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Degradation of Rail Track RCC Foundation of Stacker Reclaimer in Coal handling plant- A Case Study

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Abstract:

The stacker reclaimer system is an important component of the coal handling plant, which is use for moving coal to the coal bunker from the stockpiles. The stacker/declaimer machine create coal stockpiles on either side of the rail track and also to retrieve coal from stockpiles so that a conveyor belt system can transport it to the coal bunker. The RCC foundation supporting the rail track of stacker reclaimer in the coal handling plant undergoes deteriorating effect such as carbonation of concrete, corrosion of reinforcement, cracking, de-lamination resulting in to structural performance of rail track. The apparent properties of hardened concrete such as carbonation of hardened concrete, concrete quality, probability of active corrosion of the reinforcement, thickness of the concrete cover were inspected. The causes of the structural damage and deterioration of concrete were studied using Non Destructive Testing.

This case study is an attempt made to understand the degradation of the RCC rail track foundations for identification of structural defects in the rail track of the stacker-reclaimer. The generated data will be helpful to understand the distress mechanism to counteract the premature damage.

Keywords — **Reinforced cement concrete [RCC], Potential of Hydrogen [pH], Corrosion, Coal Handling Plant, Non Destructive testing.**

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I. INTRODUCTION

The RCC rail track foundation of stacker reclaimer, deteriorates during the prolonged service life and get damaged due to external environmental condition in contact with moist coal dust. Alternate drying and wetting conditions tends to degrade the concrete resulting in to initiation of corrosion of embedded reinforcement. This leads to a reduction in dependability and performance of the RCC rail track foundation. Hence, it is essential to understand the degradation process of RCC foundation of stacker reclaimer. Onsite monitoring and technological research helps in preventing severe accidents and also for extending the service life of structural foundation within the life span of structure.

It has been observed that the RCC foundation of the stacker reclaimer which is situated in an corrosive environment absorb moisture easily from the corrosive media causing the durability distress.

The various types of gaseous which is present in coal environments such as carbon dioxide, hydrogen chloride gas, salt water, sulfate-rich mist, as well as dust containing calcium and magnesium chloride highly susceptible for initiation of degradation process of RCC foundation of stacker reclaimer foundation. The principal corrosive anions and cations were SO_4, Cl, and Mg^{2+}. The calcium and magnesium chloride present in the coal dust that initially deteriorates the cover concrete.

When the depth of carbonation is beyond the reinforcement level, the coupling effects of gaseous, liquid, and solid media damage the protective layer of the concrete.

Owing to the continuous and regular requirement for coal in coal handling, coal is usually piled high and distributed via conveyor belts, stackers, and reclaimers, all of which are crucial components of this process. Even with the weight of the equipment, there is a higher dynamic reaction when there is a dynamic load because its movement is placed on top of the rail track which is supported by the RCC foundation.

The RCC foundation deteriorates during the prolonged service life due to continuous distribution of load.

In the coal handling plant, it is observed that cracks develops along the direction of embedded reinforcement and causes significant damage to some of the concrete area. The reinforcement corrosion is dangerous and can cause significant damage to the entire concrete foundation.

In order to determine the damage and deterioration impacts on the RCC foundation of the stacker reclaimer under exposure moist condition and the concrete's performance under alternating drying and wetting cycles, a case study was carried out to determine the extent of degradation of stacker-reclaimer RCC foundation in the coal handling plant. In order to analyse the condition of concrete, drilled hole powder samples were obtained by drilling the holes in the concrete at 40mm and 80 mm depths for laboratory investigations to examine the environmental impact on concrete rail track foundation due to exposure to aggressive coal condition.

2.0 Performance of Stacker-Reclaimer rail track foundation:

Similar to any other railway track system, the RCC foundation distributes loads evenly on larger area by maintaining the required track geometry and to give support and stability to the track. The compressive strength of the concrete determines the strength of ties and its stiffness. Loss of stiffness can cause excessive rail deflections and pumping of the ballast and subgrade. Excessive stiffness can also result in increased loads at the bottom of the tie and at the rail seat. If there is inadequate concrete cover to the reinforcement or cracked concrete that permits the ingress of moisture the embedded reinforcement may corrode excessively with huge loss of cross section of steel. Flexural cracks in concrete tie beams typically indicate high rail seat positive moments or high center negative moments. Reinforced cement concrete(RCC) that deteriorates due to chemical attack or surrounding environmental condition may result in to corrosion of steel. For uniform distribution of load of coal stack piles to be distributed to the larger bearing area at the bottom. The condition of RCC of stacker-reclaimer foundation must be sound & durable.

