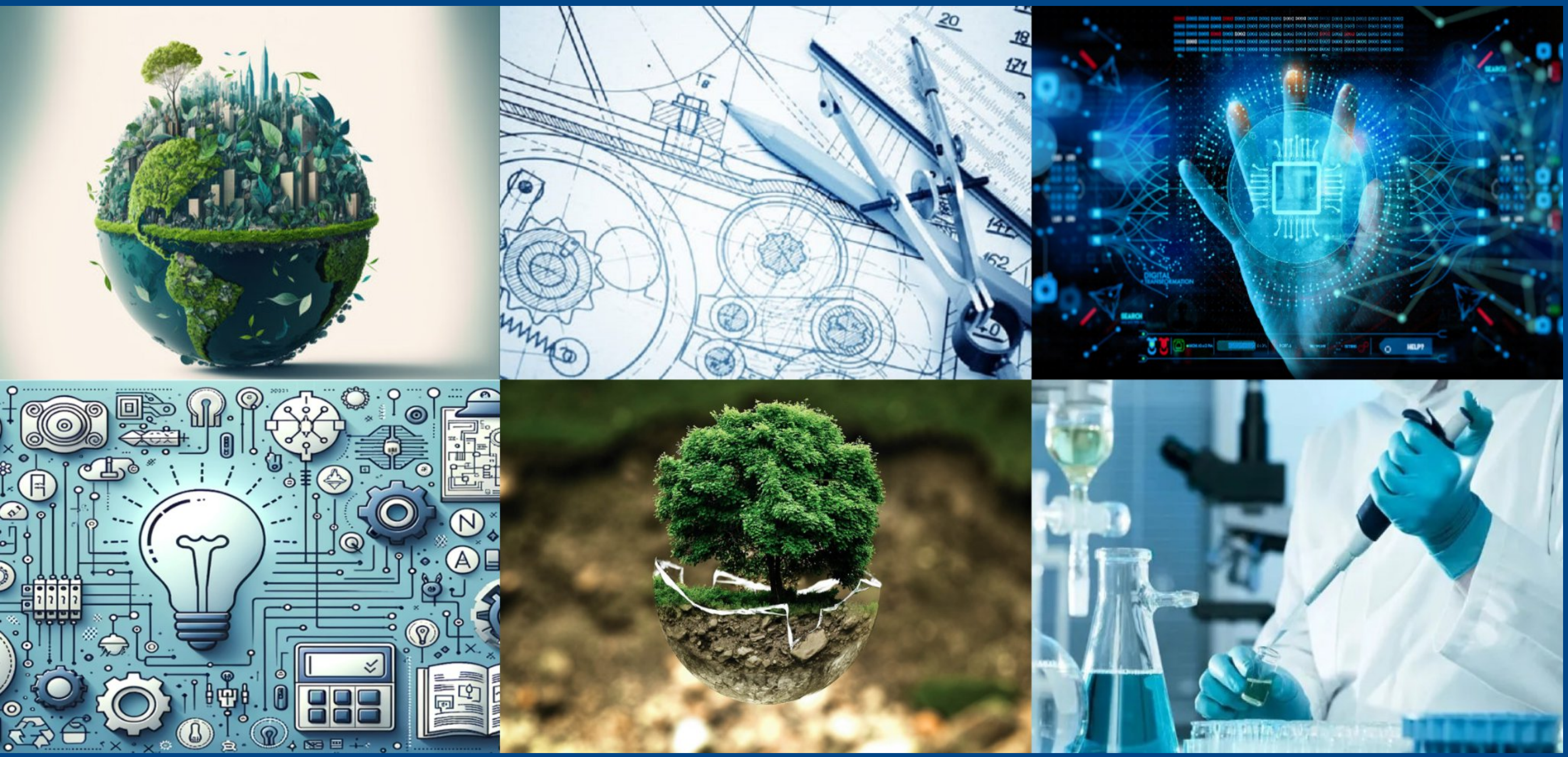
ISSN: 2582-7219

International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206

Volume 9, Issue 4, April 2026

www.ijmrset.com ijmrset@gmail.com +91 6381 907 438 +91 63819 07438

© 2026 IJMRSET | Volume 9, Issue 4, April 2026 | DOI:10.15680/IJMRSET.2026.0904339

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

SBR-Modified Cementitious Coatings for Corrosion Protection of Steel Reinforcement – A Review

S. Inthumathi, S. Kandasamy

Research Scholar, Department of Civil Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, Tamil Nadu, India

Professor, Department of Civil Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, Tamil Nadu, India

