Fly ash utilization in Prism Cement Limited

Content

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- Cement Process Overview
- What is Fly ash & how it’s Benefit for Cement
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- Option of Fly Ash Integration
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- Prism Cement Journey in Fly ash Utilization
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- Infrastructure for Fly ash Utilization
- Way Forward / Future Plan to improve Fly ash Usage
- Conclusion


PRISM
CEMENT
U-II : 3.5 MTPA Cement
Commissioned : Jan’2011
U-I : 3 MTPA Cement
Commissioned : 1997

Plant Capacity

SECTION	UNIT-I	UNIT-II
Clinkerization	6000 TPD (Guaranteed)	7200 TPD (Guaranteed)
	7200 TPD (Operating)	8000 TPD (Operation)
Cement Grinding	3.0 MTPA (PPC)	3.6 MTPA (PPC)

Core Equipment Capacity

SECTION	UNIT-I	UNIT-II
Lime stone Crusher	1200 TPH	750 TPH x 2 nos
Raw Mills	275 TPH x 2 nos.	300 TPH x 2 nos
Kiln	6000 TPD / 7200 TPD	7200 TPD / 8000 TPD
Coal mill	70 TPH	80 TPH
Cement Mills	180 TPH x 2 nos.	275 TPH x 2 nos
Packers	120 TPH x 6 nos.	240 TPH x 5 nos


PRISM
CEMENT

Company Profile

- M/S PRISM CEMENT LIMITED (PCL) IS A PUBLIC LIMITED COMPANY WITH ITS REGISTERED OFFICE AT “305, LAXMI NIVAS APARTMENT, AMEERPET , HYDERABAD - 500016“1.7

- THE COMPANY PROMOTED BY RAJAN RAHEJA GROUP OF CO. MUMBAI

- M/S PRISM CEMENT LTD. HAS BEEN AWARDED IMS (ISO-9001:2008, ISO-14001:2004, OHSAS-18001:2007 , SA- 8000 : 2008 & ISO: 50001)

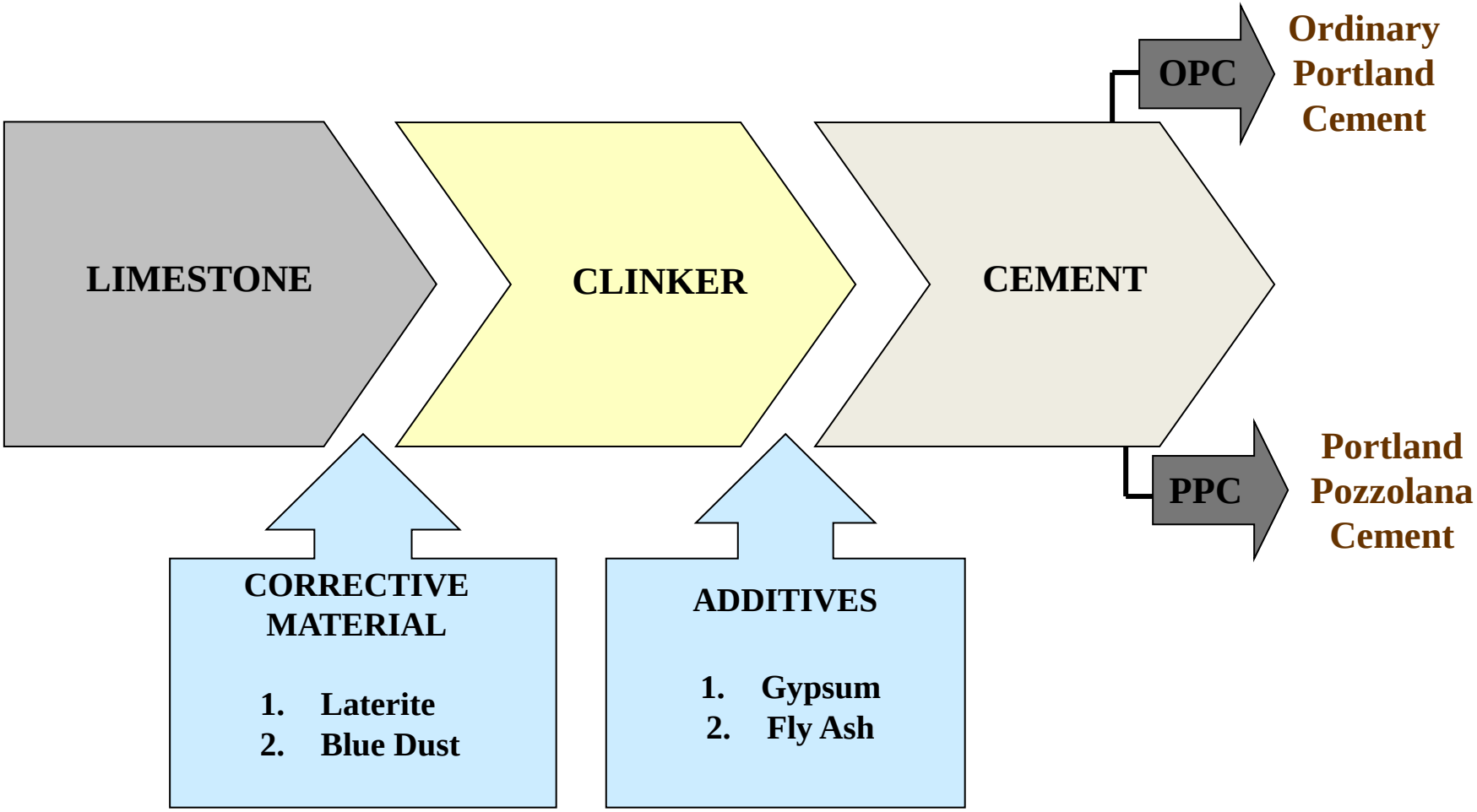
- M/s RAJAN RAHEJA GROUP OF COMPANIES HAVE DIVERSIFIED BUSINESS

- FOOD RETAILING
- HEALTH & BEAUTY RETAILING
- LIFE INSURANCE
- MUTUAL FUNDS
- SOFTWARE DEVELOPMENT
- PETRO CHEMICALS
- HOSPITALITY
- INFRASTRUCTURE
- MEDIA

