



INDIAN FARMERS FERTILISER COOPERATIVE

LTD, PARADEEP, ORISSA

March - 2013



**STRUCTWEL DESIGNERS &
CONSULTANTS PVT. LTD.**

Structwel, Plot No. 15, Sector 24,

Off Sion Panvel Highway, Turbhe,

Navi Mumbai – 400 705.

Tel. : 91-22-2784 10 10 (7 Lines) Fax : 91-22-2784 10 07

INDEX

Sr. No.	Description	Page No.
	Detailed Inspection Reports	1-81
1	Ash Pipe rack - I	2-6
2	Ash Pipe rack - II	7-10
3	Ash silo –I (old)	11-15
4	Ash silo -II	16-19
5	ESP structure	20-24
6	ESP control room	25-27
7	F D Foundation	28-29
8	I D Fan Foundation	30-37
9	P A Fan Foundation 1A,1B and 2A,2B	38-40
10	Water pipe rack	41-44
11	Common Recommendations for 1 to 11	45-49
12	Chimney	50-58
13	NDT Reports	59-81

March 25, 2013.

Health survey of the existing plant structures at IFFCO
Paradeep Unit.

INSPECTION REPORT

For

Condition Assessment

Of All the Structures under

“AFBC Boiler”

Of

Paradeep, Orissa.

1. ASH PIPE RACK

Ash Pipe Rack:-

History / Background of the structure:

The structure under reference i.e. "Ash pipe rack-I" situated in Boiler Plant at Indian Farmers Fertilizers Cooperative Ltd. (IFFCO) Paradeep unit, Orissa. The structure has been constructed with structural steel framing system and suitably rest on RCC foundations. However, it is not visible since the area is further encased with RCC for the area above.

Please refer the photograph below.



Observations:-

- RCC pedestals noted with honey combing and localized damaged edges.



- The pipe rack i.e. vertical members, horizontal members, cross bracings and M.S sheets etc. noted with corrosion and peeling of paint due to the environmental effects.



- Localized missing / cut down/slotted members noted at some locations.
- Localized missing of cleat/seat angles etc. noted as a matter of inadequate connections.

INFERENCE OF N.D.T. RESULTS FOR ASH PIPE RACK-I

In order to have adequate assessment of the pathological condition of the structure i.e. series of health parameters, series of NDT investigations are carried out. These include number of steel thickness test have been carried out. All the NDT findings are enclosed herewith.

1. Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Inference of N.D.T. Results at Ash Conveying Pipe Rack Silo 1

In order to have adequate assessment of the pathological condition of the structure NDT investigations are carried out. These include number of ultrasonic thickness gauge readings. All the NDT findings are enclosed herewith.

Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Sr. No.	Locations	Member	Standard Thickness	Thickness Obtained (mm)	% Reduction
	<u>AFBC Boiler Plant</u>				
	<u>Ash Conveyor Pipe Rack Silo 1</u>				
	<u>Column</u>				
1	Column A1 (200)	ISMC	6.10	6.20	-
2	Column B1 (200)	ISMC	6.10	6.00	1.64
3	Column B2 (150)	ISMC	5.40	5.40	0.00
4	Column B3 (150)	ISMC	5.40	5.10	5.56

The percentage of reduction in the thickness of columns varies from 1.64 to 5.56% with respect to the original thickness.

2. ASH PIPE RACK-2

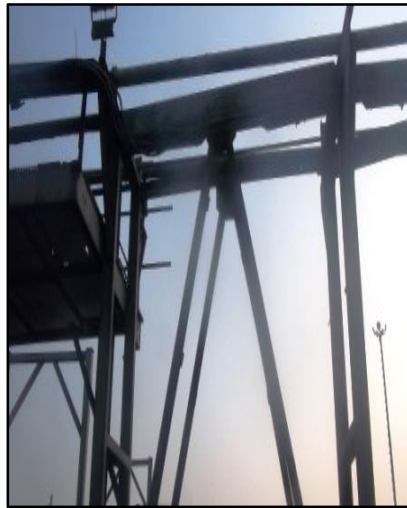
ASH PIPE RACK-II

History / Background of the structure:

The structure under reference i.e. "ASH PIPE RACK-2" situated in Boiler Plant at Indian Farmers Fertilizers Cooperative Ltd. (IFFCO) Paradeep unit, Orissa. The structure has been constructed with structural steel framing system suitably resting with RCC foundations.

Observations:

- The structure noted with minor corrosion in structural members, scaling on nut bolts, pitting and peeling of paint observed at many locations. Please refer photographs below.



- Pipe rack noted with minor to severe corrosion and pitting at some locations. Please refer photographs below.



- RCC pedestal have been provided at the bottom of the vertical members; noted with honey combing and localized damaged edges.



