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Improvements in Material Handling: A Case Study of Cement Manufacturing Plant

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***Abstract*—**The globalization of the Indian economy has thrown a great challenge to the Indian industries in respect of productivity, quality, cost, delivery etc. Achieving success• the global market has required fundamental shift in the way business is conducted and has dramatically affected virtually every aspect of process industry. The internal manufacturing process and supporting infrastructure should be such that it can compete successfully in global markets with better flexibility and delivery.

The paper deals with a case study of a reputed process industry, some changes in the process has been suggested, which leads to reduction in labor cost and production cost.

***Keywords*—**Indian Cement Industry, Material Handling, Plant Layout.

I. Introduction

A good deal of effort is often required in moving material from one place to other. The handling is costly and adds nothing to the value of the product. Therefore, there should ideally be no handling at all. Unfortunately this is not possible. A more realistic aim would move material by most appropriate method and equipment at the lowest possible cost .This aim may be met by:

* Eliminating or reducing handling.
* Improving the efficiency of handling.
* Making the correct choice of material handling equipment.

Materials handling accounts for a significant portion of the total production cost. Workers and materials have to travel long distances in the course of the manufacturing process; this leads to loss of time and energy and nothing is added to the value of the product. Through effective plant layout analysis and design, much material handling operations can be reduced or eliminated. The choice of material handling methods and equipment is an integral part of the plant layout design. [2]

In many factories either the initial layout was not well through out or, as the enterprise expanded or changed some of its produce or, as the enterprise expanded or changed some of its products or processes, extra machines, equipment or offices were added wherever space could be found. In other cases temporary arrangements may have been made to cope with an emergency situation, such as the sudden increase in demand for certain product; but then these arrangements remain on a permanent basis even if the situation that provoked them subsequently changes. The net result is that materials an workers often have to make long, round about journeys in the course of the manufacturing process; this leads to a loss of time and energy without anything being added to the value of the product. Therefore need for improvement of layout.

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II. Case Study

XYZ Ltd. has different units in its campus. Installed capacity of various units are shown in Table 1, Cement plant of XYZ Ltd. was commissioned in 1987 to utilise the calcium hydroxide sludge coming from sister carbide plant. Earlier this sludge was being dumped into lagoons located its compound only. There were economic burden as valuable land was going waste and threat to environment. So, a decision was taken by the authorities to recycle this sludge from lagoons and convert it to cement. Owing to the moisture present in the sludge, the company had to opt for wet process plant [2].

William Aspidin first manufactured cement in England in the year 1848. Since, cement has become the most versatile building material of modem times. Today various grades of cement are available for a wide variety of application ranging from simple household construction to high temperature refractories. Cement is foundation of today's economies and states [3].

Chemically cement contains following constituents:

1. tricalcium silicate (C_3S) i.e. $3CaO.SiO_2$
2. dicalcium Silicate (C_2S) i.e. $2CaO.\ SiO_2$
3. tricalcium aluminate (C_3A) i.e. $3CaO.Al_2O_3$
4. tetracalciumaluminoferrite (C_4AF) $4CaO.Al_2O_3.Fe_2O_3$

TABLE I
INSTALLED CAPACITY OF XYZ LTD

Unit	Installed Capacity (tons/day)
Ammonia	720
Urea	1000
PVC Plant	100
Castic Soda Plant	120
Calcium Carbide Plant	170
Chlorine	25
Hydro Chloric Acid(100%)	75
Cement plant	850
Electric power	85 MW
Steam	234 t/hr

A. Overall Description of The Process

The major operations carried out in the plant are as follows:

- Crushing of limestone, coal, and other materials
- Storage arid blending of raw materials -

- Preparation of raw mix
- Raw mix grinding and homogenisation
- Pyro processing of raw materials in the kiln
- Cooling and storage of clinker
- Grinding of clinker with gypsum to cement
- Storage and dispatch of cement [1]

III. Observation

After deep study and observation of existing process, it is found that major problems are associated with the crushing section and packing section. So main emphasis is given on crushing section and packing section.

A. Problems with Crushing Section:

After observing the process for 46 days it is found that main problems are with the additional crusher i.e.: chocking of crusher, slipping of belt, causing long length of belt etc, Due to these problems maintenance cost, labor cost, cycle time is increased and operations experienced frequent stoppage.

B. Problems with Packing Section:

After deep study and long observation, It is observed that this packing section has scope of improvement. In the existing process bags are first transferred to small truck by belt conveyor and after that it loaded on the long truck.