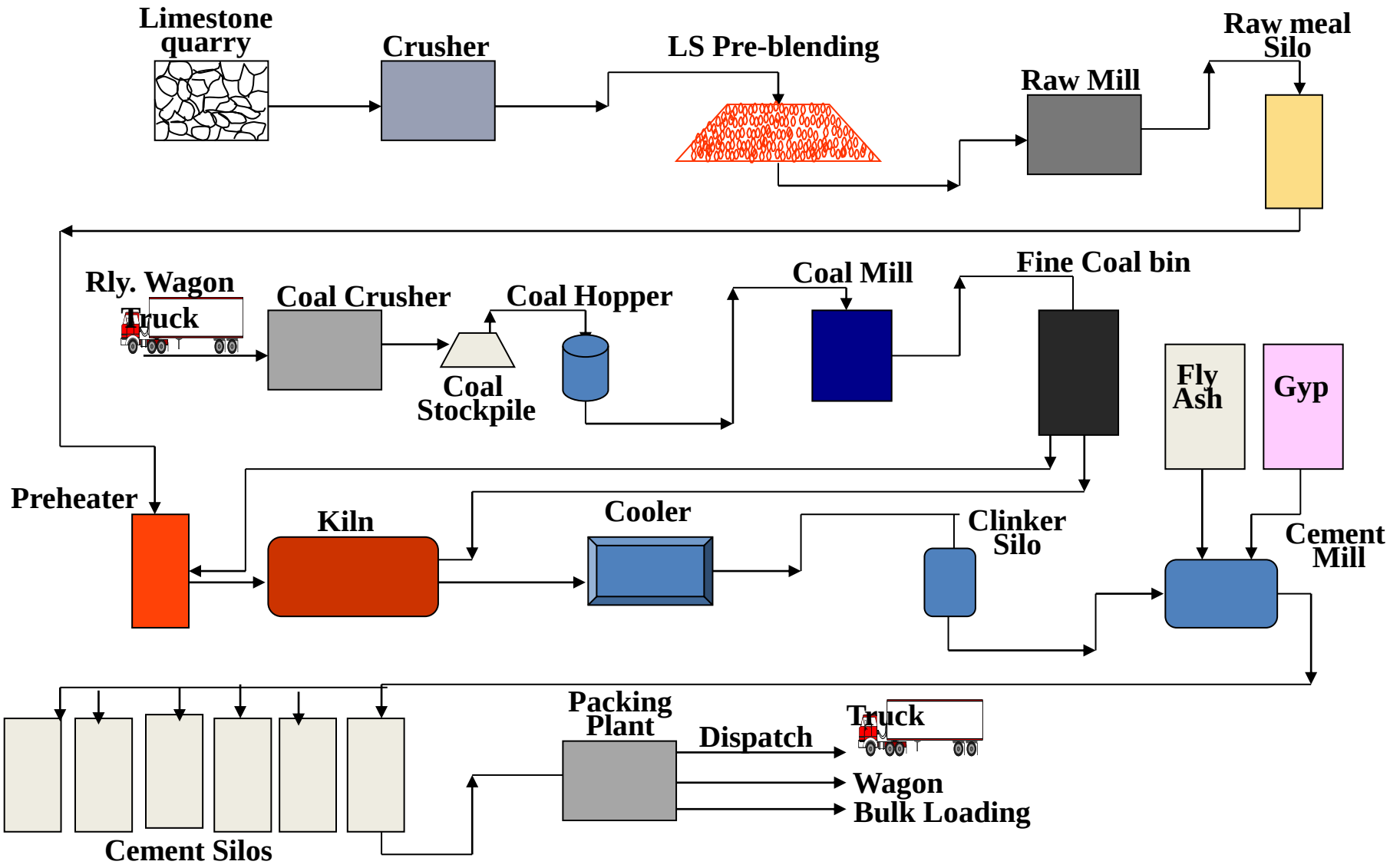
Major achievements / Awards

- Achieved Second Prize in National Energy Conservation Award 2015 in Cement Category, by BEE Government of India
- Achieved First Prize at National Level in Industrial Safety for the year 2010, given by Ministry of Labor & Employment, Govt. of India. This prize has been exclusively given to Allahabad Packing Plant of Prism Cement Ltd
- Achieved First Award for Energy Conservation for two successive years 2006 & 2007 and Second for year 2008 at National Level awarded by Govt. of India, Ministry of Power & presided by President of India
- Achieved State Level Environmental Award for the Year 2004-05 given by Govt. of Madhya Pradesh, Ministry of Environment & Housing given on 23.02.2008
- Achieved State Level Environmental Award for the Year 2008-09 given by Govt. of Madhya Pradesh, Ministry of Environment& Housing given on 10.01.2011.
- Achieved Third Place at National Level Green Rating Ranking conducted by CSE, New Delhi for the Year 2005. First Place in M.P.& Chhattisgarh.

CEMENT MANUFACTURING PROCESS



PROCESS FLOW SHEET



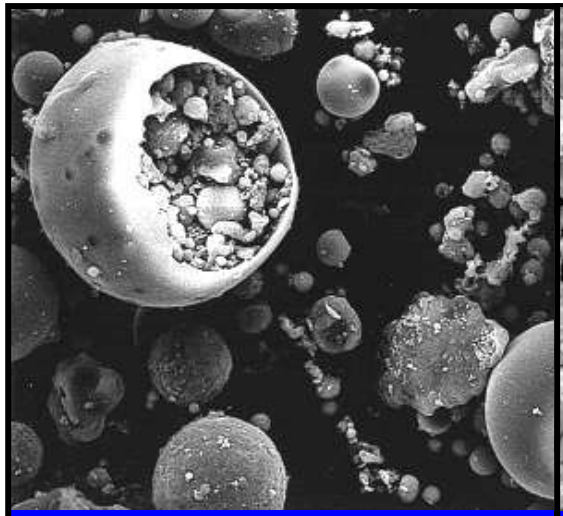
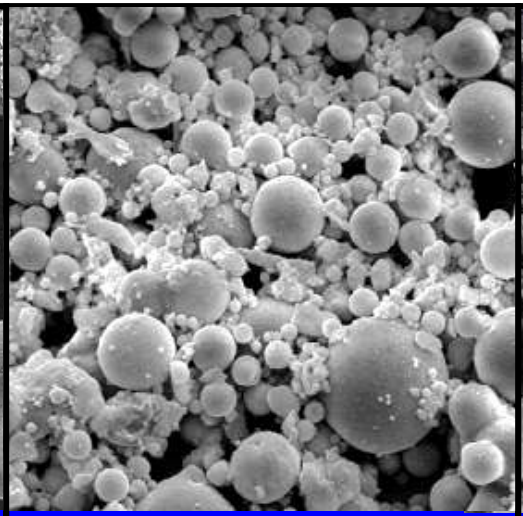
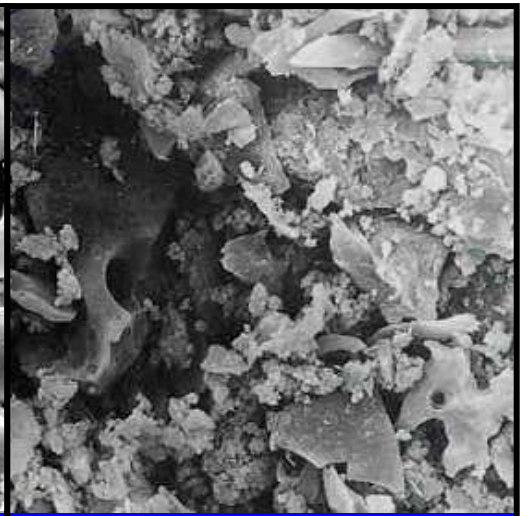
Advantages of fly ash use

- Economical benefit
  - Reduce clinker factor
  - Reduction in variable cost of Cement
- Differentiation of cement types
- Improvement of concrete performance
- Waste disposal & resource conservation
- Creation of new markets
- Reduction of CO_2 emissions
- Use as special binders

Quality and Quantity of Fly Ash Determined by

- Coal
  - Coal type
  - Ash content
  - Bed rock material
- Boiler
  - Boiler Type, Temperature
- Dedusting equipment
  - Electrostatic precipitator
  - Baghouse
  - Cyclones
- Environmental installation
  - High dust equipment for DeSOx and DeNOx

Impact of Boiler type

			
	Dry Bottom Furnace	Slag Tab furnace (Wet bottom furnace)	Fluidized Bed Combustion
Temp. (°C)	**1300 - 1500**	1500 - 1700	850 - 900
Pozzolanic Spheres	**50 – 80%**	70 – 100%	0%
Workability Water demand	↗	↑	↓

How does an optimum fly ash looks like?

