ADOPTION OF NEW CONCEPTS IN MATERIAL HANDLING IN CEMENT INDUSTRY

By

Jai P. Gupta, Chief General Manager and Rakesh Kalra, General Manager
HOLTEC Consulting Private Limited

1. INTRODUCTION

Indian cement industry has witnessed rapid growth in past 2-3 decades. The overall production capacity of the industry, which used to be approximately 60 million tonnes in early 90s, has more than quadrupled in about 20 years. Such rapid growth has posed several challenges in front of the Industry, some of which are:

- The conventional "**Easy to access"** limestone deposits are no more available. New projects are forced to go for difficult to access / approach limestone deposits; hence the new projects are being located in remote areas, from where material movements are difficult.
- Industry is facing difficulties in land availability / acquisition, hence being forced to go away from the markets.
- Growing demands and need of flyash based PPC production has forced many of the Industry players to set up grinding units close to thermal power plant for fly ash consumption. As these thermal power plants are generally located closer to densely populated areas, space is always a constraint, hence can not develop good infrastructure for rail / road movement of material.
- Unit sizes becoming larger to harness economies of scale. The usual capacity of new production lines ranges from 5,000 – 10,000 TPD clinker production, as compared to 2000 to 3000 TPD in early 90s. Such enlargement in size is forcing industry to market their product in larger areas. To do so, most of the new players are installing one or more split grinding units, requiring additional material handling.

All the issues enumerated above, are putting more and more pressure on the logistics of material movements. As material transportation, is a sizable portion of the total cost of production, any gains / reduction in cost of material movement could help the industry greatly.

Due to the needs of high capacity material movement at fast pace and inadequacy of road networks in remote areas, Industry's reliance on rail transportation has substantially increased. Therefore the paper covers majority of the suggestions relating to the material movement through rail routes. The majority of material transportation includes bulk transportation of Coal, clinker, flyash and cement. This paper covers certain concepts which could substantially reduce loading and unloading time, area for grinding units or reduce the quantity of material movement.

These concepts have been successfully employed by Holtec in cement as well as other industries, and could help the cement industry in optimizing expenses on material handling.

2. NEW CONCEPTS IN MATERIAL HANDLING

The paper covers the following 4 concepts,

i. **In motion loading of clinker in railway rakes.**

ii. **Use of bottom discharge wagons for coal and clinker transport and its easy and fast unloading.**

iii. **Use of wagon shifters to reduce the area for the grinding units**

iv. **Flyash blending units, to reduce material transportation in general.**

Due to the limitation of size, paper briefly covers the concept, principle of operation and how it could be adopted by the Cement Industry. Likely benefits and certain pre-requisites, which are needed for adaptation, are also covered to a certain extent. In case of any customized needs, Holtec could be consulted for further help.

2.1 IN MOTION LOADING OF CLINKER IN RAILWAY RAKES

For the clinkrization units, having split located grinding units, and transport connectivity through railways, clinker loading is usually done through overland hoppers, constructed on top of the railway tracks and loading of clinker is done through telescopic chutes. Depending upon the capacity and speed requirements, more and more number of hoppers / silos are being constructed such that more number of wagons could be loaded simultaneously. As per the usual concept approximately one rake material is stored in the overland hoppers. The usual time taken for one complete rake, varies from 3-6 hrs depending upon the number of hoppers available for loading of clinker. Although more number of hoppers reduces total time for filling the rake, but adds to other complications, such as

- High number of equipment and their drives.
- Heavy to very heavy civil construction.
- Constraint of permanent structure construction as per railway norms.
- Occupation of large area.
- More number of operators.
- Dust nuisance etc.

This paper suggests loading of rail rakes in motion (Rapid loading system). With Rapid loading system, the entire rake could be loaded in about **60-80 minutes**, from a single discharge point.

