

Tehran Cement

Date: 02.10.10

Raw Mill – 6

Mill Audit Report

We would like to thank you all for the kind courtesy extended to undersigned and support during visit to your plant on 24th August'10 for the audit of Cement mill.

The objective of mill study was to evaluate mill performance, efficiency and to check possibility for improvement from process and maintenance viewpoint.

During the visit, crash stoppage was taken to evaluate,

- ✓ Present condition of mill internal from maintenance point of view.
- ✓ Chamber sample collection for evaluation of grinding efficiency of the mill.
- ✓ Volume loading of first and second chamber.
- ✓ Material level in the chamber (To determine mill operational condition)

The comments and recommendation to enhance mill performance mentioned herein are based on the observation of mill audit and information/feed back provided by plant officials.

We request you to provide your feedback/comments on our findings and observations.

Assuring you of our best services all the time.

Thanking you,

With Best Regards,

Bhavesh Bilimoria
Sr. Engineer (Tech.Services)

Mill Study Report

Raw Mill : 6
Date of Inspection : 24.08.10

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Summary of Report

Condition

The mill under observation is mono chamber mill and a horizontal impact crusher is installed in a series to fed crushed material to the mill. It is designed to produce 380 tph @ R90 mic 12%.

Purpose

The main purpose of study was to analyze the drop of the output and to obtain design capacity of the mill.

Conclusion

Maintenance Viewpoint

- Replacement of the worn-out liners of the crushing chamber.

Process viewpoint

- Product of the Horizontal impactor is very coarse to feed to the separator, R16 mm - 6.86% and R2.5 mm - 48%.
- Poor crushing observed in the chamber, bigger particles are being accumulating at the discharge end.
- Drop of the separator efficiency, due to high variation of the particle size in the separator feed.
- Material level in the chamber measured 240 to 260 mm above the ball charge, which is extreme high.
- Inappropriate grinding media distribution.

Raw Mill : 6, Monochamber

✓	Year of commissioning	: 1978.
✓	OEM	: Polysius
✓	Mill Size	: Mill size Ø 5.6 M X 13 M Long.
✓	Rated Capacity	: 380 TPH, @ 12% R 90 mic
-	Mill RPM	: 13.1 to 13.7 RPM, variable speed
✓	Critical Speed (On Shell)	: 17.87%
✓	% Critical Speed	: 73.30% to 76.66%
✓	Direction of Rotation	: Clockwise looking from feed end
✓	D Effective	: 5.45 M
✓	L Effective	: 12.25 M
✓	Installed power	: 5600 KW
✓	Absorbed power	: 5300 KW
✓	Circuit	: Close circuit.
✓	Present out put	: 320 tph, Target Residue 15 to 17% on 90 mic
✓	Feed Composition	: Limestone - 88 to 89% Bauxite - 1.5 to 2% Corrective material - 8 to 10%
✓	Mill Fan	: ?? M³/h.
✓	Separator Fan	: 90,000 M³/h
✓	Mill Inlet Gas Temp.	: 320°C
✓	Material Discharge temp.	: 100° to 120°C

Mill chamber measurement, Ball Charge and calculation

Mill Chamber details	
Effective Diameter	5.45 M
Effective length	12.25 M
GM Loading (apprx.)	90 mm – 52.2 T
	80 mm – 58.5 T
	70 mm – 41.4 T
	60 mm – 62.1 T
	50 mm – 36.0 T
	40 mm – 46.8 T
30 mm – 18.0 T	
Total	315 T
Average Ball Piece Weight (Grams)	2179
Total nos. of Balls (Nos.)	144532
Total Surface (CM ²)	22453594
Measured Volume Load based on Free Height	24% @ free height 3.86M
Calculated Present Ball Charge w.r.t free height	315.49
Calculated power based on the measured Volume Load	5069 KW @ 13.1 RPM
	5365 KW @ 13.7 RPM
Absorbed Power (Average)	5300 KW
Installed power	5600 KW
Mill present output	320 TPH
Mill Specific power consumption	15.8 KWH/T @13.1 RPM
	16.8 KWH/T @ 13.7 RPM

Mill Feed Granulometry

Feed to the separator/Discharge of horizontal impact crusher.

