

No. RW/NH/34041/44/91-S&amp;R

Dated, the 14th March, 2000

To

The Chief Engineers of State PWD/UTs, (dealing with National Highways and other centrally sponsored projects); Director General Border Roads; Chairman, National Highways Authority of India

Subject : Use of Fusion Bonded Epoxy Coated Reinforcement in Bridges on National Highways and other centrally sponsored Bridges Projects to be Constructed in Marine Environment Susceptible to Severe Corrosion.

A large number of bridges involving Reinforced Concrete Components are located in marine environment on National Highways running parallel and close to the sea shores in the country. Keeping in view the huge investment required for constructing these bridges as well as the difficulties and high cost involved in their subsequent rehabilitation due to corrosion related distresses, there is an urgent need to prevent or minimize the possibility of corrosion of the steel reinforcement by taking suitable measures at the construction stage itself of such bridges. Considering that the use of Fusion Bonded Epoxy Coated Reinforcement (FBECR) as per international standards could be the best available option among protective coatings, detailed guidelines were issued on the above subject vide Ministry's Circulars Nos. RW/NH-34041/18/93-S&R dated 15.3.1994 and RW/NH-34041/44/91-S&R dated 29.5.1998. The instructions given below are now issued in supersession of the above circulars in the light of further experience and knowledge gained in this regard.

2. The following requirements need to be complied with for the use of FBECR for bridges located in marine environment susceptible to severe corrosion:

- (a) The FBEC reinforcement shall only be used for all reinforced concrete components of bridges located in marine environment where the rate of corrosion is greater than 0.25 mm per year or where severity of corrosion is confirmed from the inspection of nearby structures (bridges/buildings). In locations where it is difficult to ascertain the rate of corrosion, a zone within fifteen km from the sea or creek shall be considered as severe. However, it may be ensured that a Fusion Bonded Epoxy Coating plant shall be available within a distance of 300 km from the bridge site.
- (b) For bridges located beyond 300 km from the coating plant, considering the problems of handling/transportation of the reinforcement and the extra cost involved thereof, effort will be made to avoid adoption of R.C.C. structures to the extent possible by adopting prestressed concrete or steel components. However, if unavoidable, the proposal to adopt FBECR, in such cases may be sent with full justification to the Ministry for obtaining prior approval before submission of the estimate. Such cases will be considered on merit in the Ministry on a case-to-case basis.
- (c) Fusion bonded epoxy coated reinforcement shall conform to the latest ASTM Specifications (A 775/A775 M-97) till such time the relevant BIS code (No. IS:13620-1993) is updated.
- (d) The FBE Coating shall be got done by an authorized firm approved by the Department. The contractor, shall produce certificate from the coating firm that quality of powder epoxy material and other components of fusion bonded epoxy coating conform to the relevant ASTM specifications (till such time IS Codes are updated) and such certificate shall accompany each consignment of delivery while leaving the plant. The coating firm shall furnish at the time of shipment, a certificate that the finalised product, viz, coated reinforcement bars also meet the requirements of the latest ASTM Specifications. Apart from these certificates from the coating firm, the department should also carry out independent tests on materials/components as well as finished product (i.e. coated bars) as listed in at para 3 below at the plant site for sample cross-checking. The contractor's agreement with the coating firm shall include the provision for such independent checking by the Department and that if the coating quality is not approved by the Department, the decision of the Department to reject or repair the coating shall be final and binding on all the parties.
- (e) Reinforcement to be coated shall be HYSD bars strictly conforming to IS:1786 and it shall be out of billets and not out of scrap steel if the same is used in re-rolling mills. There shall be no compromise in the requirements of quality of concrete, such as, clear cover, minimum cement content, use of appropriate cement, etc. as per relevant IRC and BIS code provisions. The department shall make proper arrangement for supervision to ensure this.
- (f) The job-site precautions to be observed in respect of the use of FBECR are brought out in the *Annexure-1* enclosed herewith and the same shall be incorporated in the project specifications.

3. It is to be emphasized that the quality assurance plan may be strictly enforced as per latest ASTM Specifications for the Construction with FBEC Reinforcement. In this connection, some important provisions of the latest ASTM Specifications (A775/A775M - 97) are reiterated below:

- (a) The following requirements for the coated bars given below shall be met at the manufacturer's plant prior to the shipment:-