2.1.1 What is Rapid Loading?

In rapid loading of material, material is loaded on rake, while the railway rake is in motion. One silo (of about one full rake capacity) is constructed on top of rail track. Below the hopper, another small hopper is provided on load cells, which can accommodate about 1 wagon load of material. The above 2 hoppers are connected through hydraulic gates, and large chute, so that within seconds, material gets transferred from the main hopper to the pre-weigh hopper (mounted on load cell).

Before a rake arrives, silo is filled, so that fast material loading on the rake, does not get disturbed. In the beginning the load cell hopper is filled with pre-weighed material. As soon as the wagon comes in position, the loading starts and the complete wagon is loaded, by the time it crosses. During the period of wagon change, pre-weigh hopper again receives the material from main hopper, so that by the time another wagon comes into position, it is ready with the material. During this entire operation railway rake moves at the speed of about **0.6 to 0.7 km / hr**. That means a full rake of clinker **(about 650 m in length)** is likely to get loaded in **about 1 hr of time.**

A typical pictorial view is shown in following figure:

Fig-1: Rapid Loading System in Operation

The majority of the collieries in India have been using rapid loading system for coal rake loading. Adopting the similar concept, Holtec designed one rapid loading system for lignite. As the system was designed for lignite, it was substantially different from the usual rapid loading system, however have been performing very successfully for last 7-8 years. At this location, rake of about **40 wagons** is being loaded in about **45 minutes**. Although the system is located close to a densely populated area, but as it hardly generates any nuisance dust, Owners do not face any difficulties in operation.

The material filling and closing are through hydraulic gates, and wagon positioning is sensed through the proximity switches. A little bit of maintenance and care in operation, has been enough to keep the system spillage free.

The arrangement as installed for lignite loading has been depicted in the following figures:

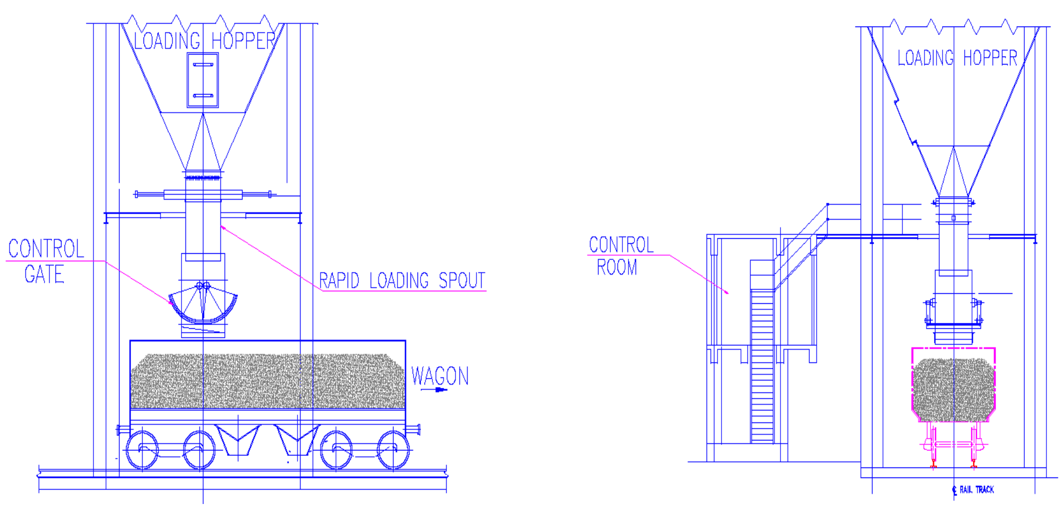

Fig-2: Lignite Loading System in Operation

2.1.2 Expected Benefits

- ✓ The conventional system of rail loading requires **3 to 6 hrs** for loading of one complete rail rake, whereas with rapid loading system, the entire loading operation for one rake could be completed in about one hour. Assuming about **3 hrs saving on one rake**, could result into about **2,000 hrs** of rake handling time, for a clinkrization unit of about 2 mio tpa capacity. Such faster movements of rake, shall help in better utilization of rakes, especially if the company owns the rakes.
- ✓ The total investment required for rapid loading are substantially lower as compared to the conventional systems.
- ✓ Numbers of drives required are very few, as compared to the multiple units and equipment required for conventional systems.
- ✓ Number of operators and attendants required would be 2 - 3 (at the time of loading) for entire operations as compared to 4 - 5 (at the time of loading) for conventional system due to the size of the system and high number of equipment.
- ✓ Dust nuisance substantially reduces as compared to the conventional systems.