ABSTRACT: Reinforced concrete (RC) structures are widely used in modern infrastructure due to their high compressive strength, durability, and economic advantages. However, corrosion of steel reinforcement remains one of the most significant causes of deterioration in RC structures, leading to cracking, spalling, and reduction in service life. The penetration of chloride ions, moisture, and oxygen through the concrete cover initiates electrochemical corrosion processes on the reinforcement surface. Various corrosion protection techniques have been developed to mitigate reinforcement corrosion, including epoxy coatings, corrosion inhibitors, cathodic protection systems, and protective coatings. Among these methods, polymer-modified cementitious coatings have gained considerable attention because of their compatibility with concrete and ease of application. Styrene–Butadiene Rubber (SBR) latex is widely used as a polymer modifier in cementitious materials due to its excellent bonding properties, flexibility, and ability to reduce permeability. SBR-modified cementitious coatings applied on reinforcement bars can form a dense protective layer that reduces the ingress of aggressive agents such as water and chloride ions. In addition, corrosion inhibitors such as calcium nitrite are commonly incorporated into concrete to delay corrosion initiation by stabilizing the passive oxide layer on steel reinforcement. This paper presents a comprehensive review of corrosion mechanisms in reinforced concrete, properties of SBR-modified cementitious materials, and the role of calcium nitrite corrosion inhibitors. The review summarizes recent research developments and highlights research gaps related to the combined use of polymer-modified cementitious coatings and corrosion inhibitors for improving the durability of reinforced concrete structures.

KEYWORDS: Reinforcement corrosion, SBR latex, Polymer modified cement, Calcium nitrite inhibitor, Cementitious coatings, Durability

I. INTRODUCTION

Reinforced concrete (RC) is one of the most widely used construction materials for buildings, bridges, marine structures, and transportation infrastructure. The combination of concrete and steel reinforcement provides excellent compressive and tensile strength, making it suitable for structural applications. Under normal conditions, the highly alkaline environment of concrete forms a protective passive oxide layer on the steel reinforcement surface, preventing corrosion (Page and Treadaway, 1982).

However, in aggressive environments such as marine exposure, industrial pollution, and chloride-contaminated environments, the passive layer protecting the reinforcement may break down. Chloride ions penetrate the concrete cover through pores and microcracks and accumulate at the steel surface, initiating corrosion (Ann and Song, 2007). Carbonation caused by atmospheric carbon dioxide may also reduce the alkalinity of concrete, contributing to corrosion initiation (Andrade et al., 1993).

Corrosion of steel reinforcement leads to the formation of rust products that occupy a larger volume than the original steel. This expansion generates internal stresses within the surrounding concrete, causing cracking, delamination, and spalling of the concrete cover. As a result, the durability and service life of reinforced concrete structures are significantly reduced.

Various corrosion protection techniques have been developed to mitigate reinforcement corrosion. These include epoxy-coated reinforcement, corrosion inhibitors, cathodic protection systems, and protective coatings. Among these methods, polymer-modified cementitious materials have attracted significant attention due to their compatibility with concrete and improved durability properties.

II. CORROSION MECHANISM IN REINFORCED CONCRETE

Corrosion of reinforcement in concrete is an electrochemical process involving anodic and cathodic reactions occurring on the steel surface. In reinforced concrete structures, steel is normally protected by the highly alkaline environment of concrete, with pH values ranging from 12.5 to 13.5. This alkaline environment forms a passive oxide layer on the steel surface that prevents corrosion.

However, this passive film may be destroyed due to chloride attack or carbonation. Chloride-induced corrosion occurs when chloride ions penetrate the concrete and reach the reinforcement surface. Once the chloride concentration exceeds a critical threshold value, the passive film breaks down and localized corrosion begins (Ann and Song, 2007).

Carbonation-induced corrosion occurs when carbon dioxide from the atmosphere reacts with calcium hydroxide in concrete, forming calcium carbonate and reducing the alkalinity of the concrete. As the pH decreases, the passive layer surrounding the steel reinforcement becomes unstable, allowing corrosion to initiate (Andrade et al., 1993).

During corrosion, iron atoms at the anode oxidize and form corrosion products such as iron oxides and hydroxides. These corrosion products occupy two to six times the volume of the original steel, producing tensile stresses within the concrete cover. This expansion eventually leads to cracking, spalling, and loss of structural integrity.

III. CORROSION TESTING METHODS USED IN PREVIOUS STUDIES

The evaluation of corrosion performance of steel reinforcement in concrete structures has been extensively investigated using several experimental techniques. These corrosion testing methods are used to assess corrosion initiation, corrosion rate, and durability performance of reinforced concrete systems exposed to aggressive environments. Various researchers have adopted different experimental methods to study corrosion behaviour, including accelerated corrosion tests, half-cell potential measurements, electrochemical techniques, and weight loss measurements.

One of the most widely used methods for evaluating corrosion behaviour in reinforced concrete is the half-cell potential method. This technique measures the electrochemical potential of steel reinforcement embedded in concrete relative to a reference electrode. According to ASTM C876, the measured potential values provide an indication of the probability of corrosion activity occurring in reinforcement. Page and Treadaway (1982) studied the electrochemical behaviour of steel reinforcement in concrete using half-cell potential measurements and reported that corrosion initiation is strongly influenced by chloride concentration and environmental exposure conditions.

Another commonly used technique for corrosion evaluation is the accelerated corrosion test (ACT). In this method, an external electrical potential is applied between the reinforcement and an external electrode to accelerate the corrosion process. Accelerated corrosion tests are widely used in laboratory studies to simulate long-term corrosion behaviour within a shorter experimental duration. Andrade et al. (1993) used accelerated corrosion techniques to investigate cracking behaviour of reinforced concrete specimens subjected to reinforcement corrosion. Their study demonstrated that corrosion products generated during the corrosion process cause internal stresses that lead to cracking and spalling of the concrete cover.