Deterioration of the concrete may cause an incorrect canting of rail, which would result in concentrated rail seat stresses.

2.1 Types of failures observed in stacker-cum-reclaimer system during operation in coal handling plant:

1. Failure due to impact load on supporting rail track due to operational conditions of the rail track on which the machine travels.

2. Completely corroded connecting bolts and nuts causing excessive vibrations results into failure.

3. Mechanical failure of the stacker-cum-reclaimer assembly as a result of steel slewing bearings, discharge boom ties, gusset plates, bucket wheel axle, and carrying structural cracks.

4. Failure of rail track joint due to failure of fish plates, weld joint , failure of RCC foundation.

2.2 Cases of structural failures :

Few examples of structural damages occurred in components of rail track fastening. :

Fig.1 An illustration of the degradation of a concrete-tie rail seat

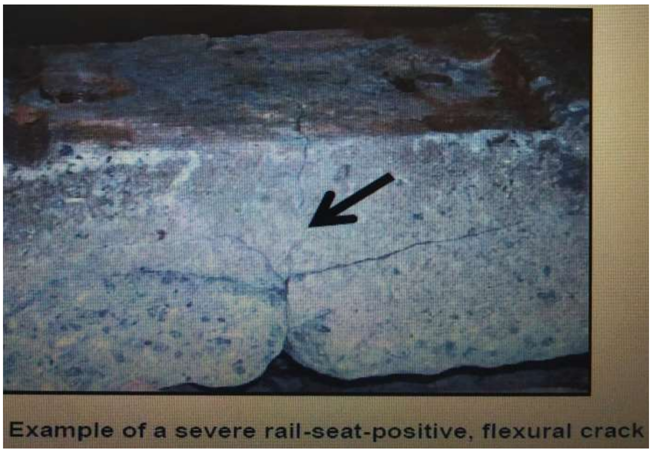

Fig.2 An illustration of a severe, flexural, rail-seat-positive crack

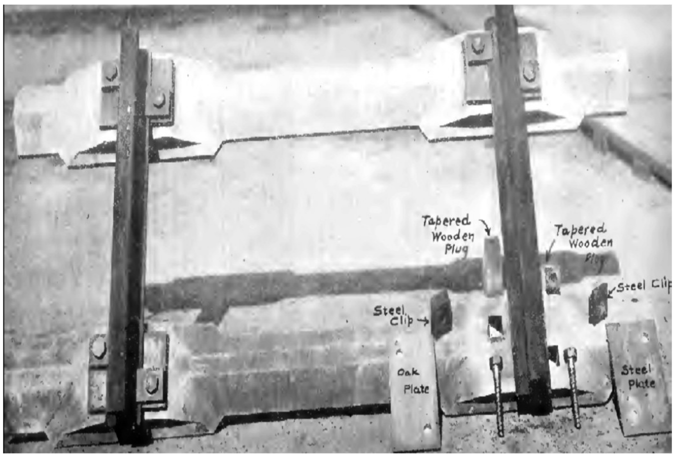

Fig.3 Example of a reinforced concrete tie with steel and wood plates built at the Pittsburgh & Lake Erie rail seat

3. Literature Review :

The impact of aged concrete's durability in the caustic environment of coal was compiled in the literature review that follows.

Reported by **Shuchun, ZhouSun Lei, Haijian Xie, and Henglin Lv** from the China University of Mining & Technology's School of Architecture and Civil Engineering are members of the Jiangsu Key Laboratory of Environmental Impact and Structural Safety in Engineering. The author of this study has analyzed how the natural surroundings and the mechanical environment of technology interact to produce physical and chemical reactions that damage and deteriorate concrete surfaces. Acid erosion and sulfate assault are examples of chemical effects, while freeze-thaw cycles and other variations in moisture and dryness are examples of physical consequences. He continued by saying that the concrete's surface layer will fracture and lose strength as a result of the alternate cycles of drying and wetting caused by the crystalline expansion of Na2SO4 and MgSO4, which had attacked the concrete but had not produced a chemical reaction. Furthermore, the core concrete will become loose beyond the reinforcing.