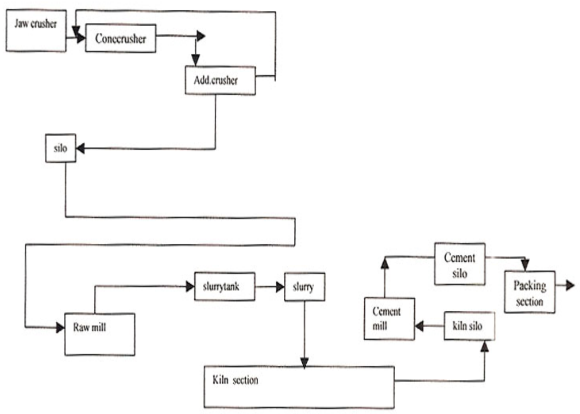

Fig.1 Existing process of cement manufacturing plant of XYZ Ltd.

TABLE II
BASIC SELECTION OF CRUSHER

Material	lime stone
Bulk density	1.6 TIM^3
Bond index	13-14
Lay content	5% by weight
May true content	1% by weight
Feed size	-(50) mm
Capacity	120 TPH
Return speed	1200 rpm
Drive arrangement	Through chain & driven pulley with V belts
Motor rating	132 kw 1000 rpm

EXISTING CRUSHER

Material to be crushed	lime stone
Bulk density	1.6 T/M^3
Hardness/work index	Work index 13-14
Surface moisture intent	1% by weight
Material temperature	Ambient
Crushed product size (mm)	- 25 mm
Minimum feed rate. TPH	180
Suggest no. of crushing stage and types of crusher	single open circuit

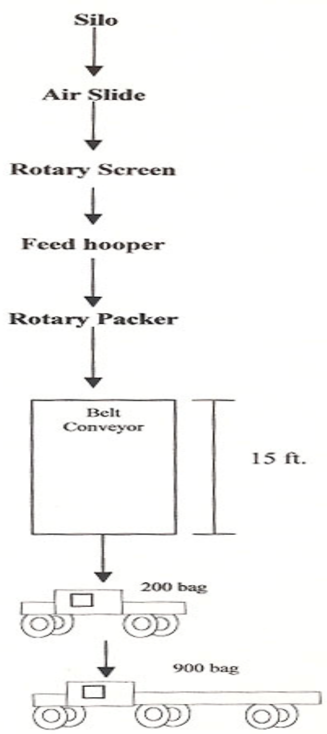

Fig.2 Flow diagram of existing packing process of XYZ Ltd.

IV. Packing section

In this section improvement efforts are discussed.

* Before Improvement

\# After Improvement

* The capacity of small truck is 200 bags, fIrst due to belt conveyor bags transfer to small truck and after that it loaded on the big truck. Time taken for this task is approx 1 hour, 12 workers performs this task at a time.

\# The position of belt conveyor is changed, now bags directly loaded on large truck. Time taken for this task is approx 40 min. 8 workers perform this task at a time.

Hence the time is reduced by 20 minute and 25% labour cost is reduced.

* All the plant machines were not installed at the same level. It used to cause great fatigue to the workers due to loading and unloading.

\# Now all machines can be installed at the same level and a platform is provided so that material can move on the

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platform. It reduces the fatigue and monotonous work on the part of worker. It also increases the efficiency and speed of processes

TABLE III
FLOW PROCESS CHART FOR PRESENT METHOD OF MANUFACTURING [4]

Flow process chart			Material Type		
Chart No:1 Sheet No :1	Summary				
	Activity		Present	Proposed	Saving
Subject charted :	Operation	⬭	15		
	Transport	⇨	18		
	Delay	D			
Activity: receive, check,inspect,store and transfer Method Present	Inspection	□	01		
	Storage	▽	03		
Location	Distance in meter		300		
Operative(s) Clock No.	Time (min.)		186		
	Cost				
	Labour				
	Material				
	Total				

Description	Qty (1case)	Distance	time	⬭	⇨	D	□	▽	Remark
Lime stone in jaw crusher				⊗					
Transfer through belt conveyor-C1			01		⊗				
Magnetic separator started				⊗					
Transfer through belt conveyor C- 2		90	01		⊗				
Crushed into cone crusher			02	⊗					
Exact reduced size lime stone inter into belt conveyor-c3			01		⊗				
Inexact lime stone inter into conveyor c-4		50	01		⊗				
Crushed in additional crusher			01	⊗					
Exact reduced size lime stone into belt conveyor C-5			01		⊗				
Vibrating screen			0.5	⊗					

