SELECTION OF EFFECTIVE WATERPROOFING TECHNIQUES TO REDUCE THE CORROSION PROBLEMS IN CONCRETE SLAB

Project Reference No.: *48S_BE_5087*

College : S G Balekundri Institute Of Technology, Belagavi
Branch : Department Of Civil Engineering
Guide(S) : Dr. Santosh Chikkabagewadi
Dr. K. B. Prakash
Student(S): Ms. Ambika Kesapur
Mr. Pranav Bendigeri
Mr. Prathamesh Motagi
Mr. Shivanand Sampagaon

Keywords:

Structural Integrity, Waterproofing material, concrete Structures, Sustainability.

Introduction:

Corrosion of reinforcement within concrete slabs is a pervasive issue that significantly reduces the structural durability and service life of concrete structures. This study focuses on identifying and evaluating effective waterproofing techniques to mitigate this problem. By preventing water infiltration, these techniques can curtail the electrochemical reactions responsible for reinforcement corrosion. The research involves a systematic review of waterproofing materials and application methods, including membrane-based systems, integral crystalline waterproofing, and surface-applied coatings. Comparative analysis is conducted based on durability, ease of application, cost-effectiveness, and environmental impact. Additionally, the study incorporates laboratory testing to assess the performance of selected methods under simulated environmental conditions. The findings emphasize the importance of selecting techniques tailored to specific site conditions and concrete characteristics. The paper also discusses the economic implications of implementing waterproofing measures and their role in reducing long-term maintenance costs. This study serves as a practical guide for engineers, contractors, and decision-makers to adopt efficient waterproofing strategies that enhance the longevity and resilience of concrete slabs, thereby ensuring structural integrity and sustainability.

Objectives:

1. To evaluate the efficiency and durability of various waterproofing techniques for concrete slabs, focusing on performance in preventing water ingress and long-term structural protection.
2. To evaluate the efficiency and durability of various waterproofing techniques for concrete slabs, focusing on performance in preventing water ingress and long-term structural protection.

Methodology:

1. Literature Review: The effectiveness of waterproofing techniques in concrete structures has been a subject of extensive research, with various methods identified to enhance concrete's resistance to water penetration.

2. Selection of Waterproofing Techniques: The selection of appropriate waterproofing techniques depends on several factors, including the exposure conditions, the type of concrete structures and the specific requirements for durability and cost effectiveness. Following waterproofing techniques are selected for the study:

a) Cementitious Waterproofing

b) Polyurethane Waterproofing

3. Preparation of Concrete Samples: Concrete cubes and slabs of 150 x 150 x 150 mm and 300 x 500 x 20 mm respectively, were casted. And kept for 28 days curing, and then applied waterproofing solution to concrete cubes n slabs. To check the waterproofness.

4. Testing Procedure: To evaluate the performance of waterproofing techniques, several standardized tests are conducted such as Water Absorption Test, Concrete Permeability Test, Concrete Water Penetration Test, Sorptivity Test.

5. Data Analysis: Result analysis through the graphs and tests conducted.

Result and Conclusion:

1.Water absorption test: On basis of the test conducted, following are the observations noted.

Table No.1: Water absorption readings.

WEIGHT	ZYDEX	Dr. FIX IT
Initial weight W1 (kg)	8.620	8.010
Final weight W2 (kg)	8.692	8.116
Water absorption	0.858	1.29

The water absorption is calculated by the formula: - W= (W2 – W1 / W1) X 100.
Wzydex = (8.692-8.620/8.620) x 100 = 0.858
WDr. Fixit = (8.116-8.010/8.010) x 100 = 1.29

From above result, we can observe that the water absorbed by the ZYDEX is less than Dr. Fixit. Hence, it can be said that the Dr. Fixit, show a high-water absorption rate, it suggests the presence of high porosity in the mix, potentially leading to reduced strength, durability, and resistance to environmental factors like freeze-thaw cycles or chemical attacks. Whereas the water absorbed by the ZYDEX is less, which indicates a dense, well-compacted concrete mix with lower porosity, which enhances the material's durability and longevity, making it more resistant to water ingress and external elements.

2. Sorptivity test: The following are the readings were obtained. Where the water level is measured at every 10 minutes of time interval using a measuring scale in cm. And sorptivity values were obtained using the formula given below.