Concrete will be directly corroded, damaged, and flaked when the relative humidity is higher than 75%. Weak acid mist generated by CO2 and other gases will neutralize the concrete. Strong acid mist formed by HCl and Cl2 will erode the concrete and cause damage to its protective layer.

Concrete having porosity will be penetrated by a corrosive liquid high in SO4, which will react with $Ca(OH)_2$ to form $CaSO_4\surd H_2O$ or other crystals with a bigger volume expansion. The expansion force will cause the concrete to break, enlarging the microscopic fissures inside.

Through the larger cracks in the concrete, chlorides will more readily seep in and participate in an electrochemical reaction at the steel surface, causing the steel to expand and corrode. This will facilitate the further infiltration of salt solution, repeating the reaction and possibly increasing the damage to the external concrete.

Here are a few examples of the chemical reactions that take place:

HCl: $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2\uparrow$
$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + H_2O$

Cl_2: $Cl_2 + 2H_2O \rightarrow 2HCl + O_2\uparrow$
$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$
$SO_2 + 2Cl_2 + 3Ca(OH)_2 + 2H_2O \rightarrow CaSO_4\downarrow + 2CaCl_2 + 6H_2O$

SO_2: $H_2O + SO_2 \rightarrow H_2SO_3$
$Ca(OH)_2 + 2H_2SO_3 \rightarrow Ca(HSO_3)2 + H_2O$
$Ca(OH)_2 + H_2SO_3 \rightarrow CaSO_3\downarrow + 2H_2O$

NO_2: $H_2O + NO_2 \rightarrow H_2NO_3$
$Ca(OH)_2 + 2H_2NO_3 \rightarrow Ca(NO_3)2 + 2H_2O$

CO_2: $CO_2 + H_2O \rightarrow H_2CO_3$
$Ca(OH)_2 + 2H_2CO_3 \rightarrow Ca(HCO_3)_2 + H_2O$
$Ca(OH)_2 + H_2CO_3 \rightarrow CaCO_3\downarrow + 2H_2O$

The bond ability between the reinforcement and concrete is significantly impacted by the levels of reinforcement corrosion and concrete deterioration.

Nadir, HM and Ahmed [2]

The Civil Engineering Group is located in the Civic Quarter, Northern Terrace, Leeds, UK, within Leeds Beckett University's School of Built Environment & Engineering. The author came to the conclusion that the external attack is severe and occurs over an extended period of time by absorption of sulfate solutions from the surrounding atmosphere and soil water, converting monosulfate aluminate hydrates into ettringite and causing expansion and cracks, ultimately leading to ultimate failure.

This conclusion was based on a thorough review of the literature and an analysis of various experimental works. The Hardened concrete begins to crack as sulfate from the environment breaks down monosulfate aluminate hydrate into long, needle-like ettringite crystals. On the other hand, the structures expand as a result of the micro-ettringite crystals that grow in vacancies.

The attack by magnesium sulfate results in gypsum and a flaky, fibrous magnesium-silicate-hydrate gel that lacks strength and ultimately causes the building to collapse.

More $Ca(OH)_2$ indicates that the hardened concrete is vulnerable to external sulfate attack. $Ca(OH)_2$ is a highly soluble compound that dissolves quickly in water even after the concrete has hardened, causing increased leaching, porosity, and vulnerability to sulfate attack.

A.K. Mittal, S.P. Agrawal, P.C. Thapliyal, and S.R. Karade[3]CBRI,Roorkee

The authors came to the conclusion in their paper on the deterioration and repair of concrete structurers in thermal power plants that the conditions that CHP structures are subjected to are dusty, unclean, and frequently damp. They are occasionally subjected to unintentional coal fires as well. Concrete spalling, reinforcing corrosion, and structural cracking are examples of deterioration seen in these constructions. Every day, there are more and more decaying concrete buildings in thermal power plants that run on coal. The primary causes of these structures' deterioration are acidic flue gasses and coal dust. CBRI has conducted a number of studies to evaluate the reasons and extent of some of the concrete structures in the power plants.

