INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 6.078
(Volume 6, Issue 4)
Available online at: https://www.ijariit.com

Polymer-concrete composites: Impregnation

Ankur Kapooria
ankur.kapooria@gmail.com
Indian Institute of Technology Delhi, New Delhi, Delhi

ABSTRACT

We see monuments and beautiful old building around us that were built ages before. They not only provide a great visual joy but also remind us of our history and connects to our ancestors. With time, several of these have deteriorated causing the risk of demolition any time. Clearly these buildings require reinforcement for sustainment. Advancement in concrete technology has led to polymer impregnated concrete which can be used for restoration of such structures.

Keywords: *PIC, Polymer Concrete, Monomer, Restoration*

1. INTRODUCTION

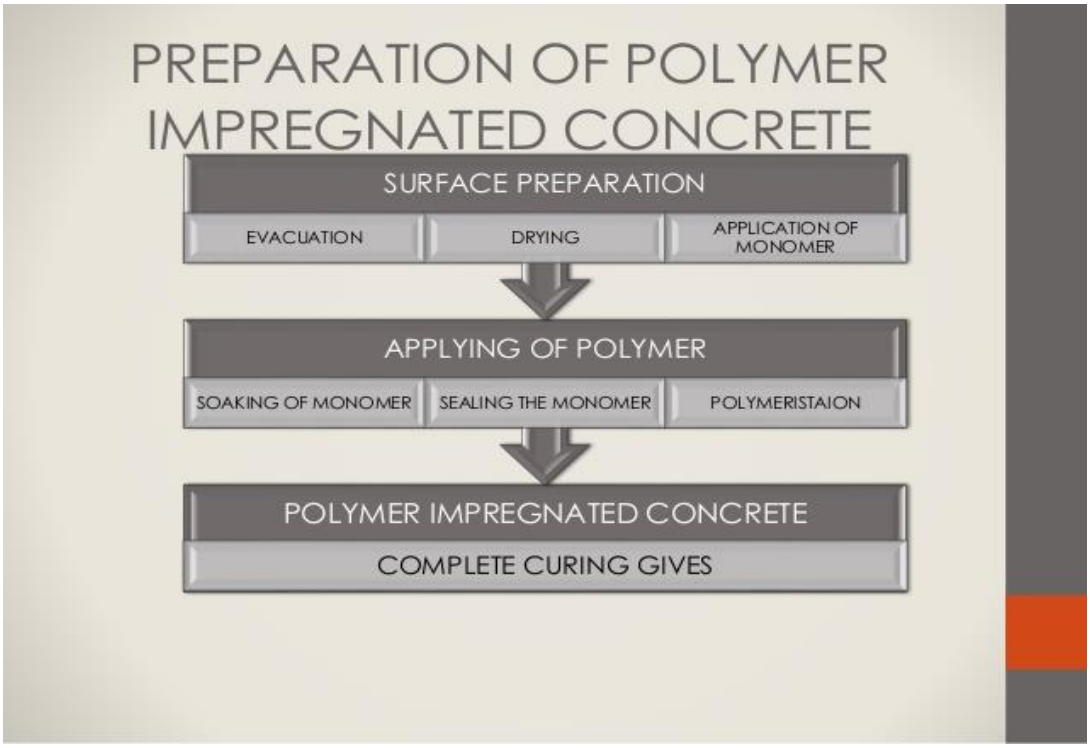
Using polymer as binding glue instead of cement forms Polymer Concrete(PC). Adding some cement to polymer and using the cement-polymer mixture as paste is known as Polymer Modified Concrete(PMC). Adding polymer to completely hydrated (fully set) concrete is known as Polymer Impregnated Concrete(PIC).

There is porosity in concrete due to air-voids, water voids or due to the inherent porosity of gel structure itself; as a result of which it can develop cracks and deteriorate under influence of several chemicals in the atmosphere. Decrease in porosity leads to increase of strength of concrete. Therefore, process like vibration, spinning, pressure application etc., are practiced to reduce porosity. All these methods have been found to be helpful, but none of these methods could reduce the voids to great extent. The impregnation of monomer and polymerisation is one of the ways to remove the voids and improve the characteristics of concrete.