INFERENCE OF N.D.T. RESULTS FOR ASH PIPE RACK-II

In order to have adequate assessment of the pathological condition of the structure i.e. series of health parameters, series of NDT investigations are carried out. These include number of steel thickness test have been carried out. All the NDT findings are enclosed herewith.

1. Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Inference of N.D.T. Results at Ash Conveying Silo -2 Pipe Rack

In order to have adequate assessment of the pathological condition of the structure NDT investigations are carried out. These include number of ultrasonic thickness gauge readings. All the NDT findings are enclosed herewith.

Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Sr.	Locations	Member	Standard	Thickness Obtained	% Reduction
No.	<u>AFBC Boiler Plant</u>	-	Thickness	(mm)	
	<u>Ash Conveyor Silo -2 Pipe Rack- Column</u>				
1	Column 1 (200)	ISMB	5.70	5.70	0.00
2	Column 2 (150)	ISMB	4.80	5.20	-
3	Column 3 (150)	ISMB	4.80	5.40	-
4	Column 4 (150)	ISMB	4.80	4.90	-
5	Column 5 (150)	ISMB	4.80	4.70	2.08
6	Column 6 (150)	ISMB	4.80	5.00	-
7	Column 7 (150)	ISMB	4.80	5.10	-
8	Column 8 (150)	ISMB	4.80	5.40	-
9	Column 9 (150)	ISMB	4.80	5.20	-
10	Column 10 (150)	ISMB	4.80	5.20	-
11	Column 11 (150)	ISMB	4.80	5.40	-
12	Column 12 (150)	ISMB	4.80	4.50	6.25
13	Column 13 (150)	ISMB	4.80	5.00	-
14	Column 14 (150)	ISMB	4.80	4.80	-
15	Column 15 (150)	ISMB	4.80	4.80	-

The percentage of reduction in the thickness of columns varies from 2.08 to 6.25% with respect to the original thickness.

3. ASH SILO-I (OLD)

ASH SILO-I

History / Background of the structure:

Ash Silo -I: - It is a huge circular steel tank supported by structural steel framing system. The entire system finally rest on RCC foundations / pedestals of size 450mm x 450mm x 300mm as seen in the photograph below. The area around the said structure is wet and dusty.

Observations:

- Steel platform / walk way provided with shed, noted with corrosion in structural elements, localized missing of proper welding and cleat angles etc. Please refer photograph below.



- Peeling of paint and deposition of raw material noted on Steel elements. Please refer photographs below.



INFERENCE OF N.D.T. RESULTS FOR ASH SILO - I

In order to have adequate assessment of the pathological condition of the structure i.e. series of health parameters, series of NDT investigations are carried out. These include number of steel thickness test have been carried out. All the NDT findings are enclosed herewith.

1. Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Inference of N.D.T. Results at Ash Silo (Old)

In order to have adequate assessment of the pathological condition of the structure NDT investigations are carried out. These include number of ultrasonic thickness gauge readings. All the NDT findings are enclosed herewith.

Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Sr.	Locations	Member	Standard	Thickness Obtained	% Reduction
No.	-	-	Thickness	(mm)	
	<u>AFBC Boiler Plant</u>				
	<u>Ash Silo (Old)</u>				
	<u>Column</u>				
1	Column A1 (300)	ISMC	7.60	7.60	0.00
2	Column A2 (300)	ISMC	7.60	7.50	1.32
3	Column B1 (300)	ISMC	7.60	7.50	1.32
4	Column B2 (300)	ISMC	7.60	7.50	1.32
The percentage of reduction in the thickness of columns varies from 0.00 to 1.32% with respect to the original thickness.					

Inference of N.D.T. Results at Ash Silo (Old) Staircase

In order to have adequate assessment of the pathological condition of the structure NDT investigations are carried out. These include number of ultrasonic thickness gauge readings. All the NDT findings are enclosed herewith.

Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Sr. No.	Locations	Member	Standard Thickness	Thickness Obtained (mm)	% Reduction
AFBC Boiler Plant					
Ash Silo (Old) Staircase					
Column					
Ground Floor					
1	Column A1 (300)	ISMB	7.50	7.50	0.00
2	Column A2 (300)	ISMB	7.50	7.40	1.33
3	Column B1 (300)	ISMB	7.50	7.40	1.33
4	Column B2 (300)	ISMB	7.50	7.50	0.00
5	Staircase Beam (150)	ISMB	4.80	4.00	16.67
First Floor					
6	Column A1 (300)	ISMB	7.50	7.50	0.00
7	Column A2 (300)	ISMB	7.50	7.40	1.33
8	Column B1 (300)	ISMB	7.50	7.40	1.33
9	Column B2 (300)	ISMB	7.50	7.50	0.00
Second Floor					
10	Column A1 (300)	ISMB	7.50	7.40	1.33
11	Column A2 (300)	ISMB	7.50	7.40	1.33
12	Column B1 (300)	ISMB	7.50	7.50	0.00
13	Column B2 (300)	ISMB	7.50	7.50	0.00

The percentage of reduction in the thickness of columns varies from 1.33 to 16.67% with respect to the original thickness.

