Special chemicals for effective restoration of distressed bridge foundations

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Objekttyp: **Article**

Zeitschrift: **IABSE reports = Rapports AIPC = IVBH Berichte**

Band (Jahr): **80 (1999)**

PDF erstellt am: **24.09.2024**

Persistenter Link: https://doi.org/10.5169/seals-60790

SPECIAL CHEMICALS FOR EFFECTIVE RESTORATION OF DISTRESSED BRIDGE FOUNDATIONS

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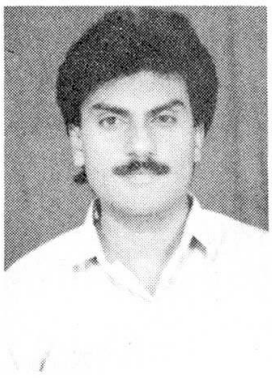

M.S.Venkatesh obtained his Civil Engineering degree in 1985 and a post graduate degree in Structural Engineering in 1988. He has more than twelve years experience in various aspects of Civil Engineering like Design, Execution, Teaching, Research and Consultancy. Presently he is involved in offering technical consultancy services for Repair & Restoration of structures using speciality chemicals.

SUMMARY

Bridges are one of the oldest structures built by man and even now they play a vital role in the development of the country by forming an important part of the infrastructure for both roadways & railways. Many RC bridges constructed in the recent past have begun to show distress features like cracking, corrosion of reinforcement , spalling of concrete. etc. There distress features could be observed in any of the bridge components.

The conventional methods of repair do not provide long term solutions. The newly developed specialty chemicals like polymers, epoxies, micro concretes, polyethanes, etc. help in not only restoring the distressed bridges but will also provide a long term protection against various harmful agent like chlorides, sulphates, carbon dioxide, moisture etc.

This paper briefly discusses the causes for deterioration of bridge structures. The different distress features normally observed in the bridge foundations & the role of special chemicals in effective restoration of the distressed bridge foundations is also discussed.

1.0 INTRODUCTION

Bridges from an important constituent of the transportation segment and millions of Rupees are spent annually not only in the construction of new bridges but also on the repair & restoration of distressed bridges.

A bridge eventually consists of three major structural components namely the foundation, substructure & superstructure.

The distress features could be observed in any or all the units of these components.

2.0 BRIDGE DETERIORATION

Bridge Deterioration may arise from a number of independent sources. These sources may be classified as

a Design and construction deficiencies
b Environmental effects and
c Changes in use

2.1 **Design and construction deficiencies** : These include

- Insufficient concrete cover over reinforcement
- Grouping in tendons
- Improper compaction of concrete
- Inefficient bearings
- Differential movement/ shifting
- Inadequate spacing between tendons
- Incomplete grouting of tendons
- Bad detailing of reinforcement leading to congestion
- Bad deck drainage system
- Inadequate curing

2.2 **Environmental effects** : These include

- Material quality
- Environmental aggression (Chloride)
- Freeze thaw deterioration
- Support movement
- Carbonation
- Alkali silica reaction
- Shrinkage
- Thermal strains
- Stress corrosion
- Hydrogen Embrittlement
- Corrosion

2.3 Changes in use : This is a significant factor affecting the bridge deterioration and includes.

- Increase in traffic volume
- Increase in maximum permitted vehicle size i.e. load
- Increase in the number of frequency of large six wheeled vehicles i.e., repeated loading to maximum.
- Wear and fatigue are two mechanisms that directly lead to deterioration of the bridge and its deck.

3.0 DISTRESS IN BRIDGE FOUNDATIONS

The commonly noticed problems in bridge foundations are

- Excessive scouring
- Erosion & cavitation damages
- Settlement of foundation
- Tilting
- Differential movement / shifting
- Damages to protection work
- Corrosion & cracking
- Air voids & Honeycombs

4.0 ROLE OF NEW MATERIALS / SPECIAL CHEMICALS

The conventional methods of repair like patching up mortar/ concrete, guniting, shotcreting, etc. indeed provide a solution to the problem but these are only short term approaches. The conventional methods do not provide a long term solution. It has been found from experience that many bridges repaired with the conventional methods fulfill the serviceibility needs for a short duration of time only and within a few years the structures start developing the same types of symptoms or distresses as was observed before.