2. PREPARATION

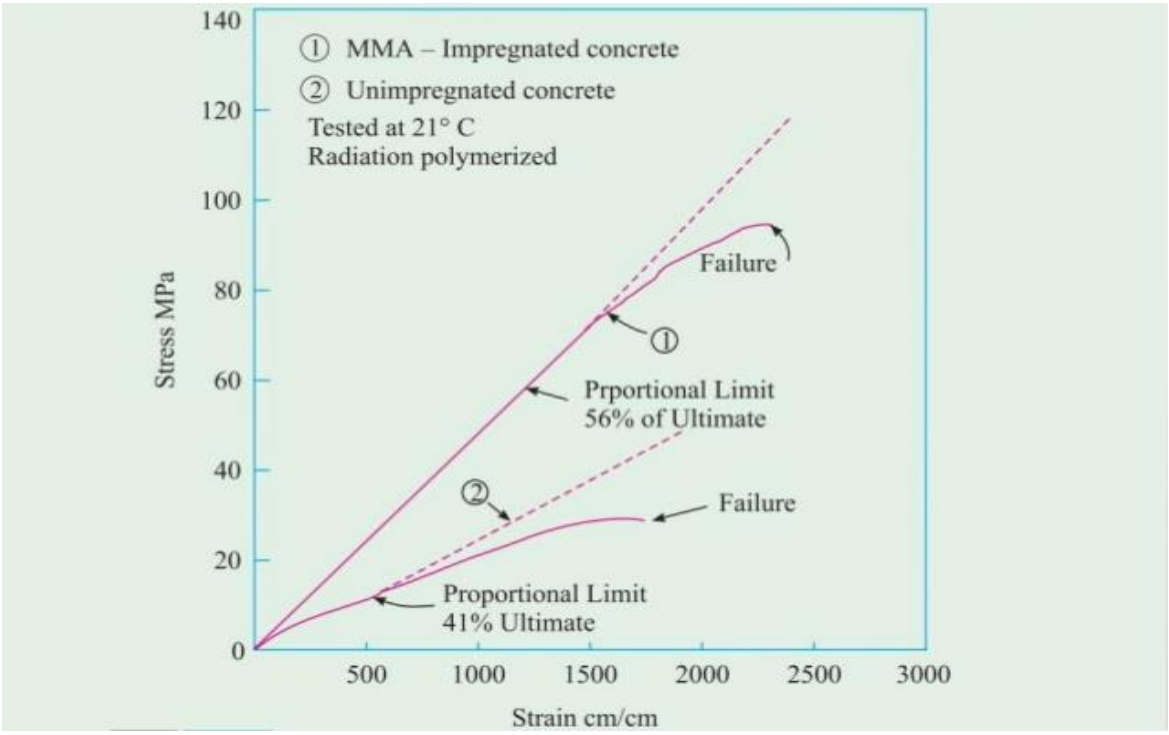
- Produced by infiltrating a hardened concrete with a monomer.
- The voids are reason for low strength and poor durability of concrete. Monomer units are able to penetrate the cement and reaches the unwanted voids where polymerisation takes place filling the voids with polymer forming a continuous internal structure with great strength and durability.
- A precast and hydrated Portland cement concrete is taken and completely cured and oven dried and monomer is applied onto it.
- The voids in concrete contain water and air, thus it is necessary to heat and vacuum dry properly for the monomer to act. Also the monomer should be adequately viscous to flow into the concrete block.
- The time for penetration of monomer is affected by viscosity and the initial preparation of concrete. (Lesser air voids means less monomer required and less is the time)
- Penetration of monomer inside the concrete depends on size of monomer, time period for which concrete is kept immersed in monomer and temperature.
- Vacuum treatment for long period of time leads to better penetration of monomer. Increase in pressure increases soaking of monomer.
- Commonly used monomers are **methyl methacrylate** and **styrene** because of their **low viscosity**, **high boiling point** and **low cost.**
- After penetration of monomer into the void and cracks, has to be polymerised which can be done in three ways-

1. A combination of **promoter chemicals and catalysts-**
   - Room temp
   - Slow and less controllable.
2. **Gamma radiation**.
   - Room temp
   - Hazardous for Health
3. **By Heating (Thermal Catalytic Polymerisation)**
   - Most common
   - Monomer-catalyst mixture used for penetration, and heating the concrete with water or infrared heaters.