Sieve Size	Cumulative Retention	
	Sample 1	Sample 2
16 mm	0.51	6.86
9.5 mm	5.29	14.72
4.7 mm	17.31	29.56
2.36 mm	36.68	48.03
1.7 mm	47.81	55.68
200 mic	83.72	81.92
90 mic	90.40	86.70

- ✓ Feed analysis indicates that performance of the Horizontal impactor is not consistent, high variation observed between two samples.

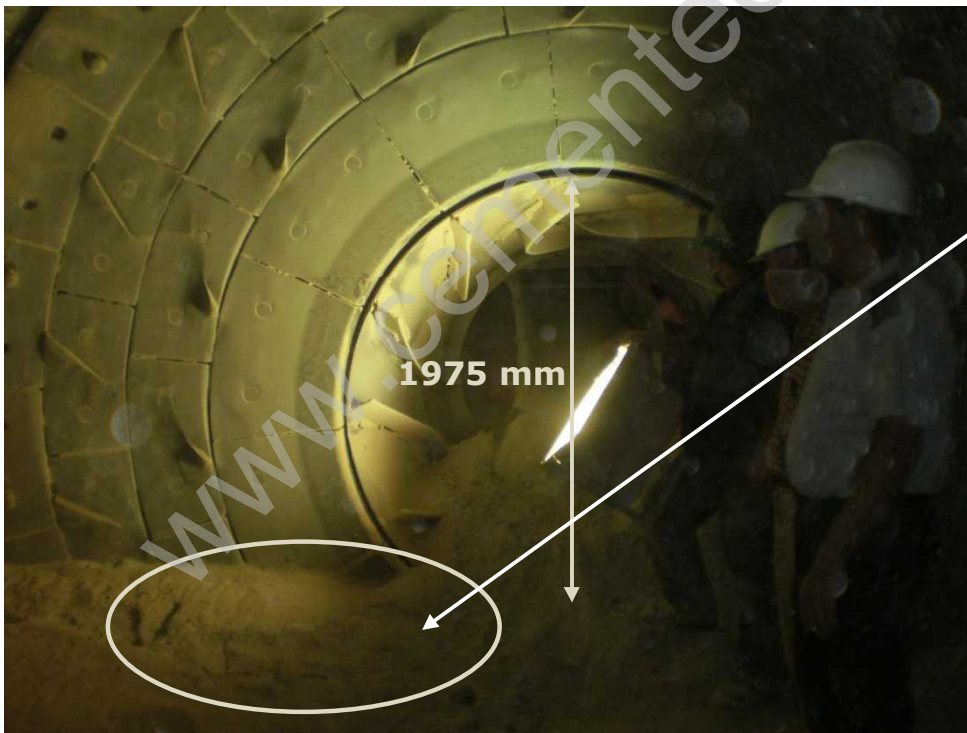
Mill Inspection Report

General observations of the Mill Internals

Effective diameter of the chamber	: 4.45 Mt.
Effective length of the chamber	: 12.25 Mt.
Inlet trunion diameter	: 1.975 Mt.
Volume loading	: 24% @ Empty height 3.86 M
Liner condition	: Worn out Crushing zone
Grinding media condition	: Could not be checked due to high level of material
Grinding media size variation	: 90 - 30 mm
Outlet diaphragm central screen Dia. (Grate Plate Inner Diameter)	: 1.740 Mt

A. Feed Head Liners

Type of liners	: Without lifters
Supplier	: Iran Zob
No. of rows	: Four
Material	: Manganese Steel
Running hours	: Not available, partly replaced on breakage/wear.
Condition of liners	: Normal.
Thickness measured	: 55 to 80 mm



- Accumulation of the fine material at the mill Inlet.

- Material level observed 200 to 250 mm over the ball charge, which is very high.

Liner position	Qty/Row	Thickness Measured
Innermost	12 nos.	76 to 80 mm
Intermediate - Second	15 nos.	55 to 60 mm
Intermediate - Third	20 nos.	67 to 70 mm
Outermost	24 nos.	??

