Repair of PCCP By the Gunnite method

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Abstract
Repair an affected pipes with mortar coating delaminating using the Gunnite method, where the method applied on the affected pipes which the surface area of affected Coating delaminating reach up to entire pipe body, this method applied on more than 480 affected pipes in Man-Made River Project in desert of Libya.

I. INTRODUCTION

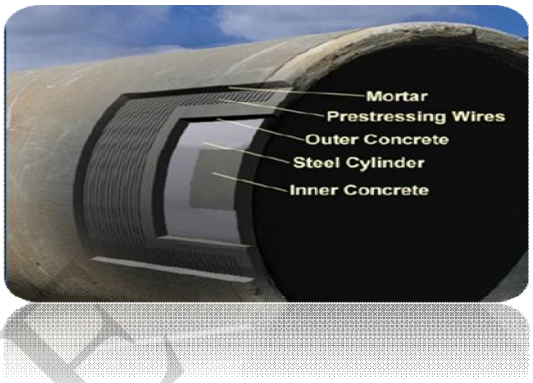
The Man-Made River Project (MRA) is one of the largest water projects in the world.
It consists of 4000 Km (2485 miles) of mainly (4.00 metre) (158-inch) diameter, and other various of diameters as (1.60, 2.00, 2.80 and 3.60 meter) (63, 79, 110 and 142 -inch) pre-stressed concrete cylinder pipe (PCCP), fig (1) components of PCCP and can convey over 6 million cubic meters of water per day from well fields deep in the Sahara Desert to the populated areas on the coast and divided in main four phases.

II. PROBLEM DEFINITION

Coating delamination occurred in some of the highly prestressed 1600 mm diameter prestressed concrete cylinder pipe (pccp) manufactured by Al Nahr company (ANC) at
at Brega plant. Coating delamination manifest itself by hollow sound when the mortar coating is tapped with a light hammer .
The hollow sound appeared after a few months from coating operation when the pipes were stored in the stockyard at Brega Plant or in the stockyard or windrow prior to installation or after installation and prior to backfilling operation. The hollow sound appeared to be starting at the spigot end of the pipe fig(2).



III. OBJECTIVE



An affirmation that the Gunnite method (Shot Crete) is suitable method to repair the pipes which an affected with coating delamintion area reach up to fall body 42m²

IV. HISTORY OF PROBLEM

- September, 2006; Alnahr company (ANC) started the pipe laying activities at (Ghadams-Zwara-Alzawia) trench.
- 2007, The Man-Made River Authority(MMRA) faced problem related to the mortar coating delamintion occurred in Phase iv (Ghadames-Zwara-Alzawia) - MMR project with 400 Km length.

where (842) pipe of the highly prestressed (1.6 meter) diameter of embedded PCCP. And manufactured by Alnahar company (ANC) in Brega plant were affected with the mortar coating delamintion.
The original repair procedure of an affected pipe with delamintion was only allowed (approved) and applied to area defected with delamination up to (4% of total mortar area).
This mean that more than (246) pipe will be rejected ,and this will lead to delay of project implementation and high cost.
Therefore MMRA in an attempt to control the coating delamination problem has taken the following steps actions:

- Trying to change the repair procedure of pipe delamination to adequate the large defect area and consulted DR (Mehdi Zarghamee) in this subject.
- MMRA has approved two methods to repair affected pipe ,one of them is Gunnite method to repair affected area reaches up to fall body .

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- In 2008 started the application of the Gunnite method to repair the pipes which were an affected with mortar coating delamintion area range from 8m² up to 12m².
- In 2009 started the application of the Gunnite method to repair the pipes which were an affected with mortar coating delamintion area range from 12m² up to 42m².
- In December 2012 excavation on (14) pipes which were repaired by the Gunnite method in 2009, and again inspected the mortar coating repaired
  we did not find any mortar coating delamination .

Gunnite (Shot Crete) Repair method : pipe with hollow sound mortar from 8 m² up to fall body.

a) Chip out the hollow sound area including the mortar between the wires, the lose materials shall not be allowed feather copper chisels may be used, make sure that no damage occurs to the wire, feather edges shall not be allowed.



b) Chamfer/inclined edge of existing old sound mortar shall be kept in inclined position.

c) The pipe should be pre-wetted by the application water on the area to be repaired applying the cement /sand slurry, and apply cement / sand slurry directly to the repair area using brushes.

d) Prior to the slurry application the pipe shall be left until excess water has drained from the repair area.

e) Cement slurry shall be applied using brushes , immediately before the gunnite is applied ,thus ensuring that the slurry coating is still moist when the area is gunnited . if the application of mortar is delayed and the repair area dries , the pipe shall be coated with a fresh application of slurry.