4. ASH SILO-II (NEW)

[ASH SILO-II](#)

History / Background of the structure:

Ash silo II - It is a huge circular steel tank supported by structural steel framing system. The entire system finally rest on RCC foundations / pedestals of size 450mm x 450mm x 300mm as seen in the photograph below.

Observations:

- Newly fabricated structure noted with localized missing of proper welding, cleat/seat angles at some locations. Please refer photographs below.



INFERENCE OF N.D.T. RESULTS FOR ASH SILO - II

In order to have adequate assessment of the pathological condition of the structure i.e. series of health parameters, series of NDT investigations are carried out. These include number of steel thickness test have been carried out. All the NDT findings are enclosed herewith.

1. Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Inference of N.D.T. Results at Ash Silo (New)

In order to have adequate assessment of the pathological condition of the structure NDT investigations are carried out. These include number of ultrasonic thickness gauge readings. All the NDT findings are enclosed herewith.

Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Sr. No.	Locations	Member	Standard Thickness	Thickness Obtained (mm)	% Reduction
	AFBC Boiler Plant				
	Ash Silo (New)				
	Column				
	Ground Floor				
1	Column A1 (500)	ISMB	10.20	10.30	-
2	Column A2 (500)	ISMB	10.20	10.30	-
3	Column B1 (500)	ISMB	10.20	10.40	-
4	Column B2 (500)	ISMB	10.20	10.20	-
	Cross Bracing				
5	Cross Bracing A1-B1 (90x90x8)	ISA	8.00	8.00	-
6	Cross Bracing B1-A2 (90x90x8)	ISA	8.00	8.10	-
	First Floor				
	Column				
7	Column A1 (500)	ISMB	10.20	10.20	-

8	Column A2 (500)	ISMB	10.20	10.20	-
9	Column B1 (500)	ISMB	10.20	10.30	-
10	Column B2 (500)	ISMB	10.20	10.40	-
11	Beam A2-B2 (500)	ISMB	10.20	10.20	-

The percentage of reduction in the thickness of columns varies from 0.00% with respect to the original thickness.

5. DERIATOR/ESP STRUCTURE

ESP STRUCTURE

History / Background of the structure:

Deriator/ESP structure is fabricated in structural framing system. Tie beam and cross bracing have been provided as seen in the photographs. Since the structure has recently painted visual distress are covered. Staircase has been provided on east side.



Observations:

- As a matter of critical observation; huge steel tank noted rest on steel beams as seen in the photograph below. However, the said steel beams (supporting the said tank) connected with comparatively small / undersized main beams. The system needs cross verification with fresh design and accordingly to re-done.



INFERENCE OF N.D.T. RESULTS ESP STRUCTURE

In order to have adequate assessment of the pathological condition of the structure i.e. series of health parameters, series of NDT investigations are carried out. These include number of steel thickness test have been carried out. All the NDT findings are enclosed herewith.

1. Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Inference of N.D.T. Results at ESP Structure

In order to have adequate assessment of the pathological condition of the structure NDT investigations are carried out. These include number of ultrasonic thickness gauge readings. All the NDT findings are enclosed herewith.

Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Sr.	Locations	Member	Standard	Thickness Obtained	% Reduction
No.	-	-	Thickness	(mm)	
	<u>AFBC Boiler Plant</u>				
	<u>ESP Structure 1</u>				
	<u>Column</u>				
1	Column A1 (250)	ISMC	7.10	7.00	1.41
2	Column A2 (250)	ISMC	7.10	7.00	1.41
3	Column A3 (250)	ISMC	7.10	7.10	0.00
4	Column A4 (250)	ISMC	7.10	7.20	-
5	Column B1 (250)	ISMC	7.10	7.00	1.41
6	Column B2 (250)	ISMC	7.10	7.20	-
7	Column B3 (250)	ISMC	7.10	7.00	1.41
8	Column B4 (250)	ISMC	7.10	7.00	1.41