Electrochemical techniques such as potentiodynamic polarization and electrochemical impedance spectroscopy (EIS) have also been widely used for evaluating corrosion performance. These techniques provide quantitative information regarding corrosion current density and corrosion rate. Saraswathy and Song (2007) used electrochemical measurements to evaluate the performance of corrosion inhibitors in reinforced concrete and reported that calcium nitrite significantly reduced corrosion current density in chloride-contaminated environments.

Another commonly used method for evaluating corrosion performance is the weight loss method, which measures the loss of steel mass due to corrosion. In this method, the steel reinforcement is cleaned after exposure and the reduction in weight is measured to estimate corrosion rate. Berke and Hicks (2008) used weight loss measurements to evaluate the long-term performance of corrosion inhibitors in reinforced concrete structures exposed to chloride environments. In addition to these methods, several studies have used chloride penetration tests and permeability tests to evaluate the resistance of cementitious materials to chloride ingress. Since chloride penetration is one of the primary causes of reinforcement corrosion, evaluating chloride transport properties of cementitious materials provides valuable information regarding their durability performance. Ramli and Tabassi (2012) reported that polymer-modified cement mortars showed significantly reduced permeability and chloride penetration compared with conventional cement mortars.

Comparative studies conducted by various researchers indicate that polymer modification significantly improves the resistance of cementitious materials to corrosion by reducing permeability and improving microstructural properties. For example, Afridi et al. (2003) reported that SBR-modified cement mortars exhibited improved durability characteristics due to reduced pore connectivity. Similarly, Wang et al. (2005) observed that polymer modification improved the microstructure of cement mortars and reduced permeability. Overall, the results reported in previous studies demonstrate that corrosion testing methods such as half-cell potential measurements, accelerated corrosion tests, electrochemical techniques, and weight loss measurements are effective tools for evaluating corrosion performance of reinforced concrete systems. These experimental techniques provide valuable information regarding corrosion initiation, corrosion rate, and durability characteristics of reinforced concrete structures.

IV. POLYMER-MODIFIED CEMENTITIOUS MATERIALS

Polymer-modified cementitious materials have been widely investigated for improving the performance and durability of cement-based systems. The incorporation of polymer latex into cementitious materials improves bonding properties, reduces permeability, and enhances resistance to aggressive environmental conditions.

Ohama (1998) reported that polymer-based admixtures significantly improve the performance of cementitious materials by enhancing adhesion, flexibility, and resistance to water penetration. Later, Ohama (2001) provided a comprehensive review of polymer-modified concrete and reported that polymer modification significantly improves durability and bonding characteristics. Afridi et al. (2003) investigated polymer-modified mortars containing SBR latex and reported improvements in tensile strength and adhesion properties. The formation of polymer films within the hydrated cement matrix reduces pore connectivity and improves bonding characteristics.

Wang et al. (2005) studied the microstructure of polymer-modified cement mortars and reported that polymer modification reduced pore connectivity and improved the density of the cement matrix. Ramli and Tabassi (2012) studied the permeability of polymer-modified cement mortars and reported significant reductions in water absorption and permeability. Ramli and Karakurt (2013) also reported that SBR-modified cementitious composites exhibit improved durability due to reduced permeability and improved microstructure. Doğan and Bideci (2016) investigated high-strength concrete modified with SBR latex and reported improvements in compressive strength, bonding properties, and durability performance.

V. SBR-MODIFIED CEMENTITIOUS MATERIALS

Polymer-modified cementitious coatings have been widely investigated for improving the durability of reinforced concrete structures. Among various polymers used in cement modification, Styrene–Butadiene Rubber (SBR) latex has demonstrated significant potential for improving adhesion and permeability resistance. When applied as a coating on reinforcement bars or concrete surfaces, SBR-modified cementitious slurry forms a dense protective layer that reduces the penetration of aggressive agents such as water, oxygen, and chloride ions.

Zhang et al. (2022) investigated SBR-modified cementitious coatings used for concrete repair applications. Their results showed that SBR modification improved adhesion and significantly reduced chloride penetration. Zhao and Liu (2023) studied polymer-modified cement coatings for reinforced concrete protection and reported that polymer coatings improved durability and resistance to aggressive environments. Chen and Liu (2023) investigated polymer-modified cement mortars exposed to aggressive environments and reported improved durability and reduced permeability compared to conventional cement mortars. Yan and Li (2024) studied SBR-modified cement mortars and reported improvements in tensile strength, bonding characteristics, and resistance to microcracking. These studies indicate that polymer-modified cementitious coatings can provide effective corrosion protection by reducing permeability and preventing chloride ingress.

The incorporation of SBR in cementitious materials improves several properties, including:
- Increased bond strength
- Reduced permeability
- Improved flexibility and crack resistance
- Enhanced resistance to water penetration
- Improved adhesion to steel reinforcement

5.1 MECHANISM OF SBR MODIFICATION IN CEMENTITIOUS MATERIALS

The incorporation of Styrene–Butadiene Rubber (SBR) latex in cementitious systems significantly modifies the microstructure of the cement matrix. When SBR latex is mixed with cement and water, the polymer particles are dispersed throughout the cement paste. During the hydration process, the polymer particles gradually coalesce and form a continuous polymer film within the hydrated cement matrix.