Fly ash type

- Hard coal fly ash
- Subbituminous fly ash

Key performance indicators

- High reactive silica (glass content) (> 25 %)
- High total CaO content (> 5 %)
- Low SO_3 content (< 2%)
- Low CaO_{free} content (< 1 % or highly reactive)
- Low LOI (India: < 5%, Europe: < 5%, US: < 2%)
- High fineness (> 2500 cm^2/g Blaine/

  residue on 45μm < 35 %)

BIS Standards for Fly ash used in Cement Plant

Sl. No.	Characteristic	Requirements	
		Siliceous fly ash	Calcareous fly ash
i)	**Silicon dioxide** (SiO_2) + **Aluminium oxide** (Al_2O_3) + **Iron oxide** (Fe_2O_3), in percent by mass, Min..	70	50
ii)	**Silicon dioxide** in percent by mass, Min.	35	25
(iii)	**Reactive Silica** in percent by mass, Min (Optional Test)	20	20
iv)	**Magnesium Oxide** (MgO), in percent by mass, Max. .	5.0	5.0
v)	**Total sulphur as sulphur trioxide** (SO_3), in percent by mass, Max.	3.0	3.0
vi)	**Available alkalis** as Sodium oxide (Na_2O), percent by mass, Max.	1.5	1.5
vii)	**Total Chlorides** in percent by mass, Max	0.05	0.05
viii)	**Loss on Ignition**, in percent by mass, Max.	5.0	5.0

Chemical Properties

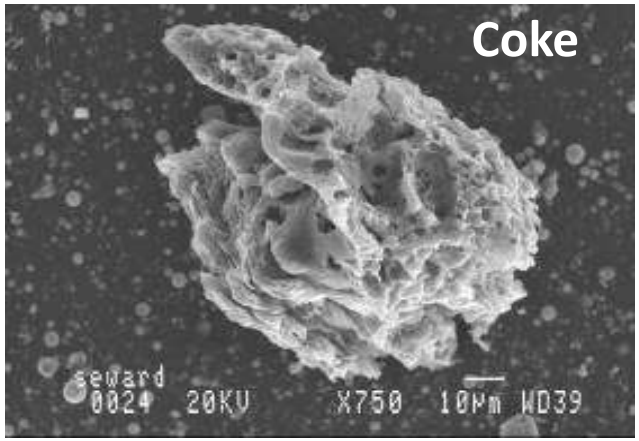
Physical Properties

Sl. No	Characteristics	Requirements for Siliceous fly ash and Calcareous fly ash
i)	**Fineness-** Specific surface in m^2/kg by Blaine's permeability method, Min.	320
ii)	**Particles** retained on 45 micron IS sieve (wet sieving) in percent, Max. (Optional Test)	34
iii)	**Lime reactivity** – Average compressive strength in N/mm^2, Min.	4.5
iv)	**Compressive strength** at 28 days in N/mm^2, Min.	Not less than 80 percent of the strength of corresponding plain cement mortar cubes
v)	**Soundness by autoclave test** - Expansion of specimen in percent, Max.	0.8

What do FA parameters tell about performance?

Chem. Parameter	Constituent	M.-%	Performance
SiO_2	Quartz (inert)	> 50%	low reactivity
Al_2O_3	Glass		Reaction Partner
Fe_2O_3	Fe-Oxides, Glass		low reactivity
CaO_{react}	Glass constituent	> 10%	high reactivity
CaO_{free}	Burnt lime	> 1%	durability (expansion)
MgO	Periclase	> 1%	durability (expansion)
Na_2Oequ.	Alkali salts	> 1%	accelerator, ASR sensitive
SO_3	Gypsum`	> 3%	set retarder, cement stand. limit
SiO_2 reactive	Glass	> 30%	high reactivity
LOI	Unburnt carbon	> 5%	water demand/standard
Fineness			
Residue on 45µm, %		> 30%	high water demand/low reactivity
Blaine, cm^2/g			No proper measure for fly ash
Bulk density, g/cm^3		< 1	reduced transport capacity

What are impacts of KPIs on performance?



Unburnt carbon
- Admixture interaction (>2%)
- Water demand (>7%)
- Black pop-ups (mainly with coke!)

Fineness, morphology
- Water demand, reactivity

Free lime, SO_3 (only lignite)
- Soundness, retarding

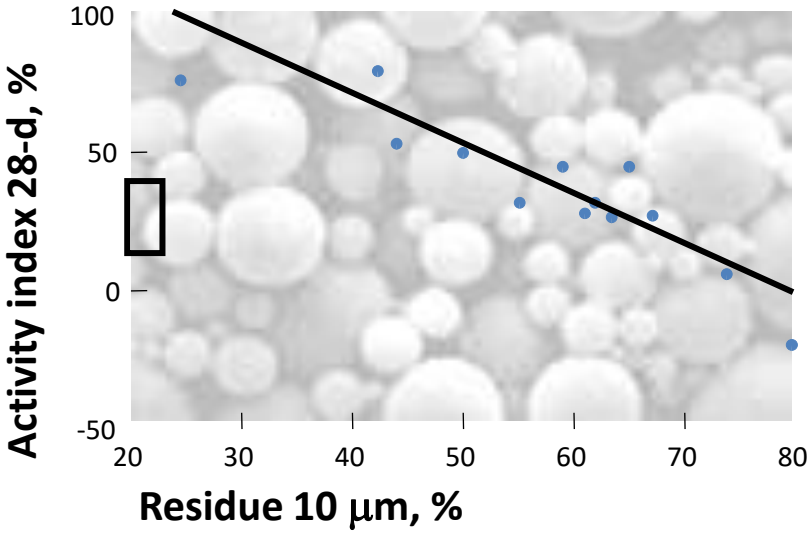
Ammonia (from DeNOx)
- Smell, working hazard