	Cross Bracing				
9	Cross Bracing A4-B4 (125)	ISMC	5.00	5.00	0.00
10	Cross Bracing A3-B3 (125)	ISMC	5.00	5.10	-
11	Cross Bracing A2-B2 (125)	ISMC	5.00	4.60	8.00
12	Cross Bracing A1-B1 (125)	ISMC	5.00	4.90	2.00
	ESP Structure 2				
	Column				
12	Column A1 (250)	ISMC	7.10	7.00	1.41
13	Column A2 (300)	ISMC	7.60	7.00	7.89
14	Column A3 (300)	ISMC	7.60	7.50	1.32
15	Column A4 (250)	ISMC	7.00	6.90	1.43
16	Column B1 (300)	ISMC	7.60	7.00	7.89
17	Column B2 (300)	ISMC	7.60	7.40	2.63
18	Column B3 (250)	ISMC	7.10	4.80	32.39
19	Column B4 (250)	ISMC	7.10	5.40	23.94
	Cross Bracing				
20	Cross Bracing A1-B1 (150)	ISMC	5.40	5.10	5.56
21	Cross Bracing A2-B2 (150)	ISMC	5.40	4.60	14.81
22	Cross Bracing A3-B3 (150)	ISMC	5.40	4.80	11.11
23	Cross Bracing A4-B4 (150)	ISMC	5.40	4.80	11.11
	ESP2 Staircase				
	Column				
24	Column A1 (200)	ISMC	6.10	6.00	1.64
25	Column A2 (200)	ISMC	6.10	6.10	0.00
26	Column B1 (200)	ISMC	6.10	6.00	1.64
27	Column B2 (200)	ISMC	6.10	6.00	1.64
28	Staircase Stranger (200)	ISMC	6.10	5.60	8.20
29	Staircase Stranger (200)	ISMC	6.10	5.80	4.92
	ESP 1 Staircase				
	Column				
30	Column A1 (200)	ISMC	6.10	5.80	4.92
31	Column A2 (200)	ISMC	6.10	6.00	1.64
32	Column B1 (200)	ISMC	6.10	6.00	1.64
33	Column B2 (200)	ISMC	6.10	6.10	0.00
34	Staircase Beam (200)	ISMC	6.10	6.00	1.64
35	Staircase Beam (200)	ISMC	6.10	5.90	3.28
The percentage of reduction in the thickness of columns varies from 1.41 to 32.39% with respect to the original thickness.					

6. ESP CONTROL ROOM

[ESP CONTROL ROOM](#)

History / Background of the structure:

ESP control room is a RCC framed structure of ground floor having brick masonry walls.

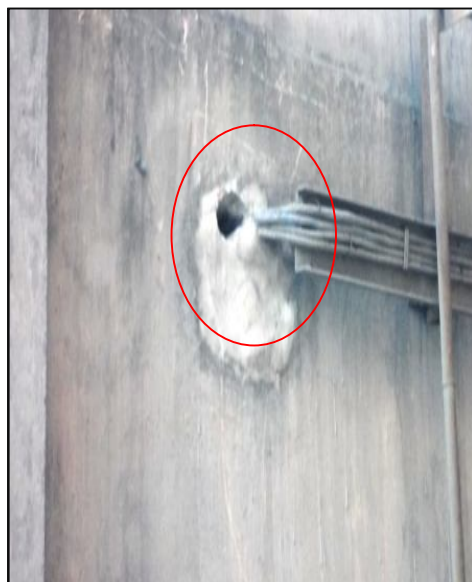


Observations:

- Peeling of external paint, localized damaged plaster, separation crack at the junction of roof beam and masonry wall, leakage/seepage resulted in moss growth etc. noted. Please refer photographs below.



- Unfinished through holes are made in masonry walls to pass the electrical cables from external sides; it might be the source of leakage. Please refer photograph below.



7.F.D FOUNDATION

F D FOUNDATION

F. D. FOUNDATION noted with honey combing. It seems the said foundations directly cast/rest on existing floor and not anchored & hence horizontal separation cracks can be seen at the bottom of the said foundations.



8. I. D. FAN FOUNDATION

I. D. FAN FOUNDATION

I. D. FAN FOUNDATION is the RCC foundation provided to support the Fans as seen in the photographs below. No major distresses except localized honeycombing & damaged edges noted in the said foundations.



INFERENCE OF N.D.T. RESULTS I D FAN FOUNDATION

In order to have adequate assessment of the pathological condition of the structure i.e. series of health parameters, series of NDT investigations are carried out. These include number of steel thickness test have been carried out. All the NDT findings are enclosed herewith.

1. Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Inference of N.D.T. Results at ID Fan

In order to have adequate assessment of the pathological condition of the structure NDT investigations are carried out. These include number of ultrasonic thickness gauge readings. All the NDT findings are enclosed herewith.

Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Sr.	Locations	Member	Standard	Thickness Obtained	% Reduction
No.	-	-	Thickness	(mm)	
	<u>AFBC Boiler Plant</u>				
	<u>ID Fan IA & IB</u>				
1	Column A1 (150)	ISMC	5.40	5.70	-
2	Column A2 (150)	ISMC	5.40	5.90	-
3	Column A3 (150)	ISMC	5.40	5.60	-
4	Column B1 (150)	ISMC	5.40	5.50	-
5	Column B2 (150)	ISMC	5.40	5.70	-
6	Column B3 (150)	ISMC	5.40	5.80	-
	<u>ID Fan 2A &2B</u>				
7	Column A1 (150)	ISMC	5.40	5.90	-
8	Column A2 (150)	ISMC	5.40	5.70	-