John. C. Zemen [4]

Reported by John.c.Zemen[4] in their thesis submitted to the university of Illinois at Urbana-Champaign, about the hydraulic mechanisms of concrete-tie rail seat deterioration.

He discussed about the chemical attack, environmental degradation (such as freeze expansion), or shear cracking can cause concrete to deteriorate. Cracking can also lead to corrosion in concrete that is too weak, and improper surface finish on prestress strands or wires can prevent concrete from developing its prestress to the full extent necessary (White 1984, Weber 1969).

For loads to be distributed at appropriate stresses, the bearing areas at the bottom of the tie and at the rail seats are crucial. The strains at these points may rise and damage the ballast, rail, or subgrade if the bearing areas are diminished by deteriorating concrete, broken fasteners, or uneven distribution of ballast. The Rail cant, or the inward tilt of the rails, is crucial for stress distribution since it transfers lateral and vertical stresses through the rail's web. Concentrated rail seat pressures may arise from inappropriate canting caused by concrete deterioration pad degradation or defective fasteners.

Shuchun Zhou,Henglin Lv, Yuanzhou Wub[5]

The author has interpreted, using our experimental study, that the sulfate attack produced four different types of products: ettringite, plaster, thaumasite, and sulfate crystals. The expansion force created by the products caused the concrete to crack or even sustain damage in this paper on "degradation behavior of concrete under corrosive coal mine environments." Concrete's elastic modulus and compressive strength were significantly impacted by calcium leaching, and the rate at which strength is lost has a binary linear relationship with both the rate of CaO loss and the ratio of SO4 to CaO concentration in the hardened cement paste. When H+ and SO4 attacked the concrete chemically and reacted with the CaO, the concrete's compressive strength dropped. As a result, the concrete's fragility increased while its ductility decreased.

LvHeng-lina, MaYinga, Zhou Shu-chuna, Liu Kuanga[6]

The author of the paper presented a case study on the degradation and collapse process as well as the healing method of RC coal bunkers at the 6th International Conference on Mining Science & Technology.
One main factor contributing to the degradation of RC is the harsh natural environment. The concrete developed pore channels and microcracks as a result of long-term, frequent wetting and drying cycles, which raised the concrete's permeability coefficient. Meanwhile, fatigue damages steadily accumulated, hastening the formation of microcracks and pore channels as a result of vibration loads from large-scale machinery and shock loads from coal falling into bunkers at a rapid speed. Following a protracted accumulation period, microcracks kept expanding. Therefore, corrosive media in harsher environments (such as CO2, H2S, HCl, SO2-Cl, Na2SO4, and so on) could more easily seep into inner RC members and erode steel bars and concrete, leading to sulfate and chloride attacks on concrete sooner. Interior tension rose, and interior fissures expanded as a result of the reaction of sulfate attractions. Concrete's permeability coefficient rose as a result, aggravating more sulfate attractions. Concurrently, the steel bars' surface began to accumulate chloride ions due to chloride attraction.
After that, the inactive layer of steel bars was penetrated by chloride ions. Subsequently, the deterioration of concrete occurred due to the rusting of steel bars, which caused the bond between steel and concrete to weaken, the expansion fractures along the steel bars to corrode, the concrete covering layer to become loose and flake off concrete covering.

Technical Report documentation [7]

Evaluation on Condition Assessment of Concrete Structure of the Old Stacker/Reclaimer Rail Track Foundation to Assess the Severity of the Old RCC Rail Track Foundation in Captive Power Plant, Angul,Odisha.

Shilpa Sharma [8]

Mechanical Engineering Department, MITS College, Gwalior(MP),India
In the International Journal of Science and Research, the author discussed about "Safety Features for Reduction of Failure in Stacker Cum Reclaimer for Thermal Power Plants."

Fundamentals of Function: Two parallel stockpiles, one on each side of the train rails, can be served by the rail-mounted stacker/reclaimer. The device is made to work with a reversible yard conveyor, which stacks and discharges at identical ends while reclaiming.

Fig 4: Stacker cum reclaimer in coal yard

It is possible to operate in the following modes: Stacking: The tripper raises the material on the forward moving yard conveyor, which is then released via a discharge guide chute onto an intermediate inclined conveyor. Another chute then lifts the material and finally discharges it onto the boom conveyor. The material is carried to its end by the boom conveyor, which then lets it drop from a stockpile.

