



RETROFITTING TECHNIQUES FOR DISTRESSED STRUCTURAL MEMBERS AND REPLACEMENT OF DAMAGED STRIP SEAL EXPANSION JOINTS IN BRIDGE REHABILITATION

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Abstract: Bridge structures are highly dependable in terms of their longevity and performance due to the quality of their concrete, which is exposed to a variety of moisture and traffic loads. Reinforced cement concrete members are prone to deterioration if not properly maintained. The strip seal system is an essential element of bridge decks, which is composed of steel extrusion cast into the concrete and neoprene glands. The steel within the concrete is essential for the structure's stability and longevity. This paper examines the effectiveness of using retrofitting techniques to strengthen distressed structural members, as well as replacing damaged strip seals expansion joints in a bridge rehabilitation project in the Eluru-Anakapalli section of AndhraPradesh, such as shotcreting in areas with delaminated surfaces, grouting in areas with honeycombed surfaces, repair mortar in areas with spalled surfaces, and high strength micro concrete jacketing in areas with anticoagulant coatings.

Keywords: Shotcreting, Grouting, ExpansionJoints, Bridge repair and Anti-Carbonation Coating

I. INTRODUCTION

Rehabilitation and retrofitting are same though but represent two contextual meanings when it concerns to the structural strengthening. Theretrofittingassociateswithseismicstrengtheningandtherehabilitationisassociatedwithrepair/strengthening of existing concrete structures under gravity loads.

In reinforced concrete T-beam cum deck slabs, strip seal joints are frequently employed. For medium span bridges, this joint is used to allow for moderate movement of between 40and50 millimeters. At the side walls of the expansion joint gap, this joint assembly is furnished with two edge beams consisting of extruded, hot-rolled, or cellular steel sections. To ensure water tightness, the expansion joint's gap is sealed by an elastomeric sealing device or rubber gland. Typically, steel anchor loops and plates that are attached to the reinforcement of the deck slab are used to support the edge beam.

For the bridges, which are continuously prone to heavy traffic loads, the distress will occur mainly either due to quality of concrete during construction, exposure conditions and also the periodical maintenance of the bridges will also play a major role in the longevity of the structure. This present paper address the latest retrofitting/repair techniques which are being adopted for bridges a case study to strengthen the structural members of the bridge like girders, deck slab, piers, abutments and even expansion joints.

The retrofitting techniques like shotcreting added with expanding grout admixture prevents the occurrence of shrinkage cracks, grouting by epoxy/cementitious way fill ups the voids within the concrete member &thus adds strength to the member, polymer modified repair mortar is used for localized spalled regions, non-shrink & high grade micro concrete is being during

replacement of strip seal expansion joints. Also, anti-carbonation coating was applied to prevent entry of water into the structural members and thus prevents corrosion of rebar within and increases durability of the structures. The road project stretch in which the bridges are repairs is located from Eluru-Anakapalli in the state of Andhra Pradesh.

II. LITERATURE REVIEW

S.Ramyakala, Mohd Waseem, Shoeb Mustafa (2020) In this study, they explored the crack healing, concrete jacketing, and other procedures on bridges that needed maintenance and repair of structures that had a longer lifespan and were impacted by adverse weather conditions, poor building methods, etc.

Vivek Kumar Yadav (4) The goal of this study is to emphasize the repair and rehabilitation techniques that should be used for structures with flaws and inadequacies that require rehabilitation. Current repair and rehabilitation techniques are examined in light of available knowledge and the benefits of a holistic system approach.

Homam Ghazal, Aman Mwafy The goal of this study is to choose an efficient mitigation strategy from a variety of choices to modify substandard RC bridges in order to fulfill the seismic performance requirements of current design standard

III. OBJECTIVES:

Concrete spalling observed in bridges at underside of the deck slab, honey combing & voids observed in the girders, piers, abutments and damages observed in the expansion joints as well.