Direct desulphurization products

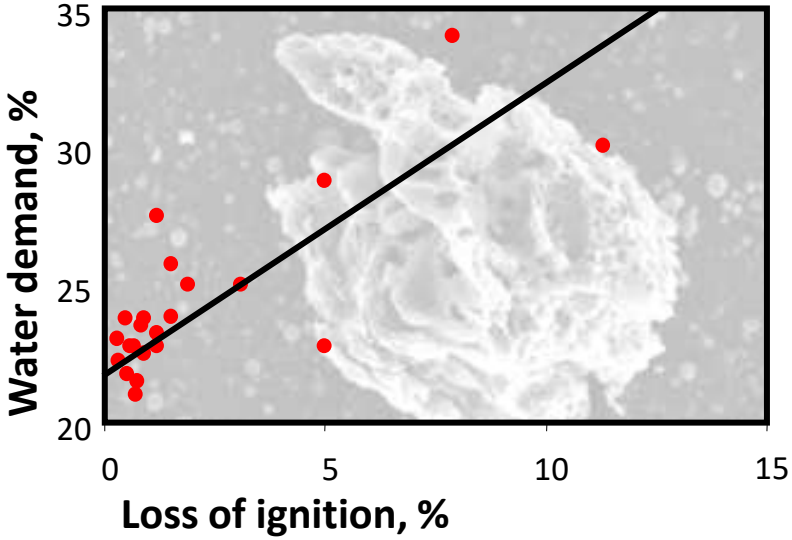
Spray Dry SDA-, Dry sorbent DSI, Fluidised bed FBC
- Generally unsuitable material

Key Performance Parameters of Fly Ash

Fineness



Unburnt carbon



Key performance indicators

Component in weight %	Lignite fly ash	Hard coal fly ash
	Dry bottom furnace (1050-1300°C)	
SiO_2	43	52
Al_2O_3	23	26
Fe_2O_3	17	7
CaO	11	3
CaO_{free}	0.5	0.1
MgO	4	2
Na_2Oequ.	2.6	0.4
SO_3	1	0.8
SiO_2 reactive	20	45
LOI	1	4
Fineness		
Residue on 45µm, %	45	29
Blaine, cm^2/g	2200	3300
Bulk density, g/cm^3	1.05	0.97

Supplementary performance indicators

Component in weight %	Lignite fly ash	Hard coal fly ash
	Dry bottom furnace (1050-1300°C)	
SiO_2	43	52
Al_2O_3	23	26
Fe_2O_3	17	7
CaO	11	3
CaO_{free}	0.5	0.1
MgO	4	2
Na_2Oequ.	2.6	0.4
SO_3	1	0.8
SiO_2 reactive	20	45
LOI	1	4
Fineness		
Residue on 45µm, %	45	29
Blaine, cm^2/g	2200	3300
Bulk density, g/cm^3	1.05	0.97

Evaluation

- Accordance to national/common standards
- Key quality parameters
  - Fineness; sieving residue not Blaine (Filler effect)
  - LOI (colour, water demand sensitive)
  - SiO_2 reactive (measure for reactivity and activation potential by grinding) > 35 %
  - SiO2 + Al2O3 + Fe2O3 > 70 %
- Supplementary quality parameters
  - Free CaO/MgO (higher contents soundness sensitive)
  - SO_3 (standards conformity)
  - Alkalies (higher reactivity but ASR sensitive)
  - Bulk density (handling, dosage, transport capacities)

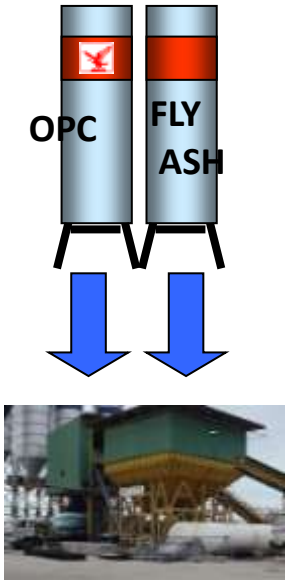
- **Its oblige to test performance in cement <u>and</u> concrete**
  - Water demand
  - Compressive strength (1-7-28d)

How can we improve quality of Fly Ash?

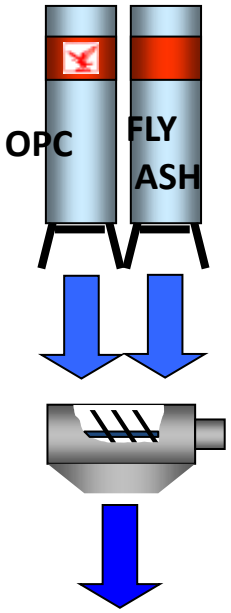
- Power plant operation — Reduce LOI/ Increase fineness
  - Coal grinding
  - Burn out (O_2 staging)
  - ESP stage separation
- Beneficiation — Reduce LOI/ Increase fineness
  - Air classification/Screening
  - LOI reduction
  - Optimum fineness
- Chemical activation — Improve Reactivity
  - Alkalies (ASR sensitive), acceleration
- Cement plant measures — Increase Fineness/reactivity
  - Intergrinding
  - Clinker mineralization
  - Separator & Grinding circuit optimization