9	Column A3 (150)	ISMC	5.40	6.10	-
10	Column B1 (150)	ISMC	5.40	5.70	-
11	Column B2 (150)	ISMC	5.40	6.10	-
12	Column B3 (150)	ISMC	5.40	5.80	-
	ID Fan 3A &3B				
13	Column A1 (150)	ISMC	5.40	6.00	-
14	Column A2 (150)	ISMC	5.40	6.10	-
15	Column A3 (150)	ISMC	5.40	6.10	-
16	Column B1 (150)	ISMC	5.40	6.20	-
17	Column B2 (150)	ISMC	5.40	5.90	-
18	Column B3 (150)	ISMC	5.40	5.60	-
	ID Fan 4A &4B				
19	Column A1 (150)	ISMC	5.40	6.10	-
20	Column A2 (150)	ISMC	5.40	5.80	-
21	Column A3 (150)	ISMC	5.40	5.90	-
22	Column B1 (150)	ISMC	5.40	5.70	-
23	Column B2 (150)	ISMC	5.40	6.00	-
24	Column B3 (150)	ISMC	5.40	5.90	-
The percentage of reduction in the thickness of columns varies from 0.00% with respect to the original thickness.					

2. Ultrasonic Pulse Velocity Test :- (IS 13311 - Part I)

This instrument works on the principle of passing high frequency sound waves through the body of the concrete & measuring the time taken. Distance of path length divided by the time taken provides velocity of the waves through the concrete member being tested.

Depending on the velocity, the quality of concrete as regards homogeneity can be judged. Lower velocity (less than 3 Km / sec) indicates some defects like honey combing, cracks, voids, rebounding etc. at the location of test.

The concrete surface is thoroughly cleaned & dried. The instrument is calibrated before taking readings. Coupling medium such as grease is applied to the probes, and reading is

taken for the pulse velocity at the location. Appropriate correction factors are applied, wherever desired, for the presence of steel.

The USPV readings around 3 Km/sec and above indicate fair quality concrete whereas readings below 2 Km / sec indicate localized weakness at that particular zone.

As per IS, velocity below 3.00 Km / sec indicates 'Doubtful' quality concrete, velocity between 3.00 to 3.50 Km / sec indicates 'Medium' quality concrete and velocity above 3.50 Km / sec indicates 'Good' quality concrete. And velocity 4.50 Km / sec indicate 'Excellent' quality concrete. From the above parameters we can judge the quality of concrete.

Details of Testing:

- The tests were conducted at total 20 locations on R.C.C pedestal
- Maximum reading obtained as 3.99 km/sec at Fan B1.
- Minimum reading obtained as 2.95 km/sec at Fan A2.
- Average reading obtained as 3.33 km/sec, which indicates medium quality of concrete.

Conclusion:

The test results indicate medium quality concrete at most of the locations.

Please refer the test results attached herewith for details.

3. Half Cell Potentiometer (ASTMC- 876-80)

Half Cell Potentiometer works on the principle of measuring milli-voltage in the circuit of reinforcement & cover concrete using copper sulphate half cell.

This test measures corrosion potential of the embedded steel in concrete with half cell (Cu/CuSo4). This method essentially consists of measurement of the absolute

potential at the concrete surface with reference to an electrode. It is necessary to have direct electrical connections to the embedded steel. The measured absolute potential with reference to the referred electrode is considered to be the best criterion for assessing the corrosion status of the embedded steel rods. The test is fairly indicative of corrosion response at present and of the future.

The negative terminal of the voltmeter is connected directly to a protruding end of embedded steel by means of a "crocodile clamp". The digital handheld operated millivoltmeter will show the potential measurements.

The following precautions are taken:-

The protruding embedded steel bar must be cleaned with an abrasive paper before making electrical connection to ensure low electrical contact resistance.

The concrete surface shall be cleaned thoroughly with a soft wire brush to remove the adhering calcium carbonated layers, which cause high electrical resistance during the potential measurement. This is essential preparatory requirement and has been ensured all along, before actual testing.

The concrete surface to be subjected to test shall be kept wet uniformly before the commencement of potential measurement.

The readings more negative than -350 mV indicate high probability of Active corrosion. More positive than -200 mV indicate high probability of no corrosion. Readings between -200 mV to -350 mV indicate uncertainty of corrosion and positive readings indicate probability of insufficient moisture in concrete. The existence of corrosion in steel is further confirmed by high percentage of chloride and less pH value obtained by other methods of testing. Such series of corroborative testing techniques are evolved to reach at most reliable findings.

Details of Testing:

- The tests were conducted at 04 locations.

Conclusion:

- The test results indicate high probability of active corrosion at all representative locations where test have been conducted.

Please refer the test results attached herewith for details.

4. Schmidt Rebound Hammer (IS 13311 Part II)

Total 16 impact readings were taken at each location and average of middle ten was calculated after discarding the top three and bottom three readings. In this manner, total no. of points was tested on the selected concrete members.