- (i) **Coating Thickness** : For acceptance purpose, at least 90 per cent of all recorded thickness measurements of the coating after curing shall be 175 to 300  $\mu\text{m}$ . Any thickness measurements below 125  $\mu\text{m}$  shall be considered adequate cause for rejection. The upper thickness limit does not apply to repaired areas of damaging coating.
- (ii) **Coating Continuity** : There shall not be on average more than holidays per metre on the coated steel reinforcing bars. The average applies to the full production length of the bar.
- (iii) **Coating Flexibility** : This shall be evaluated by a bend test as prescribed in the ASTM Specifications. No cracking or disbonding of the coating shall be visible to the unaided normal eye on the outside radius of the bent bar. Evidence of cracking or disbonding of the coating shall be considered cause for rejection of the coated bars represented by the bend test sample.
- (iv) **Coating Adhesion** : Coating adhesion shall be evaluated by testing production coated steel reinforcing bars according to the cathodic disbondment procedure described in ASTM Specifications. Data from testing pertaining to the material being furnished shall be made available to the purchaser upon request.
- (b) **Number of Tests** : The sampling and test schedule for the number and frequency of tests for coating thickness, coating continuity and coating flexibility shall be as specified in the ASTM code. Coating adhesion as measured by cathodic disbondment testing shall be conducted on at least one bar every eight-production hour.
- (c) All coating damage due to fabrication or handling (to the point of shipment) shall be repaired with patching material. The maximum amount of repaired damage shall not exceed 1 per cent of the total surface area in each 0.3 metre (linear foot) of the bar. This limit on repaired damage does not include sheared or cut ends that are coated with patching material. Repaired areas shall have a minimum coating thickness of 175  $\mu\text{m}$  (7 mils).

4. For bridges located at a distance beyond fifteen km from the sea shore, the reinforcement shall be sand blasted and used with the good quality concrete. This would be normally considered adequate and hence no coating need to be provided for rebars used in these bridges. However, in cases of some of these bridges with moderate exposure and where corrosion is expected to affect durability, other protection measures, such as, use of corrosion resistant steel bars, polymer or polyurethane based coatings to reinforcement, etc. may also be considered for adoption. The estimate for bridges with such protection measures may be submitted to Ministry with adequate justification and a decision to adopt a particular method of protection will be taken in the Ministry on the basis of the details furnished.

5. It is requested that the contents of the circular may be brought to the notice of all concerned in your organisation for compliance and appropriate action.

*Annexure-I*

*[Enclosure to Ministry's Circular No.RW/NH-34041/44/91-S&R dated 14th/21st March, 2000]*

**JOB-SITE PRECAUTIONS TO BE OBSERVED IN THE USE OF FUSION BONDED EPOXY COATED REINFORCEMENT (FBE CR) IN BRIDGES ON NATIONAL HIGHWAYS AND OTHER CENTRALLY - SPONSORED BRIDGE PROJECTS TO BE CONSTRUCTED IN MARINE ENVIRONMENT SUSCEPTIBLE TO SEVERE CORROSION**

It is of utmost importance that strict control on job-site handling of the FBE CR is exercised to avoid damage to the coating during transport, handling and erection till incorporation in the concrete. The following requirements and job site precautions need to be fulfilled in this regard:-

- (i) The project specifications should prescribe requirements for the coated steel reinforcing bars from the point of shipment to the job-site and subsequent practices at the job-site. The guidelines given at Appendix to ASTM Designation A 775/A 775M - 97 at "XI Guidelines for Job-site Practices" may be adopted for this purpose. Some of these practices have also been reiterated below.
- (ii) Training shall be imparted to field staff regarding use of FBE coated bars so that due care is exercised to ensure that the coating is not damaged till concreted.
- (iii) The bars shall be cut and bent under factory controlled conditions. For bending the bars, teflon covered pins shall be used at the bar bending bench. It is preferable to insist on the use of bar bending machine by incorporating suitable stipulation in the tender specifications.
- (iv) Bars shall be stacked on wooden battens separated from each other to protect them from rubbing. Dragging the bars shall be avoided to prevent damage to the coating.

- (v) When handling bars, care should be taken to avoid bundle-to-bundle or bar-to-bar abrasion. This may require lifting equipment with a spreader beam to sling from multiple pick-up points. All lifting equipment should use either nylon or padded slings. As far as possible rehandling at site should be minimised.
- (vi) Coated bars should be off-loaded as close as possible to the end users location to minimize rehandling. The bars should be stored off the ground on timber cribs and not directly on the ground. Coated and uncoated bars should be stored separately. Long term storage should be minimized and supply should be phased to suit construction progress. It is recommended that the storage should not exceed one month.
- (vii) The cut ends of the bars shall be touched up with special touch up materials as prescribed by the coating firm satisfying latest ASTM specifications. The patching material shall be supplied by the coating firm and the patching at site shall be done under the supervision of the coating firms' representative. The coated steel shall not be directly exposed to sun and rains and shall be protected with opaque polyethylene sheets for such other approved materials.
- (viii) After fixing in position, all the coated bars should be inspected for coating damage prior to placing concrete. Where damages are noted they should be repaired with patching materials. All chairs, spacers and binding wires in contact with the coated bars should be coated with epoxy or plastic coating materials compatible with concrete. After fixing the reinforcement, walking on coated steel reinforcement bars should be avoided. Placement of mobile equipment, concrete vibrators, etc. should be planned to avoid damage to coating bars. All internal vibrators used to consolidate concrete around epoxy coated bars, should be equipped with rubber/non-metallic vibrator heads.
- (ix) When the extent of coating damage exceeds 2 per cent of the surface area of the coated steel reinforcement bar in any 0.3 m length, the coated bar should be rejected.