This polymer film fills the pores and capillary voids within the cement matrix, resulting in a denser microstructure. The reduction in pore connectivity significantly decreases the permeability of the cementitious material. As a result, the penetration of aggressive agents such as chloride ions, oxygen, and moisture is reduced. Another important mechanism associated with polymer modification is the improvement in bonding characteristics. The polymer film improves adhesion between cement paste and aggregates as well as between cement paste and steel reinforcement. Improved adhesion helps reduce microcracking and improves the durability of cement-based materials.

SBR modification also improves the flexibility of cementitious materials. Conventional cement-based materials are relatively brittle, whereas polymer-modified systems exhibit improved strain capacity and resistance to cracking. This improved crack resistance plays an important role in preventing the penetration of aggressive agents that may initiate corrosion.

Several studies have reported that SBR modification reduces water absorption and permeability of cementitious materials. Reduced permeability directly contributes to improved durability and corrosion resistance of reinforced concrete structures.

5.2 ADVANTAGES OF SBR-MODIFIED CEMENTITIOUS COATINGS

SBR-modified cementitious coatings offer several advantages when used for the protection of reinforced concrete structures. One of the most important advantages is their excellent adhesion to both steel reinforcement and concrete substrates. Unlike conventional coatings, polymer-modified cementitious coatings bond strongly with the concrete surface, reducing the possibility of delamination.

Another advantage of SBR-modified coatings is their compatibility with concrete. Since the coating is based on cementitious materials, it exhibits similar thermal expansion characteristics as concrete, which helps prevent cracking and debonding under temperature variations. SBR-modified coatings also exhibit improved resistance to water penetration. The presence of polymer films reduces capillary porosity and blocks the pathways for water and chloride ingress. Furthermore, SBR-modified coatings provide improved flexibility and crack resistance. This allows the coating to accommodate minor structural movements without cracking. The application process of SBR-modified cementitious coatings is relatively simple compared with other corrosion protection systems such as epoxy coatings or cathodic protection systems. These coatings can be applied using conventional methods such as brushing or spraying. Due to these advantages, SBR-modified cementitious coatings have gained significant attention for use in repair and rehabilitation of reinforced concrete structures.

5.3 LIMITATIONS OF CONVENTIONAL CORROSION PROTECTION METHODS

Several conventional methods have been developed to protect steel reinforcement from corrosion, including epoxy-coated reinforcement, corrosion inhibitors, stainless steel reinforcement, and cathodic protection systems.

Epoxy-coated reinforcement is widely used in reinforced concrete structures exposed to chloride environments. However, the effectiveness of epoxy coatings depends on the integrity of the coating layer. Mechanical damage during handling or construction may expose the steel surface, allowing corrosion to initiate. Cathodic protection systems are effective in controlling reinforcement corrosion but require continuous monitoring and maintenance. The installation and maintenance costs associated with cathodic protection systems are relatively high.

Stainless steel reinforcement provides excellent corrosion resistance; however, its high cost limits its widespread application in construction projects. Because of these limitations, alternative corrosion protection techniques such as polymer-modified cementitious coatings and corrosion inhibitors are increasingly being investigated.

VI. CALCIUM NITRITE CORROSION INHIBITOR

Corrosion inhibitors are chemical substances that reduce the corrosion rate of steel reinforcement when incorporated into concrete. Calcium nitrite is one of the most widely used corrosion inhibitors in reinforced concrete structures. Calcium nitrite acts as an anodic corrosion inhibitor by stabilizing the passive oxide layer on the steel surface. The nitrite ions compete with chloride ions and help maintain the passive film on the reinforcement surface (Berke and Hicks, 2008).

Page and Treadaway (1982) studied the electrochemical behaviour of steel reinforcement in concrete and reported that nitrite-based inhibitors help maintain the passive oxide layer on steel reinforcement. Ann and Song (2007) reported that calcium nitrite significantly delayed corrosion initiation in chloride-contaminated environments. Saraswathy and Song (2007) evaluated the corrosion performance of calcium nitrite inhibitors using electrochemical measurements and observed a reduction in corrosion current density in reinforced concrete specimens containing the inhibitor. These studies indicate that calcium nitrite inhibitors can significantly delay corrosion initiation and extend the service life of reinforced concrete structures.

6.1 MECHANISM OF CALCIUM NITRITE CORROSION INHIBITOR

Calcium nitrite is an anodic corrosion inhibitor commonly used in reinforced concrete structures. The primary mechanism of calcium nitrite involves the stabilization of the passive oxide film on the steel reinforcement surface.
When calcium nitrite is added to concrete, nitrite ions migrate through the pore solution and reach the steel surface. These nitrite ions react with ferrous ions to form a stable ferric oxide layer on the reinforcement surface. The formation of this protective oxide layer helps prevent the breakdown of the passive film even in the presence of chloride ions. As a result, the corrosion initiation process is delayed. Calcium nitrite also increases the chloride threshold level required for corrosion initiation. This means that a higher concentration of chloride ions is required before corrosion begins. Several electrochemical studies have demonstrated that calcium nitrite reduces corrosion current density and increases the corrosion initiation time in reinforced concrete structures.