Fig. 5: Stacking operation

Reclamation: By swinging its revolving bucket wheel across the heap, the machine retrieves material in layers. As the buckets ascend, the ring chute directs and holds the material that the bucket has collected. The material begins to discharge into the bucket wheel chute, which directs it to the boom conveyor, when the bucket is approximately 45 degrees above horizontal. When the material reaches the end of the conveyor, it travels via the portal and center chutes before entering the yard conveyor belt, which is supported by the impact table. Both bench-type and modular techniques can be used to reclaim the full stockpile.

4.0 Probing Tests carried out at site for the condition assessment of rail track RCC foundation :

4.1 Visual examination of structure

The visual examination is one of the most versatile and powerful tool of NDT and it is first step in the evaluation of a concrete structure

4.2 Ultrasonic Pulse Velocity Test (USPV) :

The length and transit time of the path are measured to find the pulse velocity of the concrete. The citation The grading system for concrete quality at varying speeds is adapted from IS: 13311(Part 1) 1992. The citation The classification of concrete quality at various speeds is based on IS: 13311 (Part-1)1992.

Pulse Velocity (km/sec)	Concrete Quality Grading
< 3.0	Doubtful
3.1 - 3.5	Moderate
3.6 - 4.5	Okay
Beyond 4.5	Excellent

4. 3 Schmidt Hammer Rebound Test:

Concrete's surface hardness is ascertained by taking a measurement of the average rebound number. The cited Reproduced from IS: 13311(Part 2) 1992 is the concrete quality grading system for varying velocities.

4.4 Carbonation Test (CT) :

A carbonation test is conducted to ascertain the level of carbonation in the RCC members.Using this technique, the depth of carbonation is determined by spraying phenolphthalein indicator into small drilled holes.
BS EN 14630:2006

4.4.1 Stipulation of Carbonation Test :

BS EN 14630:2006 British standard for determining the carbonation depth in hardened concrete using the phenolphthalein indicator.
Carbonation Depth (D)
$D = Kt^{0.5}$ Where, K = Carbonation coefficient in mm per year, 3-4mm/year, t = time of exposure in years.

4.5 pH & Potential tests :

The level of pH in fresh concrete is generally in the range of 12.5 to 13, due to carbonation the pH value of concrete will reduced considerably. It may decrease as a result of degradation mechanisms such acid attack, carbonation or chloride intrusion.

4.6 Chemical tests:

4.6.1 Chloride Determination Test

IS 456:2000
From durability consideration permissible limit of chlorides is 500mg/l for RCC works

4.6.2 Sulphate Determination Test

IS 456:2000
From durability consideration permissible limit of chlorides is 400mg/l.

4.7 Half Cell Potential Measurement Test:
ASTM C – 876 – 1999
Half – Cell is also called corrosion potential and it is open circuit potential because it is measured under no current. A half-cell potentiometer that uses a copper sulphate half-cell measures the mil-voltage in the circuit of the reinforcement and cover concrete. Using half cell copper sulfate, this test determines the half cell potential of the steel imbedded in the concrete.

Half-cell potential reduces are indication of probability of corrosion of measured potential.

Measured Potential Difference - Probability of Corrosion
More negative than (-)350mV - High Probability of Corrosion
Between (-)200Mv to (-)350mV – Uncertainty of Corrosion
More positive than (-) 200mV - High probability of No Corrosion

5.0 A CASE STUDY :
Diagnostic study was carried out to assess the severity of the old RCC rail track foundation of stacker-reclaimer in Captive Power Plant,Angul,Odisha

- A Case Study consist of condition assessment of rail track supporting RCC foundation and the deterioration characteristics:

Fig.6: Photographic view of stacker-reclaimer RCC Foundation identified for testing

The schematic structure of old stacker reclaimer foundation consist of Assembling of two rails placed parallel to each other for forward and downward movement of Stacker reclaimer unit.
In between the two rails, Coal Conveyor Belt is running for coal feeding to Coal Bunkers.
Below the rail tracks, RCC beams were laid across the rail to support the track.