Table No.2: Sorptivity readings for ZYDEX and Dr. Fixit.

ZYDOX			
TIME (PM)	WATER LEVEL	TIME (min)	SF (cm/min)
12:26	1.2	0	0.000
12:36	1.7	10	0.538
12:46	1.8	20	0.569
12:56	2.3	30	0.727
01:06	2.4	40	0.759
01:16	2.4	50	0.759
01:26	2.5	60	0.791
01:36	2.6	70	0.822
01:46	2.6	80	0.822
01:56	2.7	90	0.854
02:06	2.7	100	0.854
02:16	2.7	110	0.854
02:26	2.8	120	0.885
02:36	2.8	130	0.885
02:46	2.9	140	0.917
02:56	2.9	150	0.917
03:06	3	160	0.949
03:16	3	170	0.949
03:26	3	180	0.949
03:36	3	190	0.949
03:46	3	200	0.949
03:56	3	210	0.949
04:06	3	220	0.949

DR.FIXIT			
TIME (PM)	WATER LEVEL	TIME (min)	SF (cm/min)
12:27	1.6	0	0.000
12:37	2.5	10	0.791
12:47	2.8	20	0.885
12:57	3	30	0.949
01:07	3.2	40	1.012
01:17	3.8	50	1.202
01:27	3.9	60	1.233
01:37	4.1	70	1.297
01:47	4.3	80	1.360
01:57	4.3	90	1.360
02:07	4.4	100	1.391
02:17	4.4	110	1.391
02:27	4.5	120	1.423
02:37	4.6	130	1.455
02:47	4.9	140	1.550
02:57	4.9	150	1.550
03:07	4.9	160	1.550
03:17	5	170	1.581
03:27	5.1	180	1.613
03:37	5.1	190	1.613
03:47	5.1	200	1.613
03:57	5.1	210	1.613
04:07	5.1	220	1.613

The sorptivity is calculated by the formula: -

S = water level / t1/2

From above readings we have obtained the graph for sorptivity analysis of both ZYDEX and Dr. Fixit.

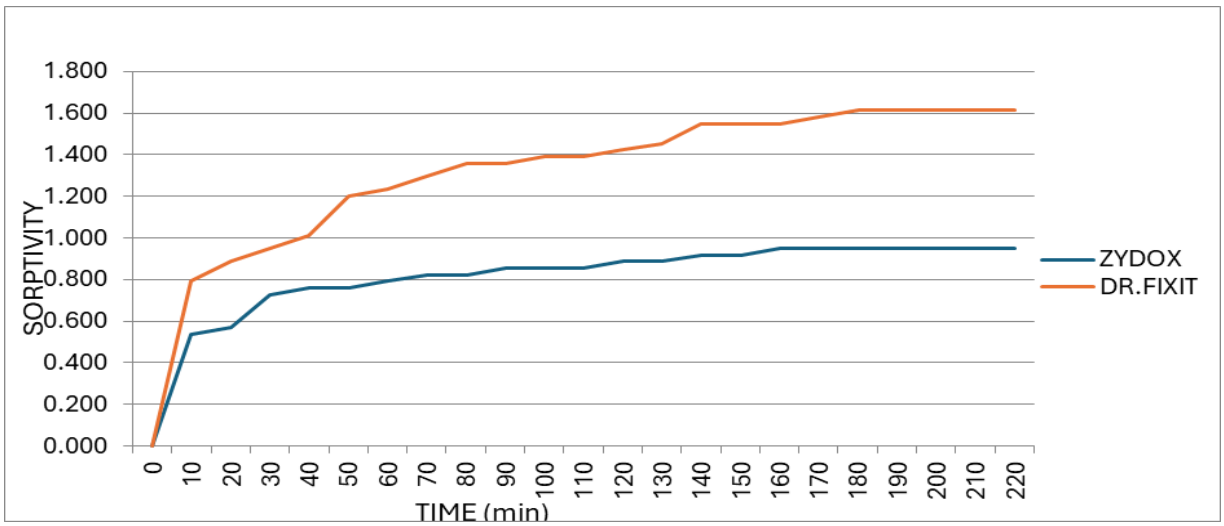

Figure1: Graphical representation of ZYDEX AND Dr. Fixit.