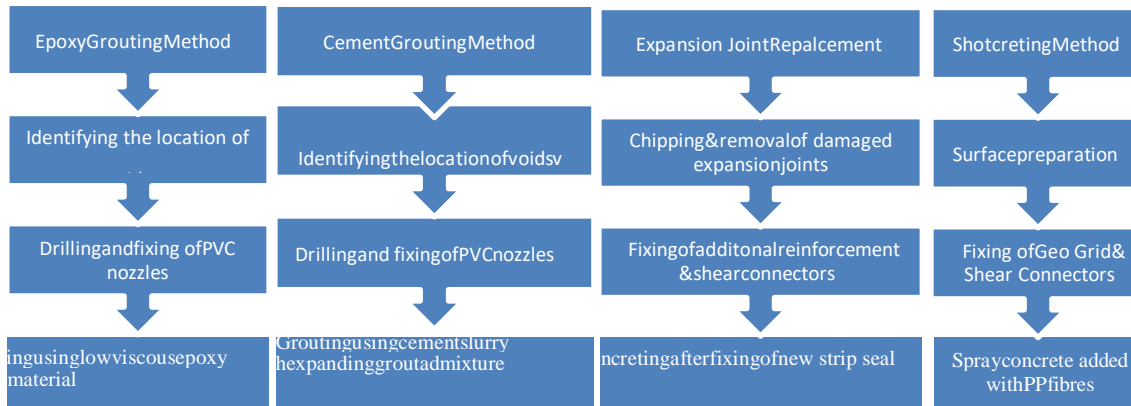


Figure-1: Bridges in the project stretch

Voids observed in the concrete members at the column-beam junction portions and at underside of the slab.

IV. RESEARCH METHODOLOGY

FLOWCHART OF REPAIR/RETROFITTING WORKS



SPECIFICATION-1: SHOTCRETING

Shotcreting of Piers/abutments and underside of deck slab to a thickness of 40-50 mm after fixing shear connectors and 50 mm x 50 mm geo grid.

Surface Preparation: This item of work shall be applicable where the concrete surfaces viz., underside of deck slab/piers/abutments etc., need to be shotcreted. All loose and spalling concrete/delaminated shotcrete shall be carefully chipped off till sound concrete/shotcrete is exposed. The chipped area shall be saturated with water prior to repair and all exposed reinforcement shall be coated with Zinc Rich Epoxy Primer IPNET RB (of M/s Krishna Conchem).

Fixing Of Shear Connectors: Holes of 14 mm dia shall be drilled to a depth of 50 mm at a spacing of 500 mm c/c. The drilled hole shall be cleaned thoroughly free from dust using air/water jet. Shear connectors of 8 mm rebar shall be fixed using polyester resin grout SYSGROUT 657 (of M/s Syscon Resins).

Fixing Of Geo Grid: Geo grid of size 50 mm x 50 mm shall be tied to the exposed reinforcement/shear connectors. It will be ensured that there is minimum sagging of geo grid especially in case of underside of slab.

Shotcreting: Before carrying out shotcreting, the prepared concrete surface shall be suitably wetted. Now carry out shotcreting using the following mix proportion:

- | | | |
|------------------------|---|------------------------|
| ▪ Cement | : | 1 Part |
| ▪ Sand | : | 2 Parts |
| ▪ 6-8 mm downagg | : | 2 Parts |
| ▪ Polypropylene fibers | : | 125 gms/bag of cement. |

The thickness on an average shall be maintained between 40-50 mm. Shotcreted area shall be cured for at least 7 days.

SPECIFICATION-2:EPOXYINJECTIONGROUTING

Treatment of soffit slab cracks by Epoxy Injection Grouting

Cutting and Sealing of Crack: Groove sealing to be taken up wherever cracks are noticed in super structure. The cracks shall be identified closely in the superstructure and clearly marked by suitable means. Using a suitable tool such as marble cutting machine/handheld grinder groove of 15 mmx 15 mm shall be cut and chipped off. The cut groove shall be cleaned using air/water jet. The cut groove shall be filled using epoxy putty using SIKADUR 31 (of M/s Sika India Limited) or equivalent. In case of vertical/overhead applications, silica powder may be added to Sikadur 31 for required consistency to avoid sagging of the putty.

Drilling and Fixing of Nozzles along Crack : Holes to be drilled along the crack at a spacing of 300 mmc/c to a depth of 50to60 mmof12/14 mm diameter. Drilled holes to be cleaned using air/ waterjet. PVC nozzles or packers to be fixed in the drilled holes using Epoxy Putty/Polyester resin grout. After epoxy grouting, the nozzles to be cut off to level. For ease of application, holes may be drilled before groove cutting and nozzles fixed simultaneously along with groove filling.

Carrying out Epoxy Injection Grouting : Once all nozzles are fixed, epoxy injection grouting shall be carried out using electricallyoperatedepoxygroutpumpusingLowviscosityepoxyinjectiongroutEPCOKP250(ofM/sKrishnaConchem) orSIKADUR52(ofM/sSika India Limited).Incaseofverticalcrackgroutingthegroutingshouldcommencefrombottom hole and progressively proceeding upwards.

SPECIFICATION-3:CEMENTGROUTING

Cement grouting to Underside of deck slab/piers/abutments

Holes of 14/16mm dia shall be drilled at a spacing of 1000mmc/c especially to the underside of slab. Additional holes shall be drilled at apparently visible honeycombed areas of slabs/piers/abutments.Thedepthofholesshallbe50to75mm.Drilled holes shall be cleaned free from dust using air/water jet. PVC nozzles of 8 mm/12 mm shall be fixed using quick setting cement grout.