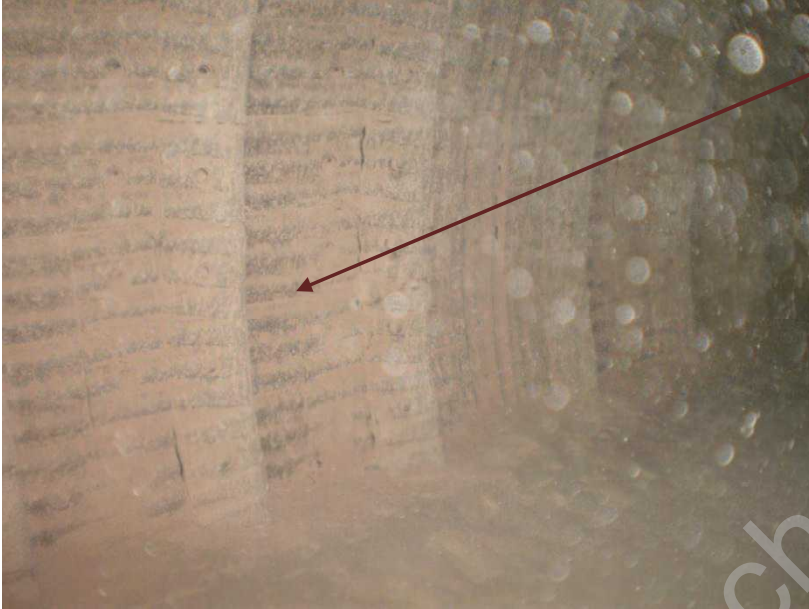
B. Crushing Zone

Type of liners	: Step liners - Bolted
Supplier	: Local - Iranian
Material	: Chrome Steel
Length occupied by the liners	: 4.625 M (37.75% of the mill effect. Length)
Date of installation	: } Part replacement is in practice
Running hours	: }
Condition of liners	: Breakage, wear of the liners
Lift of liners	: 65 to 80 mm.

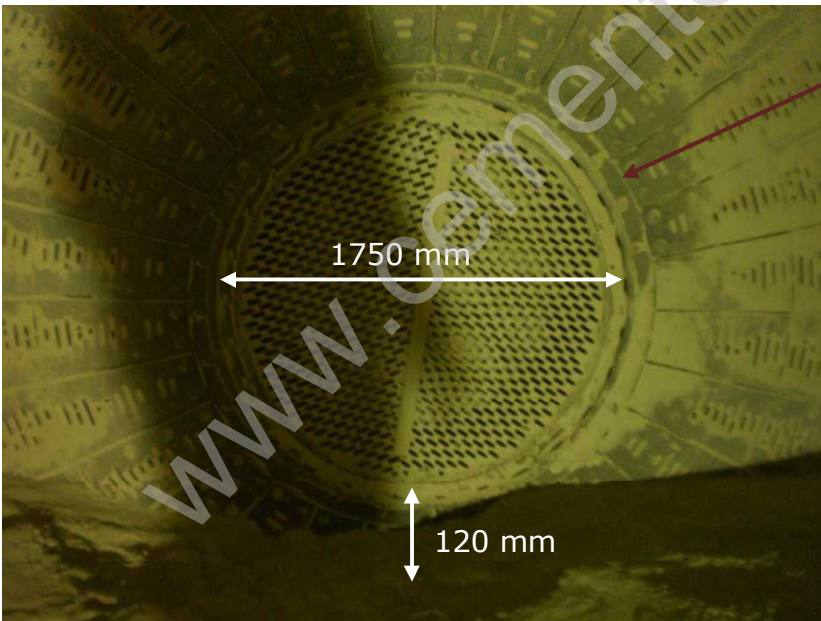


C. Grinding Zone

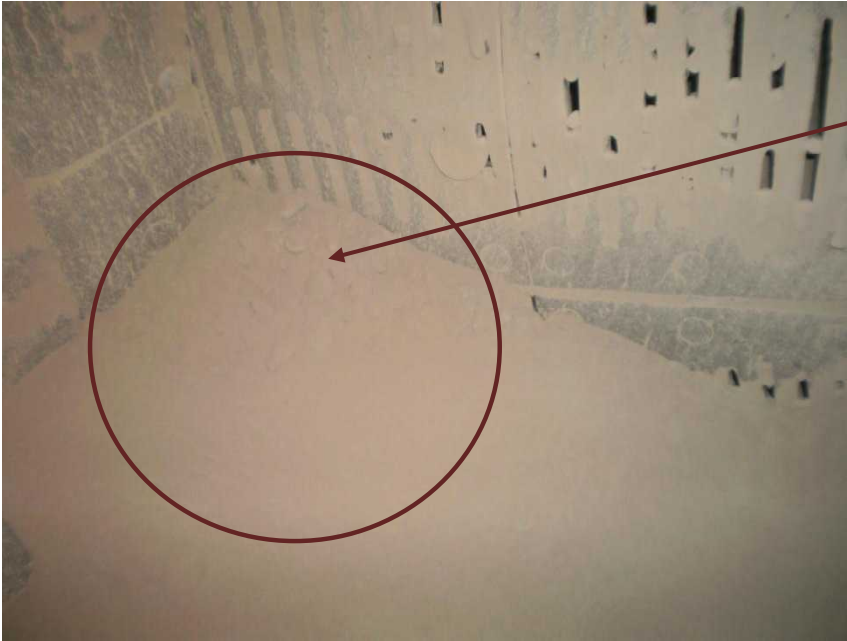
Type of Liners : Classifying Liners
Material : Chrome Steel
Length Occupied by the liner : 7.625 M.
Liner condition : Moderate
Discharge Diaph. Screen : 1.75 M.