6.2 ADVANTAGES AND LIMITATIONS OF CALCIUM NITRITE INHIBITORS

Calcium nitrite inhibitors offer several advantages in corrosion protection of reinforced concrete structures. One major advantage is their ability to delay corrosion initiation by stabilizing the passive oxide layer on steel reinforcement.Another advantage is that calcium nitrite can be easily incorporated into the concrete mix during the batching process. This makes it a convenient corrosion protection method for new construction projects. Calcium nitrite inhibitors are particularly effective in structures exposed to chloride environments such as marine structures, bridges, and parking garages. However, calcium nitrite inhibitors also have certain limitations. The effectiveness of the inhibitor depends on the dosage and the environmental exposure conditions. Insufficient dosage may not provide adequate corrosion protection. In addition, high concentrations of calcium nitrite may influence the setting time and workability of concrete. Therefore, the dosage of calcium nitrite must be carefully controlled during concrete production. Despite these limitations, calcium nitrite remains one of the most widely used corrosion inhibitors in reinforced concrete structures.

VII. LITERATURE REVIEW SUMMARY

From the above studies, it is evident that polymer-modified cementitious materials play a significant role in improving the durability and long-term performance of reinforced concrete structures. The incorporation of polymers such as Styrene–Butadiene Rubber (SBR) into cementitious systems enhances several important properties, including bonding strength, flexibility, and resistance to aggressive environmental conditions. Polymer modification also leads to the formation of a continuous polymer film within the hydrated cement matrix, which reduces pore connectivity and permeability (Ohama, 1998; Ohama, 2001). As a result, the ingress of harmful agents such as water, oxygen, and chloride ions into the concrete matrix can be significantly reduced.

Several researchers have demonstrated that SBR-modified cementitious materials exhibit improved mechanical and durability properties compared with conventional cement-based systems. Afridi et al. (2003) reported that SBR-modified mortars showed improved tensile strength and bonding properties due to the formation of polymer films within the cement matrix. Similarly, Wang et al. (2005) observed that polymer latex reduced pore connectivity and improved the microstructure of cement mortars. Ramli and Tabassi (2012) reported that polymer modification significantly reduced permeability and water absorption in cement mortars, while Ramli and Karakurt (2013) observed improved durability characteristics in SBR-modified cementitious composites.

The use of SBR modification in cementitious materials has also been reported to improve the mechanical properties of concrete. Doğan and Bideci (2016) investigated high-strength concrete modified with SBR latex and reported improvements in compressive strength, bonding properties, and durability performance. These studies indicate that SBR modification improves the structural integrity and durability of cement-based materials.

In recent years, polymer-modified cementitious coatings have also been investigated as protective systems for reinforced concrete structures. Zhang et al. (2022) studied SBR-modified cementitious coatings used for concrete rehabilitation and reported that the coatings significantly reduced chloride penetration and water absorption. Similarly, Zhao and Liu (2023) reported that polymer-modified cement coatings improved resistance to aggressive environmental conditions and enhanced the durability of reinforced concrete structures. Chen and Liu (2023) also reported that polymer-modified cement mortars exposed to aggressive environments exhibited improved durability compared with conventional cement mortars. Furthermore, Yan and Li (2024) observed improvements in tensile strength and crack resistance in SBR-modified cementitious systems.

In addition to polymer modification, corrosion inhibitors have been widely used as another effective strategy for corrosion protection of steel reinforcement. Among the various corrosion inhibitors available, calcium nitrite is one of the most widely used inhibitors in reinforced concrete structures. Calcium nitrite functions primarily as an anodic corrosion inhibitor that stabilizes the passive oxide film on the steel reinforcement surface (Berke and Hicks, 2008). Nitrite ions present in the pore solution react with ferrous ions and help maintain the protective passive layer on the steel surface. Previous research has shown that calcium nitrite significantly increases the chloride threshold level required to initiate corrosion in reinforced concrete. Page and Treadaway (1982) investigated the electrochemical behavior of steel reinforcement in concrete and reported that nitrite-based inhibitors help maintain the passive oxide layer on steel reinforcement. Ann and Song (2007) also reported that the addition of calcium nitrite increased the corrosion initiation time in chloride-contaminated environments. Saraswathy and Song (2007) further reported that calcium nitrite inhibitors significantly reduced corrosion current density in reinforced concrete specimens.

The reviewed literature clearly indicates that polymer-modified cementitious materials significantly improve the durability and permeability resistance of cement-based systems. SBR modification enhances bonding strength, reduces permeability, and improves resistance to aggressive environmental conditions. Similarly, corrosion inhibitors such as calcium nitrite have been widely used to delay corrosion initiation by stabilizing the passive oxide layer on steel reinforcement. These findings highlight the potential of polymer modification and corrosion inhibitors as effective strategies for improving the durability and corrosion resistance of reinforced concrete structures. Understanding the interaction between these protection mechanisms may provide valuable insights for developing improved corrosion protection strategies for reinforced concrete structures exposed to aggressive environments.

VIII RESEARCH GAP AND FUTURE DIRECTIONS

Based on the reviewed literature, several research gaps can be identified in the field of corrosion protection of steel reinforcement using polymer-modified cementitious materials and corrosion inhibitors. Corrosion of reinforcement remains one of the most significant durability problems affecting reinforced concrete structures worldwide, particularly in aggressive environments such as marine regions, coastal areas, and structures exposed to de-icing salts (Ann and Song, 2007). Although numerous corrosion protection methods have been developed, there is still a need for more effective and durable protection systems.