2.1.3 Pre-requisites

For the hauling of railway rake at a constant speed of **0.6 to 0.7 km/hr**, creep drive need to be installed on the locomotive. As the normal locomotives from railways do not have this facility, Plant will have to maintain their own locomotive for haulage of the railway rake.

2.2 USE OF BOTTOM DISCHARGE WAGONS FOR COAL AND CLINKER TRANSPORT AND ITS EASY UNLOADING.

Traditionally, cement industry has been using normal BOX / BOXN type of wagons for the transportation of coal & clinker. For the unloading of these wagons, wagon tipplers are installed, through which these wagons are unloaded. As Railways allows 5 hrs time for mechanized unloading, wagon tipplers were typically designed to unload full rake of 58 wagons in approximately 3-4 hrs time (ie 15- 18 wagons unloading per hour).

As Railways wish to go for longer rakes, with larger capacity wagons, (recently RDSO has released certain new guide lines), according to which, all new installations (after Nov 2010) shall take into consideration larger wagon size and unloading speed shall be increased to about 25 wagons per hour. As per the new designs of wagon tipplers, size of wagon tippler and its civil construction requirements have substantially increased along with capacities of the material handling equipment down the line.

As such installation of wagon tippler and associated auxiliaries was expensive, and recent enforcement from railways, has further escalated the cost of installations of the wagon tippler and its associated auxiliaries.

As against BOXC and BOXN type of wagon, allocated in cement industry, power plants are allocated bottom discharge wagons (BOBRN), which can be emptied through pneumatic gates installed below the wagons. For the discharge of such wagons, Thermal power plant installs long track hoppers with plough feeders. This is again quite expensive arrangement. As against normal track hoppers, Holtec designed a very simple but effective system for lignite unloading in the year of 2002, which is running successfully since then. A brief description of BOBRN type wagon is as below:

BOBRN Open hopper car with rapid (pneumatic) bottom discharge doors, air-braked. BOBRN and BOBR (see above) are most often used for carrying coal to thermal power plants, and also for ore, stone, track ballast, etc. Each wagon holds some 60t of coal loaded from the top and unloaded from the bottom by means of the pneumatically operated doors. The contents of the wagon can be discharged completely in about 15 seconds.

The door-opening mechanism is triggered by lineside devices running on a 24V or 32V DC source. As the wagons in a rake pass by the triggering devices, their doors open and their contents are unloaded into the pits below the tracks (the 'merry-go-round' system). The versions used by the power plants have 12 bottom doors, whereas IR uses variants that have 8 doors.

Extract from: http://www.irfca.org/faq/faq-stock2.html

Based on success of earlier designs system for Lignite, Holtec is designing another system for other materials such as coal, copper concentrates and rock phosphate. All these materials are quite difficult to flow and cause substantial amount of dust nuisance, accordingly the track hoppers are being designed.

The proposed wagon unloading system is quite simple, with underground hoppers and apron feeder installed for each wagon unloading track hopper. Typically about 7 to 8 minutes of time is required to unload one set of wagons, which include, wagon placement, connection of compressed air and unloading. If the system is designed with 4 hoppers, approximately 2 hrs are sufficient to empty out complete rake of 58 wagons. With more number of unloading hoppers, still better speed of emptying could be achieved. The system requires shore compressed air arrangement, which needs to be connected to the wagons and with one stroke the complete wagon gets emptied in a matter of seconds.