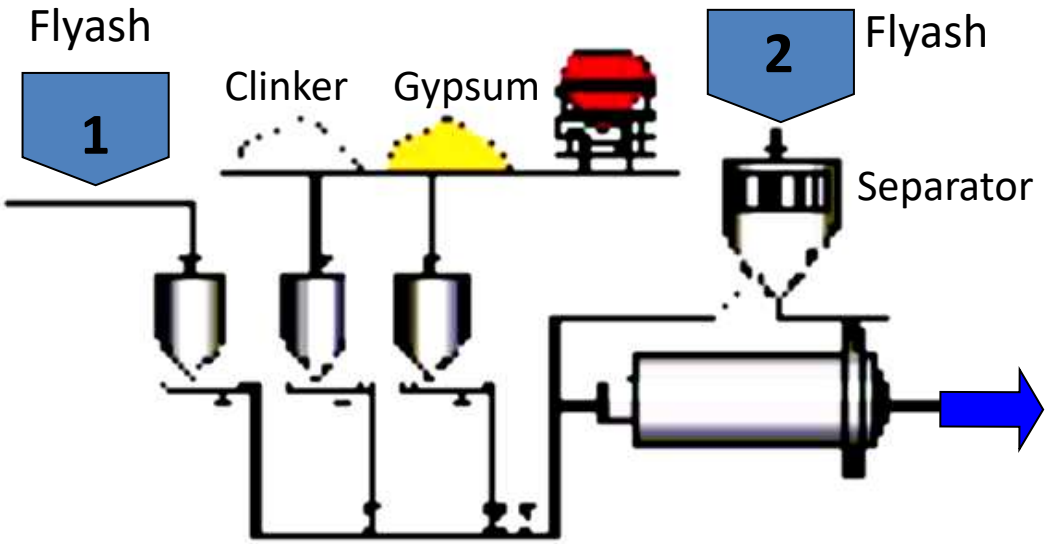
Options of fly ash integration

Concrete	Cement	
	Blending	Intergrinding



RMC plant



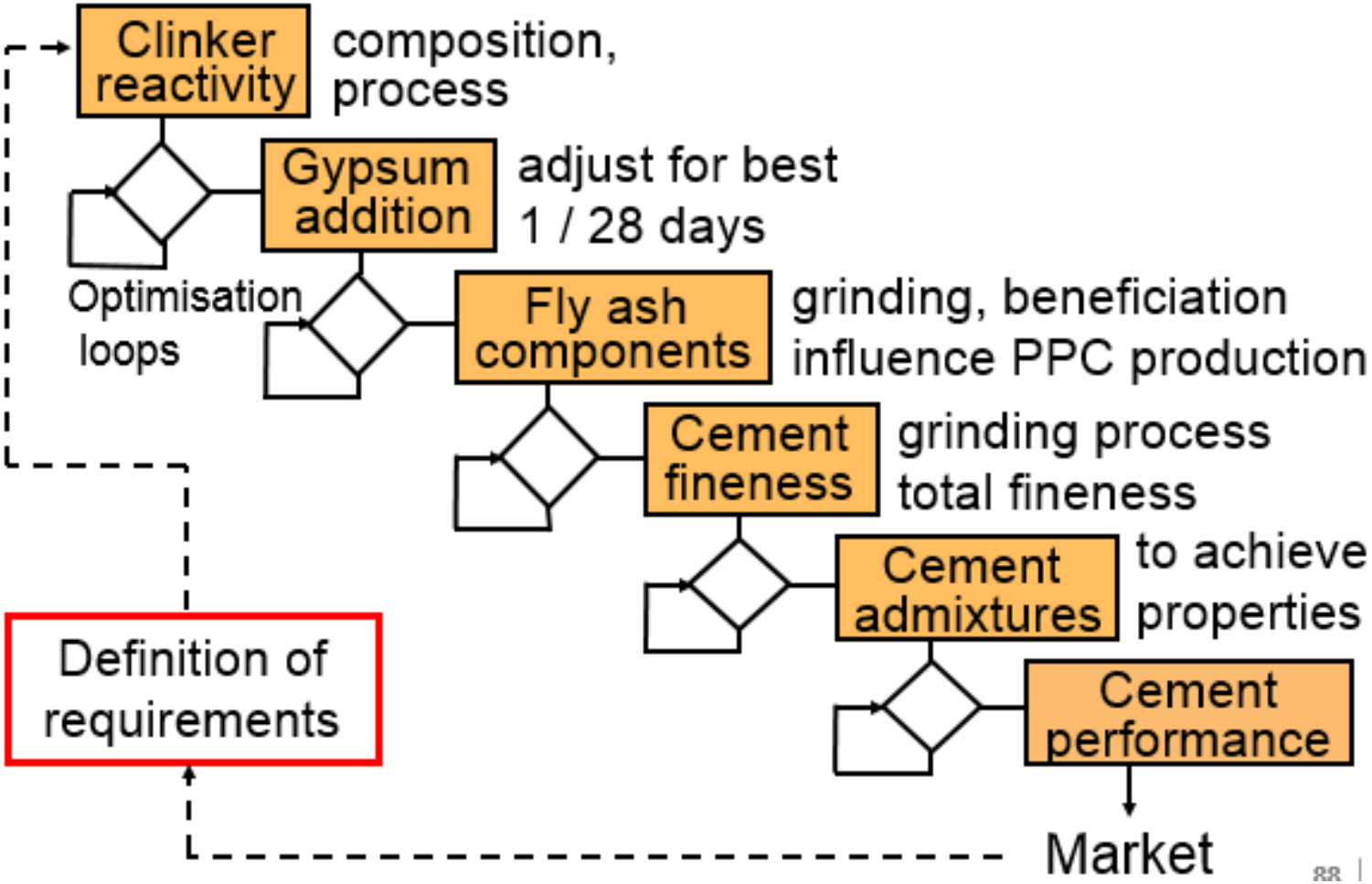


1) Mill inlet feed

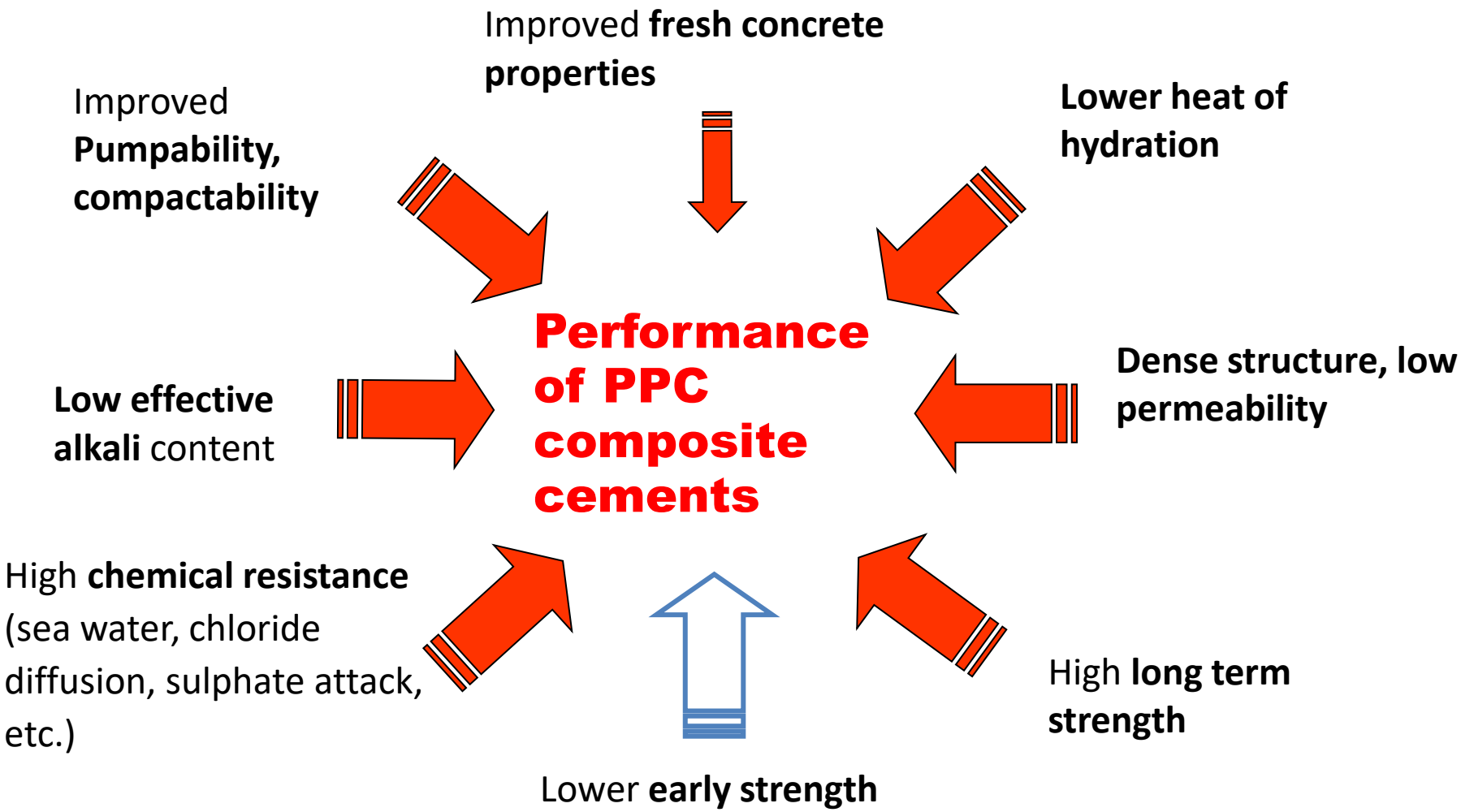
2) Separator feed

$R_{45\mu m}$ <40%	$R_{45\mu m}$ <15%	$R_{45\mu m}$ standard compliance	
		$R_{45\mu m}$ > 30%	$R_{45\mu m}$ < 30%