The probable accuracy of prediction of concrete strength by the rebound hammer is + 25% as per IS code 13311(part II)

Details of Testing:

- The tests were conducted at 12 locations.
 - The average of all the readings is 461.25 Kg/ Sq.cm.
- Please refer the test results attached herewith for details.

5. Cover meter investigations.

This test indicates the cover of concrete over the reinforcement. In this case the cover is without the plaster.

Details of Testing:

- The tests were conducted at total 8 locations.
- Several readings of cover meter are in the range of 42mm to 50 mm.
- Clear cover does not indicate depth beyond 50 mm where test has carried out.
- The average cover of concrete reveals as 46 mm.

Conclusion:

- The test results confirm sufficient cover of concrete provided to the reinforcement at many locations.

Please refer the test results attached herewith for details.

6. Carbonation Test (Ref BS 1881 Part 201: 1986).

This test is carried out to measure the depth of concrete from the external face up to which it has undergone carbonation.

The test requires core samples of 25 mm or 50 mm diameter to be taken out for a depth of about 80 to 100 mm. higher diameter cores taken can also be used for this test. The core sample is sprayed by 2% phenolphthalein solution starting from the exposed or external surface of concrete. If sprayed concrete turns pink, it is considered as non-carbonated. The depth of carbonation is measured in millimeters as the depth from the external face of concrete to the point beyond which the phenolphthalein sprayed concrete turns pink in color. If the core of concrete is not available the test can be performed by suitably exposing the concrete by cutting or breaking by chisel and performing the test on this freshly exposed surface as described above.

Details of Testing:

- The tests were conducted at total 5 locations.
- The readings of carbonation depth are noted up to 32 mm depth.

Conclusion:

- Comparing to the average clear cover of concrete to reinforcement for R.C.C. Columns, as revealed through cover Meter test i.e. 46.00 mm, the Carbonation test results confirms that the cover of concrete has carbonated up to 30 mm at representative locations where test has carried out. A carbonation test result at slab confirms that the cover of concrete has carbonated.

Please refer the test results attached herewith for details.

9. P A FAN FOUNDATION

1A /B & 2A/B

P A FOUNDATION 1A/B & 2A/B

P A FOUNDATION 1A/B AND 2A/B are the RCC foundations provided to support the equipments above it as per requirement.

Observations:

- The RCC foundations; under reference; noted with distresses like localized honey combing, horizontal separation cracks at the subsequent concrete pours and gap between RCC and top finishing layer etc. Please refer typical photographs below.





10. WATER PIPE RACK

WATER PIPE RACK

WATER PIPE RACK is a steel framing structure suitably installed over the RCC foundation. The said RCC foundation area further encased with RCC for the area above as seen in the photographs below.



Observations:

- The structure noted with distresses like exposed steel/dowel bars, minor corrosion in the steel elements, localized missing of cleat and seat angles as a matter of inadequate connections and improper / incomplete welding at localized areas etc. Please refer photographs below.



INFERENCE OF N.D.T. RESULTS WATER PIPE RACK

In order to have adequate assessment of the pathological condition of the structure i.e. series of health parameters, series of NDT investigations are carried out. These include number of steel thickness test have been carried out. All the NDT findings are enclosed herewith.

1. Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Inference of N.D.T. Results at Pipe Rack for Water Pipe

In order to have adequate assessment of the pathological condition of the structure NDT investigations are carried out. These include number of ultrasonic thickness gauge readings. All the NDT findings are enclosed herewith.

Steel Thickness Gauge:

This test is performed to acquire the thickness of the Structural steel members, as per actual.

Sr.	Locations	Member	Standard	Thickness Obtained	% Reduction
No.	<u>AFBC Boiler Plant</u>	-	Thickness	(mm)	
	<u>Pipe Rack for Water Pipe (Column)</u>				
1	Column A1 (150)	ISMC	5.40	5.40	-
2	Column B1 (150)	ISMC	5.40	5.00	7.41
3	Column A2 (200)	ISMC	5.40	5.00	7.41
4	Column B2 (200)	ISMC	5.40	5.10	5.56
5	Column A3 (200)	ISMC	5.40	5.20	3.70
6	Column B3 (200)	ISMC	5.40	5.30	1.85
7	Column A4 (150)	ISMC	5.40	5.30	1.85
8	Column B4 (150)	ISMC	5.40	5.40	0.00
9	Column A5 (150)	ISMC	5.40	5.50	-
10	Column B5 (150)	ISMC	5.40	5.50	-
11	Column A6 (150)	ISMC	5.40	5.40	0.00
12	Column B6 (150)	ISMC	5.40	5.40	0.00

The percentage of reduction in the thickness of columns varies from 1.85 to 7.41% with respect to the original thickness.