A general arrangement of track hopper has been shown in following figures:

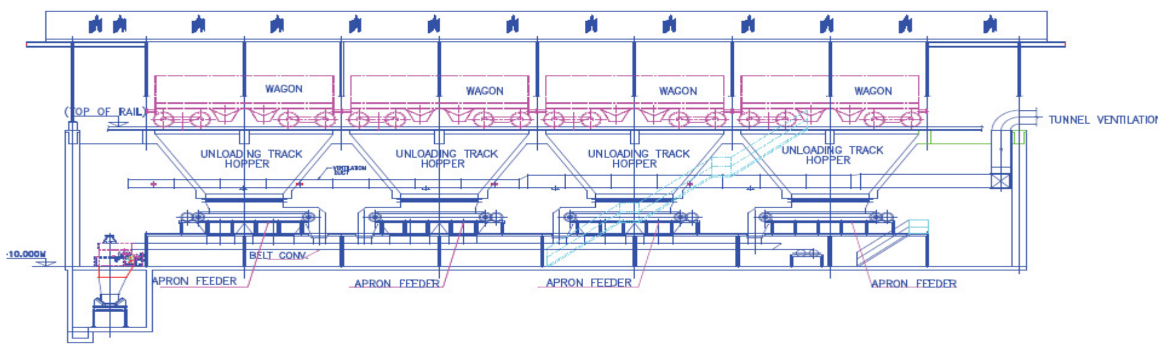

Fig-3A: Track Hopper Unloading System (Elevation View)

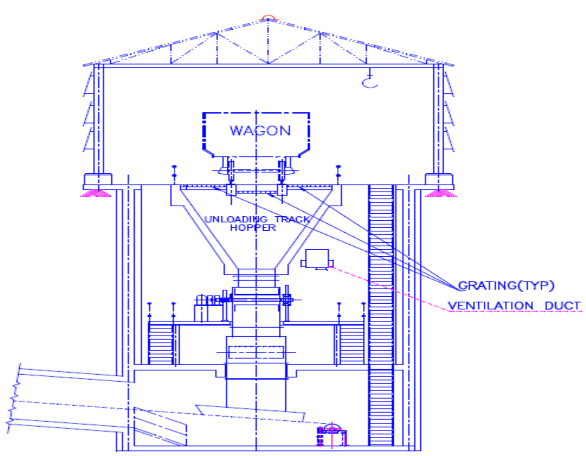

Fig-3B: Track Hopper Unloading System (Sectional View)

If the Industry insists for bottom discharge wagons from Railways, similar systems could be used in the industry, for coal and clinker unloading. The system proposed is quite simple, effective, fast and economical (not only on installation cost, but also on its operation).

2.2.1 Expected benefits

- ✓ The conventional system of un-loading (Wagon tippler) requires about 4 hrs for un-loading of one rake, whereas with proposed arrangement, the entire un-loading operation for one rake, could be completed in about 2 hrs. This 2 hrs saving on one rake, could result into substantially large annual savings, considering both clinker and coal movement by bottom discharge wagons.
- ✓ The total investment required for proposed system shall be substantially lower as compared to the wagon tippler especially of new design (G-33, Rev-01 May 2010).
- ✓ Reliability of the system shall be much better as compared to the wagon tippler.
- ✓ Dust nuisance substantially reduces as compared to the conventional systems.

2.2.2 Pre-requisites

Initially could be difficult for the industry to switch over to bottom discharge wagons, as railways have limited quantity of such wagons, but gradually they need to switch over. As many of the industry players are interested to go for their own wagons, it could be better to go for bottom discharge wagons rather than going for conventional BOXC / BOXN wagons.

2.3 USE OF WAGON TRAVERSER

As explained earlier, nowadays the trend is to go for large capacity clinkrization units, located close to the limestone deposit and construct split located grinding units nearer to the source of flyash (Thermal Power Plants). As majority of the thermal power plants are located closer to the densely populated areas, split located grinding units also get located in these areas. Due to high density of population in these areas, land is generally expensive and acquisition of adequate size of plot for such units is always a challenge.