		Meter	Min	◯	⇨	D	□	▽	
Transfer through belt conveyor c-3			0.5		⊗				
Reduce size lime stone transfer to silo through belt conveyor c-6		110	01		⊗				
Storage in silo								⊗	
Transfer through belt conveyor c-7			01		⊗				
Storage in the ground								⊗	
Use stacker for lime stone			01	⊗					
Crushed in tertiary crusher			02	⊗					
Transfer to grinding milll through belt conveyor			02		⊗				
Crushed lime stone enter into the grinding mill			05		⊗				
Lime stone change into slurry in raw mill			02	⊗					
Slurry enter into tank			02		⊗				
Mix in the tank			06	⊗					
Enter into kiln			01		⊗				
Make clinker			120	⊗					
Through bucket conveyor enter into silo			01		⊗				
Inspection of clinker							⊗		
Transfer clinker to cement mill			02		⊗				
Grinding them in cement mill			06	⊗					
Extra gypsum add in cement mill			02	⊗					
Cement powder transfer through belt conveyor into cement silo			02		⊗				
Store in the cement silo								⊗	
Due to rotary screen enter into feed hopper			02	⊗					
Due to feed hopper enter in to rotary packer			02	⊗					
Cement bag is formed			02	⊗					
Bag transfer through belt conveyor to			05		⊗				
Transfer to large truck by labour		50	10		⊗				
Transfer for sell					⊗				

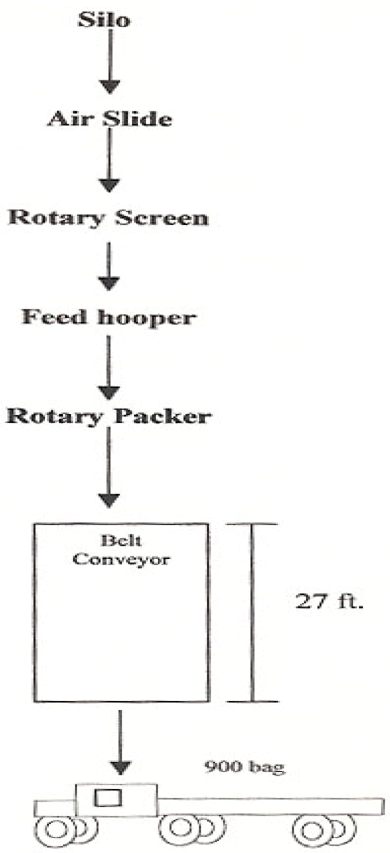

Fig.3 Flow diagram of proposed packing process of XYZ Ltd

V. Crushing section

In the crushing section we observe that maintenance cost is very high, process cycle time is high, labour cost is high, so we proposed to use a new crusher in place of presently installed crushers, which is selected due to the given basic selection of crusher. New crusher is explained below.

A. *"Hazemag Compound Impact Crusher"*

The Hazemag Compound Crusher is primarily a primary crusher but of a design that in effect does two crushing stages in one machine. The design is similar to that of the Hazemag Primary impact crusher however the crusher is equipped with a two impact rotors in one housing. The compound crusher performs the primary and secondary crushing duties in one stage with very high reduction ratios resulting in a very fine product grading obtained in the Compound Crusher in one pass.

Hydraulic gap adjustments, coupled to adjustable rotor speed enables a vide product granulometry range. Both rotors run independently and at differing speeds. In certain cases heating the impact aprons and inlet side plate eliminates any danger of the machine being clogged in wet sticky material. Excellent tramp relief mechanisms are facilitated by the ability of the impact aprons to retract on tramp entering the crushing chamber. The aprons move back to their original position in a matter of milliseconds.

The Compound Crushers are predominantly used in soft to medium-h d rock with relatively low $Si0_2$ content, similar to the Hazemag Primary Crushers, with feed size ranging from $1.5m^3$ to $2.8m^3$ at production rates of up to 2000 tons/hour, producing up to 95% < 25mrn in a single pass depending on material composition.

Hazemag Compound Crusher showing dual rotor configuration [5].