11. COMMON RECOMMENDATIONS

Recommendations / Conclusion:-

In light of the observed defects; following remedial measures are recommended to carry out for efficient improvement in the serviceable life span of the structures; under reference.

R.C.C. Members -

Corrosion related damages (in the members) shall be rectified with the use of 'Polymer Modified Mortar' as per standard methodology as follows -

➤ 1. Cracks due to corrosion of steel reinforcement in RCC members

- Expose the cracked / spalled elements completely. Use long sharp chisels of about 16-20 mm diameter and hammers upto 2 lbs weight. Remove the complete corrosion of reinforcement with wire brushes (preferably mechanical type). Remove all the loose and damaged concrete particles till sound concrete of uniform texture is visible. Apply rust removers like 'Rusticide SS' or equivalent to the reinforcement to remove the traces of rust. Clean the reinforcement once again with the wire brush. Wash the complete concrete surface including the reinforcement to remove the traces of rust remover. Apply a coat of rust passivator like 'Polyalk Fixoprime and cement' or equivalent as per the recommendations of the manufacturers. The concrete surface treated for corrosion shall be patch repaired with Polymer Modified Mortar like 'Polyalk EP' or any other equivalent as per the manufacturer's recommendations.

➤ **Exposed steel reinforcement**

- Follow methodology to treat exposed reinforcement as per recommendation mentioned in corrosion cracks in R.C.C members with replacement of snapped steel with new steel reinforcement of similar diameter, as per requirement as per existing design.

➤ **Hollow sound in RCC member**

- Break open the loose and damaged concrete, till the uniform and solid stage of concrete is witnessed.
- Give Polymer Mortar Treatment to this area as per recommendation mentioned for crack due to corrosion of reinforcement in R.C.C members.
- Grout the weak concrete areas with cement and non shrink additives or with low viscous epoxy.

➤ **Honey Combing / Cracks:-**

- These areas shall be grouted with cement grouting with addition of non shrinking additives.
- Aluminum / PVC multiperforated nipples may be used to carry out the injection operation.
- The pressure of 1.00 to 1.5 kg per sq cm may be applied for grouting.
- Care should be taken to remove trapped air inside the crack / honey combing areas to avoid back pressure.

➤ **Spalling of Concrete: -**

- This area shall be rectified by the process as explained earlier i.e. in recommendation no.1.

- The gap between concrete and top finishing layer (in RCC pedestals) shall be finished with suitable grouting as per existing system/method.
- Grout the area (in foundations/pedestals etc) with low viscous epoxy injections of reputed manufacturers, as per specification, for cracks and weak concrete areas to make the area itself watertight.

- **Structural Steel Members -**

- Localized replacement of the deteriorated steel elements as also further strengthening has to be done and need to be followed for the proposed rehabilitation work. However, the said strengthening work shall be done according to the design.
- Most of the distresses related to the inadequate connection details need be re-done with providing ideal connection details as can be best designed with improved specifications.
- Few General distresses like Existing corrosion of the steel members shall be removed as per standard method and all the Structural Steel members shall be treated with application of 3 coats of 'SUNPUGUARD' (a high quality Anti corrosive two component Polyurethane coating) or equivalent as per Manufacturer's recommendations. Proper surface preparation of all Structural Steel members shall be done before

application of SUNPUGUARD or equivalent, as per manufacturer's recommendations.

➤ This is the broad assessment of the structural health at this stage.

C.Y.Chandanshive

Mahendra Barde

J. C. Kadam

Project Manager

Sr. Associate

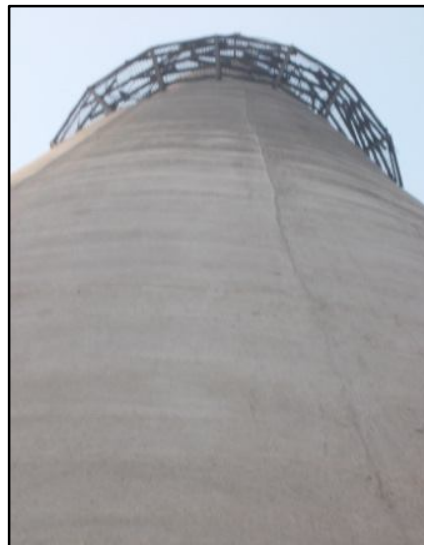
Technical Director

12. CHIMENY

CHIMENY

History / Background of the structure:

- The structure under reference i.e. RCC chimney is located at AFBC boiler area. This is a RCC conical shaped structure constructed with 900 mm thick wall.
- Suitable steel platforms/walkways are provided to the structure as per requirement.



RCC chimney observations.

- Several horizontal cracks at subsequent concrete pours of slip form lifts, localized hollow sound in RCC wall and separation crack noted between the RCC and door frame at of entrance area; as shown in the photographs below.



- Unfinished patches noted on the external periphery of the chimney, at few locations, which might made to fix anchor fasteners.