As most of these grinding units are receiving clinker through railway rakes they need to install wagon tipplers. For the effective utilization of wagon tipplers and to meet the time allocated by railways for unloading, it becomes must to have sufficient space (equivalent to one rake length) before and after the wagon tippler. Therefore even though the total land requirement for the grinding unit is only 5 hectares, about 7.5 hectares of land need to be acquired only for railways. The plot size for the railways also becomes odd (Approx 50 m wide x 1500 m long). In our recent projects we have faced lot of problems on this account.

To tackle this issue one of the suppliers for wagon tippler came out with the solution of wagon traverser, immediately after the wagon tippler. Keeping in mind the limitations of land and confidence on designs, the wagon traverser are being installed in one of Holtec project.

After the wagon is unloaded on wagon tippler, side arm charger places empty wagon on traverser table, wagon is shifted to another rail track (Exit track) through a wagon traverser where pusher ejects out empty wagon from traverser to exit track. The enclosed arrangement drawing and photograph shows functioning of wagon traverser.

The wagon shifter works at the same speed as the wagon tippler and both these equipment work in tandem. This way the space requirement for the rail tracks reduces to almost half. However, one parallel rail track needs be constructed besides the track for removal of wagons.

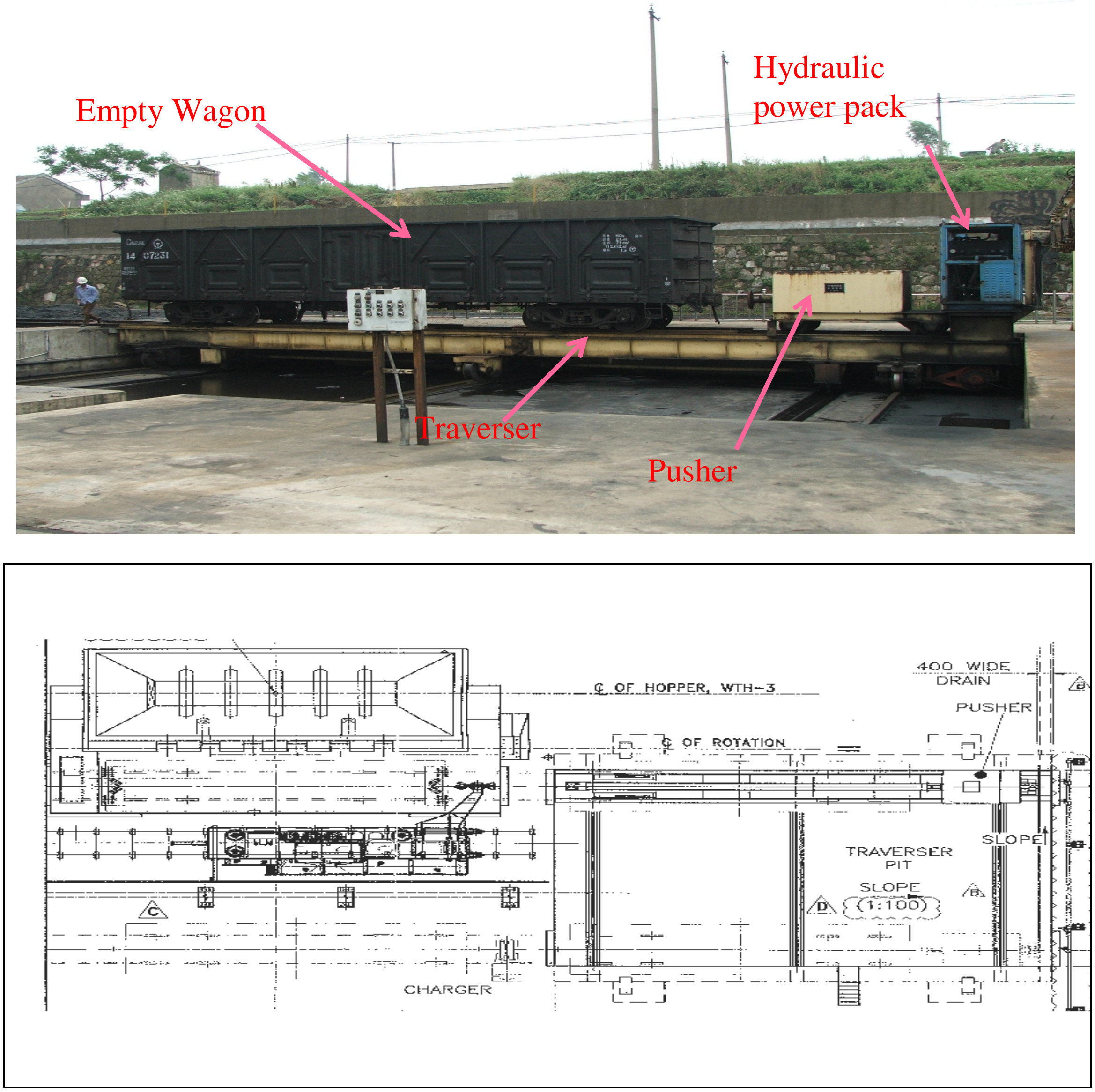

Fig-4: Typical Arrangement Wagon Traverser (Shifter)

2.3.1 Expected benefits

- ✓ Savings in land cost and veritable size of plot.

Benefits of wagon traverser are usually case specific, and in some of the cases, its inclusion could help the grinding unit greatly.

2.4 <u>FLY-ASH BLENDING:</u>

In last 2 decades of economic growth, shortage of electrical energy, government policies, have pushed private companies to enter into mega thermal power plants. These thermal power plants, along with existing ones are generating huge quantity of flyash.