PPC Cements – Decision Tree

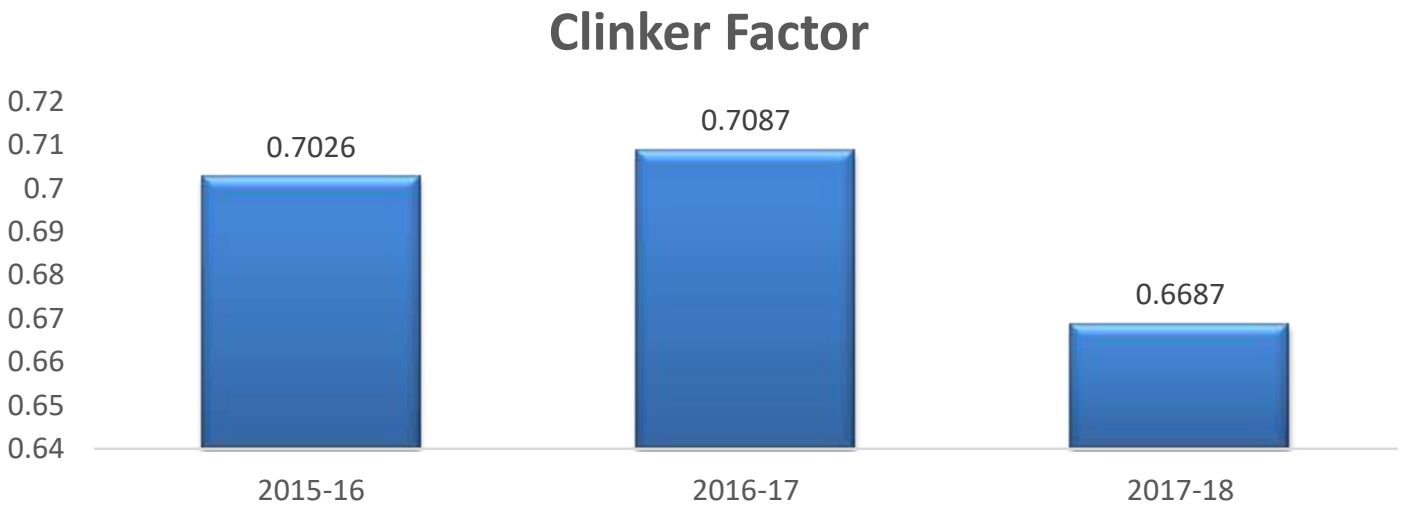


Effects of PPC cements on concrete



Fly ash Usage in Prism Cement

	2015-16	2016-17	Up to Dec 2017 LE
Fly ash usage (MTPA)	1.38	1.41	1.43
Total FA % in PPC	28.82	29.92	31.44
Cement Residue 45µ	20.38	14.52	12.25
One day strength PPC	12.4	15.45	15.62
Clinker Factor	0.7026	0.7087	0.6687



Initiative taken for Ramp-up fly ash consumption

- Installed & commissioning of Fly ash tippler for fly ash unloading
- Cleaning of Fly ash silo & replacement air slide cloths for improving dosing efficiency
- Replacement of air pad in fly ash check bin for smooth flow-ability of FA
- Spare F K Pump installed in-house as alternative arrangement for Fly ash feeding during bucket elevator maintenance
- Fly ash with > 2500 gm/cm2 blain feeding at Mill outlet for power saving & PSD improvement
- Spare weigh feeder activate as arrangement for wet fly ash feeding
- Extra point installed for fly ash bulker unloading
- Hot air arrangement from Cooler ESP for Fly ash bulker during monsoon

Initiative taken for Ramp-up fly ash consumption

- Air dryer installation at various location for improve fly ash flow-ability during monsoon
- Installation of box heater separately for blower to heat air slide.
- Provision of new feeding circuit directly to check bin in case there is extraction problem from silo

Best practices implemented for high fly ash consumption

Checks	Action Taken
Regular checking & optimize separator	SOP with checks prepared & regular weekly checking
Optimization of grinding media filling level by make-up charges	Monthly mill empty height measurement carried out & maintain 28 % media filling level
Refurbishment of liner profile	Step wise Replacement of liner under progress
Design change of water spray nozzle & Optimize consumption with PID	In house nozzle prepared & run water spray in close PID loop
Improve quality of Clinker	Action plan to be prepared & strictly follow the same
Increase Fly ash dosing by review lime % in cement & one day strength & with grinding aid	SOP Prepared for cement quality Vs Fly ash utilization Grinding aid usage system developed & design our own grinding aid material
Modifications to be done in SEPAX fan Duct as per CFD study	Reduce pressure drop & power saving