Many previous studies have primarily focused on the mechanical and durability properties of polymer-modified cement mortars and concretes. Polymer modification using materials such as Styrene–Butadiene Rubber (SBR) has been reported to improve bonding strength, reduce permeability, and enhance durability characteristics of cementitious materials (Ohama, 1998; Afridi et al., 2003). However, most of these investigations have focused on polymer-modified mortars and concrete mixes rather than their application as protective coatings directly applied to steel reinforcement bars. Therefore, limited information is available regarding the effectiveness of SBR-modified cementitious coatings when used as a direct corrosion protection system for reinforcement.

Furthermore, while polymer-modified cementitious coatings have been studied for concrete repair and surface protection applications, relatively few studies have investigated their performance specifically for corrosion protection of embedded steel reinforcement. Since corrosion initiation occurs at the steel–concrete interface, protective coatings applied directly to reinforcement bars may provide an additional barrier against aggressive agents such as chloride ions and moisture. However, the effectiveness of such coatings in long-term corrosion protection requires further investigation.

Similarly, corrosion inhibitors such as calcium nitrite have been widely studied as chemical admixtures used in reinforced concrete structures to delay corrosion initiation. Calcium nitrite acts as an anodic corrosion inhibitor by stabilizing the passive oxide layer on the steel surface and increasing the chloride threshold level required for corrosion initiation (Berke and Hicks, 2008). Several studies have demonstrated that the use of calcium nitrite inhibitors can significantly reduce corrosion rates and extend the service life of reinforced concrete structures (Saraswathy and Song, 2007). However, the effectiveness of corrosion inhibitors may vary depending on factors such as environmental exposure conditions, chloride concentration, and dosage of the inhibitor. Another limitation identified in previous studies is that polymer-modified cementitious coatings and corrosion inhibitors have generally been investigated independently. While polymer modification improves the physical barrier properties of cementitious materials, corrosion inhibitors function by stabilizing the passive film on the steel reinforcement surface. The combined use of these two protection methods may potentially provide enhanced corrosion resistance by offering both physical and chemical protection mechanisms. However, limited research has been conducted to investigate the potential synergistic effects of polymer-modified coatings and corrosion inhibitors for corrosion protection of steel reinforcement.

Moreover, the influence of polymer modification on the corrosion behaviour of reinforcement in the presence of corrosion inhibitors has not been extensively studied. Understanding the interaction between polymer-modified cementitious coatings and corrosion inhibitors could provide valuable insights into developing more effective corrosion protection strategies for reinforced concrete structures. Therefore, further research is required to investigate integrated corrosion protection approaches that combine polymer-modified cementitious coatings with corrosion inhibitors. Such studies could contribute to the development of improved corrosion protection systems capable of enhancing the durability and service life of reinforced concrete structures exposed to aggressive environmental conditions.

Future research should also focus on evaluating the long-term performance of polymer-modified coatings under different environmental exposure conditions, including marine environments, chloride-contaminated environments, and industrial atmospheres. In addition, advanced experimental techniques such as electrochemical measurements, accelerated corrosion testing, and microstructural analysis can be used to better understand the corrosion protection mechanisms associated with polymer-modified coatings and corrosion inhibitors.

IX. CONCLUSIONS

Corrosion of steel reinforcement remains one of the major durability challenges in reinforced concrete structures. Polymer-modified cementitious materials have demonstrated significant potential for improving the durability of cement-based systems. In particular, SBR latex modification enhances bonding strength, reduces permeability, and improves resistance to water and chloride penetration.