The latest specialty repair chemicals developed in the recent times play a significant role in the rehabilitation of the distressed rc bridges. These chemicals not only help in quick and effective repair but also provide long term solutions. The role of these specialty repair chemicals in effective rehabilitation of common types of distress normally observed in bridge foundation is highlighted in Table 1.

5.0 RESTORATION MEASURES

5.1 Excessive scouring

This is a common occurrence in flowing rivers. The method of restoration is to reinstate the worn out concrete with free flow anti wash out high strength cementitious underwater repair micro concrete after cleaning the exposed reinforcement to remove rust & providing with an anticorrosive treatment.

In order to protect from further scouring in future boulders can be dumped around the

region and the gap between the boulders grouted with 1:3 cement sand slurry modified with plasticising cum expanding additive.

5.2 Erosion & cavitation damages

The eroded portion can be reinstated with underwater high strength micro concrete as explained in 5.1 above and the area protected by dumping boulders.

5.3 Settlement of foundation

Whenever settlement is noticed in foundation of piers and abutments great care shall be taken to keep the situtation under control and it shall be regularly monitored. The levels shall be frequently checked and the difference be made up with plates or by micro concrete padding. If the settlement is due to scouring then the scoured portion shall be reinstated with free flow underwater micro concrete. Pitching / dumping of boulders around the piers or abutments shall also be done for protection. In case of integrated wing walls settlement is a common feature and it is preferable to build a separate wing wall.

5.4 Tilting

The tilting or leaning is due to excessive pressure or eccentricity of loading & various other factors.

Tilting can be handled by strengthening the existing foundation of abutment or piers by adding extra section. Jacketing shall be resorted and the extra section shall be provided by using high strength cementitious anti wash out underwater repair micro concrete.

5.5 Cracking on surface of foundation

This is a common problem in most of the bridge foundations. The restoration shall be carried out by sealing the cracks externally with underwater epoxy putty and grouting neat cement slurry modified with plasticising cum expanding additive in case of wider cracks (>5 mm) The minute cracks shall be sealed by injecting low viscosity, high strength moisture insensitive epoxy after sealing the cracks from the exterior using under water epoxy putty.

5.6 Corrosion, spalling & delamination

This is also a common problem noticed in the bridge foundations.

This distress can be addressed by providing an anticorrosive treatment to reinforcement after cleaning & reinstating the damaged / delaminated concrete with high strength cementitious anti worn out underwater micro concrete or with water resistant epoxy mortars in case of damage at isolated locations.

5.7 Voids & Honeycombs

This is a common problem in heavily loaded foundations due to congestion of reinforcement. It may also be caused due to poor site construction practices like improper compaction. This can be rectified by pressure grouting neat cement slurry modified with

plasticising cum expanding additive.

The various chemicals to be used for different types of foundation distress is also presented in Table 1

Table 1 : SPECIAL CHEMICALS FOR REPAIRS

Sl.No.	Types of Distress	Repair chemicals to be used
1	Excessive scouring	Anticorrosive coating for exposed reinforcement Anti washout underwater micro concrete for reinstating the scoured portions.
2	Erosion & Cavitation	Anticorrosive coating for exposed reinforcement Anti washout underwater micro concrete for reinstating the scoured portions.
3	Settlement of foundation	Underwater micro concrete for reinstating scoured / damaged portions.
4	Tilting	Underwater micro concrete for jacketing / strengthening of foundation.
5	Corrosion spalling & delamination	Anticorrosive coating for exposed reinforcement. Reinstating spalled areas with underwater micro concrete or water insensitive epoxy mortar.
6	Cracking	Underwater epoxy putty for sealing the cracks. Injection of cement slurry modified with non shrinking grouting additive or injecting low viscosity water resistant epoxy into the cracks.
7	Voids & honeycombs	Grouting with cement slurry modified with placticising , non shrinking additive.

CONCLUSION

The different types of distress noticed in the bridge foundation along with a brief methodology of repair using special repair chemicals has been presented. These specialty Chemicals help in effective restoration & provide long term solutions

ACKNOWLEDGMENT

The author wishes to acknowledge the Managing Director and the General Manager (West) of Fosroc Chemicals (India) Limited, Mumbai for the help & encouragement provided during preparation of this paper.

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