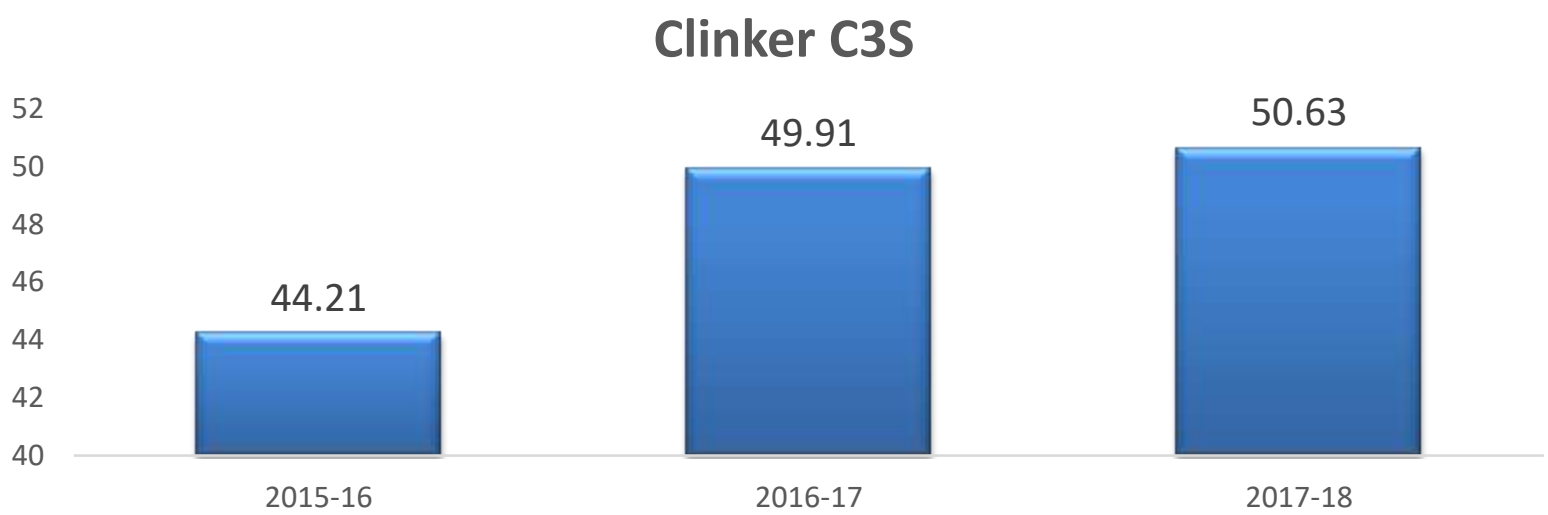
Other best practices Implement

- Clinker Storage in Silo only & Quality to be monitored on daily basis strictly
- Selection of flyash sources having low LOI, Identify sources with the latest burning technology/ modern boilers
- Fly ash received from different sources to be blended for desired quality
- Monitoring of source wise residue and LOI on daily basis
- Multiple point extraction from silo bottom
- Grinding media top up done periodically every month & Regrading of grinding media on yearly basis
- Crash stoppage done every 3 months for sampler & circuit sampling
- Checking of separator every fortnight (static vanes,rotor blades, chute inspection) Seal gap maintained minimum, Maintain bypass at <10% Separator efficiency to be checked on weekly basis
- Fly ash dozing system checked every fortnight
- SOP for unloading fly ash from different sources
- Back filter material Blaine monitored and then decide the point of discharge
- Grinding aid system operated totally DCS controlled
- Auto-samplers installed for sample collection at all required location

Best quality Clinker required for higher FA Absorption in Cement

We also improve our clinker quality by taking step in raw mix design as well as process optimizing So that our Clinker absorbed more fly ash quantity without declining our Cement quality

	2015-16	2016-17	2017-18
Clinker C3S	44.21	49.91	50.63
Heat Consumption (Kcal /Kg Clinker)	743	731	727
Clinker Production TPD	6356	6477	6562
Power for Clinkerization	21.53	21.06	20.96



Prism Cement Infrastructure for FA Handling

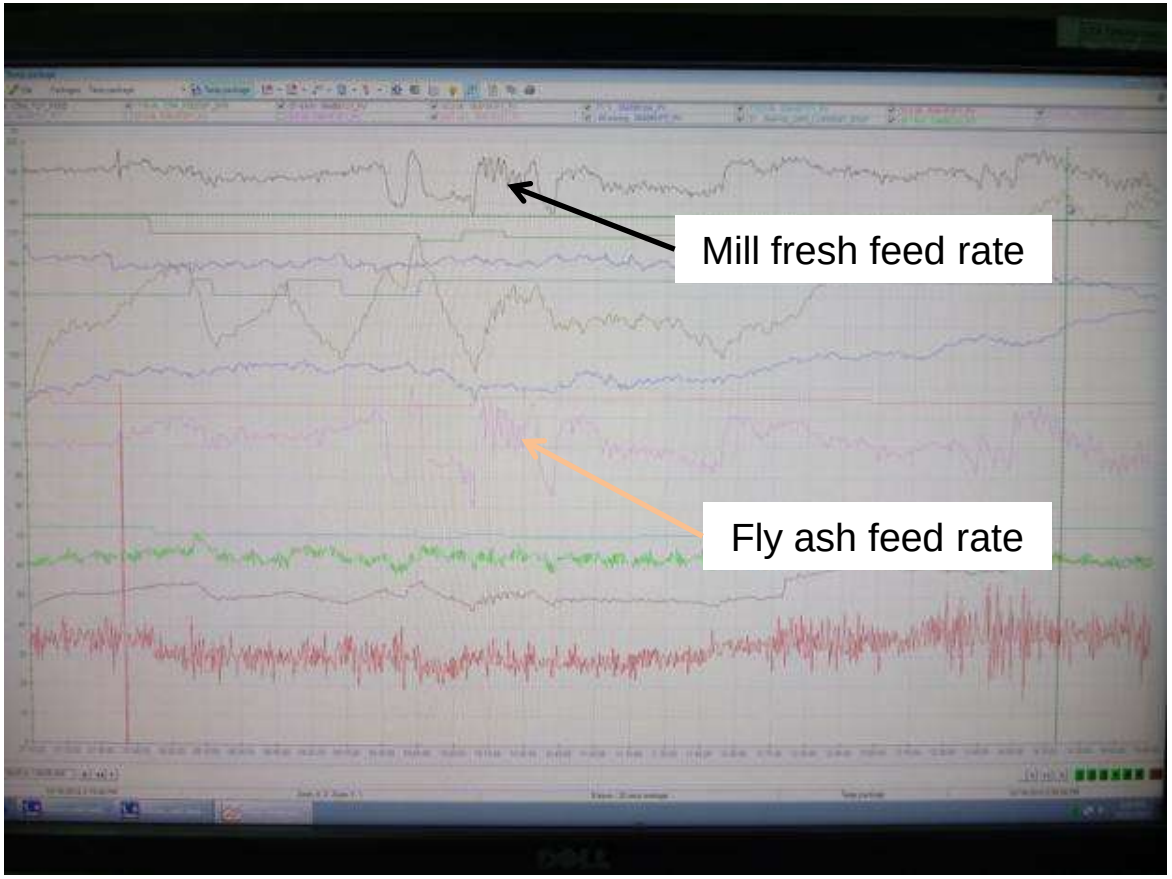
In PCL we handing > 1.4 million tons of Fly ash per annum, for that we have following infrastructure in place

- Two storage Silo with combine capacity of – 9000 MT
- Three truck tippler for unloading (Exclusively for FA) – 3000 MT/day capacity
- 10 Pneumatic unloading station for Bulker – 6000 MT/day capacity
- DCS Control feeding circuit for Silo
- Accurate dozing system for mill feeding 80 TPH & 120 TPH with flow control gate and solid flow meter in all Four Mills
- 4 pre-bin with load cells enables an elegant option for calibration
- Two way feeding flexibility as per Fly ash quality (i.e. Mill Inlet & Mill Outlet)
- Standby by arrangement with FK Pump of 240 TPH
- 18 No. of Electric heater for monsoon

Fly ash feeding & it's accuracy

EXAMPLE :

- Fly ash represents ~ 32 % of fresh feed
- Fly ash dosing suffers from erratic flow
- Fluctuations in fly ash dosing result in fluctuations in in fresh feed due to automatic recipe control
- Fresh feed fluctuations are responsible for reduced mill output