f) Sufficient mortar shall be produced and at such a rate to enable the repair to each pipe to progress in one operation without any significant interruption, any such interruption should be recorded by the QC representative.

g) During gunniting, the nozzle-man shall, at all times, maintain the orientation of the nozzle perpendicular to the surface of the repair area.



h) Upon completion of the gunniting and as soon as it is safe and practical, the surface shall be tooled and worked to provide a profiled surface suitable for barrier coating .note that the use of excess water to (trowel) the surface at this stage should be avoided .

i) A (vee) shaped channel shall be made at the edges of the repaired mortar for application of the epoxy mortar. The sides of the Vee should meet at the inclined angle and extend to the steel wire.

j) Upon satisfactory completion of the finished surface and after the initial setting time of the cement, curing water shall be lightly sprayed over the repair immediately.

k) The entire repaired area should be effectively cured by covering with closely fitting impermeable tarpaulin/sheet. the curing period shall be at least 24 hours.

l) The following should be considered during and after the application.

- Curing compound shall not be allowed.
- The vee groove shall be filled with epoxy mortar.

P) when the epoxy is dry, barrier coating (coal-tar epoxy) shall be applied to the surface by hand and allowed to cure naturally.

q) once accepted, the pipe will be used as originally specified for bar rating and earth cover.



Tools and equipment

- Chipping Hammers
- Chisels
- Trowels
- Paint Brushes and/or spray container
- Power Tools
- Calibrated containers for mixing materials
- Gunnite machine
- One m³ mixer

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V. CASE STUDY

As we mentioned in the paragraph the history of problem that the original repair procedure of an affected pipe with mortar coating delamintion was only allowed and applied to small defected area of mortar coating delamintion not exceed 4% of total mortar area, but we had 246 pipe were affected with area more than allowable ,so the man-made river authority after discussions with alnahar company ANC which was in connections with Dr (Mehdi Zargh amee) who was involved in this matter and advisory to alnahar company ANC decided as (trail) to applied the Gunnite method on (39) pipes were affected with areas range from (8m² up to 12m²).

The alnahar company's quality control team and The Man-made river authority's supervisor team worked as an one team in this experiment and to applied the Gunnite method on those an affected pipes under strictly quality control conditions to ensure that all repair operations will done under a good conditions.

The quality control team inspected all pipes which repaired immediately after the new mortar coating dried and again inspected them before pipe backfilling operations ,and they did not find any defects .

Those results encouraged The Man-Made River Authority to decide applied the Gunnite method on (131) PIPE which were an affected with mortar coating delamition area more than 12 m² ,and some of them reach up to 42 m² (fall body) . specially after consulted Dr (Mehdi Zarghamee) who accepted the previous results.

The Gunnite method applied on (131) pipe which were an affected with mortar coating delamintion areas as show in the following table

TABLE1.

12 m²≤Area≥22 m²	**22<Area<32 m²**	**Area ≥ 32m²**
61 pipe	**39 pipe**	**31 pipe**
Total 131 pipe		

TABLE2.

		12 m²≤A≥22 m²	22<A<32 m²	A ≥ 32m²
Standard	**6 Bar**	**0**	**0**	**1**
	10 Bar	**0**	**1**	**0**
	12 Bar	**43**	**22**	**10**
	Bar 14	**10**	**4**	**3**
	Bar 16	**1**	**2**	**6**
	Bar 18	**4**	**7**	**7**
HW	**Bar 16**	**0**	**1**	**0**
	18 Bar	**3**	**2**	**4**
		pipe 61	**pipe 39**	**Pipe31**

The results of inspections on the new mortar coating after finish the repair operations and pre-backfilling were satisfied . To ensure that the repairs of mortar coating delamintion by the Gunnite method is reliable .the Man-Made river Authority in December 2012 decided to excavate on (14) pipe of them and again inspected them.

VI. SUMMARY

-All pipes which comprised in this study (246)pipe and repaired by the Gunnite method submitted to strictly quality control.

- Duration of the repair activities continues for 26 months under desert climate conditions.
- the worse case is (131) pipe an affected with mortar coating delamintion , but we could repaired them by the Gunnite method and the results of inspection after four years of the working under operating bar was satisfied no coating delamination found.

VII. CONCLUSION

We can claim that the shot cut(gunnite) method is suitable method to repair the effected coating delamination of prestressed concrete cylinder pipe from small size area up to fall body .

REFERENCE :

[1] Repair procedure for Mortar Delamination

[2] Report of Mehdi Zarghamee Senior Principal and Head Engineering Mechanics & Infrastructures Division

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