Neat cement grouting shall be carried out through the nozzles using POSITIVEDISPLACEMENT electrically operated grout pump. Expanding grout admixture such as CEBEX 100(ofM/sFosrocchemicals)or INTRAPLASTN200(ofM/sSika India Ltd) shall be mixed in the grout as per manufacturer's specification.

In case of Shotcreting area, Grouting shall be carried out only after Shotcreting.

The protruding nozzles to be cut off after 24 hours of grouting and finished. In case of Piers/abutments, grouting should start from bottom to top and in case of girders, it should commence from one end and progressively proceed to other end.

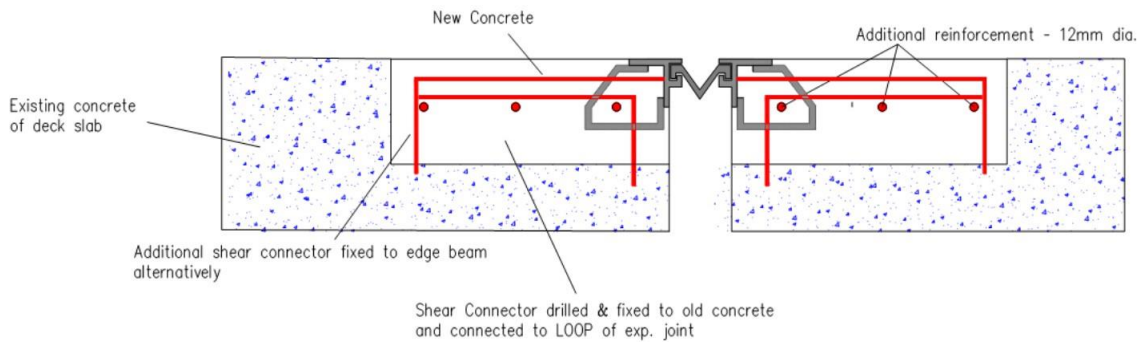
SPECIFICATION-4:EXPANSIONJOINTS

Treatment to expansion joints shall be taken up after the traffic is diverted on to the new bridge, since treatment to joints has to be synchronized with replacement of Bearings. Further, it is best suggested to carryout the wearing coarse (as proposed Bitumen Wearing Coarse) before taking up the replacement of Expansion Joints.

Opening of Joints: Firstly a saw cut shall be made parallel to the joint about 300 mm away from the joint upto the main deck slab concrete. Wearing coarse to an extent of 300 mm on either side of the joint to be chipped and opened up and the existing joint removed. Once the existing plate joint is removed, the joint to be cleaned free from debris, dust etc.

Fixing of Shear Connectors and Reinforcement: Drill holes of 16 mm dia shall be made in 2/3 rows on either side of joint at a spacing of 300 mm/c to a depth of 50-75 mm. 12 mm dia rebar is fixed in the drilled holes using polyester resin in grout as shear connectors. Reinforcement shall be fixed tied to the shear connectors as per specification.

FIXING ARRANGEMENT OF STRIP SEAL EXPANSION JOINT



Fixing of New Strip Seal Joint: Now the new strip seal joint shall be fixed to level and welded to the reinforcement. Level to be maintained to final level of the wearing coarse already carried out.

Now the concreting using M35 grade concrete shall be carried out after application of epoxy bonding agent to the old surface of concrete. Concrete to be cured for at least 7 days.

V. EXECUTION DETAILS

- All the loose, spalled concrete of the existing structural members was chipped off and localized spalled regions are repaired using polymer modified repair mortar (Figure-2 and Figure -3)



Figure-2



Figure-3

- The major delaminated regions of Piers, Slab and abutments are treated using shotcreting. Shotcreting is carried out after fixing of geo grid (Figure-4) and shotcreting carried out as per specification/methodology (Figure -5)



Figure-4



Figure-5



Figure-6



Figure-7

- The old damaged strip seal expansion joints are removed (Figure-8) and after fixing additional reinforcement (Figure-9), new strip seal expansion joint is being fixed and concreted using micro concrete (Figure-10).



Figure-8



Figure-9



Figure-10

VI. CONCLUSIONS

- All the damaged portions of the bridge structural members are repaired/strengthened.
- The localized spalled regions are treated using repair mortar, honey combed areas are treated using epoxy/cement injection grouting.
- The major delaminated or spalled regions of the structural members of the bridges are treated using shotcreting.
- The damaged portions of the strip seal expansion joints are replaced with the new expansion joints after fixing additional reinforcement and concreted using high grade micro concrete.
- After repair/retrofitting the durability of the structures are increased.

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