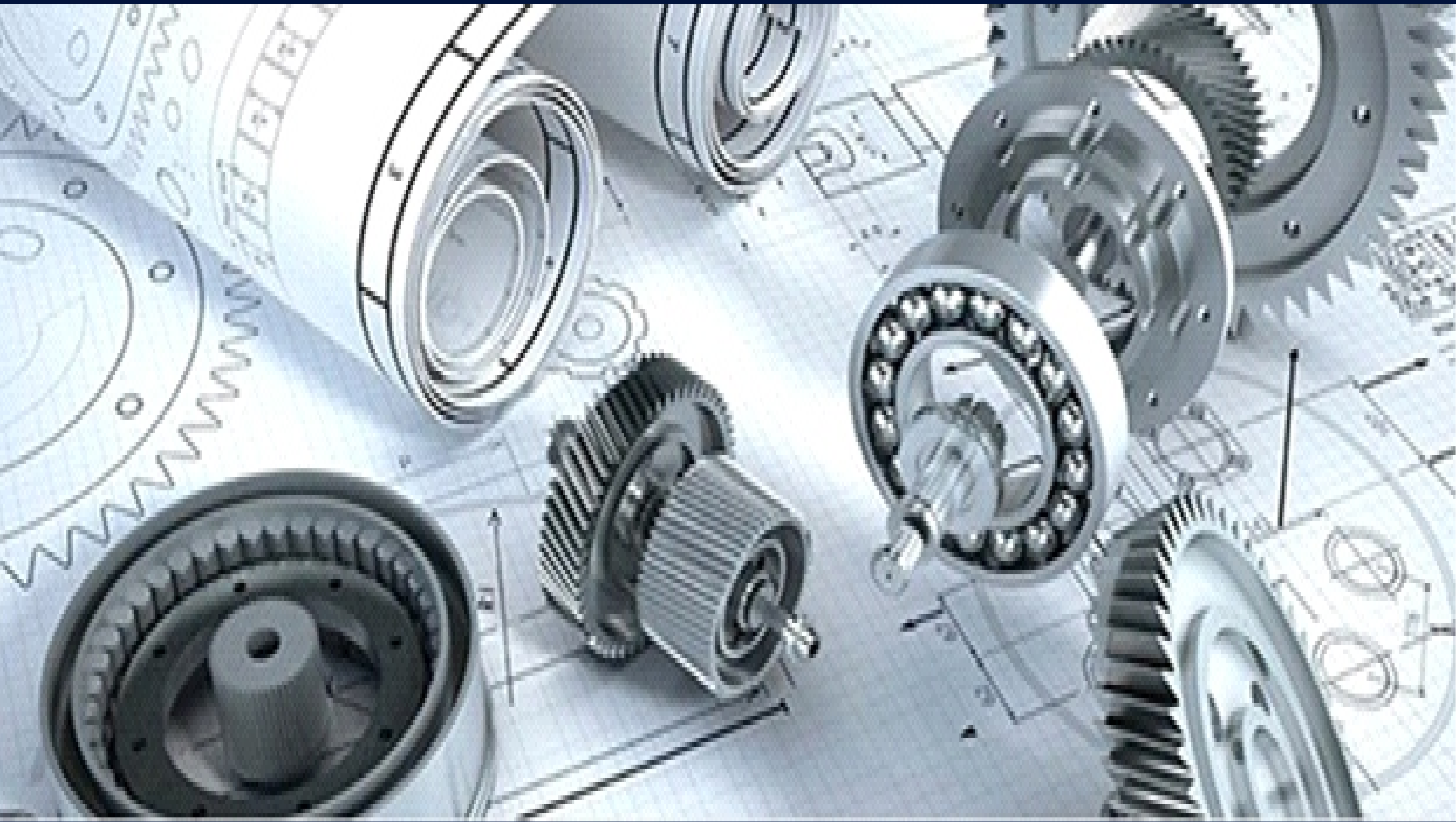
- **Reduces Chloride Ion Attacks:** Chloride attack, which occurs when chloride ions access the steel reinforcement through interconnected pores & fractures in the concrete, is a typical concern for coastal buildings, bridges, & concrete structures along highways in cold areas. If the chloride ions reach a certain concentration, they can break down the steel's naturally passivating alkaline coating & generate an electro-chemical corrosion cell. This causes the steel to corrode & rust to develop, which takes up more space than the initial steel & ultimately weakens the structure. By preventing liquids transporting chloride ions from ever reaching the steel, crystalline waterproofing has been proven to minimize chloride diffusion in concrete buildings. This aids in the protection of reinforcing steel & the prevention of damage caused by oxidation & expansion of steel reinforcement.

IV. CONCLUSION

This review examined how crystalline admixtures impact concrete durability. Chemical admixtures are gaining popularity as a way to build durable, cost-effective buildings. Permeability Reducing Admixtures (PRA) are ideal for protecting buildings from water and waterborne toxins since concrete permeability affects its lifetime. Several compounds have been discovered to protect concrete buildings against water penetration. Based on their chemistry, performance, and usage, they are classed as PRA. According to the literature, research is being done worldwide to find a viable alternative to aggregate for future needs. Industrial by-products and construction detritus are being examined for structural concrete research.

REFERENCES

[1] ACI-212.3R-10 (Report on Chemical Mixing) - American Concrete Institute.
[2] BS-8102: 2009 (Operational code for the protection of underground structures from groundwater).
[3] Saurabh Borle, GhadgeA.N.” Comparative Study of Common & Modern Methods of Water Prevention”
[4] CED 41 (7903) Draft Indian Standard Guidelines for the Protection of Groundwater Resistance to Groundwater
[5] Basumajumdar, A K Das, N Bandyopadhyay & S Maitra (2004). "Some lessons on Fly ash & Lime." Indian Academy of Sciences, 28 (2), 131-136.
[6] DujthepYadmalai, “Durable Concrete Buildings of Glossy Materials”, Sirindham International Institute of Technology Thammasat University.
[7] GangadharanManari& Anil G Kumar: Crystalline Waterproofing system for water storage & Underground Structure
[8] Li-Wei, Ram Huang &Jie Chen "A study of crystalline mechanism Penetratin sealer materials"
[9] Justin Henshell, “The blindside membrane system is below ground.
[10] A.A Ramezanianpour& V.M Malhotra, (1995). & Concrete. 17 (2), 125-133.



INNO SPACE

SJIF Scientific Journal Impact Factor

Impact Factor: 7.580

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING, TECHNOLOGY AND MANAGEMENT

+91 99405 72462 +91 63819 07438 ijmrsetm@gmail.com