Classifying Liners - Liners are in better condition.



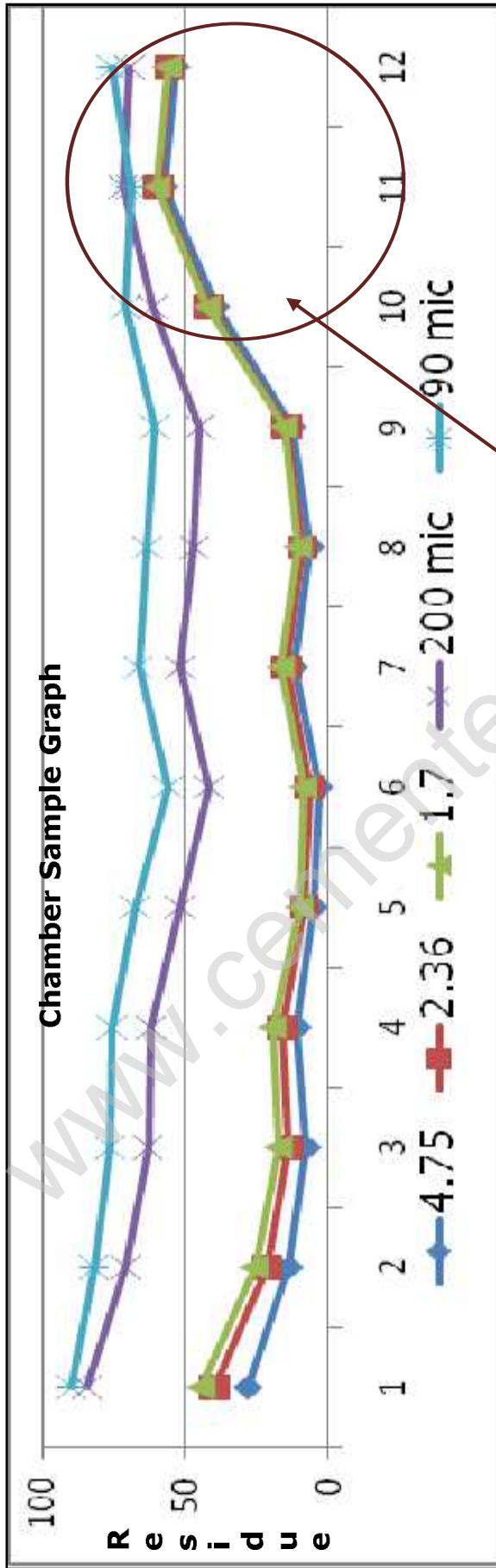
Outlet Diaphragm
- Liners condition is good.
- Slot size measured 10 mm.
- Thickness measured 50 mm



Bigger particles are accumulating at the Discharge end.



Slots of the Discharge grates observed choked by coarse particle.



Sieve Size	Sampling Point											
	1	2	3	4	5	6	7	8	9	10	11	12
4.75 mm	28.35	13.93	7.55	10.93	5.01	3.07	12.2	6.15	12.67	39.4	57.69	53.57
2.36 mm	40.01	21.77	13.91	16.15	8.31	6.58	15.05	9.03	14.88	41.91	59.74	55.94
1.7 mm	44.87	26.14	17.6	19.83	10.44	8.96	16.88	10.89	16.04	43.04	60.45	56.7
200 mic	84.56	71.05	63.08	62.16	52	41.73	51.79	46.89	45.26	61.27	71.84	69.43
90 mic	90.08	82.27	76.6	75.95	67.76	56.3	66.75	63.64	61.04	71.06	69.43	75.93

✓ Chamber sample analysis indicating high accumulation near the discharge Diaphragm.