The Stacker reclaimer is subjected for loading coal in to the Conveyor belt which is then moved in to coal Bunker. This is a continuous process as soon as the stacked coal from the stack piles are required to be used

The Visual Inspection also indicates that the condition of filler material in between rail bottom and the foundation is very poor at most of places. The filler material is subjected to cracks and delaminations and separated from the main foundation. The water lodging and growth of huge vegetation is observed adjacent to rail track which may lead to percolation of water in to the consolidated soil mass causing unequal settlement of foundation.

The alignment of rail track near idler frame 381-385 is totally disturbed both in vertical/horizontal direction; sinking, deflection, twisting and sagging is observed. The anchor bolts connected to spikes holding the concrete is subjected to corrosion and erosion. The M.S. spike plates holding rail bottom and the anchor plate in the filler material is extremely in poor condition due to corrosion resulting in to reduction of section

6.0 Test Results:
6.1 Visual Examination

Fig. 7: Disintegration of rail track concrete

Fig. 8: Formation of holes near rail track due to water percolation of Fire hydrant

Fig. 9 : Bending & twisting of rail track

Fig.10 Ultrasonic test of rail track RCC foundation of stacker reclaimer in CHP

The Visual observation indicates that the rail track foundation is degraded.

6.2 Ultrasonic Pulse Velocity Test

Table: RCC Cross Beams below rail track

S.N	Particulars	Path Length (mm)	Transit Time (µs)	Velocity (m/s)
1.	Idler frame No 255	450	334.0	1350
2.		450	134.0	3360
3.		450	106.7	4220
4.		450	128.7	3500
5.	Av. Value			3108
1.	Idler frame No 249	450	114.8	3920
2.		450	324.0	1390
3.		450	157.6	2860
4.		450	150.5	2990
5.		450	115.6	3890
6.		450	109.9	4100
7.	Av. Value			3192
1.	Idler frame No 197	450	110.9	4060
2.		450	126.7	3550
3.		450	286.0	1570
4.		450	209.0	2150
5.		450	199.7	2253
6.		450	199.8	2252
7.	Av. value			2639
1.	Idler frame No 281	450	132.8	3390
2.		450	129.7	3470
3.		450	137.9	3260
4.		450	132.0	3410
5.		450	130.8	3440
6.	Av. value			3394

In the present case study, it is observed that the average value of Ultrasonic Pulse Velocity Test is between 3.1km/sec to 3.3 km/sec of RCC cross beam below the rail track which indicates that the concrete quality grading of RCC rail track foundation is moderately low in terms of soundness of the concrete as per reference standard.

6.3 Schmidt Rebound Hammer Test :

S.N	Particulars	Rebound Value	Av. Value
1.	Idler frame No 255		
2.		29.6	
3.		28.8	
4.		25.6	
5.		25.9	
6.	Av. Value	27.5	27.5
1.	Idler frame No 249		
2.		25.9	
3.		29.3	
4.		39.6	
5.		24.7	
6.		54.8	
7.		55.6	
8.	Av. Value	38.3	38.3
1.	Idler frame No 197		
2.		45.0	
3.		39.2	
4.		49.1	
5.		61.1	
6.		56.8	
7.		56.8	
8.		57.5	
9.	Av. Value	52.2	52.2
1.	Idler frame No 281		
2.		37.9	
3.		39.8	
4.		27.6	
5.		46.3	
6.		49.7	
7.		44.3	
8.	Av. Value	40.9	40.9

The rebound value test average value varies from 27.5 to 52.2 which indicates that the surface strength is low.

6.4 Carbonation Test :

Fig.11 Carbonation test on RCC Rail track foundation of stacker reclaimer

Test Object : RCC Rail Track foundation of stacker reclaimer

Method : Drilled holes sprayed with dilute alcohol with Phenolphthalein indicator

S.N	Description	Depth of Carbonation	
		Up to 40mm	Up to 80mm
1.	Idler frame 255	Carbonation observed	Carbonation observed
2.	Idler frame 249	Carbonation observed	Carbonation observed
3.	Idler frame 197	No Carbonation observed	No Carbonation observed
4.	Idler frame 281	No Carbonation observed	No Carbonation observed

The carbonation test performed at site indicates that the cover concrete is carbonated up to and beyond the reinforcement level in some of the RCC beams of rail track while in some beams no effect is observed.

