



STRENGTHENING OF COOLING TOWER BY SHOTCRETING–CASE STUDY

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Abstract:

The concrete structures which are continuously exposed to moisture or salt water are prone to deteriorate quickly. The reinforcement present within the concrete members are the key elements for the durability of any structure. The structural members of a cooling tower are distressed due to continuous exposure of moisture and due to which concrete spalling, reinforcement corrosion occurred. To treat the distressed portions of the members shotcreting using readily available cementitious material is being used, the strengthening of columns were being done using micro concreting, the voids in the concrete members are treated using epoxy injection grouting, the localized spalled regions are treated using polymer modified repair mortar and after repairing the concrete members, the entire concrete surface is being treated using crack bridge water proofing coating and anti-carbonation coating to increase durability of the structure.

Keywords: Shotcreting, Epoxy Grouting, Micro-Concreting, Crack bridge water proofcoating and Anti-Carbonation Coating

1. INTRODUCTION:

Distress in any concrete members will arise mainly due to either quality of construction, exposure conditions and due to improper maintenance. In the current paper deals with a case study of a RCC Cooling Tower where the concrete members like Columns, Cooling Tower Dome area, Side Loafers and the slab portion of the cooling towers are distressed. This is due to continuous exposure of moisture/salt water vapours. Also at few locations, due to poor construction practice, voids observed in the concrete members. To restore the distressed portions of the concrete members, repair methods like shotcreting, micro concrete jacketing, polymer modified repair mortar, epoxy injection grouting was carried out. Also, to prevent the ingress of water/moisture, crack bridge water proofing coat was applied to the entire surface areas of the concrete members and also anti-carbonation coating was also applied on the concrete surfaces.

2. OBSERVATIONS:

RCC Cooling Tower of about 18m height is located in an aluminum factory at Angul, Orrissa. This comprises of RCC Columns, Walls, Side Loafers, Slab and also RCC dome. The purpose of cooling tower is to cool the hot water which is being sprinkled or circulated through it.

Due to continuous exposure to the moisture and due to the surrounding environmental conditions, at many locations the concrete got spalled and reinforcement got corroded & exposed.



Figure-1 : Initial Condition of cooling tower

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

3. METHODOLOGY ADOPTED

- ❖ The unsound/weak concrete material of the structural members are to be chipped off upto an average of 25mm thick for the columns, slab, beams, dome areas etc.
- ❖ The exposed reinforcement to be cleaned using wire brush and then zinc-rich epoxy primer to be applied on the exposed reinforcement.
- ❖ The surface honey combed areas/ cavities to sealed using epoxy based sealing compound or with silicon sealant after making groove cut and cleaning the area.
- ❖ At the areas of honey combings or voids, galvanized steel injection nipples of 12mm dia. to be fixed after drilling holes at regular intervals in the region.
- ❖ At low pressures, low viscous epoxy injection grouting to be carried out through the nipples
- ❖ The distressed columns are to be strengthened using micro concrete jacketing after suitable surface preparation and fixing of additional reinforcement.
- ❖ For the dome area of the cooling tower:

After chipping off the loose spalled concrete and sealing the cracks, the entire face of the dome to be fixed with wire mesh of size 75x25mm and tied to the shear keys.

Epoxy bonding agent to be applied on the entire surface area of the dome.

Shotcreting using ready to use cement based spray applied repair mortar to be carried out for the entire outer surface of the dome. Aggregates of 6mm down size shall be added as per manufactures specification and also steel fibres at a rate of 250 grams per 25 kg mortarto be added and to be sprayed.

- ❖ For the localized spalled areas, chemically modified polymer modified repair to be applied after necessary surface preparation & treatment to corroded rebars.
- ❖ After repairing the distressed portions of the concrete members of the cooling tower, the entire surfaces of the concrete members are to be treated using crack bridge water proofing coating.
- ❖ After drying the water proofing coating, anti-carbonation coating to be applied on the entire surface of the concrete members to prevent ingress of any fumes etc. and thus increase durability of the structure.

4. EXECUTION :

- All the loose, spalled concrete of the existing structural members waschipped off. Figure-2
- The exposed corroded reinforcement was cleaned using wire brush to remove the rusted portion and then treated using zinc-rich anti- corrosive paint.



Figure -2

- The cracks & surface honey combings/cavities in the concrete members are sealed using epoxy sealant. Figure-3 . Also wire mesh fixed to the dome portion using shear connectors Figure-4.



Figure -3



Figure -4

- In the areas of honey combing and voids, galvanized steel nipples are fixed and Epoxy grouting using low viscus epoxy material is carried out at low pressures. Figure-5



Figure-5



- Epoxy bonding agent is applied on the dome area prior to shotcreting. Figure-6 and shotcreting is carried out for the entire surface of dome using readily available repair mortar. Figure-7 and Figure-8



Figure -6



Figure -7



Figure -8

- After carrying out the repair activities by way of shotcreting, concrete jacketing and repair mortar, entire surface areas of the concrete members are treated using crack bridging water proofing coating and anti-carbonation coatings. Figure-9 , Figure-10 and Figure-11.



Figure -9



Figure -10



Figure -11

- Condition of cooling tower after strengthening: Figure-12, Figure-13 and Figure-14

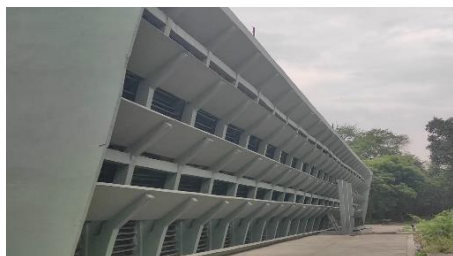


Figure -12



Figure -13

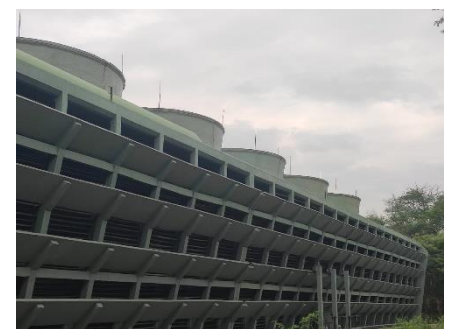


Figure -14

5. CONCLUSION:

- All the distressed areas of the structural members are strengthened.
- The localized spalled regions are treated using repair mortar, voids are treated using epoxy injection grouting, the dome portion is strengthened by shotcreting, the columns are strengthened using micro concrete jacketing.
- Crack bridge water proofing coating applied to entire surface area of all the concrete members of the cooling tower. This will act like a barrier for water percolation.
- Anti-carbonation coating applied to concrete surface. This will increase durability of a structure by preventing the ingress of any fumes, moisture etc.

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