Expectation towards fly ash dosing Systems

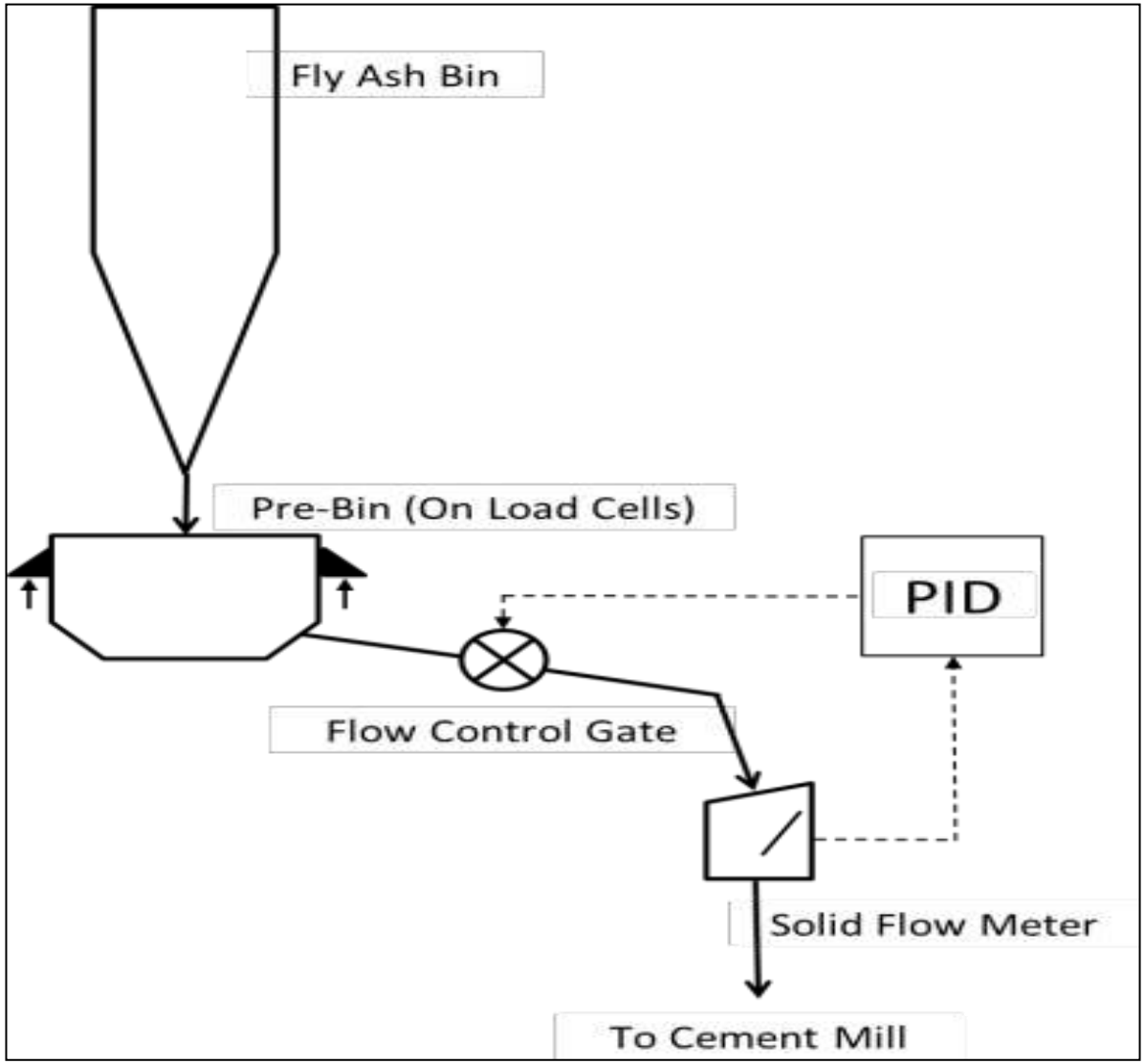
Expectations:

- Accurate dosing close to set point
- Reliable dosing without feed interruptions
- Fast reaction when changing the feed rate
- Low wear and operating costs of the system

Standard system in cement industry:

- Flow Control Gate + Solid Flow Meter (SFM)

Working principle: Dosing with Flow control gate and SFM



Truck Tippler for Mechanize Fly ash unloading

FK Pump – 225 TPH as Stand By arrangement for CM Feeding

Heaters & dryers for smooth fly ash conveying during monsoon

Modification of Fly Ash Control and Mechanism to Achieve Better Accuracy as the system is absolute and old .

PRISM CEMENT

New Fly Ash Feeding point For Bulker unloading direct to check bin

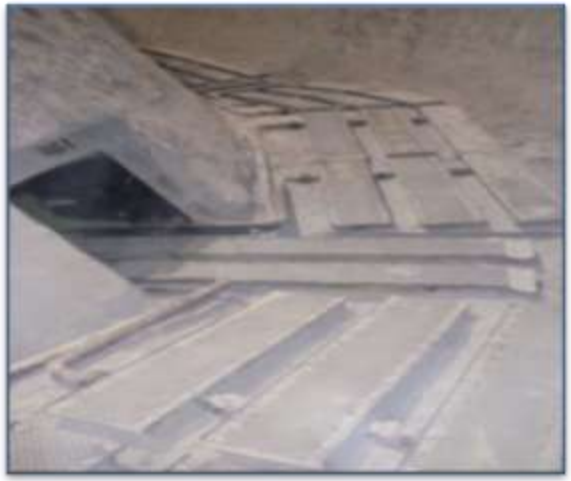
Modification of Fly Ash Discharge Air Slide chute

In House Developed of Central Discharge Check Bin In Place of Side Discharge

Pneumatic Unloading Stations for Bulker

Flyash Silo Cleaning & Open Air Slides reconditioning & cloth replacement

Before Replacement



After Replacement

Higher wear rate required regular maintenance

Way Forward – Prism Cement

- For increasing our mechanical unloading capacity one more Fly ash truck tippler under project with cost of 50 million INR
- For Increasing Storage capacity 5000 MT Silo under construction with CAPEX of 100 million INR
- Bogie Covered Fly Ash/Cement type Wagons (BCFC) in Railway under study (Pneumatic arrangement required at site for unloading)
- Separate Fly ash grinding & Mixing with OPC project under evaluation
- Fly ash rotary dryer with Cooler ESP air under study
- 100 % Fly ash feeding at mill outlet under execution after source qualification

Conclusions

- Sampling program required before contracting to ensure consistency
- Small operational changes at power station can have big impact
- Proper quality control essential for high fly ash consistency
- Robust & accurate system required for fly ash feeding
- Enough storage & unloading facilities required at site
- Special precaution to be taken during monsoon
- Regular maintenance & process audit for grinding circuit must
- Competent quality team with testing infrastructure key point for high utilization of fly ash

PRISM CEMENT

Thank You