6.5 pH & Potential Test

Fig. 12: pH & Potential tests of samples collected

Table-2: RCC Cross Beams below rail track

Test Object : RCC Rail Track foundation of stacker reclaimer					
Method : Direct measurement					
Instrument : EI Digital pH meter					
S. N	**Particular**	**pH**	**Potential (mV)**	**pH**	**Potential (mV)**
		Depth - 40mm		**Depth - 80mm**	
1.	Idler No 255	9.50	-122	8.5 3	-73
2.	Idler No 249	9.36	-114	9.05	-107
3.	Idler No 197	11.35	-182	11. 33	-211
4.	Idler No 281	10.14	-163	9.95	-154

The result of pH & Potential test carried out on the drilled hole powder samples collected from site and tested with EI make digital pH meter indicates that the pH values are below permissible limit of 13.0 indicates that the concrete is in acidic condition & embedded reinforcement is in passivity condition.

6.6 Chemical Tests :

6.6.1 Chloride & Sulphate determination tests

Test Object : RCC Rail Track foundation of stacker reclaimer			
Method : Titration			
S.N	**Description**	**Chloride**	**Sulphate**
		mg/l	**mg/l**
1.	Idler frame No. 255	127	115
2.	Idler frame No. 249	130	102
3.	Idler frame No. 197	132	127
4.	Idler frame No. 281	123	128

The result of chemical tests carried out in the laboratory with titration method indicates that the chlorides & sulphates present in the hardened concrete are within permissible limits.

6.7 Half Cell Potential Measurement Test

Test Object : RCC Rail Track foundation of stacker reclaimer Idler frame No. 197			
Method : Half Cell Potential Measurement Test			
Measurement points(X,Y); Potential Difference (mV)			
(X,Y)	0.10	0.20	0.30
0.10	-115	-166	-102
0.20	-116	-156	-127
0.30	-114	-147	--
Potential difference Range, mV			
From	-102	-	-
To	-166	-	-

The half-cell potential test carried out in situ for the embedded reinforcement measured in mV observed in the range from -102 mV to -166 mV indicates that there is a high probability of no corrosion in the reinforcement.

7.0 Analysis of Test Results on the test conducted:

7.1 Principle of analysis:
The results of various NDT tests are analysed based on IS Codes and ASTM standards

The results of ultrasonic pulse velocity (USPV) are utilized to assess the quality of concrete in terms of soundness categorized as Excellent, Good, Medium and Doubtful. The results of Schmidt Rebound Hammer Test are utilized to infer upon the surface strength of concrete. The Carbonation tests of the concrete plays a very important role in maintaining the desired parameters as per required standards. The pH & Potential tests determine the acidic and alkaline condition of concrete and electrochemical test indicates the probability of embedded reinforcement to know the extent of distress occurred during the life span of the structure.

8.0 CONCLUSION

The case study that was conducted allows for the following conclusions to be made:
The RCC Rail track foundation in coal handling Plant is deteriorated due to surrounding corrosive environment, mostly by acidic coal dust, corrosive gas concentration and frequently due to alternate dry and wet condition. Frequent monitoring and testing and inspection of RCC foundation of rail track considering "higher safety factors should be adopted.
The alignment and leveling of rail track, maintenance of proper drainage system, availability of ballast underneath the rail track shall be ascertained before movement of the Stacker/reclaimer. In addition to this, it is a matter of great concerned to ascertained the condition of spikes/bolts/fishplate/weld joints provided for holding the rail track to prevent the occurrence of failure of rail track stacker reclaimer assembly. The continuity, verticality of bolts, alignment of bolts are the major important parameters for anchoring the rail track assembly which needs to be observed by the Plant authorities from a durability perspective.
The durability of concrete of rail track RCC foundation certainly can be increased using high strength concrete M_{25}-M_{30} and the ageing affect can be minimized if poured under controlled condition

ACKNOWLEDGEMENT

In order to avoid catastrophic failures, the author intended for the case study to be extremely helpful for the operation and maintenance of the stacker reclaimer in the coal handling facility. Throughout the system's entire life, the case study offers crucial information for developing proactive measures for effective plant maintenance. The authors sincerely appreciate the management's assistance and permission to submit this technical article and finish the diagnostic case study at the process industry work site.

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