As the biggest user of flyash (PPC production), cement producers are finding it lucrative to set up grinding units nearer to these power plants, but as majority of these power plants are located in densely populated areas or SEZs, cement producers find it difficult to do so. Hence many of the cement producers are forced to transport flyash for long distances. In certain cement clusters, demand for flyash also exceeds the supply, forcing cement producers to go to power plant, which are not nearest to them.

Such logistics have given substantial rise to bulk movement of clinker, flyash and cement. The cement producers, which are able to make use of both way transportation and are able to develop good logistics of material movement / optimize logistics of these materials, have been able to maximize their profits and sustain good growth.

In last 10 years, Holtec has done substantial work on the development of logistics of material movement in addition to the project engineering work for split located grinding units.

For one of the customer Holtec developed a flyash blending unit. Although the concept adopted was simple, but innovative and ultimately proved to be a successful venture.

2.4.1 Basic Concept

The entire concept of flyash blending unit is dependent on the fact, that flyash generated by power plant is usually of approximate 2,000 blaines. That means if the flyash is separated between coarse and fine fractions, we can achieve almost 50 % flyash, which could be straightway blended with the cement and rest is coarse fraction, which needs grinding with the cement.

2.4.2 Typical Usage of this concept

This concept is particularly useful for the cement producers, who bring in flyash from long distance (for example cement producers in north east bring flyash from a distance of approximately 1500 km of distance). If their flyash movement could be reduced to half (only coarse fraction) and on the other side of bulker movement, they carry OPC, they can substantially gain on cost of transportation. Many of the cement producers are in similar situation and are forced to transport flyash from long distances.

2.4.3 Flow diagram:

Following figure shows the typical mass flow diagram of the flyash blending unit:

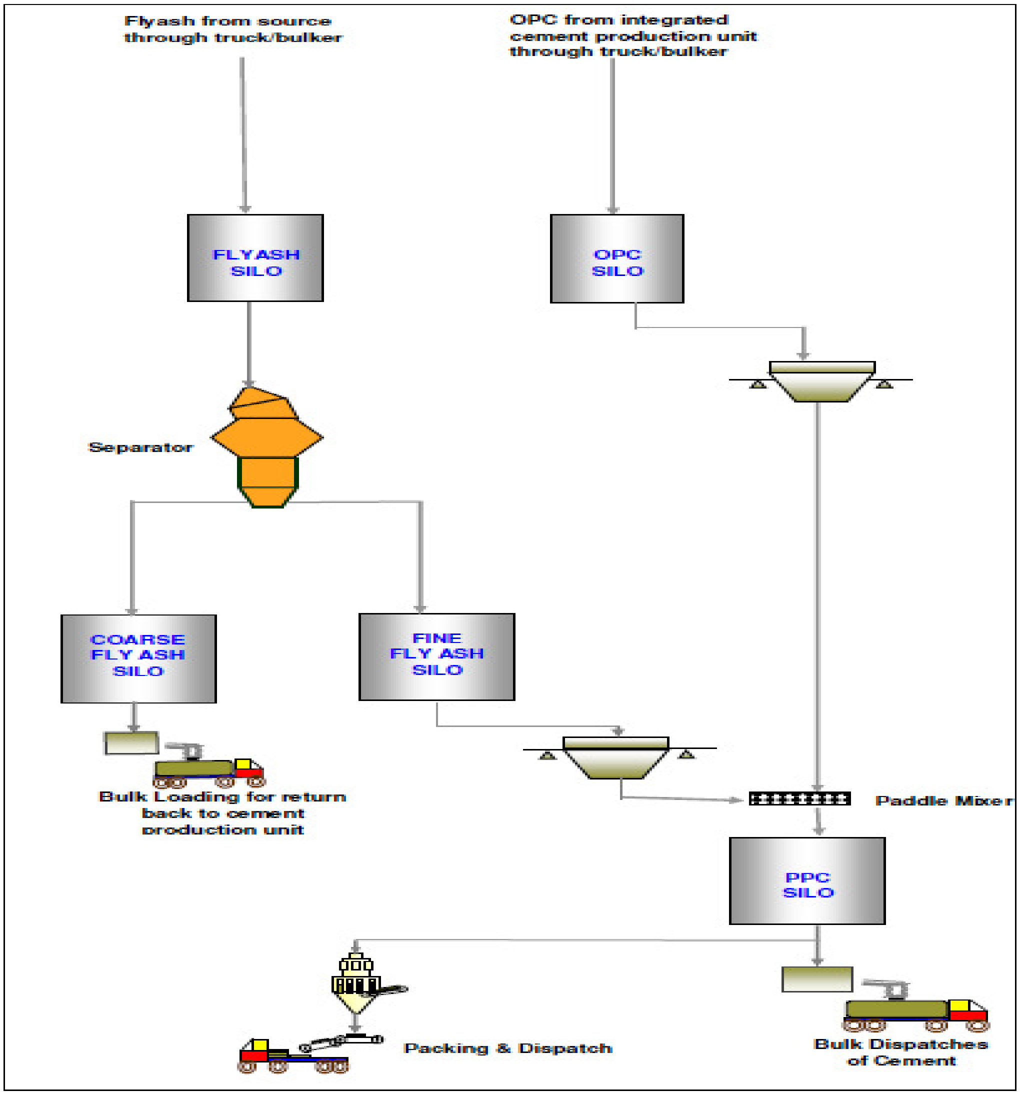

Fig-5: Typical Mass Flow Diagram of Flyash Blending Unit

2.4.4 Likely Benefits:

- ✓ Such units can substantially improve the cost of transportation of materials as explained above.
- ✓ The unit could produce very consistent cement production, as flyash quantity could be controlled effectively. In fact this also helps in maximization of flyash percentage into cement.

3. CONCLUSION

Development in material handling system is a dynamic process and an emerging area of research; in the view of definition of project "Completion of a unique activity in a specific time, cost and scope" selection of material handling system turn extremely imperative.

As a writer of this paper we have tried to cover certain innovative ideas, which could help industry adopt newer material handling concepts, we do believe that the primary purpose of this paper to make the people aware about new material handling concepts available and help to them in decision making for adoption of the same.

We can conclude that adoption of new material handling concept can:

- Reduce the investment cost and handling time.
- Reduce the number of equipment and dust generation.
- Make the system more reliable.

However adoptions of the new concept are mainly depends on the following:

- Case specific and vary with project requirement.
- Subjected to approval of respective Govt. bodies.