- Honey combing and exposed steel reinforcement/dowels noted in connected patch of ducting connection area.



INFERENCE OF N.D.T. RESULTS AT AFBC CHIMENY:

In order to have adequate assessment of the pathological condition of the structure i.e. series of health parameters, series of NDT investigations are carried out. These include number of ultrasonic pulse velocity readings, half cell potentiometer test for corrosion potential, number of concrete chemical analysis, Carbonation and Cover meter test have been carried out. All the NDT findings are enclosed herewith.

1. Ultrasonic Pulse Velocity Test :- (IS 13311 - Part I)

This instrument works on the principle of passing high frequency sound waves through the body of the concrete & measuring the time taken. Distance of path length divided by the time taken provides velocity of the waves through the concrete member being tested.

Depending on the velocity, the quality of concrete as regards homogeneity can be judged. Lower velocity (less than 3 Km / sec) indicates some defects like honey combing, cracks, voids, rebounding etc. at the location of test.

The concrete surface is thoroughly cleaned & dried. The instrument is calibrated before taking readings. Coupling medium such as grease is applied to the probes, and reading is taken for the pulse velocity at the location. Appropriate correction factors are applied, wherever desired, for the presence of steel.

The USPV readings around 3 Km/sec and above indicate fair quality concrete whereas readings below 2 Km / sec indicate localized weakness at that particular zone.

As per IS, velocity below 3.00 Km / sec indicates 'Doubtful' quality concrete, velocity between 3.00 to 3.50 Km / sec indicates 'Medium' quality concrete and velocity above 3.50 Km / sec indicates 'Good' quality concrete. And velocity 4.50 Km / sec indicate 'Excellent' quality concrete. From the above parameters we can judge the quality of concrete.

Details of Testing:

- The tests were conducted at total 60 locations on R.C.C wall.
- Maximum reading obtained as 28.17 km/sec on east side.
- Minimum reading obtained as 2.28 km/sec on east side.
- Average reading obtained as 3.26 km/sec, which indicates medium quality of concrete.

Conclusion:

The test results indicate medium quality concrete at most of the locations.

Please refer the test results attached herewith for details.

2. *Schmidt Rebound Hammer (IS 13311 Part II)*

Total 16 impact readings were taken at each location and average of middle ten was calculated after discarding the top three and bottom three readings. In this manner, total no. of points was tested on the selected concrete members.

The probable accuracy of prediction of concrete strength by the rebound hammer is + 25% as per IS code 13311(part II)

Details of Testing:

- The tests were conducted at 20 locations.
- The average of all the readings is above 600.00 Kg/ Sq.cm.

Please refer the test results attached herewith for details.

3. *Cover meter investigations.*

This test indicates the cover of concrete over the reinforcement. In this case the cover is without the plaster.

Details of Testing:

- The tests were conducted at total 20 locations.
- Several readings of cover meter are in the range of 44mm to 64 mm.
- Clear cover does not indicate depth beyond 64 mm where test has carried out.
- The average cover of concrete reveals as 54 mm.

Conclusion:

- The test results confirm sufficient cover of concrete provided to the reinforcement at many locations.

Please refer the test results attached herewith for details.

RECOMMENDATIONS:

- Grout the area with low viscous epoxy injections of reputed manufacturers, as per specification, for cracks and weak concrete areas to make the area itself watertight.

For hollow sound follow the below procedure, as per requirement

- Remove all the loose and damaged concrete particles till sound concrete of uniform texture is visible. Use long sharp chisels of about 16-20 mm dia and hammers upto 2 lbs weight.
- Remove the complete corrosion of reinforcement with wire brushes (preferably mechanical type). Apply rust removers like 'Rusticide SS' or equivalent to the reinforcement to remove the traces of rust, if any.
- Clean the reinforcement once again with the wire brush. Wash the complete concrete surface including the reinforcement to remove the traces of rust remover. Apply a coat of rust passivator like 'Polyalk Fixoprime and Cement' or equivalent as per the recommendations of the manufacturers.
- The concrete surface treated for hollow sound shall be patch repaired with Polymer Modified Mortar as per the manufacturer's recommendations & as explained earlier.

External carbonated surface of R.C.C, exposed to chemical environment should be treated with the application of Anti-Carbonation coating, as per the below procedure, as per requirement.

- Clean the surface to remove the dirt, loose particles etc using brush & water jet.
- Examine the surface closely for any cracks or openings, if any; treat such areas as mentioned above.

- Apply two coats of anti corrosive paint by brush, roller or spray, as per manufacturer's recommendations.
- Maintain a minimum interval of 4-6 hours between two successive coats.

Unfinished cutout to treat with –

- Unfinished cut – outs to be filled with the use of Micro concrete of reputed brand as per manufacturer specifications.

C.Y.Chandanshive

Mahendra Barde

J. C. Kadam

Project Manager

Sr. Associate

Technical Director