Grinding media distribution for the respective zone according to Volume loading

	Ball Size (MM)	Tonnage (T)	Total tonnage occupied @24% Volume load	Total tonnage (T) in the Mill
Crushing Zone (Step Lining)	90	52.2	116.2	315
	80	58.5		
	70	5.5		
Grinding Zone (classifying Liners)	70	35.9	198.8	
	60	62.1		
	50	36		
	40	46.8		
	30	18		

- ✓ Grinding media distribution showing that **apprx. 4 M length** of the classifying liners is being occupied by 70 and 60 mm grinding media.

Mill Circuit sample analysis

Sampling Point	Residue on Sieve	
	200 μ	90 μ
Crusher Product	81.92	86.70
separator coarse	74.59	82.31
Separator fines	8	28
static separator product	2	8.8
Mill discharge	35.2	54
Final product	8	23.2
E.S.P. Product	0.4	1.6

- ✓ Evaluation of the separator efficiency is difficult, as the coarse fraction of impactor discharge is mixed in the separator feed.

Limestone Breakability Index

LEVEL	Cumulative Height	No. of broken Pieces	
1	20	5	100
2	60	7	420
3	120	11	1320
4	200	3	600
5	300	2	600
6	420	1	420
7	560	1	560
8	720	0	0
MEASURED AT		30	4020
BREAKABILITY INDEX		134	

- ✓ A result of **BI-134** indicates that feed material is medium hard and crushing can be improved by redesigning of Liners and grinding media load.

Recommendation

Maintenance point of view

Feed Head Liners/First chamber Liners.

1. Condition of the Feed head liners to be observed on a regular, replacement of these liners to be planned on opportunity to avoid breakage during operation.
2. Step liner observed worn-out and seems to be effecting on crushing of the particle. Redesigning of the liners is recommended to improve overall performance of the mill.

Process point of view

Mill Feed Material

1. The separator feed is designed to mix coarse from the horizontal impactor and fines from the mill discharge.

The mixture fed to the separator has high variation of particle size.

Sieve Size	16mm	4.7mm	2.36mm	200 μ	90 μ
Crusher Product	6.86	29.56	48.03	81.92	86.70
Mill outlet Product				35.2	54

2. High variation of particle size causes,
 - Poor efficiency of the separator.
 - Higher circulation of fines mixed with coarse particles. Which is already observed in the chamber, as material level was measured 240 to 260 mm.
 - Higher return of the fines generates bed of fines; ultimately result in poor crushing of the chamber.
3. Since the feed to the separator is coarse, it is recommended to check individual capacity of all the handling equipments to redirect feed material suitably.

Following are the options for the diverting mill feed has been worked out according the existing condition. It is recommended to check possibilities of this alternative, as mill is expected to perform well by separating coarse and fine particles.

Option: 1

Entire product of the Impactor to be fed in the mill.

Option: 2

Feed to the Separators to be maintained as under,

Separator#1 - 70% coarse from Impactor & 30% fines from the mill.

Separator#2 - 30% coarse from Impactor & 70% fines from the mill.

Crushing Chamber – Step Liners

- Step liners are in worn-out condition and crushing is seen effected due to existing design.
Residue on respective sieves analyzed as R4.75 is 53.57% and R2.36 mm is 55.94%, which is very high.
- Results of the chamber sample analysis indicating poor crushing/grinding through the chamber as well as high accumulation of bigger particles at the mill discharge.
- Redesigning of the chamber with high efficiency crushing liners is recommended to improve mill performance.

Grinding media Distribution

- Volume Load of the chamber is calculated as 24% according measured free height.

The calculated mill shell length occupied by the respective size of balls is as under,

	Ball Size (MM)	Tonnage (T)	Mill Shell Length occupied by respective Ball size (M)	Total of the chamber	Total in Mill
Crushing Chamber	90	52.2	2	116.2	315
	80	58.5	2.3		
	70	5.5	1.5		
Grinding Chamber	70	35.9	1.5	198.8	
	60	62.1	2.5		
	50	36	1.4		
	40	46.8	1.8		
	30	18	0.75		

It is showing that apprx. **4 mtr** length of the classifying liners is being occupied by the 70 mm and 60 mm balls.

- Ball charge adjustment to be done based on the feed material size, length of crushing zone and grinding zone.

Outlet Diaphragm

- Regular cleaning of slots to be done due to frequent choking of the slots.