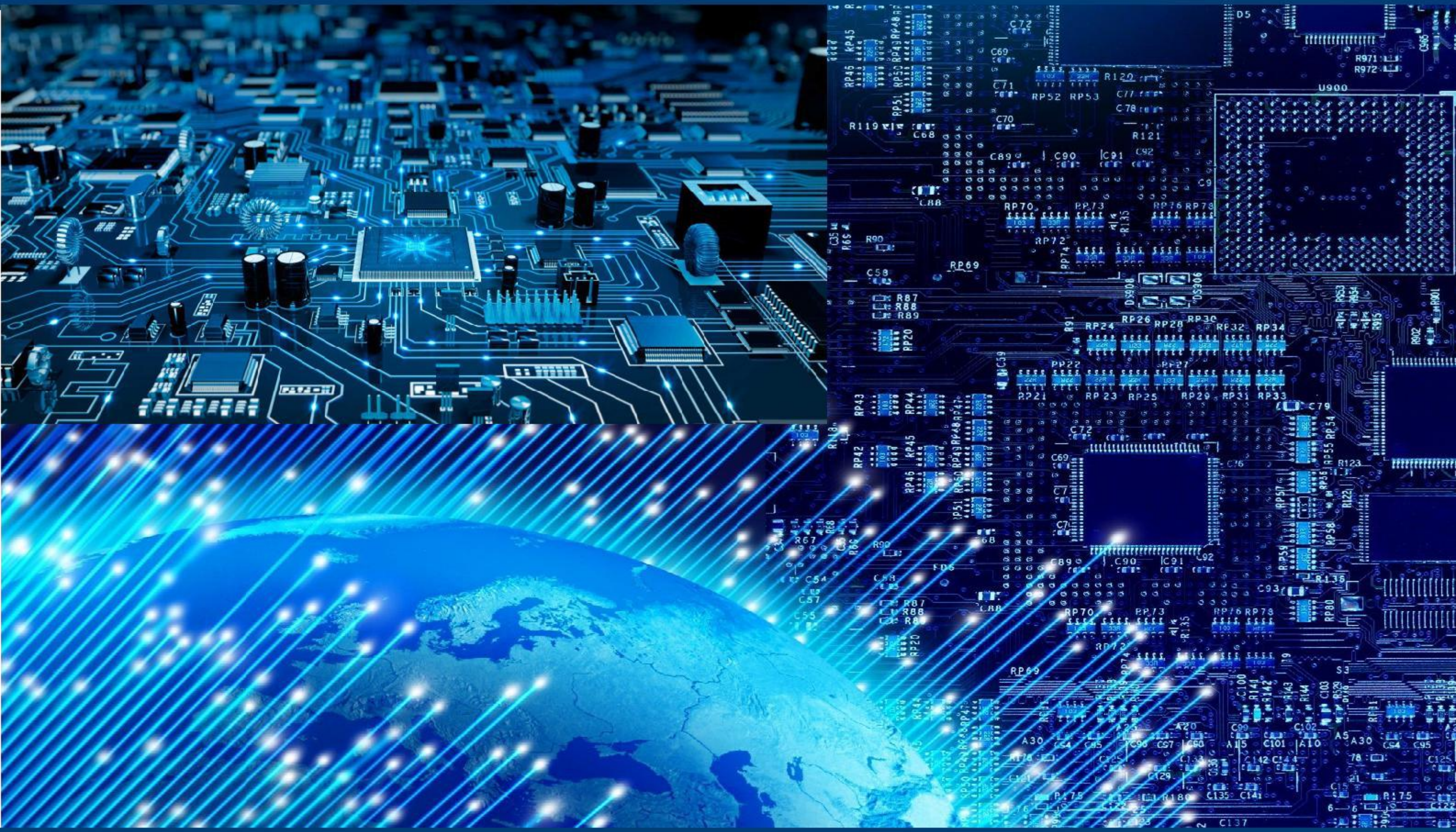
SBR-modified cementitious coatings can form a dense protective barrier that reduces the ingress of aggressive agents to the reinforcement surface. In addition, corrosion inhibitors such as calcium nitrite have been widely used to delay corrosion initiation by stabilizing the passive oxide layer on steel reinforcement.

Although both polymer-modified cementitious coatings and corrosion inhibitors have been widely studied, limited research has examined their combined use for corrosion protection of reinforcement. Further studies are therefore required to investigate integrated corrosion protection strategies that combine polymer-modified coatings and corrosion inhibitors to enhance the durability and service life of reinforced concrete structures.

REFERENCES

1. Afridi M.U.K., Ohama Y., Iqbal M.Z., Demura K., 2003. Properties of polymer-modified mortar using SBR latex. *Cement and Concrete Composites*, 25, pp. 443–449.
2. Alonso C., Andrade C., 1990. Corrosion inhibitors for steel reinforcement in concrete. *Cement and Concrete Research*, 20, pp. 525–539.
3. Andrade C., Alonso C., Molina F.J., 1993. Cover cracking as a function of bar corrosion. *Materials and Structures*, 26, pp. 453–464.
4. Andrade C., Alonso C., 2004. Test methods for on-site corrosion rate measurement of steel reinforcement. *Construction and Building Materials*.
5. Ann K.Y., Song H.W., 2007. Chloride threshold level for corrosion of steel in concrete. *Corrosion Science*, 49, pp. 4113–4133.
6. Angst U., Elsener B., Larsen C., Vennesland O., 2009. Critical chloride content in reinforced concrete. *Cement and Concrete Research*.
7. Berke N.S., 1991. Calcium nitrite corrosion inhibitor in concrete. *ACI Materials Journal*.
8. Berke N.S., 2004. Corrosion inhibitors in concrete. *Cement and Concrete Composites*, 26, pp. 653–659.
9. Berke N.S., Hicks M.C., 2008. Estimating the life-cycle of reinforced concrete structures with corrosion inhibitors. *Cement and Concrete Composites*, 30, pp. 621–627.
10. Bertolini L., Elsener B., Pedeferri P., Polder R., 2013. *Corrosion of Steel in Concrete: Prevention, Diagnosis and Repair*. Wiley.
11. Broomfield J.P., 2007. *Corrosion of Steel in Concrete: Understanding, Investigation and Repair*. Taylor & Francis.
12. Broomfield J.P., 2007. Corrosion monitoring techniques for reinforced concrete structures. *Corrosion Engineering*.
13. Chen Y., Liu J., 2023. Durability of polymer-modified cement mortars exposed to aggressive environments. *Construction and Building Materials*, 345.
14. Doğan M., Bideci A., 2016. Effect of styrene-butadiene copolymer latex on high strength concrete. *Construction and Building Materials*, 112, pp. 378–385.
15. Elsener B., 2001. Corrosion inhibitors for steel in concrete: State of the art report. *Cement and Concrete Composites*, 23, pp. 209–216.
16. Glass G.K., Buenfeld N.R., 2000. The influence of chloride binding on the chloride induced corrosion risk in reinforced concrete. *Corrosion Science*, 42.
17. Han H., Zhang L., 2024. Optimization of latex-modified concrete for improved durability. *Construction and Building Materials*.
18. Hou G., Fan L., Liao X., Shang H., Liu N., Zhao X., Sun C., 2022. Corrosion behavior of modified cement-based coated steel rebar subjected to tensile loads. *Construction and Building Materials*.
19. Hou G., Fan L., Liao X., 2022. Performance of polymer-modified cement coatings on reinforcement under corrosion conditions. *Construction and Building Materials*.
20. Li W., Zhang Y., 2022. Polymer modified cementitious materials for durability improvement. *Materials and Structures*, 55.
21. Liu J., 2021. Polymer modified cement materials: durability and performance. *Construction and Building Materials*, 282.
22. Liu J., Miao C., Chen C., 2021. Polymer modified cement composites for durability improvement. *Construction and Building Materials*, 282.
23. Liu Y., Weyers R.E., 1998. Modelling the time-to-corrosion cracking in chloride contaminated reinforced concrete structures. *ACI Materials Journal*.
24. Liu Y., Zhang J., 2024. Polymer-modified cementitious coatings for corrosion protection of reinforced concrete. *Construction and Building Materials*.
25. Mehta P.K., Monteiro P.J.M., 2014. *Concrete: Microstructure, Properties and Materials*. McGraw-Hill.
26. Mindess S., Young J.F., Darwin D., 2003. *Concrete*. Prentice Hall.
27. Monticelli C., Frignani A., Trabanelli G., 2000. Corrosion inhibitors for steel in concrete. *Cement and Concrete Research*, 30, pp. 635–642.