The graph shows that after 150 minutes, both ZYDEX and Dr. Fixit exhibit constant sorptivity values. Dr. Fixit shows higher sorptivity, indicating higher permeability and porosity, which could lead to increased vulnerability to water ingress and reduced durability, especially with risks like corrosion or freeze-thaw damage. On the other hand, ZYDEX demonstrates lower sorptivity, suggesting it has better resistance to water penetration, offering improved durability, reduced cracking, and better resistance to environmental stresses over time.

3. Concrete Permeability Test: By the test carried out, using 3- cell permeability instrument. The water level permeated into concrete cube was measured using measuring scale in cm. According to IS code 516 (Part 2/sec 1): 2018, the concrete cubes have been kept for 72 hours for the test in the instrument. And the results observed are:

1. The water permeated into concrete cube, applied with Dr. Fixit waterproofing chemical is 1cm.
2. The water permeated into concrete cube, applied with ZYDEX waterproofing chemical is 0.7cm.

From above results of water permeability test, it can be observed that the water permeated ZYDEX waterproofing chemical less than that of Dr. Fixit. By above results we can understand that using ZYDEX waterproofing chemical we can get better results in concrete structures than that of Dr. Fixit.

4. Cost Analysis: Based on the area and quantity of chemical required. The cost analysis is of waterproofing chemical is calculated.

AREA OF SLAB (m)	CHEMICAL	Milliliter's (ml)	RATE
0.3 X 0.5 m	Dr. Fixit	16.14ml	7 Rupees
9.29 m^2(100 sq. feet)	Dr. Fixit	1000ml	400 Rupees
111.44 m^2 (1200 sq. feet)	Dr. Fixit	12000 ml	5000 Rupees
0.3 X 0.5 m	Zycosil& Zycoprime	14.90 ml	22.35 Rupees
60.38 m^2 (650sq feet)	Zycosil & Zycoprime	1000ml+5000ml	9000 Rupees
111.44 m^2 (1200 sq. feet)	Zycosil & Zycoprime	11100 ml	16700 Rupees

Figure 2: Cost Comparison Between ZYDEX and Dr. Fixit.

Based on above table.

Dr. Fixit:

1000ml: 400rs: 9.29 m² = total coverage.

16.14ml: 7rs: 0.15m² = casted slab (300mmx500mm).

14.526ml: 6rs: 0.135m² = cubes (150mmx150mm).

Average cost per m² for Dr. Fixit: Approximately 43 Rs/m².

ZYDEX:

6000ml: 9000rs: 60.38m² = total coverage.

15ml: 22.35rs: 0.15m² = casted slab (300mmx500mm).

13.50ml: 20.12rs / 0.135m² = cubes (150mmx150mm).

Average cost per m² for ZYDEX: Approximately 150 Rs/m².

Based on this analysis, Dr Fixit is significantly more cost-effective than ZYDEX. Dr Fixit has an average cost of approximately 43 Rs/m², while ZYDEX has an average cost of approximately 150 Rs/m². This means that Dr Fixit covers more area for a significantly lower price.

Future Scope:

The future of waterproofing concrete structures looks promising, with advancements in technology and materials likely to revolutionize how we protect these structures. Here are some key areas for future development:

1. Nanoparticles and Nano coatings can improve the performance of waterproofing systems by creating extremely fine, dense surfaces that resist water penetration. These materials could also self-heal cracks or prevent the growth of bacteria.
2. The development of **self-healing concrete** can significantly impact waterproofing. This type of concrete contains microcapsules or bacteria that, when cracks appear, can automatically release healing agents that seal the cracks, preventing water ingress and improving the structure's longevity.
3. The push for eco-friendly construction materials is gaining momentum. Future waterproofing solutions may include **biodegradable or renewable materials**, such as plant-based coatings or sustainable polymers, which can provide high performance while being less harmful to the environment.

4. The development of more advanced membranes**,** such as **thermoplastic polyolefin (TPO)** and **epoxy-based membranes**, will likely lead to more efficient, durable, and flexible waterproofing systems. These materials are more resistant to UV degradation and extreme weather, extending the lifespan of the waterproofing layer.