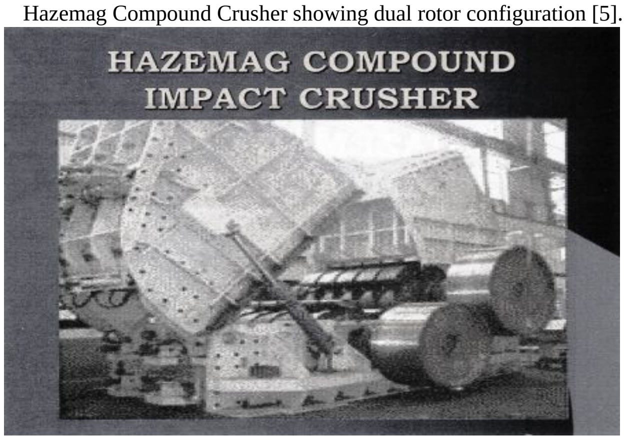

Fig.4 Hazemag Compound Impact Crusher

TABLE IV
FLOW PROCESS CHART FOR PRESENT METHOD OF MANUFACTURING [4]

Flow process chart				Material Type	
Chart No:03 Sheet No :03	Summary				
	Activity		Present	Proposed	Saving
Subject charted :	Operation	○	15	11	04
	Transport ation	⇨	18	11	07
	Delay	D			
Activity: receive,check, inspect & store Method Present	Inspection	□	01	01	
	Storage	▽	03	03	
Location	Distance in meter		300	04	260
Operative(s) Clock No.	Time (min.)		186	167	19
	Cost				
	Labour				
	Material				
	Total				

Description	Qty (1case)	Distance	time	○	⇨	D	□	▽	Remark
Lime stone in double impact crusher				⊗					
Reduced size lime stone transfer to silo through belt conveyor C-6		20	01		⊗				

		Meter	Min	○	⇨	D	□	▽	
Storage in silo								⊗	
Transfer through belt conveyor c-7			01		⊗				
Storage in the ground								⊗	
Use stacker for lime stone			01	⊗					
Crushed in tertiary crusher			02	⊗					
Transfer to grinding wheel through belt conveyor			02		⊗				
Crushed lime stone enter into the grinding mill			05		⊗				
Lime stone change into slurry in raw mill			02	⊗					
Slurry enter into tank			02		⊗				
Mix in the tank			06	⊗					
Enter into kiln			01		⊗				
Make clinker			120	⊗					
Through bucket conveyor enter into silo			01		⊗				
Inspection of clinker							⊗		
Transfer clinker to cement mill			02		⊗				
Grinding them in cement mill			06	⊗					
Extra gypsum add in cement mill			02	⊗					
Cement powder transfer through belt conveyor into cement silo			02		⊗				
Store in the cement silo								⊗	
Due to rotary screen enter into feed hopper			02	⊗					
Due to feed hopper enter in to rotary packer			02	⊗					
Cement bag is formed			02	⊗					
Transfer to large truck by labour		20	05		⊗				
Transfer for sell					⊗				

At the last we discuss about the present and proposed methods, and the benefits of proposed methods are highlighted.

TABLE V
DISCUSSION

Present	Proposed
Distance traveled by material from jaw crusher to crushed lime stone silo 300 meter	Distance traveled by material from new crusher to crushed lime stone silo 40 meter
Cycle time from crushed lime stone to cement 186 minutes.	Cycle time from crushed lime stone to cement 167 minutes.
Distance traveled by cement bag 50 meters.	Distance traveled by cement bag 20 meters.
Cycle time for loading bag on truck 15 minutes.	Cycle time for loading bag on truck 05 minutes.
Maintenance cost for crushing section 7.5 lacks	Maintenance cost for crushing section 5.8 lacks.
Labour cost is high	Labour cost is reduced by 30%
Manufacturing cost is high	Manufacturing cost is reduced by 20%
It require more human efforts for handling of material	It require less human efforts for handling of material

This calculation is based on data given by the manager (R&D).

VI. CONCLUSION

During the study of the process of the cement manufacturing plant, existing processes are examined critically with method study & layout technique.

It is observed that the cement plant is not using optimum layout and there are chances for improvement. Various layout and method study tools are applied and flow process charts, flow diagram and existing layout has been prepared. New technologies are used to reduced maintenance cost, cycle time, space and energy consumption.

With the help of recorded observation and discussion with manager f the company, improved layout and flow process chart and new devices are suggested. The company has started implementing the proposed suggestions and following benefits are realized.

- Smooth and continuous flow of materials
- Efficient material handling
- Non productive activities are eliminated
- Cycle time is reduced
- Energy consumption is reduced
- Labour cost is reduced
- Cost is reduced
- Delivery scheduled is improved

Economy of human effort and the reduction of unnecessary fatigue

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