28. Neville A., 1995. Chloride attack of reinforced concrete: An overview. *Materials and Structures*, 28.
29. Ngala V.T., Page C.L., 2002. Corrosion inhibitor systems for reinforced concrete structures. *Cement and Concrete Research*, 32, pp. 841–846.
30. Ohama Y., 1998. Polymer-based admixtures. *Cement and Concrete Composites*, 20, pp. 189–212.
31. Ohama Y., 2001. Polymer-modified concrete: Review and development. *Cement and Concrete Composites*, 23, pp. 209–218.
32. Page C.L., Treadaway K.W.J., 1982. Aspects of the electrochemistry of steel in concrete. *Nature*, 297, pp. 109–115.
33. Polder R., 2001. Test methods for corrosion of steel in concrete. *Materials and Structures*.
34. Qian S., Zhang Y., 2019. Durability improvement of polymer modified cementitious materials. *Construction and Building Materials*, 221.
35. Ramli M., Tabassi A.A., 2012. Effects of polymer modification on permeability of cement mortars. *Construction and Building Materials*, 28, pp. 81–87.
36. Ramli M., Karakurt C., 2013. Influence of SBR latex on durability characteristics of cementitious composites. *Construction and Building Materials*, 47, pp. 1070–1077.
37. Saraswathy V., Song H.W., 2007. Corrosion performance of inhibitors in reinforced concrete. *Materials and Structures*, 40.
38. Shi X., Fay L., Peterson M., Yang Z., 2009. Corrosion protection of reinforcing steel in concrete structures. *Construction and Building Materials*, 23.
39. Singh S., 2018. Polymer modified cement mortar for repair applications. *Journal of Building Engineering*, 15.
40. Song H.W., Saraswathy V., 2006. Studies on corrosion monitoring and inhibitors in reinforced concrete. *Journal of Materials in Civil Engineering*.
41. Song H.W., Saraswathy V., 2007. Corrosion monitoring of reinforced concrete structures. *International Journal of Electrochemical Science*, 2.
42. Tang L., Nilsson L.O., 1992. Rapid determination of chloride diffusivity in concrete by electrical migration test. *ACI Materials Journal*.
43. Tuutti K., 1982. *Corrosion of Steel in Concrete*. Swedish Cement and Concrete Research Institute.
44. Wang J., Zhang H., 2022. Polymer latex modified cement composites. *Journal of Materials Research and Technology*, 18.
45. Wang R., Li X., Wang P., 2005. Influence of polymer latex on microstructure and mechanical properties of cement mortar. *Cement and Concrete Research*, 35, pp. 900–905.
46. Yan Y., Li X., 2024. Mechanical and durability performance of SBR-modified cement mortars. *Polymers*, 16.
47. Zhang J., Li Y., Wang H., 2022. SBR-modified cementitious coatings for concrete rehabilitation. *Materials*, 15.
48. Zhang L., Han H., 2023. Durability performance of polymer modified concrete under aggressive exposure. *Materials and Structures*.
49. Zhang Y., Li W., 2021. Durability performance of polymer modified cement composites under aggressive environments. *Construction and Building Materials*.
50. Zhao X., Liu Y., 2023. Polymer-modified cement coatings for reinforced concrete protection. *Materials*, 16.



INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com