3. PROPERTIES

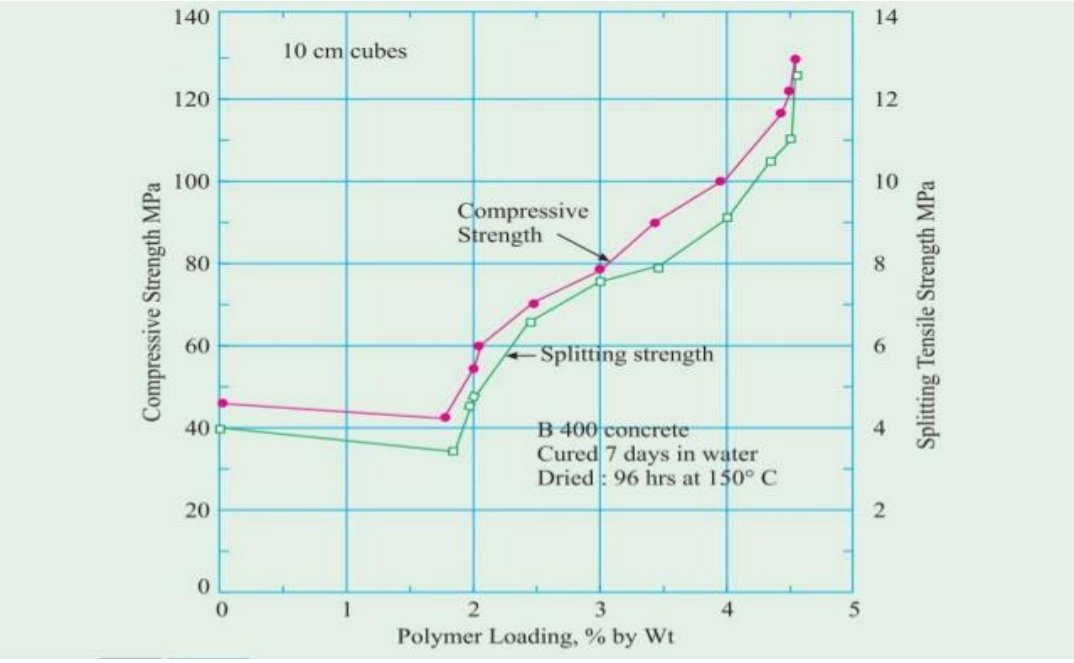
- Polymers give a more compact structure to the cement matrix. Not only they envelope the cement mortar but also seal the cracks and voids formed during the cement hydration.
- Increase in compressive and tensile strength. (The amount of increase depends on the type of polymer used and its composition)
- The flexural strength is increased to a level greater than highest strength regular concrete can reach.
- Porosity of the conventional cement mortar is greatly reduced along with water removal thereby making it highly resistant to acid, sulphate or chlorate attack.
- The degree of polymerization of monomer is greater when prepared by microwaves than from conventional thermal methods.



PIC has linear stress-strain relationship up to 80% of ultimate strength and there is no abrupt change at proportional limit. The stress strain curves for Styrene-TMPTMA impregnated concrete also show the same characteristics as MMA impregnated concrete.

4. COMPRESSIVE STRENGTH & TENSILE STRENGTH

Using methyl methacrylate as monomer (6.4%), strength of 144 MPa (from 38 MPa) has been observed using radiation technique of polymerization.



4.1 Flexural Strength

Increase in flexural strength by more than 3 times of ordinary Portland cement concrete for MMA impregnated concrete formed with radiation polymerisation. MMA impregnated concrete show negative creep on load application i.e. these concrete expand under continued compression.

4.2 Chemical Resistance

As Polymer impregnated concrete has high water resistance and less permeability, it shows excellent resistance to freeze-thaw and around 200% improvement in resistance to sulphate attack.

5. ADVANTAGES

- Good resistance against corrosion
- High chemical resistance
- Low permeability
- Can be used to fill cracks
- High tensile, flexural and compressive strengths
- Good adhesion to most surfaces
- Long term durability

6. DISADVANTAGES

- The binder is expensive
- Some safety issues arise out of the use of polymer concrete.
- The monomers can be toxic, volatile and may catch fire.
- Catalysts can be combustible and harmful to human skin.

7. APPLICATIONS

- Repair of structures and restoration of monuments.
- Surface impregnation of bridge decks to protect against chemical attack and provide strength and durability.
- Used for industrial structures and rehabilitation of structures.
- Due to structural properties and high permeability, it is used in repairing of dams and underwater construction.
- Used in swimming pools, water tanks, pipes and various marine applications.

8. CONCLUSION

Polymer Impregnated concrete(PIC) is remarkable advancement in Civil Engineering field. Its various characteristics like great strength, impermeable nature and resistance to chemicals makes it highly suitable for different purposes.

